バングラデシュ人民共和国
首相府
バングラデシュ投資開発庁
バングラデシュ経済特区庁
産業省

バングラデシュ人民共和国 投資促進・産業競争力強化プロジェクト

ファイナルレポート
別冊資料（コンポーネント3）

2022年5月

独立行政法人
国際協力機構（JICA）

株式会社コーエイリサーチ＆コンサルティング
ユニコ インターナショナル株式会社
株式会社ワールド・ビジネス・アソシエイツ

経開
JR
22-097

バングラデシュ国
投資促進･産業競争力強化プロジェクト

ファイナルレポート
別冊資料（コンポーネント 3）

目　次

IV. コンポーネント 3

IV. コンポーネント 3

1. 対象産業の現状調査結果

別冊資料１：対象セクター現状調査に係る詳細報告書

1. 目的

本調査の目的は、a）サプライチェーンを含む対象セクターの全体像を把握すること、b）両セクター企業の能力、課題及び支援ニーズを主に外資系企業[1]とのリンケージ創出・強化という観点から確認すること、及び c）同じくリンケージ創出・強化の観点からアクションプランにおける支援対象企業としての有望企業（以下、「有望企業」と呼称。）を発掘することである。

2. 活動内容

本調査は、a）文献やインターネットによる調査、b）現地コンサルタント企業に再委託した企業調査（以下、「再委託調査[2]」と呼称。）、及び c）プロジェクトチームとカウンターパート機関による企業調査（以下、「訪問調査」と呼称。）の 3 つの方法で行った。

再委託調査では、2017 年 8 月から 2 か月間、プロジェクトチームが作成した質問票に沿って、委託先企業が各セクター50 社に対してインタビュー調査を行った。一方、訪問調査では、同年 10 月から 12 月の間に 2 か月程度、各セクターの業界団体、ライトエンジアリング（以下、「LE」と呼称。）企業 42 社（金型企業 12 社を含む。）、プラスチック企業 29 社、プラスチック原料商社 2 社に対するインタビュー調査を実施した。これらの企業は、再委託調査の結果から有望と推察された企業及び業界団体・カウンターパート機関から有望企業候補として推薦された企業である。なお、LE 企業に関してはダッカ、ダッカ近郊、ジョソール、及びボグラに所在する企業、プラスチック企業についてはダッカ及びダッカ近郊に所在する企業に対する調査を行った。

3. 調査結果

ここでは本調査の結果を述べる。なお、再委託調査の結果の要約（英文）は別冊資料の 3 を参照ありたい。

3.1 LE セクター

(1) 企業の概要

1) 企業規模と主要製品

表 1 及び表 2 に、再委託調査と訪問調査における対象企業の規模の分類及び主要製品をそれぞれ示す。

両調査の結果を平均すると、調査対象企業全体のうち小企業以下の企業が 86%を占める[3]。

---

[1] 本文 2.3 節でも述べるが、リンケージ先候補セクターに関しては、2017 年 12 月より自動二輪車セクターに特化している。そのため、本資料でも「外資系企業」という用語は、基本的には「自動二輪車企業」を指す。

[2] 再委託調査の対象企業は、委託先企業の有するリストから従業員数グループ別に無作為で抽出された企業と、各セクターの業界団体から有望企業として推薦を受けた 20 社から構成された。ただし、後者については、有効回答を得られなかった企業もあるため、その分無作為抽出の企業が追加されている。なお、訪問調査と合わせると、調査対象全体の約 70%が有望企業候補の企業である。

[3] 業界団体である Bangladesh Engineering Industry Owners Association（BEIOA）からの聴取によれば、国内 LE 企業全体の

主要製品に関しては、本セクターの領域が幅広いため多岐にわたるが、金型以外については工作・建設機械や農業機器及びその部品が比較的大きなシェアを有する。また、企業内の製品の多角化は進んでおらず、再委託調査の結果では、全体の 4 割弱の企業が 100%、6 割強の企業が 80%以上の売上を主要 3 製品からあげている。少品種生産の実態は、訪問調査でも確認している。

表１　調査対象企業の従業員数による規模の分類

再委託調査			訪問調査		
規模（単位：人）	企業数	構成比	規模（単位：人）	企業数	構成比
家内工業（15 以下）	11	22%	家内工業（15 以下）	13	31%
零細企業（16-30）	9	18%	零細企業（16-30）	12	29%
小企業（31-120）	20	40%	小企業（31-120）	13	31%
中企業（121-300）	6	12%	中企業（121-300）	4	10%
大企業（301 以上）	4	8%	大企業（301 以上）	0	0%
合計	50	100%	合計	42	100%

注：従業員数による企業規模の分類は 2016 年産業政策による。

出所：再委託調査・訪問調査結果

表２　調査対象企業の主要製品

再委託調査		訪問調査	
製品	企業数	製品	企業数
機械・装置（特に工作・建設機械）	12	機械・装置（特に工作・建設機械）	7
ポンプ	10	ライナー・ピストン	6
ライナー	6	ポンプ	4
掘り抜き井戸	5	繊維機械部品	3
ボルト・ナット	5	ブレーキ部品	3
ギア	3	鉄道産業用部品	3
繊維機械部品	3	オイル/燃料フィルター	2
電気ケーブル	3	蛇口・流し台	2
自転車	1	破砕機部品	2
-	-	その他	6
金型	5	金型	12

出所：再委託調査・訪問調査結果

2) 従業員の特性

再委託調査結果によれば、半数以上の企業でエンジニア[4]が在籍せず、エンジニアが 3 名以下の企業が全体の 9 割近くを占める。全体の平均では、全従業員に占めるエンジニアの構成比は 2%程度に留まっており、セクターの性質が機械加工であることを考えれば、エンジニアが不足した状況が伺える。なお、企業規模と同構成比に相関は見られない。

また、高等教育を受けた従業員の構成比に関しても全体の平均で 5.9%、最頻値で 2%であり、国全体の高等教育機関就学率[5]の半分に満たない。この構成比と企業規模の間には正の

約 10%が従業員数 100 名以上（BEIOA の基準で大企業）、約 40%が同 41 名～99 名（中企業）、約 50%が同 40 名以下（小企業及び零細企業）である。

[4] 高等教育における機械工学を中心とした技術関連学位を持つ人材。

[5] 2014 年の数値で 13.4%。国際連合教育科学文化機関（UNESCO: United Nations Educational, Scientific and Cultural Organization）ウェブサイト（http://uis.unesco.org/country/BD）参照（2018 年 1 月 18 日）。

相関がみられる[6]。

訪問調査の結果でも、エンジニアや高等教育修了者の数は1社あたり0人〜3人程度が一般的であり、中等教育[7]を受けた人材を自社のOJTにより育てるという企業が大部分を占める。そのため、正式な教育・訓練を受けた従業員が少なく、材料、図面の読み方、寸法の測り方、機械の使い方、製品の仕上げ法などに関する正しい知識を有する人材に欠ける[8]。

なお、再委託調査によれば、社内訓練制度を有している企業は半数に満たない（40%）。

3) 売上

売上高に関しては多岐にわたるが、再委託調査の調査対象全体の70%強が1,000万タカ以上（2016年の実績）の売上をあげている一方、100万タカ以下という企業も12%ある。同年の従業員一人あたりの売上高については、異常値[9]を除いた全体の平均が117万タカであり、零細企業及び小企業の数値が比較的大きい[10]。

(2) サプライチェーン

以下に、本調査から把握したLEセクターのサプライチェーンについて、その上流部分から概要をまとめる。

1) 製品の開発

バングラデシュのLE企業は、研究開発に積極的ではない。基本的に、サンプルからのリバースエンジアリング生産か下請生産が主体のビジネスのためである。また、製品の図面を作成・使用する企業は少数派である。下請生産であっても、顧客から図面ではなくサンプルが提供され、それを基に製品を生産するというケースが多い[11]。

2) 原料・金型の調達

a. 原料の調達

a-1. 主要原料及び国内製鋼材調達

LEセクターがカバーする領域は非常に広いが、基本的には金属加工業が主体である。最も多く使用される原料は鉄と炭素鋼であり、とくに製鋼プロセス前の銑鉄や鋳鉄及び廃船からのスクラップ材を再加工した軟鋼が大勢を占める[12]。再委託調査によれば、主要製品の原料全体の30%近くが銑鉄・鋳鉄、20%弱が廃船スクラップ材を含む軟鋼である。合金鋼で最も多く使われているのはステンレス鋼と真鍮[13]で、それぞれ全体の6%、4%を占める。

---

[6] 全体の平均で、大企業では1社あたり23%、中企業で11%、小企業で3.8%、零細企業で5.8%、家内工業で1.1%、

[7] 前期中等教育が8年生まで、中期中等教育が10年生まで、後期中等教育が12年生まで。

[8] たとえば、訪問調査した企業によれば、自社の機械操作者はタイの機械操作者の1/4の回転数でしか作業を行えないという状況もある。つまり、機械の能力を最大限生かした生産活動が行われていない。

[9] より全体的な状況を示すため、最大値と最小値を除いた。

[10] 異常値を除いた平均値は、大企業で56万タカ、中企業で49万タカ、小企業で105万タカ、零細企業で124万タカ、家内工業で62万タカである。

[11] ただし、訪問調査を行った企業のうち2社は、合金鋼や金型の設計を含めたダイカスト品等の開発・設計を、自社だけではなく他社に向けても行っている。

[12] 鉄に炭素、シリコン、マンガン、リン、硫黄のみが含まれたものが炭素鋼。軟鋼は炭素鋼の一種で、炭素含有量が0.02%〜0.3%程度のもの。炭素の含有量が低いほど硬度も低くなり、軟鋼に焼入れ効果はない。

[13] 銅と亜鉛の合金で、亜鉛の構成比が20%以上のもの。

非鉄金属に関しては、アルミニウムと銅が多く各々9%、5%を占めるが、銅に関しては電気ケーブル企業のみが使っている。製品によっては、プラスチックやゴムなどの非金属材料も使われている。なお、訪問調査の結果でも同様な傾向を確認している。

原料の調達に関しては、国内の販売店から国内産の鉄や軟鋼を買うというケースが多い。再委託調査の結果では、全体の80%の原料が国内で調達されている。訪問調査した企業によれば、これらの鋼材でも顧客が求める場合には輸入材を使用することもある。

a-2. 輸入材調達

一方、硬鋼[14]、合金鋼、非鉄金属は、一部のスクラップ材を除き輸入材である。廃船のスクラップ材から硬鋼が作られないこと、バングラデシュには特殊鋼メーカーがないこと、冶金技術や合金鋼設計技術が低いことが主な理由である。中国製及びインド製が多く、再委託調査では全体の60%が両国製という結果がでている。

輸入は自社では行わず、輸入材を国内の販売店で購入することが一般的である。輸入する場合には、大量注文を行う必要があるためである[15]。しかし、購入したい輸入鋼材が国内市場で見つからないケースもある。その場合、類似の鋼材を購入するか、国内外商社をとおして輸入することになるが、輸入する場合は上記のような大量注文及び（中国からの輸入の場合）1.5〜2か月程度の納入期間が必要になる。

a-3. 材料性質加工

軟鋼には焼入れ効果がなく熱処理は行えない。訪問調査では、焼入れ効果のある硬鋼や合金鋼についても、硬度にばらつきがあること、熱処理が不十分であること、技術が不足しているため熱処理の効果が出にくいという意見が目立った。また、材料試験施設が不足しているという意見も多い。同試験を行える施設でも、費用が高いという意見もある[16]。

b. 金型の調達

再委託調査の結果では、全体の64%の企業が金型を使用しており、その多くが自社製を使っている。後述するが、そのほとんどは鋳造を行う企業である。表3に再委託調査の結果からみた金型の調達方法を整理する。

輸入元としては、中国が半数以上を占める。貿易統計[17]においても、ガラス加工用以外の金型の総輸入額（2015年の値で約7,800万米ドル）のうち64%を中国が占める。輸入されている金型のうち、輸入額ベースで56%がプラスチック金型、40%が主に鋳造用の金型、4%がプレス加工や引き抜き・押し出し加工等向けの金型（ダイ）である。ダイについては、インドからの輸入額が最大で、全体の38%を占める。

なお、国内製金型は、硬度の低い鋼材（廃船スクラップ材からの軟鋼）を使っているため長期間の耐久性を確保できず、ショット数で海外製に劣る。また、表面粗さの質も海外

---

[14] 炭素の含有量が0.3%〜2.1%程度の炭素鋼。焼入れ効果があり、焼入れにより硬度が増す。

[15] 訪問調査の結果によれば、硬鋼の場合で一回当たり5トンや25トン（1コンテナ）を注文しなければならない。とくに金型企業の場合は、多種の鋼材を少量使うため、直接輸入は経済的でない。

[16] 訪問調査結果によれば、被試験品にもよるが、一回150〜200米ドル程度になる。

[17] UN Comtrade Database（https://comtrade.un.org/data/）を参照（2018年1月19日）。プラスチック金型はHSコード848071及び848079、主に鋳造用の金型は同8480のうち848050、848071及び848079以外、ダイは同820720及び820730を参照した。なお、848071及び848079にはゴム加工用の金型も含まれる。

製に比して低いものになっている。

表 3　金型の調達方法

調達方法	回答企業数	構成比
自社製作	23	72%
輸入	7	22%
顧客からの提供	7	22%
国内金型企業からの購入	6	19%
親企業・関連企業からの提供	2	6%
国内金型販売店からの購入	1	3%
回答企業数合計	32	-

出所：再委託調査結果

3) 生産[18]

a. 生産形態

受注生産を行う企業が多数派であり、再委託調査の結果では、全体の半数以上の企業が90%以上の製品を受注してから生産しており[19]、見込み生産のみを行っている企業は 1 社にとどまる。

b. 加工と保有機械・設備

バングラデシュの LE 企業は、鋳造企業と切削加工を行う企業が大部分を占めており、プレス加工や鍛造を行う企業は少ない。再委託調査の結果では、最も多くの企業が使用する加工法[20]は鋳造（ダイカストを含む）である。その他は各種切削加工と溶接・ろう付けが多く、鍛造は 1 社、プレス加工は 0 社である[21]。

一方、保有機械・設備に関しては、切削用の汎用機械が大部分を占める。前述したダイの輸入額の構成比を含めて考えても、LE セクターにおけるプレス加工や鍛造のプレゼンスが小さいことが分かる。表 4 に、再委託調査結果からみた、LE 企業の加工法と保有機械・設備を整理する。

CNC 機械や放電加工機などの自動機械を有している企業は非常に限られており、ほとんどの企業は古い汎用機械を使っている。訪問調査を行った企業も大部分が古い汎用切削機械を使っており、据付数も 20 台に満たない企業が大勢を占める。また、プレス加工を行っている企業は 3〜4 社であり、鍛造を行っている企業及び CNC 機械を有している金型企業以外の LE 企業はなかった。鋳造企業以外は少量生産を行っている実状がうかがえる。

また、旋盤センタの芯がぶれている企業、溶接機の溶接トーチの先端が変形している企業がほとんどであり、設備メンテナンスが不十分な状況にある。加えて、機械の刃物の再研磨が行われていない、あるいは行われていたとしても精度が低い状況を確認している。

---

[18] 生産量、リードタイム、価格についても調査を行ったが、製品が多岐にわたるため全体的な分析が困難であることから、ここでは結果について記載しない。これらの結果については、アクションプランにおける個別企業の支援活動において活用する。

[19] また、全体の 80%弱の企業が 80%以上の製品を受注生産している。

[20] 主要 3 製品に使う加工法であり、当該企業が使うすべての加工法ではない。

[21] ただし、後述の保有機械をみると 5 社がプレス機械を保有している。また、最も多くの企業が保有する機械は旋盤であり、実際には旋削加工を行っている企業は調査結果より多いものと推測される。

表 4　加工法と保有機械・設備

加工法			保有機械・設備		
加工法	回答数	構成比	保有機械	回答企業数	構成比
鋳造	46	34%	旋盤	38	76%
研削	20	15%	研削盤	16	32%
溶接・ろう付け	18	12%	形削り盤	13	26%
ダイカスト	15	11%	ボール盤	10	20%
旋削・フライス加工	14	10%	フライス盤	9	18%
熱処理	10	7%	プレス機械	5	10%
鍛造	2	2%	溶接機	5	10%
その他	11	8%	断裁機	4	8%
-	-	-	その他	-	-
回答数合計	136	100%	回答企業数合計	50	-

注：加工法の「その他」には、放電加工及びレーザー加工が各 1 回答、他はプラスチック加工等。
保有機械・設備の「その他」は多数あるが、主要な加工機械・設備としては、放電加工機、圧延機及び誘導炉が各 2 社、CNC フライス盤、放電加工機及び自動メッキ槽が各 1 社など。
出所：再委託調査結果

c. 生産現場と品質

c-1. 生産現場

プロジェクトチームは、訪問調査を行った企業に対して、3S、及び 7 つのムダ[22]に関する簡易診断を行った。その結果を表 5 に示す。

表 5　3S・ムダ診断の結果

診断項目	点数（100 点満点）
3S	12.4
動作のムダ	16.5
在庫のムダ	20.3
不良をつくるムダ	22.6
つくりすぎのムダ	24.2
加工そのもののムダ	30.9
手待ちのムダ	34.2
運搬のムダ	39.8

注：点数は、各診断項目にいくつかの基準を設け、各基準に対してプロジェクトチーム専門家が点数をつけ全ての基準の点数を合計し、全社の平均をとったもの。点数が高いほど優良な状態を示す。
出所：プロジェクトチーム

結果から分かるとおり、全項目について 40 点に満たない点数がついており、3S の導入やムダの排除、あるいは生産現場のカイゼンは進んでいない[23]。とくに、3S、及び動作・在庫・不良をつくる・つくりすぎのムダの各数値については 25 点未満である。ダッカ市内の企業は作業スペースが非常に狭いが、そうした制約条件のなかでも可能な限り効率的な生産活

---

[22] 「つくりすぎ」、「運搬」、「不良をつくる」、「在庫」、「加工そのもの」、「動作」、「手待ち」の 7 つのムダ。

[23] プロジェクトチームの他国での経験から、通常は、まず現場における基礎的なカイゼン活動を行い、これらの数値がそれぞれ 60 点前後でバランスがとれるようになった後、管理技術・生産技術・製造技術に係るより高度なカイゼンを伴う企業力強化支援に移行すると、支援の効果が高くなる。

動を行おうという努力はみられない。なお、5S やカイゼンについてはほとんどの企業が知らないか、知っていたとしても導入はしていないという状況を確認している。

c-2. 品質

訪問調査を行った企業には、a）サンプルを見本に生産する、b）サンプルから図面を作成して生産する、及び c）図面の提供を受けるあるいは自社で作成して生産する、の 3 つの生産形態がある。大部分は a）の企業[24]であり、図面で指定された条件を満たすことが品質要求を満たすという認識がない。次いで多い企業は b）であるが、寸法・幾何公差に関する理解に欠ける。もっとも少ない c）には公差を理解している企業もあり、材料・製品試験を行うことで品質を保証している企業もある。しかし、c）の企業でも、仕掛品を投げて次の行程へ送ったり、製品を積み重ねていたりしているのが現状である。再委託調査の結果では、計測機器を保有している企業は全体の 4%、カイゼンを含む品質向上活動を行っている企業は 2%にとどまる。

なお、再委託調査及び訪問調査の対象企業で ISO 9001 を取得している企業は 7 社（全体の 8%）であるが、うち 5 社は自転車企業と電気ケーブル企業である。また、Bangladesh Standards and Testing Institution（BSTI）の工業規格は、LE 製品についてはほとんど開発されていない。

一方、現在の LE 企業の市場が求める品質は高くはないこともあり、製品の不良率は、再委託調査の結果では、全主要製品の平均・最頻値とも 5%程度である。ただし、訪問調査において同じ質問をした結果から、この数値は客観的なデータに基づいたものではなく、感覚的な数値である可能性が高い。

d. 製造原価

訪問調査の結果によれば、一般的に、製造原価のうち材料費が 60～70%を占める。工場従業員の月給[25]は、汎用機械の操作者で 1 万～2 万タカ、熟練溶接工で 3 万～4 万タカであるが、CNC 機械の熟練操作者になると 5 万～10 万タカ、国内では採用することの難しい CNC 機械の熟練保守・修理職員だと 10 万～12 万タカに達する。他の対象セクターであるプラスチックセクターよりも給与水準が高い。

一方、ほとんどの LE 企業は工場機械の減価償却費を製造原価として考慮していない[26]。なお、機械を動かす電気料金が高いという意見が多い。

e. 金型の生産

金型企業については CNC 機械を保有している企業を優先して訪問調査したため、12 社中 11 社において、各社 2～6 台の CNC 機械や放電加工機が設置されている状況を確認した。ただし、故障している機械も多く見られる。

また、金型製作に必須となる旋盤、研削盤、ラジアル盤、フライス盤、CNC 機械、放電

---

[24] BEIOA からの聴取によれば、LE 企業全体の約 90%は図面を理解する能力あるいは使用する習慣がない。

[25] BEIOA からの聴取結果より。

[26] CNC 機械の価格については、種類にもよるが、一般的には中国製で 250 万タカから 700 万タカ程度、インド製で 1,000 万タカ程度、日本製やドイツ製だとさらに高くなる。

加工機等をすべて保有している企業は 2 社である。一貫生産は行わず、他社との水平分業により金型を製作するというのが一般的といえる。

なお、LE 製品向けの金型を製作している企業は 4 社にとどまる。主に鋳造企業向けである。その 4 社のうち、2 社がプレス金型を製作しているが、鍛造用金型は製作していない。

大部分の金型企業は主に日用雑貨、容器、ハンガー、各種ブロー製品等向けのプラスチック金型を作っている。平面的な形状の加工深さの少ない金型が大勢を占める。一方、鋼材の問題からショット数や表面磨きの質が海外製に劣ること以外にも、生産・品質管理における多くの課題がある。これらの課題は下記「(3) 課題」にて詳述する。

4) 市場

a. 国内・海外市場

バングラデシュの LE 企業の市場は、ほぼすべてが国内市場である[27]。再委託調査の結果では、海外市場に製品を卸している企業は 50 社中 2 社であり、これらの企業でも国内市場のシェアが 80%程度になっている。また、うち 1 社は従業員 3,000 名を有する自転車企業であり、LE 企業の一般的な事情とは異なる。訪問調査においても、ほぼすべての企業が国内市場を対象にしていることを確認した。

b. 製品の用途と供給

製品の用途（どのような製品の部品になるか）に関し、再委託調査の結果を表 6 に示す。

表 6　主要製品の用途（何の部品になるか）

用途（何の部品となるか）	回答数	構成比
工作機械	24	17.6%
農業機械/機器	19	14.0%
電気製品/機器	15	11.0%
建設機械/機器	14	10.3%
家庭用品	13	9.6%
エンジアリング製品/機器	8	5.9%
製薬機械/機器	6	4.4%
包装機械/機器	6	4.4%
部品ではなく、最終製品	6	4.4%
自動車	5	3.7%
繊維機械/機器	4	2.9%
食品加工機械/機器	4	2.9%
製紙・印刷機械/機器	4	2.9%
列車/線路	3	2.2%
自動二輪車/CNC リクシャー	2	1.5%
自転車/リクシャー	2	1.5%
繊維製品	1	0.7%
合計	136	100.0%

出所：再委託調査結果

ただし、訪問調査の結果、これらの部品はそのほとんどが補修部品であることを確認し

---

[27] 自転車企業や電気部品が LE セクターに含まれると考える場合は、これらを除く。

ている。

また、過半数の企業が下請けにより顧客企業の製品の部品を供給しており、20%以上の企業が卸売店をとおして他社製品の部品を販売している。既述のとおり、その多くは補修部品である。表 7 に、再委託調査の結果から、LE 企業の製品供給の方法を示す。

表 7　製品供給の方法

供給方法	構成比
他社製品の部品を供給（下請けによる）	51.3%
他社製品の部品を供給（卸売店をとおして）	22.9%
他社製品の部品を供給（小売店をとおして）	6.8%
最終製品を卸売店をとおして販売	7.6%
最終製品を他社へ供給	5.3%
最終製品を小売店をとおして販売	2.0%
部品を補修部品市場で販売	1.6%
その他	2.5%

出所：再委託調査結果

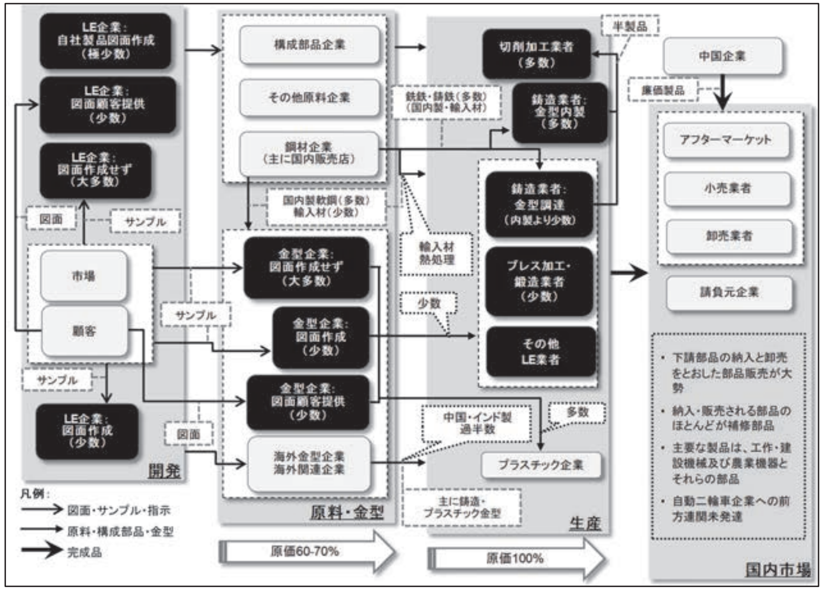
c. 市場の多角化

顧客の多角化は進んでいない。再委託調査では、売上高の大きい順に各社 3 つの顧客の回答を要求したが、全体の 30%近くの企業が顧客を 3 つあげることができず、22%の企業は 1 社のみ回答した。全体の平均では、1 社につき 51%の売上が上位 3 顧客からあげられている。

顧客の開拓方法については、他者からの紹介及び顧客候補への直接訪問が主流であり、それぞれ全体の 86%、76%の企業がこの方法をとっている。ただし、訪問調査の結果からは、新規顧客開拓のために積極的・能動的にマーケティング活動を行っている企業は非常に少ないという実状がうかがえる。

なお、再委託調査及び訪問調査双方の調査対象企業のなかで、本コンポネントのリンケージ先候補セクターとなる自動二輪車企業に対して、本報告書提出時点で部品を納入している企業は 1 社（チェーン組立企業）のみであり、その他 1 社（フィルター生産企業）の製品が受入検査中にある。

以上より、バングラデシュの LE セクターのサプライチェーンを図 1 に描く。



注：原価に機械・金型の減価償却費は含まれない。
出所：プロジェクトチーム作成

図 1　バングラデシュの LE セクターのサプライチェーン

(3) 課題

ここでは、本調査の結果から把握した本セクターが抱える課題を、とくに外資系企業とのリンケージ創出・強化という観点から考察する。

表 8 に、再委託調査と訪問調査にて企業が指摘した主要な課題及びプロジェクトチームが観察した課題をまとめる。また、表 9 に、再委託調査において、外資系企業とのリンケージ創出・強化における課題として企業が挙げた点を整理する。なお、再委託調査で企業が挙げた課題については、上位 10 項目のみを記載している。全体の結果については別冊資料の 3 を参照ありたい。

表 8　LE セクターの課題（事業一般）

企業が挙げた課題（再委託調査）	企業が挙げた課題（訪問調査）	プロジェクトチームが観察した課題
（選択方式による上位 10 項目） a. 短期融資アクセスの困難性（運転資金の不足） b. 長期融資アクセスの困難性（投資資金の不足） c. インフラの未整備（特に電力） d. 高い間接経費（特に電気代） e. 高額な輸入原料 f. 従業員給与の上昇 g. 顧客候補を知る機会の不足 h. 厳しい企業間競争 i. 従業員の低い技術 j. 通関手続きの煩雑さ	a. 融資アクセスの困難性（金利面、返済期間・猶予期間面、担保評価面など） b. 不安定な電力供給・高い電気代 c. 作業スペースの不足 d. 厳しい企業間競争 e. 需要の不足（小さな市場規模） f. 従業員の低い技術（機械保全・修理技術含む） g. 旧い生産機械（自動化不足） h. 低質な国内鋼材（高い輸入鋼材） i. 金型製作・管理技術の低さ j. 熱処理・材料試験・表面処理等の共同施設の不備	a. 事業性が低い生業的経営 b. 変化を望まない経営姿勢 c. 狭く劣悪な作業現場と物の流れの停滞 d. 3S・安全ルールの不徹底 e. 品質に対する認識不足（現市場の低い要求品質） f. 図面の理解力・活用の不足 g. 生産能力を最適化するための知識・能力の不足 h. 金型の設計・加工・保守能力の不足 i. 在庫管理の欠如 j. 技術・市場情報の不足 k. 低質な鋼材

出所：再委託調査・訪問調査結果

表 9　LE セクターの課題（外資系企業とのリンケージ創出・強化）

リンケージ創出・強化をするうえでの課題		点数
1	外資系企業を知る機会及び接する機会の不足	111
2	市場情報の不足	60
3	契約に係る困難性	25
4	不定期な注文	23
5	なし	18
6	外資系企業が求める価格基準を満たす困難性	11
7	外資系企業が求めるコンプライアンスの遵守の困難性	10
8	外資系企業が求める品質基準及び品質管理レベルを満たす困難性	8
9	外資系企業が使用することを求める原料を調達する困難性	7
10	自社製品を売り込む困難性	7

注：点数は、企業が回答した 3 つの課題について、重要な順に 3 点～1 点に点数化し合計したもの。
出所：再委託調査結果

1) 課題の全体像

全体として、企業は内部環境よりも外部環境に係る課題を重視しており、再委託調査では、内部環境としての技術面に関する課題は重要な順にならべて 9 番目に現れる[28]。一方、リンケージ創出・強化についての課題でも、品質・費用・納期に関する課題は、マーケティングや市場情報に係る課題よりも重視されていない。

技術面の課題については、生産機械の古さが最大の要因とする企業及び生産技術よりも機械の保守・修理技術の不足がより重要な課題と認識している企業が多い。ただし、企業及びプロジェクトチームとも、正式な教育・訓練を受けた従業員が不足しているため、既存の生産能力を最大限活用する能力に欠けるという認識は共有している。

一方、プロジェクトチームが重要と考える図面の理解力・活用の不足については、企業側からは課題として認識されていない。基本的には自社製品の品質に自信を持っている、あるいは現在の市場が要求する品質を十分に満たしていると考える企業が大部分を占める。また、現在の市場の要求品質を満たすことで製品が売れるため、現状に満足している状況もうかがえる。ただし、補修部品市場に関しては、価格の低い中国製品の流入により競争が激しく、それが厳しい企業間競争という課題に結びついている。

企業からもっとも頻繁に挙げられた課題は、資金アクセスの困難性である[29]。作業スペースの不足や古い生産機械（自動化の不足）は、長期資金アクセスの困難性が解決を難しくしている一つの要因である。一方、作業スペースの不足から新しい大型の機械を導入できないという現状もある。加えて、作業スペースの拡大や機械の導入に係る設備投資を阻んでいる要因の一つとして、需要が小さいため設備投資資金の回収が難しいことを指摘する企業もある。訪問調査では、劣悪な作業環境や物の流れの停滞は、作業スペースが小さいため仕方がないという意見が多く聞かれたが、3S の未導入や安全ルールの不徹底が、それをさらに悪化させていると判断される。

インフラの未整備と高い間接費も企業に重視されているが、これは不安定な電力供給と高い電気料金によるものである。高額な輸入原料や低質な国内鋼材等の原料に関する課題、金型の設計・加工・保守能力の不足に関する課題は、企業及びプロジェクトチームとも重要な課題として捉えている。

次項より、上記の課題の全体像及び現状調査の他の結果を総合的に分析した結果、LE セクターが自動二輪車企業とのリンケージを創出・強化するうえで解決が必要と考える課題を、サプライチェーンに沿って詳述する。それらの課題は次のとおりである。

a. 原料に関する課題
  - 低質な国内製鋼材
  - 輸入鋼材調達の困難性

b. 金型に関する課題
  - プレス加工・鍛造用金型入手の困難性
  - 金型設計・加工に係る能力の不足

c. 生産に関する課題
  - LE 企業のプレス加工・鍛造経験の不足
  - 不十分な精度と低質な仕上げ
  - 生産管理・品質管理技術の知識と実施の不足
  - 機械の自動化の不足

d. 市場に関する課題
  - 外資系企業を知る・接する機会や情報の不足

e. 経営・財務に関する課題
  - 設備投資資金の不足

---

[28] 上表には記載されていないが、品質管理能力の不足、標準・認証の不足、品質検査機器の不足等の品質に関する課題は 20 番目以降に現れており、それぞれ 3 社からの回答にとどまる。

[29] 再委託調査では長期資金及び短期資金へのアクセスの困難性（設備投資資金及び運転資金の不足）が、それぞれ全体の 46%、42%の企業から挙げられた。

2) 原料に関する課題

サプライチェーンの最上流に位置する原料に係る課題は、これを解決しなければその下流にある課題を解決することも難しくする根本的な問題であるため、早急な対応を必要とする重要課題である。

a. 低質な国内製鋼材

国内製鋼材の硬度の低さやバラツキ、材料試験設備の不十分さ、熱処理設備・技術の不足、国内製合金鋼の不在と冶金技術の不足など国内製鋼材に係る課題が、LE 製品や金型の品質を低める大きな要因になっている。自動二輪車企業へ部品を供給すると考えれば、質の高い鋼材を輸入するか、国内製鋼材の質を高めるしかない。後者の場合は、多大な設備投資が必要となる[30]。

鋼材の質を加工目的や用途に応じて最適にするためには、材料性質加工が重要となるが、国内製鋼材の中心である廃船スクラップ材を用いた軟鋼には焼入れ効果がない。焼入れ効果のある硬鋼や合金鋼の熱処理を行う場合でも、適切な材料試験がなされていないことに加え、材料組成に適した条件で熱処理を行うための知識と技術に欠ける。また、現状では、企業が熱処理を行える共同施設はなく、BITAC やバングラデシュ工科大学等に委託する企業もあるが、料金が高いとの意見も多い。さらに、バングラデシュでは合金鋼設計や冶金の技術が低いため、スクラップ材から（金型用に）少量の合金鋼を造ることも難しい。

顧客から鋼材の提供を受けるという考えもあり、実際に提供を受けている企業もあるが、その場合利益率が低くなり、また、持続的な国内産業振興を支える能力が育たない。

国内製鋼材の抜本的改善には多大な時間と投資が必要になるが、少なくとも材料組成の知識、熱処理・表面処理の知識・技術、材料試験設備、合金鋼設計に関する知識・技術に係る課題については、現実的な対応策を検討できる課題である。

b. 輸入鋼材調達の困難性

現状では、自動二輪車企業へ部品を供給するのであれば、国内製鋼材を使うことは現実的ではない。しかし、輸入鋼材は国内製鋼材よりも価格が高い。また、鋼材を輸入する場合は大量注文及び 1.5～2 か月程度の納入期間が必要になる。これらの制約から、個別の LE 企業にとって海外からの直接輸入は現実的ではないため、通常は国内の販売店から購入する。しかし、特定の輸入鋼材が国内市場で見つからないケースも多いため、類似した輸入鋼材を国内で購入することもある。この場合、材料組成の適性が低くなる。また、一般的には、複数の企業による鋼材の共同輸入は行われていない。これらのため、個別企業にとってニーズに合わせた輸入鋼材の調達は、直接輸入であっても国内市場からの購入であってもそのハードルは高い。

3) 金型に関する課題

金型は LE セクターに含まれると同時に、プラスチック製品の基礎となる。両対象セクターの製品の品質・価格・納期に非常に大きな影響力を有するため、自動二輪車企業とのリンケージ創出・強化のためには、金型部門の課題を解決することが非常に重要である。

a. プレス加工・鍛造用金型入手の困難性

バングラデシュの金型企業は主にプラスチック金型を作っており、LE 製品向けの金型、とくに、プレス加工用や鍛造用の金型を製作できる企業が少ない。これは、国内にプレス加工や鍛造を行う企業が少ないことも要因であるが、逆に、金型を入手できないため LE 企業がプレス加工や鍛造を行わないという現状もある。自動二輪車企業とのリンケージ創出・強化を図るのであれば、プレス加工・鍛造部品の生産が必要になるが、プラスチック金型とプレス・鍛造用金型では使われる鋼材も加工技術も異なる。

金型企業自体に経験や技術の不足があること、及び技術支援機関である BITAC のプレス・鍛造部門及びこれらの金型製作部門が他部門（特に切削加工部門）に比して設備や技術が十分でないことなどにより、プレス金型や鍛造金型の製作能力を短期間で向上させることは難しい。

一方、輸入金型については、中国製を例にすると、国内製と比べて 2 倍弱程度の価格と約 2 か月の納入期間が必要となる。さらに、金型の輸入には 20%～22%の輸入関税がかかる[31]。これらは、自動二輪車企業への部品供給の促進を図るうえで、輸入部品に比した納期や価格に係る国内部品の比較優位性を低める要因となる。

b. 金型設計・加工に係る能力の不足

前述のとおり、国内製金型は、硬度の低い鋼材を使っているため長期間の耐久性を確保できず、ショット数が海外製に劣る。また、上記 2）で示したように、金型の製作には多品種少量の鋼材が必要であるため鋼材を輸入することが現実的ではない一方、国内販売店で入手できる輸入鋼材の種類は限られているため、特定された輸入鋼材を調達することは容易ではない。これらに加え、金型の生産・品質を高めるために必要な設計・加工に関する能力について、次に示す問題が存在する。

- 設計から試作評価までの工程設計がなされていない
- サンプルから金型を製作している（図面が読めない・作成できない）
- 金型構造設計・部品図設計・加工工程設計等がなされていない
- 複雑な形状を設計・加工する能力に欠ける
- 製作前の金型の品質評価ができない
- 冷却回路・ガスベント加工が十分でない
- 表面磨きの質が低い（加工面が粗い）
- 加工仕上がり品を計測していない・測定機器を有していない

自動二輪車部品を納入する LE 企業やプラスチック企業に国内製金型を使ってもらうには、輸入金型に比して優位性のある価格や納期を維持しながら品質を向上させていき、顧客に

---

[30] ただし、金型については多品種少量の鋼材が必要となるため、合金鋼の設計・生産能力を高めることで、多大な設備投資が伴わなくても解決が不可能な課題ではない。

[31] 産業省からの聴取結果より。

よる品質・価格・納期に係る総合的な比較分析において、輸入金型に対する比較優位性を認めさせる必要がある。

4) 生産に関する課題

本文2.3節に示すように、自動二輪車企業の調達ニーズとLE企業の能力とのギャップは、LEセクターの生産に関する課題が主に生み出しており、前者が部品の国内調達を進めない重要な原因の一つとなっている。上記金型と同様に、顧客による品質・価格・納期を総合した比較分析において、輸入部品に対する比較優位性を確保するためには、生産に関する次の課題を解決する必要がある。

a. LE企業のプレス加工・鍛造経験の不足

国内にはプレス加工や鍛造を行う企業は非常に限られている。金型の入手が困難という要因もあるが、これまでプレス加工や鍛造が必要な製品・部品市場を対象にしてこなかったという要因が大きい。しかし、自動二輪車部品をターゲットにするのであれば、鋳造や切削も必須の加工技術であるが、プレス加工や鍛造に携わる企業の数やそれらに係る技術力や経験を積み上げる必要がある。

一方、企業の経験が少ないなか、まずは公的な技術支援機関からの支援が期待されるが、既述したとおりBITACの当該部門の能力や設備は、他部門と比して十分でない。自動二輪車企業へのLE部品の納入を図るうえで、BITACを含めた技術支援機関のプレス加工・鍛造に係る能力や技術を向上させて、同支援機関からの企業に対する技術移転を大々的に進めるか、あるいは鋳造部品（切削加工による付随的加工を含む）にまずは特化した課題の解決を模索するかについて、アクションプランの実施に際して検討する必要がある。

b. 不十分な精度と低質な仕上げ

バングラデシュのLE企業には、正式な教育･訓練を受けた従業員が不足している。また、現在の市場の要求品質が高くはなく、その市場が要求する品質を満たすことで製品が売れるという状態にあるため、品質を高めるという意識に乏しい。そのため、機械の使い方、図面の読み方、寸法の測り方、製品の仕上げ方法などについての正しい知識と技術、及びそれらを改善しようとする意識が不足している。これらの要因が、製品の低い制度と低質な精度に結びついている。

とくに、高い精度と高度な仕上げを阻んでいる要因として、次の4点についての正確な知識・技術及び意識の不足が挙げられる。

・図面の読み方と使用

バングラデシュのLE企業には図面を使用する企業が少ない。図面のとおり製品を作ることは品質保証における最も重要な要素である。自動二輪車企業の部品ベンダーになるのであれば、この能力は前提条件となる。

・計測器の使用と校正

訪問調査を行った企業には、正確な寸法が測定できる企業はほとんど存在しない。計測は、加工物の品質に大きな影響を与える重要な要素である。とくに、測定具の取り扱い方法（保管、使用方法）と定期的な校正に係る知識と技術に欠ける。

・設備精度の校正

訪問調査した企業では、汎用機のセンタの芯がぶれている企業、溶接機の溶接トーチの先端が変形している企業がほとんどであり、設備メンテナンスが不十分な状況にある。自動二輪車部品に求められる高い精度を確保するためには、設備の精度を維持するための知識・意識・技術を向上させることが必須である。なお、バングラデシュでは、校正のレベルを評価し、認定できる機関や制度も不在である。

・工具の再研磨

上記3つの課題が克服できても、加工物に直に接する刃物の状態がよくなければ、品質の高い製品は生産できない。訪問調査した企業では、機械刃物の再研磨が行われていない、あるいは行われていたとしても精度が低い。要求される精度や仕上げのレベルが高くなるほど、研磨についても高度な技能が要求される。自動二輪車部品の生産ではCNC機械の必要性も高まるが、CNC機械を使用する際にこの課題はより重要となる。また、バングラデシュでは、日本の切削工具研削技能士のような技能検定制度はない。

これらについては、BITACにおいても正確な知識・技能や高い意識を持つ職員の数は限られており、前述の現市場の要求品質レベルから生まれる低い品質意識も考慮すると、現状のままでは解決が困難な課題である。

c. 生産管理・品質管理技術の知識と実施の不足

自動二輪車企業に対して継続的に部品を供給するためには、求められる品質を確保・維持し、決められた量の製品を決められた納期で供給し、求められる価格に基づいて利益を確保できる費用で生産を行う必要がある。また、その前提として、これら3つの側面において輸入部品との比較優位性を得て、自動二輪車企業から部品ベンダーとして認めてもらうことが必須である。

品質の確保には、上記の原料や金型に関する課題の解決に加え、生産部門における厳密な品質管理を行わなければならない。このためには、まず品質に対する意識を向上させる必要がある。

また、現在の自動二輪車市場は拡大する傾向にあるとはいえ、いまだ小規模な状態にある。そのため、自動二輪車部品の需要にも月々の大きなぶれが予想される。結果として、自動二輪車企業からの引き合いについても、各発注部品の量や納期、あるいは価格も含めて大きな変動があることが推測できる。このような顧客のニーズに合わせて生産を行うためには、厳しい生産管理システムを構築する必要がある。しかし、現在のバングラデシュのLE企業は、少品種少量生産を、要求度の高くない市場のニーズに合わせて行っているため、生産管理も緩い体制がしかれている。

生産・品質管理といっても幅広い管理活動を含有し、現状のLE企業の管理技術能力や経験を考えれば、高度で幅広い管理技術を最初から一度に導入することは現実的ではない。

以上を鑑みると、品質に対する意識を高め、厳しい生産・品質管理を継続的に行っていくことの第一歩として 5S やカイゼンが有効であるが、現状では、5S やカイゼン活動を導入している LE 企業はほとんど存在せず、また、セクター全体においてもその認知度は低い。

d. 機械の自動化の不足

基本的に、バングラデシュの LE 企業は、鋳造企業以外は少品種少量生産を行っている。現在の市場のニーズに合わせていることや、企業規模が小さいことに由来する部分もあるが、CNC 機械等の自動機械の導入が遅れていることも重要な要因になっている。また、品質のバラつきや精度・仕上げレベルの低さについても、手作業や汎用機械に頼る生産形態が大きく影響している。

最新の機械を導入すればすべての課題が解決するという意識を持つことは間違いであり、既存の機械の能力を最大限活用する技術を習得して限界生産を行ったうえで自動機械の導入を検討するということが重要である。しかし、自動二輪車部品の供給を図るうえで、顧客のニーズに基づいた生産量・品質・価格・納期を達成するためには、CNC 機械などの自動機械はどうしても必要になる。

ただし、この課題を解決するためには、後述するように、設備投資資金へのアクセスの困難性や作業スペースの不足に係る課題に対しても同時に取り組まなければならない。

5) 市場に関する課題

現在、LE 企業で自動二輪車企業へ部品を納入している企業は 1 社のみである。まず、顧客を開拓することが自動二輪車企業とのリンケージ創出・強化の前提条件となるため、解決することが必須の課題である。

a. 外資系企業を知る・接する機会や情報の不足

再委託調査では、外資系企業を知る機会・接する機会の不足、及び市場情報の不足が、外資系企業とのリンケージを創出・強化するうえで最も重要な課題として認識されている。一方、このような機会や情報の提供に関する公的機関による支援は十分ではなく、また、そのような機会や情報を能動的に得ようとする企業の努力はみられない[32]。基本的に、これまで LE 企業の顧客の多角化は図られておらず、新規顧客の開拓は LE 企業にとって比較的経験の少ない活動である。自動二輪車企業は LE 企業にとってまさに新たな顧客の候補であり、何らかの接触機会を創出したり、企業による能動的な顧客開拓活動を後押したりする公的支援がないままでは、解決が困難な課題といえる。

6) 経営・財務に関する課題

サプライチェーンを横断する課題として、経営・財務に関する課題も重要である。

a. 設備投資資金の不足

長期資金アクセスの困難性は、企業側が認識する最重要課題である。これまで述べてきた課題の解決、とくに新規機械の導入と作業スペースの拡大には、設備投資資金へのアクセスを改善することが非常に重要である。しかし、現状では、長期融資アクセスを支援する公的制度もなく、長期融資を受けることは困難であるというのが企業側の意見である。

現在の LE 企業に対する長期資金融資の金利は、都市部や工業地域に広い土地を持っている企業で 10～12%程度、小さな土地しか持たない企業では 17～19%に達し、平均では 13%台半ば程度になるのが一般的である。担保は基本的には所有地の評価額で審査され、機械など動産が担保として評価されることはあまりない。返済期間は 3～5 年、支払い猶予期間はなしというというケースが多い。これらが、長期融資へのアクセスを制限している要因となっている。

一方、資金アクセスに関する企業側の課題としては、会計基準に即した財務諸表などの決算書類が作成されておらず、銀行側からの審査に耐えないという状況がある。再委託調査の結果によれば、バングラデシュの会計基準に則って財務諸表を作成している企業は、50 社中 3 社にとどまる[33]。また、設備投資資金を自社で賄うだけの利益留保を継続していくための利益管理が十分とはいえない。

一方、運転資金向け短期融資に関する課題も重視されているが、これについてはすでに SMEF が無担保低金利融資を行っており、一定の融資実績がある。運転資金不足への対応については、財務管理・原価管理の徹底、適切な在庫管理の実施、売掛金の管理とモニタリング[34]、前払金の確保など、企業側による経営管理に係る方策の実施がより重要となる。

以上より、これまで考察した LE セクターの課題、課題間の関連性、課題群が生み出す影響を表 10 に整理する。

---

[32] ただし、中小企業一般を対象とした展示会の開催などのマーケティング支援は SMEF が行っている。ここでは、ある産業に特化した外資系企業と国内企業のマッチングに係る支援を述べている。

---

[33] これらの 3 社は、大規模な自転車企業と電気ケーブル企業であり、一般的な LE 企業の事情とは異なる。

[34] 訪問調査した複数の企業によれば、売掛金の回収には 1.5 か月～2 か月必要となる。

表 10　LE セクターの課題間の関連性と課題群の影響

製品の質を低める要因			
原料・金型のに関する課題		金型・生産に関する課題	生産に関する課題
低質な材料 低質な国内製鋼材 低質な廃船スクラップ軟鋼 熱処理技術・施設の不足 表面処理技術・施設の不足 材料試験技術・設備の不足 国内製硬鋼・合金鋼の不在 冶金技術の不足 合金鋼設計技術の不足 国内高炉製鉄所の不在 国内特殊鋼メーカーの不在 輸入鋼材調達の困難性 大量注文の必要性 共同輸入の欠如 高い価格と長い納期 国内市場での輸入鋼材種類の不足	**低質な金型** 低質な国内製鋼材 輸入鋼材調達の困難性 金型設計・加工に係る能力の不足 海外製金型の入手困難性 高い価格と長い納期 **不十分な精度と低質な仕上げ**	**プレス加工・鍛造用金型入手の困難性** プレス・鍛造金型製作技術の不足 プレス加工・鍛造を行う企業の少なさ 技術支援機関の技術・設備不足 LE企業のプレス加工・鍛造経験の不足 プレス加工・鍛造を行う企業の少なさ **プレス加工・鍛造用金型入手の困難性** プレス・鍛造品市場参入の未実績 技術支援機関の技術・設備不足	**不十分な精度と低質な仕上げ** **低質な材料** **低質な金型** 図面理解・作成能力の不足 測定技術・機器の不足 工具の研磨技術・意識の不足 設備精度の不足 正式な訓練を受けた人材の不足 品質管理技術の知識と実施の不足 品質に対する意識の不足 現市場への満足感 現市場の低い要求品質 劣悪な作業現場 3Sの未導入・安全ルールの不徹底 機械の自動化の不足 **設備投資資金の不足** 狭い作業空間 小規模な市場・需要
生産量・納期・費用を悪化させる要因	リンケージ創出の根本的制約となる要因	サプライチェーンを横断した課題の要因	
生産に関する課題	市場に関する課題	経営・財務に関する課題	
生産管理技術の知識と実施の不足 生産管理技術の不理解・経験不足 少品種少量生産の現状 現市場の低い要求生産量・納期 機械の自動化の不足 **設備投資資金の不足** 狭い作業空間 小規模な市場・需要 在庫管理技術の不足・不徹底 原価管理の不足 5S・カイゼンの認知不足・未導入 従業員の高い離職率	**外資系企業を知る・接する機会や情報の不足** 情報や接する機会の提供支援の不足 能動的なマーケティング活動の不足 顧客多角化の経験不足	**設備投資資金の不足** 長期資金アクセスの困難性 高い金利 担保評価の硬直性 短い返済期間 支払い猶予期間の未設定 財務書類の不備 利益管理の不在	**運転資金の不足** 短期融資アクセスの困難性 高い金利 担保評価の硬直性 財務書類の不備 財務・原価管理の不足 在庫管理技術の不足・不徹底 売掛金管理の不足 前払金受領の不足 高い自家発電コスト 不安定な電力供給 高い公共電気料金

注：下線は上記 2）～6）の各項内でタイトルとして示した課題。文字下げしてある課題は上に位置する課題の原因となるもの。
出所：プロジェクトチーム

(4) 支援ニーズ

表 11 に、LE 企業の支援に対するニーズを再委託調査の結果から整理する。なお、同表には上位 10 項目のみを記載している。全体の結果については別冊資料の 3 を参照ありたい。

表 11　LE セクターの支援ニーズ

必要な支援		点数
1	無担保融資の提供	187
2	低金利融資・利子補填の提供	151
3	設備投資向け特別目的融資の提供	43
4	技術情報アクセスに係る支援の提供	42
5	なし	31
6	市場情報（顧客情報を含む）アクセスに係る支援の提供	30
7	事業診断の提供製品	27
8	自社の問題の解決を支援できる機関及び専門家の紹介・斡旋	27
9	輸出手続きに係る研修・指導の提供	25
10	融資アクセスに係るコンサルテーションの提供	21

注：点数は、企業が回答した 5 つの支援について、重要な順に 5 点～1 点に点数化し合計したもの。
出所：再委託調査結果

LE 企業が持つ支援（BDS）に対するニーズは、上記の課題の解決策に対するニーズであるため、最大の課題と企業が認識する資金アクセスの困難性を低める支援が最も必要とされている。また、技術情報や市場情報に関する支援に対するニーズも比較的大きい。

一方、「なし」という回答が上位に来ているが、訪問調査の結果においても同様な回答が多く聞かれた。事業診断に対するニーズが一定程度あることからも、企業は支援が必要ないのではなく、何が問題であるかを分かっていない、あるいは問題を認識していてもその問題の解決ためにはどのような方策が必要であるかということを明確に理解していないものと推察する。

なお、訪問調査では、顧客候補への取次ぎや金型技術に係る支援に対するニーズを有している企業が比較的多いことを確認した。また、5S やカイゼンに関する支援に対して関心を有する企業も一定程度存在した。

3.2 プラスチックセクター

(1) 企業の概要

1) 企業規模と主要製品

表 12 及び表 13 に、再委託調査と訪問調査における対象企業の規模の分類及び主要製品をそれぞれ示す。

表 12　調査対象企業の従業員数による規模の分類

再委託調査			訪問調査		
規模（単位：人）	企業数	構成比	規模（単位：人）	企業数	構成比
家内工業（15 以下）	0	0%	家内工業（15 以下）	0	0%
零細企業（16-30）	1	2%	零細企業（16-30）	1	4%
小企業（31-120）	28	56%	小企業（31-120）	7	24%
中企業（121-300）	11	22%	中企業（121-300）	9	31%
大企業（301 以上）	10	20%	大企業（301 以上）	12	41%
合計	50	100%	合計	29	100%

注：従業員数による企業規模の分類は 2016 年産業政策による。
出所：再委託調査・訪問調査結果

再委託調査及び訪問調査の結果を平均すると、調査対象全体のうち小企業以上の企業が 97%、中企業以上の企業が 6 割近くを占める。バングラデシュには約 5,000 社のプラスチック企業があり、そのうち 98%の企業が中企業以下とされる[35]。本調査では、有望企業候補が調査対象全体の約 70%を構成しているため、とくに訪問調査には規模の大きな企業が多く含まれる。なお、プラスチック産業は資本集約型の産業であるが、訪問調査では、成形品の手直し作業（バリ取りやゲート[36]の仕上げ）、印刷等の二次加工工程、及び梱包作業に多くの人手を掛けている状況を確認した。

---

[35] Bangladesh Plastic Goods Manufacturers & Exporters Association（BPGMEA）「12th Dhaka International Plastic, Packaging and Printing Industrial Fair」（2017 年 2 月 15 日～18 日開催）資料より。規模の定義は不明。

[36] 製品に樹脂を流し込む入口で、成形後に成形品を切り取り、その切り取り跡を仕上げる作業が必要になる（例：プラモデルのフレームと部分品をつないでいる部分）。

表 13　調査対象企業の主要製品

再委託調査		訪問調査	
製品	企業数	製品	企業数
ペットボトル	17	家庭用品	8
家庭用品	17	飲食品・医薬品・化粧品等容器	7
飲食品・医薬品・化粧品等容器	12	ハンガー	6
ハンガー	9	キャップ	5
家具	6	家具	4
ポリ袋	5	ペットボトル	5
その他容器	5	パイプ・継手	3
ボビン	3	ポリ袋	5
玩具	2	塗料容器	3
自動二輪車部品	2	ボビン	3
その他	-	自動二輪車部品	2
-	-	水タンク	2
-	-	バッテリーケース	2
-	-	ボールペン	1
-	-	歯ブラシ	1

出所：再委託調査・訪問調査結果

主要製品は、家具を含む家庭用品、繊維産業用付属品、包装用品・容器、及びインフラ関連製品に集中している。業界団体の Bangladesh Plastic Goods Manufacturers & Exporters Association（BPGMEA）によれば、バングラデシュのプラスチックセクターには 27 のサブセクターがあるとされるが、企業内の製品の多角化は進んでいないのが現状である。再委託調査の結果では、全体 70%の企業が 100%、80%の企業が 8 割以上の売上を主要 3 製品からあげている。

なお、ハンガーは間接的輸出企業[37]、水タンク、パイプ、継手、家具などの大型機械が必要となる製品は大企業、家庭用品は小企業から大企業まで幅広い企業が生産している。

2) 従業員の特性

再委託調査結果によれば、全体の 30%強の企業でエンジニアが在籍せず、エンジニアが 3 名以下の企業が全体の 8 割を占める。全体の平均では、全従業員に占めるエンジニアの構成比は 1.3%に留まる。LE セクターと同様に、エンジニアが不足した状況がうかがえる。なお、企業規模と同構成比に相関は見られない。

また、高等教育を受けた従業員の構成比は全体の平均で 11%弱であり、国全体の高等教育機関就学率よりも約 2%低い。LE セクターの場合と同じく、この構成比と企業規模の間には正の相関がみられる[38]。

訪問調査の結果でも、エンジニアの構成比は平均で 2%程度である。また、熟練の機械操作者についても人材が不足しており、プラスチックセクター以外の企業に勤めていた機械操作者を中途採用し、OJT や社内訓練制度をとおして知識・経験を積ませていくというケースが多い。再委託調査によれば、社内訓練制度を有している企業は 6 割を超える。ただし、従業員の離職率が高く、訓練を施した従業員が長く会社に残らないため、熟練機械操作者が不足してしまうという現状がある。

3) 売上

比較的大規模な企業が調査対象となっているため、LE 企業に比して全体的に売上高も大きい。再委託調査では、全体の 6 割に近い企業が 1 億タカ以上、15%を超える企業が 10 億タカ以上の売上をあげており、100 億タカ以上の売上高を記録する企業も 1 社ある（2016 年実績）。一方、同年の従業員一人あたりの売上高については、異常値[39]を除いた全体の平均が 137 万タカであり、中企業の数値が比較的大きい[40]。

(2) サプライチェーン

以下に、本調査から把握したプラスチックセクターのサプライチェーンについて、その上流部分から概要をまとめる。

1) 製品の開発

訪問調査の結果によれば、バングラデシュのプラスチック企業の多くは、新製品を自ら開発するよりは、家庭用品やインフラ関連市場など旺盛な需要がある市場において売れ行きのよい製品を特定し、それを模倣することで自社製品を生産するという傾向が強い。資金力の豊富な大企業が海外で自社製品を製品化（金型作成）し、小企業はそれらのサンプルを参考に国内で安価な金型を手配したうえで商品化するというモノづくりのループが回っている。なお、家庭用品やインフラ関連製品以外のほとんどの製品は、他社からの下請生産である。

2) 原料・金型の調達

a. 原料の調達

a-1. 主要原料

表 14 に、バングラデシュのプラスチック企業が使用している原料を、再委託調査の結果から整理する。

バングラデシュのプラスチック企業が使用する原料の大部分は、ポリプロピレン及びポリエチレンを中心とした汎用プラスチックである。混合原料、工業部品に多く使われる耐熱性や強度に優れたエンジニアリングプラスチック、及び繊維強化プラスチックなどの複合材の使用はほとんど見られない。なお、訪問調査の結果でも同様な傾向を確認している。

---

[37] ここでは、輸出企業による輸出向け製品の付属品を卸す企業を指す。

[38] 全体の平均で、大企業では 1 社あたり 28.6%、中企業で 13.9%、小企業で 3.2%。

---

[39] より全体的な状況を示すため、最大値と最小値を除いた。

[40] 異常値を除いた平均値は、大企業で 109 万タカ、中企業で 194 万タカ、小企業で 122 万タカである。

表 14　プラスチック企業が使う主要原料

種類	回答数	構成比
ポリプロピレン（PP）	31	26.1%
塗料	27	22.7%
高密度ポリエチレン（HDPE）	14	11.8%
汎用ポリスチレン（GPPS）	6	5.0%
低密度ポリエチレン（LDPE）	6	5.0%
耐衝撃性ポリスチレン（HIPS）	4	3.4%
カルシウム	2	1.7%
その他	6	5.0%
種類不明（「プラスチック樹脂」との回答）	23	19.3%
合計	119	100.0%

注：HDPE: High Density Polyethylene
GPPS: General Purpose Polystyrene
LDPE: Low Density Polyethylene
HIPS: High Impact Polystyrene
出所：再委託調査結果

a-2. 輸入材の調達

プラスチック原料は、リサイクル材[41]を除いてすべてが輸入材である。これは、バングラデシュに石油化学工場が不在のためである。企業は、国内外の商社をとおして輸入するか、国内の販売店から購入することで原料を調達する。訪問調査の結果では、比較的大きな規模の企業ほど輸入調達を行っている傾向が見られる。

原料の発注に関しては、定期・定量の発注方式が一般的であり、在庫量や需要量にかかわらず、定期的に定量の原料を調達する企業が多い。また、原料が輸入材であること、国内物流状況が劣悪なことなどにより、安全在庫を多めに持つ意識が高い。これらのため、過剰な原料在庫を抱える企業が頻繁に見られる。

原料の輸入元は中東諸国及びアジア諸国が多い。再委託調査及び訪問調査の結果を総合すると、サウジアラビアが全体の 38%で最も多く、インド（26%）、タイ及び台湾（各 10%）、韓国（6%）、中国（4%）、UAE 及びシンガポール（各 3%）などが続く。

プラスチック原料の輸入価格（サウジアラビア製 CIF 価格）でもっとも廉価なものはポリ塩化ビニルで、トン当たり約 900 米ドルである[42]。PP は約 1,200 米ドル/トン、PE は 1,200～1,300 米ドル/トン、ABS 樹脂[43]で約 1,500 米ドル/トンである。アジア諸国製は、サウジアラビア製よりもやや高価になる。なお、サウジアラビアからチッタゴンへの輸送費は通常約 60 米ドル/トンであり、同国やアジア諸国からの納品には 1.5～2 か月を必要とする。

HS コードにもよるが、プラスチック原料の輸入には、国内市場販売向け製品の生産企業に対しては実効税率で 30%程度の輸入関税がかかり、海外市場向け製品の生産企業（保税倉庫扱い）は無税となる[44]。

---

[41] 再委託調査の結果からは、全体の 18%の企業がリサイクル材を使っている。訪問調査の結果より、リサイクル材は新材よりもやや廉価であり、主に色の濃い製品に使われている。

[42] プラスチック原料商社 2 社からの聴取による。他の輸入価格も同様。

[43] ABS 樹脂はアクリロニトリル（Acrylonitrile）、ブタジエン（Butadiene）及びスチレン（Styrene）で構成され自動二輪車の外装品などに使われる。

b. 金型の調達

訪問調査の結果から、基本的には要求品質の高い製品を加工する場合は海外製、高くない製品の場合は国内製が使われる。また、形状が単純で小型の金型については、自社で製作する企業も多い。表 15 に、再委託調査の結果からみた金型の調達方法を整理する。なお、訪問調査を行った企業については、金型は輸入により調達し、メンテナンスは自社で行うという企業が大部分を占める。

表 15　金型の調達方法

調達方法	回答企業数	構成比
自社製作	36	73%
輸入	35	71%
国内金型企業からの購入	16	33%
顧客からの提供	15	31%
親企業・関連企業からの提供	6	12%
国内金型販売店からの購入	6	12%
回答企業数合計	49	-

出所：再委託調査結果

両調査の結果では、輸入元としては中国が最も多く全体の 6 割以上、次いでインドが 15%程度を占める。前述のとおり、金型の輸入額全体の約 56%はプラスチック金型である。

訪問調査の結果によると、金型の種類や大きさにもよるが、国内製金型は、中国製の金型と比して 60%～80%の価格となる。国内製金型は、軟鋼を使っているため長期間の耐久性を確保できず、金型を使用する側の企業が中国製の金型を選んだり、金型企業に対して輸入鋼材の使用を求めたりするケースが多い。国内製に比して中国製の金型は 2 倍～5 倍、ときには 10 倍のショット数が得られるとされる。また、国内製の金型は、表面粗さの質も低いのが現状である。

一方、自社で設計した金型の切削を他機関に委託し自社で仕上げる、自社で寸法指定した鋼材を輸入して金型を内製する、新たに金型工場を立ち上げ CNC 機械を導入するなど、金型の自社製作の能力を向上させることに積極的なプラスチック企業もある。

3) 生産[45]

a. 生産方法と製品

受注生産を行う企業が多数派であり、再委託調査の結果では、全体の 70%の企業が 9 割以上、90%以上の企業が 8 割以上の製品を受注してから生産している。

b. 加工と保有機械・設備

バングラデシュのプラスチック企業の加工法は、射出成形とブロー成形が大勢を占める。

---

[44] 同上。

[45] 生産量、リードタイム、価格についても調査を行ったが、製品が多岐にわたるため全体的な分析が困難であることから、ここでは結果について記載しない。これらの結果については、アクションプランにおける個別企業の支援活動において活用する。

それに応じて、保有機械・設備についても、射出成形機とブロー成形機を大半の企業が保有している。表 16 に、再委託調査の結果から、プラスチック企業の加工法と保有機械・設備を整理する。

表 16　加工法と保有機械・設備

加工法			保有機械・設備		
加工法	回答数	構成比	保有機械	回答企業数	構成比
射出成形	81	68%	射出成形機	46	92%
ブロー成形	28	24%	ブロー成形機	29	58%
押出成形	4	3%	印刷機	7	14%
圧縮成形	2	2%	冷却機	4	8%
その他	4	3%	押出成形機	3	6%
-	-	-	包装機械	2	4%
-	-	-	回転成形機	1	2%
-	-	-	その他	-	-
回答数合計	119	100%	回答企業数合計	50	-

注：加工法は主要 3 製品の加工法であり、各企業が使用するすべてではない。加工法の「その他」には回転成形や各種金属加工法が含まれる。保有機械・設備の「その他」は多数あるが、主に金属加工機械や裁断機などである。なお、加工法で圧縮成形の回答があるが、圧縮成形機を保有するという回答はなかった。

出所：再委託調査結果

b-1. 加工法

訪問調査の結果からは、加工法に係る技術力については、ある程度高度で機能の充実した機械を有している企業が多く、それを一定のレベルで操作できる人材がいるため、現市場が求める製品を作るうえにおいては特段の問題は認められない。

一方、工業部品等の新たな領域へ製品を多角化するうえでは、その知識・技術は十分ではない状況を確認している。詳細は、下記「(3) 課題」にて述べる。

b-2. 保有機械・設備

保有機械・設備の現状に関する訪問調査の結果は次のとおりである。

機械の設置台数を確認した企業 26 社で、計 620 台の射出成形機が設置されている。1 社あたり平均で 24 台の射出成形機を保有していることになる。大部分が、中国製、韓国製、台湾製、あるいはインド製である。

型締力[46]については、100 tonf から 300 tonf が主力であり、30 tonf から 50 tonf の小型クラスは見られない。企業によっては、椅子成形用の 800 tonf クラス、パレット・コンテナ成形用の 1,300 tonf クラスの大型成形機も導入されている。これらの射出成形機はほぼすべてがトグル機構油圧式射出成形機であり、電動式射出成形機は 1 社のみで導入されている。

射出成形機に次いで多いのが、押出ブロー機（92 台）、PET ブロー機（50 台）である。また、特殊な成形機として、キャップ成形用二色成形機（2 台）や多層押出真空成形機（3 台）の設置を確認した。

製品取出システムは、自動落下方式と手取り方式が半々程度である。ただし、1 社は、製品取出機を使用して、塗料容器を全自動成形している。二次加工の印刷については、簡易的なものを含めすべての企業で装置が設置されている。最新の熱転写の印刷システムを導入し、塗料容器のフィルム作成・印刷・熱転写（印刷）まで行なっている企業もある。

ハンガー類を生産する専門企業では、材料引張試験機や耐熱温度試験機を設備している企業も見られたが、全体的には成形品の寸法測定のための設備機器（三次元測定機など）の設置は確認できなかった。なお、工業部品の成形に最低限必要な設備である材料乾燥器や金型温調器は、ほとんどの企業で設置されていない。

c. 品質

バングラデシュのプラスチック企業は、外資系企業と取引を行う大企業が比較的多いこともあり、LE セクターに比べれば品質意識は高い。再委託調査の対象企業全体の 1/3 が ISO 9001 の認証を受けており、過半数が BSTI の工業規格を取得している。また、食品加工関連製品を扱う企業では、Good Manufacturing Practice（GMP）認証を有する企業もある。なお、製品の不良率は、全体の平均で 4%、最頻値で 5%となっている。

訪問調査を行った企業には、現状の要求品質を現在の品質保証体制で満たすことができているという認識があるため、適切な原料・金型・成形機械さえあれば、どのような製品でも求められる品質で生産することができると考える企業が多い[47]。

一方、訪問調査では、とくに今後の自動二輪車企業とのリンケージ創出・強化という観点からは、品質保証体制の不十分さを確認している。詳細は、下記「(3)課題」にて述べるが、再委託調査結果では、品質検査用の測定機器を有する企業は 50 社中 2 社にとどまる。また、バリ取りなどの仕上げを手作業で行っているため、品質にバラつきが生まれている。

なお、訪問調査では、1 社の企業が総合生産保全（TPM: Total Productive Maintenance）を大々的に進めていたり、その他数社も清潔な生産現場を保っていたりしていたが、5S やカイゼンを導入している企業はほとんどない状況を確認した。また、再委託調査の結果においても、カイゼンなどの品質向上活動を実施している企業はない。

d. 製造原価

訪問調査の結果によれば、一般的に。製造原価のうち材料費が 70～80%を占める。工場従業員の月給は、二次工程を行う一般労働者で 5,000～6,000 タカ、成形機械の非熟練操作者で 7,000～1 万 5,000 タカ程度であるが、熟練機械操作者になると 2 万タカ～4 万程度になることもある。ただし、他の対象セクターである LE セクターよりも給与水準は低い。

一方、大部分のプラスチック企業は LE 企業と同様に、工場機械や金型の減価償却費を製造原価として考慮していない[48]。なお、これも LE 企業と同様に、機械を動かす電気料金が高いという意見が多い。とくに、不安定な電力供給に対応するため、中企業以上では自家発電設備を持つことが通常であり、その燃料コストが高いとされる。

---

[46] 金型に溶融樹脂を注入する際に発生する充填圧力により金型が開くことを防ぐために締め付ける力。

[47] プラスチック成形は、成形機に金型をセットし、プラスチック原料を供給のうえ成形条件を設定すれば成形品ができあがる。成形条件に多少の設定誤差があっても、バングラデシュで生産されているような製品（主に家庭用品）では大きな品質差は生じない。これは、ショートショット品（成形品の一部が欠けること。また、それにより不完全な形状の製品になること）でない限り、多少のバリが発生しても、後工程のバリ取り仕上げ（手作業）により、現状の要求品質を満たした製品として完成させることができるためである。

[48] 成形機（射出成形機）機械の価格については、種類と大きさにもよるが、一般的には中国製で 500 万タカ程度であり、日本製だとその 2～4 倍程度となる。

4) 市場

a. 国内・海外市場

バングラデシュのプラスチック企業の主要市場は国内市場であるが、主に繊維関連付属品を生産する企業は、海外市場にも直接的・間接的に製品を輸出している。訪問調査の結果では、直接輸出、間接輸出を合わせて29社中19社が輸出される製品を生産している。

再委託調査の結果では、海外市場に製品を卸している企業は全体の14%である。大企業、中企業、小企業それぞれの全市場のうち海外市場が占める割合は、25%、27%、6%である。国内の顧客では、国内資本及び外資系の製薬企業がもっとも多く、国内・海外所在を問わず全顧客のうち13%が外資系企業である。

なお、訪問調査の結果から、家庭用品に関しては、類似の商品が大量に出回っており、市場が飽和している状況を確認している。新商品を売り出してもすぐに類似製品が販売されてしまうため、金型にコストをかけられず、品質が低いことを知りながらも販売を続ける状況にある。

b. 製品の用途と供給

製品の用途（どのような製品の部品になるか）について、再委託調査の結果を表17に示す。ただし、訪問調査の結果によれば、プラスチック企業の製品の供給の大部分は、部品供給という形態ではない。実際には、縫製産業向け付属品、内需向け家庭用品、インフラ需要向け製品、食品加工品・医療品向け容器など、国内基幹産業及び旺盛な国内市場に依存した付属品・最終製品の供給が大部分を占める。

再委託調査の結果によれば、全体の 7 割近くの企業が下請けにより顧客企業の製品の部品を供給しており、16%の企業が卸売店をとおして他社製品の部品を販売している。ただし、訪問調査の結果から、これらは部品との回答ではあるが、実際には最終製品あるいは付属品の可能性が高い。表18に、再委託調査の結果から、プラスチック企業の製品供給の方法を示す。

表 17　主要製品の用途（何の部品になるか）

用途（何の部品になるか）	回答数	構成比
家庭用品	36	30.3%
製薬機械/機器	32	26.9%
衣服・繊維製品	21	17.6%
部品ではなく、最終製品	8	6.7%
包装機械/機器	7	5.9%
自動二輪車/CNC リクシャー	5	4.2%
繊維機械/機器	3	2.5%
食品加工機械/機器	3	2.5%
家具・室内装飾	2	1.7%
玩具	2	1.7%
合計	119	100.0%

出所：再委託調査結果

表 18　製品供給の方法

供給方法	構成比
他社製品の部品を供給（下請けによる）	68.8%
他社製品の部品を供給（卸売店をとおして）	15.9%
最終製品を卸売店をとおして販売	9.3%
最終製品を他社へ供給	2.7%
他社製品の部品を供給（小売店をとおして）	2.4%
最終製品を小売店をとおして販売	0.9%
部品を補修部品市場で販売	0.4%
その他	0.6%

出所：再委託調査結果

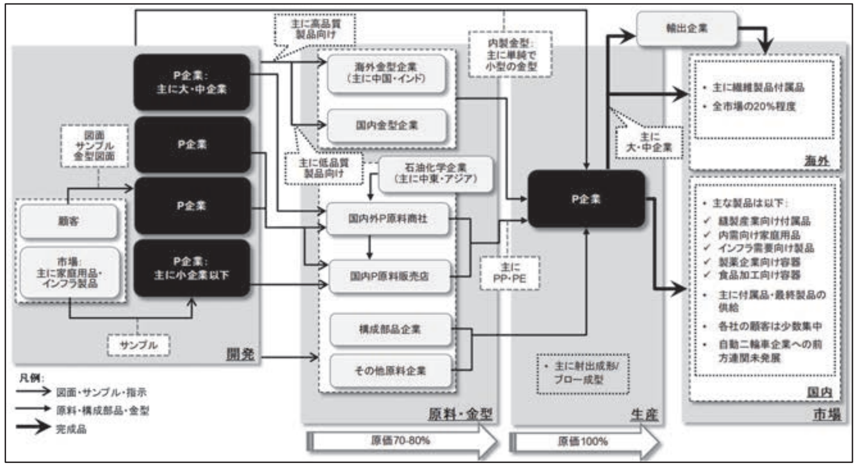
c. 市場の多角化

顧客の多角化は進んでいない。再委託調査では、売上高の大きい順に各社 3 つの顧客の回答を要求したが、全体の 30%強の企業が顧客を 3 つあげることができず、20%近くの企業は 1 社のみ回答した。全体の平均では、1 社につき 72%の売上が上位 3 顧客からあげられている。

顧客の開拓方法については、顧客候補への直接訪問及び他者からの紹介が主流であり、それぞれ全体の 90%、84%の企業がこの方法をとっている。ただし、訪問調査では、顧客開拓のために積極的・能動的にマーケティング活動を行う企業は非常に少ないという状況を確認している。

なお、再委託調査及び訪問調査双方の調査対象企業のなかで、本コンポネントのリンケージ先候補セクターとなる自動二輪車企業に対して、本報告書提出時点で部品を納入している企業は2社（1社がシート、1社がライト類、サイドカバー、フェンダーなど）にとどまる。一方、訪問調査では、上記の 2 社以外に、自動二輪車企業や外資系家電企業から、部品購買の引き合いや生産可能性の照会を受けている企業が3社あることを確認した。

以上より、バングラデシュのLEセクターのサプライチェーンを図2に描く。



注：「P」はプラスチックを表す。原価に機械・金型の減価償却費は含まれない。
出所：プロジェクトチーム作成

図２　バングラデシュのプラスチックセクターのサプライチェーン

(3) 課題

ここでは、本調査の結果から把握したプラスチックセクターが抱える課題を、とくに外資系企業とのリンケージ創出・強化という観点から考察する。

1) 課題の全体像

LE セクターと同様に、全体として、企業は内部環境よりも外部環境に係る課題を重視しており、技術や品質に係る課題は重要な問題ではないと考えている[49]。一方、これも LE セクターと同様に、外資系企業とのリンケージ創出・強化についての課題でも、品質・費用・納期に係る問題を重視していない。

品質や納期に係る問題の要因は、自社の技術力や品質・生産管理の不十分さではなく、低質な金型、古い生産機械、不安定な電力供給による不良品の発生によると考える企業が多い。また、費用に係る課題ついても、自社の経営・生産管理の問題ではなく、輸入関税を含む高い原料・金型コスト、電気代を含む高い間接費などの外部要因による部分が大きいとしている。ただし、原料混合や製品設計に関する従業員の技術不足や工業部品対応に係る知識・経験の不足は、企業、プロジェクトチーム双方が認識する課題である。

---

[49] 再委託調査では、従業員の低い技術及び低い品質意識を課題とした企業は 50 社中各 2 社、品質管理の能力の不足及び品質標準・認証の不足をあげた企業が各 1 社である。

表 19　プラスチックセクターの課題（事業一般）

企業が挙げた課題（再委託調査）	企業が挙げた課題（訪問調査）	プロジェクトチームが観察した課題
（選択方式による上位 10 項目） a.　短期融資アクセスの困難性（運転資金の不足） b.　長期融資アクセスの困難性（投資資金の不足） c.　インフラの未整備（特に電力） d.　厳しい企業間競争 e.　高い間接経費（特に電気代） f.　輸出手続きの困難性 g.　輸入原料の高い関税 h.　顧客候補を知る機会の不足 i.　従業員採用の困難性 j.　高額な輸入原料	a. 融資アクセスの困難性（金利面、返済期間・猶予期間面、担保評価面など） b. 不安定な電力供給（停電による不良品の発生） c. 厳しい企業間競争（市場の飽和、マーケティング能力の不足） d. 従業員の高い離職率（訓練した後に離職） e. 輸入原料の高い関税 f. 老朽化した機材・設備 g. 低質な国内金型（輸入コストの発生・長い納品期間） h. 従業員の技術力の不足（製品設計、原料混合、機械保全・修理） i. プラスチックに関する技術支援体制・材料試験施設の不備 j. 工業部品の情報・知識の不足	a. 変化を望まない経営姿勢 b. よい金型・原料・機材さえあれば何でもできるという意識 c. 製品開発意識・技術の欠如 d. 機能性強化プラスチックに関する知識・経験の不足 e. 過剰な原料在庫・在庫管理の欠如 f. 低質な国内金型（輸入コストの発生・長い納品期間） g. 工業部品生産に係る経験・技術・設備の不足 h. 手作業の仕上げ（精度の低い仕上げ） i. 3S・安全ルールの不徹底 j. 測定技術・品質管理の不足 k. 技術・市場情報の不足 l. 市場・製品多角化の不足

出所：再委託調査・訪問調査結果

表 20　プラスチックセクターの課題（外資系企業とのリンケージ創出・強化）

	リンケージ創出・強化をするうえでの課題	点数
1	外資系企業を知る機会及び接する機会の不足	104
2	市場情報の不足	57
3	不定期な注文	46
4	なし	33
5	契約に係る困難性	17
6	外資系企業が求める価格基準を満たす困難性	10
7	外資系企業が購入したい特定の製品をつくるための生産能力の不足	9
8	外資系企業が求める納期を守る困難性	7
9	外資系企業の生産管理システムに適応する困難性	4
10	外資系企業が求める品質基準及び品質管理レベルを満たす困難性	4

注：点数は、企業が回答した 3 つの課題について、重要な順に 3 点〜1 点に点数化し合計したもの。
出所：再委託調査結果

前述のとおり、基本的にプラスチック企業は、よい原料・金型・機械さえあれば、どのような品質の製品でも生産できるという自信を持っている。機械が充実している企業は多いため、原料と金型の手配さえあれば、自動二輪車の部品を生産できると考える企業が大部分を占める。しかし、新たな顧客を知る機会や接する機会がないため、これまで自動二輪車部品市場に参入しなかったという意見が多い。現市場から十分な収益を得ている企業は、金型・原料提供を伴った注文であれば何にでも対応できると考えるが、積極的・能動的な顧客開拓は行わない。家庭用品を生産する中小企業など市場飽和に直面している企業

に関しても、市場の多角化についての必要性は感じているが、新規製品の開発や顧客候補へのアプローチには積極的・能動的ではない。つまり、現状からの変化を強くは望んでいない企業が多い。また、現状では、プラスチック企業は工業部品を生産しておらず、そのための技術や品質管理に係る経験の蓄積はない。

LE セクターと同様に、企業からもっとも頻繁に挙げられた課題は、資金アクセスの困難性である[50]。ただし、LE セクターの場合と異なる点は、比較的大きなプラスチック企業には、自己資金による設備投資を行ったり、市場金利より低い金利にて長期融資を受けたりしている企業が多くあることである。また、輸出向け製品を生産している企業では、自国通貨建て融資よりも金利が半分程度低い外貨建て融資を活用している企業もある。一方、LE セクターの場合と同様に、運転資金の不足に関しては、短期融資アクセスの問題よりも、製造原価の大部分を占める材料の過剰在庫や売上債権回転率の低さの方が重要となる。

なお、プラスチックの成形機は小型のものでも相当な大きさになり、原料在庫や金型も合わせると、非常に大きなスペースを占有する。しかし、一部の企業を除いて、生産現場におけるモノ・人の動きの効率化や不要物の除去、探しやすさ・取りやすさを考慮したレイアウト設計やモノの配置などは行われていない。前述のとおり、TPM を推し進める 1 社以外は、体系的な生産管理・品質管理システムを導入していない。

次項より、上記の課題の全体像及び現状調査の他の結果を総合的に分析した結果、プラスチックセクターが自動二輪車企業とのリンケージを創出・強化するうえで解決が必要と考える課題を、サプライチェーンに沿って詳述する。それらの課題は次のとおりである。

a. 原料に関する課題
  - 工業部品成形原料の知識・技術の不足

b. 金型に関する課題
  - 高質な金型の入手困難性

c. 生産に関する課題
  - 工業部品成形の知識・技術・設備の不足
  - 生産管理・品質管理技術の知識と実施の不足

d. 市場に関する課題
  - 外資系企業を知る・接する機会や情報の不足

e. 経営・財務に関する課題
  - 設備投資資金の不足

2) 原料に関する課題

原料に関する課題は、サプライチェーンの下流部分の課題の根本的な原因となり得る。加えて、自動二輪車部品市場への参入にあたってこれまでと異なる原料を使う必要性が出てくることから、解決することが非常に重要な課題である。

---

[50] 再委託調査では、長期融資及び短期融資へのアクセスの困難性（設備投資資金及び運転資金の不足）双方とも、全体の 56%の企業が指摘した。

a. 工業部品成形原料の知識・技術の不足

バングラデシュのプラスチック企業の現市場は、国内家庭用品市場、縫製産業・アパレル品付属品市場、食品加工・製薬企業向け容器市場、インフラ整備向け製品市場が主であり、これらの市場では PP 及び PE を中心とした汎用プラスチックが主原料として使われている。一方、自動二輪車部品には、エンジニアリングプラスチック、スーパーエンジニアリングプラスチック、繊維強化プラスチック等の特定機能を強化したプラスチックや、複数の原料を混合させた樹脂が多く使われる。また、汎用プラスチックについても、現在の市場向けの製品ではあまり使われない ABS 樹脂やアクリル樹脂（PMMA: Polymethyl Methacrylate）も使用される[51]。

現状、バングラデシュのプラスチック企業には、これらの原料及び加工条件等に関する経験と知識に欠ける。また、原料混合に関する知識や実践技術も不足している。これらは、自動二輪車部品サプライヤーになるためには必須の知識・技術である。一方、これらの分野で十分な指導を行える技術支援機関が不在[52]なこともあり、プラスチック企業が工業部品成形原料を適切に使用すること、あるいはその技術を直ちに向上させることは困難である。

3) 金型に関する課題

金型はプラスチック製品の品質・費用・納期に非常に大きな影響力を有するため、自動二輪車企業とのリンケージ創出・強化を図るには、解決するべき重要な課題である。

a. 高質な金型の入手困難性

国内製の金型の質を低める要因となっている、金型設計・加工に係る能力の不足についての課題は、LE セクターの現状調査の報告部分で指摘した（3.1 (3) 3) a.を参照）。また、前述のとおり、国内製よりも質の高い輸入金型については、中国製を例にすると、国内製と比べて 1.5 倍程度の価格と約 2 か月の納入期間が必要となるうえ、輸入には 20%～22%の輸入関税がかかるため、大多数のプラスチック企業にとって高質な金型を入手することは極めて困難である。

一方、既述のとおり、プラスチック企業のなかには、自社で金型を製作する能力を向上させる動きがみられる。これらの企業は、鋼材の輸入に慣れていたり、鋼材輸入や自動機械購入のための資金力があったりする場合が多い。しかし、金型企業の設計・加工に係る課題は、当然のことながら、プラスチック企業による金型の設計・加工についてもあてはまる。

4) 生産に関する課題

LE セクターの場合と同様に、自動二輪車のプラスチック部品を供給するうえで、輸入部品に対する比較優位性を確保するためには、生産に関する課題を解決する必要がある。

---

[51] PMMA は自動二輪車のランプのレンズ等に使われる。

[52] ただし、業界団体である BPGMEA が、現在「Bangladesh Institute of Plastic Engineering and Technology（BIPET）」というプラスチック専門の教育・訓練機関のキャンパスを、ダッカ郊外に建設中。

a. 工業部品成形の知識・技術・設備の不足

バングラデシュのプラスチック企業はこれまで工業部品を扱った経験がほとんどないため、同部品への対応技術・設備として何が必要かについての理解は不足している。

工業部品の成形は多品種少量生産となり、現状の成形品目とは温度領域の異なる樹脂替えの技能や、金型の段取り替えの効率性向上の方策が必要となる。また、自動二輪車部品では、一切のバリは許容されず、外観不良（とくに、ヒケ、フローマーク、ウェルドライン[53]）の排除や許容寸法の遵守といったこれまで経験していない品質要求項目が発生する。そのため、必然的に成形条件を微調整する技術の習得が必要となる。基本的には成形機の加熱シリンダ内のスクリュー位置、樹脂の金型内流動位置、及びスクリューの前進速度と樹脂の金型内流動速度に対する理解が重要になる。これらは、現在のバングラデシュのプラスチック企業には不足している知識及び技術である。一方、上記工業成形部品原料に係る課題と同様に、本分野で十分な指導をできる技術支援機関は不在である。

また、プラスチック企業が設置している射出成形機そのものは最新に近い仕様の物が使用されており、工業部品の原料として多く使われるエンジニアプラスチックへの対応に大きな問題はない。一方、工業部品を成形するために必須となる材料乾燥器や金型温調器を有していない企業が多いことが課題となる。

b. 生産管理・品質管理技術の知識と実施の不足

現在の市場の要求品質は高くはなく、その市場が要求する品質を満たすことで製品が売れるという状態にある企業も多いため、品質を改善するという意識の高い企業は限られる。しかし、上述のとおり、自動二輪車部品の生産においては、要求品質が非常に高くなり、高度な品質保証体制を構築して対応する必要がでてくる。とくに、品質保証の基本となる寸法測定ができておらず、継時変化を含めた計測評価に必要な知識・技術・機器が不足している。また、バリ取りを手作業で行っていることも、今後要求される品質を確保するうえでは大きな課題となる。品質の確保には、上記の原料や金型に関する課題の解決に加え、生産部門における厳密な品質管理を行わなければならない。このためには、まず品質に対する意識を向上させる必要がある。

一方、生産管理については、LE 企業とは異なりプラスチック企業は少品種大量生産を行っているものの、3.1 節の当該部分で LE セクターについて記述した課題はプラスチックセクターに対してもあてはまる。それに加え、プラスチック企業では、原料在庫の管理能力が不足している、あるいは管理に対する意識が低い。プラスチック企業の製造原価の 7 割から 8 割が材料費となっている。一方、訪問調査では、過剰な原料在庫や購入から相当時間がたったと思われる原料の放置が見られた。過剰な原料在庫は、プラスチック企業が非常に重要な課題としてあげる運転資金の不足に直結する問題であるとともに、輸入部品に対する国内プラスチック部品の価格優位性を低める要因ともなる。

LE セクターの場合と同様に、品質に対する意識を高め、厳しい生産・品質管理体制を継続的に行っていくことの第一歩として 5S やカイゼンの導入が有効であるが、現状では、5S・カイゼンなどの体系的な品質向上活動を行っている企業は極めて少ない。

5) 市場に関する課題

本文 2.3 節で示す通り、自動二輪車企業は、まずプラスチック部品から国内調達を開始することを検討している。そのようなニーズに対応するためには、顧客から部品企業の候補として認知されることが前提条件となるため、解決されねばならない重要な課題である。

a. 外資系企業を知る・接する機会や情報の不足

3.1 (3) 5) a で述べた内容と同じである。

6) 経営・財務に関する課題

サプライチェーンを横断する課題として、経営・財務に関する課題も重要である。

a. 設備投資資金の不足

プラスチック企業については、LE 企業よりも自己資金力のある企業や長期融資を一般的な金利より低いレートで受けている企業が多い。しかし、それでも長期融資アクセスの困難性（設備投資資金の不足）は多くの企業から指摘されており、自動二輪車企業とのリンケージの創出・強化の観点からも、解決が図られるべき課題である。

本課題の詳細は、3.1 (3) 6) a で述べた内容と同じであるが、銀行からの審査対象の一つとなる財務諸表に関しては、再委託調査の結果では、全体の 4 割近くの企業が国の会計基準に則った財務諸表を作成している。また、訪問調査を行った企業の多くも同様である。

以上より、これまで考察したプラスチックセクターの課題、課題間の関連性、課題群が生み出す影響を表 21 に整理する。

---

[53] 成形不良の種類。「ヒケ」は成形品外表面に発生する凹み、「フローマーク」は成形品表面に発生する縞模様、「ウェルドライン」は金型内で溶融樹脂の流れが合流して融着した部分に発生するＶノッチ状の細い線状痕（ユーエムジー・エービーエス株式会社ウェブサイト（https://www.umgabs.co.jp/jp/trouble/t_30.html#t06））参照）（2018 年 1 月 24 日）。

表 21　プラスチックセクターの課題間の関連性と課題群の影響

製品の質を低める要因			
原料・金型関する課題		生産に関する課題	
工業部品成形原料の知識・技術の不足 工業部品成形の経験の不足 国内製工業部品需要の小ささ 市場・製品の多角化努力の不足 専門性の高い技術支援機関の不在	**低質な金型** 高質な金型の入手困難性 金型設計・加工に係る能力の不足 不十分な精度と低質な仕上げ 低質な国内製鋼材 輸入鋼材調達の困難性 海外製金型の入手困難性 高い価格と長い納期	**工業部品成形の知識・技術・設備の不足** **工業部品成形原料の知識・技術の不足** 測定知識・技術・機器の不足 成形条件の微調整技術の不足 金型段取り替え効率性の不足 温度領域の異なる樹脂替え能力の不足 材料乾燥器、金型温調器等設備の不足 工業部品成形の経験の不足 国内製工業部品需要の小ささ 市場・製品の多角化努力の不足 専門性の高い技術支援機関の不在	**品質管理技術の知識と実施の不足** 品質管理技術の不理解・経験の不足 測定知識・技術・機器の不足 仕上げ設備の不足 品質に対する意識の不足 現市場への満足感 現市場の低い要求品質 5S・カイゼンの認知不足・未導入 従業員の高い離職率
生産量・納期・費用を悪化させる要因	リンケージ創出の根本的制約となる要因	サプライチェーンを横断した課題の要因	
生産に関する課題	市場に関する課題	経営・財務に関する課題	
生産管理技術の知識と実施の不足 生産管理技術の不理解・経験の不足 少品種大量生産の現状 現市場の低い要求納期 現市場の安定した需要 在庫管理技術の不足・不徹底 現市場の低い要求納期 現市場の安定した需要 原価管理の不足 5S・カイゼンの認知不足・未導入 従業員の高い離職率	**外資系企業を知る・接する機会や情報の不足** 情報や接する機会の提供支援の不足 能動的なマーケティング活動の不足 顧客多角化の経験不足	**設備投資資金の不足** 長期資金アクセスの困難性 高い金利 担保評価の硬直性 短い返済期間 支払い猶予期間の未設定 利益管理の不在	**運転資金の不足** 短期融資アクセスの困難性 高い金利 担保評価の硬直性 財務・原価管理の不足 在庫管理技術の不足・不徹底 売掛金管理の不足 前払金受領の不足 高い自家発電コスト 不安定な電力供給 高い公共電気料金 高い原料・金型輸入コスト

注：下線は上記 2）～6）の各項内及び LE セクターの当該箇所でタイトルとして示した課題。文字下げしてある課題は上に位置する課題の原因となるもの。
出所：プロジェクトチーム

(4) 支援ニーズ

表 22 に、プラスチックセクターの支援（BDS）に対するニーズを再委託調査の結果から整理する。

表 22　プラスチックセクターの支援ニーズ

	必要な支援	点数
1	無担保融資の提供	178
2	低金利融資・利子補填の提供	162
3	設備投資向け特別目的融資の提供	75
4	自社の問題の解決を支援できる機関及び専門家の紹介・斡旋	40
5	顧客候補訪問・会合の調整	30
6	市場情報（顧客情報を含む）アクセスに係る支援の提供	24
7	製品開発に係る研修・指導の提供	22
8	生産性向上手法（カイゼン、リーン生産方式等）に係る研修・指導の提供	22
9	事業診断の提供	17
10	原価低減・原価管理に係る研修・指導の提供	17

注：点数は、企業が回答した 5 つの支援について、重要な順に 5 点～1 点に点数化し合計したもの。
出所：再委託調査結果

なお、同表には上位 10 項目のみを記載している。全体の結果については別冊資料の 3 を参照ありたい。

LE セクターの場合と同様に、資金アクセスの困難性を低めるための支援に対するニーズが最大である。また、顧客候補と接する機会の調整や市場情報の提供などのマーケティングに係る支援に対するニーズも比較的大きい。

訪問調査の結果においても同様なニーズが多く聞かれた。また、金型技術に関する支援に対するニーズが大きい状況を確認した。なお、再委託調査の回答にもあがっているが、5S やカイゼンに関する支援に対して関心を有する企業も一定程度存在した。

3.3 有望企業

本調査の目的の一つである有望企業の発掘に関し、これまでに LE 企業 27 社、プラスチック企業 18 社を有望企業候補としてロングリスト化している。有望企業候補としての選定基準は、自動二輪車企業への部品供給の開始・強化という観点からみた、製品種、保有技術、保有機械、従業員数、工場所在地、及び経営者の意欲である。

今後、これらの企業への再訪問や関係者との協議を通じて、各セクター10 社程度の最有望企業を選定していく。

2. 対象産業の現状調査に係る再委託調査結果

Appendix 2: Summary of Results: Subcontracted Questionnaire Company Survey

I. Light Engineering Sector

This is a summary report of the subcontracted questionnaire company survey on fifty light engineering companies conducted from August to September 2017. Chapter 1 to 4 presents the results regarding company profile (Chapter 1), products and production (Chapter 2), market (Chapter 3), and support/services, linkage with foreign companies and quality control (Chapter 4). In addition, three Annexes at the end of this report indicate the results of problems in business operation and in development of linkage with foreign companies (Annexes I-1 and I-2) as well as needs for support (Annex I-3).

1. Company Profile

1.1 Company Size Classified by Industrial Policy 2016

Number of Employees			Values of Total Fixed Assets		
Size (in person)	Number	Share	Size (in 100,000 Taka)	Number	Share
Cottage (15 or below)	11	22%	Cottage and Micro (below 75)	14	28%
Micro (16-30)	9	18%			
Small (31-120)	20	40%	Small (75-150)	31	62%
Medium (121-300)	6	12%	Medium (150-500)	1	2%
Large (300 or above)	4	8%	Large (500 or above)	4	6%
Total	50	100%	Total	50	100%

Size of the companies targeted in this survey does not represent general distribution of light engineering (hereinafter referred to as "LE") companies in Bangladesh, because about a half of the survey sample was selected based upon potentiality for developing linkage with foreign companies.

- Forty companies, or 80%, of the total surveyed companies are classified as Cottage, Micro and Small (by the number of employees defined by the Industrial Policy 2016 as in the table above; the same applies hereinafter if initial letter of "large," "middle," "small," "micro" and "cottage" is capital.).
- Four companies classified as Large are: a foundry, two electrical cable companies, and a bicycle company.

1.2 Engineer (Mechanical Engineer)

Engineers apparently lack in this industry despite the fact that the LE sector is a machining industry in nature.

- More than half (52%) of the total surveyed companies have no engineer and 86% of them have three or less.
- On average, engineers constitute 2.3 percent of the total employment in a company. No correlation exists between proportion of engineers and company size.

1.3 Higher Education

Average proportion of employees with higher education certificates in the surveyed companies is lower than national average of tertiary education enrollment ratio (13.4% in 2014 by UNESCO). Larger companies retain more of such employees than smaller companies do and national average is.

- On average, employees with higher education certificates constitute 5.9% of the total employment in a company, while the mode is 2%.
- Positive relation exists between this proportion and the company size; on average, 22.5% of the total employees are those with higher education certificates in a company classified as Large; 10.5% for Medium, 3.8% for Small, 5.8% for Micro and 1.1% for Cottage.

1.4 Age Group

Employees in this sector are young.

- On average, 74% of the total employment in a company is at the age between 15 and 34 and 52% at the age between 14 and 44, compared to the proportion in the total national population, 51.6% and 70.9% respectively.
- The largest proportion is the age group of 25 to 34 (45%).

1.5 In-company Training

Minority (40%) of the companies provide their employees with in-house training, while the training field is concentrated almost only on skills/technologies.

- Twenty companies, or 40%, of the total surveyed companies regularly conduct in-company training.
- Training of skills/technologies is conducted in all of these 20 companies; marketing and human resource management in one company each.

1.6 International and Industrial Standards Obtained

Less than 15% of the companies have obtained ISO 9001 while no company is certified for ISO 14001. There does not seem to be clear correlation between ISO-certified companies and company size. Only electrical cable and bicycle companies have acquired BSTI standards as the standards has not been set for most of LE products.

- Seven companies, or 14%, of the total surveyed companies have obtained ISO 9001, of which one has also acquired UKAS.
- Two out of these seven companies are classified as Large (50% of the total Large companies); one as Medium (17%) and four as Small (20%). Four out of the seven companies are electrical cable companies.

- Three companies, or 6%, of the total surveyed companies have acquired BSTI standards, out of which two are electrical cable companies and one is a bicycle company.

1.7 Sales Revenue in 2016

Amount of sales revenue of companies vary widely. Relatively high average amount of per-employee sales revenue is found in Small and Micro companies.

- Thirty-six, or 72%, of the total surveyed companies earned sales revenue of BDT 10 million or more in 2016; BDT 100 million or more by 22% and BDT 1 billion or more by 6% of the companies. Meanwhile, six companies, or 12%, of the companies earned BDT 1 million or less in the same year.
- Average of per-employee sales revenue in total surveyed companies in 2016 was BDT 1.34 million; or BDT 1.17 million if the maximum and minimum values (abnormal values) are excluded from the calculation. The median was BDT 0.56 million.
- Average value of per-employee sales revenue in 2016 for the Large companies was BDT 1.16 million (BDT 0.56 million if done as above); BDT 1.98 million (BDT 0.49 million) for Middle, BDT 1.19 million (BDT 1.05 million) for Small, BDT 1.7 million (BDT 1.24 million) for Micro, and BDT 0.93 million (BDT 0.62 million) for Cottage.

1.8 Financial Statements

Less than 10% of the total surveyed companies prepare yearly financial statements of national standards. These companies are electrical cable companies and a bicycle company in Large and Medium categories.

- Three companies, or 6%, of the total surveyed companies prepare yearly financial statements according to BFRS/BAS; 76% of them do so as per company standards and 18% of them do not make financial statements.
- Out of these three companies, two are Large and one is Middle.

2. Products and Production

2.1 Main Products (3 Products of Largest Sales Revenue of Each Company in 2016)

There is a wide variety at a product level while, in a broader category, agricultural equipment and its parts as well as machine tool constitute a large part of the products produced by the surveyed companies. Products produced in each company are not diversified very much.

- The product produced by the largest number of the surveyed companies is pumps (ten companies) followed by liners (6), die/molds, bolts/nuts and tube wells (5 each), gears and gears for textile equipment (3 each), etc.
- In addition, there are 12 companies, 5 companies, and one company that produce various types of machine tools, electrical cables and bicycles, respectively.
- Eighteen companies, or 36%, of the total surveyed companies earn the total sales revenue from these three products only and 62% of them earn 80% or more from these products. Meanwhile, 8% of the total surveyed companies earn less than half of the total sales by these products; the smallest value is 35%.

2.2 Processing Methods

The processing method applied most widely by the surveyed companies is casting/die-casting, followed by the conventional machining methods including grinding, welding/brazing, and turning/milling. Pressing/stamping and forging are rather rare processing method of the surveyed companies.

- A processing method used most frequently to produce the main products above is casting/die-casting (34% and 11% of the total answers, respectively) followed by grinding (15%), welding/brazing (12%), and turning/milling (10%). It should however be noted that , from the data in “2.7 Machine and Equipment” below, turning may actually be more frequently used.
- No surveyed company uses press/stamping while one company each applies forging and electric discharging. Heat treatment is performed by 7% of the total surveyed companies.

2.3 Components (For what products are the main products above used as components?)

Parts/components of:	Frequency	Share
Machine tool	24	17.6%
Agricultural machine/equipment	19	14.0%
Electrical goods/equipment	15	11.0%
Construction machine/equipment	14	10.3%
Homewares	13	9.6%
Engineering goods/equipment	8	5.9%
Pharmaceutical machine/equipment	6	4.4%
Packaging machine/equipment	6	4.4%
Not a part/component, but the final product	6	4.4%
Car	5	3.7%
Textile machine/equipment	4	2.9%
Food processing machine/equipment	4	2.9%
Paper/printing machine/equipment	4	2.9%
Railway/rail line	3	2.2%
Motorbike/CNC rickshaw	2	1.5%
Bicycle/rickshaw	2	1.5%
Garment/textile goods	1	0.7%
Total	136	100.0%

These figures correspond to the main products above, constituting parts of diverse products.

2.4 Production Volume and Price

Production volume and prices largely vary from one product to another.

- In case of pumps (excluding centrifugal pumps and submersible pumps) in the main product above, yearly production volume ranges between 1,000 and 40,000 (five companies produce more than 10,000 while three make less than 5,000) , while the unit price (factory price) is set at BDT 4,000 to 5,000.

- As for liners excluding the engine liner produced by one company, yearly production volume ranges between 3,000 and 20,000 (one company produces 3,000 while other four make 10,000 to 20,000), while the unit price is set at BDT 55 to 350. One company set the unit price at BDT 55 and other four set it at BDT 300 to 350.
- Prevalent unit price of die/molds ranges between BDT 50,000 and 100,000 while that for preform molding and caps of containers is more costly; BDT 300,000 to 400,000.

2.5 Lead-time (from Order to Shipping)

Lead-time for half of the main products is less than 20 days. The lead-time is likely to depend much on the time required to procure die/mold and raw materials as well as size of the products.

- Lead-time for all the main products (136 products produced by 50 companies) ranges between one day and about a year. The lead-time is less than ten days for 42% of the total products; less than 20 days for half of the products and less than a month for 60% of the products.
- The product having the longest lead-time, or 350 days, is a type of steel structure produced by one company, followed by stainless rotor for paper manufacturing machine, flour mill and feeding machine (180 days each), rotogravure machine (150 days) and cardboard manufacturing machine (100 days). Only these six products of the surveyed companies require 100 or more days of lead-time.
- Other products requiring relatively long lead-time include: pumps, liners, and tube-wells (90 days each) and gears (30 to 90 days).
- Regarding die/molds, three companies' lead-time ranges between 10 days and a month, while that of other three companies is from one day to five days. The former produces relatively costly die/molds.

2.6 Defective Rate

Average defective rate of the main products is 5.5%

- Defective rates for all the main products range between 0% and 30% with the average and mode being 5.5% and 5%, respectively.
- The products with defective rate of 20% or higher include gears of three companies (20%), valves of three companies (20%), bolts/nuts of two companies (20% and 25% respectively), and stainless rotor for paper manufacturing machine of a company (30%).

2.7 Machine and Equipment

Machine for conventional machining except pressing and forging prevails, while CNC machine, electrical discharging machine, auto-plating machine, etc. are not commonly used in the surveyed companies. Machine maintenance is generally conducted once in two to five weeks. .

- The machine possessed by the largest number of the surveyed companies is lathe machine (38 companies) followed by grinding machine (16), shaper (13), drilling machine (10), milling machine (9), pressing machine and welding machine (5 each), cutting machine (4) and induction furnace, electroplating machine and rolling machine (2 each).

- Other machine including CNC milling machine, electric discharging machine, auto-plating machine, etc. is held by one company each.
- Years of the most recent installation vary from 1960 to 2017 with the average being 2004.
- All the surveyed companies perform regular maintenance for every machine. Frequency of the maintenance varies; the average frequencies for lathe machine, grinding machine, shaper, drilling machine and milling machine are once in 22 days, 23 days, 25 days, 37 days and 16 days, respectively.
- All the surveyed companies conduct the maintenance by their own employees, out of which ten companies use local technicians as well.

2.8 Make-to-Order or Make-to-Stock

Most products are produced on a make-to-order basis.

- Twenty-seven companies, or 54%, of the total surveyed companies produce 90% or more of the products after receiving the order; 76% of the companies does so for 80% or more of the products.
- Eight companies, or 16%, of them do so for less than half of the products while one company produce its products only on a make-to-stock basis.

2.9 Mold

Own production of die/molds prevail while China is the main source of the imported die/molds.

- Thirty-two companies, or 64%, of the total surveyed companies use die/molds for their products.
- Out of these 32 companies, 23 companies (72%) produce die/molds by themselves. Meanwhile, seven companies (22%) import them, while seven companies (22%), six companies (19%), two companies (6%) and one company (3%) procure die/molds from customers, local dice/mold producers, parent/related companies, and domestic dice/mold dealers, respectively.
- Out of seven companies importing the die/molds, four companies (57%) import from China; two companies from India and one company from Japan.
- All the 32 companies perform dice/mold maintenance on their own, out of which five use local technicians as well.

2.10 Raw Materials

Iron before steelmaking process and mild steel prevail while aluminum, copper and brass are main non-ferrous materials used in production. As for alloy steel, only stainless steel is used in the surveyed companies. Main sources of imported materials are China and India. Purchase-consumption ratio is high

- Twenty-seven percent of the total answers (137 answers regarding raw materials used in the production) fall into pig iron and cast iron, followed by scrap steel and mild steel (9% each), stainless steel (6%), aluminum and copper (5% each), and brass (4%).

- Non-metal materials including plastics (4%) and rubber (3%) as well as cokes (4%) are also used.
- Copper and plastic materials are used mostly by electrical cable companies.
- As for source of raw materials, 20 answers, or 15%, of the total answers are procurement by import.
- As for the import source, eight answers (40%) fall into China followed by four (20%) into India, two each into Japan and South Korea, and one each into United States, Thailand, Singapore and Saudi Arabia.
- Average consumption rate of the raw materials procured in a month is 97%.

3. Market

3.1 Route of Supply (% of the Total Sales)

Supply Form	Average percent
Supply parts/components for products of other companies (by sub-contract)	51.3%
Supply parts/components for products of other companies (through wholesalers/agencies)	22.9%
Supply parts/components for products of other companies (through retailors)	6.8%
Supply products NOT for parts/components to other companies	5.3%
Supply products NOT for parts/components through wholesalers/agencies	7.6%
Supply products NOT for parts/components through retailors	2.0%
Supply parts/components for after-market	1.6%
Others	2.5%

Sub-contracted supply of parts/components to other companies does not represent the general route of supply of the LE products, but is still the majority.

- Ten companies, or 20%, of the total surveyed companies earn all sales revenue through the supply of parts/components for products of other companies (by sub-contract), while 46% of them do so for 80% and 54% of them do so for 50% or more of the products.
- On the other hand, 14 companies, or 28%, of the total surveyed companies do not supply their products in such a way.

3.2 Customers (Top 3 Customers of Each Company)

Customers are not much diversified and markets are domestic.

- Customers named by the largest number of surveyed companies are dealers (nine companies), followed by Bashundhara Group (8), PRAN-RFL Group and Bangladesh Railway (4 each), Akij Group (3), and Meghna Group and ACI Group (2 each). Other customers are named by one surveyed company only.
- Eleven companies, or 22%, of the total surveyed companies answer one customer only; three companies (6%) raise two customers only.

- Except nine surveyed companies which raise only dealers as their customers, four companies (10%) earn the total sales from the top three customers only and 21 companies (51%) earn half of the total sales from those customers. On overall average, 51% of the total sales of a company come from the top three customers.

3.3 Means to Find Customers

Means to Find Customers	Frequency	Share
Through introduction by others	43	86.0%
Through direct visit to potential customers	38	76.0%
Through advertisement	10	20.0%
Through participation in exhibitions	7	14.0%
Through company brochure (both in hardcopy and on website)	4	8.0%
Marketing/Sales Team	3	6.0%
Through online matching systems	1	2.0%
Base	50	-

Main means to find customers are through introduction by others and through direct visit to potential customers.

4. Support/Services, Linkage with Foreign Companies, and Quality Control

4.1 BDS Providers (Support Institutions) Used in the Past

Organization	Frequency	Share
BEIOA	38	76.0%
BUET	16	32.0%
BITAC	15	30.0%
BSCIC (Bangladesh Small and Cottage Industries Corporation)	9	18.0%
FBCCI (Federation of Bangladesh Chambers of Commerce and Industry)	6	12.0%
BSTI (Bangladesh Standards and Testing Institution)	4	8.0%
SMEF	3	6.0%
NPO	3	6.0%
LEPBPC (Light Engineering Product Business Promotion Council)	3	6.0%
DCCI (Dhaka Chamber of Commerce & Industry)	3	6.0%
BPGMEA	3	6.0%
None	2	4.0%
BIM (Bangladesh Institute of Management)	1	2.0%
Base	50	-

Support from the association is most utilized while that from BUET and BITAC is used by about a third of the surveyed companies.

- Ninety-six percent of the total companies that have received support/services from the BDS providers above are satisfied with the support/services.
- Four companies indicate response to market needs, machine and equipment used in training, instructors/experts, and cost of services as points for improvement.

4.2 Interests in Supplying Parts/Components to Foreign Companies

Interest	Frequency	Share
Yes (already supplying)	1	2.0%
Yes (not supplying yet)	44	88.0%
No for now	3	6.0%
No for now and in future	2	4.0%
Total	50	100.0%

Most of the surveyed companies are interested in supplying parts/components to foreign companies.

- Two companies answering “No for now and in future” are electrical cable companies.
- A company answering “Yes (already supplying)” is a bicycle company.

4.3 Quality Control (Presence of Activities and Records about Quality Control)

Activates/Records regarding Quality Control	Frequency	Share
Record of complaints/customer satisfaction	32	64.0%
Finished products inspection	26	52.0%
Received materials inspection	22	44.0%
In-process products inspection	22	44.0%
Record of finished products inspection	20	40.0%
Record of employees satisfaction	18	36.0%
Operating instructions for manual work for workers	18	36.0%
Operating process flow for workers	15	30.0%
Record of in-process products inspection	13	26.0%
Record of equipment/machinery productivity (e.g. the number of unit, production time)	13	26.0%
Using PC for keeping operation/productivity records (e.g. Excel sheet)	12	24.0%
Regular maintenance for equipment for quality check	10	20.0%
Record of workers' productivity	10	20.0%
Record of received materials inspection	9	18.0%
Operating instructions for machine/equipment usage for workers	9	18.0%
Record of training outcome	8	16.0%
Record of stock/inventory	7	14.0%
Training for workers	6	12.0%
Record of yearly inventory-taking	5	10.0%
Equipment/instruments for quality check	2	4.0%
Activities of quality improvement (KAIZEN, 5S, QC Circle, JIT, TPM, etc.)	2	4.0%
Base	50	-

Values of activities/records regarding measurement and stock management are relatively low.

Annex I-1. Problems in Business Operation Answered in Subcontracted Survey_LE

	Major Problems	Score
1	Difficulties in access to short-term loans (lack of working capital)	95
2	Difficulties in access to long-term loans or fund-raising (lack of investment capital)	89
3	Lack of infrastructure	63
4	(C) High expenses/overhead	45
5	(C) High price of imported raw materials and intermediary goods	42
6	Increasing wages of employees	34
7	Lack of opportunities to meet potential customers	30
8	Severe competition	30
9	Low capability/skills of employees	27
10	Cumbersome customs clearance	24
11	(C) High import duties of raw materials and intermediary goods	22
12	Obsolescence of production/processing technologies	20
13	Low capacity/obsolescence of machine and equipment	19
14	(Q) Lack of employees' awareness for quality	18
15	High turnover rate of employees	18
16	Difficulties in export procedure	15
17	Low capability of formulating business plan	14
18	Lack of market information	12
19	Lack of product promotion	12
20	Low capability of developing business strategy/business model	12
21	Difficulty in sourcing raw materials and intermediary goods of necessary quantity	11
22	Lack of quality of raw material	10
23	(D) Difficulty in physical distribution	9
24	(Q) Lack of standards and certifications	9
25	(Q) Lack of inspection facilities/instruments	7
26	Severe requirements of customers for quality, cost and delivery	7
27	Strict/inconsistent regulations	7
28	Lack of collaboration with other companies	6
29	(C) High labor cost	5
30	(D) Long lead-time	5
31	(Q) Low capability of quality control	5
32	Difficulty in employee recruitment	5
33	Low capability of financial management (including accounting/bookkeeping)	5
34	(C) Low capability of cost control	4
35	Low capability of production control	4
36	Difficulty in trading with distributors	3
37	Lack of successor to the current manager	3
38	Unstable purchasing order of customers	2
39	Low capability of product development/R&D	1
40	Low capability of product development/R&D	1

Note: Score is calculated by summing weighted mark (from 5 (most significant) to 1 (fifth most significant)) in each answer.

Annex I-2. Problems in Linkage with Foreign Companies Answered in Subcontracted Survey_LE

Major Problems in Beginning/Strengthening Linkage with Foreign Companies		Score
1	Lack of opportunity to know and contact foreign companies	111
2	Lack of market information	60
3	Difficulty in making contract (legal matters, guarantees, payment, etc.)	25
4	Unstable order (spot-order)	23
5	None	18
6	Difficulty in meeting cost requirement of foreign companies	11
7	Difficulty in meeting regulatory compliance requirement of foreign companies	10
8	Difficulty in meeting quality/quality control level that foreign companies require	8
9	Difficulty in procuring raw materials required by foreign companies for use in the products	7
10	Difficulty in promotion of your products	7
11	Lack of production capacity to produce particular types of products that foreign companies want to procure	6
12	Difficulty in producing the product volume ordered by foreign companies	5
13	Difficulty in adjusting to the production control procedures of foreign companies	4
14	Difficulty in meeting requirement of foreign companies for accounting standards	3
15	Difficulty in meeting delivery time that foreign companies require	2

Note: Score is calculated by summing weighted mark (from 3 (most significant) to 1 (third most significant)) in each answer.

Annex I-3. Needs for Support Answered in Subcontracted Survey_LE

Needs for Support/Services in Future		Score
1	Provision of uncollateralized loans	187
2	Provision of low-interest loans/interest subsidy	151
3	Provision of special purpose loan/lease for procurement of machine/equipment	43
4	Support in access to technology information	42
5	None	31
6	Support in access to market information (including buyer information)	30
7	Diagnosis on problems in overall business operation	27
8	Introduction/referral to organizations or experts that can support you in solving the problems	27
9	Training/guidance on export procedure	25
10	Consultation on access to loans	21
11	Training/guidance on business strategy/model development	15
12	Consultation on business-related laws	14
13	Arrangement for visit to/meeting with potential customers	13
14	Provision of common production facilities	12
15	Training/guidance for manager(s) for business management	12
16	Training/guidance on cost reduction/control	12
17	Training/guidance on production/processing technologies and skills	12
18	Training/guidance on product development	11
19	Training/guidance on production control	8
20	Training/guidance on production improvement methods (KAIZEN, Lean manufacturing, etc.)	6
21	Arrangement for joint procurement of raw materials with other companies	5
22	Guidance on regulatory compliance	5
23	Training/guidance on formulating business plan	5
24	Training/guidance on industry/product standards	5
25	Training/guidance on quality control	5
26	Arrangement for technical assistance from big companies	4
27	Facilitation of business collaboration (joint product development, organization, joint-venturing, etc.)	4
28	Training/guidance for successor(s) for business management	4
29	Training/guidance on financial management/accounting (including bookkeeping and tax system)	4
30	Support in obtaining standard certifications	3
31	Support in participation in exhibitions	2
32	Guidance on international business standards (acconting system, contract, payment, protocol, etc.)	1
33	Support in access to supplier information	1
34	Training/guidance on factory layout	1
35	Training/guidance on supply chain management	1
36	Training/guidance on testing and inspection	1

Note: Score is calculated by summing weighted mark (from 5 (most needed) to 1 (fiftth most needed)) in each answer.

II. Plastic Sector

This is a summary report of the subcontracted questionnaire company survey on fifty plastic companies conducted from August to September 2017. Chapter 1 to 4 presents the results regarding company profile (Chapter 1), products and production (Chapter 2), market (Chapter 3), and support/services, linkage with foreign companies and quality control (Chapter 4). In addition, three Attachments at the end of this report indicate the results of problems in business operation and in development of linkage with foreign companies (Annexes II-1 and II-2) as well as needs for support (Annex II-3).

1. Company Profile

1.1 Company Size Classified by Industrial Policy 2016

Number of Employees			Values of Total Fixed Assets		
Size (in person)	Number	Share	Size (in 100,000 Taka)	Number	Share
Cottage (15 or below)	0	0%	Cottage and Micro (below 75)	5	10%
Micro (16-30)	1	2%			
Small (31-120)	28	56%	Small (75-150)	29	58%
Medium (121-300)	11	22%	Medium (150-500)	1	2%
Large (300 or above)	10	20%	Large (500 or above)	15	30%
Total	50	100%	Total	50	100%

Size of the companies targeted in this survey does not represent general distribution of plastic companies in Bangladesh, because about a half of the survey sample was selected based upon potentiality for developing linkage with foreign companies.

- Most of the surveyed companies (98%) have 31 employees or more; in other words, they are non-Micro or non-Cottage industries by definition of the Industrial Policy 2016.
- Five companies (10%) have more than 1,000 employees, out of which one has over 10,000.

1.2 Engineer (Mechanical Engineer)

Engineers apparently lack in the plastic industry despite the fact that the industry is capital-intensive.

- Sixteen companies, or 32%, of the total surveyed companies have no engineer and 80% of them have three or less.
- On average, engineers constitute 1.3 percent of the total employment in a company. No correlation exists between proportion of engineers and company size.

1.3 Higher Education

Average proportion of employees with higher education certificates in the surveyed companies is lower than national average of tertiary education enrollment ratio (13.4% in 2014 by UNESCO).

Larger companies retain more of such employees than smaller companies do and national average is.

- On average, employees with higher education certificates constitute 10.5% of the total employment in a company, while the mode is 2%.
- Eighty percent of the total surveyed companies have 15% or less proportion of such employees; 64% have the proportion of 10% or less and 42% have that of 5% or less. On the other hands, two companies have 50% or more proportion of such employees.
- Positive relation exists between this proportion and the company size; on average, 28.6% of the total employees are those with higher education certificates in a company classified as Large (by the number of employees in the table above; the same applies hereinafter if initial letter of "large," "middle" and "small" is capital.); 13.9% for Medium and 3.2% for Small.

1.4 Age Group

Employees in this sector are young.

- On average, 77% of the total employment in a company is at the age between 15 and 34 and 95% at the age between 14 and 44, compared to the proportion in the total national population, 51.6% and 70.9% respectively.
- The largest proportion is the age group of 25 to 34 (42%).

1.5 In-company Training

Majority of the companies provide their employees with in-house training, while the training field is concentrated almost only on skills/technologies.

- Thirty-one companies, or 62%, of the total surveyed companies regularly conduct in-company training.
- Training of skills/technologies is conducted in 29 out of these 31 companies; fire safety and compliance in two companies each and business management and human resource management in one company each.

1.6 International and Industrial Standards Obtained

One-third of the companies have obtained ISO 9001 while more than half of the companies have acquired BSTI standards. More Large and Middle companies are certified so than Small companies are.

- Seventeen companies, or 34%, of the total surveyed companies have obtained ISO 9001, of which six companies have also acquired ISO 14001. One of these six companies has also been certified for UKAS.
- More Middle and Large companies have these standards than Small companies do: seven out of those 17 companies are classified as Large (70% of the total Large companies); eight as Medium (73%) and two as Small (7%).
- More than half of those 17 companies (53%) totally or partially sell their product in international markets.

- Twenty-eight companies, or 56%, of the total surveyed companies have acquired BSTI standards, out of which 16 are those having ISO 9001. Seven out of these 28 companies are classified as Large (70% of the total Large companies); nine as Middle (82%) and 12 as Small (43%).

1.7 Sales Revenue in 2016

Amount of sales revenue of companies vary widely. Average amount of per-employee sales revenue is largest in the companies classified as Middle. ISO-certified companies constitute more than 60% of the companies whose per-employee sales revenue is above the median.

- Forty-seven, or 94%, of the total surveyed companies earned sales revenue of BDT 10 million or more in 2016; BDT 100 million or more by 58% of the companies, BDT 1 billion or more by 16% of them, and BDT 10 billion or more by one company. Meanwhile, there is a company earning BDT 1 million or less in the same year.
- Average of per-employee sales revenue in total surveyed companies in 2016 was BDT 1.5 million; or BDT 1.37 million if the maximum and minimum values (abnormal values) are excluded from the calculation. The median was BDT 1 million.
- No correlation exists between per-employee sales revenue and company size. Average value of per-employee sales revenue in 2016 for the Large companies was BDT 1.17 million (BDT 1.09 million if done as above); BDT 2.37 million (BDT 1.94 million) for Middle and BDT 1.22 million (BDT 1.27 million) for Small.
- ISO 9001-certified companies constitute 64% of 22 companies with per-employee sales revenue of BDT 1 million (the median value) or more, while 59% prepare yearly financial statements according to Bangladesh Financial Reporting Standards (BFRS) including Bangladesh Accounting Standards (BAS).

1.8 Financial Statements

About one-third of the companies prepare yearly financial statements of national standards. The larger companies tend to do so.

- Eighteen companies, or 36%, of the total surveyed companies prepare yearly financial statements according to BFRS/BAS; 62% of them do so as per company standards and one company does not make financial statements.
- Out of these 18 companies, seven are Large (70% of the total Large companies); seven are Middle (64%) and four are Small (14%).

2. Products and Production

2.1 Main Products (3 Products of Largest Sales Revenue of Each Company in 2016)

Products are not much diversified and concentrated largely in household items, containers for industries, accessories for the textile industry and packaging products.

- The product produced by the largest number of the surveyed companies is PET bottles (17 companies) followed by household items (12), hangers (9), vitamin containers (8), general containers and polybags (5 each) and jugs and oil bottles (3 each), etc.

- Thirty-five companies, or 70%, of the total surveyed companies earn the total sales revenue from these three products only and 80% of them earn 80% or more from these products. Meanwhile, 12% of the total surveyed companies earn less than half of the total sales by these products; the smallest value is 25%.
-

2.2 Processing Methods

Main processing methods are injection molding and blow molding.

- A processing method used most frequently to produce the main products above is injection molding (38% of the total answers) followed by blow molding (24%), extrusion molding (3%) and compression molding (2%).

2.3 Components (For what products are the main products above used as components?)

Parts/components of:	Frequency	Share
Homewares	36	30.3%
Pharmaceutical machine/equipment	32	26.9%
Garment/textile goods	21	17.6%
Not a part/component, but the final product	8	6.7%
Packaging machine/equipment	7	5.9%
Motorbike/CNC rickshaw	5	4.2%
Textile machine/equipment	3	2.5%
Food processing machine/equipment	3	2.5%
Furniture/interior goods	2	1.7%
Toy	2	1.7%
Total	119	100.0%

These figures correspond to the main products above. It should, however, be noted that the main products above are supplied, in most cases, not as components, but as final products or accessories in actuality.

2.4 Production Volume and Price

Production volume and prices largely vary from one product to another, but tendency is that the bigger the product is, the higher the price is, due partly to higher mold cost and cost of raw materials which constitute the largest part of production cost in this sector.

- In case of PET bottles in the main product above, yearly production volume ranges between 200,000 and 240 million, while the unit price (factory price) is set at BDT 3 to 30. Regarding the unit price, BDT 30 is an abnormal value among the answers and the average price excluding this abnormal value is BDT 7.3.
- As for hangers, yearly production volume ranges between 2 million to 120 million, while the unit price is set at BDT 6 to 96. Regarding the unit price, BDT 96 is an abnormal value among the answers and the average price excluding this abnormal value is BDT 6.6.

- Regarding vitamin containers, yearly production volume ranges between 2.5 million to 240 million, while the unit price is set at BDT 4 to 12 with the average being BDT 7.5.
- In case of side-covers and indicators for motorcycles, yearly production volume is 20,000 and the unit price is BDT 500, while those of motorcycle seat-covers are 250,000 and BDT 3,000 respectively.

2.5 Lead-time (from Order to Shipping)

Lead-time is likely to depend much upon the time required to receive the mold.

- Lead-time for all the main products (119 products produced by 50 companies) ranges between one day and 180 days. The lead-time is less than ten days for 17% of the total products; ten days to 30 days for 33% and 90 days or less for 69% of the products.
- The product having the longest lead-time, or 180 days, is liquid/ice-cream containers produced by one company.
- The average lead-time for PET bottles is 60 days, while there are abnormal values of two days and five days answered by two companies. The average lead-time for hangers is 35 days with an abnormal value of 12 days answered by one company, while that for vitamin containers is 68 days.
- The lead-time for side-covers and indicators for motorcycles produced by a company is 90 days, while that for motorcycle seat-covers is five days.

2.6 Defective Rate

Average defective rate of the main products is 5%.

- Defective rates for all the main products range between 0% and 10% with the average and mode being 4% and 5%, respectively.

2.7 Machine and Equipment

Main machine is injection molding machine and blow molding machine as seen in the Processing Method above, with the average number of installed machine in a company being ten and six respectively. Machine maintenance is generally conducted about once in a month.

- Forty-six companies, or 92%, of the total surveyed companies possess injection molding machine, while 58% of them have blow molding machine. Printing machine, extrusion molding machine, packaging machine and rotational molding machine are held by seven companies, three companies, two companies and one company, respectively.
- The average number of injection molding machine installed in a company is 20, while if the abnormal value of 700 answered by one company is excluded, the number turns to ten. The number of installed blow molding machine ranges from one to 30 with the average being six.
- Years of the most recent installation vary from 1984 to 2017 with the average being 2009.
- All the surveyed companies perform regular maintenance for every machine. Frequency of the maintenance ranges from every day to once in a month with the whole average, average for injection molding machine, that for blow molding machine and that for extrusion molding machine being once in 26 days, 28 days, 28 days and 24 days, respectively.

- Forty-nine companies, or 98%, of the total surveyed companies conduct the maintenance by their own employees, out of which two companies use local technicians as well.

2.8 Make-to-Order or Make-to-Stock

Most products are produced on a make-to-order basis.

- Thirty-five companies, or 70%, of the total surveyed companies produce 90% or more of the products after receiving order; 90% of the companies does so for 80% or more of the products.
- Two companies do so for less than half of the products; 25% and 30% respectively.

2.9 Mold

Import and own production of mold prevail and China is the main source of the imported mold.

- Forty-nine companies, or 98%, of the total surveyed companies use molds for their products.
- Out of these 49 companies, 36 companies (73%) produce molds by themselves. Meanwhile, 35 companies (71%) import them, while 16 companies (33%), 15 companies (31%), six companies (12%) and six companies (12%) procure molds from local mold producers, customers, parent/related companies, and domestic mold dealers, respectively.
- Out of the 35 companies importing the molds, 25 companies (71%) import from China; three companies each (9%) from India, Singapore or Hong Kong, and one company from South Korea.
- The local mold producers named as a mold procurement source by two or more surveyed companies are: City Moulding (by four companies), Bismillah Enterprise (by four companies), Brothers Engineering (by three companies), etc.
- All the 49 companies perform mold maintenance on their own, out of which three use local technicians as well.

2.10 Raw Materials

Materials	Frequency	Share
Polypropylene (PP)	31	26.1%
Painting Materials	27	22.7%
Plastic Resin	23	19.3%
High Density Polyethylene (HDPE)	14	11.8%
General Purpose Polystyrene (GPPS)	6	5.0%
Low Density Polyethylene (LDPE)	6	5.0%
High Impact Polystyrene (HIPS)	4	3.4%
Calcium	2	1.7%
Others	6	5.0%
Total	119	100.0%

PP and PE prevail. No engineering plastic or Fiber-Reinforced Plastic (FRP) is used by the surveyed companies. Purchase-consumption ratio is high, while this does not correspond with observation results in the interview survey conducted by JICA Project Team.

- As for source of raw materials, 80 answers, or 67%, of the total answers (119 answers) are procurement by import and 41 (35%) are procurement from local dealers.
- As for the import source, 38 answers (48%) fall into Saudi Arabia followed by 21 (26%) into India, six (8%) into Thailand, five (6%) into Taiwan, two each into Singapore, UAE and Oman, and one each into China, South Korea, Hong Kong and Belgium.
- 87% of the total surveyed companies do not use recycled materials.
- Average consumption rate of the raw materials procured in a month is 98%.

3. Market

3.1 Route of Supply (% of the Total Sales)

Supply Form	Average percent
Supply parts/components for products of other companies (by sub-contract)	68.8%
Supply parts/components for products of other companies (through wholesalers/agencies)	15.9%
Supply products NOT for parts/components through wholesalers/agencies	9.3%
Supply products NOT for parts/components to other companies	2.7%
Supply parts/components for products of other companies (through retailors)	2.4%
Supply products NOT for parts/components through retailors	0.9%
Supply parts/components for after-market	0.4%
Others	0.6%

Sub-contracted supply of parts/components to other companies is the main route of supply; however, it should be noted that they are, more precisely, supplied not as components, but as final products or accessories in most cases.

- Twenty companies, or 40%, of the total surveyed companies earn all sales revenue through the supply of parts/components for products of other companies (by sub-contract), while 10 companies (10%) do not supply their products in such a way.

3.2 Customers (Top 3 Customers of Each Company)

Markets are not much diversified and the pharmaceutical industry is the main customer. About a quarter of market of the companies classified as Large and Middle is international.

- On an overall average, 86% of the total customers are in domestic markets and 14% are in international markets.
- Six out of ten Large companies totally or partially target international market, while 25% of the total markets of the Large companies are international. The respective figures for the Middle companies are 27% and 27% while those for the Small companies are 14% and 6%.
- Customers named by the largest number of surveyed companies are dealers and Beximco Pharma which are customers for eight surveyed companies each, followed by Square Pharma (five companies), Ibn Sina Pharmaceuticals (4), Incepta Pharma (3), and Uniliver/Pran-RFL Group/Berger Paint/ACME Laboratories/ACI (2 companies). Other customers are named by one surveyed company only.

- Thirteen percent of the total customers are foreign companies, of which one is a joint venture.
- Nine companies, or 18%, of the total surveyed companies answer one customer only; seven companies (14%) raise two customers only.
- Except four surveyed companies which raise only dealers as their customers, 12 companies (26%) earn the total sales from the top three customers only and 23 companies (50%) earn half of the total sales from those customers. On overall average, 72% of the total sales of a company come from the top three customers.

3.3 Means to Find Customers

Means to Find Customers	Frequency	Share
Through direct visit to potential customers	45	90.0%
Through introduction by others	42	84.0%
Through advertisement	9	18.0%
Through participation in exhibitions	8	16.0%
Through company brochure (both in hardcopy and on website)	7	14.0%
Marketing/Sales Team	6	12.0%
Through online matching systems	1	2.0%
Base	50	-

Main means to find customers are through direct visit to potential customers and through introduction by others.

4. Support/Services, Linkage with Foreign Companies, and Quality Control

4.1 BDS Providers (Support Institutions) Used in the Past

Organization	Frequency	Share
BPGMEA	43	86.0%
BUET	18	36.0%
BSTI (Bangladesh Standards and Testing Institution)	8	16.0%
FBCCI (Federation of Bangladesh Chambers of Commerce and Industry)	5	10.0%
BITAC	4	8.0%
DCCI (Dhaka Chamber of Commerce & Industry)	3	6.0%
BSCIC (Bangladesh Small and Cottage Industries Corporation)	3	6.0%
SMEF	2	4.0%
BIM (Bangladesh Institute of Management)	2	4.0%
None	2	4.0%
TICI (Training Institute for Chemical Industries)	1	2.0%
Base	50	-

Support from the association is most utilized, while that from BITAC and SMEF is not widely used.

- Ninety-two percent of the total companies that have received the support/services are satisfied with these support/services.
- Four companies indicate cost of services as a point for improvement.

4.2 Interests in Supplying Parts/Components to Foreign Companies

Interest	Frequency	Share
Yes (already supplying)	10	20.0%
Yes (not supplying yet)	40	80.0%
Total	50	100.0%

All the surveyed companies are interested in supplying parts/components to foreign companies.

- Twenty-four percent of the total parts/components (final products or accessories in actuality) supplied by ten companies answering "Yes (already supplying)" are hangers and household items (each constitutes 24%). Others are polybags, PET bottles and furniture, each of which was raised by one company only.
- These ten companies supply parts/components (final products or accessories in actuality) to five American companies, three Indian companies, two French companies, two German companies, and one company each from Japan, China, United Kingdom, Canada and Mauritius.

4.3 Quality Control (Presence of Activities and Records about Quality Control)

Activates/Records regarding Quality Control	Frequency	Share
Record of complaints/customer satisfaction	34	68.0%
Record of employees satisfaction	27	54.0%
Record of workers' productivity	18	36.0%
Finished products inspection	18	36.0%
Record of finished products inspection	16	32.0%
Using PC for keeping operation/productivity records (e.g. Excel sheet)	15	30.0%
Record of stock/inventory	14	28.0%
Received materials inspection	14	28.0%
Operating process flow for workers	14	28.0%
Operating instructions for manual work for workers	14	28.0%
Record of received materials inspection	13	26.0%
Operating instructions for machine/equipment usage for workers	13	26.0%
In-process products inspection	13	26.0%
Record of yearly inventory-taking	11	22.0%
Record of in-process products inspection	11	22.0%
Record of equipment/machinery productivity (e.g. the number of unit, production time)	11	22.0%
Regular maintenance for equipment for quality check	8	16.0%
Training for workers	7	14.0%
Record of training outcome	6	12.0%
Equipment/instruments for quality check	2	4.0%
Base	50	-

Values of activities/records regarding measurement are relatively low. None of the surveyed company undertakes activities for systematical quality improvement including KAIZEN.

Annex II-1. Problems in Business Operation Answered in Subcontracted Survey_Plastic

	Major Problems	Score
1	Difficulties in access to short-term loans (lack of working capital)	129
2	Difficulties in access to long-term loans or fund-raising (lack of investment capital)	111
3	Lack of infrastructure	100
4	Severe competition	53
5	(C) High expenses/overhead	48
6	Difficulties in export procedure	27
7	(C) High import duties of raw materials and intermediary goods	22
8	Lack of opportunities to meet potential customers	21
9	Difficulty in employee recruitment	17
10	(C) High price of imported raw materials and intermediary goods	16
11	Difficulty in sourcing raw materials and intermediary goods of necessary quantity	15
12	High turnover rate of employees	13
13	Low capacity/obsolescence of machine and equipment	13
14	Lack of collaboration with other companies	12
15	Low capability of developing business strategy/business model	12
16	Strict/inconsistent regulations	12
17	(C) High labor cost	11
18	(C) Low capability of cost control	11
19	Lack of product promotion	11
20	(D) Difficulty in physical distribution	10
21	Cumbersome customs clearance	10
22	Low capability of formulating business plan	10
23	Increasing wages of employees	8
24	Lack of market information	8
25	Low capability of product development/R&D	7
26	Low capability/skills of employees	7
27	Obsolescence of production/processing technologies	7
28	Lack of knowledge and information regarding business-related laws and regulations	5
29	Low capability of production control	5
30	(D) Long lead-time	4
31	(Q) Lack of employees' awareness for quality	4
32	Lack of successor to the current manager	4
33	Unstable purchasing order of customers	3
34	Severe requirements of customers for quality, cost and delivery	2
35	(Q) Lack of standards and certifications	1
36	(Q) Low capability of quality control	1

Note: Score is calculated by summing weighted mark (from 5 (most significant) to 1 (fifth most significant)) in each answer.

Annex II-2. Problems in Linkage with Foreign Companies Answered in Subcontracted Survey_Plastic

Major Problems in Beginning/Strengthening Linkage with Foreign Companies		Score
1	Lack of opportunity to know and contact foreign companies	104
2	Lack of market information	57
3	Unstable order (spot-order)	46
4	None	33
5	Difficulty in making contract (legal matters, guarantees, payment, etc.)	17
6	Difficulty in meeting cost requirement of foreign companies	10
7	Lack of production capacity to produce particular types of products that foreign companies want to procure	9
8	Difficulty in meeting delivery time that foreign companies require	7
9	Difficulty in adjusting to the production control procedures of foreign companies	4
10	Difficulty in meeting quality/quality control level that foreign companies require	4
11	Difficulty in meeting regulatory compliance requirement of foreign companies	4
12	Difficulty in procuring raw materials required by foreign companies for use in the products	2
13	Difficulty in promotion of your products	2
14	Difficulty in producing the product volume ordered by foreign companies	1

Note: Score is calculated by summing weighted mark (from 3 (most significant) to 1 (third most significant)) in each answer.

Annex II-3. Needs for Support Answered in Subcontracted Survey_Plastic

Needs for Support/Services in Future		Score
1	Provision of uncollateralized loans	178
2	Provision of low-interest loans/interest subsidy	162
3	Provision of special purpose loan/lease for procurement of machine/equipment	75
4	Introduction/referral to organizations or experts that can support you in solving the problems	40
5	Arrangement for visit to/meeting with potential customers	30
6	Support in access to market information (including buyer information)	24
7	Training/guidance on product development	22
8	Training/guidance on production improvement methods (KAIZEN, Lean manufacturing, etc.)	22
9	Diagnosis on problems in overall business operation	17
10	Training/guidance on cost reduction/control	17
11	Training/guidance on financial management/accounting (including bookkeeping and tax system)	16
12	Training/guidance on business strategy/model development	15
13	Consultation on access to loans	14
14	Arrangement for technical assistance from big companies	13
15	Training/guidance on human resource management (HRM)	13
16	Guidance on international business standards (acconting system, contract, payment, protocol, etc.)	10
17	Training/guidance for manager(s) for business management	9
18	Guidance on regulatory compliance	8
19	Support in access to technology information	8
20	Training/guidance on export procedure	8
21	Training/guidance on production control	7
22	Training/guidance for successor(s) for business management	6
23	Provision of common production facilities	5
24	Training/guidance on industry/product standards	5
25	Support in participation in exhibitions	4
26	Consultation on business-related laws	3
27	Support in access to supplier information	3
28	Training/guidance on formulating business plan	3
29	Provision of public testing and inspection facilities	2
30	Training/guidance on factory layout	2
31	Training/guidance on production/processing technologies and skills	2
32	Training/guidance on quality control	2
33	Arrangement for joint procurement of raw materials with other companies	1
34	None	1
35	Training/guidance on supply chain management	1
36	Training/guidance on testing and inspection	1
37	Training/guidance on export procedure	1

Note: Score is calculated by summing weighted mark (from 5 (most needed) to 1 (fiftth most needed)) in each answer.

3. 対象産業振興のためのロードマップ・アクションプラン案

Appendix 3: Roadmap and Action Plan for Development of Target Sectors

1. Development Issues in Domestic Supporting Industry Development

This chapter summarizes the fundamental issues of the target sectors, namely, light engineering (hereinafter referred to as "LE") and plastic sectors, from the perspective of the objective of this Project, that is, "to harmonize investment promotion and domestic industry development for enhancing linkages between foreign investors and local supporting industry, thereby contributing to industrial diversification of Bangladesh," as a basis of formulation of the draft of the roadmap and the action plan.

(1) Undeveloped Industrial Base

Formation of the industrial supply chain is only observed in the textile and garment industries in Bangladesh while that of other industries, including the food processing industry which is one of the key industries in the country, is virtually nonexistent. As for the transport machinery industry and machining/metalworking industries which are related closely with the target sectors, there has not been notable development of its supporting industries and institutions, including the parts suppliers, steel makers, die/mold makers, heat treatment facilities, material/product testing and inspection facilities and many others. Thus, inter-industrial linkage does not take shape in the industrial structure of the country. In other words, not only is there no formulation of hierarchical subcontracting system with a large assembler being at the top, but also there is little horizontal division of labor in the industrial sectors of Bangladesh. All of the above indicate that the industrial base in the country is still fragile. Therefore, there are many measures, such as strengthening the industrial infrastructure, re-educating industrial human resources, educating management, promoting supporting industries, and enhancing policies and institutions, which should be taken in order to establish the industrial base for further development of the manufacturing industry in Bangladesh.

(2) Inadequacy of Long-/mid-term View for Industrial Development

Manufacturing processes of many LE companies in Bangladesh are mostly characterized by manual processing and semi-automatic processing, while few companies introduce mass production by automation. Machines used by the companies are often old and secondhand while they are installed without consideration of efficient flow of goods in the manufacturing process in a limited space of the workplace (in particular, this often applies to the factories in the Dhaka metropolitan area). While it coincides with the challenge pointed out by (1) above, Bangladesh is in a stage before the beginning of full-scale industrialization. In addition, leading companies in the Bangladeshi industries usually form the family-controlled corporate groups, or *konzern*, that incorporate not only manufacturing industries but also service industries, financial businesses, etc. Management of these corporate groups tends to act on concepts of the commercial capitalism. It is considered that many of them started their business as a distributor and are now shifting their investment focus to the domestic manufacturing as necessary. From this perspective, in order to promote not only the supporting industries but also the whole industry in the country, it is inevitable to provoke a change in mind-set of the management of these groups to acting on concepts of the industrial capitalism[1] in all aspects of people, goods and capital.

(3) Low Quality-awareness and Innovative Mind

Product development through reverse engineering largely prevails in the Bangladesh's LE sector[2]. However, mind-set of innovation in terms of finding out social challenges or market needs and manufacturing in response to them is yet to spread. In addition, there are currently few manufacturing sites where such an innovative mind-set may start to grow. This issue coincides partly with the lack of mind-set to act on concepts of the industrial capitalism pointed out in (2) above. In the meantime, the issue is also generated by lack of domestic technical support organizations and experts to foster the innovation and its mind-set. Furthermore, price-consciousness of the domestic industrial parts market (companies, users, etc.) focusing predominantly on price, not on quality in the decision-making is also hampering development of the industrial sector into a higher production level requiring the innovation. In Bangladesh, there are many excellent engineers and overseas-experienced technicians while there may not be places where they can demonstrate their creativity. Therefore, measures for industrial and entrepreneurial development using these human resources should also be considered in future.

(4) Unbalanced Development of Plastic Sector

In the Bangladesh's plastic sector, injection molding with single raw material is the mainstream processing method. The sector often applies mass production of small varieties of products, for example, containers such as plastic bottles, hangers and packaging materials. On the other hand, the advanced molding technology (know-how) with compounded plastics necessary for manufacturing industrial parts is hardly seen in Bangladesh. Additionally, mold manufacturing technology which greatly affects the quality of plastic products is yet to develop. Bangladeshi plastic enterprises, which are accustomed to the current mass production of small-varieties, are not suitable for the multi-product, small-volume production system required for, for instance, the production of plastic parts for motorcycles. Further, there is large possibility of a gap emerging between demand and supply if the current plastic companies expand their business into industrial parts production, This is expected not only for motorcycle parts production, but also for production of industrial plastic parts of various kinds that entail the small quantity, large variety production. Therefore, while there are large-scale companies in the Bangladesh's plastic sector, development of the plastic companies into industrial parts suppliers needs to start from the situation where little industrial base for such the development exists.

(5) Lack of Policy and Measures for Supporting Industry Development

A series of the Five Year Plans of Bangladesh has been focusing on, though partially, industrial development since its first version. However, the result is that development of the supporting industries have not been adequately promoted because the measures for the industrial development

---

[1] "Industrial capitalism" here involves the code of the business behavior that attempts to yield the surplus-value from the manufacturing process and keep adding the value by continuously improving and innovating the process.

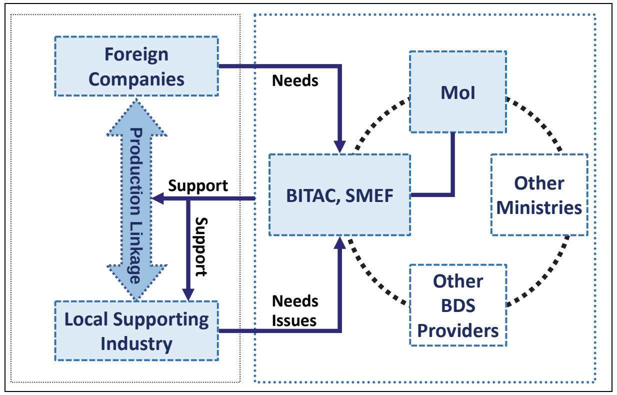
[2] Copying is the main product development method at this point while the companies have not yet been able to copy the product "completely."

have rather focused on industries of jute, cotton-based textile and garment, tobacco, leather, etc., which took advantage of abundant labors of low-wage and domestic natural resources. This tendency remained unchanged even in 1982 when the socialist industrial development policy by reinforcing the state-owned enterprises transformed into the private-investment-led development policy. Moreover, development of the export processing zones that has been in place since the 1990s has not institutionally linked with the domestic manufacturing industry (parts suppliers). As a result, development of the domestic supporting industries has again been left behind[3]. In recent years, although attraction of the foreign capital and development of special economic zones are gradually proceeding, industrial development measures focusing on the supporting industry development is yet to be formulated in the country. Thus, the government is expected to set the clear design, concepts and incentives for further support of development of the supporting industries.

(6) Other Issues

Difficulty in access to finance and in acquiring industrial land is a common issue found across the industrial sector. Further, many companies in the target sectors face challenges related to stock management, marketing (especially product diversification and customer development) and employees' awareness-building for quality improvement, among others.

Herein, the purpose of the Project is clarified again: "To harmonize investment promotion and domestic industry development for enhancing linkages between foreign investors and local supporting industry, thereby contributing to industrial diversification of Bangladesh." Figure 1 shows a concept of the purpose.



Source: JICA Project Team

Figure 1 Concept of Project Purpose

---

[3] Yet, since the number of local industrial parts suppliers were very limited at that time, even if development measures of such suppliers had been promoted intentionally, few suppliers would have been able to respond to such measures.

The purpose is relevant to the fundamental issues faced by the two target sectors and the manufacturing industry in Bangladesh. For that reason, overcoming each of these issues one by one will lead the way to achieving the project purpose.

2 Basic Concept of Roadmap

2.1 Basic Strategies of Roadmap

This section introduces the basic strategies of the roadmap as a framework of the measures that should be taken during the implementation period. These strategies involve the essential factors to achieve purpose of the Project and outcome of this Component.

Strategy 1: Promotion of Supply Chain Development in Industrial Sector

In general, policy makers attempting to promote supporting industries think of facilitating development of the vertical specialization systems in which end-product manufacturers are at the top (e.g. pyramid-shaped supply chains developed in the automobile industry). Promotion of supporting industries constitutes a significant part of an SME promotion measure in Japan where the systems have developed between large assemblers and micro and small parts suppliers, and it also generally holds true for other countries where fabricating industries have developed. In the vertical specialization system, end-product manufacturers give technical support to subcontractors. Looking into Bangladesh, however, it appears less likely that assemblers do so due to their technical capacities as well as their family management style. Meanwhile, they are positive about horizontal specialization. Given that supply chains are underdeveloped, it is realistic for them to purchase common items from horizontal specialization systems while producing firm specific items by themselves. Taking the circumstances into consideration, fostering of parts suppliers for supply chain development targets both parts producers and assemblers.

Strategy 2: Promotion of Change in Mind-set of Business Managers and Human Resources in Industrial Sector through "KAIZEN"

KAIZEN, which has been developed in manufacturing workshops in Japan, is methods, tools, activities with them, and even a business philosophy for improving quality and productivity continuously. Implementing KAIZEN is recognized as an effective way to develop human resources in workplace. Although the Project targets two subsectors, LE and plastics, changes in mind-set and corresponding activities for improving job quality are necessary in all sectors. Given business conditions of typical Bangladesh companies, it is clear that KAIZEN can achieve some economic effect. A necessary step is to launch a "Bangladesh KAIZEN Project" as a national quality-awareness-building activity, which is implemented by all the stakeholders in private, academic and public sectors in their respective fields. As a part of it, the Project promotes KAIZEN in the manufacturing sector as a plan under the action plan.

Strategy 3: Strengthening of Function and Networking of BDS Providers

BDS includes various services other than financial ones to help SMEs to grow and survive (entry to a new market, productivity improvement, etc.). BDS is provided as a form of training, consulting (business check and advisory service), marketing assistance, information provision, R&D assistance, facilitation of business linkage creation, etc. BDS organizations include government organizations, training institutes run by trade organizations, polytechnics, and universities, among others. Of them, Strategy 3 targets five of them, namely BITAC, SMEF, Pilot Plant and Process Development Centre (PP & PDC) of Bangladesh Council of Scientific and Industrial Research, Bangladesh Institute of Plastic Engineering and Technology (BIPET), and National Productivity Organization (NPO) as the recipients of capacity development programs (technical transfer to their staff). Considering them to be key BDS organizations for achievement of the project purpose, the Project plans capacity upgrading programs, and strengthens the networking function of SMEF as a BDS facilitator through the implementation of the action plan.

Strategy 4: Development of Supporting Industries through Nurturing Die/Mold Industry

Supporting industries here in the Strategy 4 refer to those engaged in processing like molding, heat treatment, coloring, jig processing, etc., that is, those doing ancillary or peripheral processing as opposed to those producing parts and materials directly supplied to assemblers. Lack of such an industrial base of processing technology can be a serious bottleneck for developing the industrial sector into competitive one. In particular, dies/molds are used in various processing including stamping, casting, forging, and plastic processing, and thus die/mold-making skills and technology are keys for product processing. In this regard, a program to make them take root constitutes the action plan; other sector-based training programs for maintenance and management technologies as well as basics like how to use measurement tools are covered in other plans under the action plan.

Strategy 5: Formulation, Budget Provision and Implementation of Policies for Development of SMEs/Supporting Industry

SME development policy is under preparation by MoI, and yet the draft just presents overall directions and frameworks, lacking details and specifics which are supposed to be articulated to cope with the above-mentioned issues. For example, it needs to list measures for reinforcement of business foundation of micro, small and middle-sized enterprises, management innovation, development of industrial workforce, consulting service, and cluster development. In addition, it is necessary to formulate sector specific promotion plans which utilize the listed measures. Sector specific promotion plans aim to develop supply chains of subsectors, targeting companies in target subsectors and their upstream and downstream industries. In sum, Strategy 5 is to review and then elaborate drafts of the SME development policy and development policies for specific industrial subsectors prepared by MoI for effective implementation.

Moreover, the Strategy supports MoI in arranging budget to implement programs in these policies and also in preparing financial measures and fiscal incentives (tax incentives and special depreciation allowance for investment promotion, and special purpose long-term low-interest loans for capital investment etc.) so that the country can achieve objectives of the policies. The budget includes funds with which public technical support organizations (BDS organizations) provide assistance for private companies. Institutional reforms associated with budgeting by MoI and the Ministry of Finance are also needed for proper budgeting.

Strategy 6: Promotion of Technical Collaboration and Investment

Supporting industries need end-product producers which buy their products. In general, end-product producers are larger than parts producers and those providing ancillary or peripheral processing. They can be both domestically-owned and foreign-affiliated, and thus promotion of business transactions with foreign enterprises as well as FDI is important for development of supporting industries. Whether they are domestic or foreign, collaboration with those from which the supporting industries can expect technical transfer or equity participation is indispensable for domestic parts producers which aspire to upgrade and expand their businesses. The Bangladesh government has implemented measures to promote FDI, exports and others including EPZ development, investment incentives, and restructuring of custom thresholds. The other components of the Project cover trade and FDI promotion and EPZ development, and coordination to make synergies among the three components is needed. In sum, Strategy 6 is setting up measures for promoting investment as well as technical collaboration for supporting industry development which are in conjunction with the activities of the other two project components.

2.2 Framework of Roadmap for the Next 4 Years

Outcome of Component 3 of this Project is that “industrial competitiveness of LE and plastic sectors in Bangladesh will be enhanced through development of linkage with foreign direct investment (especially through supply of the parts from the target sectors to foreign manufacturing companies investing in Bangladesh) to contribute ultimately to industrial diversification and advancement in Bangladesh.” Four years remain now to realize this outcome as the Project will be completed in the end of the Japanese fiscal year of 2021.

This section presents an overall framework of the roadmap, within which each plan of the action plan recommended in section 2.4.2 shall be implemented with a defined order of priority.

(1) Strategic Target Industries

The roadmap will strategically focus on specific products produced by the LE and plastic sectors with a defined scope of development because the two sectors encompass a very wide range of the subsectors. In other words, it will take approach of first tackling what is likely to produce outcome in a relatively short term and then applying the outcome to other sectors. More precisely, it will focus on development of parts suppliers of motorcycle assemblers through support extended by BDS providers and the motorcycle assemblers to selected companies in the two sectors.

The reason for selecting the motorcycle sector is that both the demand and supply of motorcycles in Bangladesh is expected to increase rapidly, thereby enlarging the demand for local procurement of the parts produced by LE and plastic sectors. A motorcycle comprises 1,000-1,500 parts, many of which are LE and plastic products. In Bangladesh, more than 30 motorcycle brands are competing with each other in the market of yearly sales of 350,000 units, implying that potentiality of future market expansion is wide. In fact, MoI expects the market to reach 500,000-unit scale and further one million by 2027[4]. In addition to the increasing demand, supply-side is now on the expansion move; for example, Complete Knock Down (CKD) assemblers are transferring into the Manufacturer and some of them, including a joint venture involving Honda Motor Company of Japan, are constructing large-scale new factories in preparation for the full local production as the Manufacturer. These factors enlarge possibility that local parts procurements by motorcycle companies in Bangladesh will further accelerate in near future.

In sum, the roadmap will focus initially on motorcycle parts produced by LE and plastic companies with future expansion into the parts used by other industries so that the local parts industry will get advanced and diversified broadly.

(2) Prioritized Areas of Support

As the first step, support to LE and plastic companies will aim for enhancement of basic capacity to produce motorcycle parts, including their prototypes, that require the processing technologies of casting/die-casting, pressing, forging and plastic molding with gradual diversification and advancement. This is because the parts constituting large portion of the manufacturing costs of a motorcycle including the engine require advanced and complicated technologies that the LE and plastic companies in Bangladesh are yet to possess. Notwithstanding, there would not be necessity to wait until all the motorcycle parts get locally available for starting expansion into the new target customers. Such expansion should proceed in parallel after achieving a certain degree of development of the motorcycle parts supplier base.

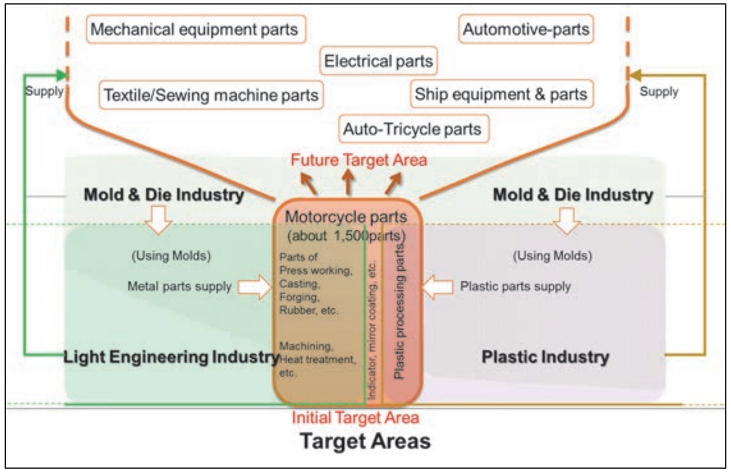
In this roadmap, priority of the support (e.g., the action plan) will be given, in addition to development of motorcycle-parts prototypes, to two important fields; namely, as a pillar of the technical support, “die/mold development” which is a common challenge to both the target sectors, and “expansion of proper use of business management[5] techniques including KAIZEN” as a pillar of management support.

The reason for focusing on the technical support on the “die/mold development” is as follows:

- A die/mold is a very basis of other products with uniform quality in mass production.
- Quality improvement of a product of the target sectors necessitates quality improvement of a die/mold.
- Not many die/mold-specialized producers exist in Bangladesh and their skills and technologies to produce a die/mold and quality of the steel used for it are inferior to those in other countries.

It should be noted here, however, that issues related to the steel used for die/mold making, although constituting the basic factors causing low-quality of local dies/molds,, shall not be tackled as an independent plan under the action plan to seek fundamental solution. This is because thoroughly solving these issues entails tremendous investment and policy change, which cannot be undertaken in the action plan. Support in development of dies/molds will focus only on basic to applied knowledge and technologies of designing, processing, maintenance, and modification of dies/molds. The issues relating to steel will be taken up as a part of the plans dealing with other main issues including this die/mold development support, especially for knowledge and technologies of material composition, processing conditions, alteration of physical and chemical property of the steel including heat treatment, etc. In addition, the action plan may include policy recommendation for privilege measures including import-duty reduction to ease the difficulty in procuring imported steel according to the needs of the local LE and plastic companies.

Figure 2 shows concept of the strategic target industry and prioritized area of support.



Source: JICA Project Team

Figure 2 Concept of Strategic Target Industry and Prioritized Area of Support

On the other hand, the reason for undertaking the “expansion of proper use of business management techniques including KAIZEN” as a prioritized management support is that:

- Most of companies in both the target sectors have limited awareness of quality and its management. This is also caused by the market which is price-conscious, not quality-conscious. Improvement of this situation entails a nation-wide quality-awareness building activity.
- Foreign companies and large domestic companies would not do business with companies with low business management standards even if the latter could produce a high-quality product.
- Permeation of KAIZEN philosophy to business managers and other human resources in the industrial sector brings about change in their mind-set.

---

[4] According to the document of Motorcycle Policy Formulation Committee.

[5] “Business management” here encompasses comprehensive business administration areas including production management and quality management.

In addition to these prioritized support areas, the action plan (draft) will also cover support for strengthening the industrial base of the target sectors including skills development and enhancement of management/marketing capabilities.

(3) Key Performance Indicators (Need to be revised according to the situation at the time to start the action plan)

1) By June 2019: Fifteen technical training extension officers will be nurtured.
2) By June 2020: Additional 15 technical training extension officers and three KAIZEN extension officers will be natured.
3) By December 2020: Additional five motorcycle parts will pass acceptance inspection by the assemblers
4) By December 2020: KAIZEN will be implemented by 15 companies with some results
5) By June 2021: Additional ten technical training extension officers and ten KAIZEN extension officers will be nurtured.
6) By December 2021: Additional seven motorcycle parts will pass acceptance inspection by the assemblers
7) By December 2021: KAIZEN will be implemented by additional 15 companies with good results.
8) By February 2022: A new system of service provision and extension of BDS providers will be established.

(4) Mid-term Evaluation and Revision

A system of monitoring, mid-term evaluation and revision of the action plan will be set up by the implementing agencies together with JICA Project Team. The mid-term review includes progress monitoring, measurement of outcome, feedback of results of the monitoring and the outcome measurement, and revision of the action plan. The mid-term review will be conducted in around March 2020 which is in the middle of the 42-month action plan period. In order to measure level of the outcome objectively, key performance indicators for each plan under the action plan (draft) will be set.

2.3 Model Companies

The most prospective companies in developing forward linkage with motorcycle assemblers (hereinafter referred to as the “model companies”) have been selected from the perspectives of “core technologies,” “machines/equipment,” “willingness to change and grow,” etc. These companies will be a primary target of the action plan for the first two years (from August 2018 to July 2020) of the implementation period. As in Table 1 below, 13 out of 16 selected companies expressed their interests in and consent to participating in the action plan in the re-visit paid by the JICA Project Team from February to March 2018. Implementing agencies together with the JICA Project Team will continue discussion with these model companies until July 2018 to elaborate support plan and methodologies.

Table 1 List of Model Companies (from August 2018 to July 2020)

Company Name		Products	Location	Re-visited	Prototype (first year)	Mold	KAIZEN
1	QVC BD	Chain, Sprocket	Dinajpur	Yes			✓
2	Progoti Engineering Works	Plastics mold	Dhaka (Jatrabari)	Yes	✓	✓	✓
3	Proteeti Toolroom &. Technologies	Mold	Dhaka	Yes	✓	✓	
4	New Grameen Motors	H Power motorcycle	Gazipur	Yes	✓		✓
5	Dhaka Products	Side cover, fender, Indicator	Dhaka		✓		✓
6	Bengal Polymer Wares	Chair, pallet, etc.	Gazipur	Yes	✓	✓	
7	Horizon & Erebus Plastic Ind.	Container for cosmetic	Gazipur	Yes	✓	✓	✓
8	Luna Plastic Ind.	Bottle/cap for food	Narayanganj	Yes	✓		✓
9	Baly Integrated Solutions	Hunger, Plastic packs	Gazipur	Yes	✓	✓	✓
10	Q Pail	Container for paints	Gazipur	Yes	✓		
11	Run Industries	Seat	Faridpur	Yes			✓
12	Advanved Technology & Training Center	Mold	Dhaka	Yes		✓	
13	BLC Tool Room	Mold and Die	Dhaka	Yes	✓	✓	✓
14	Modina Metal Industries	Rim and Spoke	Jessore				
15	Al Madina	Motorcycle Leg guard, sari guard, Stands	Dhaka				
16	Brothers Engineering Works	Mold	Dhaka				

Source: JICA Project Team

These model companies have the following characteristics.

(1) Companies Using Plastic Injection Molding Technology

Motorcycle assemblers in Bangladesh consider starting local parts procurement from the plastic parts which are more practicable than metal parts under the current circumstances. Main processing technology applied by most plastic companies in the country is injection molding. The selected plastic injection molding companies have 400-500 employees with more than 20 injection molding machines which are relatively new compared to those installed by other companies that the JICA Project Team have visited. While the companies with 400-500 employees are classified as “Large” (the companies with 301 employees or more) according to definition of the National Industrial Policy – 2016, these selected companies are small in size among the “Large” plastic companies. All the selected companies currently do business with foreign companies. Owners of those companies have high motivation to grow and venture into the new markets.

(2) Die/mold Companies with New Machines including CNC Machines

These companies employ 20-100 employees and they fall into “Micro” (the companies with 16-30 employees) or “Small” (those with 31-120 employees) categories according to the National Industrial Policy – 2016. All the companies have installed CNC machines; some of them possess electric discharge machines, coating baths and induction furnace as well. Their current main products are plastic molds. These companies fully or partially apply drawings for production, while the owners are all motivated for growth and market diversification

(3) Companies with Experience of Motorcycle Parts Production

The selected companies include those which are supplying parts to motorcycle assemblers at present or have done so in the past. These companies are mostly small in size. It should, however, be noted that only one company of them continuously supply the parts to motorcycle assemblers and some of them are supplying sub-parts to this company. On the other hand, one company is actually a local motorcycle assembler which has potential and willingness to supply the parts to other motorcycle assemblers.

2.4 Action Plan

2.4.1 Whole Framework of Action Plan

The action plan will aim for not only capacity development of BDS providers, but also nurturing of parts suppliers and business partnering between local LE/plastic companies and motorcycle companies though creation of visible accomplishment, thereby contributing to realization of expected outcome of Component 3 and ultimately to achievement of purpose of the whole Project.

Constitution of the Action Plan

Plan 1	Program for Supporting Prototype Development of Motorcycle Parts
Plan 2	Program for Enhancement of Basic Skills for LE Sector
Plan 3	Program for Enhancement of Capacity of Business Managers
Plan 4	Program for Introduction and Extension of KAIZEN
Plan 5	Program for Nurturing Die/Mold Making Technicians and Engineers
Plan 6	Program for Enhancement of Injection Molding Technologies
Plan 7	Support in Formulation of Supporting Industry Development Plan
Plan 8	Support in Establishing a Financial Scheme for Capital Investment for Modernization
Plan 9	Business Matching with Foreign Companies in Economic Zones

Table 2 shows implementing agencies for each plan of the action plan.

Bangladeshi counterpart organizations together with other BDS providers will take lead in implementing the action plan with support from the JICA Project Team. MoI, as an umbrella administration of many of implementing agencies of the action plan, is expected to arrange the budget to implement all the plans. Meanwhile, SMEF, as a BDS facilitator as well as a catalyst for networking of BDS providers, will be responsible for the coordination task for effective and efficient implementation of all the plans.

Table 2 Implementing Agencies of Action Plan

No.	MoI	BITAC	PP & PDC	SMEF	BIPET	NPO
Plan 1		**M**	**S**	**S**		
Plan 2		**M**	**S**	**S**		
Plan 3				**M**		
Plan 4				**M**		**S**
Plan 5		**M**	**S**	**S**		
Plan 6		**S**		**S**	**M**	
Plan 7	**M**			**S**		
Plan 8	**M**			**M**		
Plan 10	**M**			**S**		

Note: M = Main implementing agency, S = Support agency

In addition, the following organizations are expected to collaborate in the action plan (draft):

BEIOA: Bangladesh Engineering Industry Owners' Association
BPGMEA: Bangladesh Plastic Goods Manufacturers & Exports Association
MCCI: Metropolitan Chamber of Commerce & Industry
BMAMA: Bangladesh Motorcycle Assemblers and manufacturers Association
ACAMA: Automobiles Components & Accessories Manufacturer's Association
JETRO Dhaka: Japan External Trade Organization, Dhaka Office
FBCCI: Federation of Bangladesh Chambers of Commerce & Industry

Source: JICA Project Team

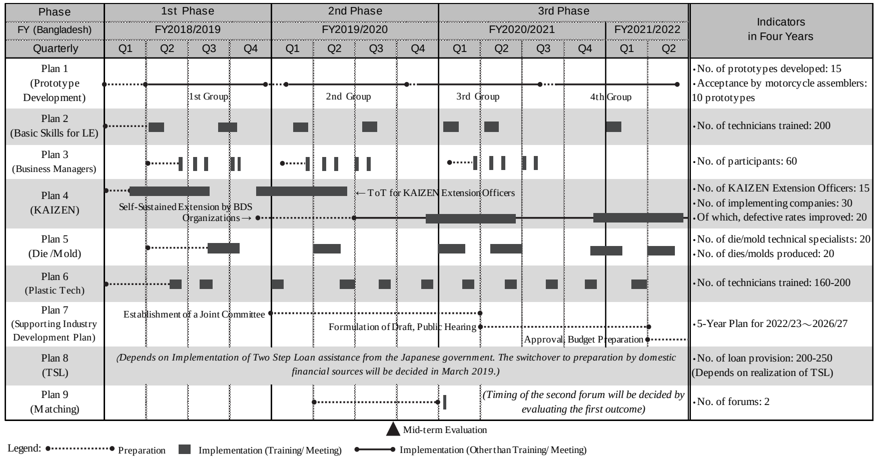
(1) Timeframe

Implementation period of the action plan (draft) will be 42 months from July 2018 to December 2021. The period will be divided into three phases as shown below.

Phase 1: July 2018 – June 2019 (Capacity development of BDS providers and provision of support to prospective companies especially model companies)
Phase 2: July 2019 – June 2020 (Expansion of support area and target by BDS providers)
Phase 3: July 2020 – December 2021 (Establishment of a new system of BDS provision and extension by BDS providers

Table 3 shows tentative implementation schedule of the action plan .

Table 3 Tentative Implementation Schedule of Action Plan



2.4.2 Overview of the Action Plan

Details of each plan of the action plan are presented from the next page.

It should be noted that the action plan entails more discussion among stakeholders for elaboration to ensure effective and feasible implementation. Especially, details of approach of Plan 8 and Plan 9 shall be discussed in a later stage of the action plan implementation.

Plan 1: Program for Supporting Prototype Development of Motorcycle Parts

Objective and Outline	This Plan is a program to support development of a prototype of motorcycle parts identified by Plan 9 "Support in Business Matching between Parts Suppliers and Motorcycle Assemblers." The program, by supporting prototype development of the model LE/plastic companies, will aim to enhance possibility of these companies to make a deal with motorcycle assemblers, thereby contributing to increase in local procurement of the motorcycle parts and ultimately to import substitution of them. In addition, the program will lead to enhancement of capacity of technicians in the model companies as well as capacity of BDS providers supporting the prototype development. Eventually, technological development of the whole target sectors is expected to accelerate. The program will provide technical support from related BDS providers backed by JICA Project Team for prototype development in due accordance with the specification defined by the motorcycle assemblers for specific parts. This is because the similar business matching program conducted in the past have not extended adequate technical support based upon the customers' needs, thus leading to only a few business transactions. It should be noted that the program will support only development of the prototype that will pass the acceptance inspection by motorcycle assemblers; not negotiations on terms and conditions of the transaction.
Implementing Agencies	- BITAC (a main implementing agency) - PP & PDC (a supporting agency (drawing-support, material testing support, etc.)
Target	- 20 model companies from LE and plastic sectors - BITAC (by capacity development) - PP & PDC (by capacity development)
Activities and Step	BITAC and, PP & PDC where necessary, will utilize their facilities and human resources as much as possible to extend technical support to the model companies for prototype development of the motorcycle parts. Steps to be taken in implementing Plan 1 are as follows. (1) Step 1 (For the 1st Group: July 2018-October 2018, except installment of machines/equipment in c.) a. BITAC with support from JICA Project Team will select motorcycle parts from those identified by Plan 9 and the model companies that can produce these parts. ➢ Note that, for the 1st Group (the parts and model companies to be targeted from August 2018 for the maximum ten months), BITAC and JICA Project Team will, due to time constraint to implement Plan 9, select the parts and model companies based upon results of interviews with motorcycle assemblers. b. JICA Project Team will re-assess capacity of existing human resources and facilities including machines/equipment in BITAC and PP & PDC to identify capacity-gap that needs to be eliminated to implement this Plan. c. BITAC and PP & PDC will take measures to eliminate this gap. ➢ These measures include formulation, and implementation if possible, of

	plans for procurement of necessary machines/equipment, retraining of staff, etc. ➢ JICA Project Team will support both organizations in taking these measures. d. BITAC with support from JICA Project Team will design an implementation plan for this program. ➢ This includes a support plan formulated from the various perspectives of PQCDSM based upon specification of the specific parts and requirements from motorcycle assemblers. ➢ How to arrange dies/molds and raw materials for prototype development will be confirmed between the model company and the motorcycle assembler. (2) Step 2 (Ditto: October 2018 -) a. BITAC will start implementing the program. ➢ A meeting/meetings will be arranged among BITAC (and PP & PDC if necessary), the model company, JICA Project Team and the motorcycle assembler to discuss how to proceed with the implementation plan. ➢ The model companies and BITAC and/or PP & PDC will exchange MOU for prototype development. b. The model companies with support from BITAC and/or PP & PDC will continuously produce prototype whereby capacity of technicians of the model companies and capacity of staff of BITAC and PP & PDC will be enhanced. ➢ Note that most of the support activities are supposed to be conducted by BITAC and/or PP & PDC with support from JICA Project Team at site of the model companies. ➢ Note that the number of prototype-makings (the number of trial-error cycles) will be decided in the MOU above. c. The model companies with support from BITAC and/or PP & PDC will internally evaluate the developed prototype by, where necessary, utilizing facilities of BITAC and/or PP & PDC. (3) Step 3 (Ditto: Continuation) a. The model companies with support from BITAC and/or PP & PDC will improve the prototype based upon results of the internal evaluation above. b. The model companies will send the developed prototype for inspection by the motorcycle assembler (incoming inspection for acceptance). ➢ Note that well-prepared time management should be ensured because inspection of many of the prototypes is expected to be conducted in the country where headquarters of the brands with which Bangladeshi motorcycle assemblers collaborate are located. c. BITAC and/or PP & PDC will provide technical support and advice to improve the prototype based upon results of the incoming inspection for acceptance above.
	(4) Step 4 (From the 2nd Group onward: July 2019 -) a. BITAC with support from JICA Project Team will revise the program according to results and lessons from the 1st Group of prototype development. b. BITAC with support from JICA Project Team will start implementing the revised program for the 2nd Group of the prototype development based on the revised program.
Input	- How to share the expenses incurred for prototype development, provision of technical support and actual processing work should be agreed before the program starts. - Ceiling of the input amount should be predetermined, although the amount may vary depending on model companies.
Budget	Budget and burden share should be defined by d. of Step 1 and a. of Step 2. - Expenses for provision of machines/equipment for BITAC including CNC machines (possibility of support from JICA would be explored for the machines/equipment that are necessary for implementation of the action plan but lack in a list of those procured by BITAC by December 2018). - Expenses for materials - Expenses for technical officers from BITAC and PP & PDC - Expenses for using the facilities of BITAC and PP & PDC
Indicator	- Twenty (20) prototypes will be developed by the end of action plan implementation. - Of which, 15 will be accepted by the motorcycle assemblers.
Remarks	- Maximum ten months will be allocated for technical support to each prototype development. - Prototype development activities and evaluation will be performed at production site of the model companies as well as facilities of BITAC and PP & PDC. - Since prototype development involves sensitive and confidential information of the customers (motorcycle companies), all the actors in this program must comply with what is required by the customers in this regard.

Plan 2: Program for Enhancement of Basic Skills for LE Sector

Objective and Outline	This Plan is a program to enhance basic skills of technicians in LE companies. The program will comprise training focusing on quality inspection/management including measurement, maintenance of machines/equipment, and maintenance of tools (cutting tools). Period of the training is supposed to be for 15 days in total and the venue will be at BITAC. The participants will need to pay fees. In future, this training is expected to be co-organized by BITAC and SMEF in regional branches of BITAC for companies located around the respective branches.
Implementing Agencies	- BITAC (provision of venue and assignment of trainers) - PP & PDC (assignment of trainers) - BEIOA-Light Engineering Training Institute (assignment of trainers)
Target	- Technicians of LE companies including model companies (workers/supervisors at production lines) - BITAC (by capacity development) - PP & PDC (by capacity development) - BEIOA-Light Engineering Training Institute (by capacity development)
Activities and Step	Steps to be taken in implementing Plan 2 are as follows. (1) Step 1 (July 2018-October 2018) a. Three organizations above with support from JICA Project Team will have discussions to formulate the training plan. b. BITAC with support from JICA Project Team will make preparation for implementation of the training at its venue. c. JICA Project Team will support the three organizations in preparing teaching materials, cutting tools, other necessary equipment and trainers. d. BITAC and/or BEIOA with support from JICA Project Team will invite and select the training participants. (2) Step 2 (October 2018 -) a. Implementation of the training ➢ The training will take form of the training of trainer (TOT) for staff of the implementing agencies. ➢ The training will, for the first two or three courses, focus on staff of the implementing agencies to nurture the technical training extension officers. ➢ The training is supposed to cover the following themes. <Quality Inspection/Quality Management> 4 days (16 hours in total) ✓ Basics of a drawing and production according to tolerances specified by the drawing ✓ Difference between quality inspection and quality management ✓ How-to-use, maintenance and calibration of various types of measuring equipment <Maintenance of Machines/Equipment>: 2 days (10 hours in total) ✓ Types of machines/equipment ✓ Maintenance of machines/equipment and its influence on product accuracy ✓ Preventive maintenance and breakdown maintenance <Maintenance of Cutting Tools>: 9 days (54 hours in total) ✓ Re-grinding of end mills ✓ Re-grinding of drills ✓ Re-grinding of taps b. Evaluation and revision of the plan
Input	- A coordinator and trainer (JICA Project Team) - Trainers (to become the technical training extension officers) (BITAC, PP & PDC, BEIOA) - Facilities (BITAC) - Teaching materials (BITAC, BEIOA and JICA Project Team) - Cutting tools, other necessary equipment (BITAC and BEIOA)
Budget	- Expenses for inputs above. ➢ Participants in the training need to pay fees covering 50% of the cost. ➢ The remaining expenses, except that for teaching materials, will be borne by BITAC and BEIOA.
Indicator	- 160-200 technicians will be trained in the program by the end of action plan implementation.
Remarks	- It will be essential to make the training appealing to owners of LE companies because cost burden (50% of the training expense) would reduce the number of the participants.

Plan 3: Program for Enhancement of Capacity of Business Managers

Objective and Outline

This Plan is a training program to enhance capacity of business managers of LE and plastic companies. The training will impart knowledge and management technologies required to do business with foreign companies.

This Plan is formulated because the current training programs provided by BDS providers in Bangladesh concentrate mostly on basic knowledge and skills for young generation to get a job, while there are only a few opportunities to learn management skills and international business practice of global standards (except some short courses offered by chambers of commerce and industry). Further, business owners in Bangladesh do not have adequate awareness of regulatory compliance, environmental issues, safety management, accounting standards, etc. that are of significant importance to do business in global arena.

Implementing Agencies

- SMEF

Target

- Owners and management officers in LE/plastic companies including model companies
- SMEF (by capacity development)

Activities and Step

Steps to be taken in implementing Plan 3 are as follows:

(1) Step 1 (October 2018-December 2018)

SMEF will perform the following task with support from JICA Project Team.

a. Designing of the training

- ➢ The training will take form of the training of trainer (TOT) for staff of SMEF.
- ➢ Training schedule will be adjusted to the busy schedule of business owners; for example, once in a month for five months.
- ➢ The training is supposed to cover the following themes.

Themes		Details
1	Roles of Managers – Learning from Multinational Companies Implemented in: December 2018 (for the 1st course)	Business environment keeps changing. Under such circumstances, business managers are responsible for i) identifying the company's challenges in all aspects of PQCDSM, ii) provoking change in employees' mindset and code of conduct for solving these challenges, and iii) achieving the organizational innovation of the company. The participants will learn what needs to be done to achieve such innovation. For this opportunity to be more practical, the training will introduce how managers of large Japanese companies including HONDA, TOYOTA, Panasonic, etc. have achieved such the innovation. More concretely, the participants will learn i) business environment analyses, ii) functional strategies (on production, finance, HR, etc.), and iii) issues in these strategies and solutions for them (e.g., QC activities, 5S, KAIZEN, etc.) by practicing these in the specific formats.
2	Supply Chain Management – Response to Changes Implemented in: January 2019 (for the 1st course)	Introduction of the just-in-time system of Toyota and Supply Chain Management (SCM) would help companies to extricate themselves from chronic management culture that they have been riddled with. Business managers are required to have mind-set to accept a radical change that would take place by introducing a new system. In this theme, the participants will learn essential factors that business managers need to know in doing the contract manufacturing with foreign companies. More precisely, they will learn i) basics of SCM, ii) transformation from the push-style manufacturing system into the pull-style manufacturing system, iii) a concept of "the downstream processes are customers," iv) difference between prototype-making and mass-production, e) quality management required for manufacturing genuine parts/components of foreign companies, v) disclosure of financial information and information about production processes for financial/process audits by customers, and vi) basics of goods management (for dies/mold, jigs, etc.)
3	Toward "Win-Win Relationship" Implemented in: February 2019 (for the 1st course)	Various companies in an SCM system establish a partnership. This partnership benefits all the members therein; such relationship is called "Win-Win Relationship." Each of these companies should undertake to achieve a total optimization as the SCM system. For this, every company needs to act on global standards. In this theme, the participants will learn, as a potential motorcycle parts maker, i) company-wide safety education, ii) environment-friendly procurement policies, iii) punctuality, contract compliance, and duty of confidentiality, iv) measures against defects and prevention of recurrence, and v) employee education/training.
4	Introduction of Financial Management for Business Managers Implemented in: April 2019 (for the 1st course)	Business managers need to enhance company's financial credibility to sustain continuous business with customers. They also need to yield financial outcome by undertaking decision-making regarding goal-setting, business expansion under the changing environment, investment in such expansion, fund-raising for the investment, and education and training to nurture employees able to carry out these tasks. For these, business managers should be familiar with the financial management. In this theme, the participants will learn i) a balance sheet, ii) a profit-loss statement, iii) a cost report, iv) cash-flow analysis, v) break-even point analysis, vi) a business income and expenditure plan, and vii) International Financial Reporting Standards (IFRSs).
5	Formulation and Presentation of a Business Income and Expenditure Plan Implemented in: May 2019 (for the 1st course)	The participants will formulate a business income and expenditure plan required to realize the functional strategies that they have learned on Day 1. They will also present the plan to others (10 minutes/person)

b. Selection and invitation of resource persons

- ➢ For example, managers of Japanese companies in Bangladesh and business managers of local large companies who can speak of their international business experience.

c. Invitation and selection of the participants.

(2) Step 2 (October 2018 -)

a. Implementation

b. Evaluation and revision of the plan.

Input

- Coordinators (SMEF)
- Half of the trainers (SMEF, BIM and other local BDS providers)
- Half of the trainers (foreign resources including companies and JICA Project Team)
- Facilities (SMEF)
- Teaching materials (SMEF and JICA Project Team)
- Other necessary equipment (SMEF)

Budget

- Expenses for inputs above.
  - ➢ Participants in the training need to pay fees covering almost all the expenses.
  - ➢ Venue will be provided by SMEF for free of charge.

Indicator	- About 60 business owners/management officers will be trained in the program by the end of action plan implementation.
Remarks	- The training should be appealing to business owners and management officers so that they would like to participate even if paying fees covering almost all the expenses. ➢ Especially, the training should be able to cause the companies to get internationalized or to catch up with the international business standards.

Plan 4: Program for Introduction and Extension of KAIZEN

Objective and Outline	This Plan is a program to introduce and disseminate KAIZEN, or quality and productivity improvement activities. The program will comprise seminars, workshops and consultation/technical services to enhance quality and productivity and their management system in LE and plastic companies. At the same time, the program will foster KAIZEN extension officers by offering opportunities for classroom and onsite practical training as well as provision of technical services by the extension officers. In addition, the program will also support BDS organizations in Bangladesh in establishing a sustaining system to introduce and extend KAIZEN by themselves. The ultimate goal of the program is to change the mind-set of business managers and other human resources in the industrial sector because many of business owners in Bangladesh do not have adequate awareness of significance and necessity of quality management technologies and better working place. They tend to think that only the existence of good machines and workers who can use the machines will enable their companies to produce massive products of good quality. At this point, SMEF and NPO provide services to introduce KAIZEN while BIM renders KAIZEN-related courses.
Implementing Agencies	- SMEF (a main implementing agency) - BIM (a supporting agency that dispatches candidates of KAIZEN extension officers) - NPO (a supporting agency that dispatches candidates of KAIZEN extension officers)
Target	- LE and plastic companies (not limited to the model companies) - Candidates of KAIZEN extension officers of SMEF, BIM and NPO
Activities and Step	In the first half of the program period, JICA Project Team will train KAIZEN extension officer candidates by lectures and on-site technical service (OJT) in the model companies, while the KAIZEN extension officer candidates will take lead in technical services to the companies with support from JICA Project Team for the second half. Steps to be taken in implementing Plan 4 are as follows. (1) Step 1 (July 2018-September 2018) SMEF will set up an operation office to implement KAIZEN introduction and extension by September 2018. a. The operation office will comprise representatives from the implementing agencies of this Plan while SMEF will assign a specialized officer in charge of this program. b. The operation office will formulate a plan for training to foster the KAIZEN extension officers. c. JICA Project Team together with SMEF will prepare training curriculum, training materials, etc. for the training to foster the KAIZEN extension officers (the materials for companies may be an excerpt from this training materials). ➢ Training curriculum and materials used in JICA projects in other countries will be fully utilized as reference and adjusted to Bangladesh’s contexts. ➢ The training is supposed to cover the following topics. <Classroom Training> 8 days

	✓ What is KAIZEN? ✓ 6S (including Safety) ✓ QC story ✓ 7 QC Tools ✓ 5 Whys ✓ Industrial Engineering (IE) ✓ Group discussion on case studies of the topics above <On-site Training> 2 months (a visit/week), 3 themes ✓ 6S ✓ Quality improvement ✓ Productivity improvement d. The operation office will select the companies (model companies) where onsite technical services (on-site training) will be provided. e. The operation office will have the plan approved by MoI and obtain the implementation budget. (2) Step 2 (September 2018-December 2021) a. The operation office will start dissemination and awareness-raising activities of this Plan, expected effects of KAIZEN, etc. b. JICA Project Team will conduct the training to foster KAIZEN extension officers in September 2018 (on a free-of-charge basis) ➢ The training will be provided in 2018, 2019, 2020 and 2021 (4 times in total) and the maximum number of the participants per time will be ten. ➢ The training in 2018 and 2019 will take form of TOT where JICA Project Team will train candidates of the KAIZEN extension officers. ➢ The training in 2020 and 2021 will take form of TOT where the extension officers fostered in 2018 and 2019 will train the new candidates with support from JICA Project Team. c. The operation office and JICA Project Team will perform regular monitoring and evaluation. (3) Step 3 (July 2019 -) Each of the implementing agencies of Plan 4, with support from JICA Project Team, will do the following tasks. a. Preparation for establishing a system to provide the fee-based services. b. Establishment of a sustaining system to conduct KAIZEN introduction and extension services and TOT by themselves (January 2020 -). c. Extension of the services to more companies (for a fee) (January 2020 -). ➢ This will include both the training in 2020 and 2021 mentioned above and the services rendered by each agency on its own.
Input	- Trainers to foster KAIZEN extension officers (several experts from JICA Project Team) - 3-6 candidates of KIAZEN extension officers from each implementing agency (maximum 10 person/training) - Venue, teaching materials, and other necessary items for the training to foster KAIZEN extension officers, seminars and workshops (SMEF)
Budget	- Expenses for inputs above. ➢ Expenses incurred for dispatch of KAIZEN extension officer candidates including travel allowance will be borne by respective implementing agencies. ➢ Venue and other necessary equipment for the training will be borne by SMEF. - JICA Project Team will support some of expenses in the first half of the program period, while for the second half of the period, the implementing agencies will bear all the expenses from their budget or from earnings from the fee-based KAIZEN technical services.
Indicator	- Fifteen (15) KAIZEN extension officers will be nurtured by the end of action plan implementation. - Thirty (30) companies will be provided with the KAIZEN technical services by the end of action plan implementation
Remarks	- Effective dissemination activities (presentation of success cases, presentation from companies which have introduced KAIZEN, PR through media, etc.) should be performed to have KAIZEN widely take root in the target sectors as well as the whole industrial sector. - Future networking of KAIZEN consultants including private consultants should be taken into consideration from the early stage of the program.

Plan 5: Program for Nurturing Die/Mold Making Technicians and Engineers

Objective and Outline	This Plan is a program to nurture die/mold making technicians and engineers. The program will be implemented because there is a significant lack of die/mold making technologies in Bangladesh including product designing and drawing, process designing, steel selection, steel treatment, processing work and many others. The program will comprise both classroom and onsite practical training on basic and applied topics. These topics will include the following: - Characteristics and processing conditions of various types of steel - Knowledge and techniques of heat/surface treatment and alloy designing/metallurgy - Basics of drawings and applied knowledge of die/mold drawings - Knowledge and techniques of processing/machining including CNC machine operation - Processing accuracy - Maintenance and troubleshooting of dies/molds, etc. Both dies/molds for LE products (especially dies for pressing) and molds for plastic products will be taken up in the training. Training of basics (theories) of die/mold-making will be provided for both the products together, while practical training of processing technologies will separately be rendered. Meanwhile, JICA Project Team will provide the training on processing conditions/machining, processing accuracy and relationship between the two, the most significant issues among the topics above, to all the participants including staffs from BITAC and PP & PDC, while training of other topics will be rendered by BITAC and PP & PDC with support from JICA Project Team. Whereas the training is supposed be conducted twice (two days) per week over the two-month period (15 times), the actual schedule will be elaborated after discussion with the companies.
Implementing Agencies	- BITAC (a main implementing agency) - PP & PDC (a supporting agency)
Target	- Technicians and engineers of LE/plastic companies including model companies making dies/molds - Technicians and engineers of specialized die/mold making companies (mainly model companies) - BITAC (by capacity development) - PP & PDC (by capacity development)
Activities and Step	BITAC will mainly implement this Plan with support from JICA Project Team. The main training venue will be at Tool Institute of BITAC. Steps to be taken in implementing the Plan 5 are as follows. (1) Step 1 (October 2018-March 2019) BITAC with support from JICA Project Team will do the following. a. Designing of training ➢ Preparation of training process/timeframe based upon the opening schedule of the Tool Institute and its readiness for use for the training ➢ The training will take form of the training of trainer (TOT) for staff of the implementing agencies. ➢ The training will, for the first two or three courses, focus on staff of the implementing agencies to nurture the technical training extension officers. ➢ The training is supposed to cove the following. <Designing (including practical session)> 5 days ✓ Basics of a drawing and drawing-making ✓ Basic structure of dies/molds ✓ Basics of a die/mold-drawing and die/mold drawing-making ✓ Basics of a drawing for die/mold parts ✓ Maintenance and repair of dies/molds, etc. <Processing (including practical session)> 10 days ✓ Basics of a processing technologies ✓ Basics of machine tools ✓ Types of steels and their processing conditions ✓ Surface roughness of dies/molds according to the processing conditions ✓ Practice of using CAD/CAM and CNC machines ✓ Practice of maintenance and repair of dies/molds, etc. b. Selection of the participants c. Preparation for implementation (2) Step 2 (March 2019-December 2021) BITAC (and PP & PDC where necessary) with support from JICA Project Team will do the following: a. Implementation ➢ The training will be conducted for six times in 2019, 2020 and 2021. b. Collaborative actions with Plan 1 for die/mold prototype development c. Onsite consultation at the companies for troubleshooting d. Evaluation and revision of the program
Input	- Dies/molds for training use (including transparent ones made of acrylic) - Measurement equipment (calipers, micrometer calipers, etc.) - Steel for die/mold making - Steel processing machines including CNC machines - Teaching materials, plotting paper, painting materials, etc. - Technical service providers from BITAC and PP & PDC
Budget	- Expenses for inputs above. ➢ Participants in the training need to pay fees (the amount will be decided later).
Indicator	- Eighty (80) technicians will be trained in the program by the end of action plan implementation. - Die/mold prototypes will be developed for Plan 1.
Remarks	- Whereas BITAC will be the main implementing agency and venue for the program, necessary infrastructure for the training including instructors, facilities, materials, etc. has not yet been well developed in the organization. - The training should be made as practical as possible through, for example, collaboration with Plan 1 for die/mold prototype development.

Plan 6: Program for Enhancement of Injection Molding Technologies

Objective and Outline	This Plan is a training program to enhance injection molding technologies of workers and supervisors at production lines in plastic companies. The program will comprise classroom training and onsite practical training of seven days per time. The participants will need to pay fees. Topics of the training will include knowledge of plastic resins including those used for industrial parts, and processing conditions, finishing and improvement of molding defects especially for industrial parts molding. In addition, the training will take up the actual cases of trouble that have happened in the companies so that the participants will be able to increase practical capacity to deal with the troubles.
Implementing Agencies	- BPGMEA - Bangladesh Institute of Plastic Engineering and Technology (BIPET) ➢ The training will be integrated into the existing training programs of BIPET ➢ If the training involves use of machines, occasional organization of the training at BITAC will be considered depending on availability of machines for the training.
Target	- Technicians (especially workers/supervisors at production lines) of plastic companies including model plastic companies - BITAC (by capacity development) - BIPET (by capacity development)
Activities and Step	This Plan will focus on enhancement of injection molding technologies. The training will, based partly on discussion with BPGMEA, be formulated to be effective in view of supporting industry development. Steps to be taken in implementing Plan 6 are as follows. (1) Step 1 (July 2018-December 2018) a. BIPET and BITAC with support from JICA Project Team will have discussions to formulate the training plan. ➢ The training will take form of the training of trainer (TOT) for staff of the implementing agencies. ➢ Decision will be made as to whether the training will be conducted through the training program of BIPET or it will be directly rendered to plastic companies at site (on-site training only). ➢ In case the training will be directly provided to plastic companies, decision will be made as to whether it will be conducted at each company or at some selected companies ➢ Duration of the training will be two days for classroom training and five days for on-site practical training per time. ➢ The training is supposed to be conducted for once in 2018, four times in 2019, three times in 2020 and three times in 2021 (11 times in total). b. BIPET and BITAC with support from JICA Project Team will prepare teaching materials. ➢ Teaching materials will be prepared by revising the current materials of BIPET and BITAC written in Bengali through discussion with BPGMEA. ➢ The main topics will be basic technologies for injection molding while various plastic products including industrial parts and plastic resins used for the industrial parts will also be covered. ➢ The training is supposed to cover the following topics (every topic will comprise classroom training and on-site practical training). ✓ Basics of injection molding technologies ✓ Difference between commodity plastic resins and engineering plastic/super engineering plastic resins ✓ Basics of processing conditions of each plastic resin ✓ Basics of specification of injection molding machines ✓ Basics of flow behavior of resins inside molds ✓ Procedure of processing condition setting ✓ Molding defects and measures against the defects ✓ Implementation of troubleshooting ✓ Introduction of special molding machines and products, etc. c. BIPET and BITAC with support from JICA will prepare machines/equipment for the training (mainly the existing machines/equipment in these organizations) d. Invitation and selection of the participants (including staff of implementing agencies) (2) Step 2 (December 2018 -) BIPET and BITAC with support from JICA Project Team will do the following. a. Implementation of the training (December 2018 for the first course) ➢ The training will, for the first course, focus on staff of the implementing agencies to nurture the technical training extension officers. ➢ Training in Japan and/or the third country will be considered. b. Evaluation and revision of the training program
Input	- A coordinator and trainer (JICA Project Team) - Candidates of technical training extension officers (BIPET and/or BITAC) - Teaching materials (BIPET and BITAC) - Plastic resins including engineering plastic resins (BIPET or JICA Project Team) - Other necessary machines and equipment (BIPET and/or BITAC)
Budget	- Expenses for inputs above. ➢ Participants in the training and BPGMEA need to cover 50% of the total expenses. ➢ The remaining expenses will be borne by the Project budget.
Indicator	- 160-200 technicians will be trained by the end of action plan implementation
Remarks	- Plastic companies, especially medium- and large- sized companies, are expected to be able to pay fees covering (together with BPGMEA) 50% of the total expenses, thus making it less difficult, than the case of LE companies, to have the sufficient number of the participants in light of the indicators above. - Even so, the training should be appealing to owners of the plastic companies. - Implementation of the training in Japan and/or the third country will be considered after the start of the training.

Plan 7: Support in Formulation of Supporting Industry Development Plan

Objective and Outline	This Plan will aim to formulate a master plan for development of the industrial supply chain and supporting industries of Bangladesh. At this point, there is no assembler of automobiles except large commercial vehicles in Bangladesh, though the automobile industry has the largest supporting industries in the manufacturing sector. It is, however, necessary to formulate the policy for supporting industry development that involves backward linkage from the automobile industry in consideration of future income growth and motorization in the country. On the other hand, the motorcycle market in Bangladesh has been steadily expanding, thereby augmenting needs for development of domestic supporting industries and supply chain of the sector. Thus, the master plan will first focus on development of supporting industries and supply chain of the motorcycle sector, while covering measures for future development for those of the automobile sector. Plan 7 will support formulation of this master plan, tentatively entitled “Motor Vehicle Supporting Industries Development Policy,” which will become a basis of activities to be undertaken for supporting industry/supply chain development in the country in future including those under this action plan. The master plan will cover not only forward linkage of parts/component, but also that of other related industries including dies/molds and raw materials such as iron/steel and plastic resin.
Implementing Agencies	- MoI (a main implementing agency) ➢ JICA Project Team will support activities undertaken by MoI. - BIDA, BEZA and other related agencies (members of the committee below)
Target	- LE and plastic sectors - Motorcycle and automobile sectors - Other related actors in supply chain of the sectors above.
Activities and Step	Plan 7 will start with review on a final draft of “Motorcycle Development Policy 2017” currently under public hearing and on the similar policies in other Asian countries. Based upon results of such review and the current situation survey conducted so far in this Project, “Motor Vehicle Supporting Industries Development Policy 2019” will be formulated. Steps to be taken in implementing Plan 7 are as follows. It should be noted that the steps below are premised on the case where MoI will officially announce “Motorcycle Development Policy 2017” by the end of May 2018. (1) Step 1 (July 2018-September 2018) Setting-up of a private-academia-public joint committee for policy formulation a. MoI, with initiative of its Additional Secretary, will set up a private-academia-public joint committee for formulation of the policy, tentatively called “Committee on Formulation of Motor Vehicle Supporting Industries Development Policy 2019,” composed mainly of the current “Motorcycle Policy Formulation Committee” members. ➢ Since this policy is supposed to cover promotion of business partnering with foreign companies, BIDA and BEZA will be invited to the committee. b. MoI will officially announce establishment of the committee by the end of August 2018, followed by the first committee meeting to be organized in September 2018. c. MoI will establish and confirm the rules and operational management mechanism of the committee, while preparing budget to be incurred until the public hearing. (2) Step 2 (September 2018-September 2019) The committee will undertake the following tasks. a. Review on related policies/plans of other Asian countries ➢ An overseas study tour will be considered by the Project budget. b. Setting of goals and framework of the policy (December 2018) c. Discussion on the action plan to be implemented under the policy d. Formulation of a draft of the policy e. Organization of the public hearing (September2019) (3) Step 3 (September 2019-May 2020) MoI will perform the following tasks. a. Estimation of budget to implement the action plan under the policy b. Coordination with related organizations (including donor agencies) c. Finalization of the policy and proceeding of governmental formality for policy formulation (December 2019) d. Preparation of budget and human resources for implementation of the action plan under the policy (4) Step 4 (July 2020 -) Each implementing agencies of the action plan under the policy and MoI will do the following. a. Implementation and continuous monitoring of the action plan (July 2020-) b. Evaluation based on the monitoring results and revision of the action plan
Input	- For formulation of the policy: Committee members on a voluntary basis - For implementation: Implementing agencies assigned by the policy including BDS providers targeted in this action plan of the Project
Budget	- Meeting and operational expenses of the committee (by MoI)
Indicator	- “Motor Vehicle Supporting Industries Development Policy (2019) (Tentative)” will be formulated by the end of December 2019 - Implementation of the action plan under the policy will be started from July 2020.
Remarks	- Steps above are premised on the case where MoI will officially announce “Motorcycle Development Policy 2017” by the end of May 2018. - The committee for this policy will be a private-academia-public initiative. - The members of the committee may include the foreign companies currently investing or interested in investing in Bangladesh. - An important point is that the committee should not be just a formality, but be able to formulate the feasible and effective policy based on profound knowledge and vast experience of the target industries and their supply chain in Bangladesh and foreign

	countries. - An overseas study tour should be utilized effectively for policy formulation. - Collaborative and complementary relationship will be ensured between the action plan of this Project and the action plan of this policy while overlap between the two should be avoided.

4. 経営管理者能力向上支援プログラム（プラン 3）教材

Project for Promoting Investment
and Enhancing Industrial Competitiveness
in the People's Republic of Bangladesh

Program for Enhancement of Capacity of Business Managers

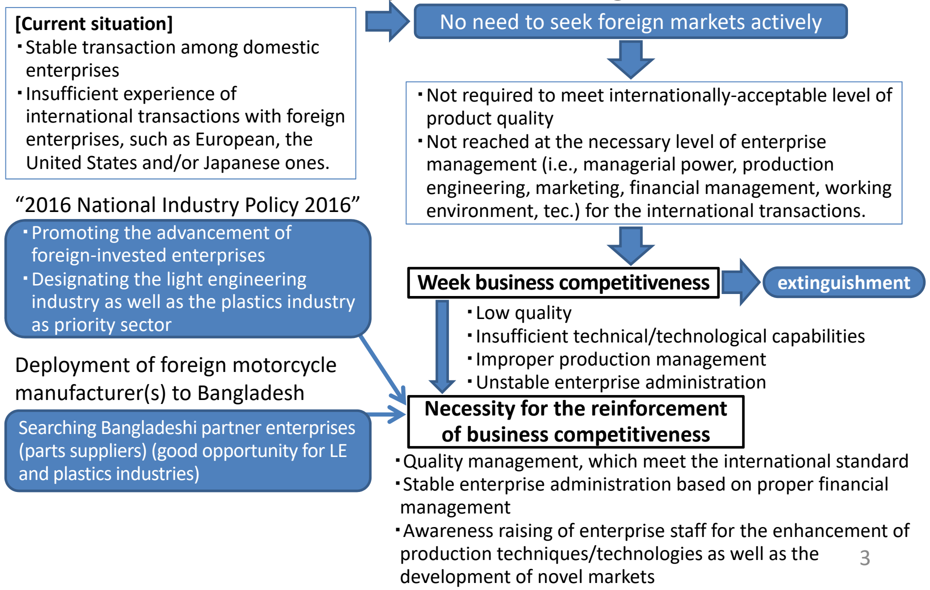
Program Overview

NAOYA NISHIGAKI
JICA Expert

Introduction of Lecturer

- Mr. Naoya NISHIGAKI, a 64-year old licensed consultant, graduated from the faculty of business administration of the *Ritsumeikan* University, running a one-man enterprise from the age of 26, working in the area of the small and medium-sized enterprise (SME) management consulting for over 40 years with the experiences of 1,000 or more enterprises diagnoses.
- I grew up in NAGOYA city of AICHI prefecture, which has been producing the largest shipment value of manufactured goods in the country for 40 consecutive years
- Main Books
  - A dictionary for powering on-site administrators.
  - Seven tools for on-site administrators.

Current Situation and Issues of LE and Plastic Companies in Bangladesh



[Current situation]
・Stable transaction among domestic enterprises
・Insufficient experience of international transactions with foreign enterprises, such as European, the United States and/or Japanese ones.

No need to seek foreign markets actively

・Not required to meet internationally-acceptable level of product quality
・Not reached at the necessary level of enterprise management (i.e., managerial power, production engineering, marketing, financial management, working environment, tec.) for the international transactions.

Week business competitiveness

extinguishment

・Low quality
・Insufficient technical/technological capabilities
・Improper production management
・Unstable enterprise administration

"2016 National Industry Policy 2016"
・Promoting the advancement of foreign-invested enterprises
・Designating the light engineering industry as well as the plastics industry as priority sector

Deployment of foreign motorcycle manufacturer(s) to Bangladesh

Searching Bangladeshi partner enterprises (parts suppliers) (good opportunity for LE and plastics industries)

Necessity for the reinforcement of business competitiveness

・Quality management, which meet the international standard
・Stable enterprise administration based on proper financial management
・Awareness raising of enterprise staff for the enhancement of production techniques/technologies as well as the development of novel markets

---

Questions

- What do you expect from becoming a parts supplier?
- What do you think differ between producing current products and producing parts for foreign assemblers?

  (Hint: think from their standpoint)
- What changes do you think are necessary to become a parts supplier?

Benefits of Business with Assembler

Parts suppliers can:

- Receive more orders according to assembler's sales increase
- Have further business opportunities (exports, overseas production, etc.)
- Enhance capabilities in production and management up to global standards in an effort to meet requirements set by assembler
- Have opportunities to learn production and technology of assembler and other suppliers

Relationship between Assembler and Parts Supplier

Parts suppliers need to:

- Build mutual trust with assembler
- Be able to help assembler to implement their business strategy, understanding their strategy as well as their business attitude
- Be able to be go through even without orders from assemblers;

  Their orders may disrupt temporarily due to their shutdown caused by political/economic turmoil, natural disasters, etc.
- Receive audit (process check) from assembler and follow their advice

Relationship between Assembler and Parts Supplier (cont.)

Parts suppliers need to:

- Meet quality requirements set by assembler;

  Assembler loses customers if defective parts from suppliers cause product defects.
- Meet requirements set every year by assembler (price, defect rates, delivery requirements, etc.)
- Improve technology, invest in machinery, enhance workers' capacities, etc. according to requests and suggestions from assembler

Necessary Conditions to be Considered as a Potential Parts Supplier

- Adherence to the terms and conditions of business agreement

  ☞ *Meeting QCD requirements is a must*

- Good corporate governance
- Aspiration for better-ness

- Stability of production and product quality

  ☞ *Solid production and quality control system*
- Unique properties（price competitiveness, unique technology)

- Financial soundness

- Proposal capabilities

Training Objective

- Fill the gaps between where you are now and where you need to be.

Namely …

- Enhance management capabilities in the following four (4) areas to become eligible to make transactions with foreign assemblers.
  1. Business management
     (Business philosophy and strategy)
  2. Supply chain management
  3. Production management
  4. Financial management

Training Objective (cont.)

Using formats,

- Re-consider business philosophy and strategy
- Consider what new areas to work on
- Identify what changes are needed

  and
- Present your idea on the fifth day of the training

Schedule

Training Topics	Date
Management Philosophy and Management Strategy	10 Oct (today)
Supply Chain Management	11 Oct (tomorrow)
Production Management	*Tentative: 11 Nov*
Financial Management	*Tentative: 12 Nov*
Presentation	*Tentative: 18 Nov*

Project for Promoting Investment
and Enhancing Industrial Competitiveness
in the People’s Republic of Bangladesh

“Program for Enhancement of Capacity of Business Managers”

I. Corporate Philosophy and Strategy

Naoya NISHIGAKI
JICA Expert

Training Objective

- Learn how to lead the organization *with eye on becoming a parts supplier to assemblers*
  - Clarify corporate philosophy and strategy
  - Identify challenges
  - Set mid-term goals
  - Formulate strategy to achieve the goals

Training Composition

1. Overview of Corporate Philosophy and Strategy
2. Corporate Philosophy and Vision
3. Management Strategy
4. Development of Management Strategy
5. Roles of Top Management
   - Strategy that drive forward the organization -
6. Corporate Philosophy and Strategy of Japanese Manufacturers

---

Formulation of Corporate Strategy for Business Growth

In order for a company to grow and continue to do business under presumption of “going concern," it needs to

- Indicate future direction
- Work out feasible measures (strategies) that make it possible to sustain competitive advantage

---

Formulation of Corporate Strategy for Business Growth (cont.)

To map out future direction and strategies, not only top management but also middle management personnel need to:

- Deepen understanding of business management
- Exercise leadership

I. Corporate Philosophy and Strategy

1. OVERVIEW OF CORPORATE PHILOSOPHY AND STRATEGY

1-1. Corporate Philosophy and Strategy: Composition and Structure

- **Corporate philosophy and vision** represent will of management and dream of employees.

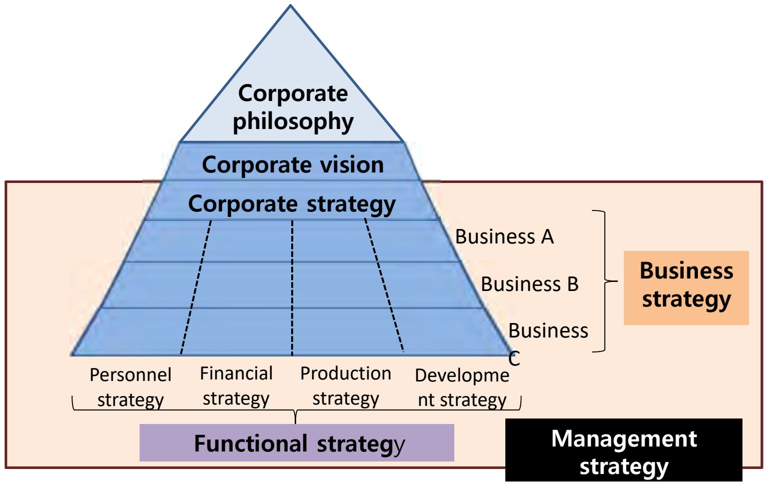
  But, there are gaps from reality.

- **Management strategy** is basic framework and concrete methodology to fill the gaps.

Ref: GLOBIS CORPORATION. 2007a

Fig.1

Structure of Corporate Philosophy and Strategy



Corporate philosophy

Corporate vision

Corporate strategy

Business A

Business B

Business C

Business strategy

Personnel strategy

Financial strategy

Production strategy

Development strategy

Functional strategy

Management strategy

Ref: GLOBIS CORPORATION. 2007a

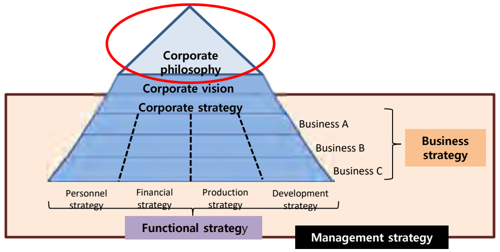
I. Corporate Philosophy and Strategy

2. CORPORATE PHILOSOPHY AND VISION

2-1. Corporate Philosophy

Corporate philosophy

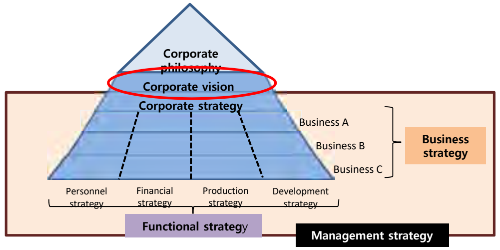
- Represent raison d'être, value, and mission in a universal form
- Expressed in various forms such as code of conduct, credo, essential conditions of success, etc.
- In general, indicate timeless ideas on society and employees



Ref: GLOBIS CORPORATION. 2007a

2-2. Vison

Vision describes what a company wants to be like in the mid-term to investors, employees and society as a whole.



Ref: GLOBIS CORPORATION. 2007a

2-3. Functions of Corporate Philosophy

1. Guide decision-making of the management
2. Provide all employees with guiding principles for decisions and actions
3. Help to create better corporate culture

   i.e. become organizational culture when shared by employees as code of conduct

4. Appeal to people outside

   i.e. inform stakeholders of fundamental idea of what it exists for, what it wants to achieve, and how to achieve

Ref: GLOBIS CORPORATION. 2007a

2-4. Key Points in Developing Corporate Philosophy

1. Core purpose
   a. Customers: who are direct customers, who are final customers, both existing ones and potential ones?
   b. Motives of doing business: Customer satisfaction, creation of some sort of culture, etc.
2. Business attitude
   - Customer first principle, evaluation based on ability, family-like management, how to interact with community, etc.
3. Orientation expected of employees
   - Self-management, personal development, service mindset, hopes on customers’ prosperity, willingness to serve to society through own growth

2-5. Checkpoints of Corporate Philosophy

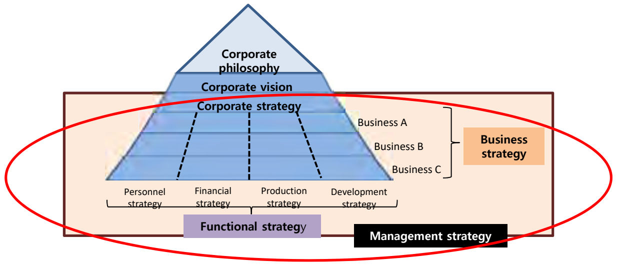
1. Do employees understand it?
2. Do employees feel empathy for it?
3. Does it serve as the basis of employees' behavior?

I. Corporate Philosophy and Strategy

3. MANAGEMENT STRATEGY

3-1. Management Strategy

Management strategy is structured action plan to establish sustainable competitive advantage and thereby to achieve business objectives.



Ref: GLOBIS CORPORATION. 2007c

3-2. Significance of Management Strategy

- As management resources are limited, selection and concentration are unavoidable.
- Developing management strategy helps to clarify what to do and what not to, and what strengths to develop further.
- Clarifying direction enables you to gain support from and draw out higher performance from employees.

Ref: GLOBIS CORPORATION. 2007c

3-2. Significance of Management Strategy (cont.)

Good strategy

1. Determine what areas to engage in
2. Provide a path
   a. most favorable against environmental changes and/or competitors' actions
   b. ensuring sustainment of competitive advantage
3. Function as a mechanism
4. Feasible

3-3. Composition and Viewpoint of Management Strategy

Management strategy is composed of:

1. **Corporate strategy**
   developed based on company-wide viewpoint
2. **Business strategy**
   developed based on individual business viewpoint
3. **Functional strategy**
   developed based on functional viewpoint

- They have to be consistent with corporate strategy and vision as well as with each other.

Ref: GLOBIS CORPORATION. 2007a

3-4. Corporate Strategy

Corporate strategy defines:

a. Business domains (areas of doing business)
b. Core competence (sources of competitiveness to rely on) *
c. Business portfolio (business combination)
d. Resource allocation

** to be explained later.*

- Corporate strategy of single business company is same as its business strategy.
- Company doing multiple businesses (diversified company) needs to have company-wide perspective in addition to strategy for each business.

Ref: GLOBIS CORPORATION. 2007a

3-5. Business Strategy

Business strategy is concerned with strategic decisions within a particular business.

- As corporate strategy covers multiple businesses, competitors and customers may differ in each area.
- Focusing attention on a specific business area or operation allows analysis of competition in a specific market.
- Development of a specific action plan based on the result of the analysis is needed.

Ref: GLOBIS CORPORATION. 2007a

3-6. Functional Strategy

Functional strategy incorporates measures on how to implement business strategy from functional standpoint.

- Marketing strategy
- Financial strategy
- Personnel strategy, etc.

Ref: GLOBIS CORPORATION. 2007a

I. Corporate Philosophy and Strategy

4. DEVELOPMENT OF MANAGEMENT STRATEGY

4-1. Development of Management Strategy

Formulating concrete management strategy with feasible business plan is necessary to realize the company's vision.

- Identify and evaluate challenges
- Set a course of actions
- Formulate strategy first how defective it appears; and revise it whenever possible to better and finalize it

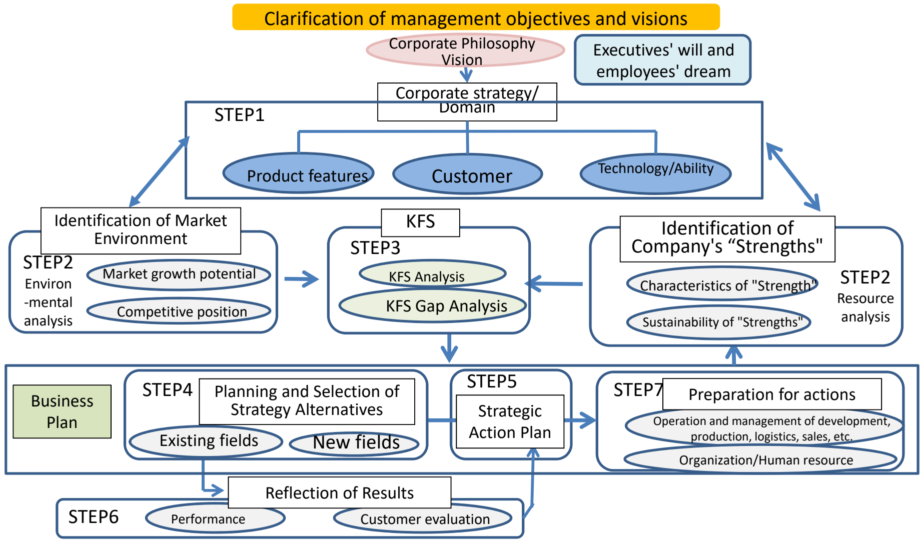
4-2. Key Points in Developing Management Strategy

1. Recognize strengths and weaknesses correctly
2. Reflect external environmental changes into strategy
3. Formulate annual plan based on goals to achieve in 3 to 5 years ahead
4. Forecast changes in market, and develop technology/product
5. Change organizational culture, which is a key to promote strategy
6. Promote restructuring and reengineering
7. Involve executive level personnel

4-3. Articulation of Goal (Ideal) and Direction

- Organized and systematic effort as well as articulation and direction are required to adapt proactively to increasingly difficult business environment and to realize sustainable growth.
- Role of top management is to lay out a mid-term goal or ideal form, recognize gaps between ideal and reality, and present a roadmap to achieve the goal.
- Decision-making on what to allocate limited resources constitutes backbone of management strategy.
- Strategic management is composed of:
  - ✓ Evaluation of market attractiveness
  - ✓ Evaluation of own competitiveness
  - ✓ Selection of priority business fields
  - ✓ Determination of resource allocation
  - ✓ Employment of business strategy and competitive strategy for individual fields
  - ✓ Task setting for managerial functions that complement above strategies
- Business plan with specific timeframe serves as compass.

Fig.2
Management Strategy Planning Framework 1



Clarification of management objectives and visions

Corporate Philosophy Vision

Executives' will and employees' dream

Corporate strategy/ Domain

STEP1

Product features

Customer

Technology/Ability

Identification of Market Environment

STEP2 Environ -mental analysis

Market growth potential

Competitive position

KFS

STEP3

KFS Analysis

KFS Gap Analysis

Identification of Company's “Strengths"

Characteristics of "Strength"

Sustainability of "Strengths"

STEP2 Resource analysis

Business Plan

STEP4

Planning and Selection of Strategy Alternatives

Existing fields

New fields

STEP5

Strategic Action Plan

STEP7

Preparation for actions

Operation and management of development, production, logistics, sales, etc.

Organization/Human resource

Reflection of Results

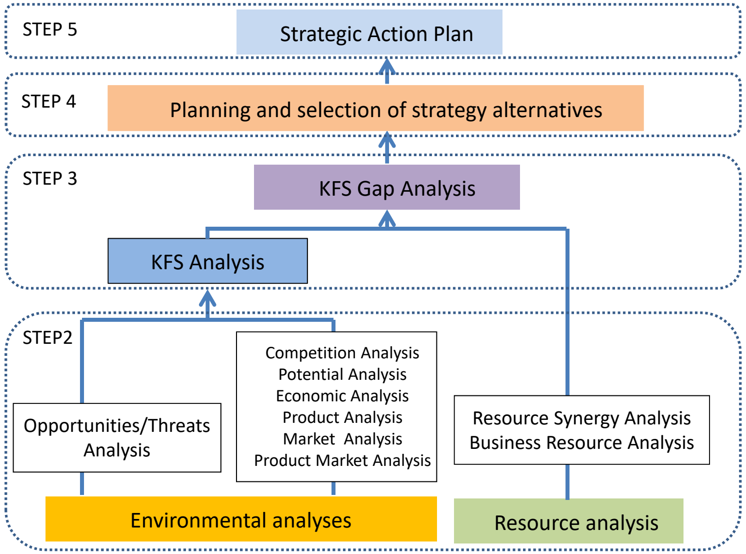
STEP6

Performance

Customer evaluation

Ref: Asahi Bank Institute of Research.

Fig. 3
Management Strategy Planning Framework 2



STEP 5

Strategic Action Plan

STEP 4

Planning and selection of strategy alternatives

STEP 3

KFS Gap Analysis

KFS Analysis

STEP2

Opportunities/Threats Analysis

Competition Analysis
Potential Analysis
Economic Analysis
Product Analysis
Market Analysis
Product Market Analysis

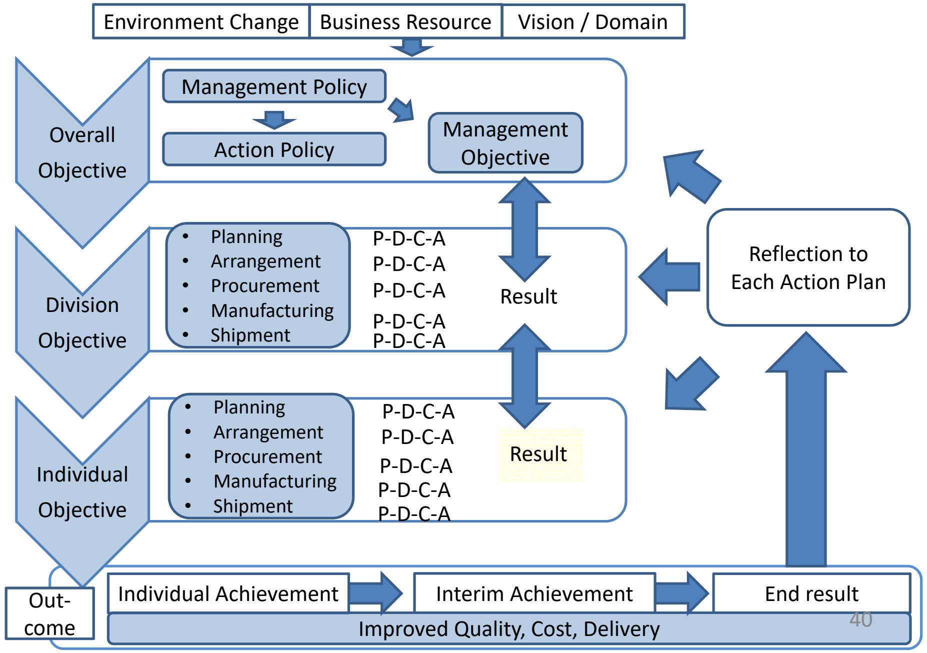
Resource Synergy Analysis
Business Resource Analysis

Environmental analyses

Resource analysis

Ref: GLOBIS CORPORATION. 2007b

Fig.4 Management Strategy Planning Cycle



Environment Change

Business Resource

Vision / Domain

Overall Objective

Management Policy

Action Policy

Management Objective

Division Objective

- Planning
- Arrangement
- Procurement
- Manufacturing
- Shipment

P-D-C-A
P-D-C-A
P-D-C-A
P-D-C-A
P-D-C-A

Result

Individual Objective

- Planning
- Arrangement
- Procurement
- Manufacturing
- Shipment

P-D-C-A
P-D-C-A
P-D-C-A
P-D-C-A
P-D-C-A

Result

Reflection to Each Action Plan

Out-come

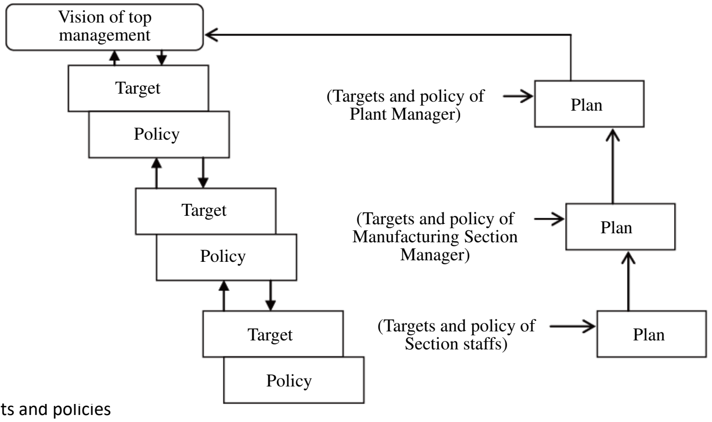
Individual Achievement

Interim Achievement

End result

Improved Quality, Cost, Delivery

Fig. 5
Relationship between Targets and Policies


Vision of top management
Target
Policy
Target
Policy
Target
Policy
(Targets and policy of Plant Manager)
(Targets and policy of Manufacturing Section Manager)
(Targets and policy of Section staffs)
Plan
Plan
Plan

Targets and policies
(1) Target: A goal that should be achieved within a specific period
(2) Policy: A guideline that shows the direction to achieve a target and areas of focus
(3) Plan: Procedure or rational approach to achieve a target

Ref: SANNO Institute of Management.

4-4. Step 1: Corporate Strategy
(1) Domain

Defining business domains is to determine core businesses, or what you do and what you do not.

- Choose what company can continue to engage in for at least several years
- Change them according to changes in available resources and business environment
- Define them in a way to help customers understand your business
- Speak about them repeatedly inside the company to keep employees informed

---

4-4. Step 1: Corporate Strategy
(1) Domain (cont.)

Defining domains enables company to

- Create sense of coherence among employees
- Identify what technology, know-how, information, etc. to accumulate
- Determine direction and scope of product development, which leads to increased efficiency and centralization in development
- Gain understanding and support from customers and business partners

---

Table 1
Change of Domains-1

Company	What (Function)	To whom (Customer group)	How (Technology)	Policy
Company A ・85 employees ・Annual sales: 8 billion yen (US$70 million)	Design, manufacturing, installation and maintenance of automatic control system and measurement applied equipment ＋ Provision of lightning protection system	Government offices through main contractors ＋ Companies at risk of lightning to radars and antennas	Prompt provision of specialized electronics technology, installation, maintenance services ＋ ・Technology licensing agreement with U.S. company ・Commercialization of systems based on electronic technology	Prompt response to subcontract orders ＋ ・Break away from a position as a subcontractor ・Strengthening of sales through distributors ・Enhancement of engineers including architects

Ref: Asahi Bank Institute of Research.

Table 2
Change of Domains-2

Company	What (Function)	To whom (Customer group)	How (Technology)	Policy
Company B ・180 employees ・Annual sales: 6 billion yen (US$53 million)	Sheet-metal processing ↓ Manufacturing of air blowers, pumps, exhaust-gas/deodorization/dust-collecting equipment, etc. ↓ Plant engineering for air purification (environmental protection)	Chemical/Drug makers, Automobile manufacturers ↓ Steel/Plant makers, Government offices ↓ Organization emitting exhaust gas, mist, etc.	Plating technology ↓ Plant business (production and installment) of air blowers and other equipment /system ↓ ・Grading up of key air blower technology ・Provision of comprehensive service related to chemical processing from development/ planning to maintenance	Technology development-first ↓ Customer service-first ↓ ・Becoming a market leader ・Utilization of outsourced production R&D by subsidiaries ・Orientation to creativity

Ref: Asahi Bank Institute of Research.

Table 3
Change of Domains-3

Company	What (Function)	To whom (Customer group)	How (Technology)	Policy
Company F ・350 employees ・Annual sales: 20 billion yen (US$ 18 million)	Metal container manufacturing + Plastic products manufacturing	Chemical, paint, oil, food manufacturers + ・Packaging materials dealers ・Environment facility developers	Securing of market-leading products through technical innovation of manufacturing process such as streamlining of process, improvement in welding technology and development of metallic materials + Development of products with unique characteristics such as plastic bands, synthetic wood using waste plastic, etc.	・Independence of large company-affiliated companies ・Revenue management by calculation by each section + ・Financially independent division system ・Information sharing through sales conference, etc. ・Meritocracy in the personnel system

Ref: Asahi Bank Institute of Research.

4-4. Step 1: Corporate Strategy
(2) Resource Allocation

- Company handling several businesses needs to consider proper resource allocation from the company-wide standpoint as well as how to do individual businesses successfully.
- Resource shortage can be made up for from outside in addition to strengthening internally.

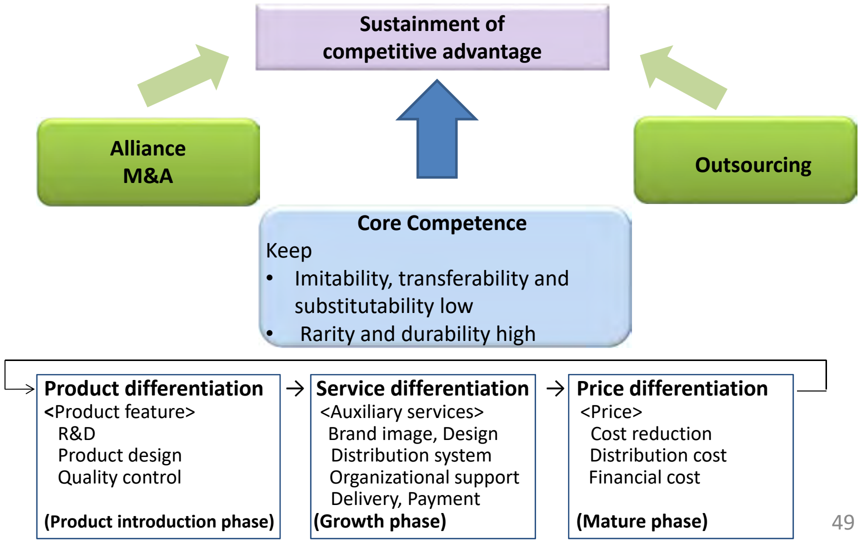
  e.g.
  - Business alliance
  - Acquisition of other companies (M&A)
  - Outsourcing

4-4. Step 1: Corporate Strategy
(3) Core Competence

Core Competence refers to core businesses with competitive advantage, or business know-hows, product development capability, technology, etc. which a company has accumulated.

Ref: KADOKAWA ASCII Research Laboratories. Inc.

Fig. 6
Elements to promote competitive advantage



Sustainment of competitive advantage

Alliance
M&A

Outsourcing

Core Competence
Keep
- Imitability, transferability and substitutability low
- Rarity and durability high

Product differentiation
<Product feature>
R&D
Product design
Quality control
(Product introduction phase)

→ **Service differentiation**
<Auxiliary services>
Brand image, Design
Distribution system
Organizational support
Delivery, Payment
(Growth phase)

→ **Price differentiation**
<Price>
Cost reduction
Distribution cost
Financial cost
(Mature phase)

4-5. Step 2: Environmental and Resource Analysis (SWOT Analysis)

Table 4 SWOT Analysis

	Strengths (S)	**Weaknesses (W)**
Opportunities (O)	Strategic opportunity (active business development): What to do to leverage strengths to take advantage of market opportunities. • Immediate measures • Mid- to long-term measures	Enhancement of management resources: What to do not to miss market opportunities due to weaknesses. • Immediate measures • Mid- to long-term measures
Threats (T)	Adaptation to environment : Is there any way to leverage strengths to change threats for competitors into opportunities for us. • Immediate measures • Mid- to long-term measures	Consideration of withdrawal : Is there any way to avoid withdrawal in spite of threats and weaknesses. • Immediate measures • Mid- to long-term measures

Ref: bn0707bn.

4-6. Step 3: Key Factors for Success (KFS)

- KFS refers to the most important factor for building competitive advantage.
- KFS analysis, a must in planning business strategy, aims to identify KFS by figuring out:
    1. Best practice in a specific market, i.e.
        a. What strengths successful companies have
        b. How they take advantage of them
    2. Issues which customers attach importance to
- KFS analysis enables you to recognize gaps (where and to what degree) and to set realistic strategic goals.

Ref: Nomura Research Institute.

4-6. Step 3: Key Factors for Success (KFS) (cont.)

1. KFS Analysis

(1) How to make KFS Analysis:

a. Analyze competitors

i.e. newly entered companies, successful companies and failed companies

b. Extract keys to success

c. Compare successful competitors and your company

4-6. Step 3: Key Factors for Success (KFS) (cont.)

(2) KFS Gap Analysis

After clarifying KFS, analyze to see where gaps exist and degree of gaps as compared to your resources

a. Whether you are superior or inferior

b. Degree of gaps

c. What countermeasures to take

Table 5
Key Factors for Success (example)

Procure-ment	• <Securing raw materials> • <Product procurement> Low-cost purchase of raw materials, timely purchase
R&D	• <Basic research> • <Design> Technical barriers by patent, technology development capability
Production	• <Production equipment> High quality, product reliability • <Manufacturing technology> Low cost, production technology, flexible production
Merchan-dizing	• <Products line-up>
Adver-tising	• <Recognition degree> • <Brand image> Brand value, product mix, packaging, clear concepts
Sales	• <Sales network/ Selling capacity> No. of sales people, Ability to collect information of end-users needs
Service	• <Inspection and repair> • <Customer Relations> Complaint management, creditworthiness

---

4-7. Step 4: Business Plan

Consideration of direction of business development

- Direction of business:
  1. Expand/scale down current fields
  2. Whether to enter into new fields

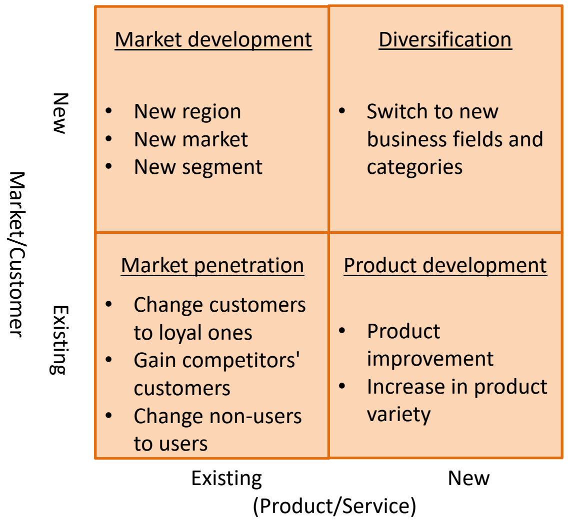
Domains and resource allocation need to be re-considered when trying to create qualitative changes of current core business markets or technology therein and/or when having found these changes.

4-7. Step 4: Business Plan (cont.)

Directions of business development are divided into the following four patterns:

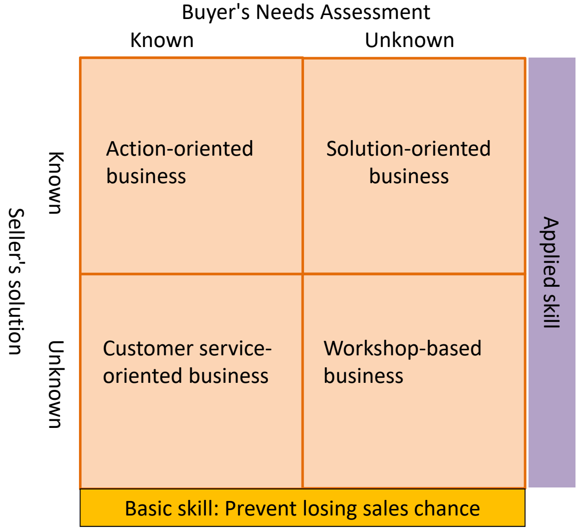
1. Market development strategy ･･･Development of new customers for existing technology and products
2. Product development strategy ･･･ Development of new technology and products for existing customers
3. Peripheral market creation strategy ･･･Creation of new markets in line with customer needs around existing ones
4. Diversification strategy ･･･ Advance into totally different areas from existing ones with new technology and know-how

Fig 7
Ansoff Growth Matrix



Market/Customer	New	Market development • New region • New market • New segment	Diversification • Switch to new business fields and categories
	Existing	Market penetration • Change customers to loyal ones • Gain competitors' customers • Change non-users to users	Product development • Product improvement • Increase in product variety
		Existing	New
		(Product/Service)	

Fig. 8
Business Forms



		Buyer's Needs Assessment		
		Known	Unknown	
Seller's solution	Known	Action-oriented business	Solution-oriented business	Applied skill
	Unknown	Customer service-oriented business	Workshop-based business	
		Basic skill: Prevent losing sales chance		

Ref: M. Shimaguchi.

I. Corporate Philosophy and Strategy

5. ROLES OF TOP MANAGEMENT

- STRATEGY THAT DRIVES FORWARD ORGANIZATION -

5-1. Strategy and Organization

- Management strategy is developed to give direction to influence group of people or organization.
- Formulation of strategy by some people does not suffice.
- It is many other people who implement strategy to achieve results.
- Organization has own habits and culture.
- Strategy needs to fit into organizational culture and obtain support from group members.
- Strategy needs to be feasible, taking into consideration strengths and weaknesses of group members as well as group dynamics.

Need of consideration on humanity in strategy

Strategy is for organization

5-2. Need to Articulate Strategy

Defining strategy, or indication of direction, helps to

1. Smoothen coordination between individual activities
2. Implement activities with long-term perspective in mind
3. Provide core source of organizational unity and common goal
4. Foster organizational culture to value rationality, planning and strategic thinking

---

5-3. Penetration of Strategy

- Instilling strategy is more difficult than developing good strategy.

Thorough implementation of mediocre strategy

Result >>>>>

Halfway implementation of excellent strategy

5-3. Penetration of Strategy (cont.)

- How to instill strategy
  1. Codify – simply
  2. Speak – patiently
  3. Involve
  4. Demonstrate – as example
  5. Reflect in evaluation – clearly
  6. Do what to do (but what you have not done) as something taken for granted

---

5-4. Strategy to Influence Organization

- Three (3) factors to influence organization:
  1. Harmonization – align vectors
  2. Momentum – make vectors larger and longer
  3. Creative tension – keep vectors upward
     - ✓ ***Creative tension*** *refers to a situation where disagreement or discord ultimately gives rise to better ideas or outcome.*
     - ✓ *An organization needs to avoid slack or inclination to "take the easy way out" to sustain creative tension*

Ref: Collins Dictionaries.

5-5. Strategy to Drive forward the Organization (cont.)

1. How to create harmonization
   a. Avoid communication gaps
   b. Avoid in-house politics (sectionalism, pursuit of personal interest)
      – *Focus on priorities of organization as a whole.*
   c. Clarify where to allocate resources to back up strategy
   d. Continuously do "good small things" over a long time
      – *It is impossible for an organization to do outstanding activities continuously over long time.*

5-5. Strategy to Influence Organization (cont.)

2. How to create momentum
   a. Present long-term goal of what your company wants to be like as core of management strategy
      — *Articulate raison d'être, significance, what strategy is for*
   b. Let staff experience small success in early stage
      — *Erase resignation and underdog mentality*
   c. Arrange occasional opportunities when many staff do same activity at same time and in same place
      — *Have employees know others, other sections, what they do, and what they think about their work*
   d. Pay due attention not to fail to notice it when momentum is generated

5-5. Strategy to Influence Organization (cont.)

a. Try something new at all times
   — *Introduction of extraordinary and alien elements*
   → Destabilization → Response to something new
   → Change
b. Employ strategy which barely gains consensus
   — *Avoid strategy which gain unanimous approval*
c. Employ strategy incompatible with environment and/or resources
   — *Tension caused by unsuitability creates pressure, opportunity and capacity to make a proper decision*
d. Employ strategy unfit for organizational culture
   — *Create tension for breakthrough*

I. Corporate Philosophy and Strategy

6. CORPORATE PHILOSOPHY AND STRATEGY OF JAPANESE MANUFACTURERS

6-1. Examples of Corporate Philosophy and Strategy of Japanese Manufacturers

1. HONDA
   https://www.youtube.com/watch?v=GcIO5qo9-Js

2. HIKARI SEIKO CO., LTD.

- Number of employee: 612
- Sales: 20 billion Yen, equivalent to (2006)
- Business contents : Precision automobile parts (parts of engine, transmission), Universal joint, Hydraulic functional parts, Designing and manufacturing of dedicated bearing machines
- TPM, ISO9000, ISO14000,QS9000

Reference

Asahi Bank Institute of Research. 1996. Research by Asahi Bank Institute of Research No. 50. “Cases of SMEs’ Business Strategy: ‘Reigning Business Domain’ as Keystone. ” (in Japanese)

bn0707bn. 2009. Three-minute Messages from President “SWOT Analysis for Strategy.” (in Japanese) https://bn0707.exblog.jp/12479286/

Collins Dictionaries. Free Online Dictionary. “creative tension.” https://www.collinsdictionary.com/dictionary/english/creative-tension

GLOBIS CORPORATION. 2007a. Part I: Management Strategy. “Corporate Philosophy and Strategy Level.“ (in Japanese) https://diamond.jp/articles/-/1618

——— 2007b. Part I: Management Strategy. “Process of Strategy Formulation.“ (in Japanese) https://diamond.jp/articles/-/7169

——— 2007c. Part I: Management Strategy. “Significance of Management Philosophy and Purpose of Enterprise.“ (in Japanese) https://diamond.jp/articles/-/5956

KADOKAWA ASCII Research Laboratories. Inc. Digital Term Dictionary. “Core competence.” (in Japanese) http://yougo.ascii.jp/caltar/%E3%82%B3%E3%82%A2%E3%82%B3%E3%83%B3%E3%83%94%E3%82%BF%E3%83%B3%E3%82%B9

M. Shimaguchi. 1996. *Sakura* Eye 96-7. *“Special Feature: Enhancing Sales Capabilities - Long-term Trust with customers as the most Important Key.”* (in Japanese)

Nomura Research Institute. Fundamental Business Terms. “KFS Key Factor for Success.”(in Japanese) https://www.nri.com/jp/opinion/m_word/management/kfs.html

SANNO Institute of Management. 1996. Textbook for Practical Training for Assistant Managers. (in Japanese)

Project for Promoting Investment
and Enhancing Industrial Competitiveness
in the People’s Republic of Bangladesh

“Program for Enhancement of Capacity of Business Managers”

II. Supply Chain Management (SCM)

Naoya NISHIGAKI
JICA Expert

Training Objective

Learn fundamentals of supply chain management (SCM) and related issues which parts suppliers need to understand and practice:

- Supply chain management (SCM)
- Just-in-time (JIT) production , and good and bad aspects of inventory
- Theory of constraints (TOC), and how to run a factory taking constraints into consideration

Training Composition

1. Overview of Supply Chain Management
2. Three Keys of SCM
3. Just-in-time Production
4. Theory of Constraints
5. Issues of Bangladesh Companies for Practicing SCM and JIT production

---

II. Supply Chain Management

1. OVERVIEW OF SUPPLY CHAIN MANAGEMENT

1-1. Supply Chain

Supply chain refers to:

- Network across organizations/companies of operations* relating to goods supply.

  *product design, development, planning, procurement, sales, ancillary service, etc.
- Individual organizations have own chain of operations as well.

Ref: Sugiyama

1-2. Supply Chain Management

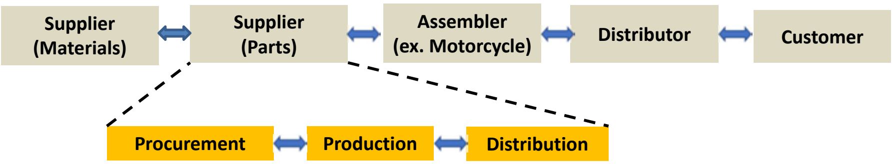
Supply chain management (SCM) refers to:

- Strategic management aiming to optimize a supply chain as a whole, and thereby to simultaneously achieve higher customer satisfaction (elimination of opportunity loss, higher sales), shorter lead time, smaller inventory, and larger cash flow.
- Management based on flow of relevant information for matching supply to demand, integrating it with distribution flow and commercial flow, and thereby improving efficiency of a supply chain.

- SCM integrates supply chains of individual companies with overall supply chain for total optimization.

Ref: Sugiyama

Fig.1
Conceptual Diagram of Supply Chain



Ref: Sugiyama

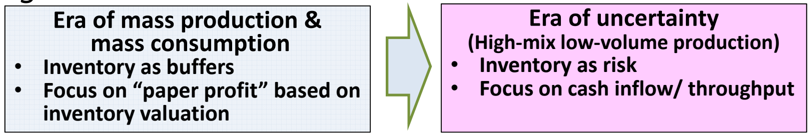
1-3. Purpose of SCM

- Higher customer satisfaction
  a. Elimination of loss opportunity
  b. Higher sales
- Higher efficiency
  a. Shorter lead time
  b. Smaller inventory
  c. Cash flow maximization

Ref: Sugiyama

1-4. Emergence of SCM (Background)

Fig.2



Era of mass production & mass consumption
- **Inventory as buffers**
- **Focus on "paper profit" based on inventory valuation**

- Limitation of pursuit of partial optimization
- Decline of total efficiency

Era of uncertainty
(High-mix low-volume production)
- **Inventory as risk**
- **Focus on cash inflow/ throughput**

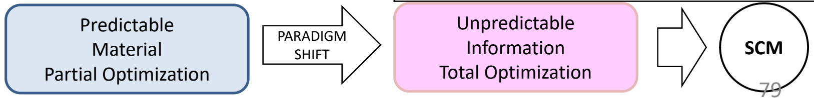
- Quick response to market changes
- Information sharing and realization of total optimization

Production	• Pursuit of production efficiency →Large-lot production →Lot of WIP
Logistics	• Minimization of transport cost →Bulk transportation →Lot of distribution inventory
Sales	• Minimization of stock-out →Lot of in-store inventory

(1) Focus on swift response
～Grasp of demand without time lag

(2) Change in medium of supply/demand adjustment
～From inventory buffers to information buffers

(3) Focus on flow control
～Synchronization of distribution flow, commercial flow and information flow

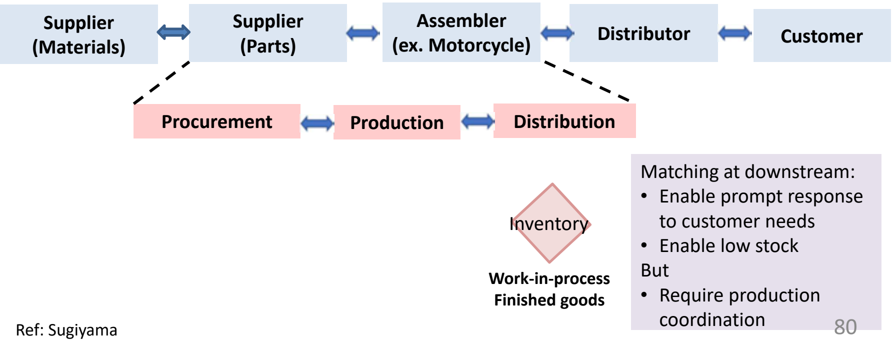


Ref: Sugiyama

1-5. Inventory Point

- Where to match supply to demand (inventory point) determines macro structure of supply chain.

Fig.3



Matching at downstream:
- Enable prompt response to customer needs
- Enable low stock

But
- Require production coordination

Ref: Sugiyama

II. Supply Chain Management

2. THREE KEYS OF SCM

2-1. Three Keys of SCM

Three keys of SCM are:

1. Customer orientation
2. Total optimization
3. Flow control, or synchronization of three flows, namely
    a. Distribution flow (physical flow of goods)
    b. Commercial flow (flow of transactions, i.e. contracting, orders, payment, ownership transfer, etc.)
    c. Information flow

Ref: Sugiyama

2-2. Customer Orientation

- Changes of customer needs or demand are often unpredictable.
- SCM aims at demand-driven goods supply, i.e. provision of demanded items of the demanded volume at the timing demanded.

Ref: Sugiyama

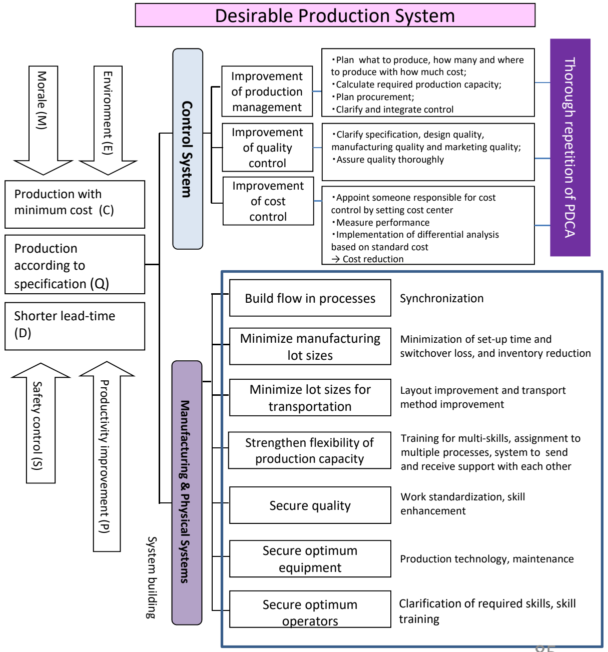
2-3. Total Optimization

- SCM aims at total optimization of a supply chain as a whole by each player’s acting as if they formed a virtual organization.
- Pursuit of own optimality by individual actors does not lead to total optimality; on the contrary, it may break down overall balance of the supply chain they belong to.
- All actors need to try to achieve total optimization through building WIN - WIN relationship.

Ref: Sugiyama

Fig. 4
Win-Win Relationship

It is important for all suppliers to build a production system as shown in the figure and to establish win-win relationship with every concerned body.

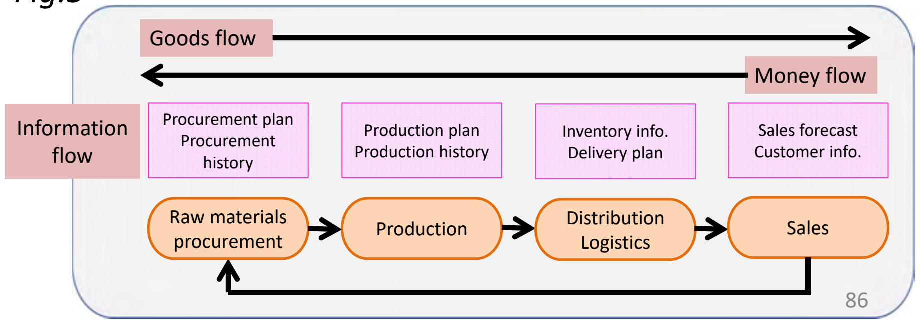


Ref: K. Yoshimoto., K. Watanabe., and H.Onari.

2-4. Flow Control

- Link or synchronize three flows (goods, transactions, and information) in supply chain
- Share information in the chain

Fig.5



2-5. Role of information

Information triggers actions.

To achieve total optimization,

- Information is necessary for each actor to respond to market needs quickly, and thereby to match supply to demand.
- Coordination based on information requires timeliness (quickness), accuracy of information, and belief in synchronization of three flows

→ Utilization of information technology (IT) is a must.

Ref: Sugiyama

II. Supply Chain Management

3. JUST-IN-TIME PRODUCTION

3-1. Origin of SCM: Toyota Supply Chain with *Kanban* system

- In production, Toyota thoroughly follows principle of procuring items in the necessary amount when necessary with *kanban* or just-in-time system.
- Toyota applies the principle to distribution and logistics as well.
- Other manufacturers followed suit to promote high-mix low-volume procurement, production, and distribution.
- This principle or approach is considered to be one of the origins of SCM.

3-1. Origin of SCM: Toyota Supply Chain with *Kanban* system (cont.)

Toyota supply chain management explains how to achieve balance and efficiency by focusing on v4L.

- v4L Principles:

Variety	Determine variety of offerings based on operational efficiency and market demand.
Velocity	Maintain a steady flow through all processes of the supply chain.
Variability	Manage inconsistencies carefully to reduce cost and improve quality.
Visibility	Ensure the transparency of all processes to enable continuous learning and improvement.

Ref: A. V. Iyer, S. Seshadri, R. Vasher.

3-2. Inventory: Pros. and Cons.

Pro.

- (Bulk purchase) lower unit purchase cost, which lead to higher profit
- Secure higher sales (*if it is certain that goods sell.*)
- Avoid missing sales opportunity

3-2. Inventory: Pros. and Cons. (cont.)

Cons. (or adverse effect of excess stock):

- Need space (and increase storage cost)
- Lower efficiency and increase cost through increased time and effort (with resulting higher labor cost) for search and control
- Increase interest costs, when purchased is made by loan
- Kill employees’ awareness on excess stock
- Unknowingly promote more purchase
- Can go obsolete, causing write-down
- Can unknowingly put pressure on profits

II. Supply Chain Management

4. THEORY OF CONSTRAINTS

4-1. Backbone of SCM: Theory of Constraints (TOC)

Backbone of SCM is theory of constraints (TOC).

TOC refers to:

- Concepts and methodology aimed (like lean production) mainly at achieving most efficient flow of material in a plant through 'continuous process improvement' (CPI).

Eliyahu M. Goldratt introduced it in his 1984 book titled *The Goal.*

Ref: Business Dictionary Com.
E. M. Goldratt. and J. Cox.

4-1. Backbone of SCM: Theory of Constraints (TOC) (cont.)

- Basically a scheduling and inventory control philosophy, TOC proposes that
  1. a firm is a 'chain' of interdependent links (departments, functions, resources) some of which may have potential for greater performance but cannot realize it because of
  2. a weak link that is an external or internal **bottleneck (constraint)** and every firm has at least one.
  3. The highest priority of a management is (or should be) to maximize the firm's **throughput** (rate of generation of revenue) and not just output (rate of generation of goods or services).

Ref: Business Dictionary Com.

4-2. Bottlenecks/Constraints

- A chain is no stronger than its weakest link;
  Strengthening another link does not increase the strength of the chain; strengthening the weakest link is needed.

Likewise,

- In factory production, the process with the smallest capacity (bottleneck process) determines overall production capacity.
- Improvement of the bottleneck process is necessary to increase production.

4-3. Five Focusing Steps of TOC

1. Identify the bottleneck process	・Which process slows overall production flow? ・Why? e.g. actual process capability, high defect rates, manpower.
2. Exploit the bottleneck process (Run the bottleneck at full capacity)	・Capacity of the bottleneck governs overall capacity. ・Heighten utilization or output of the bottleneck with existing resources (e.g. reducing defects, reducing changeover time, not stopping the bottleneck process in break time).
3. Subordinate everything else to the bottleneck (Align the other processes with operation of the bottleneck process)	・Upstream processes of the bottleneck need to process items which need to be processed in the bottleneck on a priority basis (in order not to avoid causing waiting hours of the bottleneck process). ・Upstream processes avoid processing more than the bottleneck can handle.
4. Alleviate the bottleneck	・Invest in the bottleneck process (if needed)
5. Repeat (return to step 1.)	

Ref: E. M. Goldratt. and J. Cox.

4-4. Types of Constraints and Countermeasures

Physical / Resource Constraints

- Constraints caused by facilities, tools, human, materials, etc. (supply capacity < demand)
- ➢ Reduce downtime, reduce changeover time, control quality, etc.

↓

Policy Constraints

- Constraints caused by measures, rules, policies, and behavior
- Often causes physical and market constraints
- ➢ Place priority on total optimality or throughput maximization

↓

Market Constraints

- Constraints caused by market demand (supply capacity > demand)
- ➢ Reduce fixed cost, reduction of material purchase, etc.

4-5. Production to Increase Throughput

When finding a bottleneck in production:

1. List all overdue orders (overdue products)
2. Number them in order of the number of days overdue from (in descending order)
3. Check what parts/components of overdue products the bottleneck process needs to process
4. Produce overdue products according to the number determined in the step 2. (Never change the order of production)

4-6. Consideration on Policy Constraints

- After solving (alleviating) constraints in the production line, constraints outside the line may remain.
- What to do if you face policy constraints?

  Keeping excess stock is out-of-date way of management.

  Under what policy do you determine stock volume?

4-7. Throughput

Throughput refers to:

- The rate at which the system generates money through sales

  meaning
- **Sales - Totally variable cost***

  or (for simplification) largely equivalent to

  Sales – Raw materials cost (= marginal revenue)

*Totally variable cost: cost that grows directly proportionally to the sales of every additional unit of the product, i.e. cost of raw materials, components and direct paid services for production of products to be sold or the cost of products bought for reselling.

Ref: Theory of Constraints Practitioners Alliance.

4-7. Throughput (cont.)

What to do to continue to make a profit?

- Increasing equipment effectiveness?
- Introducing automation?
- Reducing personnel?
- Expand overseas business?

4-7. Throughput (cont.)

- Sales and raw materials cost can be directly tied to individual items:

  Sales = Number of items sold × Unit sales price

  Raw materials cost = Number of items sold × Raw materials cost/item
- TOC does not allocate operation expenses (all the other cost items such as labor cost, utility cost, depreciation cost) to individual items

  → No full unit cost

4-8. TOC Indicators

- Indicators to know whether you make money or not:
  (1) **Net profit** (= Throughput – Operation expenses)
  (2) **Return on Investment (ROI)** (= Net profit/Investment)
  (3) **Cash flow**
- Indicators to be monitored on the ground in place of the above indicators:
  (1) **Throughput** – *Need to be increased*
  (2) **Inventory** (= money spent to sell products) – *Need to be reduced*
  (3) **Operation expenses** – *Need to be reduced*

4-9. Need to Change Perspective

Which to focus on, throughput or efficiency?

- Do you opt to pile up WIP stock which does not lead to throughput increase without solving (alleviating) bottlenecks?
  ☞*You need to solve (alleviate) bottlenecks to increase throughput.*
- Do you allow operators to pile up WIP stock to avoid reducing partial efficiency (or to keep high efficiency of individual machines) ?
  Under operators' discretion, e.g.
  - I don't want to do changeover frequently.
  - I produce them now because they will be necessary eventually.
  ☞ JIT production does not allow discretion of individual operators to eliminate unnecessary WIP stock.

You need to focus on increasing throughput (pursuing total optimality), instead of pursuing partial optimality.

II. Supply Chain Management

5. ISSUES OF BANGLADESH COMPANIES FOR PRACTICING SCM AND JIT PRODUCTION

5-1. Issues

1. Issues in production
2. Issues to address to be a part of a supply chain
3. Issues to make transaction with foreign assemblers
4. Recent trends in the Japanese manufacturing industry

Reference

E. M. Goldratt. and J. Cox. 1984. The goal: A process of ongoing improvement. Great Barrington, MA: North River Press.

A. V. Iyer, S. Seshadri, R. Vasher. 2009. Toyota Supply Chain Management: A Strategic Approach to Toyota's Renowned System. New York. McGraw-Hill Education.

S. Sugiyama. 2000. Technique to build SCM system with ERP: SAP, R/3. "Chapter 1. Supply Chain Management." (in Japanese) at http://www.src-j.com/books/pdf/135_pt.pdf

Theory of Constraints Practitioners Alliance. TOC Terms and Concepts. "Throughput." http://tocpractice.com/category/references/?ap=t

K. Yoshimoto., K. Watanabe., and H.Onari. 2001. Method Engineering. Tokyo. Asakura Publishing. (in Japanese)

Webfinance Inc. 2018. Business Dictionary Com. "Theory of constraints."
http://www.businessdictionary.com/definition/theory-of-constraints-TOC.html

Project for Promoting Investment and Enhancing Industrial Competitiveness in the People's Republic of Bangladesh

"Program for Enhancement of Capacity of Business Managers"

IV. FINANCIAL MANAGEMENT

NAOYA NISHIGAKI

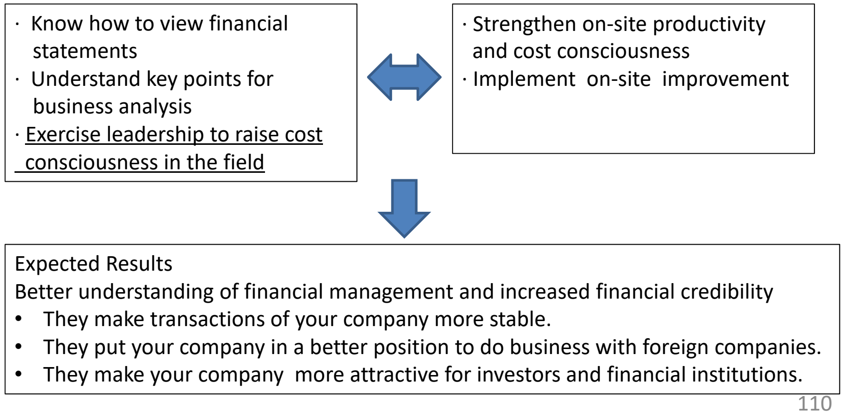
JICA EXPERT

I. Training Objectives

Purpose: To Increase financial credibility

· By improvement of management skills regarding financial management

· By acquisition of basic knowledge for international standards operation



· Know how to view financial statements

· Understand key points for business analysis

· Exercise leadership to raise cost consciousness in the field

· Strengthen on-site productivity and cost consciousness

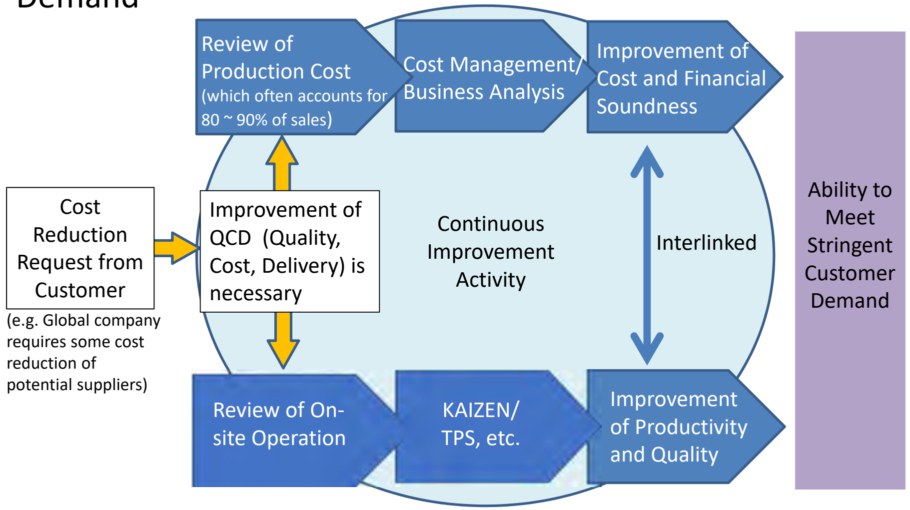
· Implement on-site improvement

Expected Results

Better understanding of financial management and increased financial credibility

- They make transactions of your company more stable.
- They put your company in a better position to do business with foreign companies.
- They make your company more attractive for investors and financial institutions.

II. How to Develop an Ability to Meet Stringent Customer Demand



"Cost Management" and "On-Site Productivity (KAIZEN)" are two sides of the same coin

---

III. Training Composition

1. Overview of Financial Management
2. Overview of Financial Statements
3. Business Analysis
   - Analysis on Profitability , Productivity, and Liquidity
4. Break-even Point
5. Cash Flow
6. Cost Control

1. Overview of Financial Management

What is financial management?

Financial Management

- Financial management is a part of business management.
- Financial management is a general term for a series of activities to plan and control financial resources, such as fund procurement and fund management.
- The purpose of financial management is to raise funds, allocate them to each business, get higher returns, and improve financial conditions.

---

2. Overview of Financial Statements

2-1. What is Financial Statements?

Financial statements

- Balance Sheet (B/S)
- Income Statement (Profit & Loss, P/L)
- Manufacturing Cost Report (C/R)
- Cash flow (CF) statement

2-2. Balance Sheet (B/S)

The balance sheet shows the financial condition of a company at a certain point in time.
It is a report that clarifies the financial condition of a company by contrasting the company's "asset", "liability" and "capital".
The balance sheet is divided into debit (left/assets) and credit (right/liabilities & Capital).

(Assets)		(Liabilities)	
Current assets		Current liabilities	
Cash and deposits	xxxxx	Notes payable	xxxxx
Notes receivable	xxxxx	Accounts payable	xxxxx
Accounts receivable	xxxxx	Short-term borrowings	xxxxx
Raw materials	xxxxx	· · · · · ·	
Work-in-process	2,000	Fixed liabilities	
Products Inventory assets	1,200	Long-term borrowings	xxxxx
· · · ·	xxxxx	· · · · · ·	xxxxx
Total current assets	xxxxxx	Specific provisions	
Tangible fixed assets	xxxxxx	Reserve for retirement allowance	xxxxx
Buildings	xxxxx	· · · · · ·	xxxxx
Facilities	xxxxx	(Shareholders' equity)	
Intangible fixed assets	xxxxxx	Capital	xxxxx
· · · · · ·	xxxxx	Legal reserve	xxxxx
Investments	xxxxx	· · · · · ·	
		Current income	300
Total assets	25,000 (000 yen)	Totalliabilities and equity	25,000 (000 yen)

2-3. Income Statement

Income statement represents results of income and expense of a company in a certain period of time. In other words, it shows how much income was generated in what form, how much expense was incurred in what form, and as a result, how much net profit or loss was generated. Basically, income is revenue and expense is expenditure.

Sales amount		20,000 (000 yen)
Sales cost		
1. Opening inventory	1,000 (000 yen)	
2. Manufacturing Cost	18,000	
Total	19,000	
3. Ending inventory	1,200 (-)	17,800
Gross profit on sales		2,200
Selling and general administrative expenses (SGA)		1,500
Operating profit		700
Non-operating income		300
Non-operating expense		400
Current profit		600
After-tax profit		300

2-4. Manufacturing Cost Report

Manufacturing Cost Report represents costs consumed to manufacture products in a certain period of time.
In other words, it shows the status of expense generated from manufacturing activities during a certain period of time.

1. Material cost	11,000
2. Labor cost	5,000
3. Manufacturing expense	3,000
Total manufacturing expense	19,000
Opening work-in-process	1,000
Total	20,000
Ending work-in-process	2,000
Manufacturing Cost	18,000

Financial Statements are related to each other

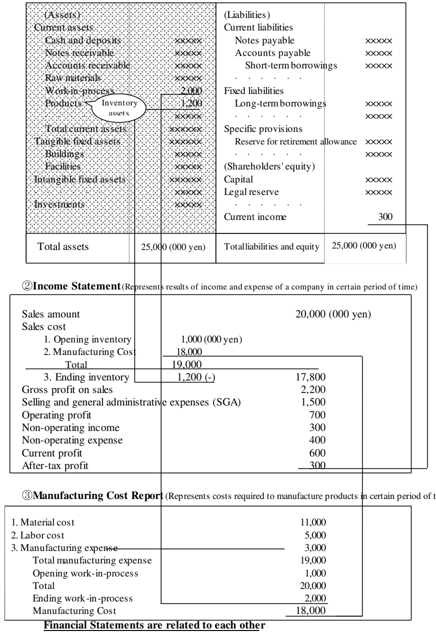
2-5. Cash Flow Statement

"Cash flow" is the flow of money (in-flow/out-flow, income · expenditure).
"Cash flow statement" represents the net change in cash balance during one accounting period of a company. It shows the management status of the company through flow, increase and decrease of funds.

Cash Flow Statement
For the year Ended December 31

Ⅰ.Operations		
Net income		$100,000
Add back depreciation, since no cash is used	5,000	
Cash flow provided by operations	105,000	
Ⅱ.Investing activities		
Purchase of office equipment		▲10,000
Cash flow used by investing activities		▲10,000
Ⅲ.Financing activities		
Borrowing from bank		15,000
Cash flow provided by financing activities	15,000	
Net cash flow	110,000	
Add begging cash balance		125,000
Ending cash balance	**125,000**	

2-6. Relationship among B/S, P/L, and C/R



(Assets)		(Liabilities)	
Current assets		Current liabilities	
Cash and deposits	×××××	Notes payable	×××××
Notes receivable	×××××	Accounts payable	×××××
Accounts receivable	×××××	Short-term borrowings	×××××
Raw materials	×××××	· · · · · · ·	
Work-in-process	2,000	Fixed liabilities	
Products	1,200	Long-term borrowings	×××××
	×××××	· · · · · · ·	×××××
Total current assets	××××××	Specific provisions	
Tangible fixed assets	××××××	Reserve for retirement allowance	×××××
Buildings	×××××	· · · · · · ·	×××××
Facilities	×××××	(Shareholders' equity)	
Intangible fixed assets	××××××	Capital	×××××
	×××××	Legal reserve	×××××
Investments	×××××	· · · · · · ·	
		Current income	300
Total assets	25,000 (000 yen)	Total liabilities and equity	25,000 (000 yen)

②**Income Statement** (Represents results of income and expense of a company in certain period of time)

Sales amount		20,000 (000 yen)
Sales cost		
1. Opening inventory	1,000 (000 yen)	
2. Manufacturing Cost	18,000	
Total	19,000	
3. Ending inventory	1,200 (-)	17,800
Gross profit on sales		2,200
Selling and general administrative expenses (SGA)		1,500
Operating profit		700
Non-operating income		300
Non-operating expense		400
Current profit		600
After-tax profit		300

③**Manufacturing Cost Report** (Represents costs required to manufacture products in certain period of time)

1. Material cost	11,000
2. Labor cost	5,000
3. Manufacturing expense	3,000
Total manufacturing expense	19,000
Opening work-in-process	1,000
Total	20,000
Ending work-in-process	2,000
Manufacturing Cost	18,000

Financial Statements are related to each other

2-7. Profit and Cost Management

(1) Profit-making as a Corporate Objective

Pursuit of profit

- Return to shareholders
- Reinvestment of retained earnings

Contribution to the society

- Provide good products
- Offer more employment opportunity
- Tax payment

Business survival and development

2-7. Profit and Cost Management (cont.)

(2) Three ways to increase profit

Manufacturers generate profit by producing and selling products
Sales - Cost = Profit
Profit = Quantity sold x (Selling price - Cost)

To increase profit
1) Increase sales volume
2) Increase selling price
} It is difficult in a highly competitive market

3) Reduce cost・・・・It is easier for companies to reduce cost than increasing sales volume/selling price

Q. Why cost reduction is important?

Selling price - Profit = Allowable cost
In order to ensure the desired amount of profit, you have to produce spending less than such a cost amount (Allowable cost)

2-7. Profit and Cost Management (cont.)

(3) Financial Accounting and Management Accounting

- Purpose of Financial Accounting:
  To provide information for stakeholders outside the company
- Purpose of Management Accounting:
  To provide information for management personnel within the company

(4) Purpose of Cost Control

- Cost reduction
- Performance evaluation
- Decision on in-house production or outsourcing
- Decision-making on purchase of equipment
- Development of new products

2-7. Profit and Cost Management (cont.)

(5) Manufacturing Cost

a) Three Major Elements
  - Material cost
  - Labor cost
  - Expense

b) Classification of variable cost and fixed cost
  - Variable cost: Cost that increases or decreases in proportion to changes in production
    (E.g. Material, supplies expense)
  - Fixed cost: Cost almost constantly incurred regardless of changes in production
    (E.g. Labor cost, depreciation, interest rate, etc.)

Exercise (Group Discussion)

1. How the profit should be used?

2. Why is cost reduction important?

3. What are the three major elements of cost?

4. What will you do for cost reduction?

3. Business Analysis

(1) Significance of Business Analysis

- Company's financial position and operating results are all summarized in the financial statements.
- Therefore, by analyzing the B/S, or looking at the balance of assets, liabilities and equity, you can understand the adequacy of financial position.
- Further, by analyzing the P/L, or looking at the balance of sales, expense and profit, you can understand the adequacy of operating results.

The way to read financial statements by such manners is called business analysis or financial statement analysis.

---

(2) Ways of Business Conditions Comparison

There are 3 ways to compare business conditions:

a) Period comparison
b) Cross comparison
c) Standard comparison

- Period comparison compares the numerical record of business performance in the previous year and the current year of a company and clarifies the change from the previous year.
- Cross comparison compares the figures of a specific firm with that of comparable firm in the same period and clarifies the difference between them.
- Standard comparison compares the figures of a specific firm and the standard figures of all the other firms in the same industry and clarifies the position of the specific firm in the industry.

---

(3) Types of Business Analysis

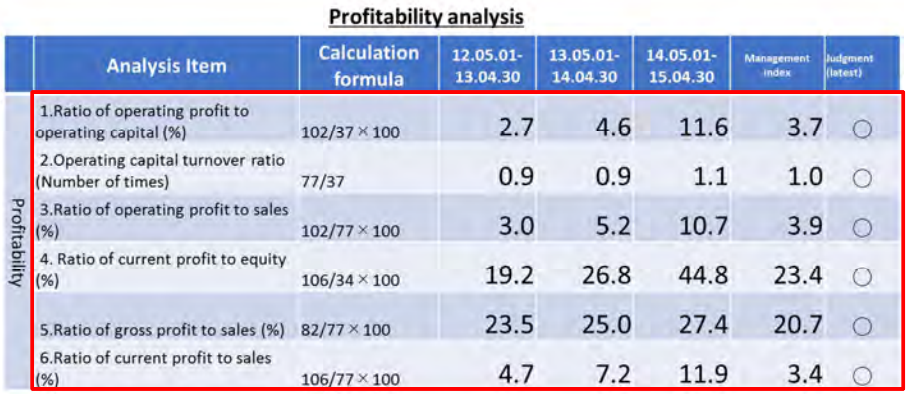
There are 3 types of business analysis:

a) Profitability analysis
b) Productivity analysis
c) Liquidity (soundness) analysis

---

a) Profitability analysis

The purpose of profitability analysis is to clarify to what extent the intended profit is achieved by a company.
If it is not generating sufficient profit, it clarifies the degree, causes and to show where to improve.



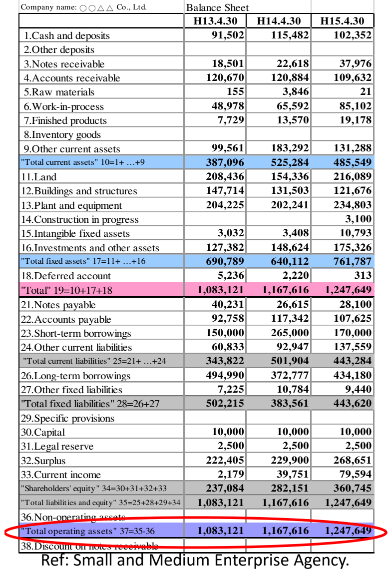
Profitability analysis

	Analysis Item	Calculation formula	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30	Management index	Judgment (latest)
Profitability	1.Ratio of operating profit to operating capital (%)	102/37 × 100	2.7	4.6	11.6	3.7	○
	2.Operating capital turnover ratio (Number of times)	77/37	0.9	0.9	1.1	1.0	○
	3.Ratio of operating profit to sales (%)	102/77 × 100	3.0	5.2	10.7	3.9	○
	4. Ratio of current profit to equity (%)	106/34 × 100	19.2	26.8	44.8	23.4	○
	5.Ratio of gross profit to sales (%)	82/77 × 100	23.5	25.0	27.4	20.7	○
	6.Ratio of current profit to sales (%)	106/77 × 100	4.7	7.2	11.9	3.4	○

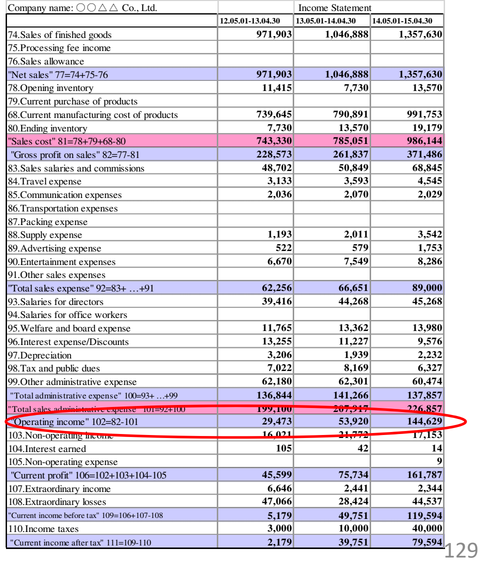
Ref: Small and Medium Enterprise Agency.

Overall ratios: Ratios that represent the overall results of a company.

Ratio of operating profit to operating capital: Earning power of operating capital invested into a company (No.1) = *Operating income/Total operating assets ×100*



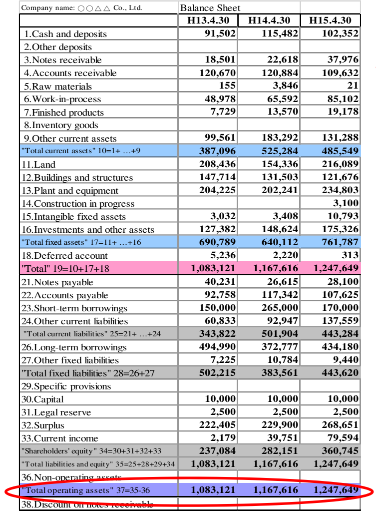
Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			



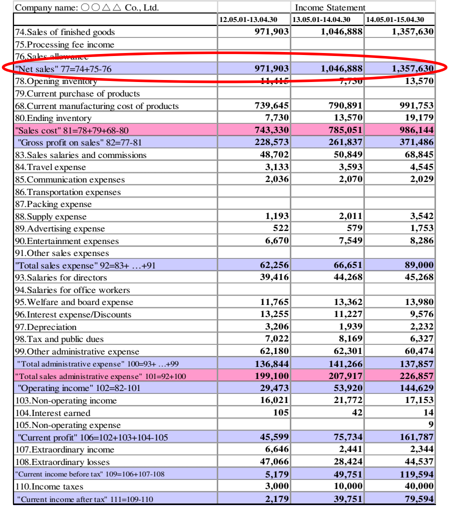
Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium Enterprise Agency.

Operating capital turnover ratio: An index that shows the degree of use of operating capital invested into a company in the form of sales (No.2)
(Number of times) = *Net sales/ Total operating assets*



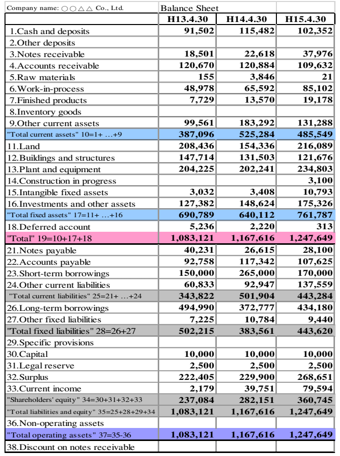
Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			



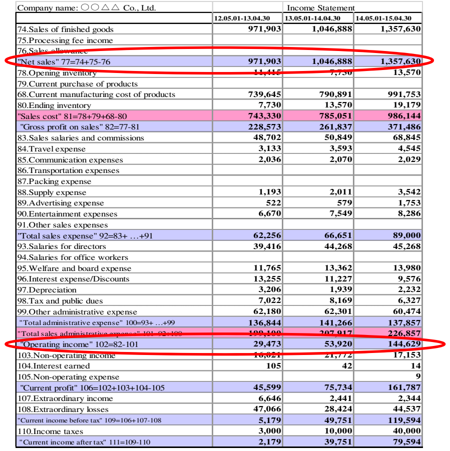
Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium Enterprise Agency.

Ratio of operating profit to sales: Percentage of operating profit in sales, which indicates the profitability of business activities. Even if this ratio lowers, the capital return will increase if the capital turnover ratio increases more than Ratio of operating profit to sales (No.3)
= *Operating income/ Net sales ×100*



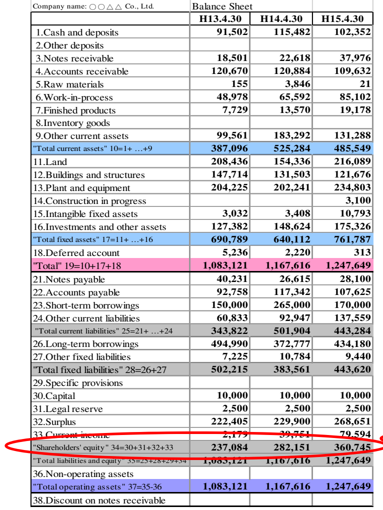
Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			



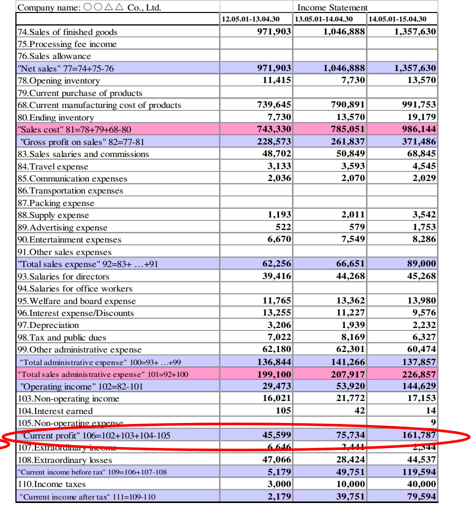
Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium Enterprise Agency.

Ratio of current profit to equity: Ratio of the current profit obtained relative to the equity capital, which indicates the profitability of shareholders' equity (No.4) = *Current profit/ shareholders' equity ×100*



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

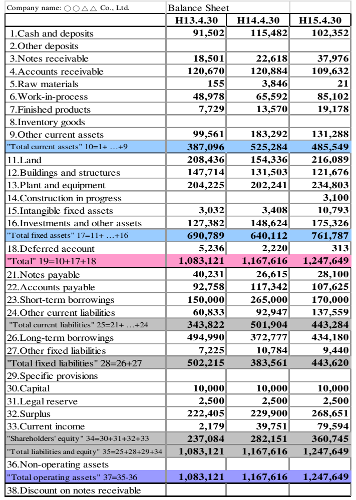


Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

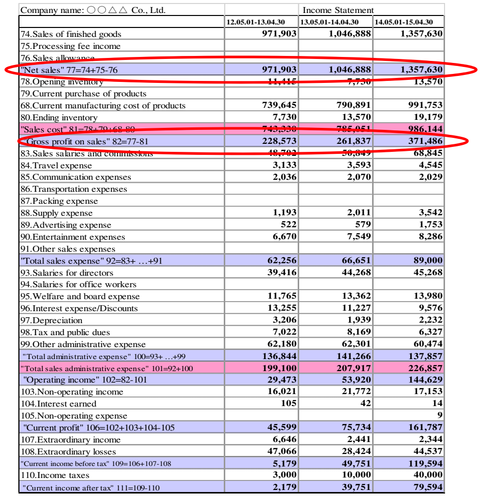
Ref: Small and Medium Enterprise Agency.

Sales ratios: Ratios that indicate how good or bad sales performance is.

Ratio of gross profit to sales: Percentage of gross profit generated from sales that shows the sales performance (No.5) = *<u>Gross profit on sales/Net sales ×100</u>*



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

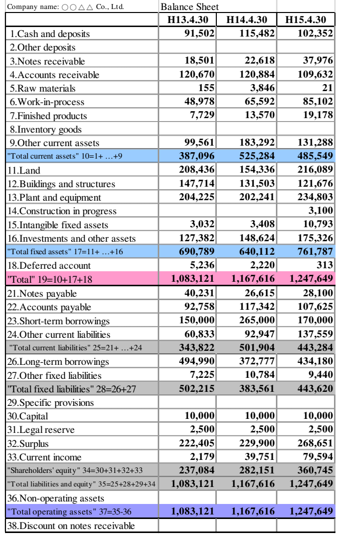


Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

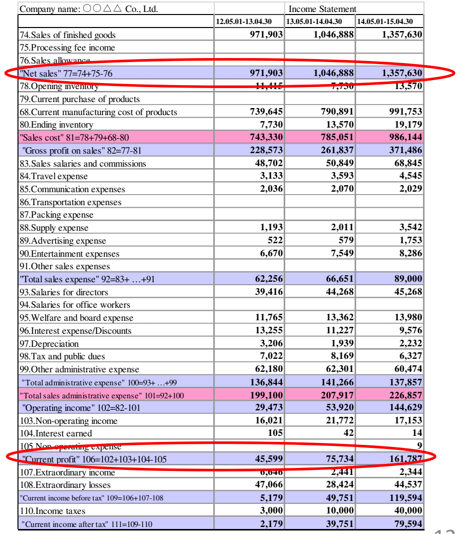
Ref: Small and Medium Enterprise Agency.

Ratio of current profit to sales: Percentage of current profit in sales that represents the final results of business activity (No.6)

= Current profit/ *<u>Net sales ×100</u>*



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			



Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium Enterprise Agency.

b) Productivity analysis

1) Significance of productivity

To evaluate management performance in manufacturing business, it is imperative to conduct productivity analysis in addition to the profitability analysis. Productivity is the ratio of production factors employed (input) to its result (output).

Productivity calculation formula

$$\text{Labor productivity} = \frac{\text{Production output, sales volume, added value, etc.}}{\text{Number of employees, working hours, etc.}}$$

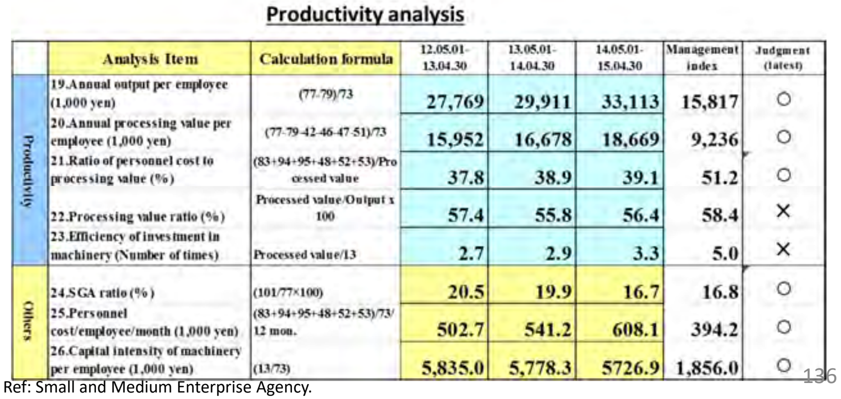
$$\text{Capital productivity} = \frac{\text{Production output, sales volume, added value, etc.}}{\text{Number of facilities, value of equipment, etc.}}$$

In the above calculations, if you try to grasp the output amount in terms of value added, it is called value-added productivity. For example, value-added labor productivity is shown in the following calculation.

Value-added labor productivity = Total added value ÷Number of employees

To increase such added value per person is called "Improvement of labor productivity."

- Added value is value that is newly generated through the manufacturing process of converting raw materials which was purchased by a company from outside to products (External purchases amount).
- Added value can be obtained from the sales amount. However, it is more appropriate to obtain from output (value).
- Additionally, it can be obtained by subtracting the external purchase value from output (value), as well as by adding added value items (i.e. operating income, personnel expenses, depreciation expenses). Such added value is called processing value.

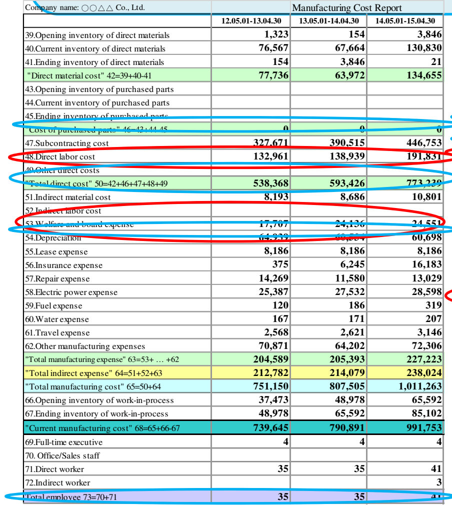


Productivity analysis

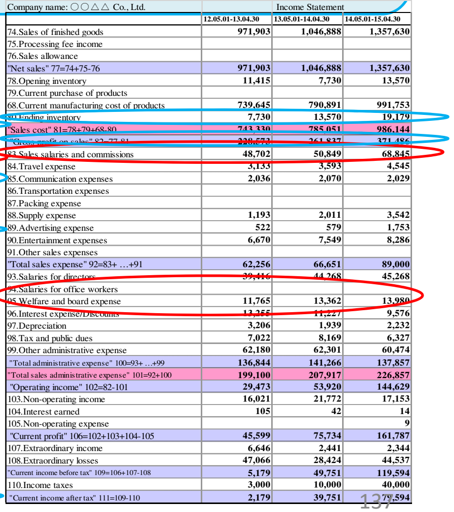
	Analysis Item	Calculation formula	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30	Management index	Judgment (latest)
Productivity	19.Annual output per employee (1,000 yen)	(77-79)/73	27,769	29,911	33,113	15,817	○
	20.Annual processing value per employee (1,000 yen)	(77-79-42-46-47-51)/73	15,952	16,678	18,669	9,236	○
	21.Ratio of personnel cost to processing value (%)	(83+94+95+48+52+53)/Processed value	37.8	38.9	39.1	51.2	○
	22.Processing value ratio (%)	Processed value/Output x 100	57.4	55.8	56.4	58.4	×
	23.Efficiency of investment in machinery (Number of times)	Processed value/13	2.7	2.9	3.3	5.0	×
Others	24.SGA ratio (%)	(101/77×100)	20.5	19.9	16.7	16.8	○
	25.Personnel cost/employee/month (1,000 yen)	(83+94+95+48+52+53)/73/ 12 mon.	502.7	541.2	608.1	394.2	○
	26.Capital intensity of machinery per employee (1,000 yen)	(13/73)	5,835.0	5,778.3	5726.9	1,856.0	○

Ref: Small and Medium Enterprise Agency.

- Added value/Number of employees = Labor productivity = <u>Processing value per employee=(77-79-42-46-47-51)/73 (No.20)</u>
- Added value/Equipment value = Capital productivity = <u>Efficiency of investment in machinery=(processed value/plant and equipment) (No.23）</u>
- Personnel cost/Added value = Personnel cost distribution rate = <u>Personnel cost to processing value ratio =(83+94+95+48+52+53)/processed value (No.21)</u>



Company name: ○○△△ Co., Ltd.	Manufacturing Cost Report		
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
39.Opening inventory of direct materials	1,323	154	3,846
40.Current inventory of direct materials	76,567	67,664	130,830
41.Ending inventory of direct materials	154	3,846	21
"Direct material cost" 42=39+40-41	77,736	63,972	134,655
43.Opening inventory of purchased parts			
44.Current inventory of purchased parts			
45.Ending inventory of purchased parts			
"Cost of purchased parts" 46=43+44-45	0	0	0
47.Subcontracting cost	327,671	390,515	446,753
48.Direct labor cost	132,961	138,939	191,831
49.Other direct costs			
"Total direct cost" 50=42+46+47+48+49	538,368	593,426	773,239
51.Indirect material cost	8,193	8,686	10,801
52.Indirect labor cost			
53.Welfare and board expense	17,707	24,136	24,551
54.Depreciation	64,939	60,534	60,698
55.Lease expense	8,186	8,186	8,186
56.Insurance expense	375	6,245	16,183
57.Repair expense	14,269	11,580	13,029
58.Electric power expense	25,387	27,532	28,598
59.Fuel expense	120	186	319
60.Water expense	167	171	207
61.Travel expense	2,568	2,621	3,146
62.Other manufacturing expenses	70,871	64,202	72,306
"Total manufacturing expense" 63=53+ … +62	204,589	205,393	227,223
"Total indirect expense" 64=51+52+63	212,782	214,079	238,024
"Total manufacturing cost" 65=50+64	751,150	807,505	1,011,263
66.Opening inventory of work-in-process	37,473	48,978	65,592
67.Ending inventory of work-in-process	48,978	65,592	85,102
"Current manufacturing cost" 68=65+66-67	739,645	790,891	991,753
69.Full-time executive	4	4	4
70. Office/Sales staff			
71.Direct worker	35	35	41
72.Indirect worker			3
Total employee 73=70+71	35	35	41



Company name: ○○△△ Co., Ltd.	Income Statement		
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium Enterprise Agency.

---

2) Productivity Index

- ✓ Annual output per employee: Value of output produced by one employee in a year (Value obtained by subtracting products purchasing cost from sales) that shows the size of production. (No.19)
- ✓ Annual processing value per employee: Value of processing of one employee in a year that shows the degree of labor productivity. Processing value is calculated as follows. (No. 20)

Processing Value (Added value)

Processing Value = Output – External purchases
However,
Output = Net sales value — Current cost of products purchased
External purchases = Direct material cost + Cost of purchasing parts + Subcontracting cost + Indirect material cost

To increase such processing value is <u>“improvement of labor productivity."</u>

Processing value ratio: Ratio that indicates the percentage of in-house processing in total output, which is also called added value ratio.

- ✓ The higher the ratio is, the higher the value added of the in-house processing work is. (No. 22)
- ✓ Processing value to personnel cost ratio: Percentage of personnel cost paid for processing jobs, which is called labor share.(No21)
- ✓ Efficiency of investment in machinery: Percentage of processing value earned from machines and equipment that shows the machine utilization.(No. 23)

---

3) Others

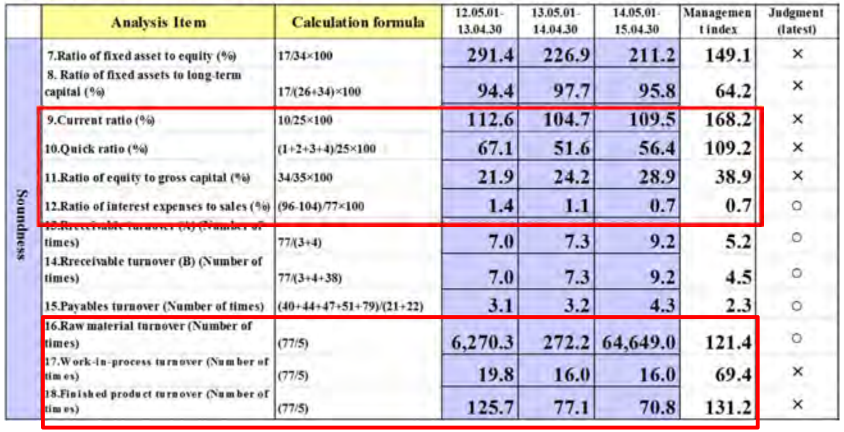
- ✓ Selling/administrative expense ratio (SGA): Percentage of selling and administrative expenses needed to achieve sales, which implies that the smaller the SGA, the more efficient the selling and administrative activities were. (No. 24)
  ※SGA: 'Selling, General & Administrative Expense - SG&A’
- ✓ Monthly average personnel cost per employee: Personnel cost paid to one employee in a month, which is the sum of salesperson's salaries and allowances, direct labor cost, indirect labor cost, and welfare and statutory welfare costs. This indicates the salary level (whether it is high or low). (No. 25)
- ✓ Capital intensity of machinery per employee: Amount of tangible fixed assets used by one employee that shows the level of mechanization. (No. 26)

c) Liquidity analysis (Soundness)

1) Significance of liquidity analysis

Liquidity indicates the capital needed by a company and the level of its sufficiency, which can also be said 'degree of safety.'

Liquidity is determined by the adequacy of capital structure, solvency, or stability of capital structure. For this reason, the equity-to-total assets and the fund raising/operation ratios are calculated.



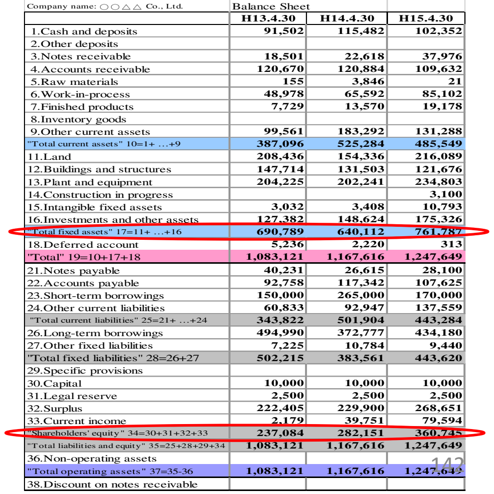
	Analysis Item	Calculation formula	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30	Management index	Judgment (latest)
Soundness	7.Ratio of fixed asset to equity (%)	17/34×100	291.4	226.9	211.2	149.1	×
	8. Ratio of fixed assets to long-term capital (%)	17/(26+34)×100	94.4	97.7	95.8	64.2	×
	9.Current ratio (%)	10/25×100	112.6	104.7	109.5	168.2	×
	10.Quick ratio (%)	(1+2+3+4)/25×100	67.1	51.6	56.4	109.2	×
	11.Ratio of equity to gross capital (%)	34/35×100	21.9	24.2	28.9	38.9	×
	12.Ratio of interest expenses to sales (%)	(96-104)/77×100	1.4	1.1	0.7	0.7	○
	13.Rreceivable turnover (A) (Number of times)	77/(3+4)	7.0	7.3	9.2	5.2	○
	14.Rreceivable turnover (B) (Number of times)	77/(3+4+38)	7.0	7.3	9.2	4.5	○
	15.Payables turnover (Number of times)	(40+44+47+51+79)/(21+22)	3.1	3.2	4.3	2.3	○
	16.Raw material turnover (Number of times)	(77/5)	6,270.3	272.2	64,649.0	121.4	○
	17.Work-in-process turnover (Number of times)	(77/5)	19.8	16.0	16.0	69.4	×
	18.Finished product turnover (Number of times)	(77/5)	125.7	77.1	70.8	131.2	×

Ref: Small and Medium Enterprise Agency.

2) Liquidity metrics (soundness)

Ratio of fixed asset to equity: Ratio that shows the balance between fixed assets and shareholders' equity. Ideally, it is desirable that value of the fixed asset is lower than that of shareholders' equity (i.e., this ratio is lower than 100%). If the value of fixed asset is larger, it mean that the financial structure is weak, because a part of the fixed asset that cannot be converted to cash is covered by the debt that have to be paid back in cash. (No. 7)

= Total Fixed Cost /stakeholders' equity ×100

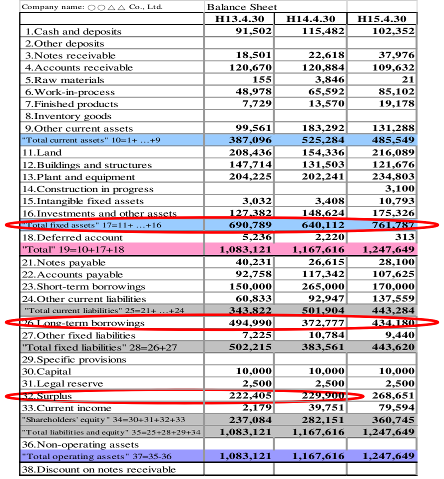


Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ ...+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ ...+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ ...+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

Ref: Small and Medium Enterprise Agency.

Ratio of fixed assets to long-term capital: Ratio that shows the adequacy of fixed assets and long-term capital (Sum of long-term borrowing and shareholders' equity). Fixed assets must be lower than long-term capital, i.e. this ratio must be lower than 100%. Even if the above No7 is more than 100%, it won't particularly pose a problem for solvency, if this ratio is less than 100%.

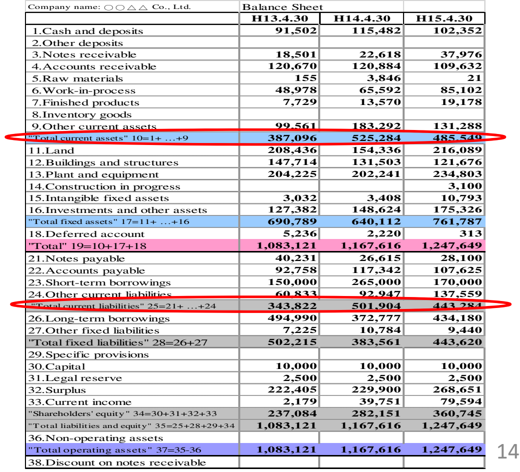
(No. 8) = Total Fixed Cost /(Long-term borrowings + stakeholders' equity) ×100



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ ...+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ ...+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ ...+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

Ref: Small and Medium Enterprise Agency.

Current ratio: Ratio that indicates the equilibrium of current assets and current liabilities, which shows short-term solvency. Current assets should be more than current liabilities and ideally, more than 200%. For this reason, it is called '2:1 Principle.' (No. 9) = (Total current assets / Total current liabilities)×100



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ ...+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ ...+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ ...+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

Ref: Small and Medium Enterprise Agency.

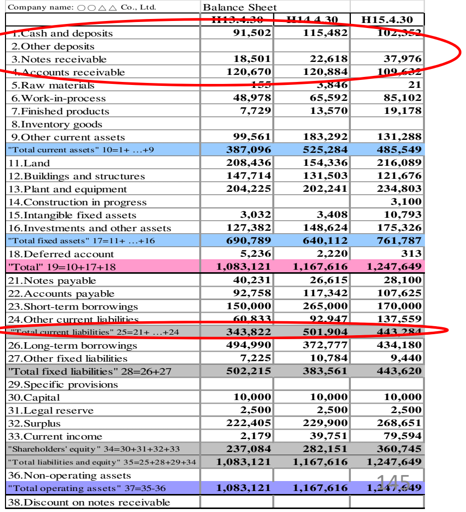
Quick ratio: Ratio of quick assets (Value obtained by subtracting inventory assets from current assets) to the current liabilities that shows immediate solvency. It is desirable that the quick assets that can be converted to cash without taking selling process are more than current liability, i.e. this ratio is more than 100%.

(No. 10) =

((Cash & deposit + other deposit

+ Notes receivable + Account receivable)

/ Total current liabilities)×100



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

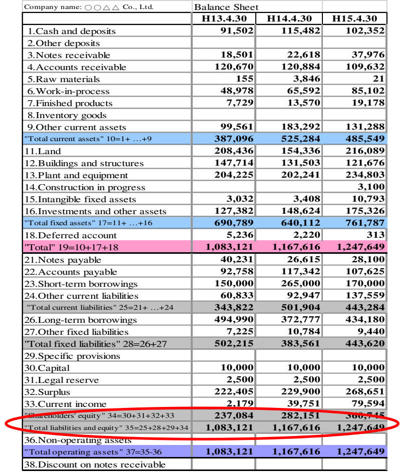
Ref: Small and Medium
Enterprise Agency.

Ratio of equity to gross capital: Ratio that indicates the proportion of liabilities and shareholders' equity that shows the adequacy of capital structure. It is desirable that the shareholders' equity is more than liability, i.e. this ratio is more than 50%. However, Japan's current standard is about 30%. To raise this ratio is the very way to correct capital structure.

(No. 11)

（Shareholders' equity /

Total liabilities and equity) ×100



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

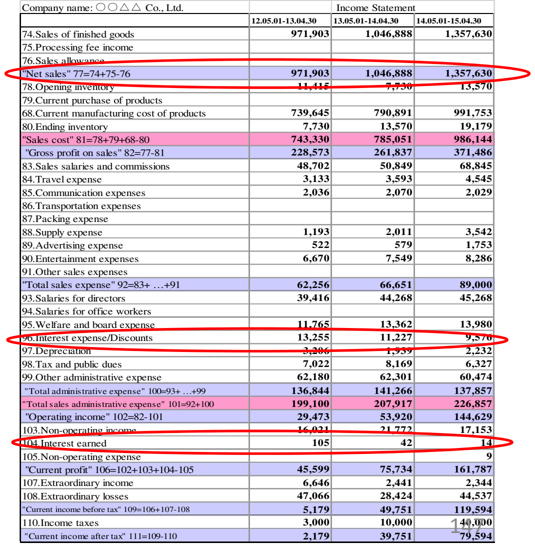
Ref: Small and Medium
Enterprise Agency.

Ratio of interest expense to sales: Percentage of interest expense in sales that represents the degree of interest burden. Of course, it is desirable that this ratio is low. (No. 12)＝

((Interest expense/Discounts

－Interest earned)/

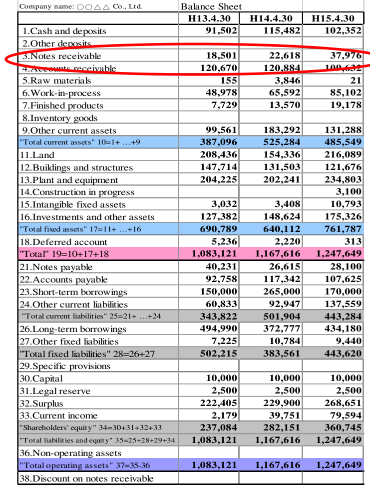
Net sales)×100



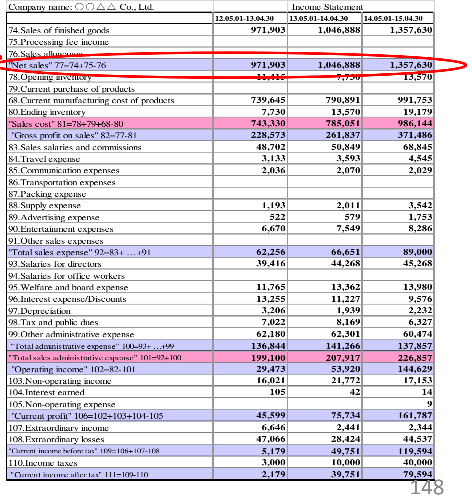
Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium
Enterprise Agency.

Receivable turnover: The ratio of sales, which is the business outcome, to the accounts receivable balance (Total accounts receivable and notes receivable), which shows the degree of collection of accounts receivables. The number of days obtained by dividing 365 days by this turnover ratio represents the number of days you need from sales to collection of cash.(No. 13~14)



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			

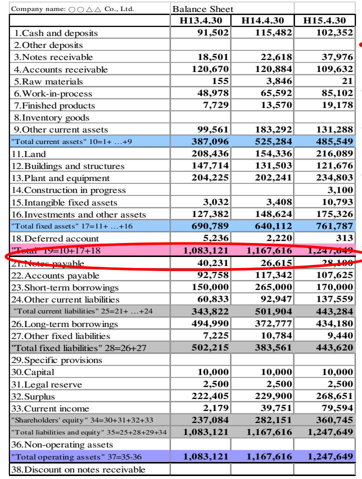


Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

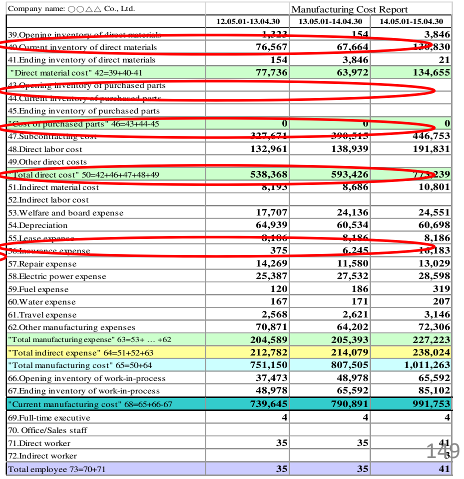
Ref: Small and Medium Enterprise Agency.

Payables turnover: Ratio of external purchase value (Direct material purchase + Purchased parts + Subcontracting cost + Indirect material cost + Current cost of products purchased) to accounts payable (Total notes payable and accounts payable), which represents the degree of payment of accounts payable. The number of days obtained by dividing 365 days by this turnover ratio represents the number of days you need from purchase to payment in cash. (No. 15)

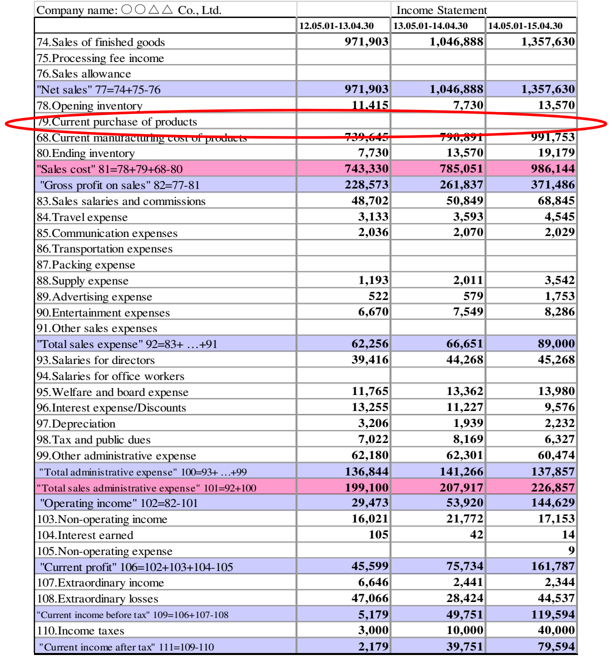
Reference : The Small and Medium Enterprise Agency management Index of SME



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			



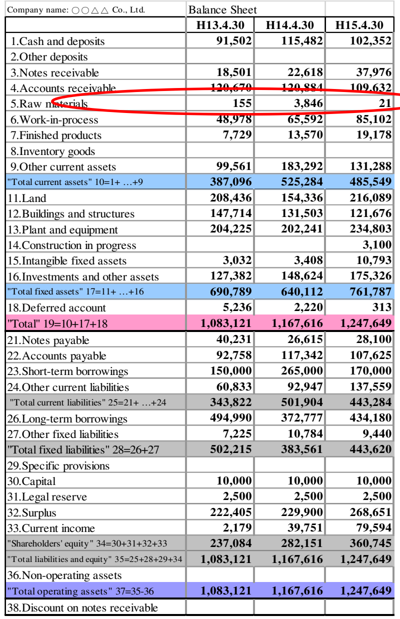
Company name: ○○△△ Co., Ltd.		Manufacturing Cost Report	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
39.Opening inventory of direct materials	1,323	154	3,846
40.Current inventory of direct materials	76,567	67,664	130,830
41.Ending inventory of direct materials	154	3,846	21
"Direct material cost" 42=39+40-41	77,736	63,972	134,655
43.Opening inventory of purchased parts			
44.Current inventory of purchased parts			
45.Ending inventory of purchased parts			
"Cost of purchased parts" 46=43+44-45	0	0	0
47.Subcontracting cost	327,671	390,515	446,753
48.Direct labor cost	132,961	138,939	191,831
49.Other direct costs			
"Total direct cost" 50=42+46+47+48+49	538,368	593,426	773,239
51.Indirect material cost	8,193	8,686	10,801
52.Indirect labor cost			
53.Welfare and board expense	17,707	24,136	24,551
54.Depreciation	64,939	60,534	60,698
55.Lease expense	8,186	8,186	8,186
56.Insurance expense	375	6,245	16,183
57.Repair expense	14,269	11,580	13,029
58.Electric power expense	25,387	27,532	28,598
59.Fuel expense	120	186	319
60.Water expense	167	171	207
61.Travel expense	2,568	2,621	3,146
62.Other manufacturing expenses	70,871	64,202	72,306
"Total manufacturing expense" 63=53+ … +62	204,589	205,393	227,223
"Total indirect expense" 64=51+52+63	212,782	214,079	238,024
"Total manufacturing cost" 65=50+64	751,150	807,505	1,011,263
66.Opening inventory of work-in-process	37,473	48,978	65,592
67.Ending inventory of work-in-process	48,978	65,592	85,102
"Current manufacturing cost" 68=65+66-67	739,645	790,891	991,753
69.Full-time executive	4	4	4
70. Office/Sales staff			
71.Direct worker	35	35	41
72.Indirect worker			3
Total employee 73=70+71	35	35	41



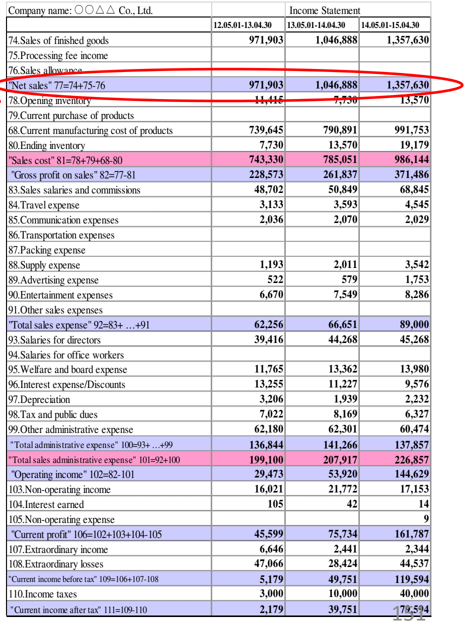
Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium Enterprise Agency.

Raw material , work-in-process, finished product turnover (No. 16~18)



Company name: ○○△△ Co., Ltd.	Balance Sheet		
	H13.4.30	H14.4.30	H15.4.30
1.Cash and deposits	91,502	115,482	102,352
2.Other deposits			
3.Notes receivable	18,501	22,618	37,976
4.Accounts receivable	120,670	120,884	109,632
5.Raw materials	155	3,846	21
6.Work-in-process	48,978	65,592	85,102
7.Finished products	7,729	13,570	19,178
8.Inventory goods			
9.Other current assets	99,561	183,292	131,288
"Total current assets" 10=1+ …+9	387,096	525,284	485,549
11.Land	208,436	154,336	216,089
12.Buildings and structures	147,714	131,503	121,676
13.Plant and equipment	204,225	202,241	234,803
14.Construction in progress			3,100
15.Intangible fixed assets	3,032	3,408	10,793
16.Investments and other assets	127,382	148,624	175,326
"Total fixed assets" 17=11+ …+16	690,789	640,112	761,787
18.Deferred account	5,236	2,220	313
"Total" 19=10+17+18	1,083,121	1,167,616	1,247,649
21.Notes payable	40,231	26,615	28,100
22.Accounts payable	92,758	117,342	107,625
23.Short-term borrowings	150,000	265,000	170,000
24.Other current liabilities	60,833	92,947	137,559
"Total current liabilities" 25=21+ …+24	343,822	501,904	443,284
26.Long-term borrowings	494,990	372,777	434,180
27.Other fixed liabilities	7,225	10,784	9,440
"Total fixed liabilities" 28=26+27	502,215	383,561	443,620
29.Specific provisions			
30.Capital	10,000	10,000	10,000
31.Legal reserve	2,500	2,500	2,500
32.Surplus	222,405	229,900	268,651
33.Current income	2,179	39,751	79,594
"Shareholders' equity" 34=30+31+32+33	237,084	282,151	360,745
"Total liabilities and equity" 35=25+28+29+34	1,083,121	1,167,616	1,247,649
36.Non-operating assets			
"Total operating assets" 37=35-36	1,083,121	1,167,616	1,247,649
38.Discount on notes receivable			



Company name: ○○△△ Co., Ltd.		Income Statement	
	12.05.01-13.04.30	13.05.01-14.04.30	14.05.01-15.04.30
74.Sales of finished goods	971,903	1,046,888	1,357,630
75.Processing fee income			
76.Sales allowance			
"Net sales" 77=74+75-76	971,903	1,046,888	1,357,630
78.Opening inventory	11,415	7,730	13,570
79.Current purchase of products			
68.Current manufacturing cost of products	739,645	790,891	991,753
80.Ending inventory	7,730	13,570	19,179
"Sales cost" 81=78+79+68-80	743,330	785,051	986,144
"Gross profit on sales" 82=77-81	228,573	261,837	371,486
83.Sales salaries and commissions	48,702	50,849	68,845
84.Travel expense	3,133	3,593	4,545
85.Communication expenses	2,036	2,070	2,029
86.Transportation expenses			
87.Packing expense			
88.Supply expense	1,193	2,011	3,542
89.Advertising expense	522	579	1,753
90.Entertainment expenses	6,670	7,549	8,286
91.Other sales expenses			
"Total sales expense" 92=83+ …+91	62,256	66,651	89,000
93.Salaries for directors	39,416	44,268	45,268
94.Salaries for office workers			
95.Welfare and board expense	11,765	13,362	13,980
96.Interest expense/Discounts	13,255	11,227	9,576
97.Depreciation	3,206	1,939	2,232
98.Tax and public dues	7,022	8,169	6,327
99.Other administrative expense	62,180	62,301	60,474
"Total administrative expense" 100=93+ …+99	136,844	141,266	137,857
"Total sales administrative expense" 101=92+100	199,100	207,917	226,857
"Operating income" 102=82-101	29,473	53,920	144,629
103.Non-operating income	16,021	21,772	17,153
104.Interest earned	105	42	14
105.Non-operating expense			9
"Current profit" 106=102+103+104-105	45,599	75,734	161,787
107.Extraordinary income	6,646	2,441	2,344
108.Extraordinary losses	47,066	28,424	44,537
"Current income before tax" 109=106+107-108	5,179	49,751	119,594
110.Income taxes	3,000	10,000	40,000
"Current income after tax" 111=109-110	2,179	39,751	79,594

Ref: Small and Medium Enterprise Agency.

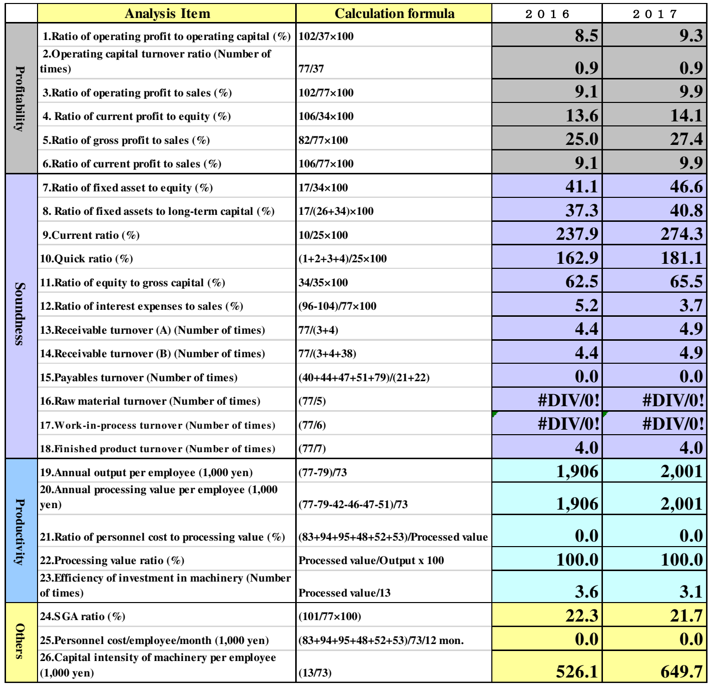
Receivable turnover
= Net sales /(Notes receivable + Accounts receivable) (No. 13)
or
= Net sales/(Notes receivable + Accounts receivable + Discount on notes receivable)
(No. 14)

Payables turnover (No. 15)
= (Current inventory of direct materials + Current inventory of purchased parts + Subcontracting cost + Indirect material cost + Current purchase of products) / (Notes payable + Accounts payable)

Raw material turnover (No. 16)
= (Net sales / Raw materials)

Work-in-process turnover (No. 17)
= (Net sales / Work-in-process)

finished product and inventory turnover (No. 18)
= (Net sales / Finished products or inventory)



	Analysis Item	Calculation formula	2016	2017
Profitability	1.Ratio of operating profit to operating capital (%)	102/37×100	8.5	9.3
	2.Operating capital turnover ratio (Number of times)	77/37	0.9	0.9
	3.Ratio of operating profit to sales (%)	102/77×100	9.1	9.9
	4. Ratio of current profit to equity (%)	106/34×100	13.6	14.1
	5.Ratio of gross profit to sales (%)	82/77×100	25.0	27.4
	6.Ratio of current profit to sales (%)	106/77×100	9.1	9.9
Soundness	7.Ratio of fixed asset to equity (%)	17/34×100	41.1	46.6
	8. Ratio of fixed assets to long-term capital (%)	17/(26+34)×100	37.3	40.8
	9.Current ratio (%)	10/25×100	237.9	274.3
	10.Quick ratio (%)	(1+2+3+4)/25×100	162.9	181.1
	11.Ratio of equity to gross capital (%)	34/35×100	62.5	65.5
	12.Ratio of interest expenses to sales (%)	(96-104)/77×100	5.2	3.7
	13.Receivable turnover (A) (Number of times)	77/(3+4)	4.4	4.9
	14.Receivable turnover (B) (Number of times)	77/(3+4+38)	4.4	4.9
	15.Payables turnover (Number of times)	(40+44+47+51+79)/(21+22)	0.0	0.0
	16.Raw material turnover (Number of times)	(77/5)	#DIV/0!	#DIV/0!
	17.Work-in-process turnover (Number of times)	(77/6)	#DIV/0!	#DIV/0!
	18.Finished product turnover (Number of times)	(77/7)	4.0	4.0
Productivity	19.Annual output per employee (1,000 yen)	(77-79)/73	1,906	2,001
	20.Annual processing value per employee (1,000 yen)	(77-79-42-46-47-51)/73	1,906	2,001
	21.Ratio of personnel cost to processing value (%)	(83+94+95+48+52+53)/Processed value	0.0	0.0
	22.Processing value ratio (%)	Processed value/Output x 100	100.0	100.0
	23.Efficiency of investment in machinery (Number of times)	Processed value/13	3.6	3.1
Others	24.SGA ratio (%)	(101/77×100)	22.3	21.7
	25.Personnel cost/employee/month (1,000 yen)	(83+94+95+48+52+53)/73/12 mon.	0.0	0.0
	26.Capital intensity of machinery per employee (1,000 yen)	(13/73)	526.1	649.7

Sample/Business Analysis of Bangladeshi company

---

4. Break-even Point

(1) Break-even point

Break-even point refers to sales or sales volume where sales and expense amounts are exactly equal. The former is called break-even point sales and the latter is called breakeven point sales volume.

Break-even point: the point at which sales and expense exactly match (Sales - Expense = 0)

Sales - Expense = 0 (When profit is 0)
Sales = Expense
Sales = Variable cost + Fixed cost

$$\text{Sales} = \text{Sales} \times \frac{\text{Variable cost}}{\text{Sales}} + \text{Fixed cost}$$

$$\text{Sales} - \text{Sales} \times \frac{\text{Variable cost}}{\text{Sales}} = \text{Fixed cost}$$

$$\text{Sales} \times \left(1 - \frac{\text{Variable cost}}{\text{Sales}}\right) = \text{Fixed cost}$$

$$\text{Break Even point} = \frac{\text{Fixed cost + Profit (=0)}}{1 - \boxed{\dfrac{\text{Variable cost}}{\text{Sales}}}}$$

Variable cost ratio

1－Variable cost ratio＝Marginal profit ratio

Marginal profit ＝Fixed cost＋Profit

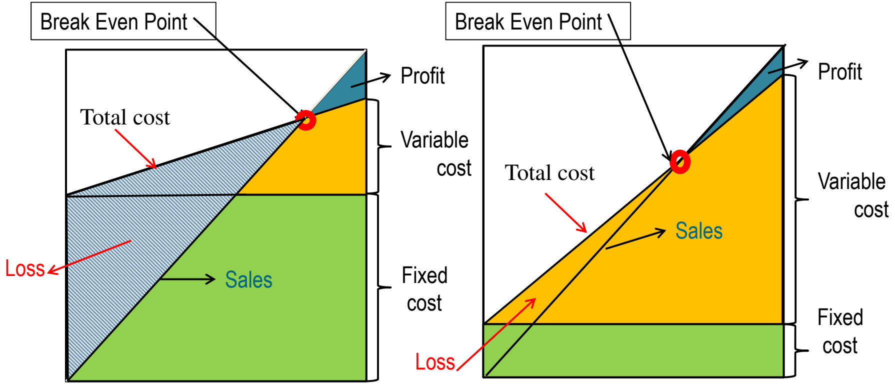
$$\text{Break-even sales} = \frac{\text{Fixed cost(Profit is zero)}}{\text{Marginal profit ratio}}$$

$$\text{Break-even sales including profit} = \frac{\text{Fixed cost＋Profit}}{\text{Marginal profit ratio}}$$

(2) Direct cost accounting

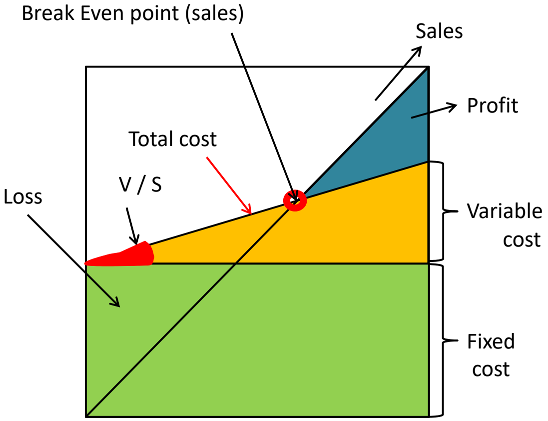
		1. Sales = Unit price × Quantity	1.1 billion Taka
Manufacturing cost	Total Variable Cost	2. Material cost	
		3. Supply expense	
		4. Subcontracting cost	
		5 = 2 + 3 + 4	300 million Taka
	Marginal profit 6= 1 - 5		
	Total Fixed Cost	7.Personnel cost(Factory)	
		8.Depreciation	
		9.Rent	
		10.Lease	
		11.Other manufacturing expense	
		12 = 7+8+9+10+11	600 million Taka
13.Total general administrative expense(fixed cost)			100milion Taka
Profit 14 = 6 – 12 -13			

Comparison between firms with high fixed costs and companies with variable costs



High fixed cost enterprises require more sales to reach break-even points, but it will be easier to earn more profits if sales exceed this.

Companies with high variable costs have a low profit margin, even if sales over the breakeven point are secured.



$$\text{Safety rate} = \frac{\text{Current sales} - \text{Break even sales}}{\text{Current sales}}$$

(3) To increase profit

a. Increase sales volume
b. Increase the selling price
c. Reduce variable cost
d. Reduce fixed cost

Q1: See the diagram above and find the break-even sales of your own company.
Q2: Find the management safety rate.
Q3: Find the break-even sales when variable cost is reduced by 10% while the fixed cost is constant.
Q4: Find the break-even sales when fixed cost is reduced by 10% while the variable cost is constant.

Guide for judgment

BEP＜70%	Excellent
90%＞BEP＞70%	Normal
100%＞BEP＞90%	Critical

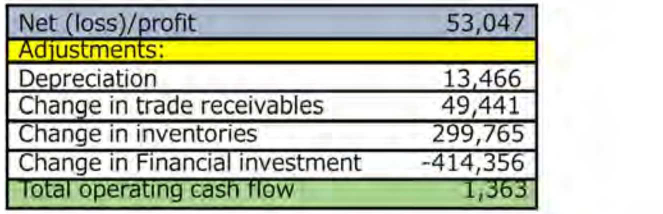
5. Cash & Flow

- "Cash flow" is the flow of money (inflow / outflow, income · expenditure). "Cash flow statement" represents the increase or decrease in cash and cash equivalents (such as time deposits within three months, negotiable certificates, etc.) during one accounting period of the company.
  You can check the management status of the company through flow, increase and decrease of funds.
- In the statement of cash flow you will see items such as cash flow from sales activities, investment activities and financing activities. Cash flow from operating activities refers to money actually earned through business activities and cash flow from investing activities refers to the outflow of money due to capital investment, investment in securities, acquisitions, etc., Cash flow from financing activities refers to inflow (outflow) of money due to debt (repayment) and capital increase (dividend payment).

---

5. Cash & Flow (cont.)

- The sum of cash flow from operating activities and cash flows from investing activities is called "free cash flow" and represents the money that a company can freely use.
  In the case of a good company, there is a tendency that the operating cash flow is positive (operating performance was favorable), the investment cash flow is negative (aggressive capital investment) and the financial cash flow is negative (repayment of borrowings).



Net (loss)/profit	53,047
Adjustments:	
Depreciation	13,466
Change in trade receivables	49,441
Change in inventories	299,765
Change in Financial investment	-414,356
Total operating cash flow	1,363

Ref: Japan Securities Dealers Association.

---

6. Cost Control

Purpose of cost control

a) Cost reduction
b) Performance evaluation
c) Decision on in-house production or outsourcing
d) Decision-making on purchase of equipment
e) Development of new products

6-1. Target Cost Setting

(1) Target cost setting based on customer information, competitive conditions

- Determine target cost based on marketing information, adoption of new technology / new design, movement of other companies in the same industry, etc.

(2) Request from parent company

- A company often receive an order from its parent company to reduce cost by a specific amount or percentage.

6-2. Points of Cost Reduction

(1) The point of eliminating loss needs to be considered in terms of both quantity and unit cost.

(2) Reduce standard cost (target)

(3) The standard cost setting is different from company to company

6-3. VE (Value Engineering)

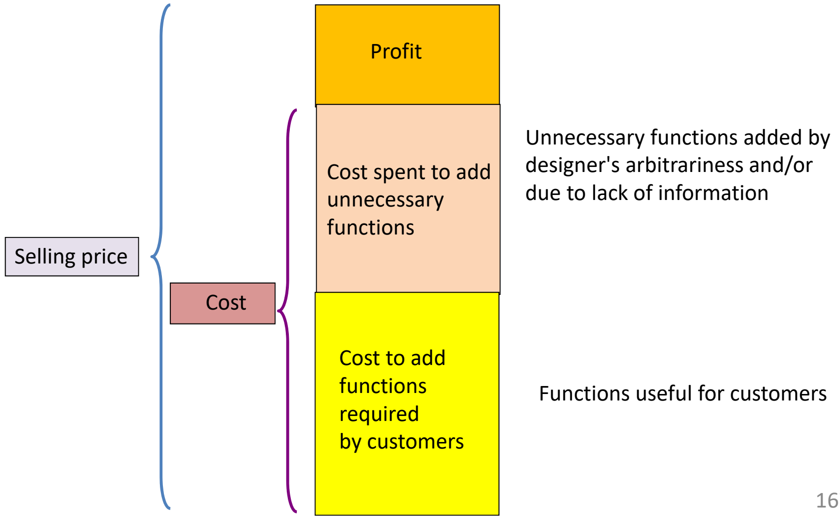
(1) Founded in 1947 by Lawrence D. Miles, Purchasing Manager, GE, USA

(2) VE is an organizational effort to focus on product and functional research to ensure that the required functions are achieved at the lowest lifecycle cost.

(3) In Japan it was introduced in 1954 for the first time and was used to reduce procurement costs in the purchasing department in the early stages. Currently it is used in various fields such as automobiles, construction, electric machinery, logistics and service sales activities. As a concrete method, it is used for idea, mainly function analysis, there are methods such as tear down, bench marking, as application method.

Ref: Tsuchiya. H., Nakagami. Y., and Tanaka. M.

6-4. Cost from a Functional Point of View



Selling price

Cost

Profit

Cost spent to add unnecessary functions

Unnecessary functions added by designer's arbitrariness and/or due to lack of information

Cost to add functions required by customers

Functions useful for customers

6-5-1. Conditions for Achieving the Function

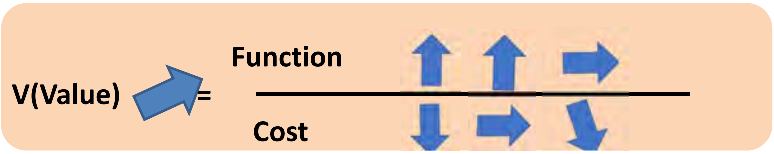
(1) Performance: degree of achievement of function

(2) Reliability: Sustainability of function achievement

(3) Integrity: Ease of repair in case of stoppage

(4) Safety: Safety in achieving functions

(5)Ease of Operation



6-5-2. Standard Price Checklist (excerpt)

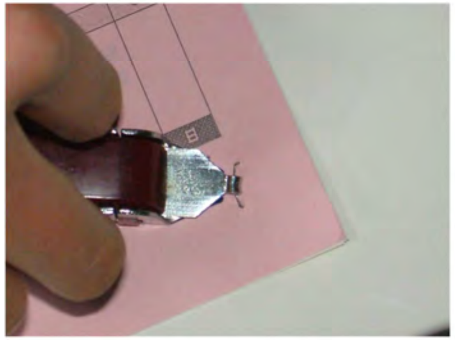
Calculation of standard cost.
Whether the basis of standard cost calculation is clear
A. Is it standard operation?
B. Is it standard work?
C. Is it standard work efficiency?
D. Standard expense ratio
E. Standard equipment operation rate
F. Is it a standard good rate (or defect rate)?
G. Is it standard yield rate?
Is the rule of management clear?
A. How to set the standard price
B. How to analyze the difference between standard cost and actual cost
C. Investigate the causes of differences and plan for measures
D. Implementation of measures and follow-up

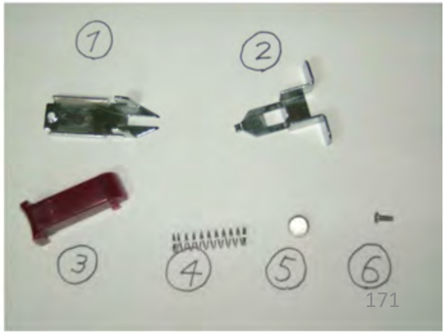
Ref: Advance Management Co ., LTD.

6-5-3. Cost Sheet

	Product Name –	Date –
SL	**Particulars**	**Cost (in Taka)**
1	Raw Matrials	
2	Direct Labor	
3	Prime Cost (1+2)	
4	Factory Overhead	
5	Packing Cost-Poly	
6	Accessories Cost	
7	Cost of Goods Sold (3+4+5+6)	
8	Sales,Marketing & Distribution Expense	
9	Administrative Expense	
10	Finance Charge	
11	Rejection Expense	
	Total Cost Tk. (7+8+9+10+11)	
	Markup @10%	
	Selling Price-(Without considering TDS)/Pc	
	Selling Price-(Considering TDS @ 4%)/Pc	
	Selling Price-(Considering TDS @ 15%)/Pc	

6-6. Ex





Let's think about products with the same function.

6-7. Improvement of Efficiency

$$\text{Productivity} = \frac{\text{OUTPUT}}{\text{INTPUT}}$$

There are two ways to improve productivity:
(1) Efficiency (2) Operation Rate

Production efficiency

$$\frac{\text{Actual manpower}}{\text{Standard manpower}}\ \textbf{(Efficiency)} \qquad \frac{\text{Actual production time}}{\text{Working hours}}\ \textbf{(Operation rate)}$$

Exercise
Standard manpower :3 workers produce 120 pieces per hour
Actual manpower : 4 workers produce 80 pieces per hour
Working hours :(e.g.) 8 hours (8:00~17:00 <except one-hour lunch time >
Actual production time: 7hours

6-7-1. Improvement of Efficiency

How to reduce Muda

Muda (Working hours – Actual production hours) doesn't produce additional value.

There are many ways to improve efficiency.

(1) Technical improvement

- **Improvement of equipment**
  (improvement of equipment, mechanization of equipment)
- **Improvement of process method**
  (design to make easy, simplification of work)

(2) Work method

- **Review of work**
  (improvement of work method, elimination of waste)
- **Elimination of work**
  (improvement of jigs and tools, improvement of transportation)

(3) Improvement of quality

- **Improvement of system**
  (quality assurance, management system)
- **Improvement of work**
  (standardization, prevention of recurrence, etc.)

(4) Improvement of ability

- **Objective management**
  (setting of the aim, improvement plan of motivation)
- **Improvement of skill**
  (skill training)

6-7-2. Improvement of Operation Rate

Improvement of operation rate reduces non added value operation (Muda) such as transportation, moving, walking, etc.
Operation rate is the proportion of actual working time of man and machine to working time.

Improvement of operation rate =

- Operation rate of operators
  - Elimination of waste time
  - Improvement of layout
- Operation rate of machines
  - Improvement of setup
  - Reduction of machine trouble
- Managerial operation rate
  - Leveling of load
  - Management of extra capacity

Reduction of Work Time-1

Elimination of waste and standardization	• Standard operation that thoroughly omits wasteful operation • Setting for standard time.	• Improve work time by classifying seven wastes. • Stable production, prevent reverse flow.
Mechanization /Automation	• Hand work Use jig and tools: Mechanization Elimination(reduction) of labor → Automation	• Install handmade machines Instead of handwork.
Work improvement	• Improvement of work method and work procedure	• Improve activate index (material handling)

Reduction of Work Time-2 (other methods)

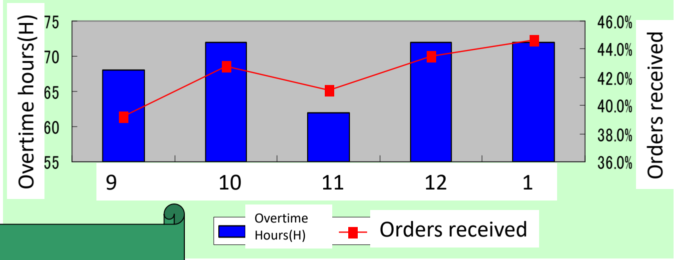
Layout	- **Improvement of layout and transportation**	- <u>Make process flow of converting raw materials to products in consideration of minimization of stagnation and transportation.</u> - Use all effective space.
	- **Principles of management simplification**	- Layout which is easy for manager and supervisor to control.
	- **Principles of safety and satisfaction**	- Workers' safety and satisfaction need to be considered.

Case Study

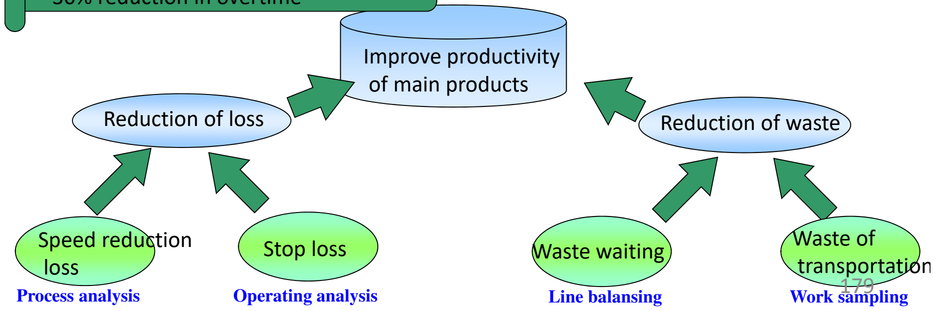
(1) Industry: Manufacturing of automobile parts
(2) Issue: Orders for main products have increased, which increased overtime hours
(3) Target: Improve productivity of the main product and thereby reduce overtime by 30%
(4) Countermeasure: Utilization of idle facilities, and prevention of short stoppage/short-time breakdown

---

Monthly overtime hours and percentage of orders received for main products



Target
Improvement of productivity of main products !!
30% reduction in overtime


Improve productivity of main products

Reduction of loss

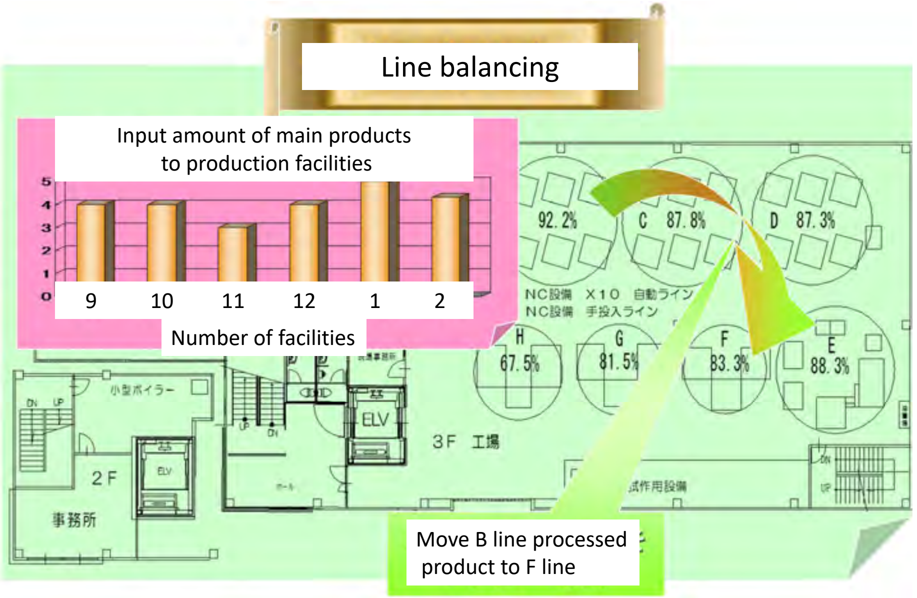
Reduction of waste

Speed reduction loss
Process analysis

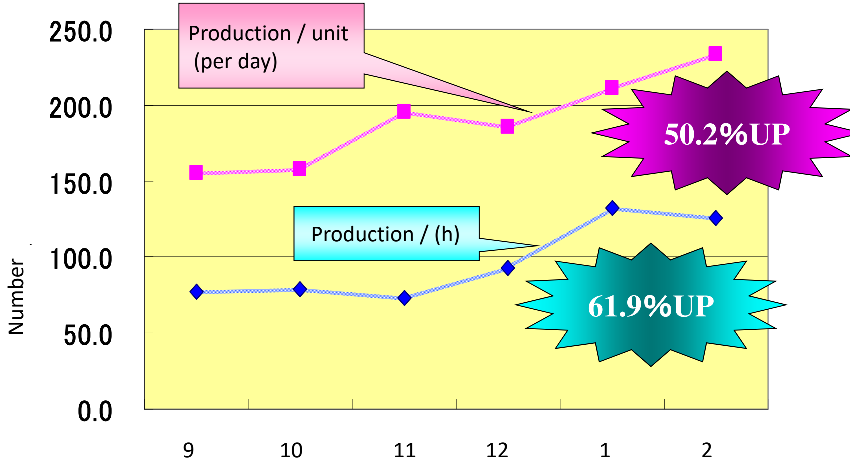
Stop loss
Operating analysis

Waste waiting
Line balansing

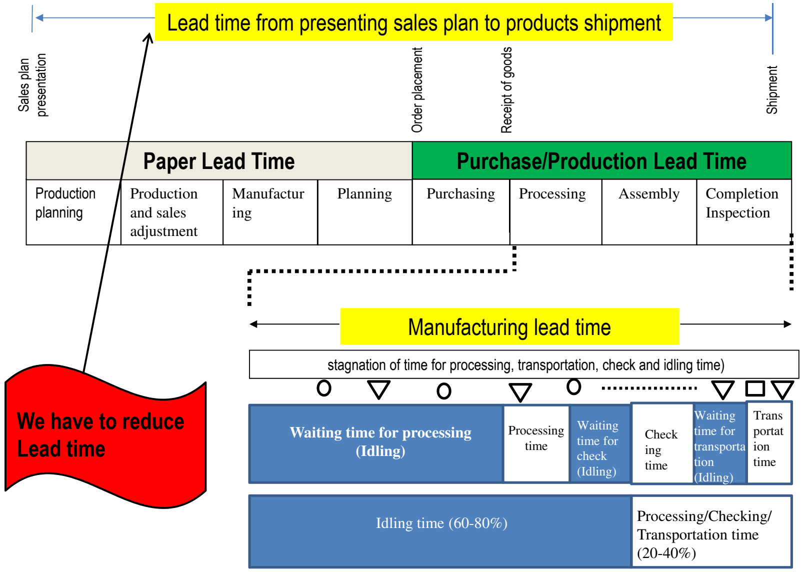
Waste of transportation
Work sampling



Productivity improvement evaluation



6-8. Concept of Process Control



Lead time from presenting sales plan to products shipment

Paper Lead Time				Purchase/Production Lead Time			
Production planning	Production and sales adjustment	Manufacturing	Planning	Purchasing	Processing	Assembly	Completion Inspection

Manufacturing lead time

stagnation of time for processing, transportation, check and idling time)

Waiting time for processing (Idling)	Processing time	Waiting time for check (Idling)	Checking time	Waiting time for transportation (Idling)	Transportation time

Idling time (60-80%)	Processing/Checking/ Transportation time (20-40%)

We have to reduce Lead time

Question 1 (Group Work)

A company has implemented a process line improvement. As a result, the company reduced the number of operators required in a process line from 5 to 3 operators. Labor cost per head is Tk. 10,000/ per month.

In this case, how much cost effectiveness was obtained as a result of the process improvement?

Question 2 (Group Work)

There are two types of machines: machine A and B that have the same function. Both are available for hire (they can be rented on lease).

- The sum of lease fees and fixed maintenance cost per month:
  Machine A: Tk. 1 million
  Machine B: Tk. 2 million

- The variable processing cost required for a product:
  Machine A: Tk. 600
  Machine B: Tk. 400

If you lease either machine A or B, which machine should you choose?

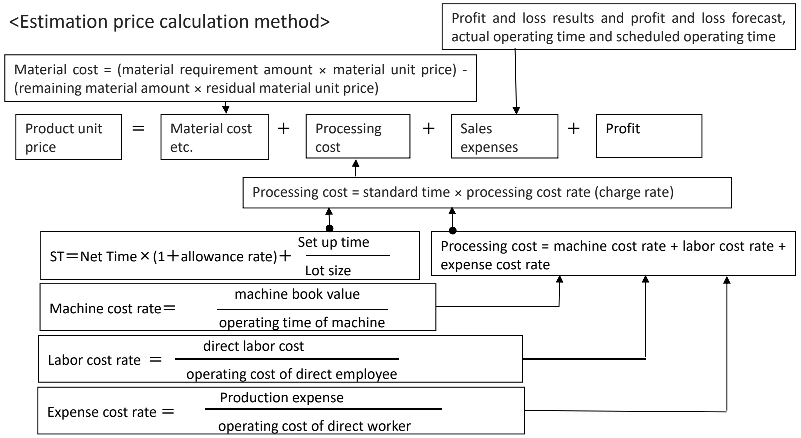
Question 3 (Group Work)

What kind of impacts do you expect on business management if you have an excessive amount of work in process and product inventory ?

Please share individual views and summarize an opinion as a group.

Question 4 (Group Work)

Answer the following questions (see the next slide) with reference to the following estimation method.



<Estimation price calculation method>

Profit and loss results and profit and loss forecast, actual operating time and scheduled operating time

Material cost = (material requirement amount × material unit price) - (remaining material amount × residual material unit price)

Product unit price = Material cost etc. + Processing cost + Sales expenses + Profit

Processing cost = standard time × processing cost rate (charge rate)

$\text{ST}=\text{Net Time}\times(1+\text{allowance rate})+\dfrac{\text{Set up time}}{\text{Lot size}}$

Processing cost = machine cost rate + labor cost rate + expense cost rate

$\text{Machine cost rate}=\dfrac{\text{machine book value}}{\text{operating time of machine}}$

$\text{Labor cost rate}=\dfrac{\text{direct labor cost}}{\text{operating cost of direct employee}}$

$\text{Expense cost rate}=\dfrac{\text{Production expense}}{\text{operating cost of direct worker}}$

Question 4 (Group Work) (cont.)

Based on the formula above

1) Calculate the part cost

   i) Material cost: material unit cost = 300T/kg (T=Taka)
   ii) Material = 10g
   iii) Machine cost rate = 3,000T/Hour
   iv) Molding cycle = 30 sec
   v) Number of picking products：2 pcs

Molded item cost:

Material cost (unit price × weight used) + processing cost (machine rate × molding time)

Calculation example of molded item cost

= 300T ×10g/1000g / 2 + 3000 ×(30sec/ 3600 sec) /2 = 14T / 1 piece

---

Question 4 (Group Work) (cont.)

2) Profitability and productivity

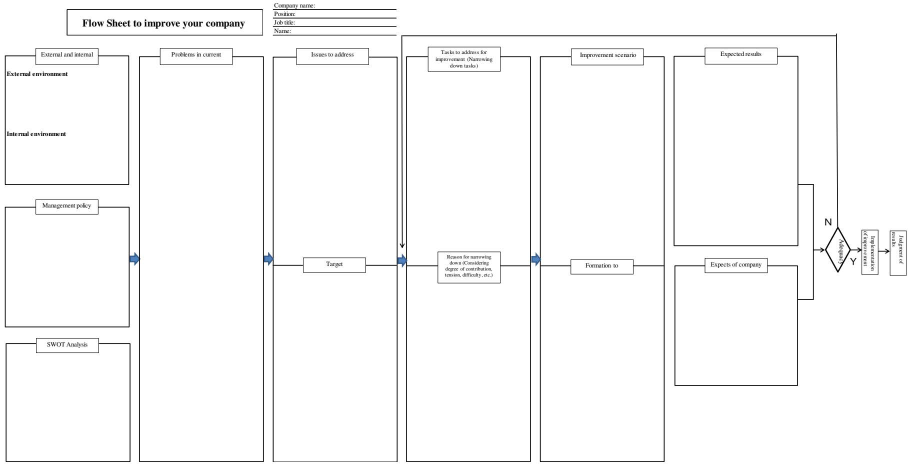
Based on the calculation example above (in the previous slide), what kind of method will improve profitability and productivity?

Profitability & Productivity

Improve yield rate, increase number of picking products, eliminate waste time of a machine, decrease set up time, decrease defects

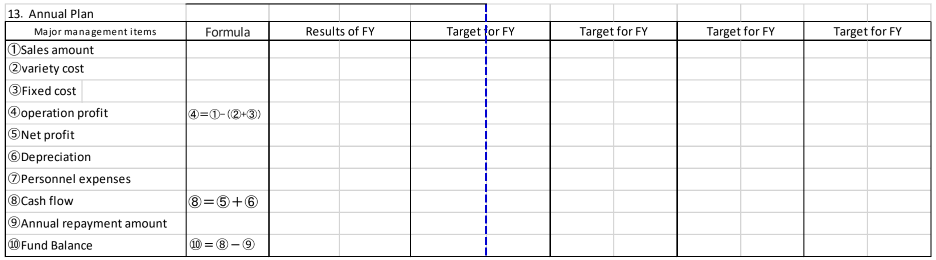
Productivity: Employees have many facilities at once. Eliminate wasteful time of operation.

Question 5 (Individual Work-1)



Question 6 (Individual Work-2)

While preparing the format of the financial statements, we will proceed and finalize the income and expenditure plan.



13. Annual Plan

Major management items	Formula	Results of FY	Target for FY	Target for FY	Target for FY	Target for FY
①Sales amount						
②variety cost						
③Fixed cost						
④operation profit	④=①-(②+③)					
⑤Net profit						
⑥Depreciation						
⑦Personnel expenses						
⑧Cash flow	⑧=⑤+⑥					
⑨Annual repayment amount						
⑩Fund Balance	⑩=⑧−⑨					

Reference

Advance Management Co ., LTD. 2004. Checklist of Standard Cost Accounting. (in Japanese) http://www.adv-keiei.com/rensaipdf/1/rensai8-2/82-07.html

Japan Securities Dealers Association. Year not known. Cash flow Statement. (in Japanese) http://www.jsda.or.jp/jikan/word/044.html

Nishizawa, O. 1986. Financial Management. Tokyo. Sembundo/Zeimu Keiri Kyokai Co.,LTD. (in Japanese)

Small and Medium Enterprise Agency. 2000. Management Index of SME. (in Japanese)

Tsuchiya. H., Nakagami. Y., and Tanaka. M. (ed.) 2008. VE Handbook. Supervised by Tanaka. I. Tokyo. Society of Japanese Value Engineering. (in Japanese)

Project for Promoting Investment
and Enhancing Industrial Competitiveness
in the People's Republic of Bangladesh

How To Be A Genuine World-Class Factory

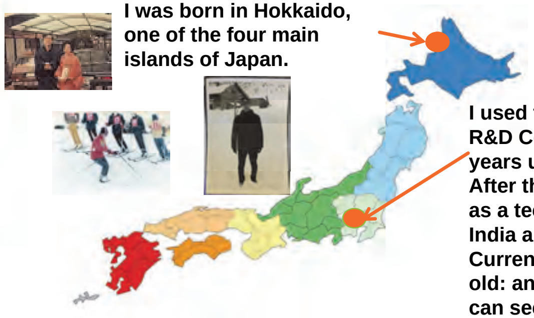
Osamu SATO
JICA Project Team

How To Be A Genuine World-Class Factory

Hello, my name is Osamu Sato.

"Sato" is the most common last name in Japan, so I was born with a No. 1 title ☺.

I know it is nothing to proud of though!



I was born in Hokkaido, one of the four main islands of Japan.

I used to work in Honda R&D Co., Ltd. over 40 years until 2009. After that, I have worked as a technical advisor in India and China. Currently, I am 68 years old: an old man as you can see.

How To Be A Genuine World-Class Factory

Today, I would like to present an idea of how to be a world-class factory based on the Japanese way of thinking (or Japanese way of manufacturing).

Your tradition and culture are different from ours, so you might find something difficult to understand.

According to my experience as a technical advisor in India and China, however, "the world of technology is universal."

I hope you agree on the idea.

How To Be A Genuine World-Class Factory

In my opinion through 40 years' experience, principles which have supported Honda's growth and development are:

- **Seek technical originality; never just copy others**
- **Invest generously in equipment and employees for R&D, and establish and maintain originality**
- **Place the first priority on the customer perspective, and eliminate self-satisfaction**
- **Establish the Honda-ism in the mind of every employee, and create pleasant work environment**
- **Follow the principle of the Three Actuals, "go and see for yourself to understand what's going on for a right decision"; everyone including management staff visits workshops**
- **Treat employees equally regardless of educational backgrounds; do not form academic or sectional cliques; apply the same salary system for factory operators and R&D staff; and create workplace in which everyone feels they have an equal chance to reach a top management position if they are capable and lucky enough.**

I myself enjoyed working for Honda for 40 years until my retirement.

I wish if I had had a little more of capability and luck, though ☺.

How To Be A Genuine World-Class Factory

Technology can belong to organizations as well as individual persons.

- **From the next slide, I present "HONDA Philosophy," which consists of HONDA's Fundamental Beliefs, Company Principle, and Management Policies.**
- **The philosophy formed the basis of the training I received for 40 years.**
- **All HONDA employees imprint it on their mind, because it is repeated in the training and also practiced in daily operation.**

Website of HONDA

How To Be A Genuine World-Class Factory

HONDA Philosophy: Fundamental Beliefs

- **Respect for the Individual (Initiative, Equality, Trust)**
- The Three Joys （The Joy of Buying, The Joy of Selling, The Joy of Creating)

Respect for the Individual	**Initiative**	**Initiative means not to be bound by preconceived ideas, but to think creatively and act on your own initiative and judgment, while understanding that you must take responsibility for the results of those actions.**
	Equality	**Equality means to recognize and respect individual differences in one another and treat each other fairly. Our company is committed to this principle and to creating equal opportunities for each individual. An individual's race, gender, age, religion, national origin, educational background, social or economic status has no bearing on the individual's opportunities.**
	Trust	**The relationship among associates at Honda should be based on mutual trust. Trust is created by recognizing each other as individuals, helping out where others are deficient, accepting help where we are deficient, sharing our knowledge, and making a sincere effort to fulfill our responsibilities.**

Reference: HONDA Philosophy, Website of HONDA
https://world.honda.com/profile/philosophy/

How To Be A Genuine World-Class Factory

HONDA Philosophy: Fundamental Beliefs

- Respect for the Individual (Initiative, Equality, Trust)
- **The Three Joy （The Joy of Buying, The Joy of Selling, The Joy of Creating)**

The Three Joy	**The Joy of Buying**	**The joy of buying is achieved through providing products and services that exceed the needs and expectations of each customer.**
	The Joy of Selling	**The joy of selling occurs when those who are engaged in selling and servicing Honda products develop relationships with a customer based on mutual trust. Through this relationship, Honda associates, dealers and distributors experience pride and joy in satisfying the customer and in representing Honda to the customer.**
	The Joy of Creating	**The joy of creating occurs when Honda associates and suppliers involved in the design, development, engineering and manufacturing of Honda products recognize a sense of joy in our customers and dealers. The joy of creating occurs when quality products exceed expectations and we experience pride in a job well done.**

Reference: HONDA Philosophy, Website of HONDA
https://world.honda.com/profile/philosophy/

How To Be A Genuine World-Class Factory

HONDA Philosophy

Company Principle (Mission Statement)

- **Maintaining a global viewpoint, we are dedicated to supplying products of the highest quality, yet at a reasonable price for worldwide customer satisfaction.**

My Example: Flight Boarding Record
Number of business trips:3*7*
(Domestic 14 times, International 23 times）
198,001 miles
About 6.5 laps of the earth.
The total boarding time is about 461.3 hours.

Maintaining a global viewpoint	1	**"Globalization": consideration of business on a global scale**
	2	**Effort to provide products and services that exceed customer expectations in each region**
	3	**Pursuit of the highest level of work quality in the world**
	4	**Attempt to solve global issues such as environment protection and resource conservation**

Reference: HONDA Philosophy, Website of HONDA
https://world.honda.com/profile/philosophy/

How To Be A Genuine World-Class Factory

In order to manage quality

- Always use the same material
- Always under the same conditions
- Always in the same process
- Always use the same criteria
- Always with no mistakes in measurement
- Always in the same management
- It is always possible to ship the same
- Always keep records on everything

In addition, keeping production records is essential. It enables you to quickly track down its root causes, identify affected products, and minimize loss, danger, and inconvenience of customers, when a problem is found.

How To Be A Genuine World-Class Factory

It is true that we are encouraging you to implement the basics of manufacturing. We also believe that you are able to meet them in a short time.

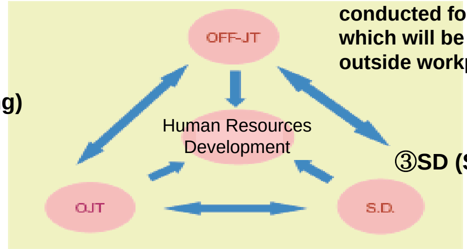
However, you need to keep meeting them.
Discipline, one of pillars of 6S, is a key.
Moreover, providing goods at fair prices is another key: achievement of which requires company-wide cost-consciousness about all relevant items.

How To Be A Genuine World-Class Factory

Framework For Human Resources Development

①OJT (On The Job Training)

Training which will enable workers to learn necessary skills, capacity, knowledge and/or attitude, value, etc. through actual work.



②OFF− JT (Off the job training)

Collective training normally conducted for around 10 workers which will be implemented regularly outside workplace

③SD (Self Development)

Workers voluntarily try to improve capacity and acquire skills.

How To Be A Genuine World-Class Factory

Human skills required as a professional

Principle（Knowledge）＋ Actual Site/Item（Insight）＋ Discussion（Willpower）

Knowledge is the power to understand

Newly employed workers

Insight is the power to judge

Mid-career workers

Willpower is the power to determine and implement

Mid-career workers, Managers

How To Be A Genuine World-Class Factory

The Rules Required For Professionals

Knowledge is the power to understand

- **Take action by considering contributions for the company**
- **Make a note every time when you get new ideas or cautions**
- **Give and give and give, instead of give and take**
- **Always show gratitude for the people around you**
- **Do not just sell your products or service but sell your own personality**
- **Steal and absorb only the strong points of the people around you**

How To Be A Genuine World-Class Factory

Be An Engineer/Professional With Willpower

Even if an engineer learnt knowledge in a college, it does not mean that they can apply their knowledge in their workplace. This is because knowledge has to be ripened as insight to apply.

Further, in order to produce results by involving the boss and other workers, keep in your mind that you must become an engineer with willpower who can lead by resisting the pressure of your boss and/or conventional methods. To become a such engineer, daily self-improvement is crucial.

How To Be A Genuine World-Class Factory

What Kind of Engineers Are Required?

- **“ I-Type Engineer”: Highly Skilled Engineer**
- **“ T-Type Engineer” : Highly Skilled Engineer with A Wide Range of Knowledge**
- **“π-Type Engineer” : Highly Skilled and Knowledgeable Engineer Who Has Acquired A Business Management Sense**

How To Be A Genuine World-Class Factory

Example of Human Resources Development Program in Japanese Companies

Strengthening Expertise
- Technical Know-how (Intellectual property, Quality, Production, etc.)
- Training through Skill Evaluation and/or Training System will be considered

Training By Position
- Training For Top Management
- Training To Be Executive
- Technical Training For Managers
- Training For Newly Appointed Managers
- Technical Training For Mid-Career Workers
- Training For Newly Employed Workers

Human Resources Program
- Human resources interaction with other org. / Dispatch to other org. / Inter-department exchange / Industry-academia exchange / Study abroad, etc.)
- Communication Program

Example of Panasonic Corp.

The founder Konosuke Matsushita thought that the first tip for successful management is “human resources development.”

He said “Panasonic makes human resources. Panasonic also makes electric appliances: However, before that, making human resources comes first.”

Human Resource Development
DAY 5

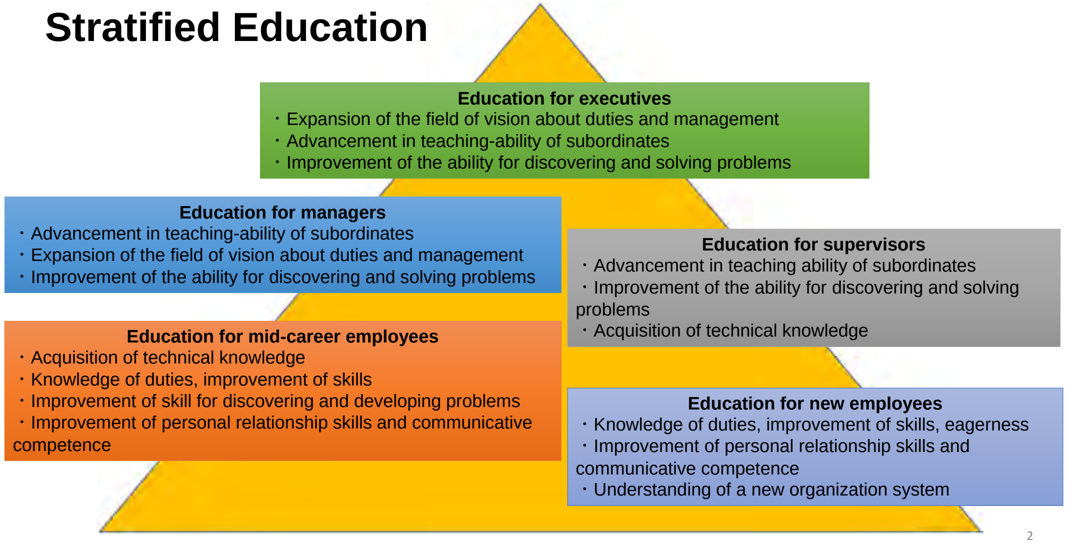
JICA Expert

Naoya NISHIGAKI

AIM:
Human resource development is very important to become a global company.
It is necessary to create the framework for human resource development education and promote stratified education.

In this seminar, we focus on 3 items about education for managers and supervisors who are the core of the company;
1. Education for managers and supervisors (TWI: Training within Industries)
2. Education for subordinates by manager (OJT: On-the-Job Training)
3. QC circle activities by workers.

Stratified Education



Education for executives
・Expansion of the field of vision about duties and management
・Advancement in teaching-ability of subordinates
・Improvement of the ability for discovering and solving problems

Education for managers
・Advancement in teaching-ability of subordinates
・Expansion of the field of vision about duties and management
・Improvement of the ability for discovering and solving problems

Education for supervisors
・Advancement in teaching ability of subordinates
・Improvement of the ability for discovering and solving problems
・Acquisition of technical knowledge

Education for mid-career employees
・Acquisition of technical knowledge
・Knowledge of duties, improvement of skills
・Improvement of skill for discovering and developing problems
・Improvement of personal relationship skills and communicative competence

Education for new employees
・Knowledge of duties, improvement of skills, eagerness
・Improvement of personal relationship skills and communicative competence
・Understanding of a new organization system

---

1. Education for managers and supervisors

(TWI: Training Within Industries)

1-1. Summary of the education for managers and supervisors

Role expectations for managers

What is learning-model of competency?

A person who can get good performance always gets good performance. Evaluate his/her processes that get good performance and change his/her competency to standard. We call it learning-model of competency.

Reference: "*TWI trainer practical Handbook" (in Japanese)*, Koyo Mondai Kenkyukai

---

The term "competency" means the **behavioral characteristics of human resources** with high performance.

Professor McCleland (Harvard University) advocated this concept of human resource management in the 1970s.

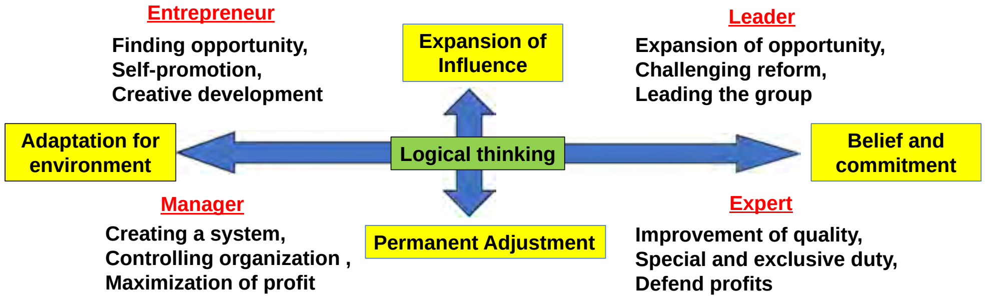
It is known that people who perform well in their work have a common tendency in their behavior, regardless of educational background, intelligence, or age.

Competency is summarized as behavioral characteristics that research and analyze this common tendency by using action observation, interview and assessment test.

- **Building a business efficiently**
- **Building an intimate relationship with the people**
- **Listening to the story of the people**
- **Fostering a team unity**

Competency for manager

Human resource characteristics required for managers (behavior type and role assignment)



Reference: "*TWI trainer practical Handbook" (in Japanese)*, Koyo Mondai Kenkyukai

---

1-2. About TWI (Training Within Industry)

Introduction of TWI

TWI is the training system for supervisors, which was introduced to Japan in 1950.

TWI became popular as a "scene-shifter" of the Japanese industrial economic growth from the late 1950s to the mid 1970s. Also, TWI became the parent of other supervisor training systems and served as a catalyst for the development of in-house training.

TWI answers to the request of the Japanese industries even now.

Reference: "*TWI trainer practical Handbook" (in Japanese)*, Koyo Mondai Kenkyukai

1-2. About TWI (Training Within Industry)

TWI was established in the U.S.

- TWI was developed and spread in the United States during World War II. The U.S. government requested private companies to develop plans to conduct in-house training for increasing wartime production, and TWI was established.
- During World War II, the supervisors were busy with the work of "educating" employees and needed help in all factories of U.S.
- However, it was able to "educate" only 5% of employees at external educational facilities. The remaining 95% of employees had no other way to "educate" in the factories, especially in the workplace. Therefore, it was necessary to clarify the method of "education" in the workplace training.

Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

---

1-2. About TWI (Training Within Industry)

In August 1941, a specific direction was launched.

- Formulating a "Job Instruction program"
  This program meets the points that the lack of supervisors and carried out effective services for companies.

Then,

- "Job Relations" and "Job Methods" are summarized in November 1941.

  It aimed two types of training for supervisors: "human relations" and "production management".

Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

---

1-3. Development of TWI in JAPAN

TWI was introduced to Japan in 1949.
In 1955, the foundation for the spread and development of TWI was completed. Entering the mid 1950s, it played a part in Japan's high economic growth.
Contents：How to teach the job (JI: Job Instruction),
How to treat the man (JR: Job Relations),
How to improve: Kaizen (JM: Job Methods)

Why TWI?
To strengthen manufacturing skills of Bangladeshi companies in the future, the supervisory technology should be advanced and human resources will be trained. Learning TWI, the basics of work TWI, will clarify the basics of factory managements. And it will lead to create a highly productive factories.

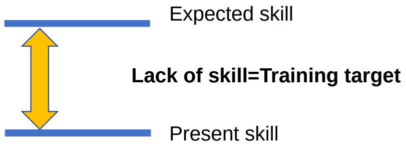
Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

---

1-4. Five Requirements for Supervisors

Key points

- Key points are important in in-house training.
- It is needed to make training plans after clarifying the purpose of the training from the beginning.
- Definition: The gap between required skills for work and the worker's current skills.
- Training: Refers to supplementing the lack of skills necessary for work.
- Trainer: The supervisor of the workers is the most eligible as a trainer. However, if supervisor is busy or don't have enough training skills, other training staffs should help the training.



Reference: "***TWI trainer practical Handbook***" (***In Japanese***),
Koyo Mondai Kenkyukai

1-4. Five Requirements for Supervisors
(1) Knowledge of the work

It’s necessary for supervisor to understand the enough knowledge of the work in workplace

- **Supervisors should have the skills to perform the same tasks as workers in the workplace.**
- **Supervisors should have sufficient work-related knowledges.**

For example, the knowledges necessary for supervisors are;

- Knowledge of machining operation. In addition, knowledge on the characteristics of workpiece and tool materials and precautions (safety management) when processing.
- Knowledge of various machines in the workplace such as conveyance equipment, measuring tools and processing.
- Knowledge to handle these equipment and teach their subordinates.
- Supervisors need to adapt the future rapid technological changes.
- Also, it is required for supervisors to have not only the knowledge and skills that are directly related to the work, but also knowledge about management technologies such as quality, process, safety and transportation.

Reference: “*TWI trainer practical Handbook” (in Japanese)*, Koyo Mondai Kenkyukai

---

1-4. Five Requirements for Supervisors
(2) Knowledge of Responsibility

“Knowledge of responsibility” includes a sense of responsibility, an essential understanding and specific knowledge of responsibility and authority.

a. About responsibility

“Responsibility” refers to the job that requires results. It is important that who is required to produce results. A person who is required for results bears responsibility for his or her duties to those who request results.

- For example, the supervisor is responsible to the section manager for the quantity of the product.
- The CEO is finally responsible for the company.
- The company is responsible to shareholders for profit dividends, responsible. to the customer for product quality, quantity and delivery. In addition, the company is responsible for the employees to making good working places and paying appropriate wages.

Reference: ““*Development of Humanity and Creativity*” *(in Japanese)*, Japan Productivity Center

---

1-4. Five Requirements for Supervisors
(2) Knowledge of Responsibility

How to give a sense of responsibility to the employees?

1. Clarify the expectations of work to the group and individuals.
2. Express the degree of achievement for the expected value quantitatively and show as a score or target.
3. Stratify the scores to facilitate comparison among individuals and groups.
4. Indicate only the items that need to be strictly observed, and give a free decision to the implementing persons.
5. Check whether people place blame on someone else for mistakes especially when their work doesn't go well and they can't achieve their targets.

→ If you find someone shifts their responsibility to others, devise a mechanism to prevent the recurrence.

Reference: ““*Development of Humanity and Creativity*” *(in Japanese)*, Japan Productivity Center

---

1-4. Five Requirements for Supervisors
(2) Knowledge of Responsibility

b. Authority

“Authority” consists of decision and enforcement.

- The supervisor should make decision and enforcement to someone to do their work.
- The performed by the supervisor is to decide who is allowed to do what and to actually do it.

- If the supervisor is not given the ability to “decide” and “enforce”, supervisor cannot perform the “execution of responsibility”.

Reference: “*TWI trainer practical Handbook” (in Japanese)*, Koyo Mondai Kenkyukai

1-4. Five Requirements for Supervisors
(2) Knowledge of Responsibility

c. Specific responsibility and authority

Specific responsibility and authority is given to each supervisor in workplace. (For example, the production amount per month, the defective rate of the product is 1% or less).

- Supervisors are also responsible for machine maintenance, work allocation and subordinate workplace training to achieve goals.
- The policies and regulations are developed to implement the goals for the basis of the supervisory authority.
- Supervisors must fulfill their responsibilities in accordance with the company / factory arrangements. An arrangement is a responsibility given to you and you must have a full understanding of the powers that accompany it.

Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

---

1-4. Five Requirements for Supervisors
(3) Skill in Instructing

Basic of TWI is OJT (On-the-job Training).

- OJT means the training of subordinates by supervisors through work in the workplace.
- Training targets by workplace supervisors include new hires, transferees, regular workers, and technical trainees.
- TWI targets new hired employees. And OJT is applied when teaching standard operation for workers.

Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

---

1-4. Five Requirements for Supervisors
(3) Skill in Instructing

"Teaching skills" can help training workers and improve their work skills. "Teaching" can eliminate waste, rework, and defective products, work-related accidents and damage to tools and equipment.

Target persons to teach
1. Current workers who are in operation
2. Newly hired workers

Being a good trainer is one of the most important qualifications as a supervisor.

There are various methods for training, and one of them is as follows;

[How to teach work] = To learn the work quickly, accurately, safely and conscientiously

Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

---

1-4. Five Requirements for Supervisors
(4) Skill in Improving Methods

TWI improves small things of the daily operation.

- TWI is done by improvement of machine, facilities, overall process, time/motion study of basic survey, PERT (Program Evaluation And Review Technics) / analysis and other methods.
- To improve appropriate and effectively, supervisors should cooperate because they are familiar with the problems of workplace.
- It's a best way to do the management cycle (plan-do-check) through organization.
  This cycle includes the improvement of the supervisors.

Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

1-4. Five Requirements for Supervisors
(4) Skill in Improving Methods

TWI improves small things of the daily operation.

- When implementing improvements, workplace resistance occurs. The resistance become small when supervisors make improvements than when professional staffs do it.
- Small improvements can make the big improvement. If a supervisor doesn't have skill for improvement, he/she can't develop new technology, and there will always be a threat from foreign technology in the name of technical innovation.

The needed skill is to break down, rearrange and combine the operation by studying the details. This skill makes more efficient use of materials, machines and labor force at present.

Reference: “***TWI trainer practical Handbook” (in Japanese)*** , Koyo Mondai Kenkyukai

First step: Break down the operation.

If you break down the working operation, you will notice the necessity of improvement.
Record all details of the working operation of;

- Transport operation
- Machinery operation
- Manual operation

Second step: Thinking for improvement of operation

1. **Why is the operation necessary?**
2. **What is the purpose of the operation?**
3. **Where is the best for the operation?**
4. **When do you do the operation?**
5. **Who is the most applicable for the operation?**
6. **What way is the best for the operation?**

Why
What
Where
When
Who
How
How much

5W2H

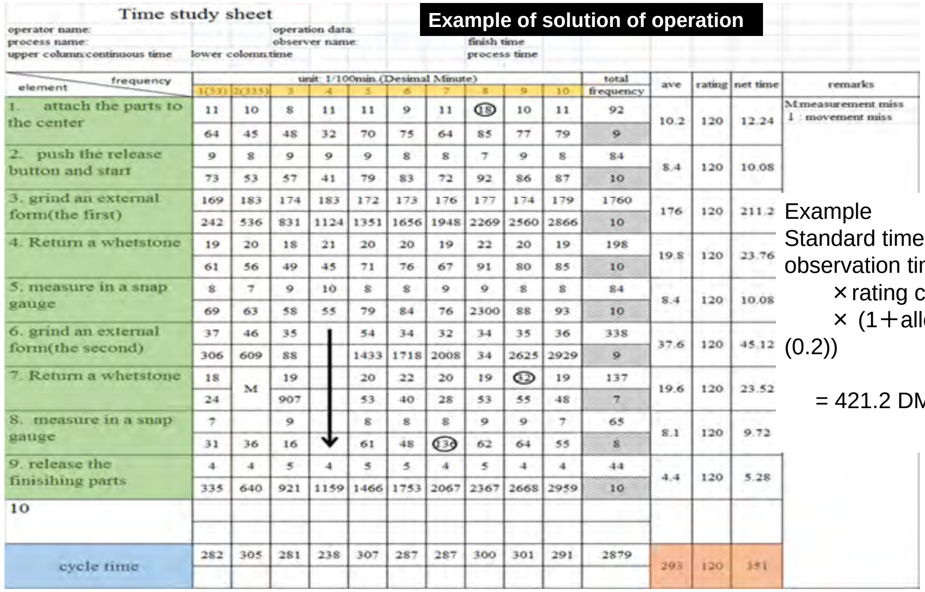
Third step: Think about new ways

Why, What …remove
Where, When, Who …combine and recompose
What kind of way …simplify

Fourth step Implementation of new ways

Reference: “***TWI trainer practical Handbook” (in Japanese)*** , Koyo Mondai Kenkyukai

Example of solution of operation



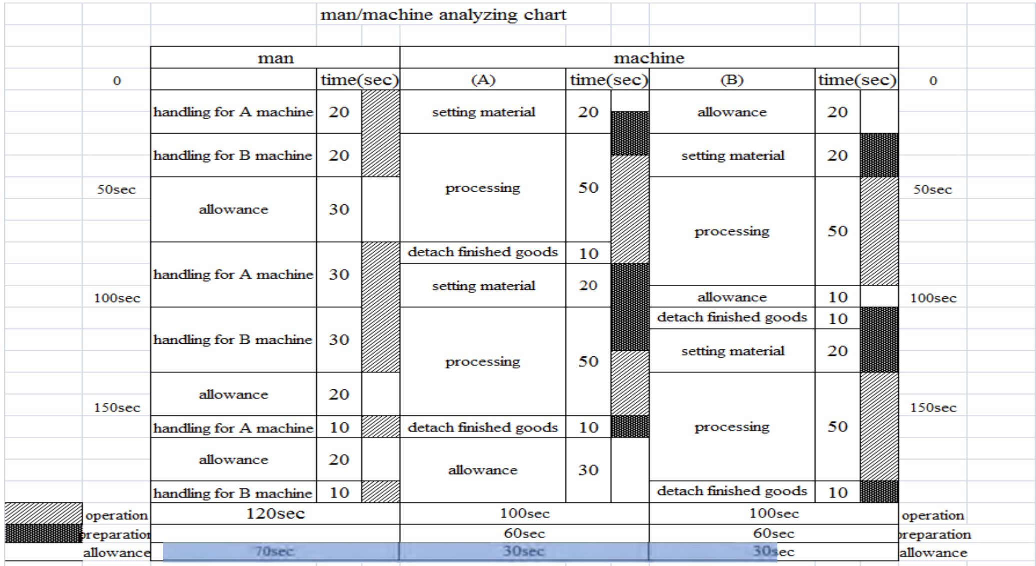
Time study sheet

operator name: operation data:
process name: observer name: finish time
upper column:continuous time lower colomn:time process time

frequency element	unit: 1/100min.(Desimal Minute)										total	ave	rating	net time	remarks
	1(53)	2(335)	3	4	5	6	7	8	9	10	frequency				
1. attach the parts to the center	11	10	8	11	11	9	11	⑱	10	11	92	10.2	120	12.24	M:measurement miss ↓ : movement miss
	64	45	48	32	70	75	64	85	77	79	9				
2. push the release button and start	9	8	9	9	9	8	8	7	9	8	84	8.4	120	10.08	
	73	53	57	41	79	83	72	92	86	87	10				
3. grind an external form(the first)	169	183	174	183	172	173	176	177	174	179	1760	176	120	211.2	
	242	536	831	1124	1351	1656	1948	2269	2560	2866	10				
4. Return a whetstone	19	20	18	21	20	20	19	22	20	19	198	19.8	120	23.76	
	61	56	49	45	71	76	67	91	80	85	10				
5, measure in a snap gauge	8	7	9	10	8	8	9	9	8	8	84	8.4	120	10.08	
	69	63	58	55	79	84	76	2300	88	93	10				
6. grind an external form(the second)	37	46	35	↓	54	34	32	34	35	36	338	37.6	120	45.12	
	306	609	88		1433	1718	2008	34	2625	2929	9				
7. Return a whetstone	18	M	19		20	22	20	19	㉜	19	137	19.6	120	23.52	
	24		907		53	40	28	53	55	48	7				
8. measure in a snap gauge	7		9		8	8	8	9	9	7	65	8.1	120	9.72	
	31	36	16		61	48	(136)	62	64	55	8				
9. release the finisihing parts	4	4	5	4	5	5	4	5	4	4	44	4.4	120	5.28	
	335	640	921	1159	1466	1753	2067	2367	2668	2959	10				
10															
cycle time	282	305	281	238	307	287	287	300	301	291	2879	293	120	351	

Example
Standard time =
observation time 292.5
×rating coefficient1.2
× (1＋allowance rate (0.2))

= 421.2 DM (252.7sec)



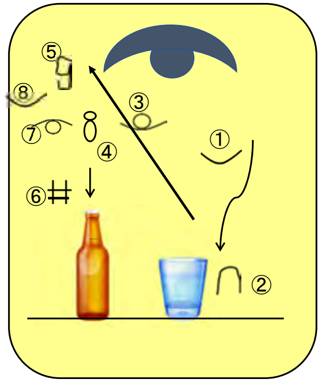
man/machine analyzing chart

	man			machine						
0		time(sec)		(A)	time(sec)		(B)	time(sec)		0
	handling for A machine	20	▨	setting material	20		allowance	20		
			▨			■				
	handling for B machine	20	▨	processing	50	■	setting material	20	■	
			▨			▨			■	
50sec	allowance	30				▨	processing	50	▨	50sec
						▨			▨	
						▨			▨	
	handling for A machine	30	▨	detach finished goods	10	▨			▨	
			▨	setting material	20	■			▨	
100sec			▨			■	allowance	10		100sec
	handling for B machine	30	▨	processing	50	■	detach finished goods	10	■	
			▨			■	setting material	20	■	
			▨			▨			■	
	allowance	20				▨	processing	50	▨	
150sec						▨			▨	150sec
	handling for A machine	10	▨	detach finished goods	10	■			▨	
	allowance	20		allowance	30				▨	
									▨	
	handling for B machine	10	▨				detach finished goods	10	■	
▨ operation	120sec			100sec			100sec			operation
■ preparation				60sec			60sec			preparation
allowance	70sec			30sec			30sec			allowance

Analysis example: Motion study (therbligs)

Ex1: One hand analysis
(Take the glass on the table, put the glass on the top of bottle, and take hand back to original place)

	Element of movement	Therblig
1	Reach out hand to the glass	◡
2	Grasp the glass	∩
3	Carry the glass to the bottle	⊍
4	Turn the glass	8
5	Find position for putting glass on top of the bottle	9
6	Put glass on the top of the bottle	#
7	Release your hand	⌒
8	Take hand back to original place	◡



How to improve

1-4. Five Requirements for Supervisors
(5) Skill in Leading

“The skill in leading” relates to human relationships.

- In human relationships, there are **two fields**.

Field 1: Regarding the supervisor’s mind, attitude and behavior.
It is so called as “Basic knowledges for improving relationships with people” in TWI.

Four points

1. Tell the subordinates him/herself whether their work is good or not.
2. Compliment subordinates him/herself when their work is good
3. Inform subordinates him/herself the change that affect them in advance.
4. Make the most of their power.

~You should treat subordinates as individuals~

Reference: “*TWI trainer practical Handbook” (in Japanese)* , Koyo Mondai Kenkyukai

Field 2: The skill to solve problems

Second step of TWI is “Handling workplace problems”.

Determine the objectives

Confirm whether the purpose was achieved through the first to fourth stage.

Do you achieve the objectives?

Reference: “*TWI trainer practical Handbook” (in Japanese)* , Koyo Mondai Kenkyukai

1-5. How to teach the work

Even if you have enough knowledge and skills of the work, the communication do not work well if you do not have enough skills to teach.

Also, no matter how hard you teach, you will need to teach again if the student does not remember the work correctly.

They don't remember the work because you didn't teach them the work.

Reference: “*TWI trainer practical Handbook” (in Japanese)* , Koyo Mondai Kenkyukai

How to teach the work (4 steps of teaching)

1) First step (Preparation to learn)
- Make subordinates relaxed and explain them the activity to carry out.
- Check the knowledge level of the work of them.
- Make them to want learn the work.
- Put them in the right position.

2) Second step (Explaining the work)
- Explain, demonstrate and write to teach the main steps one by one
- Emphasize the key points clearly, completely and patiently
- Do not force them beyond their understanding

3) Third step (Let them do the work)
- Let them do the work and fix their mistakes. Let them explain while working.
- Let them say the key points while doing the work again.
- Confirm them until they understand the work.

4) Fourth step (Check later what you taught)
- Set subordinates to take charge of the actual work. Also, decide the person who will be asked by them if they don't understand the work.
- Check occasionally. Encourage them to ask questions.
- Reduce the frequency of guidance gradually.

Reference: "***TWI trainer practical Handbook" (in Japanese)*** , Koyo Mondai Kenkyukai

---

Second step (Explaining the work) procedure

1	While supervisor explains the main steps of the work • *Show the subordinates/workers how to process (once) • *Let works observe how supervisor processes
2	While supervisor explains the key points • *Show workers how to process (once more) • *Let works observe how supervisor processes
3	While supervisor explains the reason to implement the key points • *Show workers how to process (once more) • *Let works observe how supervisor processes

What are the key points?

1) That can decide whether the work can be completed or not (success or failure)

2) That may cause injury to workers (safety)

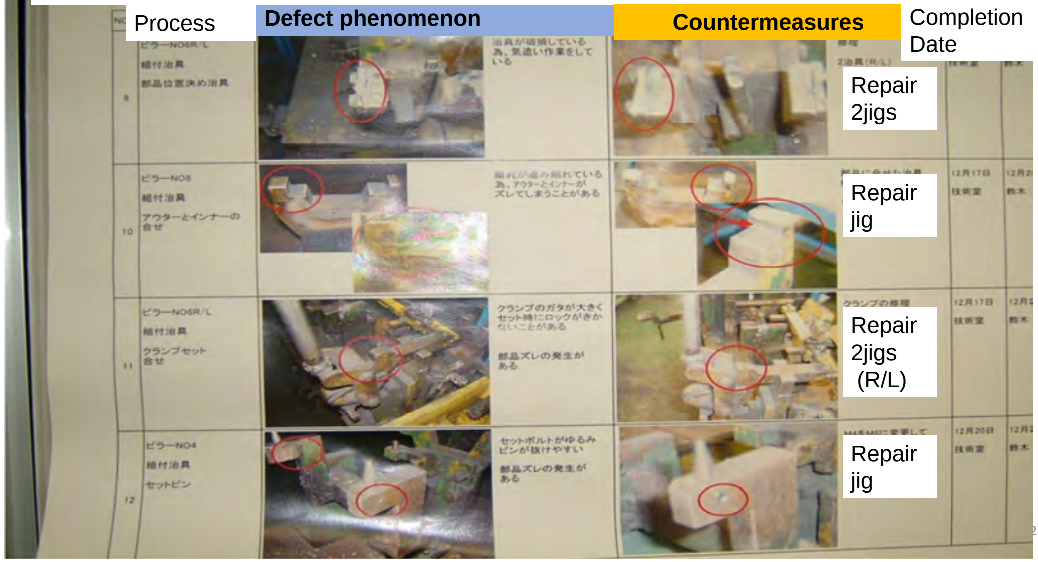
3) That makes work easier (intuition, tips, etc.)

Third step (Let them do the work) procedure

1	Let workers perform it silently.	1) Whether workers operate according to procedure 2) Whether workers operate the key points
2	Let workers perform while he/she puts procedure (step) into words	1) Whether workers operate according to procedure 2) Whether workers operate the key points 3) Whether workers can explain the procedure
3	Let workers perform while he/she puts the key points into words	1) Whether workers operate according to procedure 2) Whether workers operate the key points 3) Whether workers can explain the procedure > Whether workers are aware of the key points
4	Let workers perform while he/she puts the reason to implement the key points into words	1) Whether workers operate according to procedure 2) Whether workers operate the key points 3) Whether workers can explain the reason to implement the key points > Whether workers understand the work

---

Prevention improvement of the fluctuation by work improvement



Process

Defect phenomenon

Countermeasures

Completion Date

Repair 2jigs

Repair jig

Repair 2jigs (R/L)

Repair jig

2. Education for Subordinates by Managers (OJT: On-the-Job Training)

2-1. How to proceed OJT

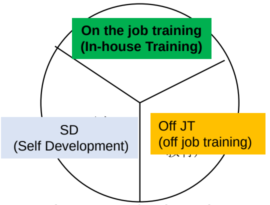
1. The objective of OJT

1) Advancement of performance, solving the problem, the promotion of workplace improvement
2) Support for human formation and enlightenment
3) Promote communication and trust relationships
4) Tradition: Knowledge, technology and perspectives

2. What is OJT? (On-the-Job Training)

OJT is a planned management action in which supervisors focus on teaching and developing necessary knowledges, skills, and attitudes through their daily work.

1) Education through work in the workplace.
2) Supervisors should directly teach to their subordinates.
3) Teach things directly related to work.
4) In principle, OJT should be done by one-on-one.



The way of education

Reference: "*OJT Practical Training Text*" (*In Japanese*), Sanno University

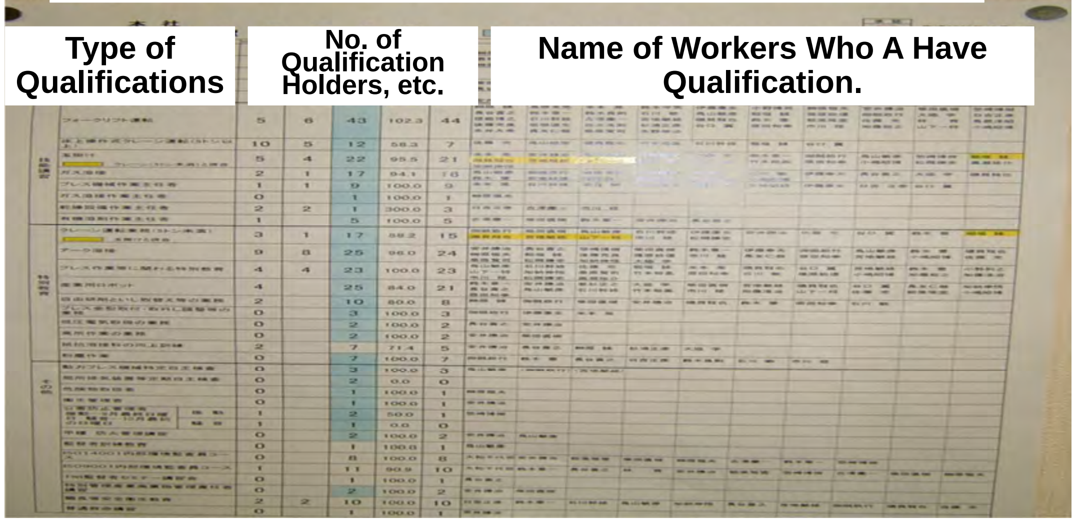
---

OJT PLAN	Workplace	Production 1	Framework	Increase the productivity of production 1			Date	YYMMDD
	Name	〇〇××					In charge	Mr. X
			Strategic formation of OJT					
			Educational instruction					
Expected target	Current situation	Target	Knowledge experience	Study through	System of work	Work climate	Period	Instructor in charge
Increase production effectiveness through appropriate instruction and adjustment.	1)Cannot grasp the on-site situation well 2)Cannot grasp the process that I am poor at. 3)Time to judge it is late 4)Measures are late by leaving all to others	1)Till confirmation again that must be grasped process 2)Till understand the process and machines that I am poor at. 3)Till understand my role. 4)Achieve above maintaining strong willingness and energy.	Have an interview with X, the person in charge, once a month. Report work situation of every process Attend the process meeting and report above Implement on site KAIZEN	Go around the process with X, the person in charge, once a month. Make questions. Support the process that seems to be delayed.	Tell a person clearly what is their responsibility and authority, and what should be informed. Make a report clear in the process meeting.	Take delayed countermeasures and put them up on site.	3 months	Mr. X

OJT PLAN

	Workplace		Framework				Date	YYMMDD
	Name							
			Strategic formation of OJT					
			Educational instruction					
Expected target	Current situation	Target	Knowledge experience	Study through	System of work	Work climate	Period	Instructor in charge

Sample: A list of qualified persons



Type of Qualifications

No. of Qualification Holders, etc.

Name of Workers Who A Have Qualification.

Reference

- Edited by QC Circle Headquarters (2008) How to operate QC circle activities, JUSE Press Ltd.
- Human Resource Development Bureau of Ministry of Health, Labour and Welfare (2008) TWI Trainer
Practical Handbook, Koyo Mondai Kenkyukai
- Katsuya Hosotani (1991) The Qc Problem Solving Approach: Solving Workplace Problems the Japanese Way, 3A Corporation
- OJT Practical Training Textbook, Sanno University
- Takanori Yoneyama (2008) Text Book for QC Practices for Beginning Level, JUSE Ltd.
- The Creativity Development Committee of Japan Productivity Center (1971) Development of Humanity and Creativity, Japan Productivity Center

Concept of a World Class Model Production Line

Osamu Sato

Expert, JICA Project Team

Concept of a World Class Model Production Line

Nearly 1.5 years have passed since we, the JICA Project Team, started activities helping some local companies to become a supplier for international motorcycle assemblers.

Today, I would like to introduce these activities and essentials in them.

I have been realizing rapid infrastructure development in Bangladesh every time I visit these companies. I have been working with them with feeling of continuous momentum of development in this wonderful country.

I believe that the management of all the companies has been endeavoring to catch up with this momentum, always eying on what their companies should be like in future.

I do hope that the companies' top management becomes able to think and act proactively to promote further growth of their companies by referring to my experience as a Japanese.

It would be my sincere pleasure if today's presentation would contribute to further growth of your great company.

Concept of a World Class Model Production Line

Always Discuss and Make Clear What Your Factory Should be Like in Future

Establishing a world class production model line ("**model line**") along the current production lines serves as an indication to competitors and company stakeholders including the employees about what operation system you aim to establish in the factory as well as the course of direction you take as a company.

Effort to establish a model line also makes employees involved with it learn what they should be like and see their growth.

These are very important for factory operation from the mid-term and long-term perspective.

Source: Japan Management Association (2017), "Saikyo No Koujou Wo Tsukuru 4S No Kufuu", Nikkei Business Publication, Inc.

Concept of a World Class Model Production Line

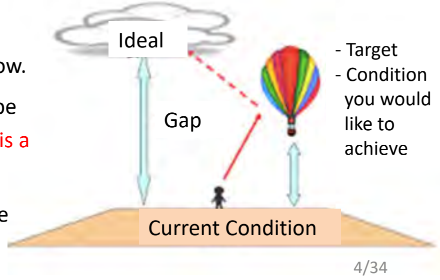
Image What Your Company Should be Like

Discuss what your company should be like.

Start by clarifying what your entire company should be like to know what your factory should be like and what to do to become so.

For this,

1. Clarify what your company (factory) is like now.
2. Clarify what your company (factory) should be like in future by improving the 1 above (This is a model line).
3. Think widely about what you need to achieve to become the 2 above.



Concept of a World Class Model Production Line

Take Measures Eying on Growth of Your Company.

It is not easy for those without prior experience to appropriately understand what to do and how to do for establishing a model line that can meet customer's requirements.

Currently, experienced experts in the JICA Project Team have been setting examples and giving technical advice, thereby helping local companies to grow and meet these requirements.

Then, those who have learnt in the model line can train others to apply the same system in other lines.

The following slides show the steps for model line establishment.

Concept of a World Class Model Production Line

Steps to Establish a Model Line

1st Step (Launch)

(1) Practice basics of production thoroughly

- **Set a world-class and ideal model line**
  - ✓ Establish a world class model line
    Machine setting, quality control and safety measures with your eyes setting on future business transactions with world renowned manufacturers
  - ✓ Manage product designs and specifications properly
    Preparation of drawings of all products and production based on them.

Source: Japan Management Association (2017), "Saikyo No Koujou Wo Tsukuru 4S No Kufuu", Nikkei Business Publication, Inc.

Concept of a World Class Model Production Line

(2) Thoroughly implement your corporate philosophy

- Build a solid QC system, QC methods, and operation standards, and then visualize them at every work site.

(3) Create the factory able to produce "quality products" consistently

- Re-educate 5S (for production at a clean and safe workplace)
- Apply "always the same principle" to materials, lines, inspection methods, management, and shipment
- Optimize production conditions to reduce defects (e.g. visualization of production conditions and defective rate)
- Display (visualize) operation standards

Source: Japan Management Association (2017), "Saikyo No Koujou Wo Tsukuru 4S No Kufuu", Nikkei Business Publication, Inc.

Concept of a World Class Model Production Line

Steps to Establish a Model Line: Continued

2nd Step (Growth)

(1) Involve everyone for changes and trials

- Generate awareness and responsibility in the model line members whereas making them a role model for the others

(2) Set good examples from the top and promote spontaneous actions in the model line

- Change the mind-set of everyone including top management; everyone needs to be proactive (find and try to address problems on their own)
- Create a mechanism to encourage the initiative ("QC circle" activity, suggestion system, etc.)

Source: Japan Management Association (2017), "Saikyo No Koujou Wo Tsukuru 4S No Kufuu", Nikkei Business Publication, Inc.

Concept of a World Class Model Production Line

Steps to Establish a Model Line: Continued

3rd Step (Upgrading)

(1) Promote initiative of employees for changes and reforms

- Let them identify and address long-term issues as well as imminent ones

(2) Be open for employees' suggestions for improvement

- Show the "course of direction" of the company, encourage employees to raise problems, and listen to them sincerely

Source: Japan Management Association (2017), "Saikyo No Koujou Wo Tsukuru 4S No Kufuu", Nikkei Business Publication, Inc.

Concept of a World Class Model Production Line

At present, the companies that we are supporting have just completed or started the 1st Step (Launch).

They will step up to the 2nd Step (Growth) from now.

In fact, the most essential part, and thus, the most challenging part, starts from the 2nd Step (Growth) to become a world class factory and world class engineers (people)

It is not good enough for operators and others just to produce items following instructions from supervisors and managers.

Everyone has to raise awareness and willingness to change for the better, take actions to solve problems and thereby keep making better the model line and the factory as a whole.

It is important to have such an experience of success.

Concept of a World Class Model Production Line

We propose that the top management attach higher value to the number of problems solved rather than to the quantity produced.

The model line should be a place to help solve problems (reduce defects) brought from the other lines!!

Experiencing successes is a key to growth for engineers and operators. We would like the model line to be a place for employees' education.

This is where we the Japanese experts have vast experience including those which failed.

Concept of a World Class Model Production Line

In fact, we, experts of the JICA Project Team, had different opinions about what the mode line should be like and how to establish it.

The most significant difference was whether we should guide concepts of the model line; which may cause the situation where the companies just follow our guide without any initiative taken by them. What the model line should be like should be discussed and then decided through the initiative taken by the companies themselves.

Nonetheless, we thought that it would be better to show ideas and samples that can stimulate your image about your own model line.

If you want to establish a model line, please deeply discuss what your ideal model line is like; what gaps are in between this ideal and the current situation; of which, what gaps can be eliminated realistically.

Then, please take action toward what your company should be like.

The key is that you establish a long-term plan by yourself and implement it.

Concept of a World Class Model Production Line

The following is a very basics of the model line.

· Always **safety first**

· Always maintain workplace **clean and efficient**

· Always use the same **materials**

· Always under the same **conditions**

· Always in the same **process**

· Always use the same **criteria**

· Always no mistakes in **measurement**

· Always in the same **management**

· Always **ship** the same quality product

· Always **keep records** on everything

· In appropriate **cost**

Concept of a World Class Model Production Line

Production Planning

- Management of receiving/placing of orders
- Improvement of the department in charge
- Proper production, proper stock

Concept of a World Class Model Production Line

Management of Resin Acceptance

Control of major sites in a model line by installation of CCTV.

- Elimination of unreasonableness, inconsistency
- Early analysis of causes of abnormality

CCTV

Granular or powdered raw material

Improvement of the material acceptance department which can assess material properties properly.

- Evaluation and a pass/fail judgment based on the supplier-analysis table.
- Mixing of the similar materials are surely prevented.
- Correlation management
  from Material Lot → to Molding Lot

Always use the same materials

Concept of a World Class Model Production Line

Management of Steel Acceptance

CCTV

<写真>六角棒・アングル・チャンネルの在庫の一部

Improvement of the material acceptance department which can assess material properties properly.

- Evaluation and a pass/fail judgment based on the supplier-analysis table.
- Mixing of the similar materials are surely prevented.
- Each material is orderly stocked without any mixture.
- Controlled based on the company's own rules on material quality inspection.

Always use the same materials

Always keep records

Concept of a World Class Model Production Line

Resin Stock

Always keep records

Concept of a World Class Model Production Line

Resin drying / Prevention of Contamination

Pellets of molding materials generally absorb a certain proportion of moisture in the air.

Hydrolysis of the pellet is likely to cause molding defects and worsen the defects.

Thus, a lack of proper pre-drying process may cause fluctuations in fluidity, deterioration in physical properties and molding defects.

Pre-drying process is inevitable (MUST) for ABS, and is preferable (WANT) for PP.

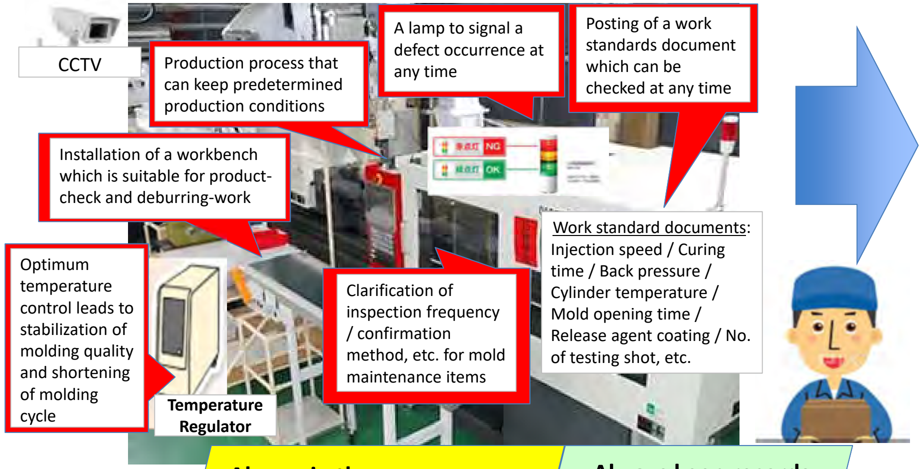
・Low pressure heat transfer type dryer
Equipment to evaporate moisture in the pellet by heat transfer under reduced pressure: this makes it possible to dry at low temperature.

Equipment to prevent contamination

Always under the same conditions

Concept of a World Class Model Production Line

Plastic Molding Process



Production process that can keep predetermined production conditions

A lamp to signal a defect occurrence at any time

Posting of a work standards document which can be checked at any time

Installation of a workbench which is suitable for product-check and deburring-work

Work standard documents: Injection speed / Curing time / Back pressure / Cylinder temperature / Mold opening time / Release agent coating / No. of testing shot, etc.

Optimum temperature control leads to stabilization of molding quality and shortening of molding cycle

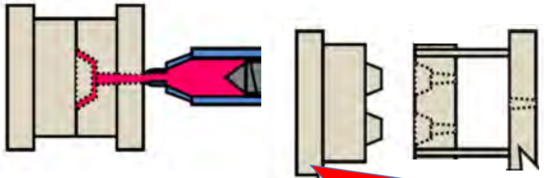
Clarification of inspection frequency / confirmation method, etc. for mold maintenance items

Always in the same process

Always keep records

Concept of a World Class Model Production Line

Review of Molds



- Gate, runner
- Material of the main part of the mold
- Hardness of the main part of the mold
- Product protruding method
- Mold polishing level
- Presence / absence of slide core
- Slide core operation method
- Product removal method
- Mold temperature adjustment method

Concept of a World Class Model Production Line

Steel Cutting Process

CCTV

Pipe Cutter

Shearing Machine

Work standard documents: Cutting length / Shape / Deburring / Rust prevention / Bending angle, etc.

Cut steel at length needed for products and deliver it timely to the next process

Always in the same process

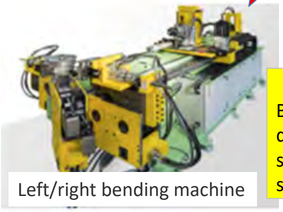
Concept of a World Class Model Production Line

Steel Bending Process

CCTV

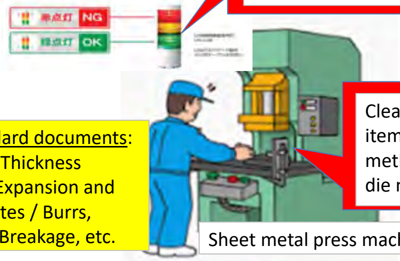
Always follow standard bending conditions

Lamps alarming whenever defects or accidents happen



Left/right bending machine

Work standard documents: Bending R / Thickness deviation / Expansion and shrinkage rates / Burrs, scratches / Breakage, etc.



Sheet metal press machine

Clearly standardize items, frequency, methods, etc. for die maintenance

Wear safety protectors and cloths as per the rules

Always in the same process

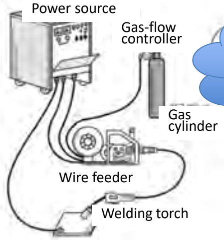
Concept of a World Class Model Production Line

Welding Process

CCTV

Work standard documents: Welding voltage / Weld-starting point / Welding-height and length / Sputtering / Measurement accuracy (tolerance), etc.

Wear safety protectors and cloths as per the rules



Installment of a welding machine requires grounding work for both outside box and welding base metal

Always in the same process

Concept of a World Class Model Production Line

Parts Inspection

- Do not allow defective products in the production line by checking with limit samples
- Establishment of a confirmation bed
- Stop the line at any time when defective products occurred

CCTV

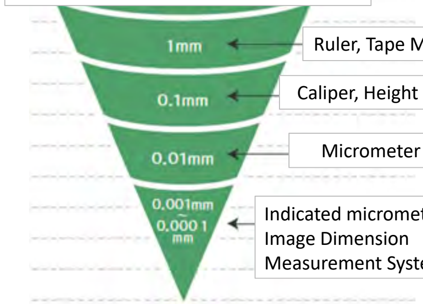
Always use the same criteria

Always keep records

Concept of a World Class Model Production Line

Appropriate Equipment for Inspection

Choose by Measurement Accuracy



Ruler, Tape Measure

Caliper, Height Gauge

Micrometer

Indicated micrometer, Image Dimension Measurement System

Till now: Sample inspection by calipers/micrometers

Frequent Problems

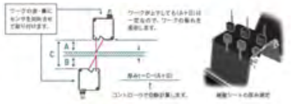
- Measurement differs by person
- Difficulty to identify sudden abnormality and the change over time

Frequent Needs

- Improve accuracy and eliminate human error
- Speed up measurement with less frequency
- Save data in PC/PLC
- Make it possible by anyone

Suggestion: Non-contact measurement for in-line full-length inspection

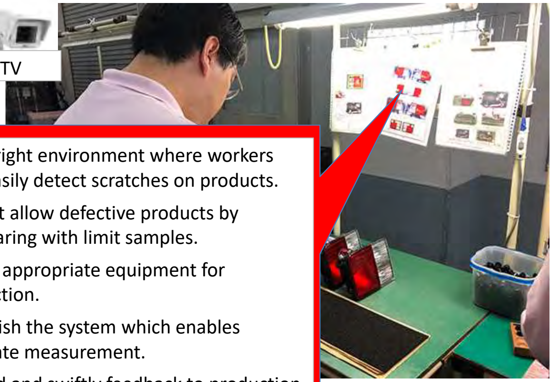
Measurement by Reflective Laser Displacement Sensor



Concept of a World Class Model Production Line

Parts Quality Control

CCTV



In a bright environment where workers can easily detect scratches on products.

Do not allow defective products by comparing with limit samples.

Install appropriate equipment for inspection.

Establish the system which enables accurate measurement.

Record and swiftly feedback to production lines.

Always no mistakes in measurement **Always keep records**

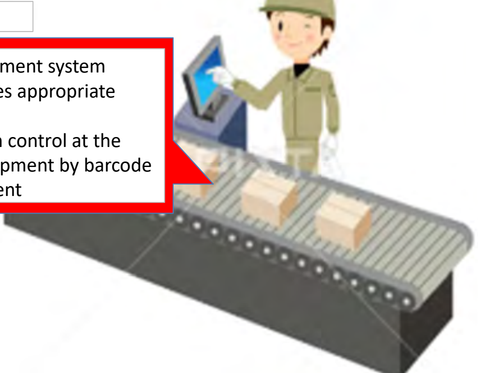
Concept of a World Class Model Production Line

Parts Shipment Control

CCTV

Suitable shipment system which ensures appropriate packing

- Production control at the time of shipment by barcode management



Always ship the same quality products **Always keep records**

Concept of a World Class Model Production Line

Quality Control (QC) "Most important department to strengthen"

- Enhance authority of the department as a product warranty management team, not only for inspection work.
- Strengthen the department which will have all responsibilities regarding quality including function of a customer contact center.
- The department will have authority to stop the production line in case there is a problem with the product.
- The department will be responsible for certification and settlement of quality control documents.

QC department will also control monitoring of CCTV cameras

Concept of a World Class Model Production Line

Quality Control (QC)
"Most important department to strengthen"

Department which is responsible for all products
(Department directly under top management)

Product warranty by assuming product usage in the market. Responsibility assurance system and improvement activity base in daily production

---

Concept of a World Class Model Production Line

Parts Inventory Control

CCTV Camera

- Smooth inventory management by shelf-number management
- Product management by barcode
- Strengthening the First-In, First-Out system
- Use of pallets to avoid placing products on the floor
- Promotion of inventory minimization through collaboration with purchasing department

Concept of a World Class Model Production Line

Shipment Planning

- The First-In First-Out method is kept as a basis of production.
- The department is capable of tracking production lots even after shipment to the market.

Concept of a World Class Model Production Line

Shipment of Parts

From Bangladesh
To the World

Concept of a World Class Model Production Line

Summary

- This concept of a model line is one of the examples which JICA Project team recommends for what it should be like as the best possible condition. If your company is interested in establishment of a world class model line, please start to plan how to establish it in your workplace by referring to this concept as the best possible goal.
- In the presentation, we underscored importance of the following departments which are the key pillars of the model line. If your company already has the same departments, please enhance capability of the existing department.
    1. Production Planning Control Department
    2. Material Acceptance Control Department
    3. Enhanced Quality Control Department
    4. Inventory Control Department

Thank You For Your Attention

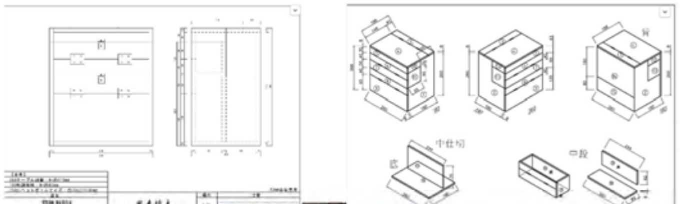
Osamu Sato, JICA Expert

Follow-up Discussion

- What is the gaps between an ideal model line and reality?
- Which gaps should your company fill?
- Of these gaps, what gaps can your company fill realistically?

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -



JICA Expert
Osamu Sato

August 2020

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

When I visited factories in Bangladesh, I was surprised that drawings are not applied in production process even in industrial products. Moreover, it seems that there were no drawings in public organizations which support private companies.

By using 3D-CAD or 3D printer, it could be possible to make a product without 2D drawings nowadays. However, it is necessary to use drawings if you would like to manufacture high precision products without mistake.

When I was a young engineer in a Japanese company, drawings were necessary even to make a small prototype product. A senior machining staff used to check drawings that I made at that time. Then, I was scolded and strictly taught importance of drawings.

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

I believe factories in Bangladesh have been able to survive without drawings till now as many products are deigned inside the company or products are for domestic market which do not require high precision.

However, if you would like to make the world class model line that enables to deal with foreign companies by industrial products, it is inevitable to manage all production process by drawings.

I have also visited factories in China and India as I have worked as an advisor. In China and India, factories have been managing production by drawings.

Therefore, I strongly hope that Bangladesh companies will promote and utilize drawings in order to develop your industry.

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

<u>Why Is Technical Drawing Vital in Mechanical Design?</u>

Technical drawings are the fundamental way of communication in engineering.

It is impossible to verbally explain a product shape in a precise manner unless it is very simple. Description by handwritten drawings has also a limitation.

On the other hand, technical drawings can show accurate product shapes and other detailed information, which makes all persons concerned on the same page.

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

Another Function of Drawings: Evidence

Drawings have another important role; it serves as an evidence of mutual understanding.

Drawings contain various information agreed upon in the designing process. In other words, you can leave the record of decisions in drawings.

Generally, the title block placed at the bottom right of a drawing sheet include spaces for signatures, from which you see who has checked and who has approved them.

Experienced designers are to check and to approve drawings. Check and approval by experienced designers ensure high quality of drawings.
Further, drawings serve as a tool of education and technology transfer for young engineers.

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

In terms of drawing preparation, the following steps are phases of knowledge level on design.

- Step 1: To Be Able To Read Drawing
- Step 2: To Be Able To Write Drawing
- Step 3: To Be Able To Design

Reading and writing of drawing are minimum requirement for those who aspires to be a designer.

Even some of those who have a mechanical engineering degree are not fully aware of the rule for drawing preparation.

Thus, it is important to remember the rule for drawing preparation to understand designer’s opinion.

Another important point is that drawing is outcome of designer’s work

---

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

To understand the role of CAD

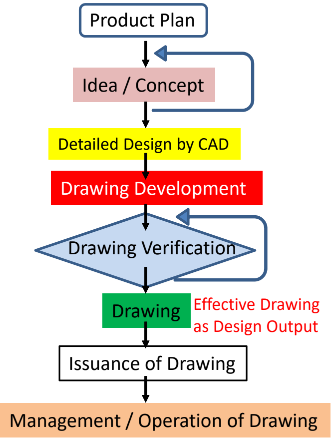
The flow at the right shows standard design process in Japan and other countries. CAD design is a part of design process to formulate drawing as output of design.

Designer’s and engineer’s opinion should be shared through drawing as output. On the other, repeating to copy-and-paste drawing in CAD without enough understanding, inferior and irresponsible drawing will be made.

The current situation in Bangladesh indicates that design process is not properly followed and only completed in CAD design process.

I am worried that many Bangladeshi companies are following incomplete design process without drawing.

Flow of Design Process



Product Plan

Idea / Concept

Detailed Design by CAD

Drawing Development

Drawing Verification

Drawing

Effective Drawing as Design Output

Issuance of Drawing

Management / Operation of Drawing

Reference: Manabu Yamada (2011) *Importance of Drawing, CAD Guidance for Operators: Drawing Technology to Be A Global Engineer - Drawing Is The Official Language That Is Mightier Than English*,
Otsuka Corporation Website, accessed in July 2020.
https://mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture/2011/201111.html

---

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

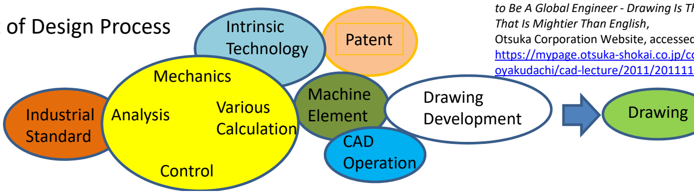
Relationship between Design and Drawing

Quality, cost and usability of products will be different according to designer’s idea. Consumers will choose products not only by its function but by multiple aspects of products including price and design. There is no clear answer for design before products enter the market. However, consumers will determine it in the market.

Companies in every country are striving to accelerate formation of product plan/design concept, to improve productivity, to minimize production cost, to create attractive products, to gain competitive advantage and to get recognition by customers.

The below figure shows relationship between design and drawing. Drawing is also a part of and the final process of designing . Sometimes, drawing does not stand out but it is output of the process.

Concept of Design Process



Intrinsic Technology

Patent

Mechanics

Industrial Standard

Analysis

Various Calculation

Control

Machine Element

CAD Operation

Drawing Development

Drawing

Reference: Manabu Yamada (2011) *Importance of Drawing, CAD Guidance for Operators: Drawing Technology to Be A Global Engineer - Drawing Is The Official Language That Is Mightier Than English*,
Otsuka Corporation Website, accessed in July 2020.
https://mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture/2011/201111.html

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

Relationship between Design and Drawing

Some designers misunderstood drawing as an old-fashioned paper document that shows dimension in a projection to process a product. On the other, drawing is supposed to serve as a tool to put your heart into each of your own works/products that you developed as a designer.

In this sense, "put your heart" means a process to realize original design concept by fulfilling required quality and cost .

The followings should be set and indicated in drawing.

- Basic Dimension
- Tolerance (dimensional tolerance, geometrical tolerance) to control variation
- Surface Property
- Material
- Surface Treatment

Proper instruction of above items will lead to improvement of drawing quality as well as product quality.

Reference: Manabu Yamada (2011) *Importance of Drawing, CAD Guidance for Operators: Drawing Technology to Be A Global Engineer - Drawing Is The Official Language That Is Mightier Than English*, Otsuka Corporation Website, accessed in July 2020.
https://mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture/2011/201111.html

---

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

Relationship between Design and Drawing

Too much reliance on CAD is a result of product development to reduce lead-time by copying /pasting mechanism and structure of similar products to easily develop copy-products.

The actual role of drawing is to deliver original concept of a designer to those who produce accurately. By creating accurate and informative drawing, products will be produced without mistake.

What is accurate drawing?

It means drawing which has information on product shape/dimension/material as well as other necessary information for production such as process and finishing, etc. Most importantly, it is drawing which everyone will understand clearly.
There is a rule on drawing development which is called "standard".

Reference: Manabu Yamada (2011) *Importance of Drawing, CAD Guidance for Operators: Drawing Technology to Be A Global Engineer - Drawing Is The Official Language That Is Mightier Than English*, Otsuka Corporation Website, accessed in July 2020.
https://mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture/2011/201111.html

---

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

Importance of Drawing

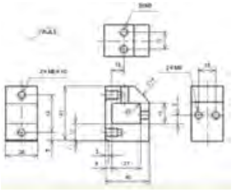
Drawing is output of design process and is basis of products/parts which will be produced in the factory.

Please compare the painting and the drawing at the right. Both of them are information media on a paper.

Painting will be evaluated by sensitivity and each of us will be able to have different impression. In other words, some might consider it as childish painting while other person might hope to purchase it.

In contrast with painting, everyone needs to have same impression in mechanical design drawing. In other words, commonality is required.
This means that even persons in a third party of different culture / history / language need to understand by using same drawing.

Sensitivity
Impression can be different by each person



Commonality
Every person needs to have same understanding

Reference: Manabu Yamada (2011) *Importance of Drawing, CAD Guidance for Operators: Drawing Technology to Be A Global Engineer - Drawing Is The Official Language That Is Mightier Than English*, Otsuka Corporation Website, accessed in July 2020.
https://mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture/2011/201111.html

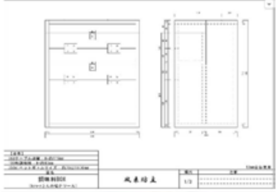
---

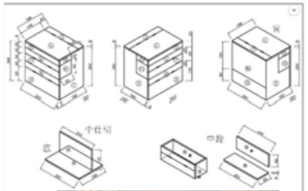
Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

Let me introduce my hobby as interlude of training: I like home carpentry.
As you can see below, you can find drawing of woodwork products in the internet these days.
If you learn a bit of skill, you can build a hand-made product by yourself.

I built this chest and am using when I go camping. Thankfully, I received critical acclaim from my family for this. Okay, so I wanted to brag about my chest. At the same time, this is an example of commonality in drawing.



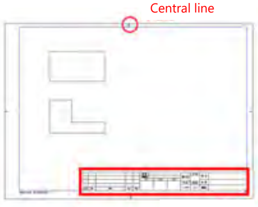


Commercial Product

Product Built by Mr. Sato

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -



Please set a drawing sheet format of your company

Each company has their own drawing sheet format.

Typical drawing sheets have a title block lies at the bottom right.

A typical title block includes the following items.

Item	Remark
Name	Object Name
Drawing No.	Set the rule to control
Quantity	No. of objects to be produced
Projection Method	Typically, third angle projection method
Scale	Ratio of size in the drawing (e.g. 1/2)
Material	Material(s) to be used for production
Date	Date when the drawing was made
Approval Space	Spaces where a designer, an inspector and an authorizer sign as proof of approval

---

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

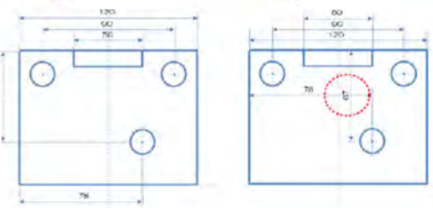
Specific drawing preparation method has been set by the following drafting method.

Today, I will explain on tolerance which is especially important, from the next slide.

Major Contents Determined by the Drafting Method	
1	Projection Method of Drawings
2	How to show a cross-sectional view
3	Types of drawing line and its thickness
4	Drawing scale
5	How to show dimensions
6	Basic rule of dimensioning
7	How to show tolerance
8	Standard /notation method of fit tolerance
9	Geometric Tolerances
10	Indication of Surface Roughness
11	Welding symbols

Please tell designers of your company to study these 11 items.

○ Good ✕ Bad



Summary of Dimensioning

- Mark dimensions in the front view to the extent possible.
- Avoid double dimensioning. Or show them as reference dimensions with brackets.
- Avoid drawing dimension lines over dimension figures.
- Avoid drawing dimension lines inside the view as much as possible.
- Line up dimension figures which are related with each other.

Why are drawing sheets necessary?

-Basic Knowledge of Mechanical Design Drawing-

What is “Dimensional Tolerance”?

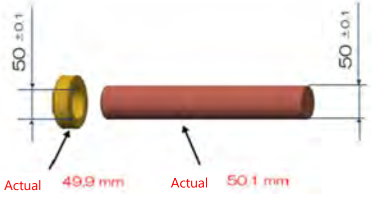
All manufactured part features are subject to variation. “Dimensional tolerance" refers to the amount of variation that is acceptable in any given dimension.

Why is “Dimensional Tolerance” Necessary?

In daily operation, tolerances are used to distinguish defective articles from good ones. However, their underlying purpose is to make sure that manufactured articles work properly.

The below figure shows what can happen when setting tolerances wrongly; the shaft does not fit into the bearing hole even though the diameters of the two articles fall within tolerances.

An article with too large dimension relative to its mating article cannot be jointed. Too small dimension makes joints loose. Setting proper dimension tolerances is necessary to avoid such cases.



Bearing < Axis

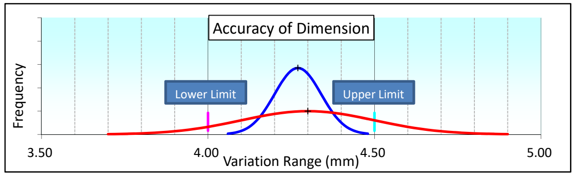
Does not fit (The sizes follows the drawing)

Why are drawing sheets necessary?

- Basic Knowledge of Mechanical Design Drawing -

Why does tolerance need to be set?

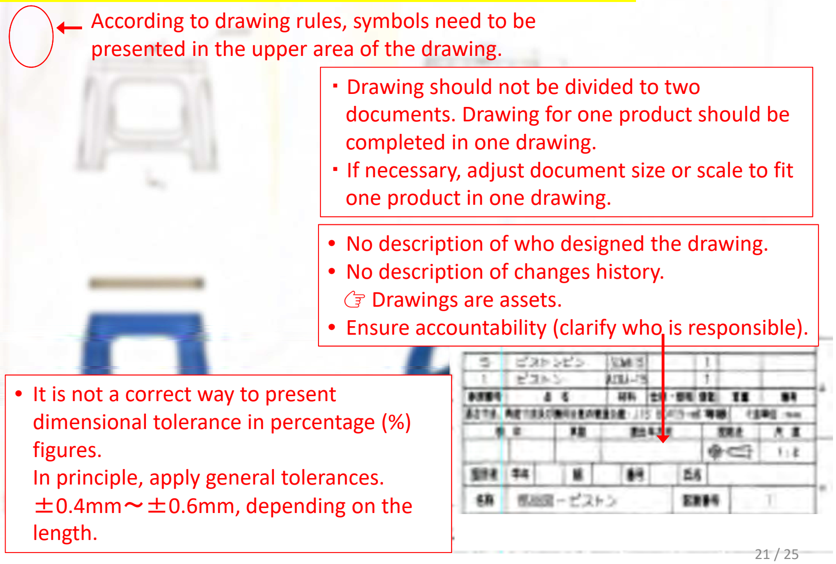
- Variation is unavoidable even in the machine processing of industrial goods.
- Variation creates a need of dimensional control, process control, and shipment control.
- Consistency is a source of high quality and a strong brand.



- Reduce variation, and make sure to control the variation small enough so that dimensions of all produced items fall within the specified tolerances . For major products, check quality of a product at the lower limit .
- Production control needs to be reviewed and improved until achieving the above condition. Otherwise, the specification needs to be changed.
- When all parts are combined, the amount of variation increases. The allowable range of all variations will be the factory shipping quality and the product control range.
- Even under proper production control, few defective items are produced and thus inspectors have to check items to avoid shipment of defective ones.

Why are drawing sheets necessary?

-Basic Knowledge of Mechanical Design Drawing-



According to drawing rules, symbols need to be presented in the upper area of the drawing.

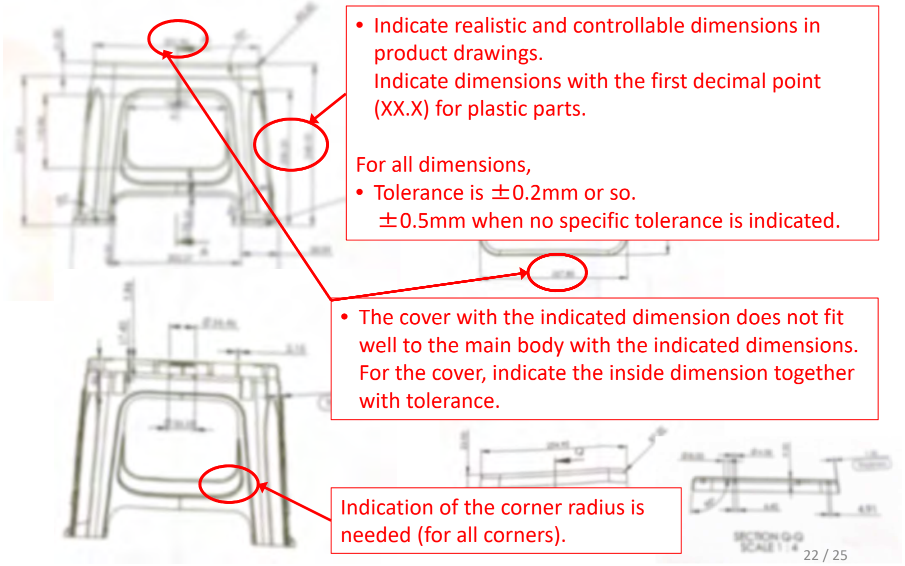
- Drawing should not be divided to two documents. Drawing for one product should be completed in one drawing.
- If necessary, adjust document size or scale to fit one product in one drawing.

- No description of who designed the drawing.
- No description of changes history.
  ☞ Drawings are assets.
- Ensure accountability (clarify who is responsible).

- It is not a correct way to present dimensional tolerance in percentage (%) figures.
  In principle, apply general tolerances.
  ±0.4mm〜±0.6mm, depending on the length.

Why are drawing sheets necessary?

-Basic Knowledge of Mechanical Design Drawing-



- Indicate realistic and controllable dimensions in product drawings.
  Indicate dimensions with the first decimal point (XX.X) for plastic parts.

For all dimensions,

- Tolerance is ±0.2mm or so.
  ±0.5mm when no specific tolerance is indicated.

- The cover with the indicated dimension does not fit well to the main body with the indicated dimensions. For the cover, indicate the inside dimension together with tolerance.

Indication of the corner radius is needed (for all corners).

Summary

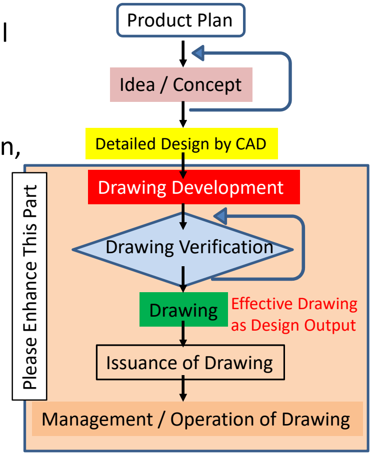
As mentioned at the beginning, it is standard to use drawing to start or continue business on industrial products in Japan, even among small companies.

All technical conversation in each process is based on drawing: this includes cost estimation, process technology and production schedule.

If mid level engineers would like to review the basics of design, I would recommend to study on Mechanical Design Drawing.

This is because the world standard process of design needs to have attention at tolerance and is not completed by CAD design only.

Flow of Design Process



Summary

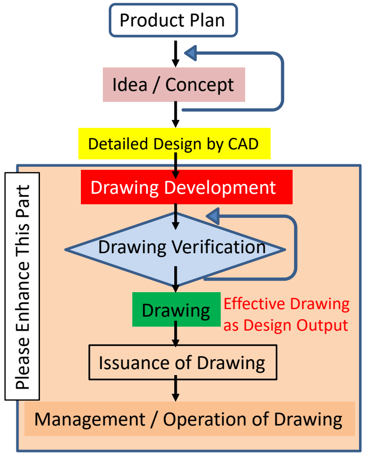
Moreover, if your company properly manages drawing, drawing will be your company's valuable asset.

Please remember that drawing is an asset and highly confidential information.

Each company needs to manage drawing carefully including strict management of your client's drawing as confidential information.

I hope that everyone who has attended today will start to consider using drawing in your workplace from now on.

Flow of Design Process



Costing in Dealing with Foreign Companies and Necessary Cost Reduction

JICA EXPERT
NAOYA NISHIGAKI

Table of Contents

1. Basic Concept of Cost Management

1) Type of Cost Management

a) Financial accounting:
To offer information to the outside stakeholders concerned of your company

b) Control (managerial) accounting:
To offer information to the management of your company

2) Profit

- **To secure profit**
You produce products and sell them in the market, and thereby the profit occurs.

Sales – Cost = Profit

→ Profit = (Sales Quantity × Unit Price) - Cost

→ To increase profit:

a) Increase sales quantity
b) Raise a unite price, and/or
c) Reduce cost

3) Purpose of Cost Management

a) Cost reduction
b) Assessment of management achievement
c) Formulation of internal and external company policies
d) Decision-making of equipment purchase
e) New product development, etc.

4) What is Cost?

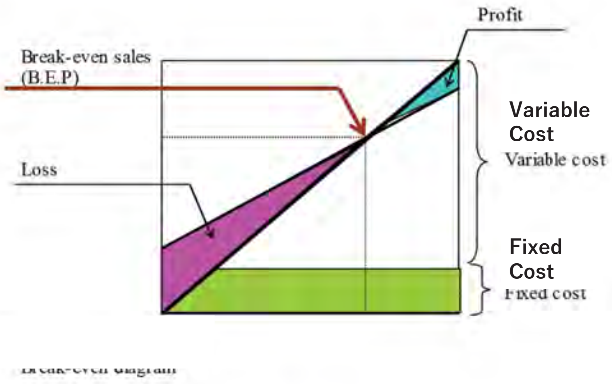
a) Classification by nature

Material cost, Labor cost, Expense (3 major elements of manufacturing cost)

b) Classification by behavior (variable and fixed costs)

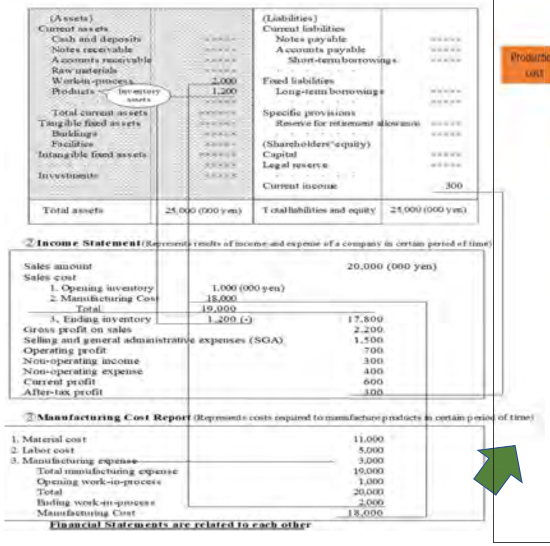
Variable Cost: Cost that changes in proportion to change in production/sales volume
Fixed Cost: Cost that is almost constant regardless of changes in production volume

5) Break Even Point



$$\text{Safety rate} = \frac{\text{Current sales} - \text{Break-even sales}}{\text{Current sales}}$$

Balance Sheet (Company's Financial Situation in Certain Period of Time)



(Assets)		(Liabilities)	
Current assets		Current liabilities	
Cash and deposits	*****	Notes payable	*****
Notes receivable	*****	Accounts payable	*****
Accounts receivable	*****	Short-term borrowings	*****
Raw materials	*****		
Work-in-process	2,000	Fixed liabilities	
Products (Inventory assets)	1,200	Long-term borrowings	*****
	*****		*****
Total current assets	*****	Specific provisions	
Tangible fixed assets	*****	Reserve for retirement allowance	*****
Buildings	*****		*****
Facilities	*****	(Shareholders' equity)	
Intangible fixed assets	*****	Capital	*****
	*****	Legal reserve	*****
Investments	*****		
		Current income	300
Total assets	25,000 (000 yen)	Total liabilities and equity	25,000 (000 yen)

② **Income Statement** (Represents results of income and expense of a company in certain period of time)

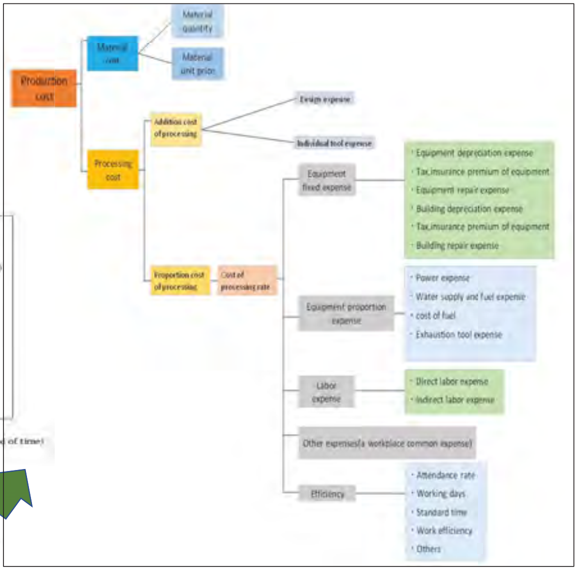
Sales amount		20,000 (000 yen)
Sales cost		
1. Opening inventory	1,000 (000 yen)	
2. Manufacturing Cost	18,000	
Total	19,000	
3. Ending inventory	1,200 (-)	17,800
Gross profit on sales		2,200
Selling and general administrative expenses (SGA)		1,500
Operating profit		700
Non-operating income		300
Non-operating expense		400
Current profit		600
After-tax profit		300

③ **Manufacturing Cost Report** (Represents costs required to manufacture products in certain period of time)

1. Material cost	11,000
2. Labor cost	5,000
3. Manufacturing expense	3,000
Total manufacturing expense	19,000
Opening work-in-process	1,000
Total	20,000
Ending work-in-process	2,000
Manufacturing Cost	18,000

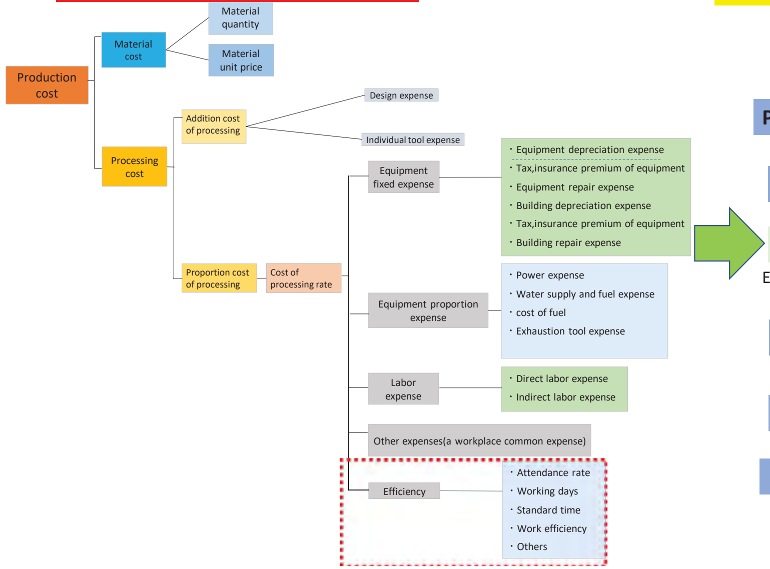
Financial Statements are related to each other

2. Manufacturing Cost System and Estimate Cost



---

1) Manufacturing Cost System



- Production cost
  - Material cost
    - Material quantity
    - Material unit price
  - Processing cost
    - Addition cost of processing
      - Design expense
      - Individual tool expense
    - Proportion cost of processing
      - Cost of processing rate
        - Equipment fixed expense
          - Equipment depreciation expense
          - Tax,insurance premium of equipment
          - Equipment repair expense
          - Building depreciation expense
          - Tax,insurance premium of equipment
          - Building repair expense
        - Equipment proportion expense
          - Power expense
          - Water supply and fuel expense
          - cost of fuel
          - Exhaustion tool expense
        - Labor expense
          - Direct labor expense
          - Indirect labor expense
        - Other expenses(a workplace common expense)
        - Efficiency
          - Attendance rate
          - Working days
          - Standard time
          - Work efficiency
          - Others

2) Estimate Cost

Mold cost

+

Purchasing (material) cost

+

Inventory cost

+

Production cost

E.g., Injection, Machining, Painting etc.

+

Warehouse & Shipping cost

+

Quality cost

+

Management cost

+

Profit

---

3. Calculation of Total Estimate Cost (Quotation-Making)

1) Cost Items

Estimated product unit price =

Material cost + Processing cost + Other expenses + Profit

Processing cost = Standard time X Processing cost rate

Processing cost rate = <u>Machine cost rate</u> + <u>Labor cost rate</u> + <u>Other cost rate</u>

Machine cost rate = Machine purchase cost / Machine operating time

Labor cost rate = Direct labor cost / Working time of direct labor

Other cost rate = Other cost / working time of direct labor

<u>Total cost estimation sheet</u> = Estimated product unit price + Equipment cost (including maintenance cost) + Quality management cost + Packaging cost + Warehouse cost + Shipment cost + Management expense, etc. + Tax

2) Example of Format (Price Quotation for International Manufacturer)

Quoted for Client A (Ref. No.: 20200806-PP-A)	
Product Name	Battery holder
Drawing Number	50300-G-552
Material Used	PP (Reliance-REPOL CO15EG)
Weight	0.352
Average Thickness	0.93 mm
Painting Process	N/A
No. of Orders	42,000 pieces/month

Cost Category	Particulars	BDT
Material Cost	Rate (KG) x Unit quantity	***
	Insurance	***
	Landing/transportation	***
	Import tax, AIT, VAT	***
	Warehouse management	***
	Direct labor	***
	Subtotal	***

Conti-
nued

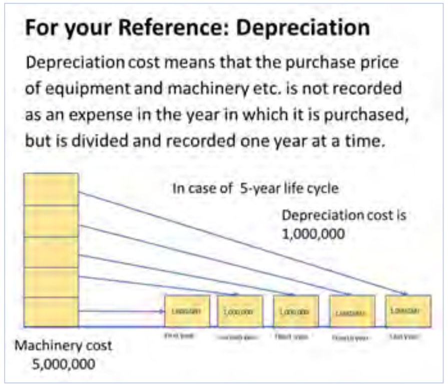
Cost Category	Particulars	BDT
Mold Cost (Cavity = 2)	Materials (in China)	***
	Processing (in China)	***
	Travel to China	***
	Landing/transportation/insurance	***
	Import tax, AIT, VAT	***
	Mold start-up (Local)	***
	Maintenance (Local)	***
	Direct labor (Local)	***
	Depreciation	***
	Subtotal	***
Processing Cost (Molding cycle time = 60 sec; Machine rate cost = ***BDT)	Maintenance	***
	Direct labor	***
	Depreciation	***
	Power	***
	Subtotal	***

Continued from the previous slide

Cost Category	Particulars	BDT
Quality Management Cost	Direct labor	***
	Subtotal	***
Packaging Cost	Packing (Bubble poly)	***
	Direct labor	***
	Carton	***
	Subtotal	***
Warehouse Management Cost	Management	***
	Direct labor	***
	Subtotal	***
Shipment Cost	Transportation	***
	Subtotal	***
Cost of Manufacturing		***
HQ Expense		***
Total Cost		***
Profit Margin		***

Continued

Price before Tax	***
Tax (@15%)	***
Offered Price	***



For your Reference: Depreciation

Depreciation cost means that the purchase price of equipment and machinery etc. is not recorded as an expense in the year in which it is purchased, but is divided and recorded one year at a time.

---

4. Exercise to Calculate Total Estimate Cost

Calculate total estimate cost based on the following conditions!

<u>Your company received an order from Client A for 42,000 pcs parts each month.</u>

Task: Make a total cost estimation sheet against the client's order (Use format in Slide 23)

<u>Prerequisites</u>:

a) Production condition

- Production days per month = 22 days, 1 day = 8 hours, 3 operators
- Monthly amount of production capability = 42,240 pcs
- Amount of shipping of products every month = 40,000 pcs

b) Production process

Material purchase → Mold purchase → Injection → Quality control → Packing → Warehouse Mgt. → Shipment

---

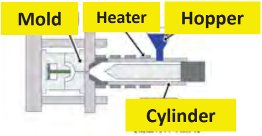
4. Exercise to Calculate Total Estimate Cost – Continued

c) When you make 4 products with 10 gram plastic material (@ 400 BDT/Kg) in 1 minute by using an injection molding machine which costs 4,000 BDT machine-cost-rate per hour, calculate unit price of molded product.

d) Molding cycle time＝60sec, Machine cost rate ＝ 4,000 BDT/hour, Cavity＝4

<u>For this, you need to calculate items below!!</u>

- **Material cost per one piece,**
- **Processing cost per one piece, and then**
- **Unit price of molded product**



Reference:
TEIKA PRECISION COMPANY

4. Exercise to Calculate Total Estimate Cost – Continued (Hints!)

<u>Molded product cost = Material cost + Processing cost</u>

1) Material Cost

Material cost = Unit price X Material weight

2) Processing Cost

Processing cost = Machine cost rate X Molding time

---

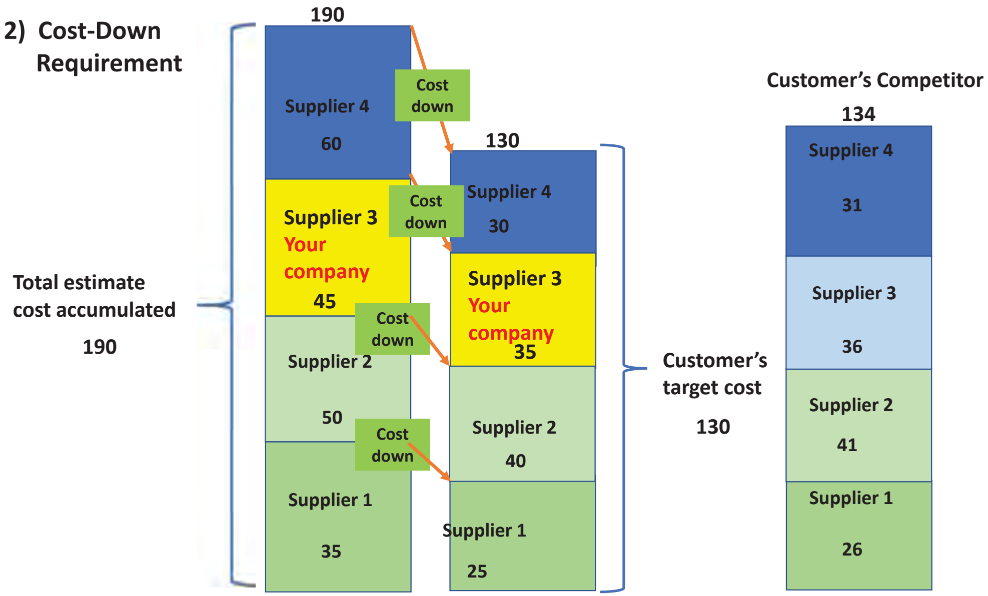
5. Points in Calculating Appropriate Estimate Cost

1) <u>You need to consider yourself to be one of the supply chain members!!!</u>

- ✓ **Perform cost management in such a way that your costumer (not only your company!) can achieve and maintain their target cost.**
- ✓ **For this, you should set and achieve indicators of P (Productivity), Q (Quality), C (Cost), D(Delivery), S (Safety), M(Morale), and E (Environment) so that you can meet requirement from your customer.**
- ✓ **Pay more attention to the costs that are actually occurring at production site; Don't just estimate them from the desk in the head office.**
- ✓ **Grasp the whole processes at production site from purchasing order to shipping to know what expenses occur and how they are incurred between PO and shipping process.**
- ✓ **Study more how labors are working at production site to know more precisely how labor costs are generated.**
- ✓ **Understand importance of depreciation expenses of dies/molds and equipment which constitute large portion of the manufacturing cost.**

---

2) Cost-Down Requirement



Total estimate cost accumulated 190

190
Supplier 4 60
Supplier 3 Your company 45
Supplier 2 50
Supplier 1 35

Cost down

130
Supplier 4 30
Supplier 3 Your company 35
Supplier 2 40
Supplier 1 25

Customer's target cost 130

Customer's Competitor

134
Supplier 4 31
Supplier 3 36
Supplier 2 41
Supplier 1 26

---

3) Issues that should be Addressed for Bangladeshi Companies

- ✓ **Accounting department manages cost-data at production site remotely from the head office. However, it is doubtful whether the data reflects the actual situation at the site (especially the cost that varies with work efficiency).**
- ✓ **Since the work standardization at production site is usually not present in Bangladeshi companies, conditions of manufacturing process frequently change, and thus, production is not stable and the cost also varies.**
- ✓ **Accounting department tends to create a quote sheet on its own while not-well grasping the actual cost incurred at production site. As a result, the calculated cost tends to be higher than the customer's expectation (because the cost inappropriately covers what may have been reduced by enhancing the work efficiency and standardization).**
- ✓ **Bangladeshi companies generally do not know that international manufacturers (customers) require their suppliers to reduce the cost <u>every year</u>. Meeting this requirement, however, will cause the company to become robust.**
- ✓ **Thus again, it's very important to do continuous *<u>Kaizen</u>* activities that reduce the cost or improve P, Q, D, S, M, and E of your company.**

PROGRAM FOR ENHANCEMENT OF CAPACITY OF BUSINESS MANAGERS (5TH TRAINING BATCH)

23, 24 AND 25 AUGUST 2021

SME FOUNDATION & JICA PROJECT TEAM

JICA PROJECT TEAM

NAOYA NISHIGAKI

	Day 1	Day 2	Day 3
Date and Time	23 August 2021 14:00 - 16:00	24 August 2021 14:00 - 16:00	25 August 2021 14:00 - 16:00
Theme	**How to be a high-quality factory:** to aim for a world-class manufacturer	**How to reduce defective products:** to aim for a zero-defect factory	**How to enhance a factory:** integrated operation from management to workplace
Topics	• Establishment of "model line" • Principal policies of factory management ➢ KAIZEN (Elimination of *MUDA*) ➢ Standardization ➢ Enhancement of organization ➢ Visualization	• Quality management based on drawing • QC Process Chart • Operation Standard Sheet • Our Remarks on Operation Standardization	• Enforcement of organization ➢ QC Circle Activities ➢ Creation of Lively Workplace
Exercise	• Think about your company's wastes! • Consider how to eliminate them by 2S!	• Consider obstacles in your companies for dealing with demanding foreign customers!	• Discuss how to have QC Circle activities root in Bangladeshi companies!

How to be a high-quality factory: to aim for a world-class manufacturer

---

Day 1: Contents

1. Establishment of "Model Line"

2. Principal Policies of Factory Management

- ➢ **KAIZEN (Elimination of *MUDA*) (Day 1)**
- ➢ Standardization (Day 2)
- ➢ Enhancement of Organization (Day 3)
- ➢ Visualization (On another opportunity)

3. KAIZEN (Elimination of *MUDA*)

1. Establishment of "Model Line"

---

1. Establishment of "Model Line"

What is a Model Line?

A World-class Model Production Line ("Model Line") is a separate production line to practice high-level production/quality management system that meets requirement of world-class manufacturers (your future customers) like TOYOTA, HONDA, BMW, etc.

A Model Line is also a model that can be applied to other production lines in your factory in future so that your factory will be able to develop in an overall manner.

In addition, a model line serves as a wonderful opportunities for human and organizational development at high level.

In other words, in a Model Line, all the "**Principal Policies of Factory Management**" which you will learn from today to Day 3 are practiced.

JICA Project Team has been working with three local plastic companies in establishing a model line since January 2019.

---

1. Establishment of "Model Line"

Always Discuss and Make Clear What Your Factory Should be Like in Future

Establishing a Model Line along the current production lines serves as an indication to competitors and company stakeholders including the employees about what operation system you aim to establish in the factory as well as the course of direction you take as a company.

Effort to establish a model line also makes employees involved with it learn what they should be like and see their growth.

Then, those who have learnt in the model line can train others to apply the same system in other lines.

These are very important for factory operation from the mid-term and long-term perspective.

---

1. Establishment of "Model Line"

A THING TO DO FIRST: IMAGE WHAT YOUR COMPANY SHOULD BE LIKE

Discuss what your company should be like.

Start by clarifying what your entire company should be like to know what your factory should be like and what to do to become so.

For this,

1. Clarify what your company (factory) is like now.
2. Clarify what your company (factory) should be like in future by improving the 1 above (This is a model line).
3. Think widely about what you need to achieve to become the 2 above.

1. Establishment of "Model Line"

Step to Establish a Model Line

(1) Practice basics of production thoroughly

- **Set a world-class and ideal model line**
  - ✓ Set up a world class model line
    Machine setting, quality control and safety measures with your eyes setting <u>on future business transactions with world renowned manufacturers</u>
  - ✓ Manage product designs and specifications properly
    Preparation of <u>drawings</u> of all products and production based on them.

---

1. Establishment of "Model Line"

Step to Establish a Model Line

(2) Thoroughly implement your corporate philosophy

- Build a solid QC system, QC methods, and operation standards, and then visualize them at every work site.

(3) Create the factory able to produce "quality products" consistently

- Re-educate 5S (for production at a clean and safe workplace)
- Apply "**<u>always the same principle</u>**" (see the next slide) to materials, lines, inspection methods, management, and shipment
- Optimize production conditions to reduce defects (e.g. visualization of production conditions and defective rate)
- Display (visualize) operation standards

---

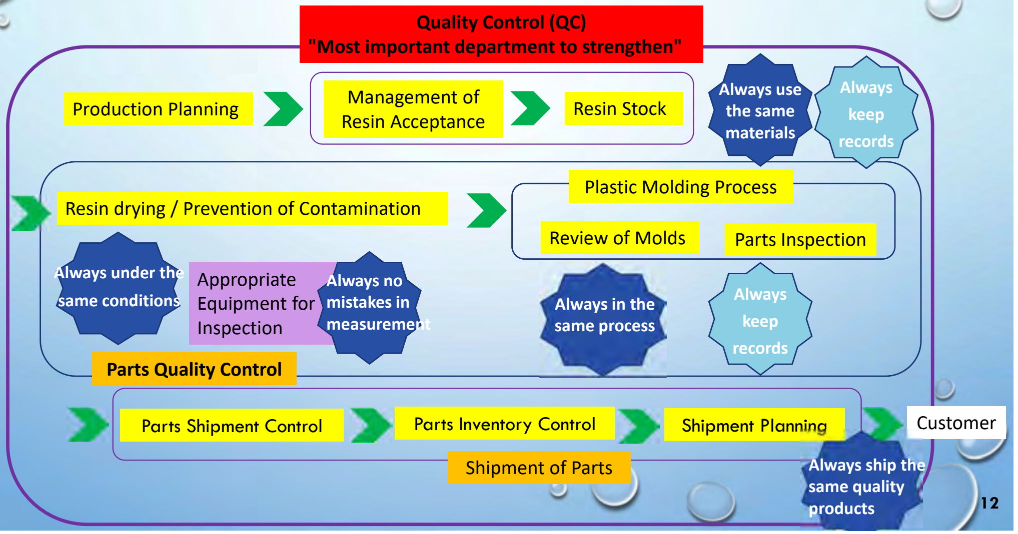
1. Establishment of "Model Line"

Apply "Always the Same Principle"!!

- · Always **safety first**
- · Always maintain workplace **clean and efficient**
- · Always use the same **materials**
- · Always under the same **conditions**
- · Always in the same **process**
- · Always use the same **criteria**
- · Always no mistakes in **measurement**
- · Always in the same **management**
- · Always **ship** the same quality product
- · Always **keep records** on everything
- · In appropriate **cost**

---

1. Establishment of "Model Line"



1. Establishment of “Model Line” Example: To-Do list

Work				Started on	Progress	Finish by
1	Setting-up of Model Line	1-1	Install all machines and equipment as per the final layout			
		1-2	Implement and maintain “**complete 3S**”			
		1-3	Maintain “**safe**” and “**efficient (easy to move)**” production line			
		1-4	Select and produce 3 **model products**			
		1-5	Complete management of materials, molds, machines, quality and packaging along the model line			
2	Constitution of Model Line Team	2-1	Assign “**committed**” model line members from regular employees			
		2-2	Provide a “**special uniform**” for model line members			
		2-3	Conduct **training** to model line members with management’s commitment			
		2-4	Create an “**organization chart**” with face pictures of model line team			

Work				Started on	Progress	Finish by
3	Establish Responsible Production and Quality Management System (**Change from quantity-oriented to quality-oriented: *No defective goods to be shipped outside!!***)	3-1	Make and manage “**drawings**” for 3 model products			
		3-2	Prepare and visualize a “**QC Process Chart**” for each model product			
		3-3	Prepare and visualize “**operation standard sheets**” for all the process from material acceptance to shipping			
		3-4	Prepare and visualize “**standard molding conditions (parameter) table**” for 3 model products			
		3-5	Prepare and visualize “**inspection standard sheets (check-sheets)**” for all the processes			
		3-6	Prepare “**record formats**” for all the processes			
		3-7	Install mold temperature controller and resin dryer			

1. Establishment of “Model Line”

Before-After Comparison

Again, Apply “Always the Same Principle”!!

- Always **safety first**
- Always maintain workplace **clean and efficient**
- Always use the same **materials**
- Always under the same **conditions**
- Always in the same **process**
- Always use the same **criteria**
- Always no mistakes in **measurement**
- Always in the same **management**
- Always **ship** the same quality product
- Always **keep records** on everything
- In appropriate **cost**

2. Principal Policies of Factory Management

---

2. Principal Policies of Factory Management

To practice "**Principal Policies of Factory Management**," the following four actions are the key; <u>these *four keys are practiced in a model line*</u>.

- **KAIZEN (Elimination of *MUDA*)**
- **Standardization (Day 2)**
- **Enhancement of Organization (Day 3)**
- Visualization (On another opportunity)

We will learn three of these 4 keys from today to Day 3. As for visualization, we will leave it for the next training.

Today, we take up "**KAIZEN**." KAIZEN covers many improvement activities; however, we focus on "**Elimination of *MUDA***" by 2S activities, which is one of the critical actions in KAIZEN.

---

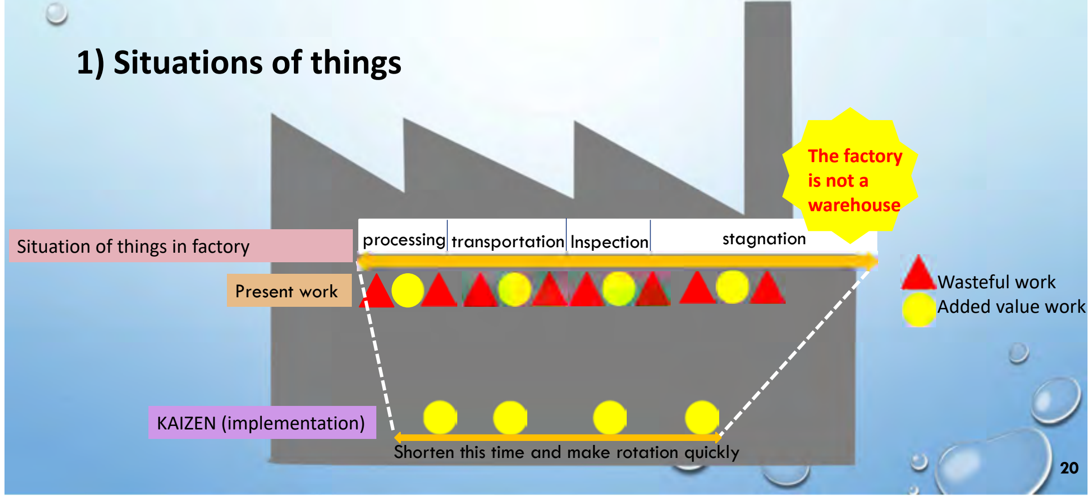
3. KAIZEN (Elimination of *MUDA*)

---

3. KAIZEN (Elimination of *MUDA*)

3-1 What is KAIZEN ?

1) Situations of things



The factory is not a warehouse

Situation of things in factory

processing | transportation | Inspection | stagnation

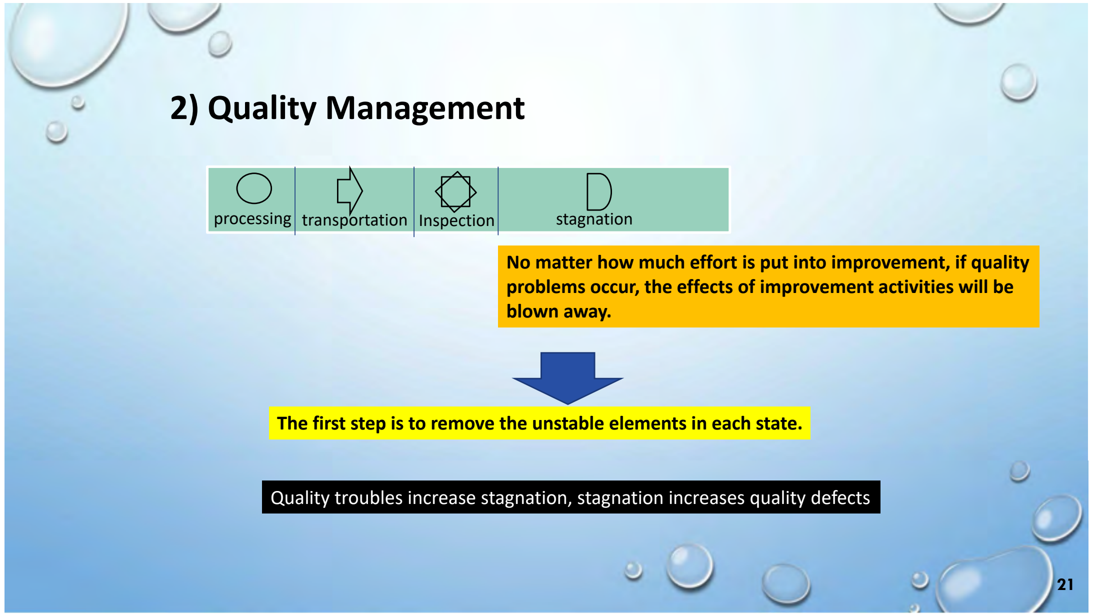
Present work

KAIZEN (implementation)

Shorten this time and make rotation quickly

▲ Wasteful work

● Added value work



2) Quality Management

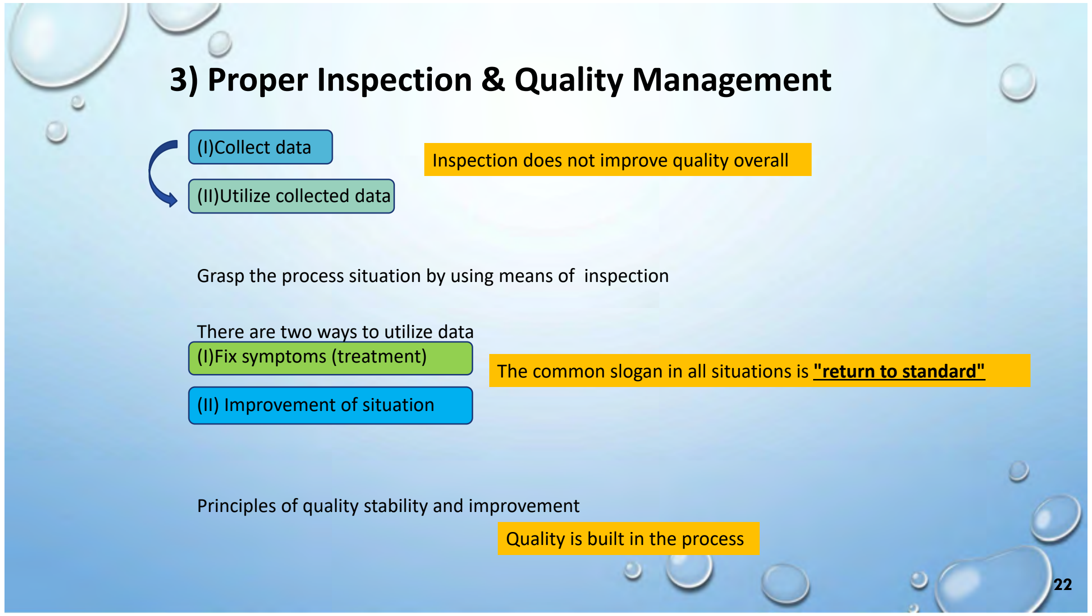
processing	transportation	Inspection	stagnation

No matter how much effort is put into improvement, if quality problems occur, the effects of improvement activities will be blown away.

The first step is to remove the unstable elements in each state.

Quality troubles increase stagnation, stagnation increases quality defects

---



3) Proper Inspection & Quality Management

(I)Collect data

(II)Utilize collected data

Inspection does not improve quality overall

Grasp the process situation by using means of inspection

There are two ways to utilize data

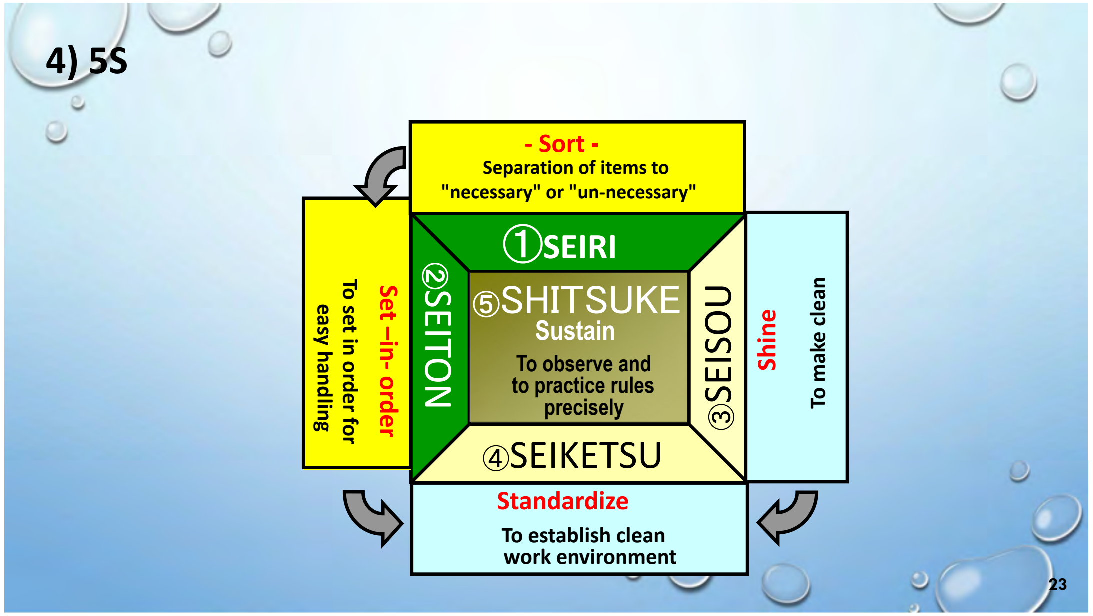
(I)Fix symptoms (treatment)

(II) Improvement of situation

The common slogan in all situations is **"return to standard"**

Principles of quality stability and improvement

Quality is built in the process



4) 5S

- Sort -
Separation of items to "necessary" or "un-necessary"

①SEIRI

②SEITON

Set –in- order
To set in order for easy handling

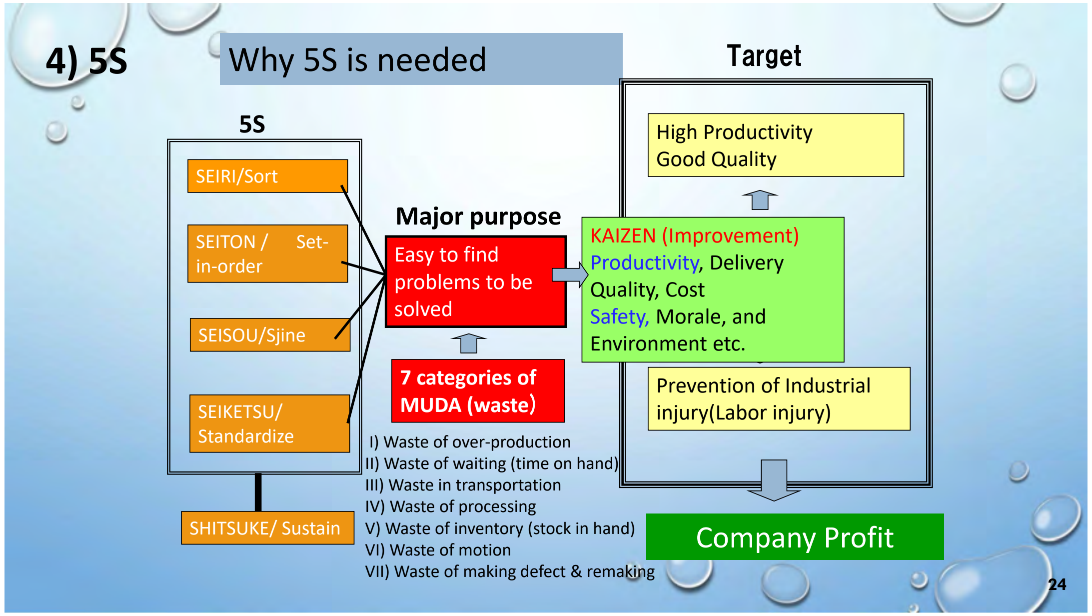
⑤SHITSUKE
Sustain
To observe and to practice rules precisely

③SEISOU

Shine
To make clean

④SEIKETSU

Standardize
To establish clean work environment



4) 5S

Why 5S is needed

5S

SEIRI/Sort

SEITON / Set-in-order

SEISOU/Sjine

SEIKETSU/ Standardize

SHITSUKE/ Sustain

Major purpose

Easy to find problems to be solved

7 categories of MUDA (waste)

I) Waste of over-production
II) Waste of waiting (time on hand)
III) Waste in transportation
IV) Waste of processing
V) Waste of inventory (stock in hand)
VI) Waste of motion
VII) Waste of making defect & remaking

Target

High Productivity
Good Quality

KAIZEN (Improvement)
Productivity, Delivery
Quality, Cost
Safety, Morale, and
Environment etc.

Prevention of Industrial injury(Labor injury)

Company Profit

4) 5S

2S is the first step and most important in 5S activity.

5S

SEIRI / Sort
SEITON / Set-in-order
SEISOU / Shine
SEIKETSU / Standardize
SHITSUKE /Sustain

➡

Start from thorough **2S**

SEIRI / Sort
SEITON / Set-in-order

Why is 2S most important?
Because 2S has the strongest relation with the productivity (Elimination of MUDA) and safety among 5S

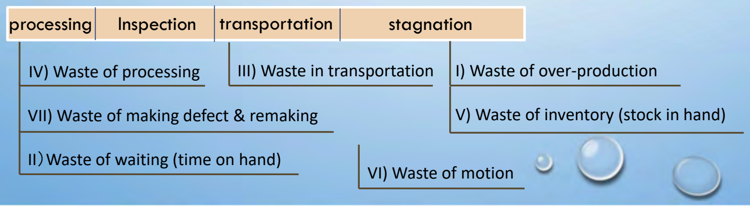
---

5) Elimination of "*MUDA* (Waste)": We learn this today!!

"***MUDA***" is something that is hidden in normal behavior and is difficult for both the person and the surroundings to notice.

Seven Types of Waste

I) Waste of over-production
II) Waste of waiting (time on hand)
III) Waste in transportation
IV) Waste of processing
V) Waste of inventory (stock in hand)
VI) Waste of motion
VII) Waste of making defect & remaking



I) Waste of over-production

a. Pre-consumption of materials and parts
b. Waste of energy
c. Increase in pallets, containers, etc.
d. Increase in storage space, warehouse, etc.
e. Increase in transport vehicles, lifts, etc.
f. Increase in management man-hours

II) Waste of waiting (time on hand)

Waste of waiting is easily converted into overproduction

III) Waste in transportation

No matter how long you carry, the value of things will not increase

VI) Waste of processing

a. Work that can be done by another process simultaneously
b. Work that can be **un**necessary by rearranging the process
c. Work that can become common like setup

The wasteful work above exist as if it is naturally needed

V) Waste of inventory (stock in hand)

a. Inventory waste leads to stagnation (causing extension of lead time)
b. Important cash goes to bed
c. Need a place for inventory (Less inventory, less place required)

VI) Waste of motion

a. Inevitable operation at the moment
b. Work you want to eliminate
c. Work that should not be done

VII) Waste of making defect and remaking

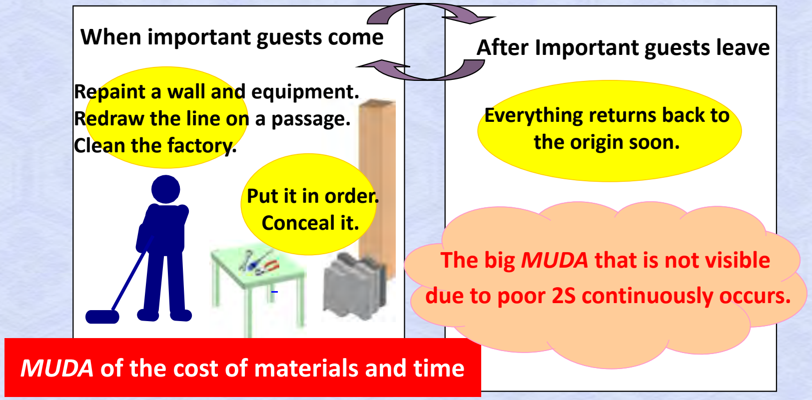
Quality problems are important issues for survival of a company

Poor quality and defect-rectification consume the large amount of man-hours and materials, leading to increase in process stagnation.

3-2 Making Profit by Eliminating "*MUDA*" by 2S

1) Difference between understanding 2S and not understanding 2S?

Isn't your factory pretending to be clean?



When important guests come

Repaint a wall and equipment.
Redraw the line on a passage.
Clean the factory.

Put it in order.
Conceal it.

After Important guests leave

Everything returns back to the origin soon.

The big *MUDA* that is not visible due to poor 2S continuously occurs.

***MUDA* of the cost of materials and time**

A refreshing workplace

Shelf management (localization, fixed product, fixed quantity)

3-2 Making Profit by Eliminating "*MUDA*" by 2S

2) What is *MUDA* caused by poor 2S? - 1

(a) *MUDA* due to spending a lot of time to look for things.

Necessary item now

① Look for necessary item
② Move other things aside.
③ Making products
④ Bend the waist and put it.
⑤ Pile up it like a mountain.
⑥ Tranship it on a trolley.

Work that doesn't make a profit

① Look for
② Move aside
④ Bend the waist
⑤ Pile up
⑥ Tranship etc.

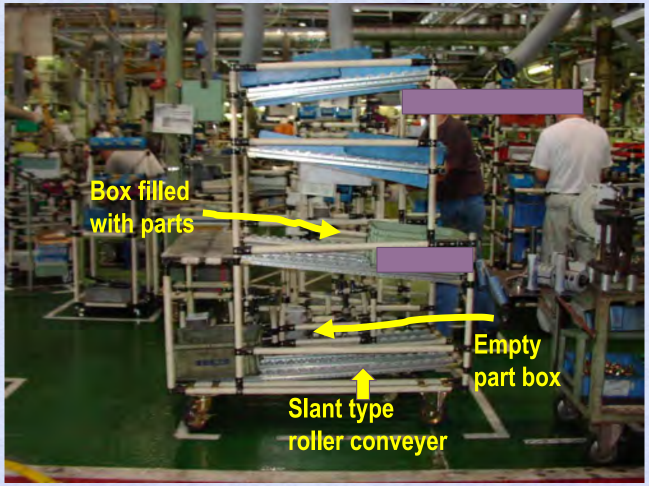
The big invisible *MUDA* has remain as it is.

In case of 100 employees, when an employee looks for a necessary item or move other things beside for average 30 minute in a day

***MUDA*=100 employees×0.5hour×250days/year=12,500 hours/year**

- ・Floor layout considered minimum walk distance
- ・Depository considered work easiness.
- ・Work table・・・Position is clarified with line.
- ・Trolley・・・ Position is clarified with line
- ・Prohibition of putting things on a floor directly.
- ・Obligate 2S at the end of work.

Example of parts shelf with slant type roller conveyer used for First in First out (FIFO)



Shelf management that is the search-less

3-2 Making Profit by Eliminating "*MUDA*" by 2S

2) What is *MUDA* caused by poor 2S? - 2

(b) *MUDA* due to industrial injury caused by slippery and fall-down

When industrial injury happens:

1. Report to police office and labor bureau of government.
2. Hold a meeting to discuss how to deal with it.
3. Study recurrence prevention and implement countermeasures.
4. Arrange an alternative worker, educate and train new worker
5. Treat injury

If your factory does not assures safety, industry injuries will happen sooner or later; it's a matter of time

Various *MUDA*-elimination actions are required.

3-2 Making Profit by Eliminating "*MUDA*" by 2S

2) What is *MUDA* caused by poor 2S? - 3

(c) *MUDA* where items you bought by cash are stagnating in house

<e.g.>"In a warehouse, you find the mountain of treasures. "

***MUDA* of stagnation of money**

Expensive tools, materials and products are stored in an unorganized fashion like a mountain.

If you cannot find necessary items even if you actively look for

1. There is an issue of additional purchase slip
2. The storage of items which you accepted is insufficient, and even if everyone searches for them, they cannot find anything and it makes a fuss.
3. Finally everyone forgot where they have put it.
4. Moreover, additional purchase is required repeatedly

3-2 Making Profit by Eliminating "*MUDA*" by 2S

3) Aim of 2S is to "Eliminate *MUDA*" that consumes money and time

(a) Introduce "2S(or 5S) activity" as a basic policy of the company.

(b) Build/integrate 2S into the works of entire company

(c) Conduct 2S by all members as their routine work every day.

i) Aim at zero of *MUDA* to look for or move aside.
→**Necessary things should be taken out in 30 seconds.**

ii) Make slippery and fall-down zero.
→**Enhance awareness that most values safety**

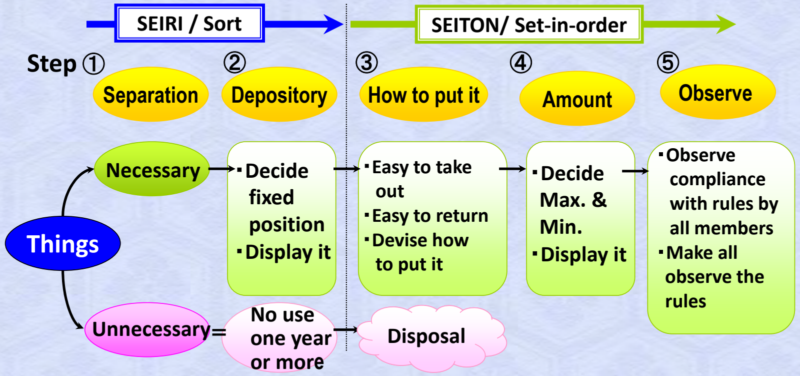
iii) Make *MUDA* purchase zero.
→**Visualization of stocks and minimization of extra purchasing.**

Promote 2S (or 5S) by strong leadership of a top management, and aim at *MUDA* zero!!

3-2 Making Profit by Eliminating "*MUDA*" by 2S

4) How to advance 2S (SEIRI/Sort and SEITON/Set-in-order) - 1

(a) 2S of the things



2S of things is to surely take step ① -⑤.

Storage for final products

Optimum stock:
(200 pieces/box)
3 box for 1 day
=12 boxes(4 days)

Specify fixed positions.

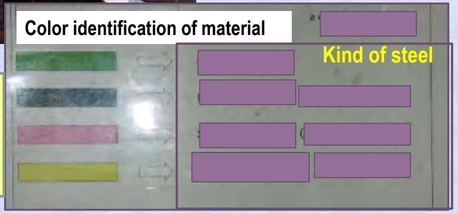
Clarify maximum and minimum amount of stocks.

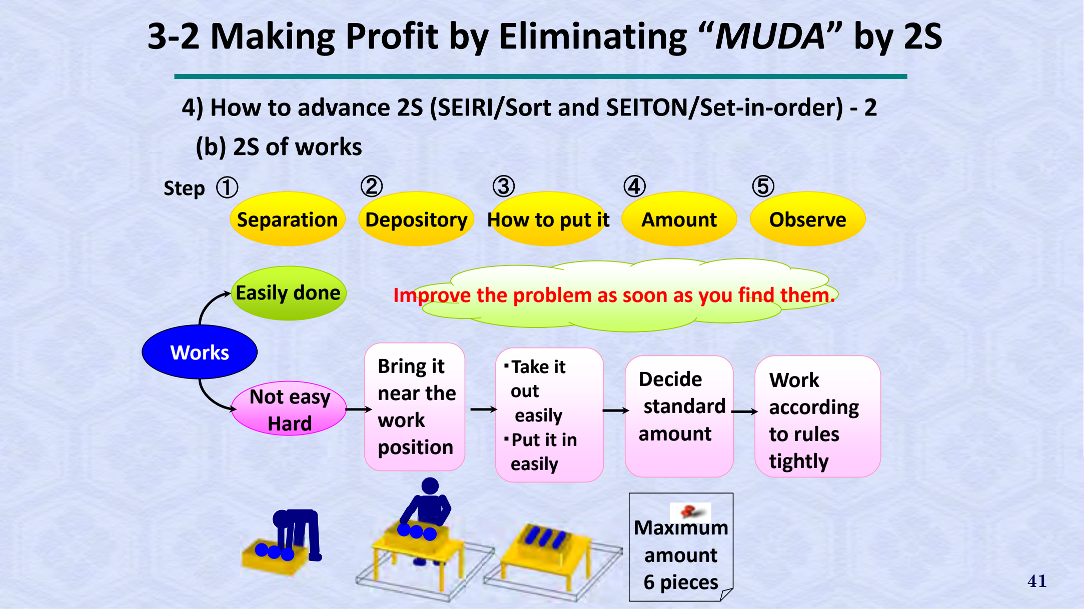
Detachable number board

Storage for thick steel sheets

The use order is specified by No..

The kinds of material is specified according to the color.





3-2 Making Profit by Eliminating "*MUDA*" by 2S

4) How to advance 2S (SEIRI/Sort and SEITON/Set-in-order) - 2

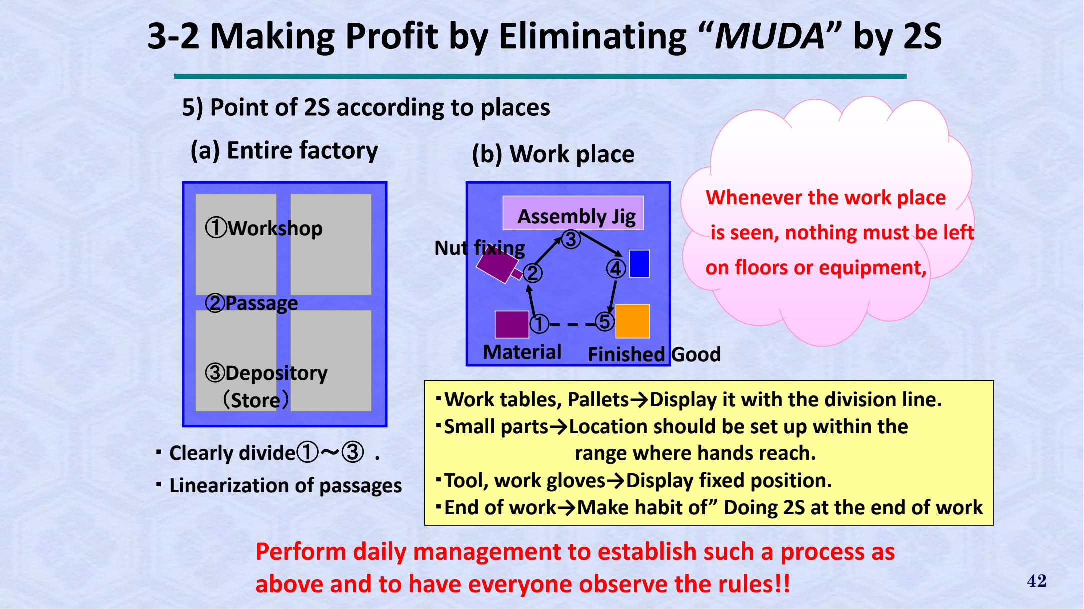
(b) 2S of works

Step ① Separation ② Depository ③ How to put it ④ Amount ⑤ Observe

Works → Easily done: Improve the problem as soon as you find them.

Works → Not easy Hard → Bring it near the work position → ・Take it out easily ・Put it in easily → Decide standard amount → Work according to rules tightly

Maximum amount 6 pieces



3-2 Making Profit by Eliminating "*MUDA*" by 2S

5) Point of 2S according to places

(a) Entire factory

①Workshop
②Passage
③Depository (Store)

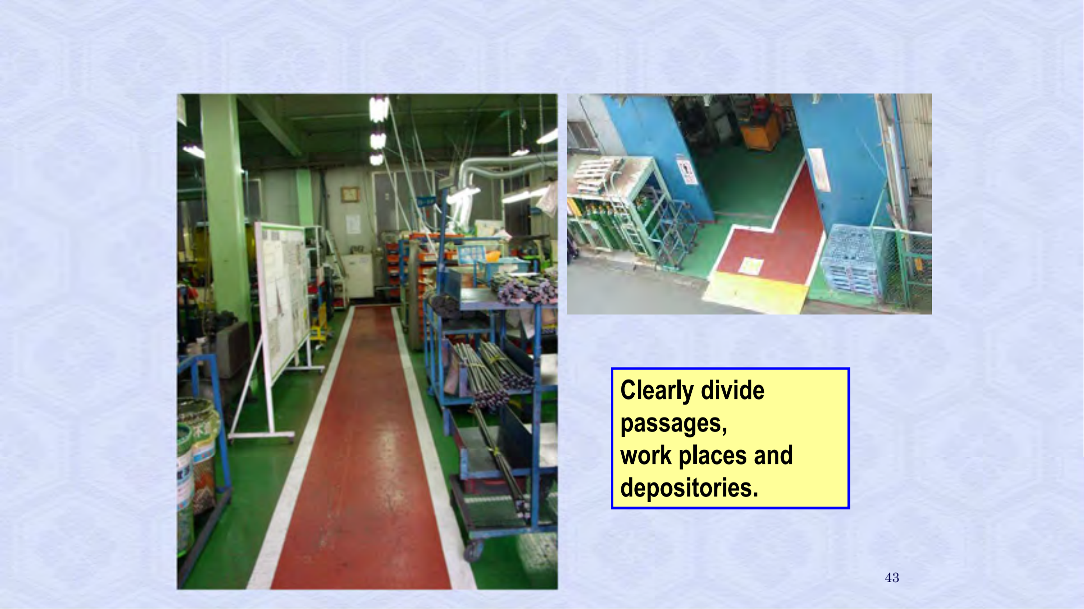
- Clearly divide①～③ .
- Linearization of passages

(b) Work place

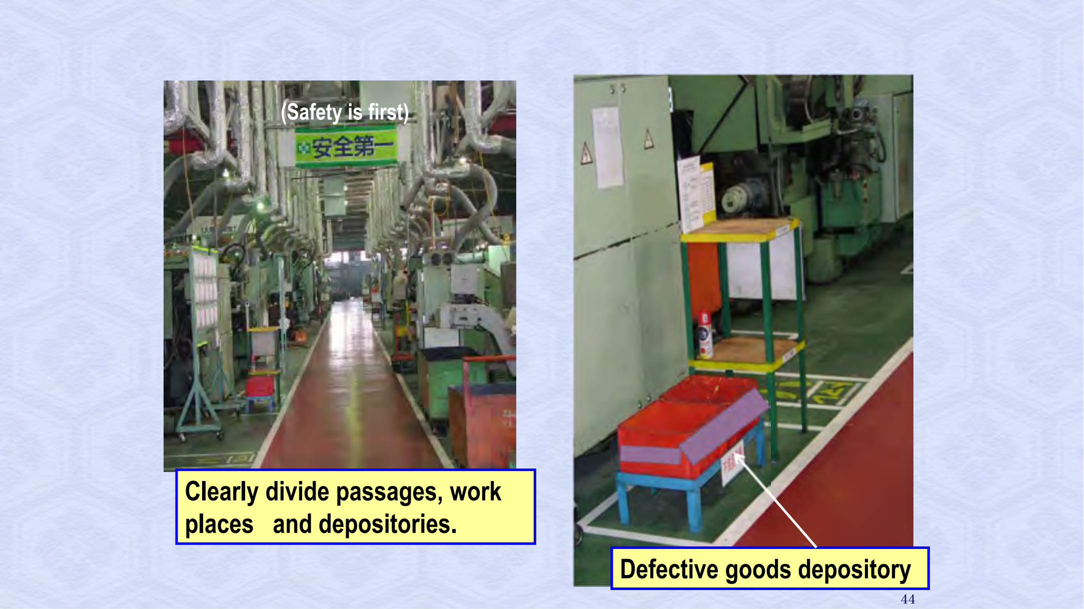
Whenever the work place is seen, nothing must be left on floors or equipment,

- ・Work tables, Pallets→Display it with the division line.
- ・Small parts→Location should be set up within the range where hands reach.
- ・Tool, work gloves→Display fixed position.
- ・End of work→Make habit of" Doing 2S at the end of work

Perform daily management to establish such a process as above and to have everyone observe the rules!!



Clearly divide passages, work places and depositories.

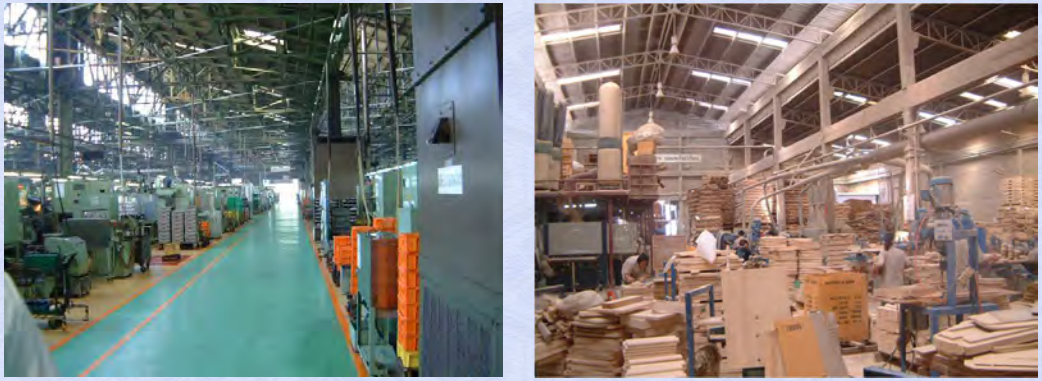


Clearly divide passages, work places and depositories.

Defective goods depository

Exercise

Compare the two factories and find what and where the wastes are. Also think about how to eliminate these wastes



Day 2

How to reduce defective products: to aim for a zero-defect factory

24 August 2021
JICA Project Team
Naoya Nishigaki

Day 2: Contents

Standardization

1. Our Remarks on Operation Standardization
2. QC Process Chart
3. Operation Standard Sheet

---

1. Our Remarks on Operation Standardization

অপারেশন স্ট্যান্ডার্ডাইজেশন সম্পর্কে আমাদের মন্তব্য

---

1. Our Remarks on Operation Standardization

অপারেশন স্ট্যান্ডার্ডাইজেশন সম্পর্কে আমাদের মন্তব্য

Challenges regarding the operation standardization in Bangladeshi companies that We have visited.
আমরা যেসমস্ত বাংলাদেশী কোম্পানি পরিদর্শন করেছি, তাদের অপারেশন স্ট্যান্ডার্ডাইজেশন সংক্রান্ত চ্যালেঞ্জসমূহ

1) Drawings are not applied for production and quality management!! উৎপাদন এবং মান নিয়ন্ত্রণ বেবস্থাপনায় ড্রইং প্রয়োগ করা হয় না

- Manufacturing starts with the drawings. ম্যানুফ্যাকচারিং বা উৎপাদন শুরুই হয় ড্রইং দিয়ে
- Since the product standard range is not clear, the same defects occur repeatedly. যেহেতু প্রোডাক্টের গুণগত মানের পরিসীমা পরিষ্কার নয়, তাই একই ডিফেক্ট বা ত্রুটি বারবার ঘটে।

2) Proper measuring instruments are not in place (little consideration of dimensional tolerance)!! সঠিক পরিমাপ যন্ত্রগুলি ঠিক জায়গায় থাকেনা (ডাইমেনশনাল টলারেন্স খুব সামান্যই বিবেচনা করা হয়)

3) Operation standards usually do not exist even for very important jobs!! সাধারণত অনেক গুরুত্বপূর্ণ কাজের ও কোনো অপারেশন স্ট্যান্ডার্ড থাকেনা

3) Even if the standards exist, workers are not even aware of them!! স্ট্যান্ডার্ড যদি থেকেও থাকে, ওয়ার্কার রা সেগুলো সম্পর্কে সচেতন নয়

4) Even if the standards exist, they do not match the actual situation!! স্ট্যান্ডার্ড থাকলেও সেগুলো বাস্তব পরিস্থিতির সাথে মেলেনা

- Leaders do not have understanding of the operation standards. লিডার দের অপারেশন স্ট্যান্ডার্ডের (আন্ডারস্ট্যান্ডিং) সম্পর্কে সঠিক বোধ থাকেনা
- There is tendency that leaders do not visit and try to know the production site. লিডার দের উৎপাদন সাইট বা প্রোডাকশন ফ্লোর এ ভিজিট করা এবং সেখানকার পরিস্থিতি বোঝার চেষ্টা না করার প্রবণতা কাজ করে

5) Training system and tools are not sufficient to enhance operator’s compliance with the standards!!

প্রশিক্ষণের যে ব্যবস্থা রয়েছে এবং যে টুলস বা সরঞ্জামগুলি থাকে তা অপারেটর কে স্ট্যান্ডার্ড মেনে চলতে উৎসাহিত বা অনুপ্রাণিত করার জন্য যথেষ্ট নয়।

6) <u>Observance on the standards as a company-wide rule</u> is insufficient!!
একটি কোম্পানির সাধারণ নিয়ম অনুযায়ী স্ট্যান্ডার্ড এর উপর পর্যবেক্ষণ যথেষ্ট নয়।

- ➢ Top management has a stance of leading quality control activities without company-wide engagement. শীর্ষ ব্যবস্থাপনা কতৃপক্ষের কোম্পানির যাবতীয় ব্যস্ততা ছাড়াও কোয়ালিটি কন্ট্রোল কার্যক্রমে নেতৃস্থানীয় একটি অবস্থান আছে।
- ➢ All employees should be involved in quality control activities. কোয়ালিটি কন্ট্রোল কার্যক্রমে সকল কর্মকর্তা কর্মচারীর অংশগ্রহণ বা জড়িত থাকা উচিত

7) <u>Revision</u> of the standards is not enough or not continuous!! স্ট্যান্ডার্ড এর রিভিশন ই যথেষ্ট নয় অথবা ধারাবাহিক নয়।

- ➢ It is a continuous cycle of improvement. এটি উন্নতির একটি ধারাবাহিক চক্র

8) <u>Visual management</u> is not existent or not working well!! ভিজ্যুয়াল ম্যানেজমেন্ট বা চাক্ষুশ ব্যবস্থাপনা বিদ্যমান নেই অথবা ভালোভাবে কাজ করছে না !!!

- ➢ Everyone in the floor should be able to immediately recognize whether the jobs is progressing normally or not. ফ্লোর এ থাকা প্রত্যেকেরই অবিলম্বে চিনতে বা বুঝতে সক্ষম হওয়া উচিত যে কাজগুলি স্বাভাবিকভাবে চলছে কিনা বা অগ্রসর হচ্ছে কিনা

9) <u>QC circle activities</u> are not in place!! কোনো জায়গায় কিউসি সার্কেল এর কার্যকলাপ নেই

- ➢ We will learn this on Day 3!! আমরা এটা □-৩/তৃতীয় দিন শিখবো !!

---

2. QC Process Chart

---

2. QC Process Chart

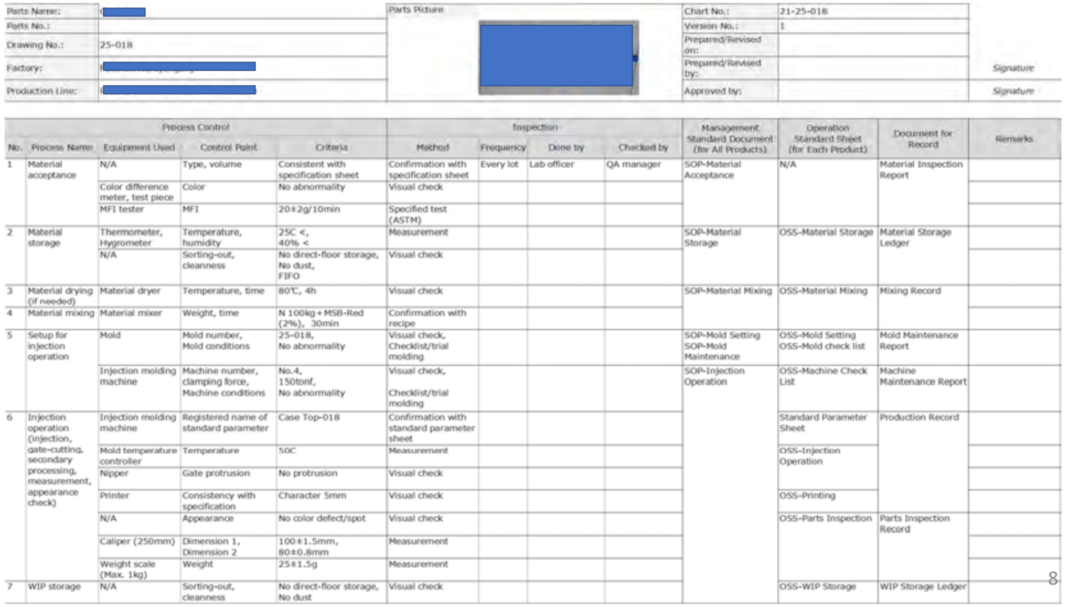
<u>What is a Quality Control (QC) Process Chart?</u>

<u>A list of quality-control points and operation/inspection standards in the whole process from material acceptance to shipping for each product/part</u>

- ✓ Used as a standard check-list to prevent defects in the whole process.
- ✓ Used to explain the whole QC system to the customer.
- ✓ Used as a textbook to educate and train the beginners.

Purpose of QC Process Chart:

- ✓ To prevent making of defective goods.
- ✓ To prevent outflow of defective goods to the next process and to customers.
- ✓ To prove the established QC system to customers.
- ✓ To make employees observe and improve the standards.



Parts Name:	[redacted]
Parts No.:	
Drawing No.:	25-018
Factory:	[redacted]
Production Line:	[redacted]

Parts Picture

[redacted]

Chart No.:	21-25-018	
Version No.:	1	
Prepared/Revised on:		
Prepared/Revised by:		Signature
Approved by:		Signature

Process Control					Inspection				Management Standard Document (for All Products)	Operation Standard Sheet (for Each Product)	Document for Record	Remarks
No.	Process Name	Equipment Used	Control Point	Criteria	Method	Frequency	Done by	Checked by				
1	Material acceptance	N/A	Type, volume	Consistent with specification sheet	Confirmation with specification sheet	Every lot	Lab officer	QA manager	SOP-Material Acceptance	N/A	Material Inspection Report	
		Color difference meter, test piece	Color	No abnormality	Visual check							
		MFI tester	MFI	20±2g/10min	Specified test (ASTM)							
2	Material storage	Thermometer, Hygrometer	Temperature, humidity	25C <, 40% <	Measurement				SOP-Material Storage	OSS-Material Storage	Material Storage Ledger	
		N/A	Sorting-out, cleanness	No direct-floor storage, No dust, FIFO	Visual check							
3	Material drying (if needed)	Material dryer	Temperature, time	80℃, 4h	Visual check				SOP-Material Mixing	OSS-Material Mixing	Mixing Record	
4	Material mixing	Material mixer	Weight, time	N 100kg＋MSB-Red (2%), 30min	Confirmation with recipe							
5	Setup for injection operation	Mold	Mold number, Mold conditions	25-018, No abnormality	Visual check, Checklist/trial molding				SOP-Mold Setting SOP-Mold Maintenance	OSS-Mold Setting OSS-Mold check list	Mold Maintenance Report	
		Injection molding machine	Machine number, clamping force, Machine conditions	No.4, 150tonf, No abnormality	Visual check, Checklist/trial molding				SOP-Injection Operation	OSS-Machine Check List	Machine Maintenance Report	
6	Injection operation (injection, gate-cutting, secondary processing, measurement, appearance check)	Injection molding machine	Registered name of standard parameter	Case Top-018	Confirmation with standard parameter sheet					Standard Parameter Sheet	Production Record	
		Mold temperature controller	Temperature	50C	Measurement					OSS-Injection Operation		
		Nipper	Gate protrusion	No protrusion	Visual check							
		Printer	Consistency with specification	Character 5mm	Visual check					OSS-Printing		
		N/A	Appearance	No color defect/spot	Visual check					OSS-Parts Inspection	Parts Inspection Record	
		Caliper (250mm)	Dimension 1, Dimension 2	100±1.5mm, 80±0.8mm	Measurement							
		Weight scale (Max. 1kg)	Weight	25±1.5g	Measurement							
7	WIP storage	N/A	Sorting-out, cleanness	No direct-floor storage, No dust	Visual check					OSS-WIP Storage	WIP Storage Ledger	

2. QC Process Chart

Step of Making of QC Process Chart

1. Decide a format of a QC process chart
2. Understand the target product/part
3. Understand the whole process
4. Set control points and control criteria of each process (“Where” and “What” of 4W1H)
5. Set inspection methods and standards of each process (“When,” “Who” and “How” of 4W1H)
6. Write a QC process chart
7. Issue it as a formal document

The source: The view and How to use of QC process chart. Published by：Nikkan Kogyo Co. Author: Mr.Yuji SOU, Mr.Haruo ABIKO

---

2. QC Process Chart

Step 2: Understand the target product/part

a. Shape and size
(Length, width, height, thickness, inside diameter, outside diameter, depth, etc.)

b. Dimensional accuracy (Tolerance)

c. Weight

d. Material characteristics
(Kind, brand, color, MFI, required heat-proof, strength, hardness, viscosity, etc.)

e. Chemical characteristics
(Corrosion resistance, non-flammability, etc.)

f. Electric characteristics

The source: The view and How to use of QC process chart. Published by：Nikkan Kogyo Co. Author: Mr.Yuji SOU, Mr.Haruo ABIKO

---

2. QC Process Chart

Step 3: Understand the whole process

a. In what order is the product processed?

b. Which part of the product is processed in each process?

c. How is the product processed ?

d. What kind of tools are necessary?
(Machines, equipment, jigs, measuring instrument, etc.)

The source: The view and How to use of QC process chart. Published by：Nikkan Kogyo Co. Author: Mr.Yuji SOU, Mr.Haruo ABIKO

---

2. QC Process Chart

Step 4: Set control points and control criteria of each process

Step 5: Set inspection methods and the standards of each process

Step 4

At what point in the process (where), is the check performed……Where

What characteristics are checked by what criteria……………………..What

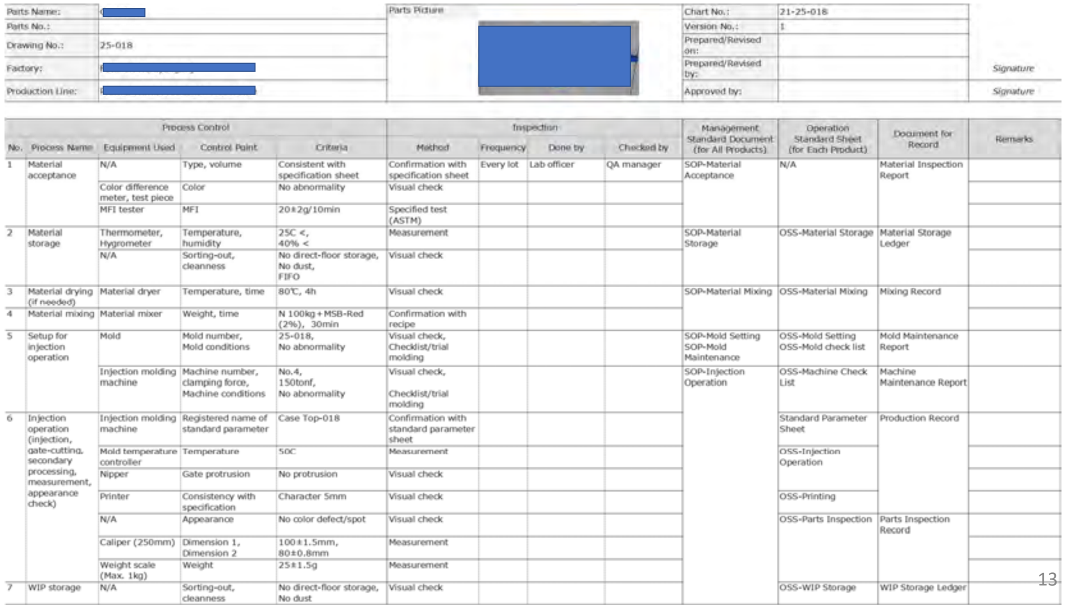
Step 5

When the check is performed…………………………………………………..When

Who perform the check and approves the results……………………… Who

How the check is performed…………………………………………………….How

“4W1H”



Parts Name:	[redacted]	Parts Picture	Chart No.:	21-25-018	
Parts No.:		[redacted]	Version No.:	1	
Drawing No.:	25-018		Prepared/Revised on:		
Factory:	[redacted]		Prepared/Revised by:		Signature
Production Line:	[redacted]		Approved by:		Signature

Process Control					Inspection				Management Standard Document (for All Products)	Operation Standard Sheet (for Each Product)	Document for Record	Remarks
No.	Process Name	Equipment Used	Control Point	Criteria	Method	Frequency	Done by	Checked by				
1	Material acceptance	N/A	Type, volume	Consistent with specification sheet	Confirmation with specification sheet	Every lot	Lab officer	QA manager	SOP-Material Acceptance	N/A	Material Inspection Report	
		Color difference meter, test piece	Color	No abnormality	Visual check							
		MFI tester	MFI	20±2g/10min	Specified test (ASTM)							
2	Material storage	Thermometer, Hygrometer	Temperature, humidity	25C <, 40% <	Measurement				SOP-Material Storage	OSS-Material Storage	Material Storage Ledger	
		N/A	Sorting-out, cleanness	No direct-floor storage, No dust, FIFO	Visual check							
3	Material drying (if needed)	Material dryer	Temperature, time	80℃, 4h	Visual check				SOP-Material Mixing	OSS-Material Mixing	Mixing Record	
4	Material mixing	Material mixer	Weight, time	N 100kg＋MSB-Red (2%), 30min	Confirmation with recipe							
5	Setup for injection operation	Mold	Mold number, Mold conditions	25-018, No abnormality	Visual check, Checklist/trial molding				SOP-Mold Setting SOP-Mold Maintenance	OSS-Mold Setting OSS-Mold check list	Mold Maintenance Report	
		Injection molding machine	Machine number, clamping force, Machine conditions	No.4, 150tonf, No abnormality	Visual check, Checklist/trial molding				SOP-Injection Operation	OSS-Machine Check List	Machine Maintenance Report	
6	Injection operation (injection, gate-cutting, secondary processing, measurement, appearance check)	Injection molding machine	Registered name of standard parameter	Case Top-018	Confirmation with standard parameter sheet					Standard Parameter Sheet	Production Record	
		Mold temperature controller	Temperature	50C	Measurement					OSS-Injection Operation		
		Nipper	Gate protrusion	No protrusion	Visual check							
		Printer	Consistency with specification	Character 5mm	Visual check					OSS-Printing		
		N/A	Appearance	No color defect/spot	Visual check					OSS-Parts Inspection	Parts Inspection Record	
		Caliper (250mm)	Dimension 1, Dimension 2	100±1.5mm, 80±0.8mm	Measurement							
		Weight scale (Max. 1kg)	Weight	25±1.5g	Measurement							
7	WIP storage	N/A	Sorting-out, cleanness	No direct-floor storage, No dust	Visual check					OSS-WIP Storage	WIP Storage Ledger	

---

3. Operation Standard Sheet

---

3. Operation Standard Sheet

Why is Operation Standardization Required?

Because you have to deliver goods to your customer timely, and these goods need to adequately meet product specification specified by the drawing, standards, etc. required by the customer.

You need to establish ways of work that enable anyone to work under the same standard at any time to achieve the same quality and the same work speed. = **Operation Standardization**

---

3. Operation Standard Sheet

What If There is no Operation Standard?

Without operation standards

With operation standards

- Unstable production
- Increase in defect goods
- Occurrence of large inventory
- Cost-up

Every time a worker makes something different.

- Stable production
- No defect goods
- No inventory
- Cost-down

No matter who makes it,
the same quality can be produced.

3. Operation Standard Sheet

Do You Remember How To Be A Genuine World-Class Factory?

In order to manage quality

・Always use the same material
・Always under the same conditions
・Always in the same process
・Always use the same criteria
・Always with no mistakes in measurement
・Always in the same management
・It is always possible to ship the same

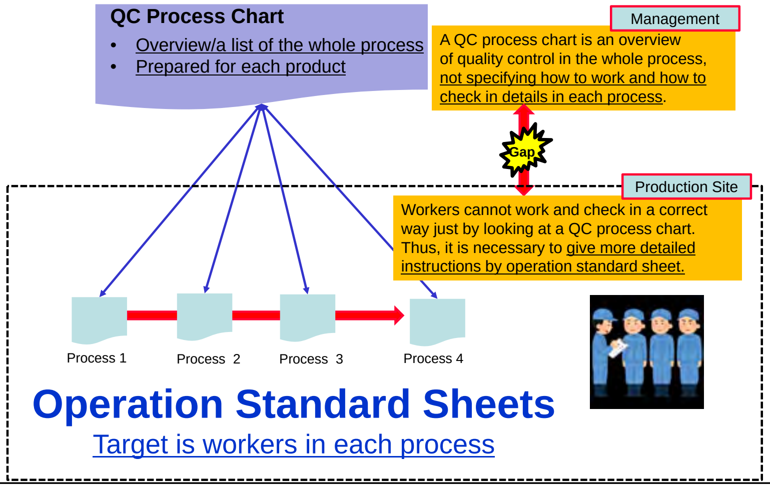
In addition, keeping production records is essential. It enables you to quickly track down its root causes, identify affected products, and minimize loss, danger, and inconvenience of customers, when a problem is found.

Operation Standard Sheets are required to realize a genuine world-class factory.

---

3. Operation Standard Sheet

Difference: "QC Process Chart" vs. "Operation Standard Sheet"



QC Process Chart

- Overview/a list of the whole process
- Prepared for each product

Management

A QC process chart is an overview of quality control in the whole process, not specifying how to work and how to check in details in each process.

Production Site

Workers cannot work and check in a correct way just by looking at a QC process chart. Thus, it is necessary to give more detailed instructions by operation standard sheet.

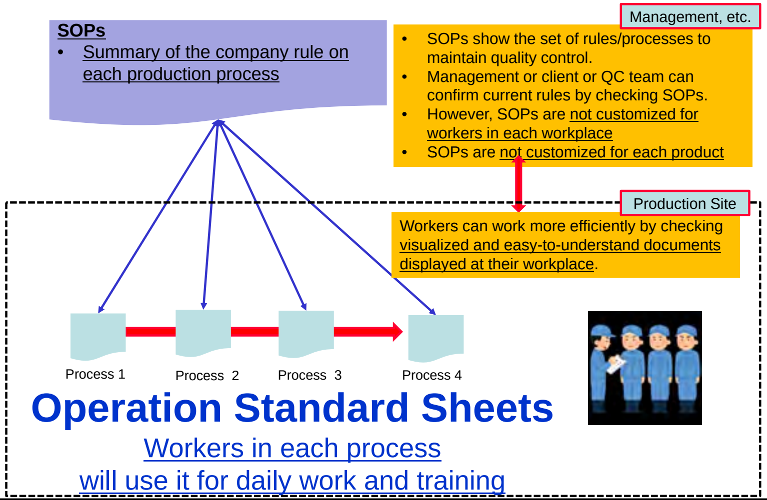
Operation Standard Sheets

Target is workers in each process

---

3. Operation Standard Sheet

Difference: "SOP(Standard Operating Procedure)" vs. "Operation Standard Sheet"



SOPs

- Summary of the company rule on each production process

Management, etc.

- SOPs show the set of rules/processes to maintain quality control.
- Management or client or QC team can confirm current rules by checking SOPs.
- However, SOPs are not customized for workers in each workplace
- SOPs are not customized for each product

Production Site

Workers can work more efficiently by checking visualized and easy-to-understand documents displayed at their workplace.

Operation Standard Sheets

Workers in each process will use it for daily work and training

---

3. Operation Standard Sheet

Operation Standard Sheets Contain the Following Information

1. Product name: name of the product to be processed
2. Product No. and Drawing No: allotted to the product/drawing
3. Process No and Name: transcribed from the corresponding QC process chart
4. Materials and parts: materials and parts to be used in the process
5. Machinery and jigs: machinery / equipment and jigs to be used in the process
6. Work procedures: step-by-step work instructions for the process
7. Key points: key points presented with easy-to-understand diagrams, photos, and illustrations

3. Operation Standard Sheet

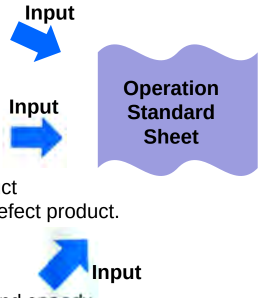
Key Points for Preparation

1. Use simple and easy-to-understand expressions
   Bulletize and explain with clear and concise sentences
2. Visualize
   Use illustrations, photos, etc. to make the message obvious at a glance
3. Use concrete expressions (as opposed to abstractive expressions)
   e.g., - Bad instruction : "set the furnace temperature at 40 ℃
   - Good instruction: "switch the dial A, adjust the bulb C until the instrument B indicates 40 ℃"
   - For sensory inspection: show samples
4. Cover all necessary processes
   Study the preceding process, the target process, and the following processes carefully to prevent omissions between the processes
5. Never insist on perfection in the first draft
   Prepare tentative ones first, and then improve it later on
6. Prepare it as a reference to be used when foremen explain work procedures to operators

---

3. Operation Standard Sheet

Who makes it?



Production engineering department

- How to manufacture
- What kind of machine to use
- What kind of tools & jigs to use
- In what order to manufacture

Quality management department

- Make and build quality into product
- Points to prevent generation of defect product.

Production department

- Best methods that enable easy and speedy manufacturing, etc.

---

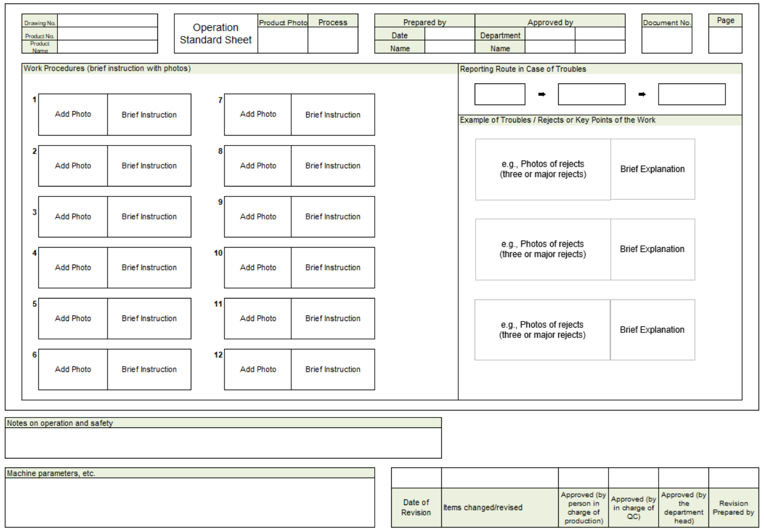
3. Operation Standard Sheet

How to Make Operation Standard Sheets

1. Choose which work/process to set an Operation Standard Sheet
2. Clarify machines/equipment and jigs to be used
3. Clarify work conditions
4. Clarify work sequence of each process
5. Clarify work methods
6. Clarify work speed
7. Create an Operation Standard Sheet by summarizing above information
8. Use/display an Operation Standard Sheet at the workplace and training
9. Revise Operation Standard Sheet regularly, to meet actual condition of the workplace

---

Format for Operation Standard Sheets



Drawing No.
Product No.
Product Name

Operation Standard Sheet | Product Photo | Process

Prepared by: Date, Name | Approved by: Department, Name

Document No.

Page

Work Procedures (brief instruction with photos)

1 Add Photo | Brief Instruction
2 Add Photo | Brief Instruction
3 Add Photo | Brief Instruction
4 Add Photo | Brief Instruction
5 Add Photo | Brief Instruction
6 Add Photo | Brief Instruction
7 Add Photo | Brief Instruction
8 Add Photo | Brief Instruction
9 Add Photo | Brief Instruction
10 Add Photo | Brief Instruction
11 Add Photo | Brief Instruction
12 Add Photo | Brief Instruction

Reporting Route in Case of Troubles

☐ ➡ ☐ ➡ ☐

Example of Troubles / Rejects or Key Points of the Work

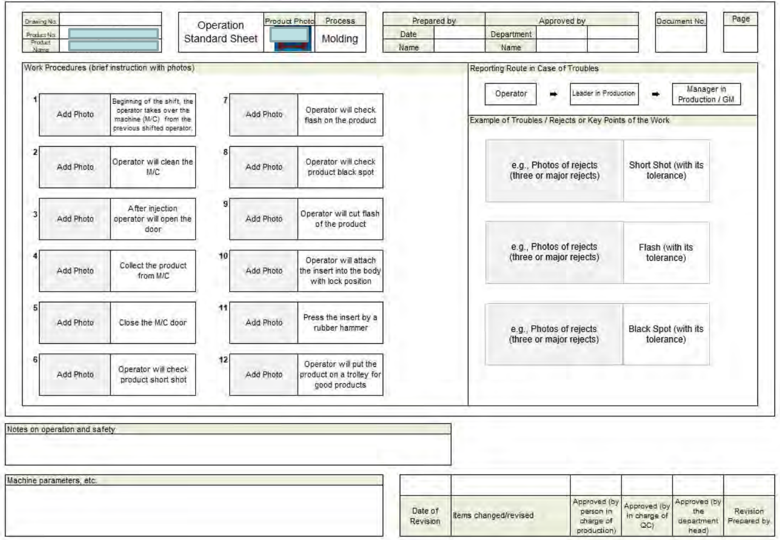
e.g., Photos of rejects (three or major rejects) | Brief Explanation
e.g., Photos of rejects (three or major rejects) | Brief Explanation
e.g., Photos of rejects (three or major rejects) | Brief Explanation

Notes on operation and safety

Machine parameters, etc.

Date of Revision	Items changed/revised	Approved (by person in charge of production)	Approved (by in charge of QC)	Approved (by the department head)	Revision Prepared by

Sample for Operation Standard Sheets (Molding Process)



Drawing No.		Operation Standard Sheet	Product Photo	Process	Prepared by	Approved by	Document No.	Page
Product No.				Molding	Date	Department		
Product Name					Name	Name		

Work Procedures (brief instruction with photos)

1	Add Photo	Beginning of the shift, the operator takes over the machine (M/C) from the previous shifted operator.	7	Add Photo	Operator will check flash on the product
2	Add Photo	Operator will clean the M/C	8	Add Photo	Operator will check product black spot
3	Add Photo	After injection operator will open the door	9	Add Photo	Operator will cut flash of the product
4	Add Photo	Collect the product from M/C	10	Add Photo	Operator will attach the insert into the body with lock position
5	Add Photo	Close the M/C door	11	Add Photo	Press the insert by a rubber hammer
6	Add Photo	Operator will check product short shot	12	Add Photo	Operator will put the product on a trolley for good products

Reporting Route in Case of Troubles

Operator ➡ Leader in Production ➡ Manager in Production / GM

Example of Troubles / Rejects or Key Points of the Work

e.g., Photos of rejects (three or major rejects)	Short Shot (with its tolerance)
e.g., Photos of rejects (three or major rejects)	Flash (with its tolerance)
e.g., Photos of rejects (three or major rejects)	Black Spot (with its tolerance)

Notes on operation and safety

Machine parameters, etc.

Date of Revision	Items changed/revised	Approved (by person in charge of production)	Approved (by in charge of QC)	Approved (by the department head)	Revision Prepared by

---

Remarks:

অপারেশন স্ট্যান্ডার্ডাইজেশন সম্পর্কে আমাদের মন্তব্য

There is no improvement without the standard!!
স্ট্যান্ডার্ড ছাড়া উন্নতি করা সম্ভব নয়

(1) QC Process Charts and Operation Standard Sheets are the very basis for workers' operation. If an accident occurs while an operator works as per such the standards, **you should not blame the operator, but should know that the standards have some faults**.

১। কিউসি প্রসেস চার্ট এবং অপারেশন স্ট্যান্ডার্ড শিট হলো ওয়ার্কারের কাজ করার ভিত্তি । একজন অপারেটর যখন এই ধরণের স্যান্ডার্ড মেনে কাজ করে তখ কোনো দুর্ঘটনা ঘটলে **অপারেটর কে দোষারোপ করা উচিত নয় বরং এটা বুঝতে হবে যে স্যান্ডার্ড এ কোনো ত্রুটি আছে।**

(1) Before blaming the operator who caused the accident, you need to clarify whether there are problems in the standards and **improve them first.**

২। যে অপারেটর এক্সিডেন্ট করেছে তাকে দোষারোপ করার আগে, আপনাকে ক্লারিফাই বা স্পষ্ট করতে হবে যে স্ট্যান্ডার্ড এ কোনো সমস্যা আছে কিনা এবং থাকলে **সেটা আগে ঠিক বা উন্নত করতে হবে**।

mustn't be done (একেবারেই করা যাবেনা)

must be done (করতেই হবে)

Only these two exist (শুধু এই দুইটা অপ্‌শন-ই থাকবে)

Clarify these in the operation standards!! অপারেশন স্ট্যান্ডার্ডে এই বিষয়ে গুলো স্পষ্টভাবে উল্লেখ করুন !!

Remarks:

অপারেশন স্ট্যান্ডার্ডাইজেশন সম্পর্কে আমাদের মন্তব্য

It is more important to practice the standards than creating them!!
স্ট্যান্ডার্ড তৈরী করার চেয়ে প্রাকটিস বা চর্চা করা বেশি গুরুত্বপূর্ণ

(1) Teach operators one by one how to work and check according to standards very deeply!!
Make an education/training record for each worker.
প্রত্যেক অপারেটর কে একজনের পর আরেকজন এভাবে খুব ভালো ভাবে প্রশিক্ষণ দিন যে কিভাবে স্ট্যান্ডার্ড অনুযায়ী কাজ করতে হয়ে এবং সেটা স্ট্যান্ডার্ড অনুযায়ী চেক করুন। প্রত্যেক ওয়ার্কার এর জন্য একটি শিক্ষা/ প্রশিক্ষণ রেকর্ড তৈরী করুন।

(2) Train them until standards are soaked into their body!!
Train them repeatedly until standards become their real standards.
যতক্ষণ পর্যন্ত আত্মস্থ না হয় ততক্ষন পর্যন্ত প্রশিক্ষণ দিতে থাকুন ।
যতক্ষণ পর্যন্ত না এই স্ট্যান্ডার্ড ই তাদের আসল স্যান্ডার্ড এ পরিণত না হয় ততক্ষন পর্যন্ত প্রশিক্ষণ দিতে থাকুন।

(3) Observe whether the standards are complied correctly!!
Rectify the standards if problems happen.
স্ট্যান্ডার্ড গুলি সঠিক ভাবে একত্রিত বা সংকলন করা হয়েছে কিনা তা পর্যবেক্ষণ করুন।
সমস্যা হলে স্ট্যান্ডার্ড গুলোকে সংশোধন করুন।

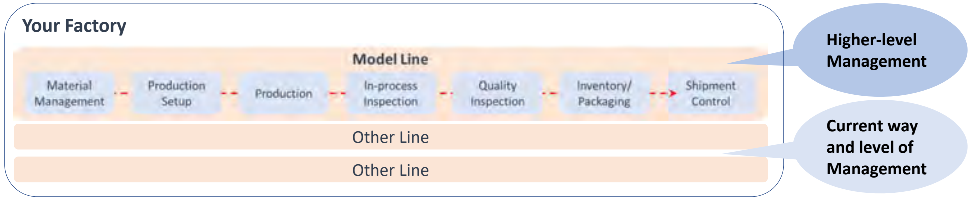
Operation standardization never ends, it is a continuous cycle of improvement!!
অপেরেশনের স্ট্যান্ডার্ডাইজেশন কখনই শেষ হয় না, এটি একটি ক্রমাগত উন্নতির ধারা/চক্র !!

What is "Model Line"?

A World-class Model Production Line ("**Model Line**") is a separate production line to practice higher-level production/quality management system that meets requirement of world-class manufacturers (future target customers) like TOYOTA, HONDA, BMW, etc.

The model line is also a model that can be applied to other production lines in your factory in future so that your factory will be able to develop in an overall manner.

The current concept of the model line is basically meant for large companies. But, it can also be applied to SMEs by adjusting target customers. It does not have to be the "World-class."



Your Factory

Model Line

Material Management - - Production Setup - - Production - - In-process Inspection - - Quality Inspection - - Inventory/ Packaging - - Shipment Control

Other Line

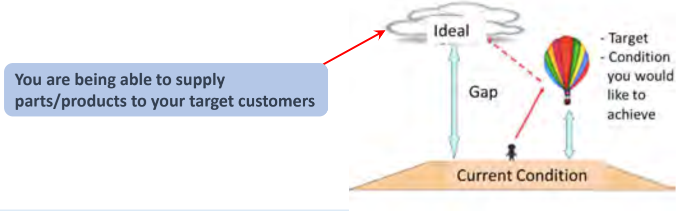
Other Line

Higher-level Management

Current way and level of Management

Principle Concepts of "Model Line" (1)

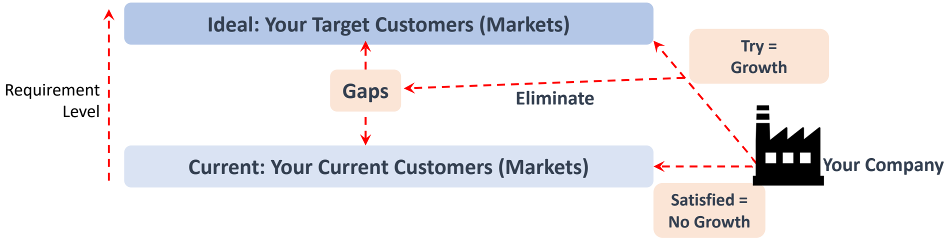
1. The most fundamental concept of a model line is to eliminate **gaps** between the ideal situation and the current situation.
2. The **ideal situation** in near future (1 to 3 years from now) is the situation where you are being able to supply parts/products to your target customers.
3. The **current situation** is literally the situation/conditions of your factory at present.
4. A successful model line is the one that has realized the ideal situation.



You are being able to supply parts/products to your target customers

Principle Concepts of "Model Line" (2)

5. The **target customers** should be the ones which require the higher-level requirements than your current customers. No need to be the "World Class" customers; it should be adjusted to your current level.
6. No try for higher-level customers, no growth ever happening to your company (Satisfaction with your current markets would never generate the growth).



Ideal: Your Target Customers (Markets)

Requirement Level

Gaps

Eliminate

Try = Growth

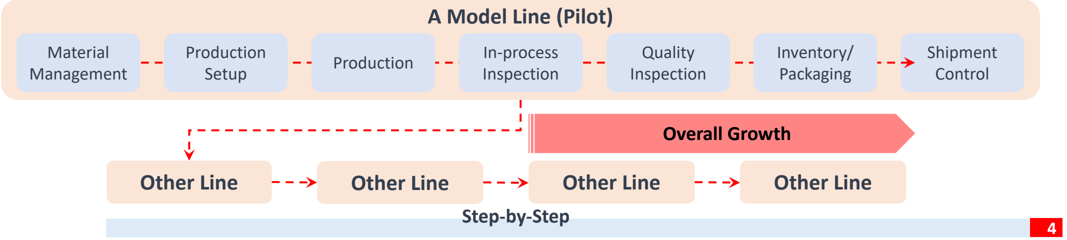
Your Company

Current: Your Current Customers (Markets)

Satisfied = No Growth

Principle Concepts of "Model Line" (3)

7. A model line is a **pilot project** to start with just one production line; a step-by-step approach by means of your current resources as much as possible. A success in one pilot project will enable you to extend the model line to other lines, which will then lead to your overall growth.
8. A model line is a pilot in a small scale, but it should be a **full-set approach**. In other words, the whole processes from material management to shipping should be completed in one model line.



A Model Line (Pilot)

Material Management - - Production Setup - - Production - - In-process Inspection - - Quality Inspection - - Inventory/ Packaging - - Shipment Control

Overall Growth

Other Line - - **Other Line** - - **Other Line** - - **Other Line**

Step-by-Step

Background of Establishing “Model Line”

1. **To know a “genuinely-good product”**
    - ➢ A company often thinks that their products are the best in the current market. Such a company does not try to see a genuinely-good product existing both in the current market and in the other markets. After all, no growth will come about.
2. **To know the difference between “what you know” and “what you can do”**
    - ➢ A company often thinks that they can do what they know how-to. In fact, they cannot do it just by knowing how-to. They need “real practice” at site like at the model line.
3. **To know “outside your territory”**
    - ➢ Often, an operator, maintenance worker, inventory worker, QC officer, etc. and even a factory manager or top management only know his own work process. Yet, each element of the production/quality management is closely linked together. Thus, every person involved in the production/quality management needs to work together. A full-set approach like the model line is important.

Step of Establishing “Model Line”

1. Clarify your ideal situation (Identify your target customers).
2. Try to know requirements of your target customers as much as possible.
3. Clarify gaps between the requirements and your current situation.
4. Clarify what gaps to eliminate mainly by your current resources as well as by a little new investment.
5. List up the activities to eliminate these gaps with an activity schedule.
6. Select “model products” as a pilot to perform these activities.
7. Set the layout of the model line from material management to shipping processes.
8. Implement and continuously improve the activities of 5 above (= Establish a model line).
9. If successful, extend the model line to other production line(s).

Step 2: Try to know requirements of your target customers as much as possible

It is quite difficult to know requirements of target customers because they are just a hypothesis customer. But, try your best to know them as much as possible by, for example:

- ➢ Try first to get acquainted with your target customer, though it may be difficult.
- ➢ Check their website thoroughly to know their vision, mission, history, business portfolio, current market, current customers, etc.
- ➢ Buy their products as a sample and study, for example, appearance quality, materials, color, dimension, weight, thickness, jointing parts, and many others. If possible, buy 10 or more samples to know their allowable tolerances.
- ➢ Compare their products and your similar products to know difference in quality between them.
- ➢ Talk, if possible, with <u>their</u> current suppliers to know the requirements in detail.
- ➢ Talk, if possible, with <u>your</u> current customers selling the similar products to your target customers in order to know difference in requirements between them.

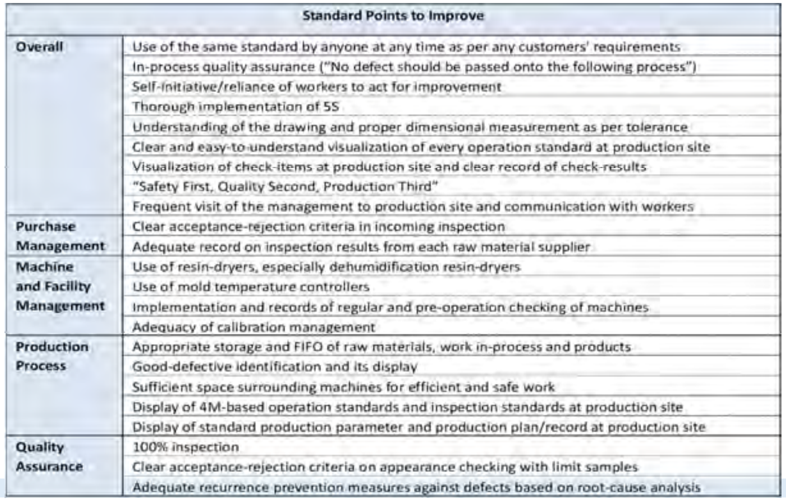
Step 3: Clarify gaps between the requirements and your current situation

This is a sample of gap-finding:

Category	**Challenges**
1) Overall	Insufficient experience of producing engineering goods
2) Purchase Management	Unclear acceptance-rejection criteria in incoming inspection
	Inadequate record on inspection results from each raw material supplier
3) Machine and Facility Management	Use of hot air resin-dryers, not dehumidification resin-dryers
	Inadequate use of mold temperature controllers
	Unclear standard parameters set for each molding machine
	Inadequacy of implementation and records of regular checking and pre-operation checking of molding machines and other equipment
	Insufficient measuring instruments, specially coordinate measuring machines/3D scanners
	Inadequacy of calibration management
4) Molding Process	Inappropriate storage of raw materials, work in-process and products
	Weak unit control (good-defective identification, before-after operation) and its display
	Subtle scars found on many products (issues in mold hardness and surface roughness)
	Insufficient space surrounding molding machines causing difficulty to do inspection and packing of products nearby the machines
	Little display of operation standards and inspection standards at production site
	Little display of tables for standard molding conditions and planned production volume
	Little display of data of raw materials (type, color, grade, etc.) used in molding machines
5) Quality Assurance	Only sample inspection by QC section with loose AQL* after 100% inspection by workers
	Unclear acceptance-rejection criteria on appearance checking with no boundary samples
	Inadequate recurrence prevention measures against defects based on root-cause analysis
	Inadequacy of dimensional measurement (lack of recognition of dimensional tolerance)
	Inadequate first-article inspection before mass production
6) Others	Excessive inventory (especially that of raw materials)
	Inadequate cost management aiming for achieving target costs

Step 4: Clarify what gaps to eliminate by both your current resources and new investment

This is a sample of gaps to be eliminated:



Standard Points to Improve	
Overall	Use of the same standard by anyone at any time as per any customers' requirements
	In-process quality assurance ("No defect should be passed onto the following process")
	Self-initiative/reliance of workers to act for improvement
	Thorough implementation of 5S
	Understanding of the drawing and proper dimensional measurement as per tolerance
	Clear and easy-to-understand visualization of every operation standard at production site
	Visualization of check-items at production site and clear record of check-results
	"Safety First, Quality Second, Production Third"
	Frequent visit of the management to production site and communication with workers
Purchase Management	Clear acceptance-rejection criteria in incoming inspection
	Adequate record on inspection results from each raw material supplier
Machine and Facility Management	Use of resin-dryers, especially dehumidification resin-dryers
	Use of mold temperature controllers
	Implementation and records of regular and pre-operation checking of machines
	Adequacy of calibration management
Production Process	Appropriate storage and FIFO of raw materials, work in-process and products
	Good-defective identification and its display
	Sufficient space surrounding machines for efficient and safe work
	Display of 4M-based operation standards and inspection standards at production site
	Display of standard production parameter and production plan/record at production site
Quality Assurance	100% inspection
	Clear acceptance-rejection criteria on appearance checking with limit samples
	Adequate recurrence prevention measures against defects based on root-cause analysis

---

Step 5: List up the activities to eliminate these gaps with an activity schedule

This is a sample of activities:

Work				Started on	Progress	Finish by
1	Setting-up of Model Line	1-1	Install all machines and equipment as per the final layout			
		1-2	Implement and maintain "**complete 3S**"			
		1-3	Maintain "**safe**" and "**efficient (easy to move)**" production line			
		1-4	Select and produce 3 **model products**			
		1-5	Complete management of materials, molds, machines, quality and packaging along the model line			
2	Constitution of Model Line Team	2-1	Assign "**committed**" model line members from regular employees			
		2-2	Provide a "**special uniform**" for model line members			
		2-3	Conduct **training** to model line members with management's commitment			
		2-4	Create an "**organization chart**" with face pictures of model line team			

Step 5: List up the activities to eliminate these gaps with an activity schedule

Continued:

Work				Started on	Progress	Finish by
3	Establish Responsible Production and Quality Management System **(Change from quantity-oriented to quality-oriented: *No defective goods to be shipped outside!!*)**	3-1	Make and manage "**drawings**" for 3 model products			
		3-2	Prepare and visualize a "**QC Process Chart**" for each model product			
		3-3	Prepare and visualize "**operation standard sheets**" for all the process from material acceptance to shipping			
		3-4	Prepare and visualize "**standard molding conditions (parameter) table**" for 3 model products			
		3-5	Prepare and visualize "**inspection standard sheets (check-sheets)**" for all the processes			
		3-6	Prepare "**record formats**" for all the processes			
		3-7	Install mold temperature controller and resin dryer			

Step 6: Select "model products" as a pilot to perform these activities

Select, from your current products, two or three model products as a pilot to perform the model line activities:

- ➢ Choose the products which are similar in size, color, shape, assembly structure, etc. to products of your target customers.
- ➢ Choose your main products (large production volume) so that you can perform model line activities fully.

Step 8: Implement and continuously improve the activities of 5 above (= Establish a model line)

This is an implementation and continuous improvement period for the activities identified by Step 5. It is a long-term activities. Essential points are "Start from what you can do now," "Learn by doing," and "Improve by learning."

The activities should vary from one company to another. Yet, most likely, the following will come up in many companies, because these are the very basis of the manufacturing.

- Maintenance of complete safety (**Safety First**!)
- Management of products and **proper measuring based on drawings**
- Implementation of **5S or 3S**
- **Operation standardization** by various standard documents
- Optimization of production conditions to **reduce defects**
- **Visualization** (Visual control)
- Compliance with the "**Always Principles**" (Next Slide)

Apply the "Always Principles"!!

- Always **safety first**
- Always maintain workplace **clean and efficient**
- Always use the **same materials**
- Always under the **same conditions**
- Always in the **same process**
- Always use **the same criteria**
- Always **no mistakes in measurement**
- Always in the **same management**
- Always **ship the same quality product**
- Always **keep records** on everything
- Always in **appropriate cost**

For Success in Model Line

1. Involve everyone for changes and trials

- Generate awareness and responsibility in the model line members whereas making them a role model for the others
- Use a model line activities as an effective opportunity for human development at high level.

2. Set good examples from the top and promote spontaneous actions in the model line

- Change the mind-set of everyone including top management; everyone needs to be proactive (find and try to address problems on their own)
- Create a mechanism to encourage the initiative ("QC circle" activity, suggestion system, etc.)

3. Promote initiative of employees for changes and reforms

- Let them identify and address long-term issues as well as imminent ones

4. Be open for employees' suggestions for improvement

- Show the "course of direction" of the company, encourage employees to raise problems, and listen to them sincerely

---

Before-After Comparison

Quality Control through Elimination of Variation and Improvement Measures

Prepared by Naoya Nishigaki
(Expert, JICA Project Team)

Lectured by Mohammad Jafar Ikbal
(Senior Assistant, JICA Project Team)

14 December 2021
SME Foundation

Contents

---

1. Introduction

Many people feel that quality management is difficult. But you can simply do it if you understand why defects occur.

Why do defects occur? It is largely because there is "**variation.**"

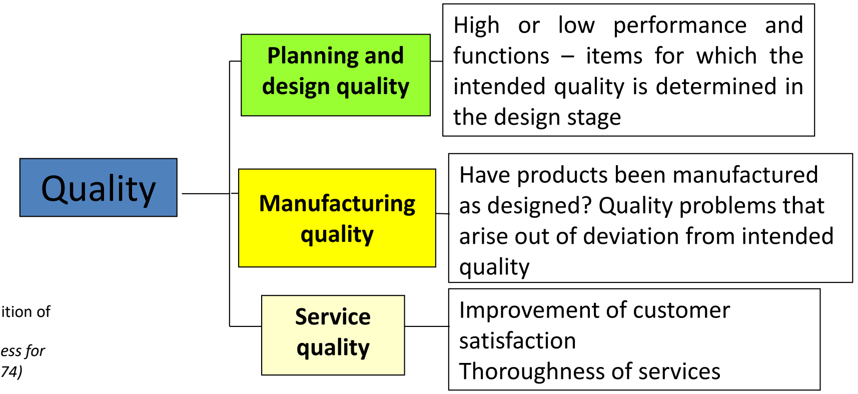
Thus, you can reduce defects if you can reduce the variation. What is variation? Why does it happen? How can we reduce it?

The first step for the quality management is to answer these questions.

In this lecture, you will learn fundamental knowledge about the variation, and at the same time, you will learn how to perform the quality management to reduce it. Eventually, it will contribute to producing high-quality products which is made possible by the basic quality management activities.

---

2. Three Elements of Quality



Quality

Planning and design quality

High or low performance and functions – items for which the intended quality is determined in the design stage

Manufacturing quality

Have products been manufactured as designed? Quality problems that arise out of deviation from intended quality

Service quality

Improvement of customer satisfaction
Thoroughness of services

Source: Definition of Quality
Quality is fitness for use (Juran 1974)

The primary objective of quality management is to adequately realize the intended quality.

3. What is Variation?

(1) Variation is a cause of nonconforming (NC) products

If all manufactured products were identical, the NC rate would be either 100% or 0%.
However, the NC rate never comes down to this way. This is due to variation.
Variation arises in products because something changes.

Even if you have purchased the same materials, they contain something different.
Machine conditions are unequal even among the same machines.
It is very difficult for a worker to work in the same way at any time.
That is why production conditions vary.
Then, that is why quality varies; meaning that defects occur.

Thus, the reason why defects occur is because the variation exists.
The variation comes up easily even if a factory tries to produce the very same product.
Making products the same through eliminating the variation is the basic idea of the quality management.

---

(2) Methods for reducing variation = Not by inspection

Think about "why inspection is conducted." If you do not perform inspection, defective goods are shipped out and you may lose the huge amount of money. The objective of inspection is to prevent defects from going outside.

However, inspection could not be necessary. Inspection is to confirm the quality only at one point. Rather, quality should be assured by other processes, not by inspection. The quality management is not the inspection. Inspection is not necessary if good products are made in the preceding processes.

You can say that the ultimate aim of the quality management is to eliminate inspection.
Yet, please note that we are NOT recommending you to skip the inspection.
Rather, **you should try your best to assure the quality before the inspection process as much as possible (in-process quality management)**.

---

4. Factors of Variation

Variation has 5 factors (“4M” + “5S”).

Materials or raw materials (Material)
Processing method (Method including measurement)
Machine (Machine)
Man (Man)
Environment (5S)

It is absolutely impossible to make the same goods from different 4M and environment (5S).

Variation has the five factors indicated above.
However, these five factors in each possess creates a certain degree of unavoidable variation.
Such variation is referred to as “uncontrollable variation.”

◆ **Variation in 4Ms**

- **When people change**
- **When machines change**
- **When materials change**
- **When method changes**

◆ **Variation in First Articles (in case of mass production)**

- **When people change**
- **Restarting after a break**
- **When changing shift**
- **Start of week**
- **When starting after a model change**
- **When the materials lot changes**
- **When equipment changes**
- **When jigs change**
- **When mold changes**
- **When restarting after an equipment failure (after inspection)**

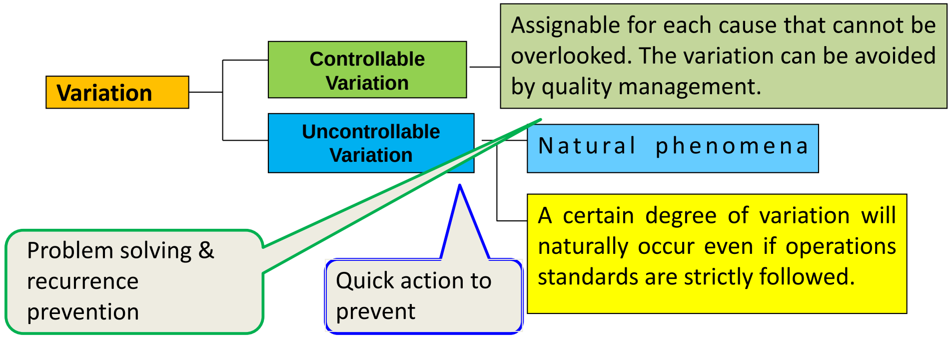
◆ **Variation in Final Products**

When work is finished or suspended on a lot that has undergone first products inspection

◆ **Variation in Operating Methods**

- **When there is nonconformity in the first article inspection, immediately stop the work and adjust machinery, etc.**
- **When there is nonconformity in the final inspection, immediately freeze the lot in question and check all the products.**

5. Elimination of Variation



Variation

Controllable Variation

Assignable for each cause that cannot be overlooked. The variation can be avoided by quality management.

Uncontrollable Variation

Natural phenomena

A certain degree of variation will naturally occur even if operations standards are strictly followed.

Problem solving & recurrence prevention

Quick action to prevent

There are many causes of the variation or quality defects.
The question is the degree of "contribution" to it.
While you can ignore small contributions, you need to tackle a few of the biggest contributions.

The quality management is successful by taking the following three steps.

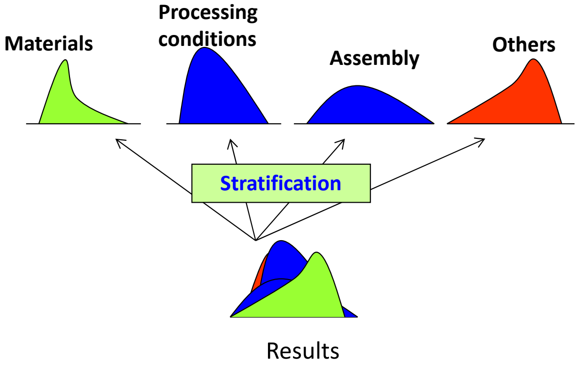
1. Find a few causes of the biggest contribution (**Process Analysis (Prioritization)**)
   Arrest a criminal of the variation.
2. Decide the normal range of variation **(Standardization)**
   Make a cage to trap the criminal.
3. Watch carefully so that variation can always be within the range (**Process Control**)
   Never let the criminal escape.

Standardization can capture the criminal in the cage; making it impossible for him to escape by monitoring (watching).
A factory should be controlled like this.
This is the quality management.

Process analysis (Prioritization) … Identify the prime causes of the quality variation.

Standardization … Keep the causes of the big contribution to a narrow scope for quality stabilization as much as possible.

Process control … Monitor so that the causes do not extend beyond a set scope. (Control chart or Shewhart chart was devised in 1924 by Walter Shewhart).



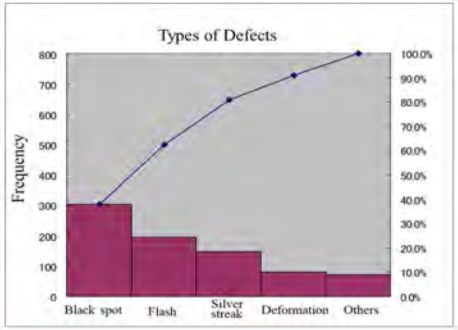
---

6. Process Analysis (Prioritization)

- ✓ There exist numerous and various problems (causes) at the workplace related to quality variation.
- ✓ To efficiently eliminate these causes by limited resources, it is crucial to sort out priorities.
- ✓ An effective method for this is a "**Pareto chart.**"
- ✓ Eliminating the causes with low frequency (multi-minor items) requires enormous efforts though its effect is small.
- ✓ On the contrary, the causes with high frequency (fewer but major items) are relatively easy to reduce, and its effect is big.
- ✓ In other words, you should focus on the selected targets to achieve greater results.
- ✓ A Pareto chart is widely used in the quality management activities.

Source: How to operate QC circle activities (second edition) edited by QC circle Headquarters , JUSE

Pareto Chart



- ✓ A Pareto chart is useful for highlighting the most important among a set of factors (causes) and which factors (causes) to address first as well as knowing how much improvement effect can bring about.

Use

With a Pareto chart, you can:

- ✓ Identify causes of problems
- ✓ Identify which causes to focus on
- ✓ Identify the degree of impact each causes poses
- ✓ Confirm effect of countermeasures

Pareto Chart

Data table

(1) Data table is necessary for drawing a Pareto chart.

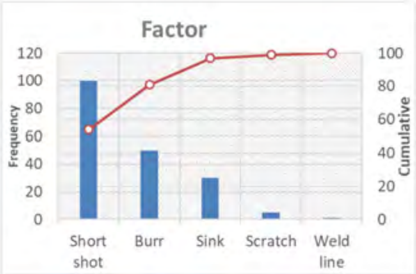
(2) Necessary data items are: factor, frequency, order of frequency, cumulative sum of frequency, percentage and cumulative percentage.

(3) Arrange factors in descending order.

(4) Appropriate number of factors is between 5 and 10 (not too many or not too small).

(5) Calculate percentage, cumulative sum, and cumulative percentage.

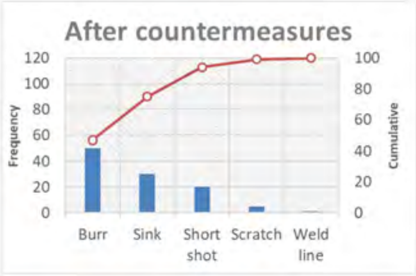
Order	Factor	Frequency	%	Cumulative sum	Cumulative %
1	Short shot	100	54	100	54
2	Burr	50	27	150	81
3	Sink	30	16	180	97
4	Scratch	5	3	185	99
5	Weld line	1	1	186	100
Total		186	100		



Pareto Chart

How to draw a Pareto Chart

- ✓ Determine data categories (factors to classify data)
  - *Category examples: defect (cause) type, place, # of defect by machine*
  - *Data examples: # of rejects, # of defects, time*
- ✓ Determine from when to when to collect data, and record data
- ✓ Aggregate data by data category
- ✓ Draw a two-axis graph composed of a bar chart (frequency in descending order) and a line chart (cumulative percentage)



---

7. Standardization

Determine rules (standards) and apply them among everyone concerned.

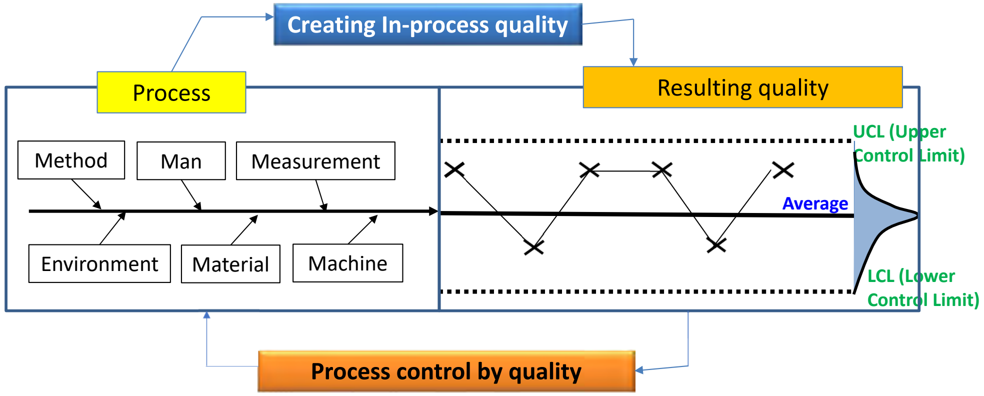
Visualization (documentation)

Education & Training

When nonconformities occur, the causes can be defined as follows in terms of standardization:

1. Standards were not defined.
2. Standards were defined; however, they were defined inadequately.
3. Standards were good but they were not applied properly.

It is too late once problems, such as defective products or serious accidents, have occurred. It is important to standardize and control processes in advance. If any problem occurs, the process should be reviewed strictly and the standards should be corrected to enhance quality of work.



Source: How to operate QC circle activities (second edition) edited by QC circle Headquarters , JUSE

Control Chart

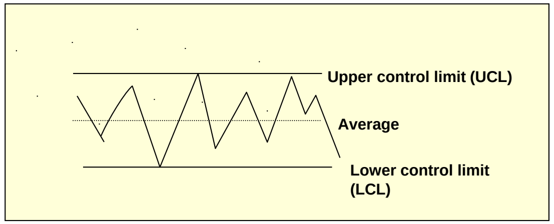
Control chart is useful for tracking changes to detect unusual behavior.

(1) Variations are caused by:

1) Chance

2) Something unusual and irregular

(2) Control charts help you to distinguish 1) and 2).



Control Chart

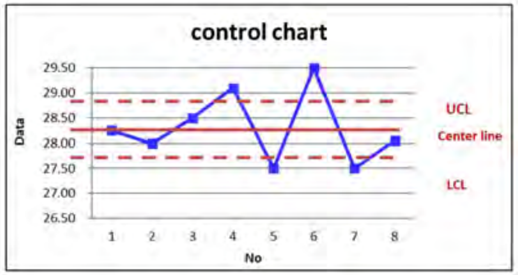
Use

With a control chart, you can:

- Identify where specification limits are
- Monitor whether a control parameter oversteps a specification limit
  - ✓ Goods whose parameter oversteps a limit are rejects.
  - ✓ Monitoring helps you to control the parameter within the limits.

You have to take countermeasures when the control parameter oversteps a specification limit.

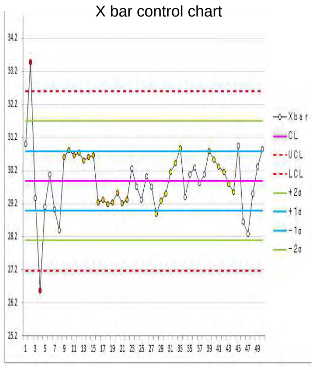
No	Data
1	28.25
2	27.99
3	28.5
4	29.1
5	27.5
6	29.5
7	27.5
8	28.05



Control Chart

How to read a control chart

Out of Control Signal	Action
(1) A point oversteps a control limit	Look for causes and take countermeasures.
(2) A run of 7 points in a row are on the same side of the centerline	Look for causes, because the phenomenon suggests that the condition (average, variation, etc.) might change. Searching for causes might give you useful technical insight.
(3), but 2 out of 3 consecutive points falling between the control limits fall on the same side of the centerline and also on the furthest 1/3 from the centerline	Need careful monitoring, because it suggests variations have become larger.
(4) When points move in an consistent and persistent pattern (move cyclically or move in the same direction)	Look for causes, because something leads to the pattern.



- ✓ A process is under control when neither of the phenomena presented above occur for 25 or more consecutive data period.
- ✓ Collect around 100 data of a parameter, and draw a control line.
- ✓ Use a solid line for the centerline, broken lines for the upper and lower control limits (UCL and LCL).

9. Measurement Management

The “base” of the quality management is the “measurement management.”

If the product is measured by wrong method or inaccurate instruments, the reliability of the product quality might be lost.

Therefore, it is necessary to select optimum measurement methods and to assure accuracy of measuring instruments.

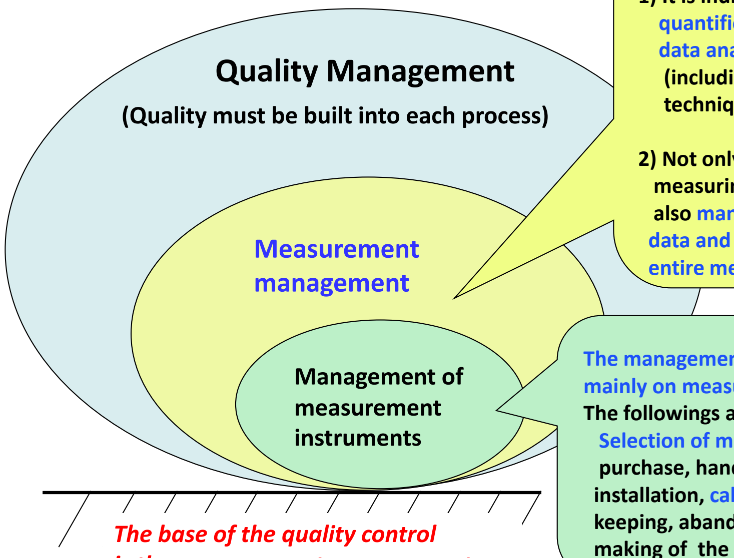
Needles to say, it is more important to use the measured data for the quality assurance.

What is measurement management ?

What is management of measurement instruments ?

What is measurement management ?

What is management of measurement instrument ?



- Work to support the entire manufacturing engineering

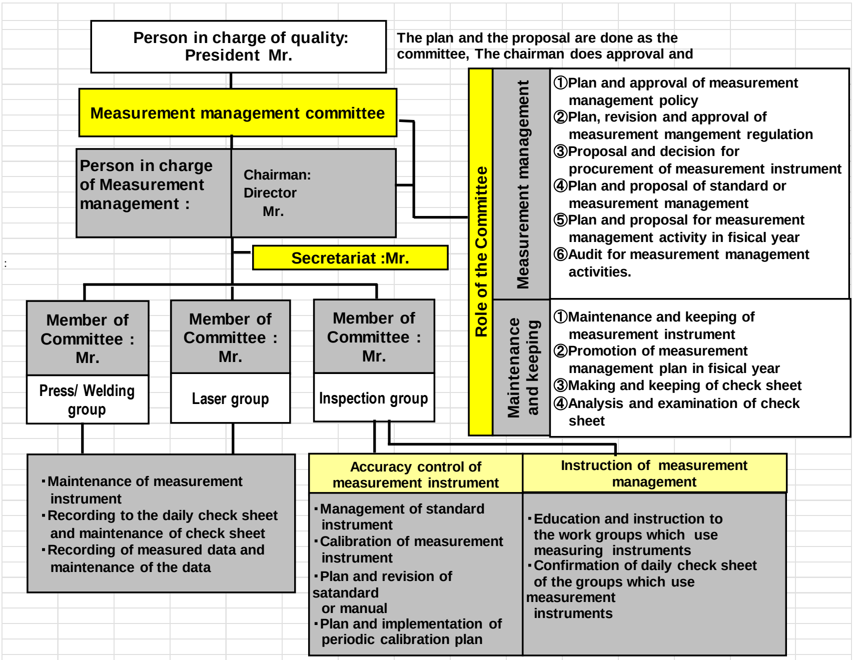
1) It is indispensable to make quantification of data and data analysis.
(including SQC or QC techniques that uses data)

2) Not only management of measuring instruments but also management of measured data and management of entire measurement system

The management which is done mainly on measurement instruments. The followings are contained.
Selection of measuring instrument, purchase, handling method, installation, calibration, repair, keeping, abandonment and also making of the handling manuals

The base of the quality control is the measurement management.

Measurement Management Organization inOO Co.



Person in charge of quality:
President Mr.

The plan and the proposal are done as the committee, The chairman does approval and

Measurement management committee

Person in charge of Measurement management :
Chairman: Director Mr.

Secretariat :Mr.

Member of Committee : Mr.	Member of Committee : Mr.	Member of Committee : Mr.
Press/ Welding group	Laser group	Inspection group

Role of the Committee

Measurement management
①Plan and approval of measurement management policy
②Plan, revision and approval of measurement mangement regulation
③Proposal and decision for procurement of measurement instrument
④Plan and proposal of standard or measurement management
⑤Plan and proposal for measurement management activity in fisical year
⑥Audit for measurement management activities.

Maintenance and keeping
①Maintenance and keeping of measurement instrument
②Promotion of measurement management plan in fisical year
③Making and keeping of check sheet
④Analysis and examination of check sheet

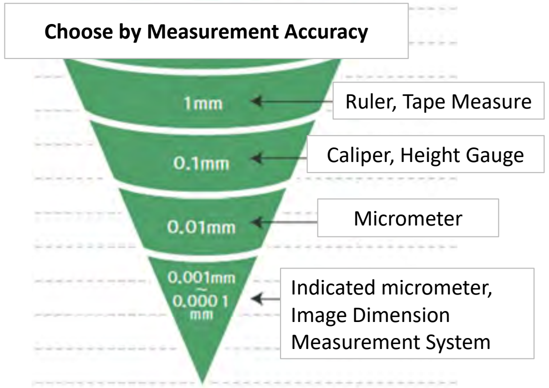
- Maintenance of measurement instrument
- Recording to the daily check sheet and maintenance of check sheet
- Recording of measured data and maintenance of the data

Accuracy control of measurement instrument	Instruction of measurement management
・Management of standard instrument ・Calibration of measurement instrument ・Plan and revision of satandard or manual ・Plan and implementation of periodic calibration plan	・Education and instruction to the work groups which use measuring instruments ・Confirmation of daily check sheet of the groups which use measurement instruments

---

For your Reference: Appropriate Measurement Instruments

Choose by Measurement Accuracy



1mm	Ruler, Tape Measure
0.1mm	Caliper, Height Gauge
0.01mm	Micrometer
0.001mm 0.000 1 mm	Indicated micrometer, Image Dimension Measurement System

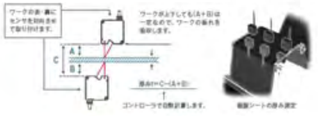
Till now: Sample inspection by calipers/micrometers

Frequent Problems
- Measurement differs by
- Difficulty to identify sudden abnormality and the change over time

Frequent Needs
- Improve accuracy and eliminate human error
- Speed up measurement with less frequency
- Save data in PC/PLC
- Make it possible by anyone

Suggestion: Non-contact measurement for in-line full-length inspection

Measurement by Reflective Laser Displacement Sensor



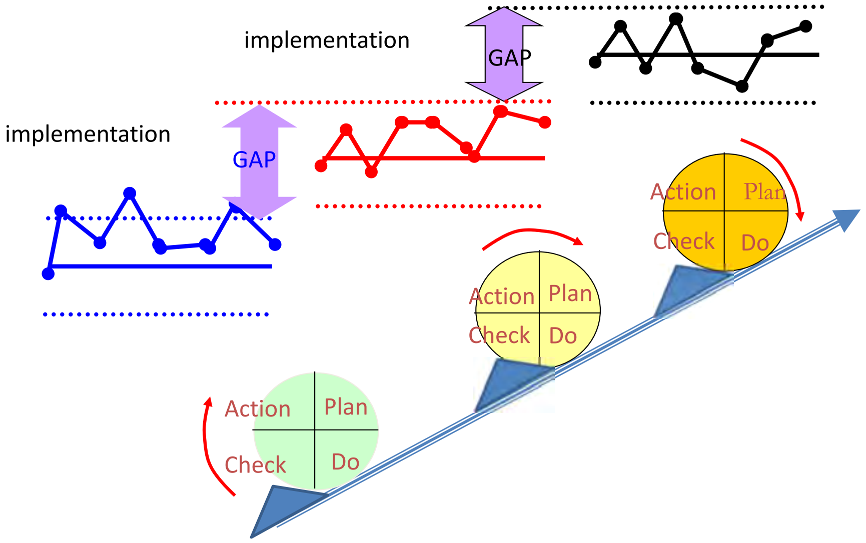
10. How to Advance Improvement

Cases where work needs to be improved:

1) When nonconformities are found in inspections or complaints arise from customers, and the cause lies in variation in manufacturing.

2) When the process control is amply stable; however, the quality level required by the customer increases or rivals launch competing products.

PDCA Cycle



Next Process is Your Customer

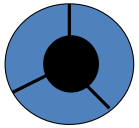
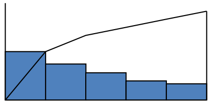
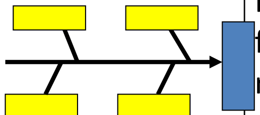
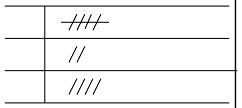
- Always keep in mind that the next process is your customer.
- “The next process” means a department/division or person receiving the results of your work or those affected by your work.
- “The next process is your customers ” means assuring the quality of your process to increase satisfaction in the next process by checking what or who is in the next process and always bearing in mind the effects on the end-user.
- Always think closely about:
  - What is required by the next process?
  - What should be done to satisfy the needs of the next process?
  - Is the next process satisfied with the outcome of your work?

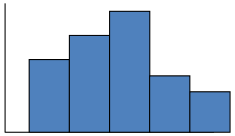
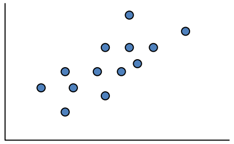
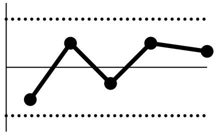
QC story

QC story proceeds with the problem solving along the following 7 steps.

1) Select the theme
2) Analyze the current situation
3) Setting the target
4) Analyze the cause
5) Considering the countermeasure and implementation
6) Confirming the effectiveness
7) Standardization

Major QC methods (7 QC Tools)

Graphs (Pie graph, bar graph, and line graph)		Visualize the data. Understand the meaning of the numbers.
Pareto Diagram		Identify, from among many challenges, which ones would be the most effective to solve.
Cause and effect diagram		Identify and reorganize factors to discover the relationship between cause and result.
Check sheet		Preparing a table to tabulate the data.

Histogram		Compare against the specification, on the basis of variations in data and clarification of distribution.
Scatter diagram		Clarify the correlation, based on a comparison of conjugated twin data.
Control chart		Check that the process is stable and there is no possibility of abnormalities occurring.

5.　カイゼン導入・普及支援プログラム（プラン 4）教材

1. KAIZEN

Contents

1. Philosophy of KAIZEN
2. KAIZEN cases
3. Exercise

---

4 stages of knowledge

1st stage : Have
2nd stage: Know
3rd stage : Understand
4th stage : Can do

---

1. Philosophy of KAIZEN

1-1. What is KAIZEN

KAIZEN…改善

KAI
“改” means “alter”

ZEN
“善” means “good”

KAI ZEN
➡ **“改善” means “alter to good”.**

1-2. Types of KAIZEN

There are 2 directions of KAIZEN.

①Routine operation : need efficiency
Way of KAIZEN->Find and Eliminate MUDA

②Service : customer satisfaction
Way of KAIZEN->Give more satisfaction

1-3. Types of KAIZEN

Hotel case:

Waiting guests, doesn’t need efficiency,

but check-out operation needs efficiency. Making and cleaning room also needs efficiency.

1-4. Types of KAIZEN

Restaurant case:

Waiting guests, doesn’t need efficiency,

Cooking, cleaning table, and washing dishes need efficiency.

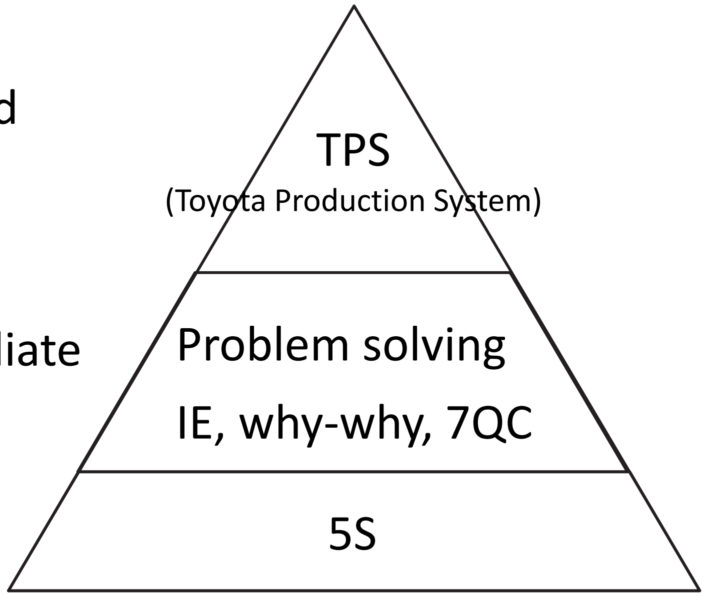
1-5. Types of KAIZEN

There are 2 directions of KAIZEN.

①Routine operation : need efficiency
Way of KAIZEN->Find and Eliminate MUDA

②Service : customer satisfaction
Way of KAIZEN->Give more satisfaction

1-6. Level of KAIZEN



Advanced

TPS
(Toyota Production System)

Intermediate

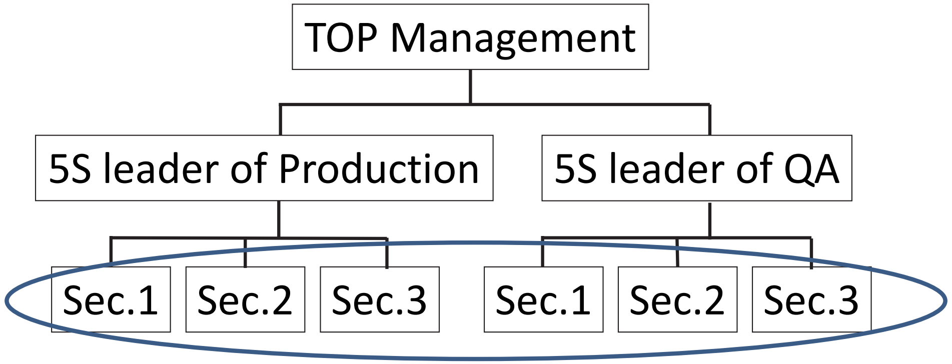
Problem solving
IE, why-why, 7QC

Basic

5S

1-7. What is KAIZEN

- Find and Eliminate MUDA



Acting with Small Group.

1-8. Eliminate MUDA

MUDA…無駄

Mu
“無” means “Nothing”

Da
“駄” means “Worthless”

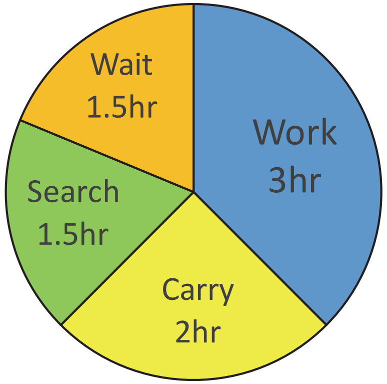
Mu Da
“無駄” means “Worthless”.

1-9. What is MUDA

How much hours do you work in a day?

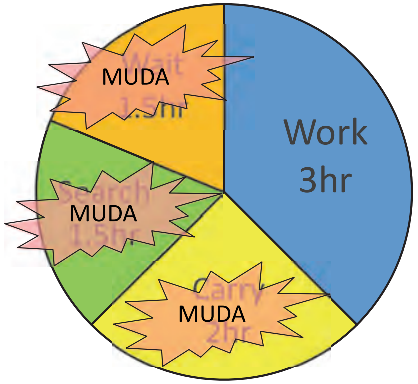
1-9. What is MUDA

How much hours do you work in a day?



1-9. What is MUDA

How much hours do you work in a day?

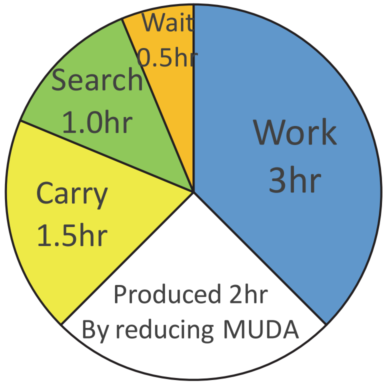


Add value

Make value

1-10. What is MUDA

How much hours do you work in a day?



1-11. MUDAs

1)Over production

2)Waiting

3)Transportation

4)Motion

5)Inventory

6)Over processing

7)Failure and rework

1-12. Purpose of KAIZEN

(1) To learn KAIZEN methodologies to improve their products or services.

1-12. Purpose of KAIZEN

(1) To learn KAIZEN methodologies to improve their products or services.
=> Better products and services generate **more profit**.

1-12. Purpose of KAIZEN

(1) To learn KAIZEN methodologies to improve their products or services.
=> Better products and services generate **more profit**.

(2) To reveal human capabilities.

1-12. Purpose of KAIZEN

(1) To learn KAIZEN methodologies to improve their products or services.
=> Better products and services generate **more profit**.

(2) To reveal human capabilities.
=> Employees with higher capabilities can produce better products and provide better services.

1-12. Purpose of KAIZEN

(1) To learn KAIZEN methodologies to improve their products or services.
=> Better products and services generate **more profit**.

(2) To reveal human capabilities.
=> Employees with higher capabilities can produce better products and provide better services.
=> Better products and services generate **more profit**.

1-12. Purpose of KAIZEN

(1) To learn KAIZEN methodologies to improve their products or services.
=> Better products and services generate

These outcomes are effective for “profit-making organizations”.

(2)

=> Employees with higher capabilities can produce better products and provide better services.
=> Better products and services generate **more profit**.

1-13. KAIZEN methods

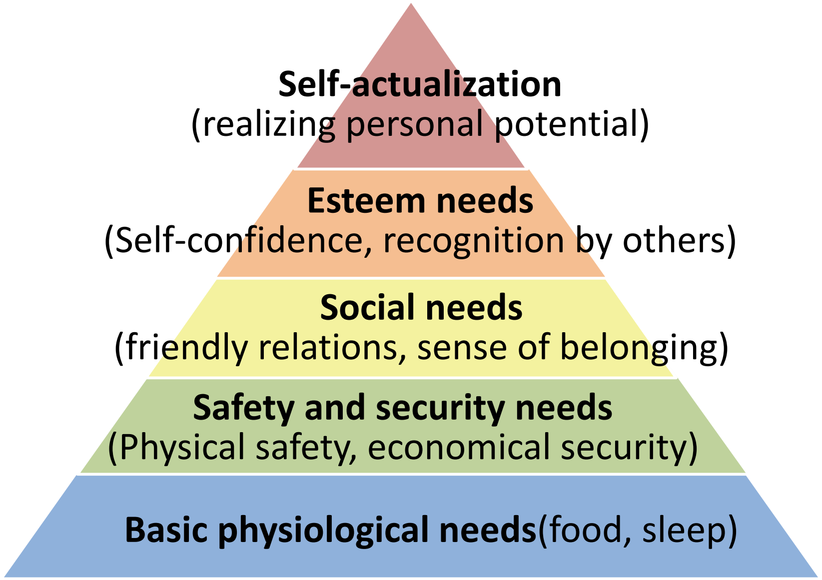
- There are many methods to facilitate KAIZEN implementation.

(1) PDCA
(2) QC story
(3) Standardization
(4) Brainstorming
(5) 3MU elimination
(6) 7 QC tools
(7) Why - why analysis

1-14. Purpose of KAIZEN

Why do you implement KAIZEN in Bangladesh?

1-15. Maslow's hierarchy of needs



Self-actualization
(realizing personal potential)

Esteem needs
(Self-confidence, recognition by others)

Social needs
(friendly relations, sense of belonging)

Safety and security needs
(Physical safety, economical security)

Basic physiological needs(food, sleep)

---

2. KAIZEN cases

2-1. Case study

2-2. Case study

2-3. Case study

2-4. Case study

2-5. Case study

2-6. Case study

2-7. Case study

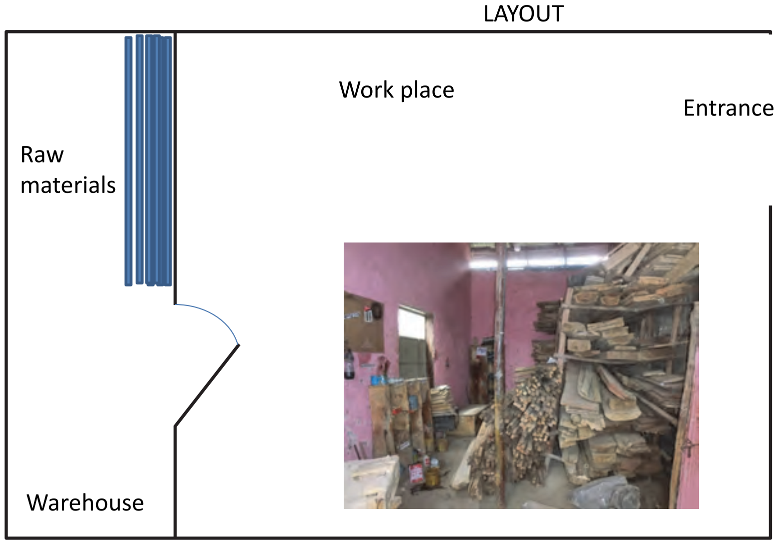
2-8. Case study

2-9. Case study

2-10. Case study

2-11. Case study

2-12. Case study



LAYOUT

Work place

Entrance

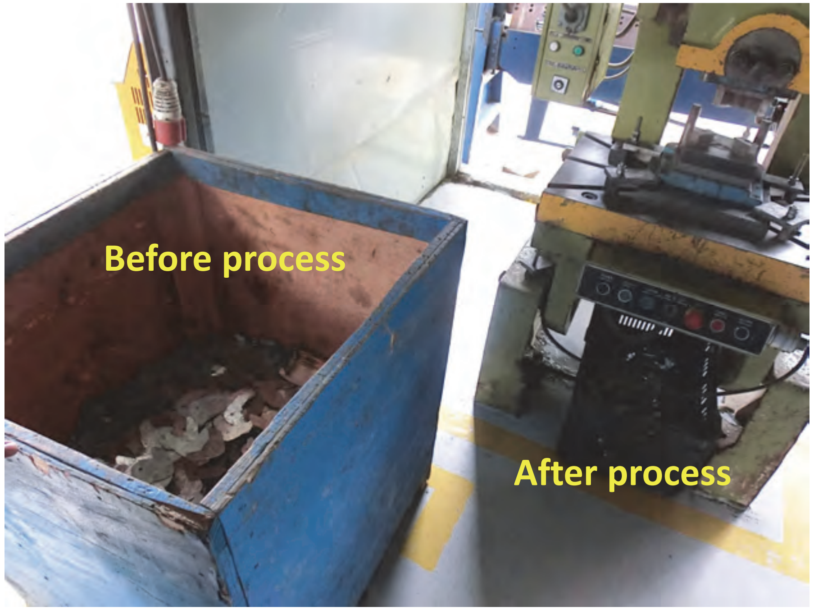
Raw
materials

Warehouse

2-13. Case study

2-14. Case study

2-15. Case study



2-16. Case study

2-17. Case study

2-18. Case study

2-19. Case study

2-20. Case study

2-21. Case study

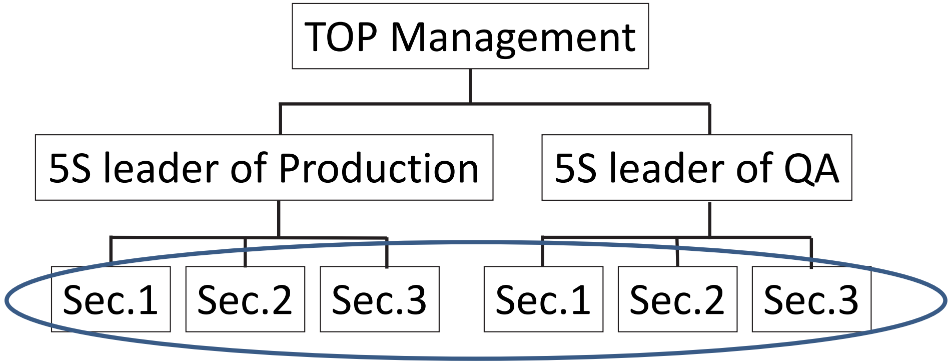
2-22. KAIZEN Philosophy

- Think always “is this the best way?”
  => You should not be satisfied.
- If you find good ideas, do quickly.
- Think “WHY?”, think deeply.

---

3. Exercise

3-1. Small group activity


TOP Management

5S leader of Production

5S leader of QA

Sec.1 Sec.2 Sec.3

Sec.1 Sec.2 Sec.3

Acting with Small Group to get better idea.

---

3. Group discussion(Moon landing)

Can group have better idea?

Read Case and individual consideration	15min
Group discussion	30min
Presentation	5min/group
General discussion	5min/group

2. 6S

Contents

1. What are 5S?
2. 6th S: Safety
3. Why do you implement 6S?
4. 6S cases & tools

1. What are 5S?

1-1. What are 5S?

- Seiri
- Seiton
- Seisou
- Seiketsu
- Shitsuke

Try to understand the words original meaning.

1-2. Seiri (Sort)

Seiri…整理

“整” means “arrange”
“理” means “reason, logical, make sense,”

“整理” means arrange accurately.
“SORT” in English.

1-3. Seiton (Set in order)

Seiton…整頓

“整” means “arrange”
“頓” means “settle”

“整頓” means arrange and settle.
“SET IN ORDER” in English.

1-4. Sort and Set in order

Seiri (Sort) and Seiton (Set in order) has similar meaning in Japanese.

In 5S definition, Sort means removing unnecessary items from the working place.

Set in order means as it is.

1-5. Seisou (Shine)

Seisou…清掃

“清” means “clean”
“掃” means “sweep”

“清掃” means “Cleaning”.
“SHINE” in English.

1-6. Seiketsu (Standardize)

Seiketsu…清潔

“清” means “clean”
“潔” means “clear, pure”

➡ “清潔” means “clean and clear”.
“STANDARDIZE” in English.

1-7. Shitsuke (Sustain)

Shitsuke…躾

➡ “躾” means “upbringing”

in 5S definition,

Shitsuke means “operate according to standard”.
“SUSTAIN” in English.

1-8. 5S summary

Seiri (Sort)	Remove unused stuff from your venue of work and reduce clutter.
Seiton (Set in Order)	Organize everything needed in proper order for easy operation.
Seisou (Shine)	Maintain high standard of cleanness.
Seiketsu (Standardize)	Set up the above three Ss as a part of the routine at every section in your place.
Shitsuke (Sustain)	Train and maintain discipline of the personnel engaged.

1-9. Important points of 5S

POINTS,

1. No unnecessary things.
2. Things are in the regular place.
(Easy access.)
3. Everybody knows that.
4. Keep this situation.

2. 6th S: Safety

2-1. What is the most important?

Don’t you see these slogans?

- Quality first
- Safety first
- Customer first
- Sales/profit first

2-2. Why safety is so important?

Once injury happens in the company,
The employee has to have painful life,
The company has to pay huge amount to the employee.
Additionally, reputation of the company will be destroyed.

⇨ The company faces the fatal situation.

2-3. How to make safety workplace?

1. Laws/Regulations
    Decibels/ Temperature/ Chemicals/ Heavy items/ Granular body/ Working hours

2-4. How to make safety workplace?

2. Prevent reccurrence

a) A operator fell a die on his foot.

=> Safety shoes.

b) A PC fell down.

=> Anchorage.

2-5. How to make safety workplace?

3. Prediction

Rotating body/ Press/ Melted metal

---

3. Why do you implement 6S?

3-1. Why do you implement 6S?

1) 6S makes efficient workplace.

2) 6S makes more sales.

3-1. Why do you implement 6S?

1) 6S makes efficient workplace.

- ▪ Minimize searching time.
- ▪ Minimize moving time.
- ▪ Maximize space utility.

⇨ Production with lower cost.

2) 6S makes more sales.

3-2. Why do you implement 6S?

How long does it take to get necessary die?

3-3. Why do you implement 6S?

1) Difficult access.
2) Long searching time to find the necessary die.
3) Difficult handling.

3-4. Why do you implement 6S?

3-5. Why do you implement 6S?

1) 6S makes efficient workplace.

- Minimize searching time.
- Minimize moving time.
- Maximize space utility.

⇨ Production with lower cost.

2) 6S makes more sales.

-

3-6. Why 6S makes more sales?

Do you want to start a new business with this company?

3-7. Why do you implement 6S?

1) 6S makes efficient workplace.

- Minimize searching time.
- Minimize moving time.
- Maximize space utility.

⇨ Production with lower cost.

2) 6S makes more sales.

- If the company implement 6S well, customers can **trust** the company and want to start a business.

⇨ More sales.

---

4. 6S cases & tools

4-1. 6S cases (Sort)

Before

After

http://www.sanotekko.com/

4-2. 6S cases (Sort)

Before

After

http://www.sanotekko.com/

4-3. Tool for Sort

Red tag

Unnecessary Card

Labeled	
Due date	
Judge	

Labeled date

2 weeks ～
1 month to judge

Scrap/Repair/
Warehouse/etc.

4-4. 6S cases (Set in order)

4-5. 6S cases (Set in order)

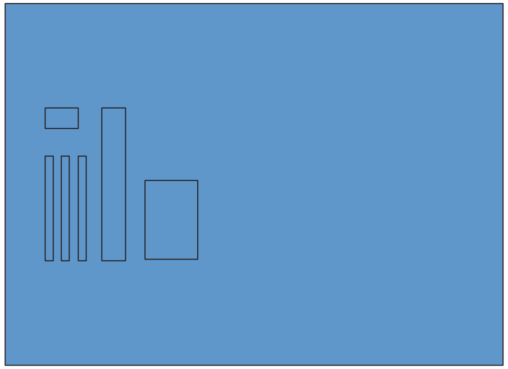
Before

After

http://hst.showa-u.ac.jp/

4-6. Tool for Set in order

Layout sheet



Desk drawer

4-7. 6S cases (Set in order)

4-8. 6S cases (Set in order)

Before

After

4-9. Rule for Set in order

Use Hourly ▪▪▪ on/in the desk

Use Daily ▪▪▪ in the office

Use Weekly ▪▪▪ in the office

Use Monthly ▪▪▪ in the warehouse

Use Yearly ▪▪▪ in the warehouse

No use a few years ▪▪▪ Throw away

4-10. 6S cases (Set in order)

Before

After

http://www.hospital.iwata.shizuoka.jp/

4-11. 6S cases (Set in order)

Before

After

http://www.hospital.iwata.shizuoka.jp/

4-12. 6S cases (Set in order)

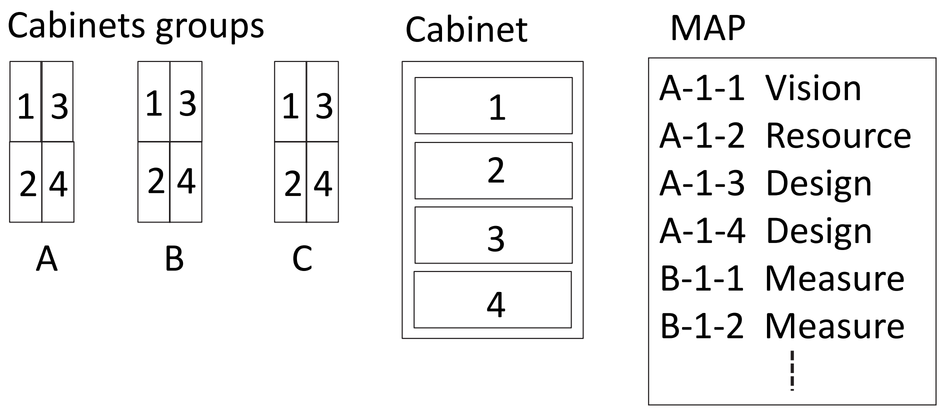
Before

After

http://www.akatake.co.jp/

4-13. Tool for Set in order

Mapping and labeling



Cabinets groups

1 3
2 4
A

1 3
2 4
B

1 3
2 4
C

Cabinet

1
2
3
4

MAP

A-1-1 Vision
A-1-2 Resource
A-1-3 Design
A-1-4 Design
B-1-1 Measure
B-1-2 Measure
⋮

4-14. Tool for Set in order

Mapping and labeling

4-15. 6S cases (Shine)

Is cleaning a tool of 5S?

4-16. 6S cases (Shine)

Is cleaning a tool of 5S?

The company had material waste problem.

4-17. 6S cases (Shine)

Is cleaning a tool of 5S?

They can know from where leakage happens.

1-8. 5S summary

Seiri (Sort)	Remove unused stuff from your venue of work and reduce clutter.
Seiton (Set in Order)	Organize everything needed in proper order for easy operation.
Seisou (Shine)	Maintain high standard of cleanness.
Seiketsu (Standardize)	Set up the above three Ss as a part of the routine at every section in your place.
Shitsuke (Sustain)	Train and maintain discipline of the personnel engaged.

4-18. 6S cases (Standardize)

Standards

4-19. 6S cases (Standardize)

Standards
=Company rules
=Need to follow

4-20. Tools of Sustain

1) Patrol
2) Presentation exhibition

Helps to keep 6S Activities.

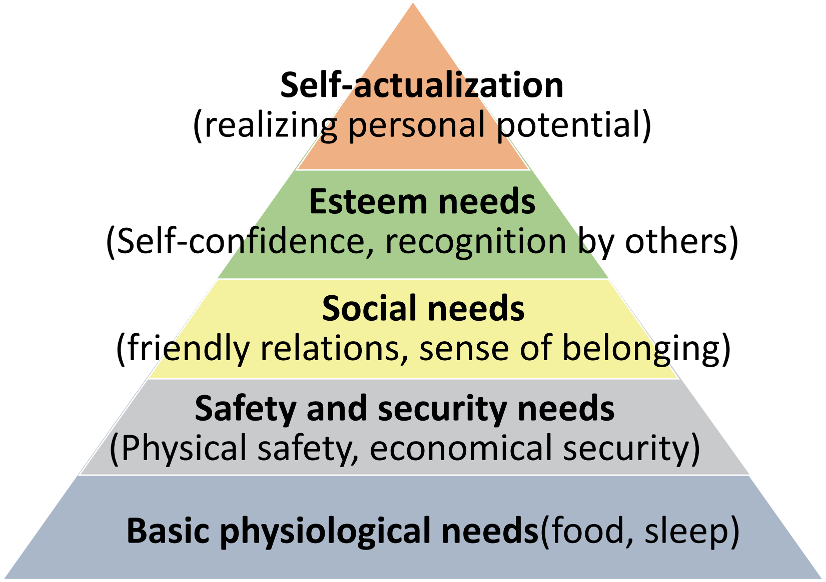
4-21. Tools of Sustain

1) Patrol : Top management needs to visit and see actually.

4-22. Tools of Sustain

1) Presentation exhibition : Make presentation about their activities in front of management.

1-13. Maslow's hierarchy of needs



Self-actualization
(realizing personal potential)

Esteem needs
(Self-confidence, recognition by others)

Social needs
(friendly relations, sense of belonging)

Safety and security needs
(Physical safety, economical security)

Basic physiological needs(food, sleep)

4-23. 6S cases (Sustain)

6S Activities is often discontinues, because

4-24. 6S cases (Sustain)

Exercise

Identify the reasons why 6S Activities doesn't continue and make countermeasure plan.

1) Group Discussion : 20 min
2) Preparation : 10 min
3) Presentation : 10 min/group

4-25. 6S cases (Sustain)

6S Activities is often discontinues, because

- 6S Activities is not interesting.
- We are too busy with existing work.
- No incentive to do.
- We don't know how to do.

4-26. 6S cases (Sustain)

- 6S Activities is not interesting.
- No incentive to do.
  ⇨ Give incentive to the employees like 6S prize, higher salary, etc.
- We are too busy with existing work.
  ⇨ Force them to do.
- We don't know how to do.
  ⇨ Provide training.

3. TQM & ISO9001

Training Contents

1. History of QC
2. What is TQM?
3. What is ISO9001?
4. Group discussion

---

1. History of QC

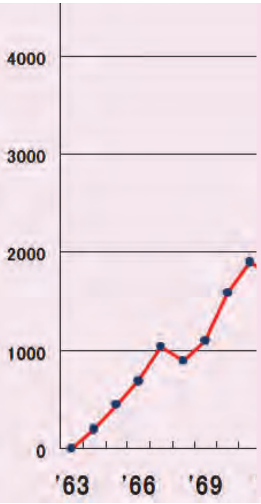
1-1. Origin of QC

- After WWⅡ, Japan introduced quality control methodologies developed in USA.
- At that time, Japanese products were called "cheap and nasty".
- Dr. Deming and Dr. Juran provided quality control training in Japan in the 1950s.
- Many companies, mainly in the manufacturing industry, started to introduce Quality Control(QC).
- They started implementing QC education and QC study meetings at the workplace level.

1-2. Origin of QC

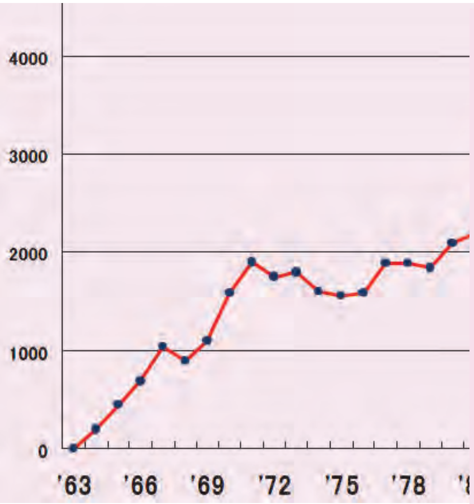
- Jul/1961: A panel discussion was organized by a "Quality Control" magazine inviting first line supervisors. There were some opinions like,
  - ✓ We want to study quality control.
  - ✓ We need a text like a QC magazine.
  - ✓ We want to have opportunities to publish our ideas or activities.
- Apr/1962 : A magazine entitled "Quality Control for the foreman" was published, lead by Dr. Ishikawa.
- Through this magazine, Dr. Ishikawa encouraged companies to form Quality Control Circle(QCC) to implement QC.

1-3. Number of presentations submitted to QCC conferences(1962-1970)



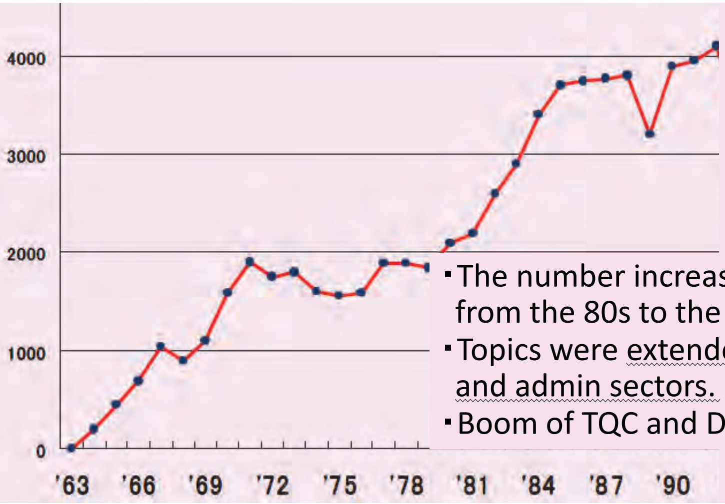
- The number of presentations in the QCC conference increased sharply from the beginning to 1970.
  (no data about the number of QCC.)
- Many companies and people were motivated to learn QC and to produce good products.
- Many companies wanted to follow the successful companies by doing the same way.

1-4. Number of presentations submitted to QCC conferences(1970-1980)



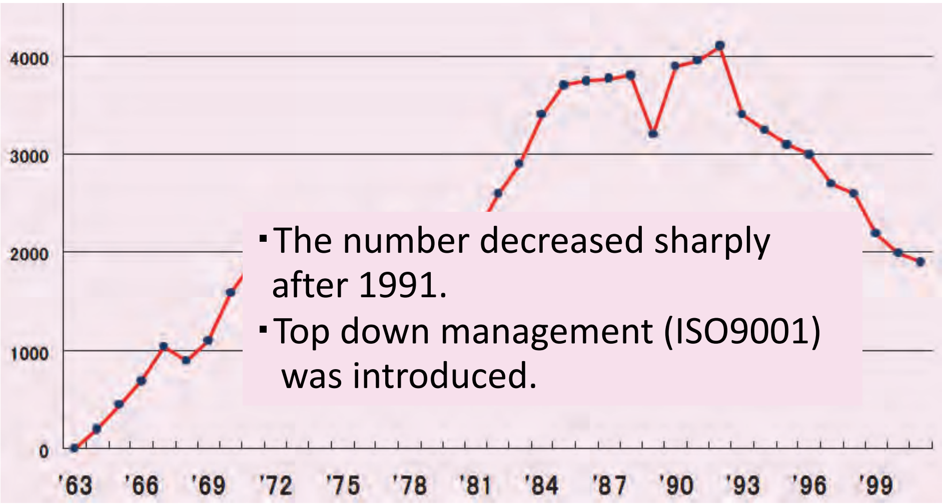
- The number was stable from the 70s to 80s because of low economic growth caused by two oil crises.

1-5. Number of presentations submitted to QCC conferences(1980-1991)



- The number increased sharply from the 80s to the 90s.
- Topics were extended to service and admin sectors.
- Boom of TQC and Deming prize.

1-6. Number of presentations submitted to QCC conferences(1991-)



- The number decreased sharply after 1991.
- Top down management (ISO9001) was introduced.

1-7. What is QCC?

- QCC is a small group consisting of first-line employees who continually control and improve the quality of their work, products, and services.

- These small groups,
  - operate autonomously.
  - utilize quality control concepts and technics and other improvement tools to tap members' creativity, and promote self-and mutual-development.

1-8. Paradigm shift of QC

	QC (up to 1980s)	TQC/TQM
Target	Products	Products, services
Management	Bottom-up Autonomous	Top-down
Optimization	Partial	Total
Driver	QCC	Cross Function Team(CFT)

=>QC modality has been changed by the demands of the time.

1-9. Expansion of QCC

- QCC was started to learn QC methodologies in the manufacturing industry in 1962.
- After the 1970s, QCC was introduced in the service industry and administration dep.
- Around this period, some governmental offices started to introduce QCC.
- QCC was expanded to foreign countries. First International Convention on Quality Control Circles(ICQCC) was held at Seoul in 1976.

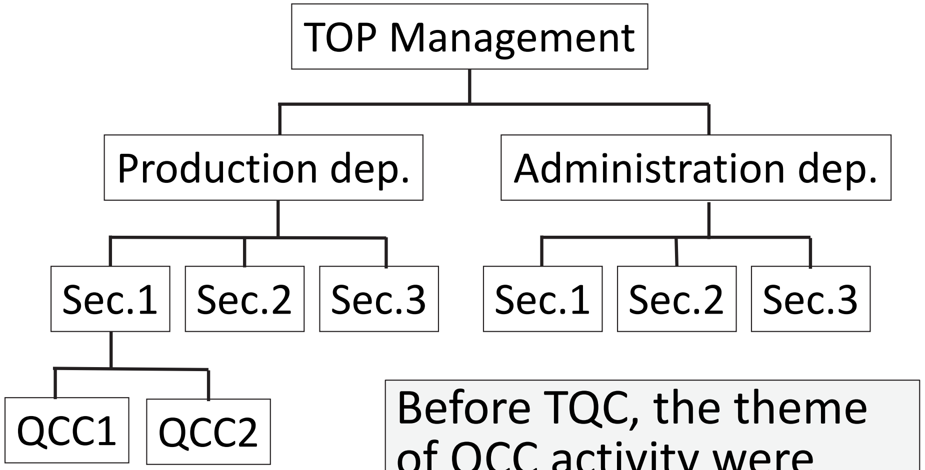
2. What is TQM?

2-1. What is TQM?

TQM is “Total Quality Management”.

TQM = QCC + Top down management

2-2. What is TQM?



TOP Management

Production dep.

Administration dep.

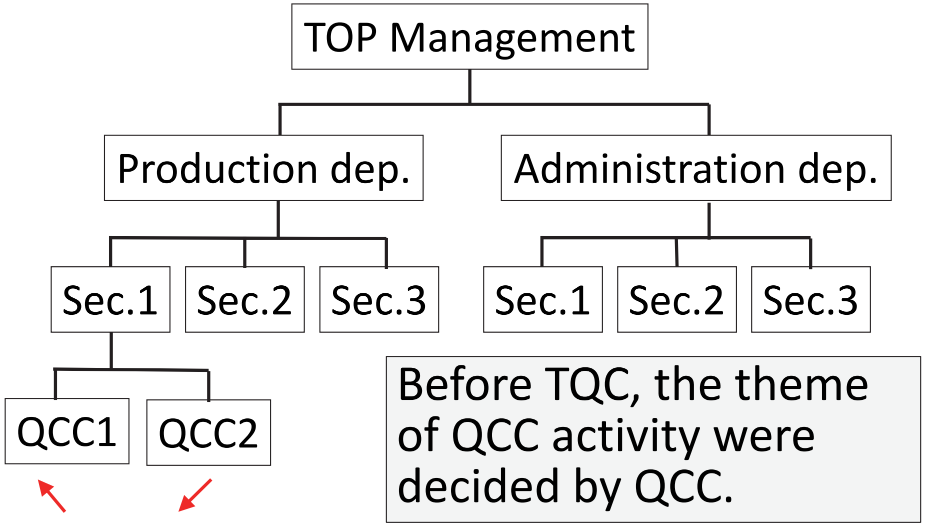
Sec.1 Sec.2 Sec.3

Sec.1 Sec.2 Sec.3

QCC1 QCC2

Before TQC, the theme of QCC activity were decided by QCC.

2-3. What is TQM?



TOP Management

Production dep.

Administration dep.

Sec.1 Sec.2 Sec.3

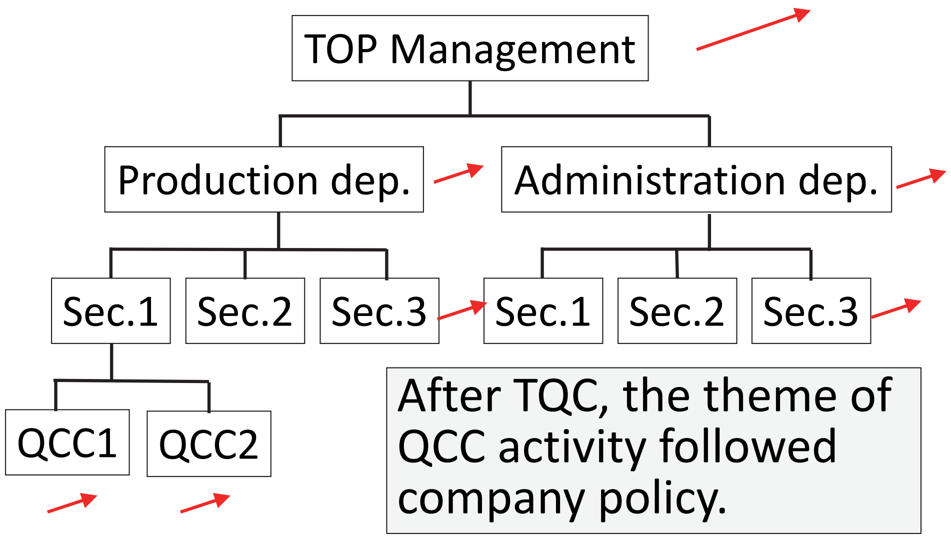
Sec.1 Sec.2 Sec.3

QCC1 QCC2

Before TQC, the theme of QCC activity were decided by QCC.

⇨ Partial optimization

2-4. What is TQM?



After TQC, the theme of QCC activity followed company policy.

⇨ Total optimization

2-5. How to manage individual themes?

Policy deployment

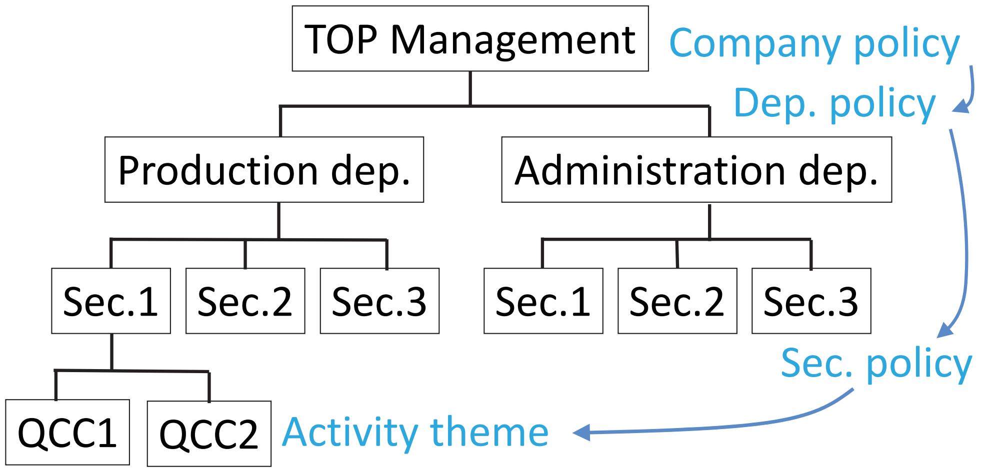
2-6. How to manage individual themes?

Policy deployment

MISSION
VISION
POLICY

} Decided by top management

2-7. How to manage individual themes?



2-8. Example of policy deployment

mission To deliver quality products and service to the right satisfaction to its customer and generate reasonable profit to the company".

vision To be preferred shoe exporting factory in Ethiopia .

policy
- Increase exporting by 50%
- To be ISO certified
- Increase production capacity

⇩

- Quality dep. : Defect rate 2.5% -> 1.0%
- Production dep. : 800 pairs/day -> 1200 pairs/day
  Maintenance : Beak down 40hr/mo -> 20hr/mo

2-9. Exercise

Exercise

You are a department manager of the company.
What kind of department policy do you make? Choose one department you like.

- Sales
- Design
- Human resource
- Finance
- Purchase

2-10. QC story (QCC activity)

QCC activity is mainly “problem solving”, following “QC story”. QC story has 9 steps.

(1) Selection of theme
(2) Planning
(3) Grasp of current situation
(4) Decision of objective P
(5) Cause Analysis
(6) Planning Countermeasures and
implementation D
(7) Assessment of the result C
(8) Standardization A
(9) Reflection and future policy

---

3. What is ISO9001?

3-1. What is ISO9001?

ISO9001 shows Quality Management System.

1 Scope

2 Normative References

3 Terms and definitions

4 Context of the organization

- 4.1 Understanding the organization and its context
- 4.2 Understanding the needs and expectations of interested parties
- 4.3 Determining the scope of the quality management system
- 4.4 Quality management system and its processes

3-2. What is ISO9001?

5 Leadership

- 5.1 Leadership and commitment
- 5.2 Policy
- 5.3 Organizational roles, responsibilities and authorities

6 Planning

- 6.1 Actions to address risks and opportunities
- 6.2 Quality objectives and planning to achieve them
- 6.3 Planning of changes

3-3. What is ISO9001?

7 Support

- 7.1 Resources
- 7.2 Competence
- 7.3 Awareness
- 7.4 Communication
- 7.5 Documented information

8 Operation

- 8.1 Operational planning and control
- 8.2 Requirements for products and services
- 8.3 Design and development of products and services

3-4. What is ISO9001?

- 8.4 Control of externally provided processes, products and services
- 8.5 Production and service provision
- 8.6 Release of products and services
- 8.7 Control of nonconforming outputs

9 Performance evaluation

- 9.1 Monitoring, measurement, analysis and evaluation
- 9.2 Internal audit
- 9.3 Management review

3-5. What is ISO9001?

10 Improvement

10.1 General

10.2 Nonconformity and corrective action

10.3 Continual improvement

3-6. Basic calculation

Question1

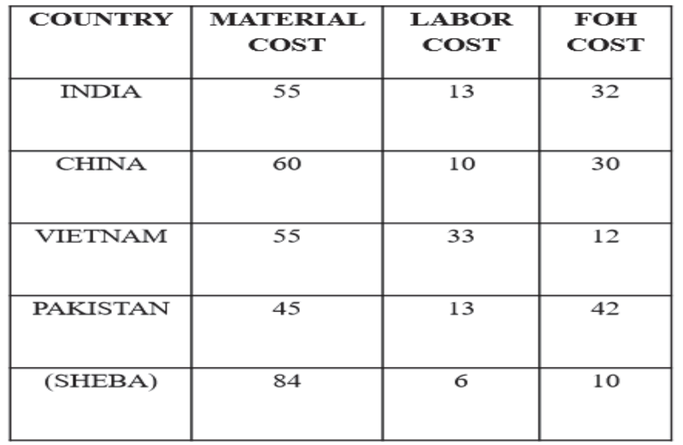
Calculate improvement ratio.

	Before	After	improve
1) Defect rate	5.3%	3.6%	
2) Productivity	800 shoe/day	950 Shoe/day	

3-7. Basic calculation

Question2

How do you think about this?



COUNTRY	MATERIAL COST	LABOR COST	FOH COST
INDIA	55	13	32
CHINA	60	10	30
VIETNAM	55	33	12
PAKISTAN	45	13	42
(SHEBA)	84	6	10

3-8. Basic calculation

Question3

Calculate weekly defect rate.

Day of wk	production	defects	%
Mon.	1,200pcs	18pcs	1.5
Tue.	1,500pcs	30pcs	2.0
Wed.	2,000pcs	10pcs	0.5
Thu.	1,800pcs	18pcs	1.0
Fri.	2,400pcs	12pcs	0.5

3-9. Basic calculation

Question4

How much money did you save?

▪Cost/shoe is 500taka.

	Before	After
Production volume	20,000 shoe/month	22,000 Shoe/month
Defect rate	5.3%	3.6%
Money saving		

3-10. Evaluation

Question5

How much percent was productivity improved?

	Daily output	Number of labor
Before	800pcs	100
After	1,200pcs	120

4. Group discussion(TQM)

Read Case and individual consideration	30min
Group discussion	60min
Presentation	10min/group
General discussion	10min/group

4. QC Story

Training Contents

1. What is a problem?
2. QC story
3. 7 QC tools
4. Case study
5. Exercise

---

1. What is a problem?

1-1. QC Story

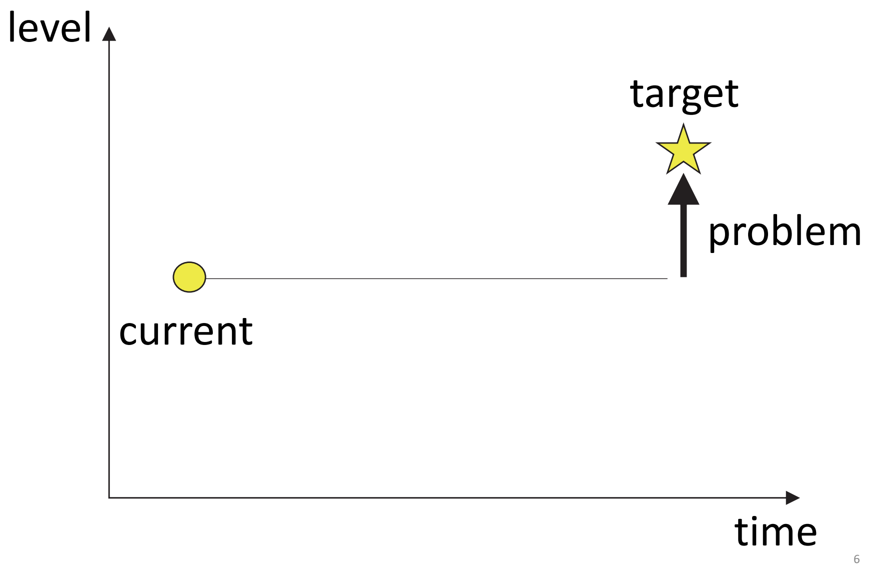
QC Story shows steps to solve a problem.

1-2. What is a problem?

Are they problems?

- ✓ Production capacity : 800 pairs/day
- ✓ Failure rate : 2.5%
- ✓ Customer complaint : 10/month

1-3. What is a problem?



1-4. Policy management

mission	To deliver quality products and service to the right satisfaction to its customer and generate reasonable profit to the company".
vision	To be preferred shoe exporting factory in Ethiopia .
policy	• Increase exporting by 50% • To be ISO certified • Increase production capacity

- Quality improvement: 2.5% -> 1.0%
- Increase capacity: 800 pairs/day -> 1200 pairs/day by Reduction of break down & Increase productivity

1-5. What is a problem?

Are they problems?

- ✓ Production capacity : 800 pairs/day
- ✓ Failure rate : 2.5%
- ✓ Customer complaint : 10/month

Problems are defined by management.

2. QC Story

2-1. PDCA

PDCA is a scientific approach to achieve goals that involves planning, performing, checking up results against goals, taking measures, and reflecting outcomes to future plans.

(1) **Plan** : Set goals, and decide how to achieve them.

(2) **Do** : Perform the plan as defined.

(3) **Check** : Examine, evaluate and confirm the result.

(4) **Act** : Take measures as dictated by the results.

2-2. QC story (Problem solving)

QCC activity is mainly "problem solving", following "QC story". QC story has 9 steps.

(1) Selection of theme
(2) Planning
(3) Grasp of current situation
(4) Decision of objective
(5) Cause Analysis
(6) Planning Countermeasures and implementation
(7) Assessment of the result
(8) Standardization
(9) Reflection and future policy

2-3. QC story (Problem solving)

QCC activity is mainly "problem solving", following "QC story". QC story has 9 steps.

(1) Selection of theme
(2) Planning
(3) Grasp of current situation
(4) Decision of objective P
(5) Cause Analysis
(6) Planning Countermeasures and implementation D
(7) Assessment of the result C
(8) Standardization A
(9) Reflection and future policy

2-4. QC story (Selection of theme)

(1) Selection of theme

At the first stage, QCC members list up problems in the workplace and select a theme among them.
—The members ask themselves, "What problems do we have and how do we solve them?"

Brainstorming is used to gather various ideas from the members.
In identifying the problems, the concept of 3MU elimination is useful.

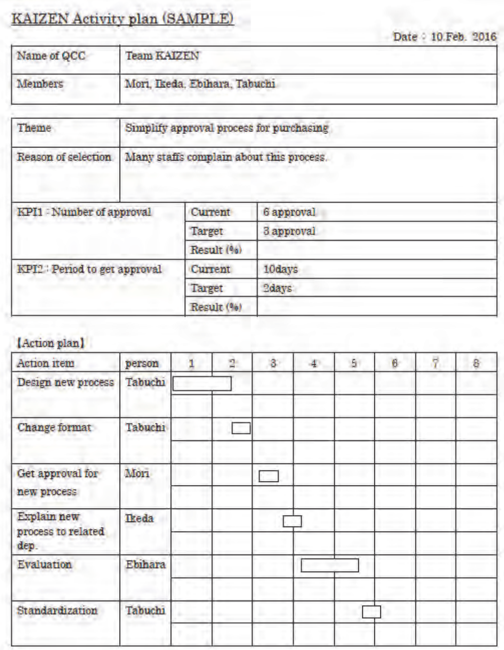
2-5. QC story (Activity Plan)

(2) Planning

Based on the data acquired in the second stage, the members set a goal of the activities. To achieve the goal, the members establish an activity plan, according to the 5W1H concept.

The members decide the issues to be tackled (what), the reason for tackling them (why), the time schedule of the activities (when), and the place and resource allocation (where, and who and how)

2-6. Sample of an Activity plan



KAIZEN Activity plan (SAMPLE)

Date：10.Feb. 2016

Name of QCC	Team KAIZEN
Members	Mori, Ikeda, Ebihara, Tabuchi

Theme	Simplify approval process for purchasing	
Reason of selection	Many staffs complain about this process.	
KPI1：Number of approval	Current	6 approval
	Target	3 approval
	Result (%)	
KPI2：Period to get approval	Current	10days
	Target	2days
	Result (%)	

【Action plan】

Action item	person	1	2	3	4	5	6	7	8
Design new process	Tabuchi	▭	▭						
Change format	Tabuchi		▭						
Get approval for new process	Mori			▭					
Explain new process to related dep.	Ikeda			▭	▭				
Evaluation	Ebihara				▭	▭			
Standardization	Tabuchi					▭	▭		

2-7. QC story (Grasping Status and Goal setting)

(3) Grasp of current situation

After a theme is selected, the members try to understand the structure and details of the problem.

The main objective of this step is to gather information and grasp the status of the problem so that members can establish a detailed set of goals.

To grasp the status, Pareto diagram, Check sheet, Histogram, Scatter diagram can be used.

2-8. QC story (Cause analysis)

(4) Cause Analysis

The main objective of this stage is to determine what measures can be taken for the selected problem.

After a theme is selected, the causes and effects of the problem need to be identified.

The members consider all possible causes of the problem and see if there are any relations among them.

2-9. QC story (Cause analysis)

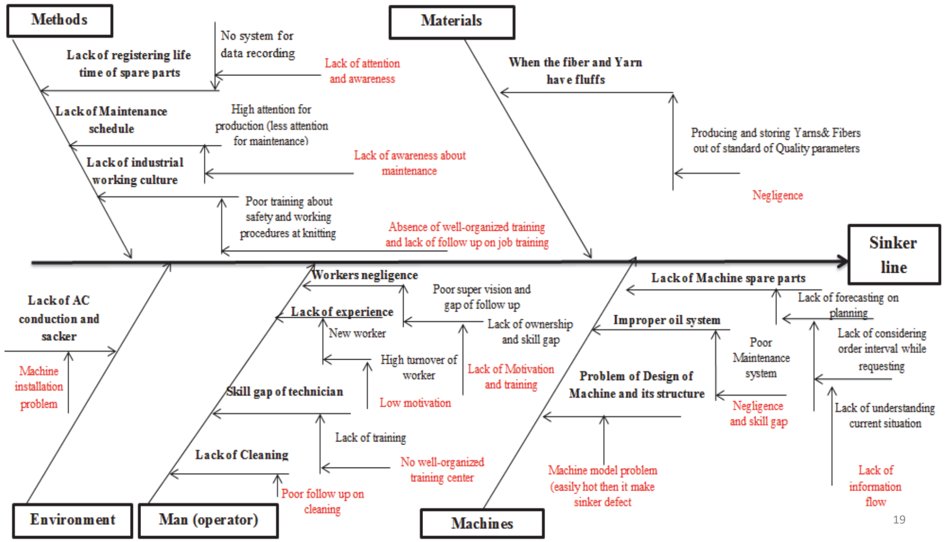
(4) Cause Analysis

Then the members use data to verify the causes, narrow down the root causes, and finally select the most critical cause. They then list up all possible solutions that eliminate the most critical cause, select the best solution, and establish a detailed plan on how to implement it.

In identifying root causes, 5 whys is useful. A cause and effect diagram is used to understand the structure of the problem.

2-10. QC story (Cause analysis)

(4) Cause Analysis (Quality)



2-11. QC story (Planning Countermeasures)

(5) Planning Countermeasures and implementation

After causes are identified, countermeasures are examined and selected. This stage aims both to specify the root causes and to establish the most effective measures to prevent the reoccurrence of the problems.

The members then implement countermeasures in daily operations, according to the plan, and monitor the results.

2-12. QC story (Confirm the result)

(6) Assessment of the result

Then an assessment is carried out to see whether the initial objectives have been met.

The members identifies the results, verifies them using data, and compares them with the initial goal.

If the results have not met the goal, then the members need to return to previous stages and reexamine the processes.

2-13. QC story (Standardization)

(7) Standardization and training

Finally after effective methods are identified, they are standardized and incorporated into daily operations.

Based on the standardization, the members train the people concerned.

The last step in this stage is for the members to determine the next problem to tackle.

2-14. QC story (Standardization)

You will operate your job according to SOP(Standard Operating Procedures). SOP should be straightforward; no detailed explanation should be needed.

- ･The most important rule about "standardization" is to follow the SOP.
- ･If a SOP does not fit the current situation, the SOP must be revised.
- ･The actual operation's conformity to the SOP must be checked periodically (audit).
- ･SOP must be reviewed periodically.

3. 7 QC tools

3-1. 7 QC tools (2)

7 QC tools are,

(1) Check sheet
(2) Pareto diagram
(3) Histogram
(4) Scatter diagram
(5) Line graph / Control chart
(6) Stratification
(7) Cause and effect diagram

3-2. 7 QC tools (Check sheet)

[Example] Number of defects

	Feb /1	2	3	4	5	6	7	8	Total
Leather defect	//	///	/	//	/	///	/	//	15
Wrong centering	/		//	/	/	/		//	8
Stitching problem	/	/		//		/		/	6
Back part wrinkle		/		//		/	/	/	6
Leather scratch		/		/	//			/	5

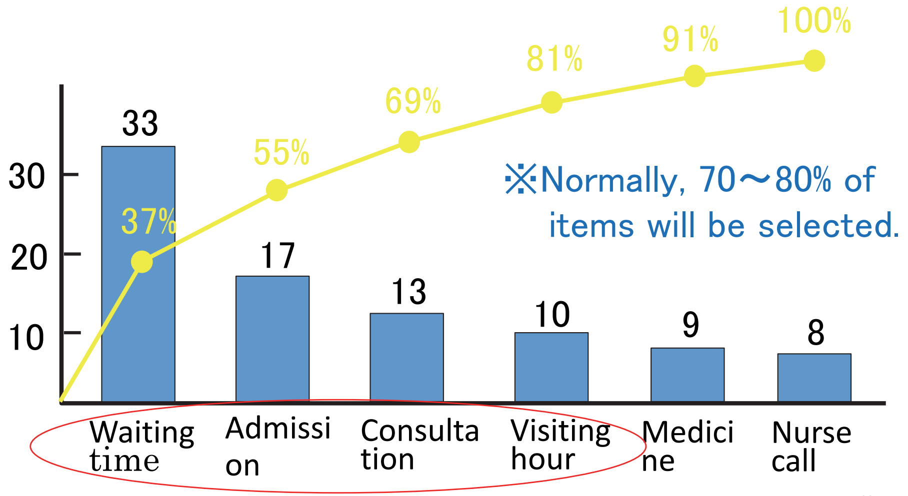
3-3. 7 QC tools (Check sheet)

A check sheet can visually summarize the obtained data values such as the number of defects or faults in either a figure or table. It shows where the data particularly concentrates.

A check sheet can be understood at one view, which can help us prioritize categorized items to be addressed.

3-4. 7 QC tools (Pareto diagram)

[Example] Result of customer feedback



※Normally, 70～80% of items will be selected.

3-5. 7 QC tools (Pareto diagram)

A Pareto diagram is used to prioritize the problems that should be addressed, which categorizes problems and enumerates them in accordance with their frequency.

From a Pareto diagram, we can find out what are the problems as well as the gravity of importance spread among the detected problems.

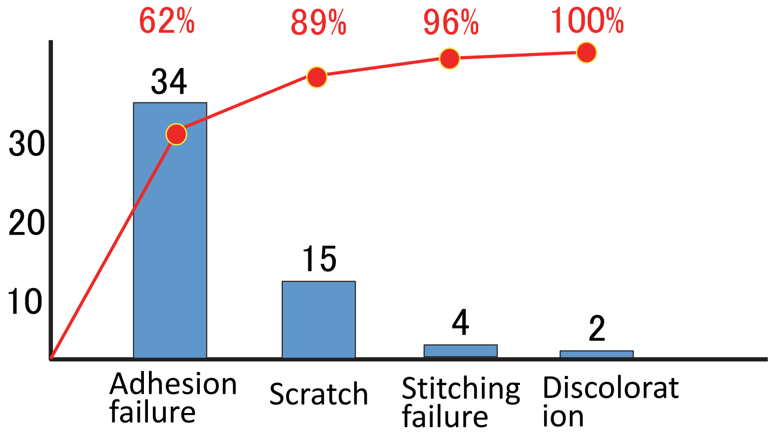
3-6. 7 QC tools (Pareto diagram)

Q : Which failure should the QCC address first?

Month	Products	Process	Prod. qty.	Failure mode	Failure qty.
Aug.	Product A	Visual check	200	Adhesion failure	10
Aug.	Product A	Visual check	200	Scratch	4
Sep.	Product A	Visual check	250	Adhesion failure	4
Sep.	Product A	Visual check	400	Adhesion failure	12
Sep.	Product A	Visual check	400	Scratch	6
Oct.	Product A	Visual check	300	Stitching failure	4
Oct.	Product A	Visual check	200	discoloration	2
Oct.	Product A	Visual check	200	Adhesion failure	5
Nov.	Product A	Visual check	100	Adhesion failure	3
Nov.	Product A	Visual check	100	Scratch	5

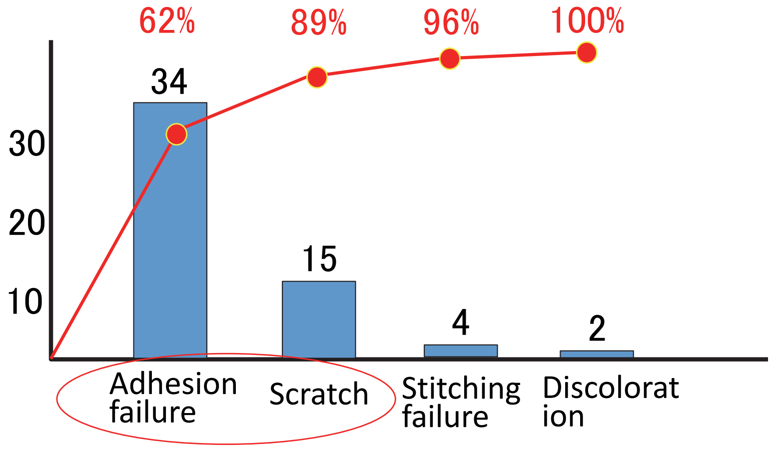
3-7. 7 QC tools (Pareto diagram)

A : ①Make Pareto chart
②Choose 70 – 80% of failure



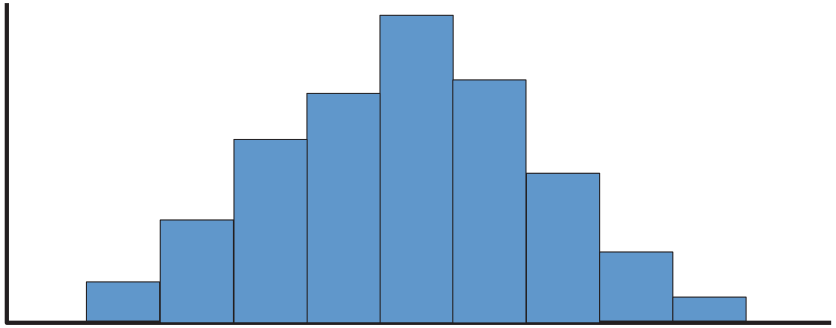
3-8. 7 QC tools (Pareto diagram)

A : ①Make Pareto chart
②Choose 70 – 80% of failure



3-9. 7 QC tools (Histogram)

[Example] Normal distribution



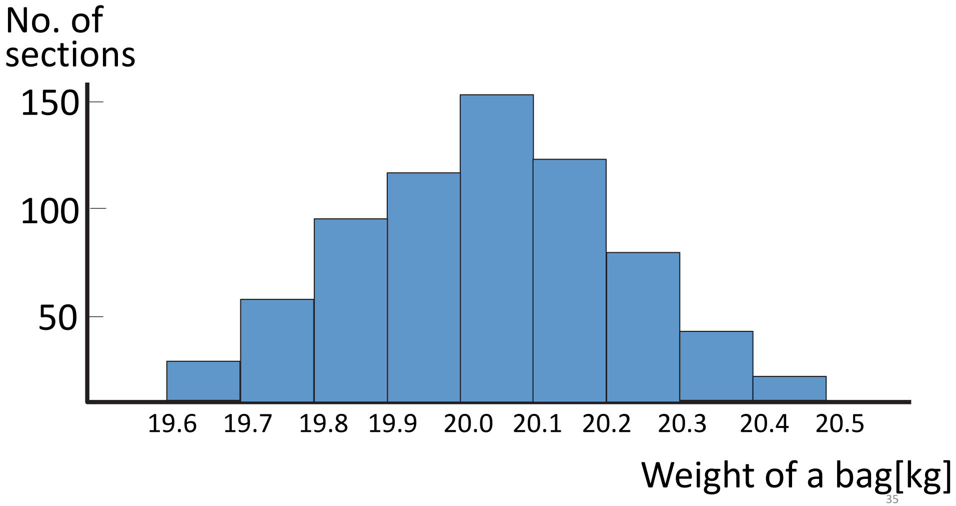
3-10. 7 QC tools (Histogram)

A histogram is a simple figure representing the distribution of data values obtained by measurements such as length, weight, and time.

A histogram can graphically summarize a data set that is hard to understand from individual numbers. It can also display the distribution of values.

3-11. 7 QC tools (Histogram)

[Example] Weight of a bag of sugar.

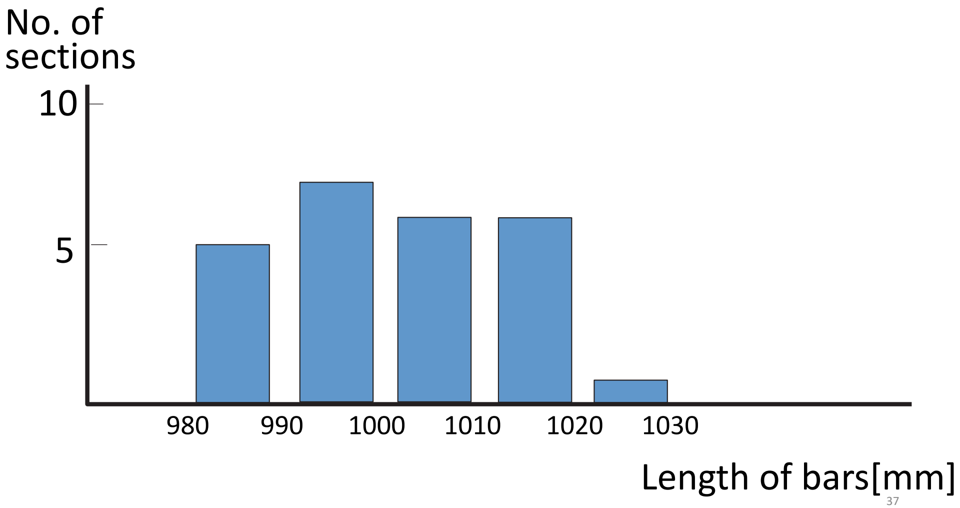


3-12. 7 QC tools (Histogram)

Q : Make a histogram of “length of steel bar.”
(Use no.1 to no.25 data.)

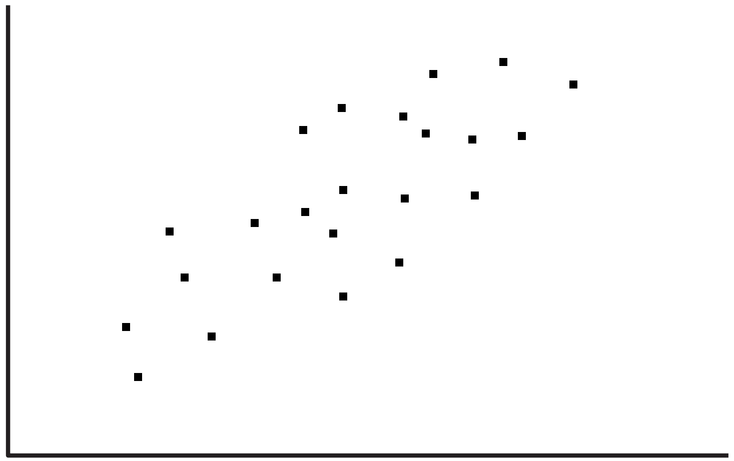
3-13. 7 QC tools (Histogram)

[Answer] length of steel bar.



3-14. 7 QC tools (Scatter diagram)

[Example] Positive correlation



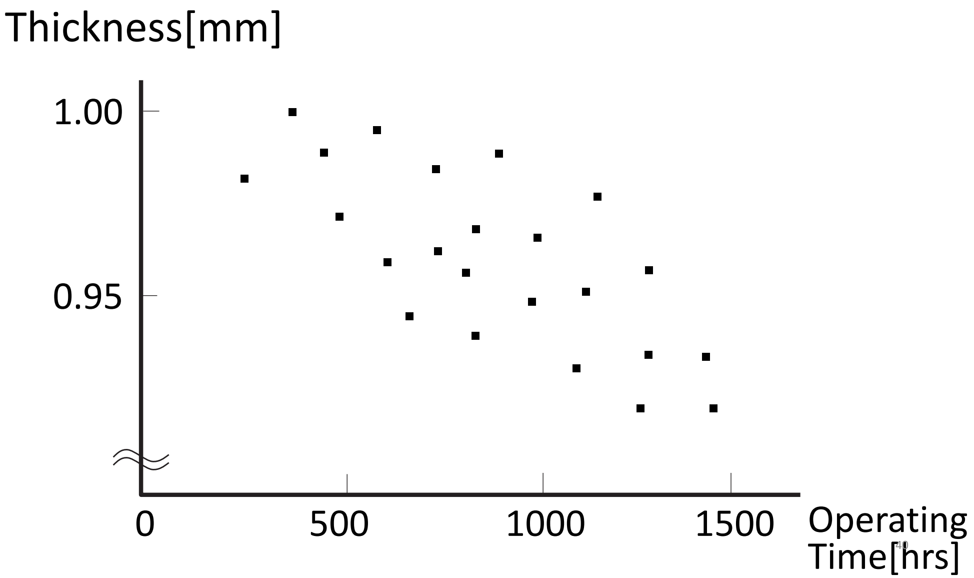
3-15. 7 QC tools (Scatter diagram)

A scatter diagram is a figure representing paired data in dots on a sheet of graph paper.

A scatter diagram can tell us relationships of paired data clearly. It is often used to see relationships between the characteristics and factors.

3-16. 7 QC tools (Scatter diagram)

[Example] Operating time and thickness of sinker



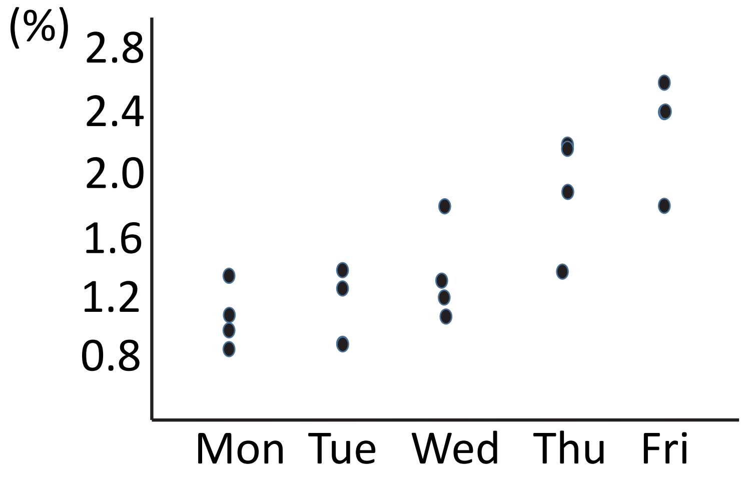
3-17. 7 QC tools (Scatter diagram)

Q : A QCC thinks that failures increase Mo to Fr.
How can this idea be evaluated?

Date	Failure	Date	Failure
1(Mo)	1.3%	15(Mo)	0.9%
2(Tu)	0.9%	16(Tu)	0.9%
3(We)	1.2%	17(We)	1.3%
4(Th)	1.9%	18(Th)	1.4%
5(Fr)	1.8%	19(Fr)	2.4%
8(Mo)	1.0%	22(Mo)	1.1%
9(Tu)	1.4%	23(Tu)	1.3%
10(We)	1.1%	24(We)	1.8%
11(Th)	2.2%	25(Th)	2.2%
12(Fr)	2.6%	26(Fr)	2.4%

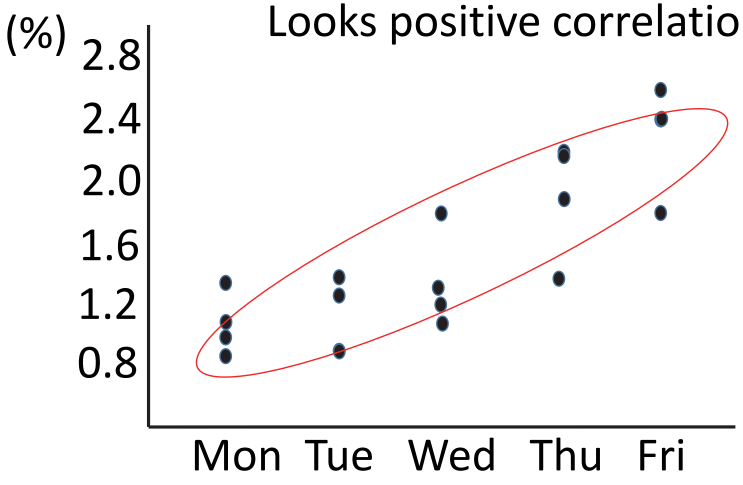
3-18. 7 QC tools (Scatter diagram)

A : ①Make Scatter diagram
②Check correlation



3-19. 7 QC tools (Scatter diagram)

A : ①Make Scatter diagram
②Check correlation



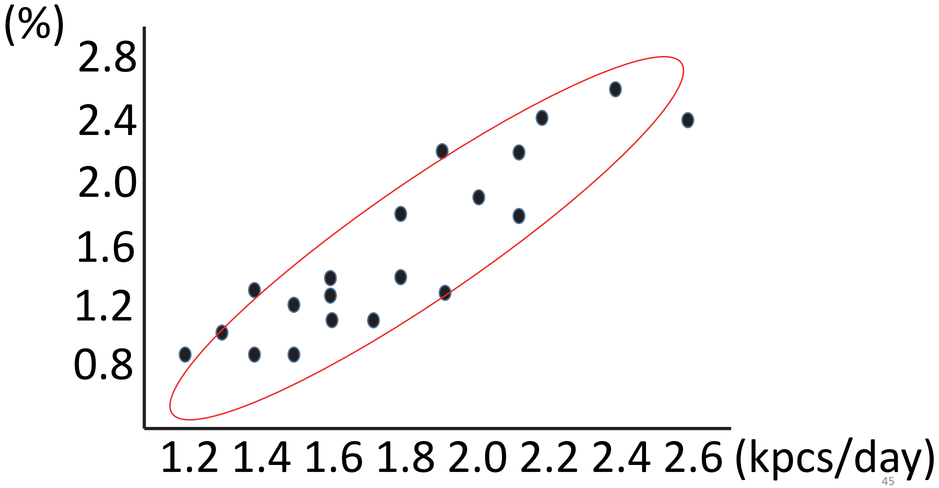
Looks positive correlation, isn't it?

3-20. 7 QC tools (Scatter diagram)

A : Add production quantity information.

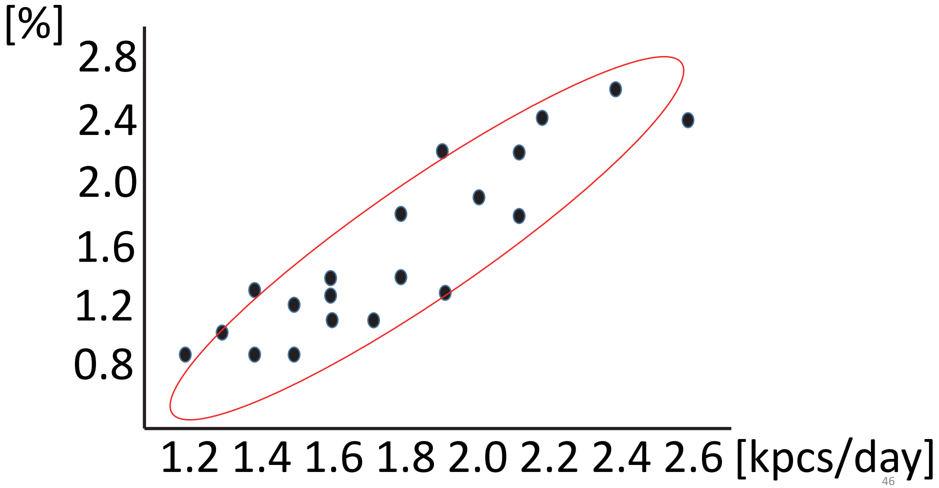
Date	Prod. qty.	Failure	Date	Prod. qty.	Failure
1(Mo)	1,400	1.3%	15(Mo)	1,500	0.9%
2(Tu)	1,200	0.9%	16(Tu)	1,400	0.9%
3(We)	1,500	1.2%	17(We)	1,900	1.3%
4(Th)	2,000	1.9%	18(Th)	1,800	1.4%
5(Fr)	2,100	1.8%	19(Fr)	2,200	2.4%
8(Mo)	1,300	1.0%	22(Mo)	1,700	1.1%
9(Tu)	1,600	1.4%	23(Tu)	1,600	1.3%
10(We)	1,600	1.1%	24(We)	1,800	1.8%
11(Th)	1,900	2.2%	25(Th)	2,100	2.2%
12(Fr)	2,400	2.6%	26(Fr)	2,600	2.4%

3-21. 7 QC tools (Scatter diagram)



3-22. 7 QC tools (Scatter diagram)

A : Former scatter diagram is spurious correlation.
Need careful consideration for correlation.



3-23. Coefficient of Correlation

To know about correlation between 2 types of data, use “Coefficient of Correlation(r)”.

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}}$$

Or “CORREL” function of excel

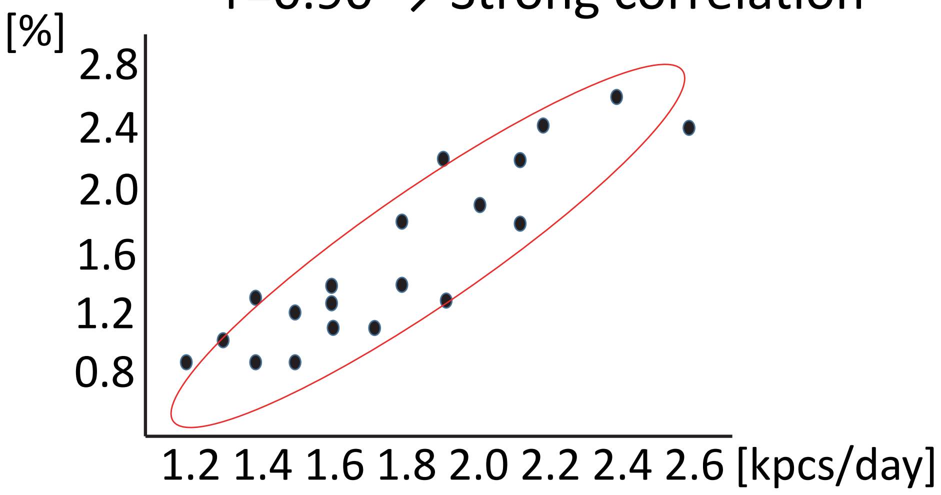
3-24. Coefficient of Correlation

Indication for strength of correlation

Coefficient of Correlation	Strength of Correlation
0.7＜|r|	Correlating strongly
0.4＜|r|≦0.7	Correlating
0.2＜|r|≦0.4	Correlating weakly
|r|≦0.2	No correlation

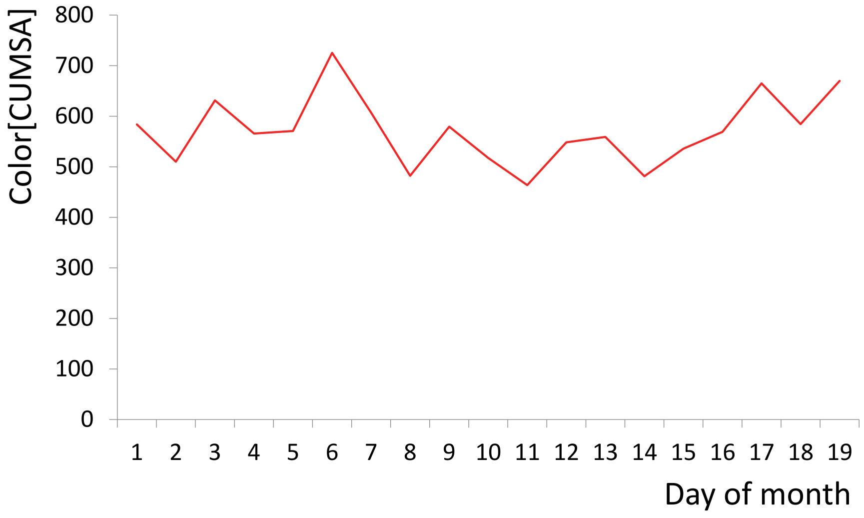
3-25. Coefficient of Correlation

r=0.90 → Strong correlation



3-26. 7 QC tools (Line graph)

[Example] Color of sugar



3-27. 7 QC tools (Line graph)

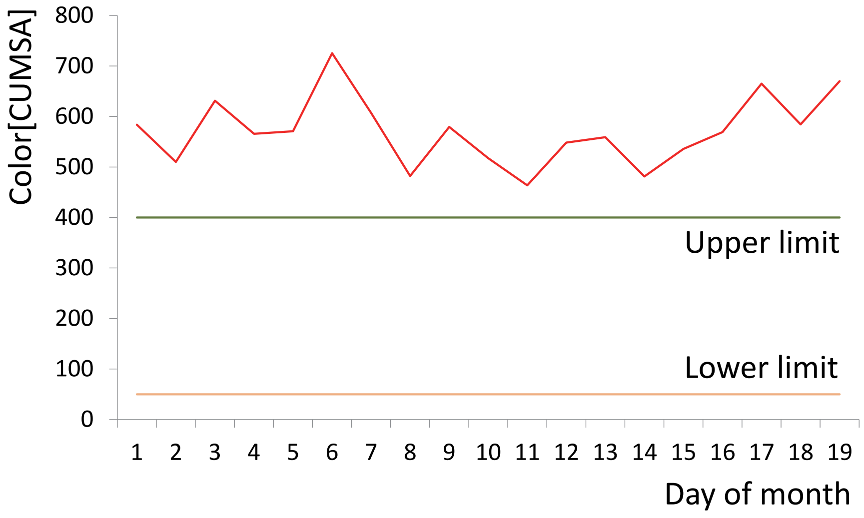
A line graph is a figure describing the movement of data in dots connected with lines.

When a center line and control limits are drawn in a line graph to determine if the dots on the graph are abnormal, the graph is called a Control chart.

A line graph is convenient for detecting temporal variations of data over a certain period of time.

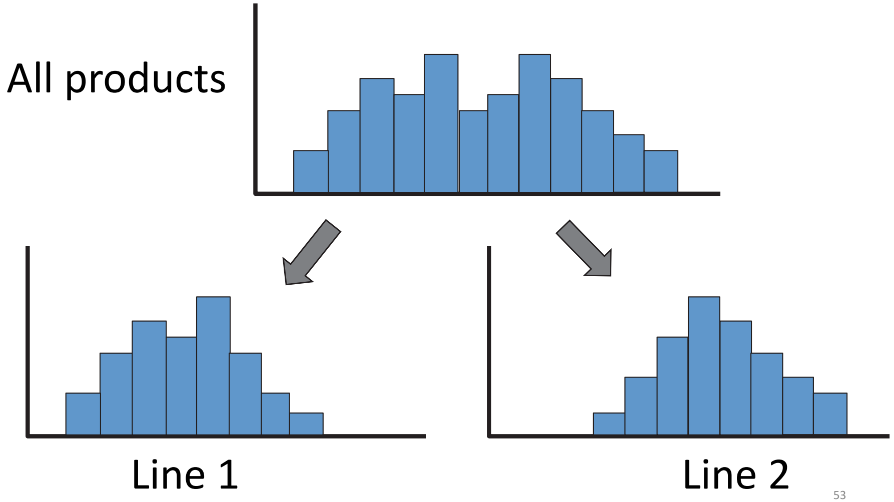
3-28. 7 QC tools (Control chart)

[Example] Color of sugar



3-29. 7 QC tools (Stratification)

[Example] Color of sugar



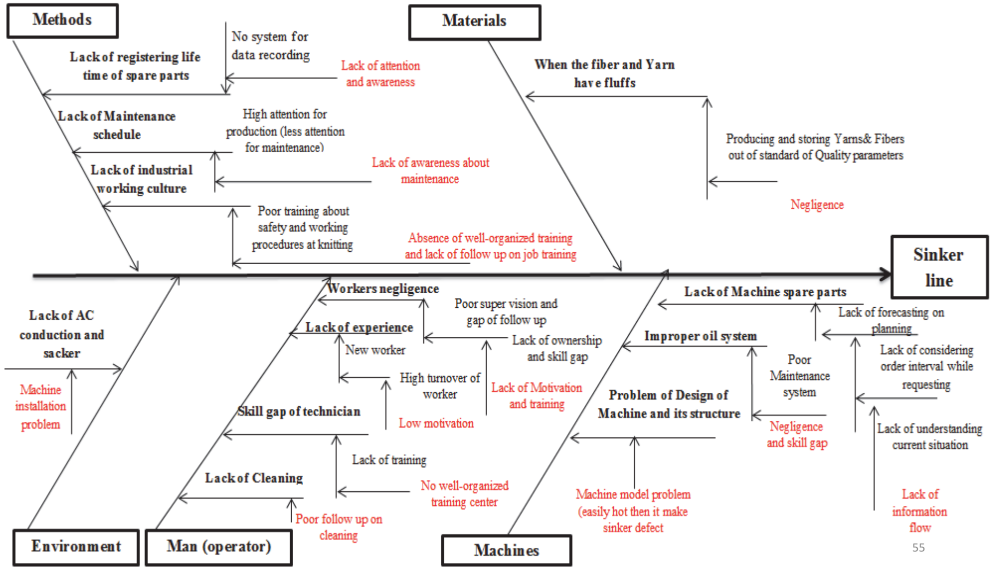
3-30. 7 QC tools (Stratification)

The objective of stratification is to grasp a problem or to analyze its causes by looking at possible and understandable factors or items.

Collected data of a single population is divided—by time, workforce, machinery, working methods, and so on—into a number of layers to find some latent characteristics among the data.

3-31. 7 QC tools (Cause & effect diagram)

[Example] Sinker line(a type of defect)



3-32. 7 QC tools (Cause & effect diagram)

A cause and effect diagram is a figure showing how the effect is affected by the cause on the view. From its shape, it is also called a fishbone diagram.

A cause and effect diagram is useful for finding out problems and solutions because it can summarize on a sheet of paper different ideas of many people.

3-33. 7 QC tools (Cause & effect diagram)

Q : Make a cause & effect diagram of
“Presenter doesn’t work.”

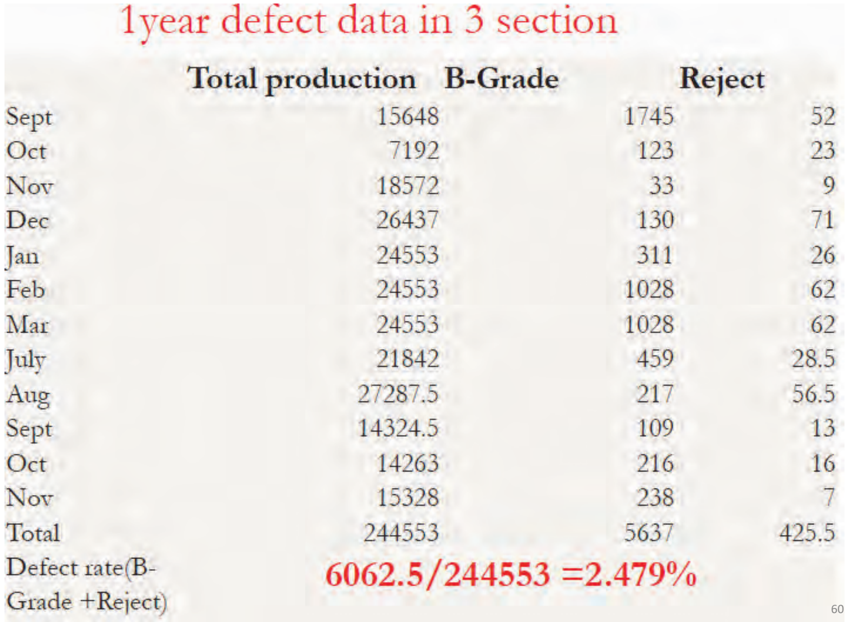
4. Case study
(Ethiopian Shoe Factory)

4-1. Selection of theme

mission	To deliver quality products and service to the right satisfaction to its customer and generate reasonable profit to the company".
vision	To be preferred shoe exporting factory in Ethiopia .
policy	• Increase exporting by 50% • To be ISO certified • Increase production capacity

- Quality improvement: 2.5% -> 1.0%
- Increase capacity: 800 pairs/day -> 1200 pairs/day by Reduction of break down & Increase productivity

4-2. Grasping status (1)



1year defect data in 3 section

	Total production	B-Grade	Reject
Sept	15648	1745	52
Oct	7192	123	23
Nov	18572	33	9
Dec	26437	130	71
Jan	24553	311	26
Feb	24553	1028	62
Mar	24553	1028	62
July	21842	459	28.5
Aug	27287.5	217	56.5
Sept	14324.5	109	13
Oct	14263	216	16
Nov	15328	238	7
Total	244553	5637	425.5
Defect rate(B-Grade +Reject)	6062.5/244553 =2.479%		

4-3. Grasping status (2)

Pareto chart for lasting section defect

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Series 1	289	211	131	113	99	86	78	61.5	52	51.5	47.5	43	39	26.5	21.5	17	12	11.5	11	9	6	1	0.5	106
Column1																								
Series 3	18.9	32.8	41.3	48.8	55.3	60.9	66	70.1	73.5	76.9	80	82	85.4	87.1	88.6	89.7	90.5	91.2	91.9	92.5	92.9	93	93	100

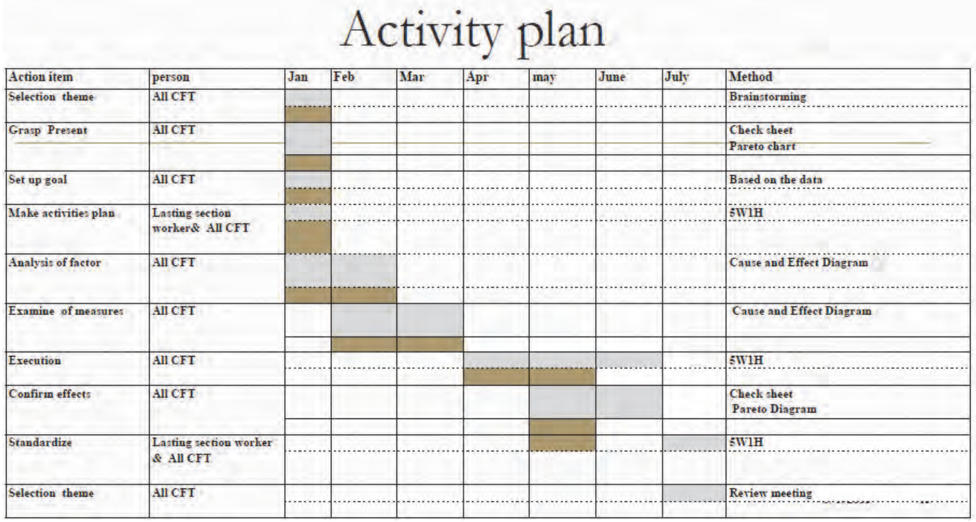
4-4. Grasping status (3)

Selected major defect type

1	**Leather Defect**	
2	**Color Variation**	

4-5. Planning

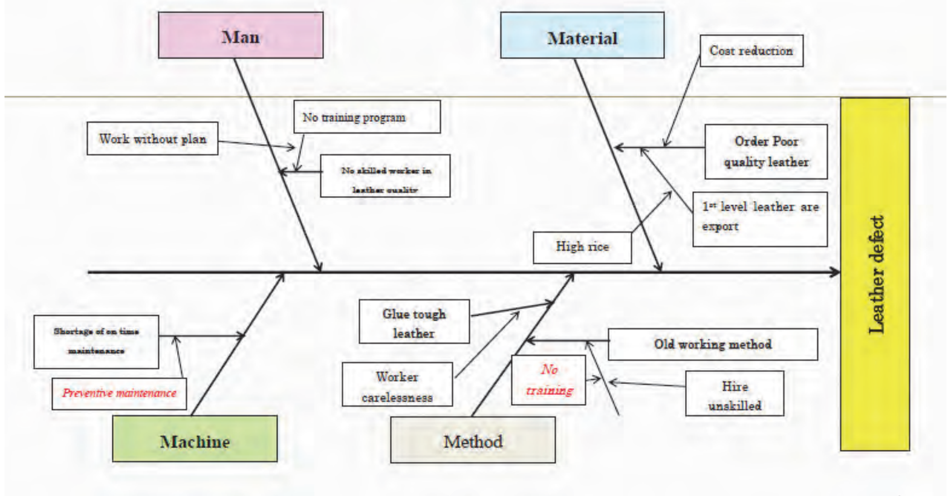
Activity plan



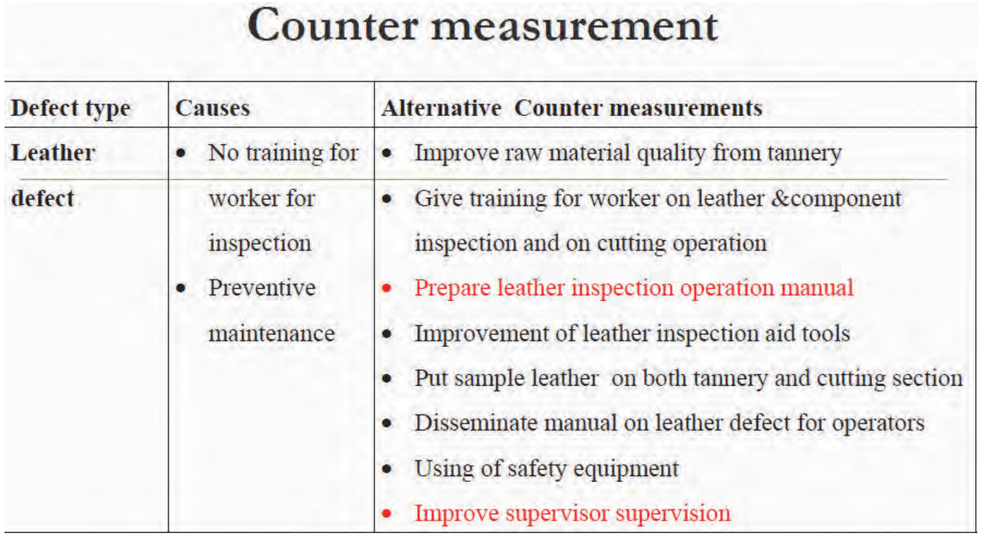
Action item	person	Jan	Feb	Mar	Apr	may	June	July	Method
Selection theme	All CFT	▨							Brainstorming
		■							
Grasp Present	All CFT	▨							Check sheet Pareto chart
		■							
Set up goal	All CFT	▨							Based on the data
		■							
Make activities plan	Lasting section worker& All CFT	▨							5W1H
		■							
Analysis of factor	All CFT	▨	▨						Cause and Effect Diagram
		■	■						
Examine of measures	All CFT		▨	▨					Cause and Effect Diagram
			■	■					
Execution	All CFT				▨	▨	▨		5W1H
					■	■			
Confirm effects	All CFT					▨	▨		Check sheet Pareto Diagram
						■			
Standardize	Lasting section worker & All CFT					■		▨	5W1H
Selection theme	All CFT							▨	Review meeting

4-6. Cause analysis

Cause analysis



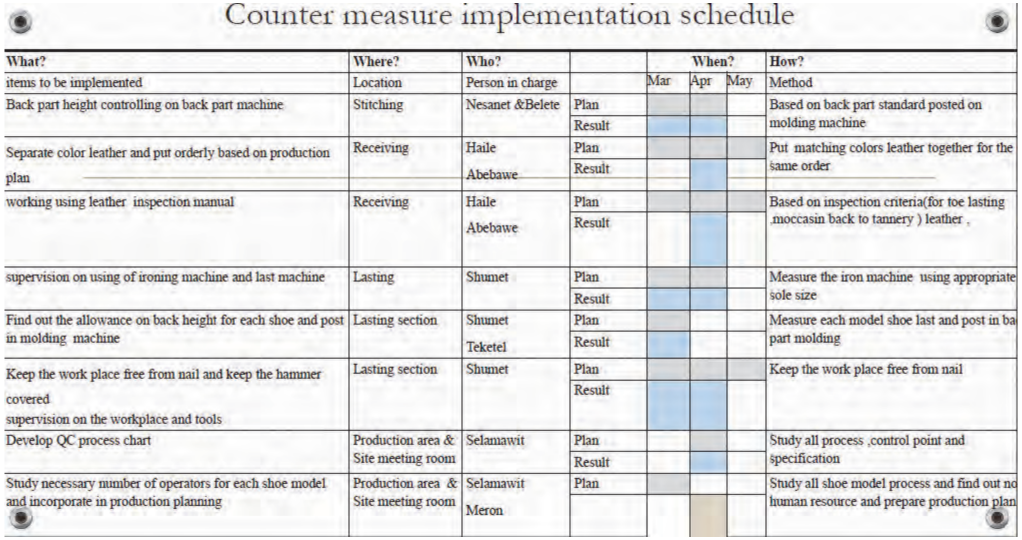
4-7. Selection of measure



Counter measurement

Defect type	Causes	Alternative Counter measurements
Leather defect	• No training for worker for inspection • Preventive maintenance	• Improve raw material quality from tannery • Give training for worker on leather &component inspection and on cutting operation • Prepare leather inspection operation manual • Improvement of leather inspection aid tools • Put sample leather on both tannery and cutting section • Disseminate manual on leather defect for operators • Using of safety equipment • Improve supervisor supervision

4-8. Planning of measure



Counter measure implementation schedule

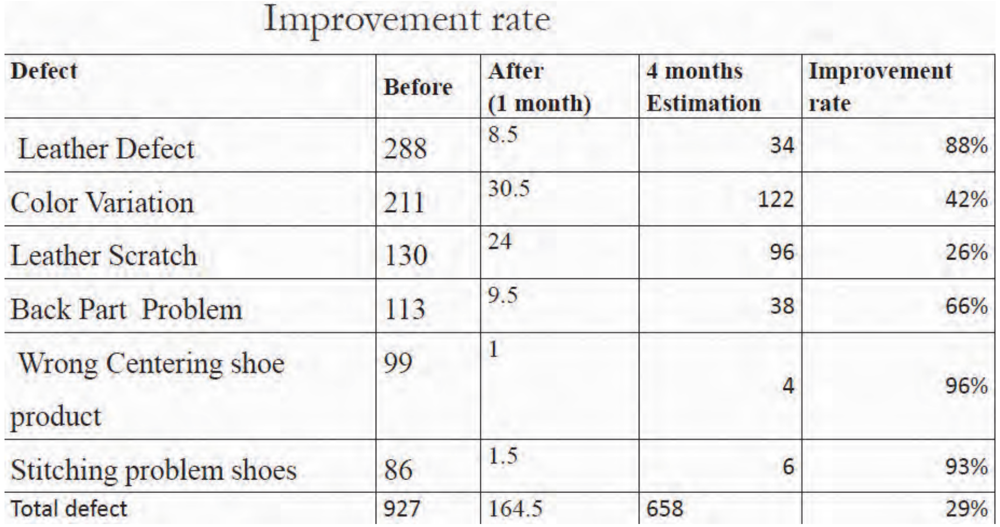
What?	Where?	Who?		When?			How?
items to be implemented	Location	Person in charge		Mar	Apr	May	Method
Back part height controlling on back part machine	Stitching	Nesanet &Belete	Plan	▨	▨		Based on back part standard posted on molding machine
			Result	🟦	🟦		
Separate color leather and put orderly based on production plan	Receiving	Haile Abebawe	Plan	▨	▨	▨	Put matching colors leather together for the same order
			Result		🟦		
working using leather inspection manual	Receiving	Haile Abebawe	Plan	▨	▨	▨	Based on inspection criteria(for toe lasting ,moccasin back to tannery) leather ,
			Result		🟦		
supervision on using of ironing machine and last machine	Lasting	Shumet	Plan	▨	▨		Measure the iron machine using appropriate sole size
			Result	🟦	🟦		
Find out the allowance on back height for each shoe and post in molding machine	Lasting section	Shumet Teketel	Plan	▨			Measure each model shoe last and post in ba part molding
			Result	🟦			
Keep the work place free from nail and keep the hammer covered supervision on the workplace and tools	Lasting section	Shumet	Plan	▨	▨	▨	Keep the work place free from nail
			Result	🟦	🟦		
Develop QC process chart	Production area & Site meeting room	Selamawit	Plan		▨		Study all process ,control point and specification
			Result		🟦		
Study necessary number of operators for each shoe model and incorporate in production planning	Production area & Site meeting room	Selamawit Meron	Plan	▨			Study all shoe model process and find out no human resource and prepare production plan
					🟫		

4-9. Implementation

Leather scratch

Problem	Cause	Solution	Counter measurement
Uncover hammer		Cover the hammer by leather	
The nail holder is no comfortable to select nails		Prepare comfortable nail holder to select easily	
Worker will disperse the nail in the work place together with shoe		Separate the nail holder and work place	

4-10. Confirm the result



Improvement rate

Defect	Before	After (1 month)	4 months Estimation	Improvement rate
Leather Defect	288	8.5	34	88%
Color Variation	211	30.5	122	42%
Leather Scratch	130	24	96	26%
Back Part Problem	113	9.5	38	66%
Wrong Centering shoe product	99	1	4	96%
Stitching problem shoes	86	1.5	6	93%
Total defect	927	164.5	658	29%

4-11. QC story (Problem solving)

QCC activity is mainly "problem solving", following "QC story". QC story has 9 steps.

(1) Selection of theme
(2) Planning
(3) Grasp of current situation
(4) Decision of objective : Pareto-diagram
(5) Cause Analysis : Why - why
(6) Planning Countermeasures and implementation
(7) Assessment of the result
(8) Standardization
(9) Reflection and future policy

5. Exercise

ANNEX

Annex-1. Brainstorming (1)

Brainstorming is a method of helping a group of people generate a lot of ideas in a short period of time.

Group thinking usually produces more ideas than individual thinking.

Annex-2. Brainstorming (2)

QC Circle can use brainstorming:

- ✓ to identify problems in the workplace,
- ✓ (to find possible causes of a problem)*,
- ✓ (to search for a solution to address a specific cause of a problem)*,
- ✓ to choose a name for the Circle,
- ✓ to figure out how to present the project to the management

* There is also an opinion that brainstorming is not appropriate to be used for fact-based analysis like cause finding.

Annex-3. Rules of Brainstorming

1. Establish a relaxed atmosphere.
2. Ensure participation of all members.
3. Gather a large number of ideas.
   - ▪Do not criticize ideas.
   - ▪Welcome common and unique ideas.
   - ▪Combine ideas.
   - ▪Record all ideas.

6. Industrial Engineering

Training Contents

1. Purpose of KAIZEN
2. What are MUDA
3. Industrial Engineering (IE)

1. Purpose of KAIZEN

1-1. Purpose of KAIZEN

What is a purpose of KAIZEN?

1-2. Purpose of KAIZEN

What is a purpose of KAIZEN?

↓

To minimize cost.

1-3. Purpose of KAIZEN

What is a purpose of KAIZEN?

↓

To minimize cost

↓

To maximize profit.

1-4. How to minimize cost

How to minimize cost?

1-5. How to minimize cost

How to minimize cost?

↓

To eliminate MUDA.

1-6. How to find MUDA

How to find MUDA?

1-7. How to find MUDA

How to find MUDA?

↓

Use Industrial Engineering(IE)

1-8. QC story (Problem solving)

QCC activity is mainly “problem solving”, following “QC story”. QC story has 9 steps.

(1) Selection of theme
(2) Planning
(3) Grasp of current situation
(4) Decision of objective : Pareto-diagram
(5) Cause Analysis : Why - why
(6) Planning Countermeasures and implementation
(7) Assessment of the result
(8) Standardization
(9) Reflection and future policy

1-9. QC story (Productivity issue)

QCC activity is mainly “problem solving”, following “QC story”. QC story has 9 steps.

(1) Selection of theme
(2) Planning
(3) Grasp of current situation
(4) Decision of objective
(5) Planning Countermeasures and implementation
(6) Assessment of the result
(7) Standardization
(8) Reflection and future policy

2. What are MUDA

2-1. 7 types of MUDA

(1) Over production
(2) Waiting
(3) Transportation
(4) Processing
(5) Inventory
(6) Motion
(7) Defects

2-2. 7 types of MUDA

1) Over production

Customer requests 5 pcs of blocks.

You plan to make 10 pcs of blocks.

What will happen?

2-3. 7 types of MUDA

1) Over production

Customer requests 5 pcs of blocks.

You plan to make 10 pcs of blocks.
What will happen?

Need stock space.

They may not be sold… Scrap

Lack of parts for 10 pcs.

2-4. 7 types of MUDA

1) Over production

Customer requests 5 pcs of blocks.

You plan to make 10 pcs of blocks.
What will happen?

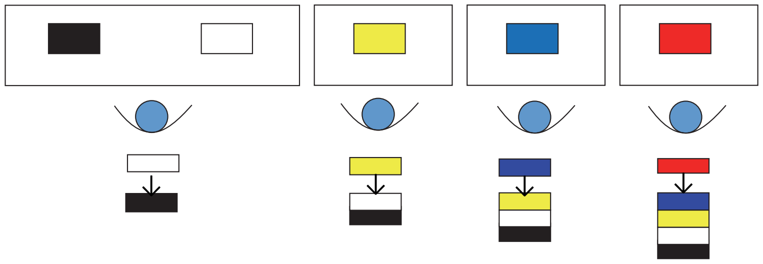
Produce necessary quantity when needed.

“**Just in time**.”

2-5. Line balance

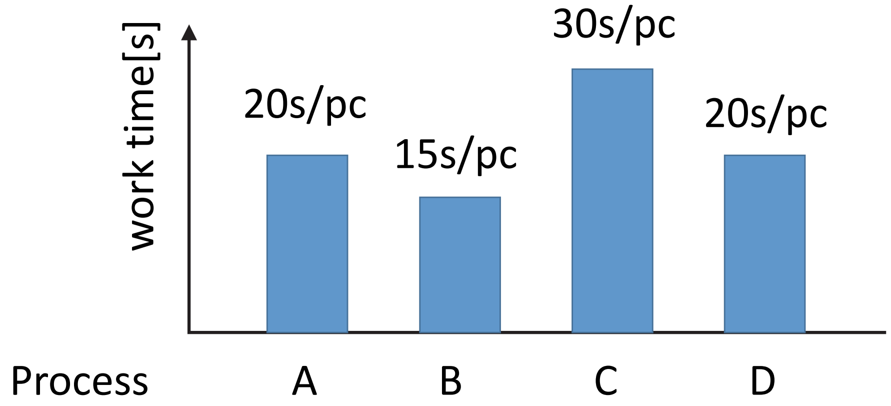
Let’s think about this process

Process	A	B	C	D
work time	20s/pc	15s/pc	30s/pc	20s/pc



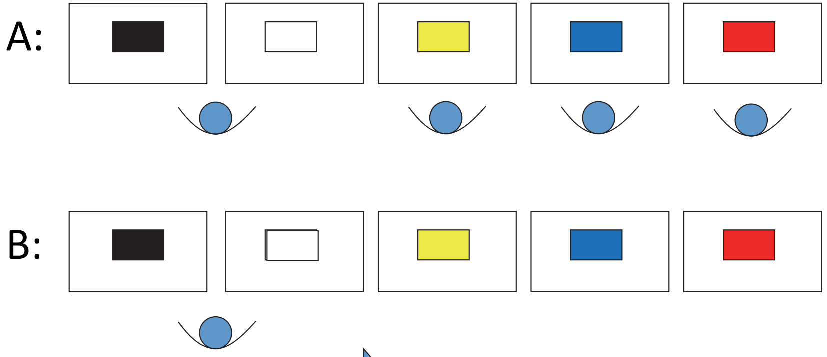
2-6. Line balance

Pitch-diagram



2-7. 7 types of MUDA

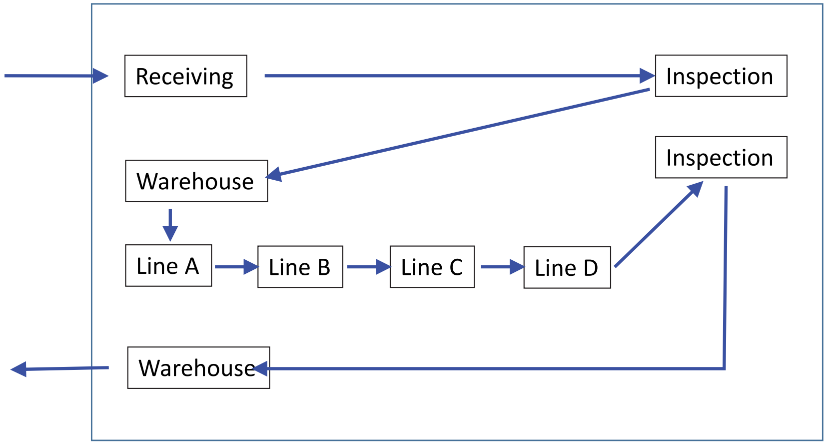
2) Waiting



➡ Way of **“Multi-skill”.**

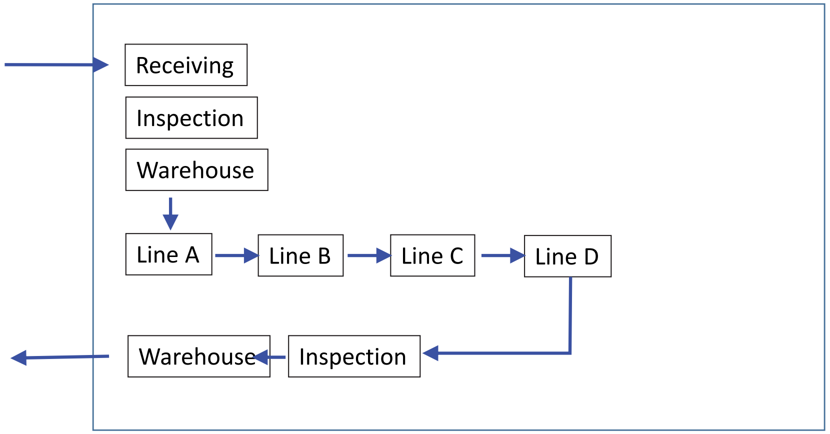
2-8. 7 types of MUDA

3) Transportation


Receiving
Inspection
Warehouse
Inspection
Line A
Line B
Line C
Line D
Warehouse

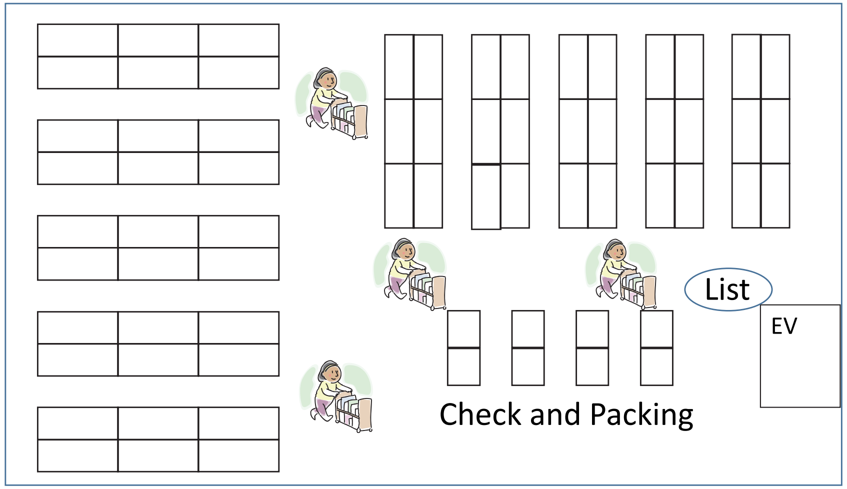
2-9. 7 types of MUDA

3) Transportation


Receiving
Inspection
Warehouse
Line A
Line B
Line C
Line D
Warehouse
Inspection

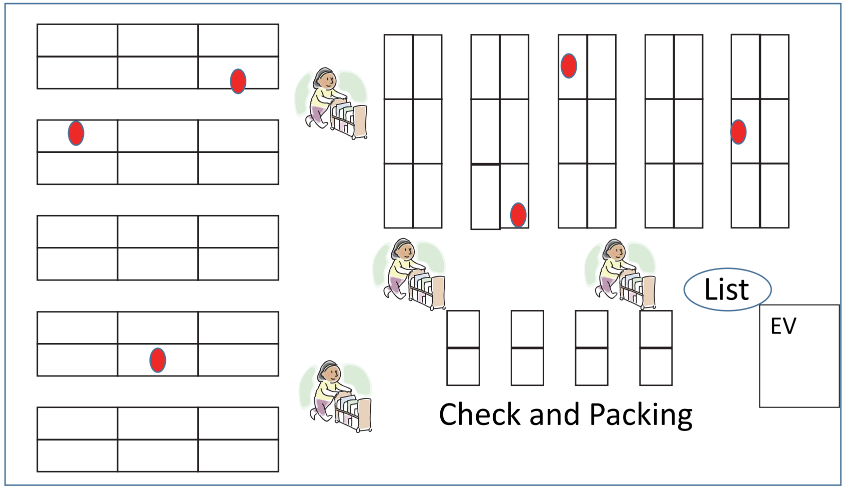
2-10. 7 types of MUDA

3) Transportation



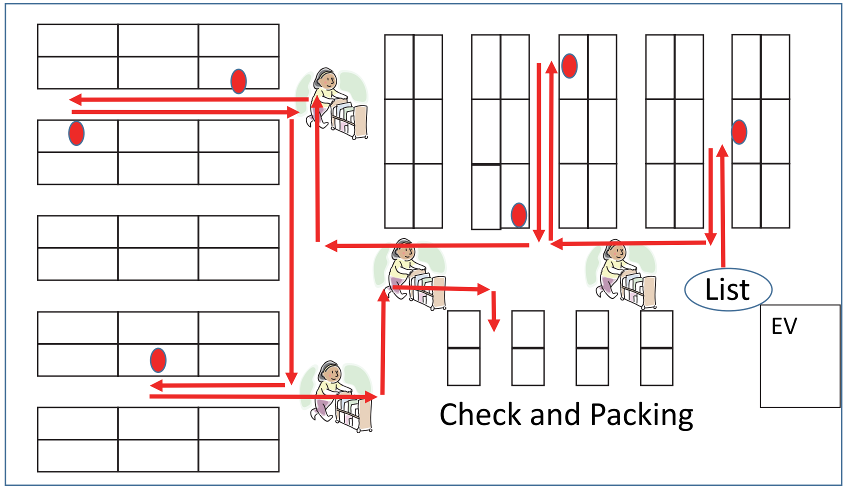
2-11. 7 types of MUDA

3) Transportation



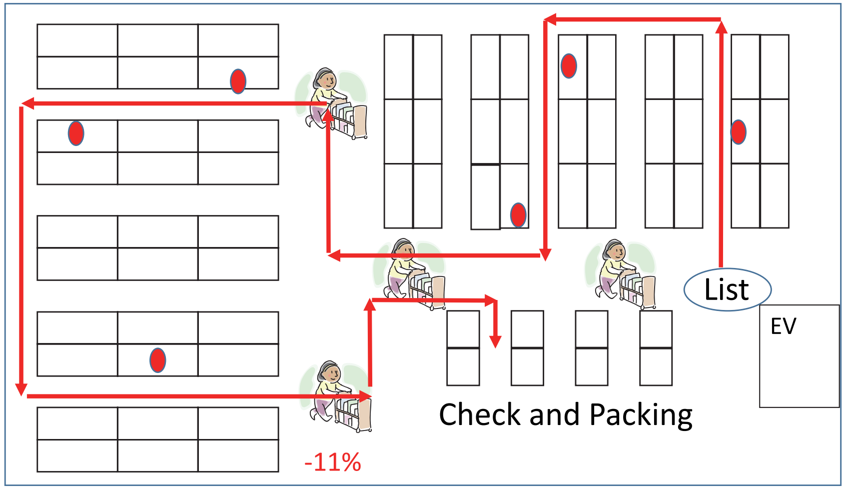
2-12. 7 types of MUDA

3) Transportation



2-13. 7 types of MUDA

3) Transportation



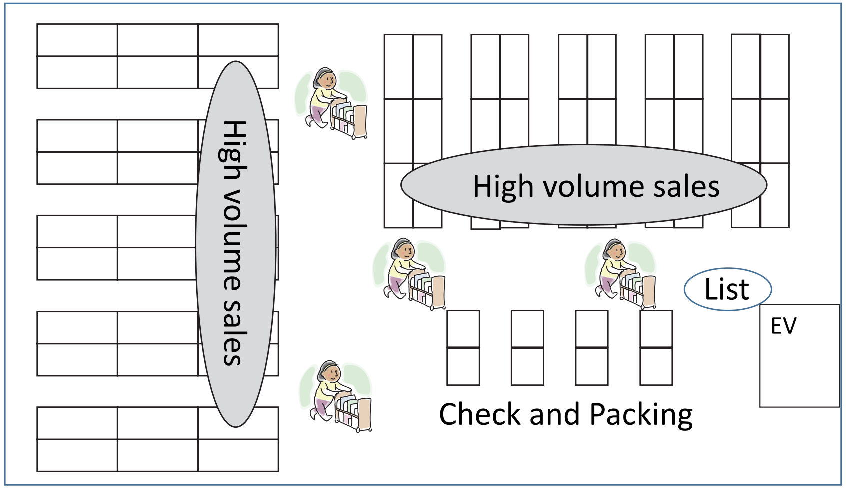
2-14. 7 types of MUDA

3) Transportation

=>Minimize transport distance.

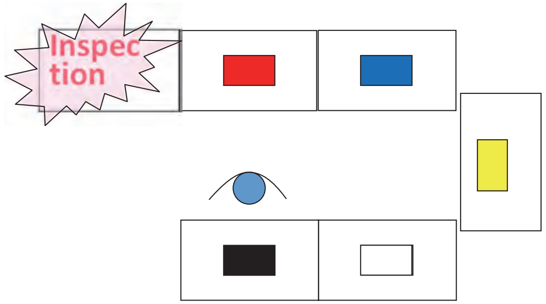
2-15. 7 types of MUDA

To shorten moving distance, anything else?



2-16. 7 types of MUDA

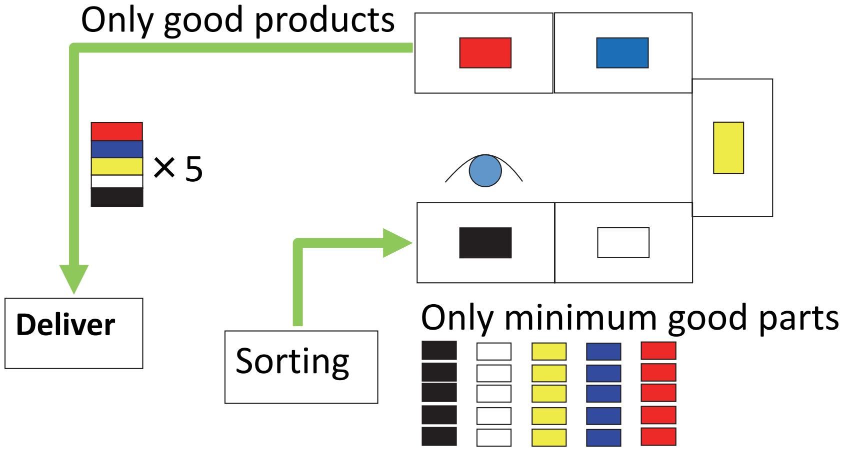
4) Processing



Inspection and Repair should be MUDA!

2-17. 7 types of MUDA

4) Processing



2-18. 7 types of MUDA

5) Inventory

"INVENTORY IS MONEY"

1) Interest

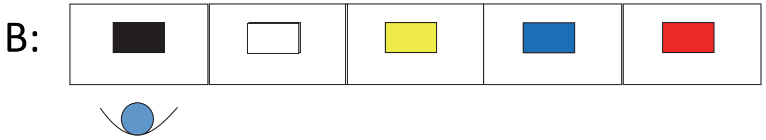
2) Inventory space : Land & building cost

3) Inventory booking : Personal cost

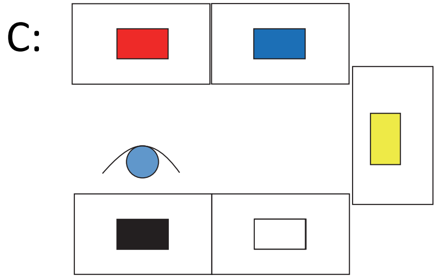
➡ Total cost = 10-15% of inventory

2-19. 7 types of MUDA

6) Motion(Moving)

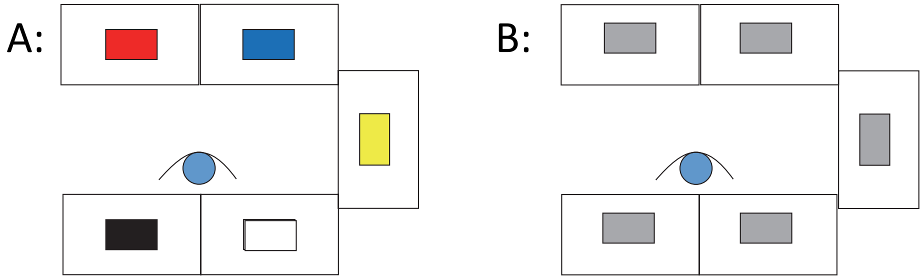


Way of
"U-shape line". ⬅



2-20. 7 types of MUDA

6) Motion(Searching)

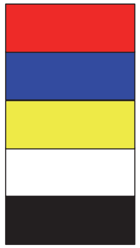


▨ : All color mixed in basket.

2-21. 7 types of MUDA

7) Failure

Specification



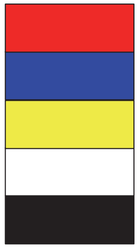
Quantity : 5

What are possible failures?

2-22. 7 types of MUDA

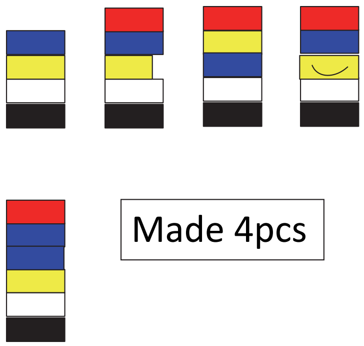
7) Failure

Specification



Quantity : 5

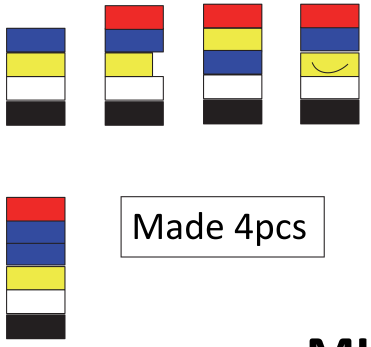
[Failure]



Made 4pcs

2-23. 7 types of MUDA

7) Failure



Made 4pcs

[To avoid delivering the failures]

- Inspection

Failure

- Repair or Scrap

MUDA of produce failure!

2-24. How to find MUDAs?

How to find MUDAs?

Video1

2-25. How to find MUDAs?

Points :

(1) Separate the operation
(2) ECRS

2-26. How to find MUDAs?

(1) Separate the operation into,

- Value-adding work
- Auxiliary work
- MUDA

2-27. How to find MUDAs?

(2) ECRS

Eliminate・・・Eliminate the process
Combine・・・2 process at one time
Rearrange・・Change process flow
Simplify ・・・ Simplify the process

2-28. How to find MUDAs?

How to find MUDAs?

Video1 Video2

2-29. How to find and eliminate MUDAs?

Step1 : Make a careful observation of target process.

Step2 : Search MUDAs with a skeptical approach.

Step3 : Take a trial before consideration.

Step4 : If the idea fails, try the next idea.
If the idea succeeds, think about standardizing and sustaining.

---

3. Industrial Engineering (IE)

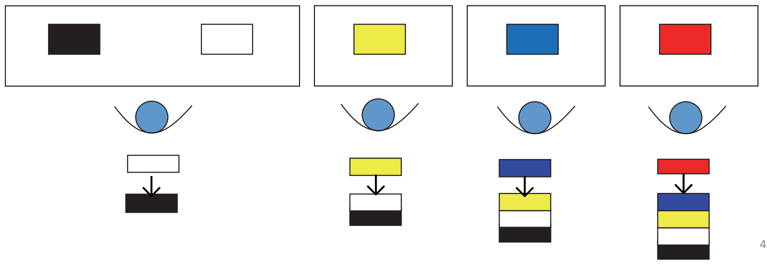
3-1. Types of IE methodology

- Process study
- Time study
- **Line balance analysis**
- Motion study
- Ratio-delay study
- Plant layout
- Multi-activity analysis

3-2. Line balance

Exercise : A company produces the goods continuously with the process shown below. Find 2 ideas to improve productivity and compare current and the two.
※Difficulty level of operation is medium.

Process	A	B	C	D
work time	20s/pc	15s/pc	30s/pc	20s/pc



3-3. Line balance

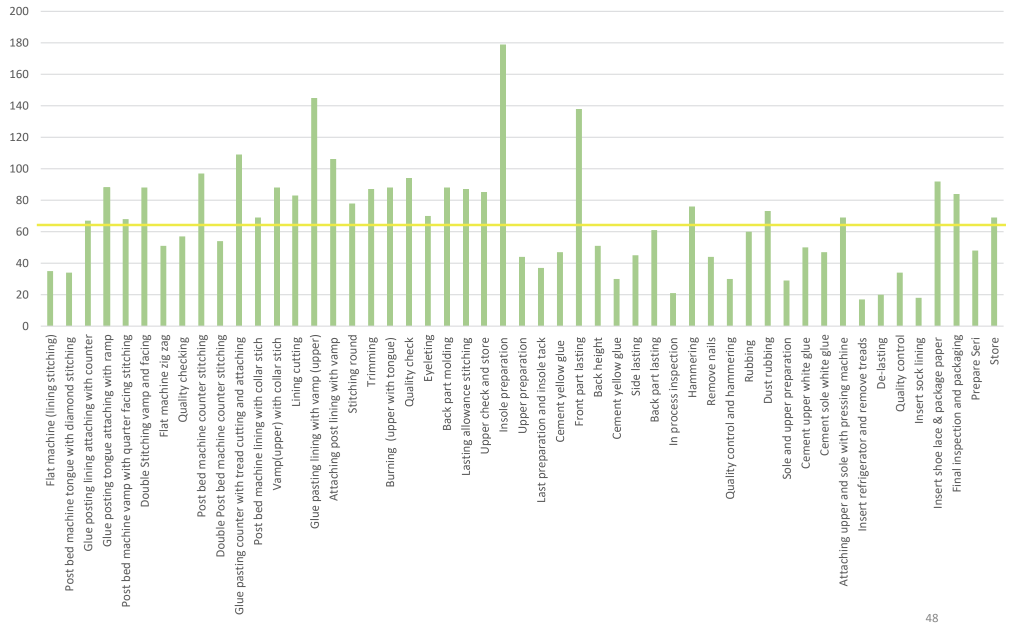
	Current	Plan A	Plan B
Improve-ment idea	Current		
Lead time	120s/pc	xx s/pc	yy / pc
Positive points	—	▪aa % up ▪	▪bb % up ▪
Negative points	—	▪ ▪	▪ ▪

3-4. Line balance

	Current	Plan A	Plan B
Improve-ment idea	Current	2 operators to process C	One person operation
Lead time	120s/pc	80s/pc	85s/pc
Positive points	—	▪17% up ▪Easy training	▪29% up ▪Flexible production
Negative points	—	▪Need additional operator	▪Training is not easy

---

3-5. Line balance



3-6. Motion study

glue pasting lining with counter

3-7. Motion study

insole preparation

3-8. Motion study

front part lasting

3-9. Line balance

no.	Process	Operation	Time (sec)
1	Glue posting lining attaching with counter	Glue posting counter	19
		Dry	30
		Attaching counter with vamp	21
		Glue posting vamp	23
		Attaching vamp with lining	17.4
2	insole preparation	Glue posting insole	14
		dry	25
		Attaching insoles	19
3	front part lasting	Heat treatment	42
		Front part lasting	20
		Hammering	12.2

3-10. Multi-activity analysis

Multi-activity analysis is an analysis method using operational timing chart between multi-activity, like man – man or man-machine. This method is used to know the loss of multi-activity.

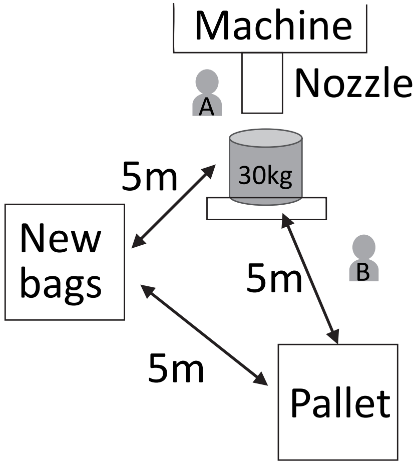
3-11. Multi-activity analysis

The finishing process in sugar factory,

3-12. Multi-activity analysis

The finishing process in sugar factory, each operating time is as follows,

Set the new bag : A : 10s
Fill sugar to the bag : A : 60s
Adjust to 30kg±1kg :A : 10s
Pack : B : 30s
Move to pallet : B : 30s
Take a new bag : B : 10s



3-13. Multi-activity analysis

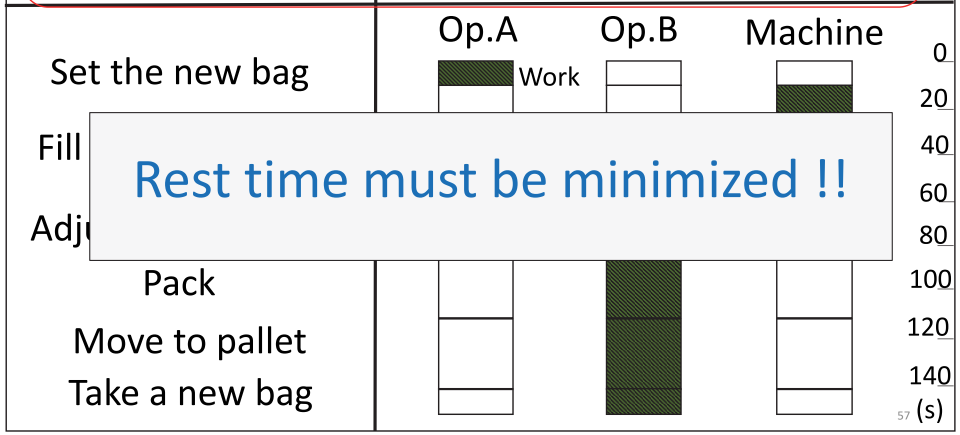
- Operational timing chart

	Op.A	Op.B	Machine
Cycle time	150s	150s	150s
Work (%)	20s(13%)	70s(47%)	60s(40%)
Rest (%)	130s(87%)	80s(53%)	90s(60%)

3-14. Multi-activity analysis

・Operational timing chart

Cycle time	150s	150s	150s
Work (%)	20s(13%)	70s(47%)	60s(40%)
Rest (%)	130s(87%)	80s(53%)	90s(60%)



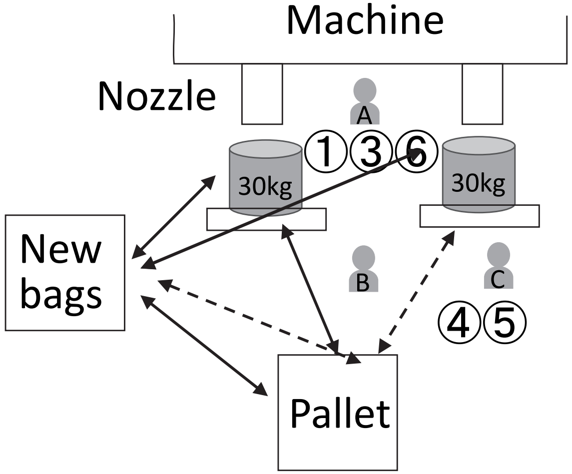
Rest time must be minimized !!

3-15. Group discussion

Read Case and individual consideration	30min
Group discussion	60min
Presentation and general discussion	20min/group

3-16. Group discussion

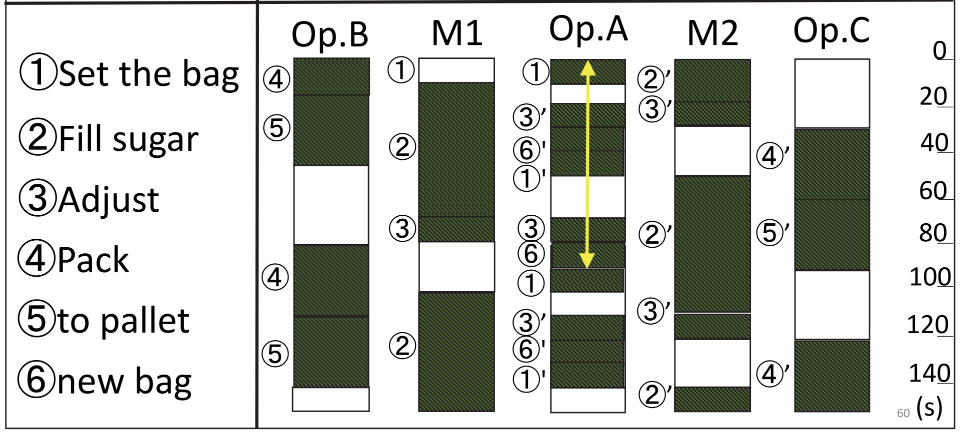
①Set the bag
②Fill sugar
③Adjust
④Pack
⑤Move to pallet
⑥Take a new bag



3-17. Multi-activity analysis

・Operational timing chart

Cycle time	90s				
Work (%)	60s(67%)	70s(78%)	60s(67%)	70s(78%)	60s(67%)
Rest (%)	30s(33%)	20s(22%)	30s(33%)	20s(22%)	30s(33%)



3-18. QC story (Productivity issue)

QCC activity is mainly “problem solving”, following “QC story”. QC story has 9 steps.

(1) Selection of theme
(2) Planning
(3) Grasp of current situation : Time study
(4) Decision of objective : Pitch-diagram
(6) Planning Countermeasures and implementation : Multi-activity analysis
(7) Assessment of the result
(8) Standardization
(9) Reflection and future policy

7. Costing & Accounting

Training Contents

1. Costing
2. Accounting

1. Costing

1-1. Purpose of Costing

Purpose of costing is to know how much money a company spent to make their products.

1-2. Example of Costing

To make a bottle of juice, it needs

- Fruits
- Water
- Factory
- Labors
- Tools
- Equipment

1-3. Exercise

Exercise

Calculate how much money is needed for a bottle of juice.
(This factory plans to produce 300 bottles/day)

- Fruits : 3,000 BDT/300 bottles
- Water : 100 BDT/20 bottles
- Factory(rental) : 6,000 BDT/day
- Labors : 6,000 BDT/day
- Tools : 9,000 BDT
- Equipment : 1,800,000 BDT

1-4. Answer

Answer

Calculate the money for a bottle of juice.
(This factory plans to produce 300 bottles/day)

- Fruits : 3,000 BDT/300 bottles … 10 BDT
- Water : 10 BDT/20 bottles … 5 BDT
- Factory : 6,000 BDT/day … 20 BDT
- Labors : 6,000 BDT/day … 20 BDT
- Tools : 9,000 BDT … 0.1 BDT*
- Equipment : 1,800,000 BDT … 4 BDT*

TOTAL 55.5 BDT

1-5. Expense and fixed asset

Expense : Amounts paid for goods
and services that may
be currently tax deductible.

⇨ Can be deducted in the year.

Fixed asset : Land, buildings, or
equipment that a
business owns and uses.

⇨ Can not be deducted in the year.

1-6. Depreciation

Fixed asset : Land, buildings, or
equipment that a
business owns and uses.

⇨ Can not be deducted in the year.

⇨ Should be deducted in some years.
e.g. PC … 2 years
Equipment … 5-8 years
Building … 30 years

1-7. Types of Costing

- Standard costing
- Actual Costing

1-8. Standard Costing

Standard costing is to make plan of the cost.

1-9. Answer

Answer

Calculate the money for a bottle of juice.
(This factory plans to produce 300 bottles/day)

- Fruits : 3,000 BDT/300 bottles … 10 BDT
- Water : 10 BDT/20 bottles … 5 BDT
- Factory : 6,000 BDT/day … 20 BDT
- Labors : 6,000 BDT/day … 20 BDT
- Tools : 9,000 BDT … 0.1 BDT*
- Equipment : 1,800,000 BDT … 4 BDT*

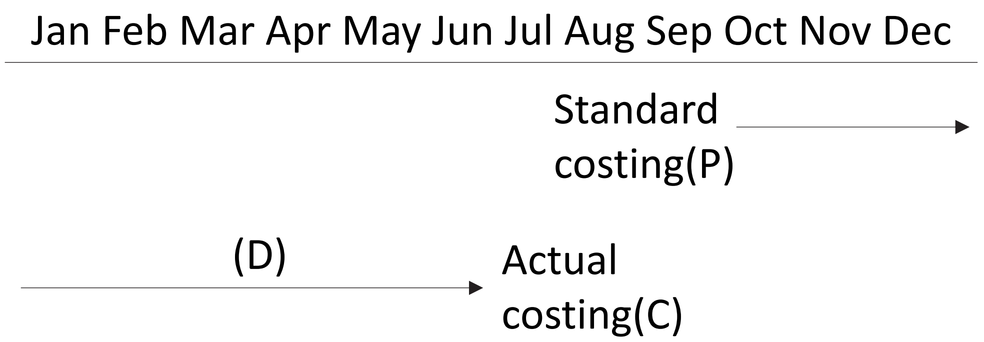
TOTAL 55.5 BDT

1-10. Actual Costing

Actual costing is to know the actual cost.

1-11. Actual Costing

Actual costing is to know the actual cost.

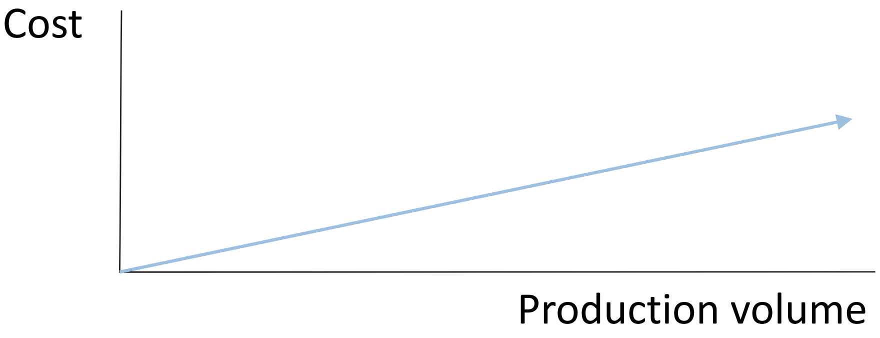


1-12. Fixed cost and Variable cost

Fixed cost : The costs that don’t increase in proportion to the production volume.

1-13. Fixed cost and Variable cost

Variable cost : The costs that increase in proportion to the production volume.



1-14. Exercise

Exercise

Identify fixed cost or variable cost.

- Fruits : 3,000 BDT/300 bottles …
- Water : 100 BDT/20 bottles …
- Factory : 6,000 BDT/day …
- Labors : 6,000 BDT/day …
- Tools : 9,000 BDT …
- Equipment : 1,800,000 BDT …

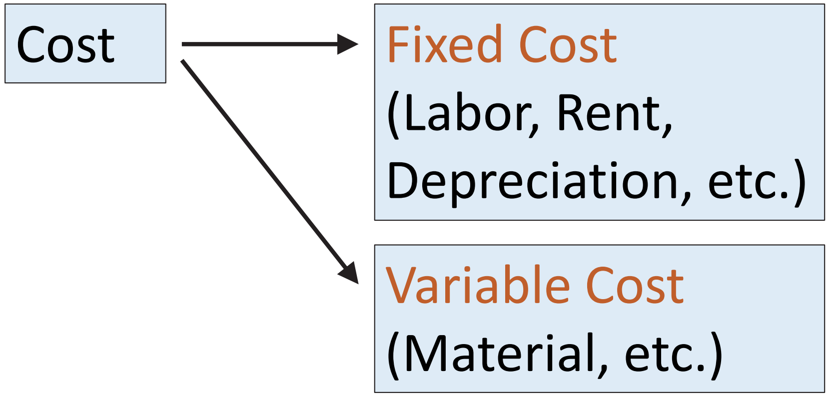
1-15. Answer

Answer

Identify fixed cost or variable cost.

- Fruits : 3,000 BDT/300 bottles … Variable
- Water : 100 BDT/20 bottles … Variable
- Factory : 6,000 BDT/day … Fixed
- Labors : 6,000 BDT/day … Fixed
- Tools : 9,000 BDT … Fixed
- Equipment : 1,800,000 BDT … Fixed

1-16. Break-even point

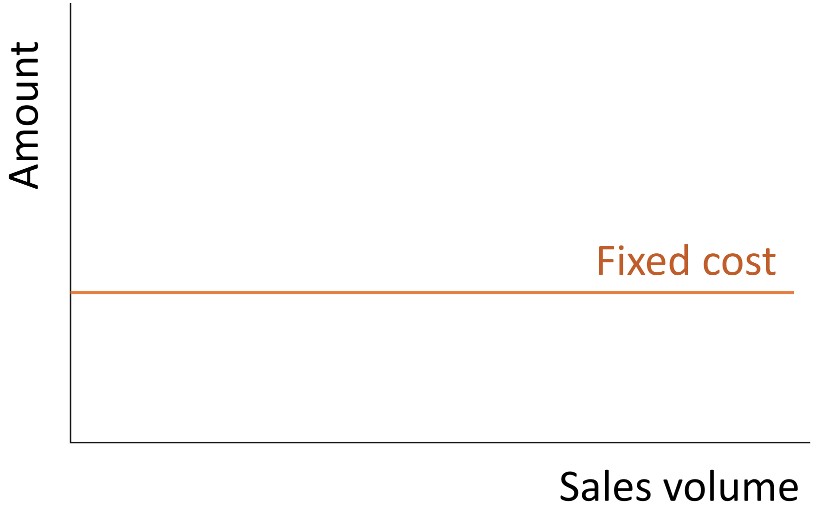


Cost

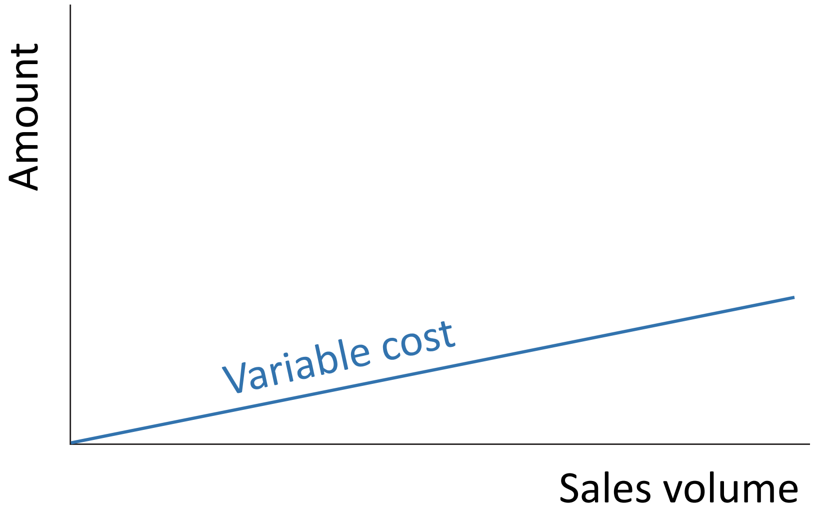
Fixed Cost (Labor, Rent, Depreciation, etc.)

Variable Cost (Material, etc.)

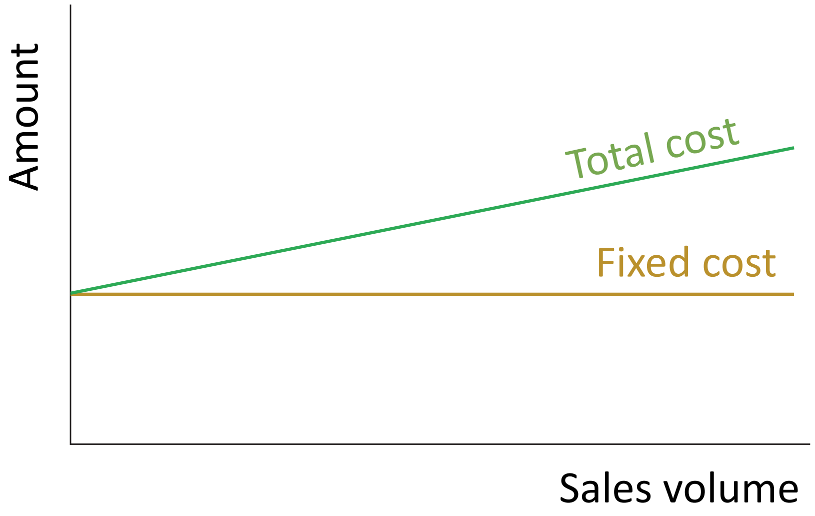
1-17. Break-even point



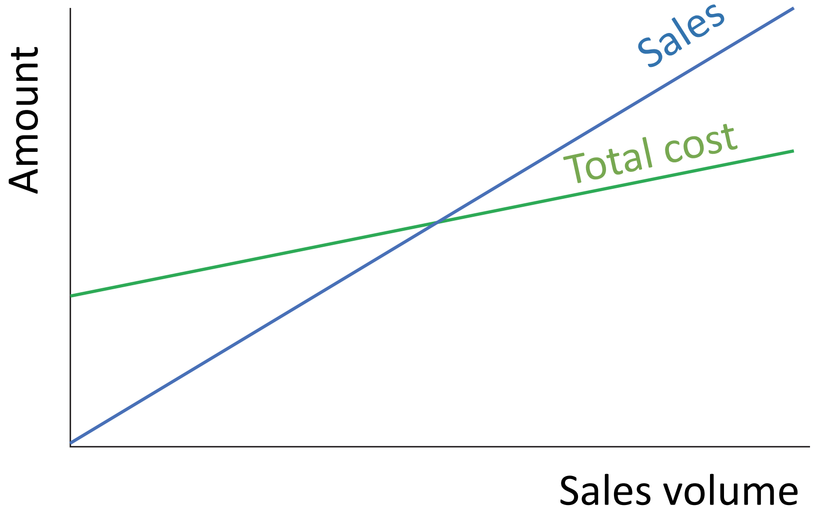
1-18. Break-even point



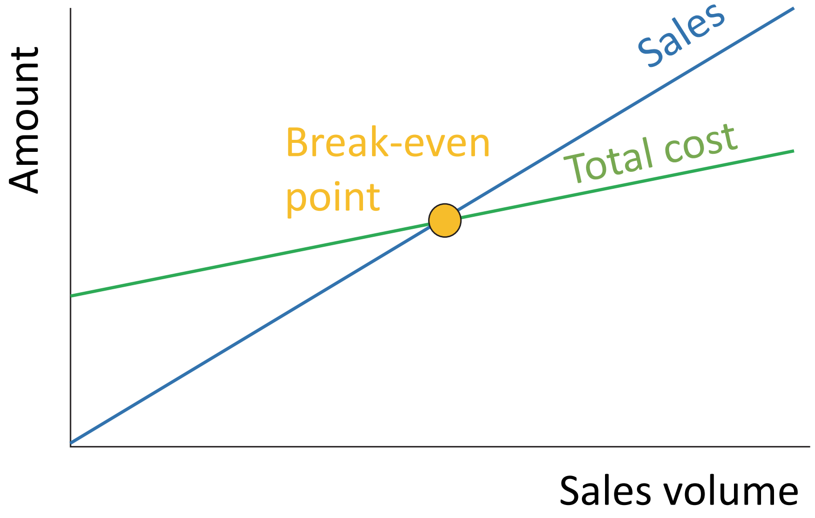
1-19. Break-even point



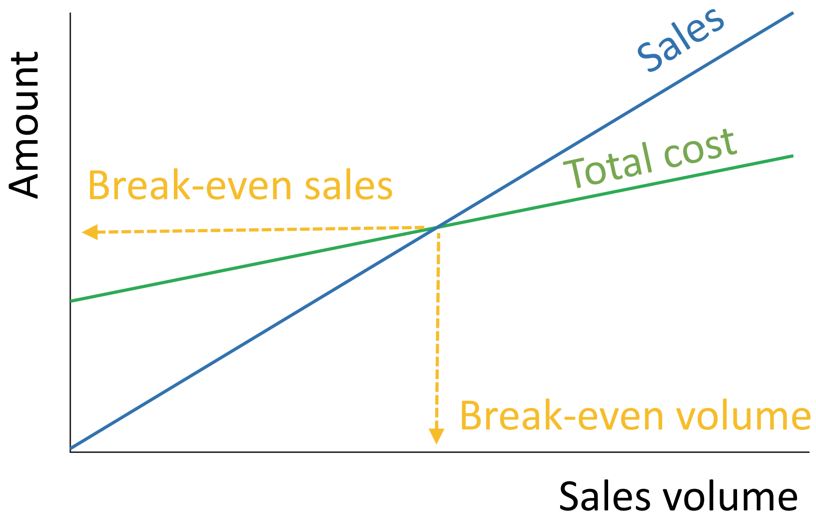
1-20. Break-even point



1-21. Break-even point



1-22. Break-even point



1-23. Break-even point

$$\text{Break-even volume} = \frac{\text{Fixed cost}}{\text{Selling price - Variable cost (/pc)}}$$

Break-even sales (Break-even point)

= Break-even volume × Selling price

1-24. Break-even point

Break-even sales

= Break-even volume × Selling price

$$= \frac{\text{Fixed cost} \times \text{Selling price}}{\text{Selling price - Variable cost (/pc)}}$$

$$= \frac{\text{Fixed cost}}{1 - \dfrac{\text{Variable cost (/pc)}}{\text{Selling price}}}$$

1-25. Break-even point

$$\text{Break-even sales} = \frac{\text{Fixed cost}}{1 - \dfrac{\text{Variable cost (/pc)}}{\text{Selling price}}}$$

$$= \frac{\text{Fixed cost}}{1 - \dfrac{\text{Variable cost (/year)}}{\text{Sales}}}$$

1-26. Break-even point

Exercise

Calculate break-even volume and break-even sales with following conditions.

- Selling price per piece : 500 BDT
- Fixed cost : 100,000 BDT/day
- Variable cost : 300,000 BDT/1,000pcs

1-27. Break-even point

Answer

$$\text{Break-even volume} = \frac{\text{Fixed cost}}{\text{Selling price - Variable cost (/pc)}}$$

Variable cost = 300,000 / 1,000 = 300

Break-even volume = 100,000 / (500 - 300)

= 500

A : 500 pcs/day

1-28. Break-even point

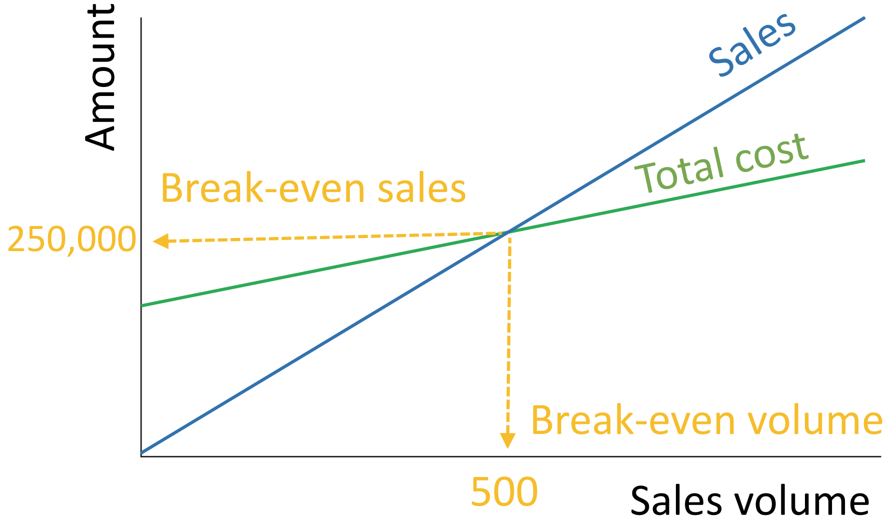
Answer

Break-even sales = Break-even volume × Selling price

= 500 × 500

= 250,000 BDT/day

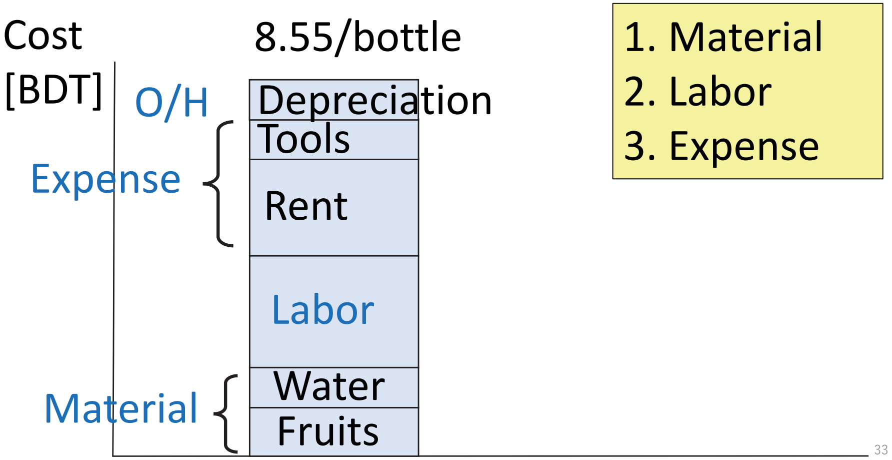
1-29. Break-even point



1-30. Cost reduction ideas

Exercise

What kind of cost reduction ideas can be taken?



1. Material
2. Labor
3. Expense

---

2. Accounting

2-1. Accounting

- Legal financial accounting
- Management accounting

Legally, legal financial accounting is more important.
But to consider how to make more profit, management accounting is useful.

2-2. Accounting

- Legal financial accounting
- Management accounting

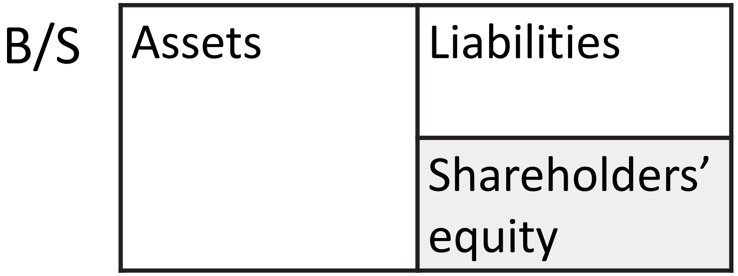
For both types of accounting, **financial statements** are key documents.

2-3. Financial statements

- Balance sheet
- Profit and loss statement
- Cash flow statement, etc.

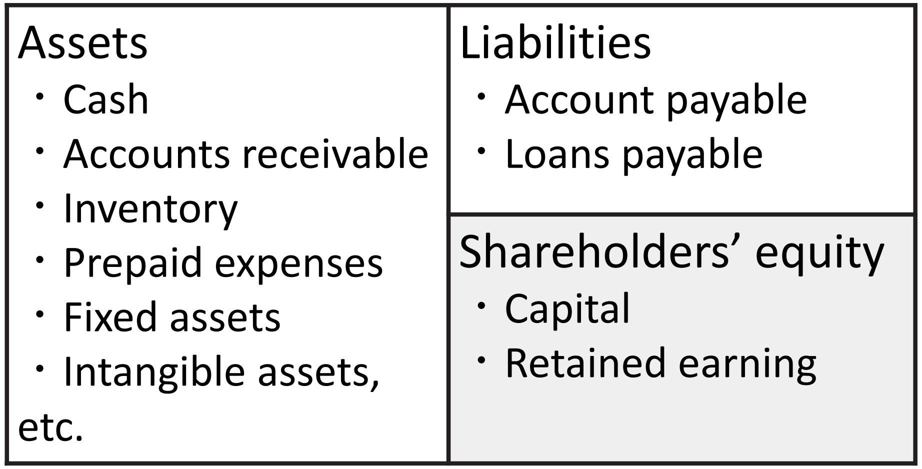
2-4. B/S and P/L

Balance sheet(B/S) is a financial statement that summarizes a company's "Assets", "Liabilities" and "Shareholders' equity" at a specific point in time.



2-5. B/S and P/L

Account titles of B/S


Assets

- Cash
- Accounts receivable
- Inventory
- Prepaid expenses
- Fixed assets
- Intangible assets,

etc.

Liabilities

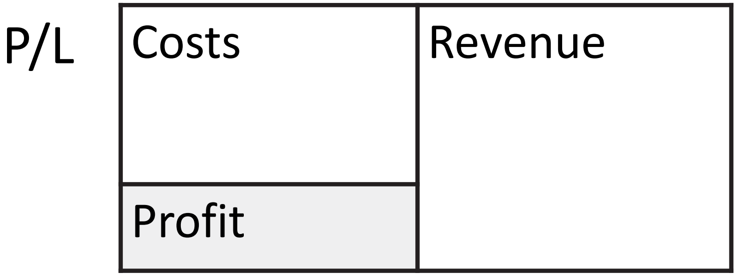
- Account payable
- Loans payable

Shareholders' equity

- Capital
- Retained earning

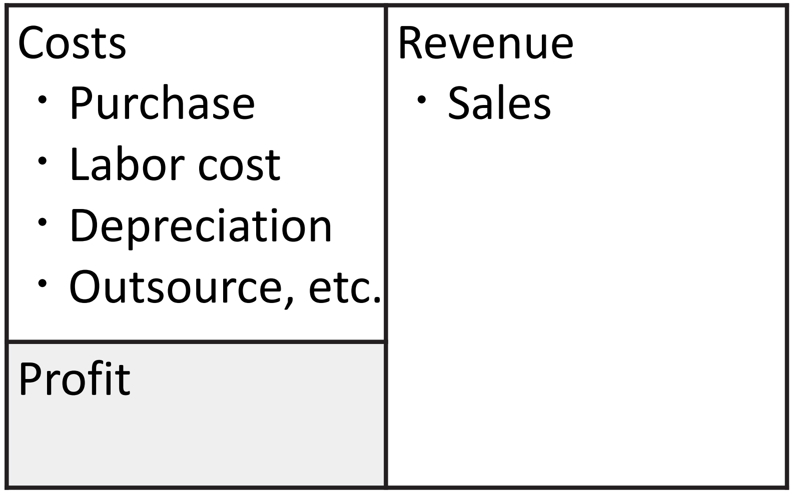
2-6. B/S and P/L

A profit and loss statement (P/L) is a financial statement that summarizes the "Revenues", "Costs" and "Profit" incurred during a specific period of time.



2-7. B/S and P/L

Account titles of P/L



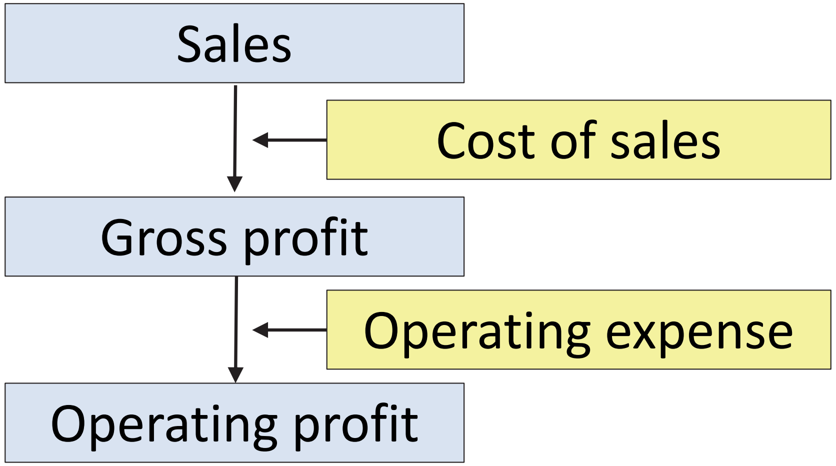
Costs
- Purchase
- Labor cost
- Depreciation
- Outsource, etc.

Profit

Revenue
- Sales

2-8. B/S and P/L

There are many types of costs and profits



Sales

Cost of sales

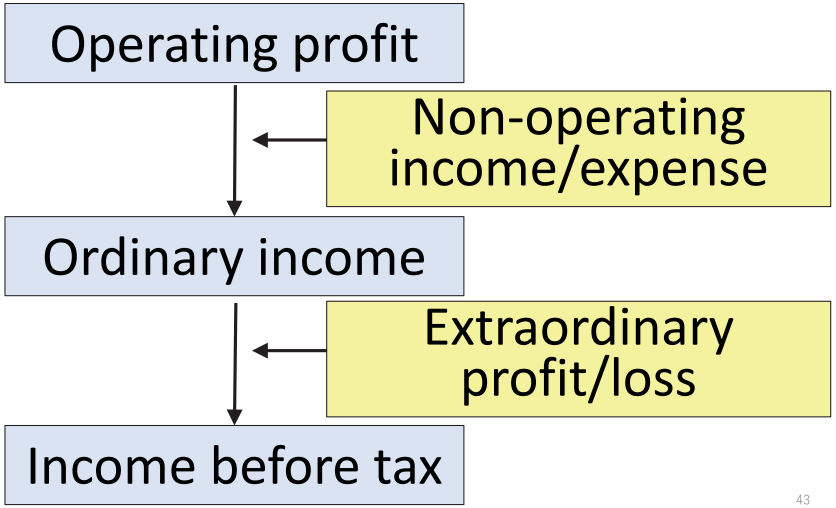
Gross profit

Operating expense

Operating profit

2-9. B/S and P/L

There are many types of costs and profits



Operating profit

Non-operating income/expense

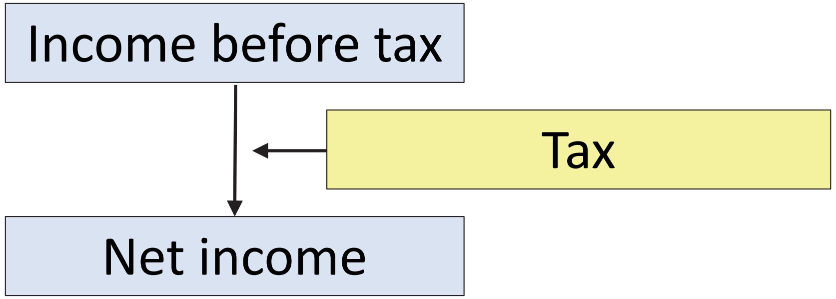
Ordinary income

Extraordinary profit/loss

Income before tax

2-10. B/S and P/L

There are many types of costs and profits



Income before tax

Tax

Net income

2-11. B/S and P/L

Cost of sales	Material, Direct labor
Operating expense	In-direct labor, Expenses
Non-operating income/expense	Interest of loan
Extraordinary profit/loss	Profit by selling fixed asset, restructuring cost,

2-12. Financial statements

- Balance sheet
- Profit and loss statement

To make these statements,
Journalizing is basic process.

2-13. Journalizing

Journalizing is separating transaction into Debit and Credit.

2-14. Journalizing

e.g. Bought a camera for 10,000BDT.

Bought a camera for 10,000 BDT.	10,000 BDT of cash decreased.
Journalizing	
Consumable 10,000	Cash 10,000

2-15. Journalizing

e.g. Borrow 1,000,000 BDT from bank.

Debit	Credit
Cash 1,000,000	Loan 1,000,000

2-16. Journalizing

e.g. Purchase goods for 100,000 BDT.

Debit	Credit
Purchase 100,000	Cash 100,000

2-17. Journalizing

Debit or Credit?

	Debit	Credit
Balance sheet	Assets ⤴	Assets ⤵
	Liabilities ⤵	Liabilities ⤴
	Equity ⤵	Equity ⤴
Profit & loss statement	Revenue ⤵	Revenue ⤴
	Costs ⤴	Costs ⤵

2-18. Journalizing

e.g. Bought a camera for 10,000BDT.

Debit	Credit
Consumable 10,000	Cash 10,000
(Cost ⤴)	(Asset ⤵)

2-19. Consumable and Fixed asset

e.g. Bought a new building for 20M BDT.

Debit	Credit
Building 20,000,000	Cash 20,000,000

2-20. Consumable and Fixed asset

e.g. Bought a new building for 20MBDT.

Debit	Credit
Building 20,000,000	Cash 20,000,000

Debit	Credit
Depreciation 660,000	Building 660,000

2-21. Journalizing

e.g. Borrow 1,000,000 BDT from bank.

Debit	Credit
Cash 1,000,000	Loan 1,000,000
(Asset ↗)	(Liability ↗)

2-22. Journalizing

e.g. Purchase goods for 100,000 BDT.

Debit	Credit
Purchase 100,000	Cash 100,000
(Cost ↗)	(Asset ↘)

2-23. B/S and P/L

Exercise

Journalize following transactions. And make B/S and P/L.

- Decide to start own business and prepare 1,000,000 BDT for capital.
- Purchase goods for 600,000 BDT.
- Sell all purchased goods for 800,000 BDT.

2-24. B/S and P/L

- Decide to start own business and prepare 1,000,000 BDT for equity.

Debit	Credit
Cash 1,000,000	Capital 1,000,000
(Asset ⤴)	(Equity ⤴)

2-25. B/S and P/L

- Purchase goods for 600,000 BDT.

Debit	Credit
Merchandise 600,000	Cash 600,000
(Cost ⤴)	(Asset ⤵)

2-26. B/S and P/L

- Sell all purchased goods for 800,000 BDT.

Debit	Credit
Cash 800,000	Sales 800,000
(Asset ⤴)	(Revenue ⤴)

2-26. B/S and P/L

- Sell all purchased goods for 800,000 BDT.

Debit	Credit
Purchase 600,000	Merchandise 600,000
(Cost ↗)	(Asset ↘)

2-27. B/S and P/L

B/S

Debit	Credit
Cash 1,000,000	Capital 1,000,000
	Cash 600,000
Cash 800,000	
Cash 1,200,000	Capital 1,000,000

2-28. B/S and P/L

P/L

Debit	Credit
Purchase 600,000	Sales 800,000

Costs 600,000	Revenue 800,000
Profit 200,000	

2-29. B/S and P/L

B/S

Debit	Credit
Cash 1,200,000	Capital 1,000,000
	Net income 200,000

Assets 1,200,000	Liabilities 0
	Shareholders' equity 1,200,000

2-30. Accounting

- Legal financial accounting
- Management accounting

Legally, legal financial accounting is more important.
But to consider how to make more profit, management accounting is useful.

2-31. Management Accounting

(1) Productivity
(2) Profitability
(3) Efficiency
(4) Safety

2-32. Management Accounting

(1) Productivity

I. Sales per person
II. Labor cost per person
III. Pretax profit per person

2-33. Management Accounting

(1) Productivity

I. Sales per person
= Sales / No. of employees
II. Labor cost per person
= Labor cost / No. of employees
III. Pretax profit per person
= Pretax profit / No. of employees

2-34. Management Accounting

(2) Profitability

I. Profit on sales (Each profit)
II. Break-even point
III. Year-on-year sales ratio
IV. Labor share ※
V. Fixed cost increase ratio

$$※\ \text{Labor share} = \frac{\text{Labor cost}}{\text{Sales} - \text{cost of sales}}$$

2-35. Management Accounting

(2) Profitability

I. Profit on sales (Each profit)

- Gross profit on sales
  = Gross profit / Sales
- Operating income on sales
  = Operating income / Sales
- Ordinary income on sales
  = Ordinary income / Sales

2-36. Management Accounting

Exercise

Company A has sales as shown next page. Calculate (1)Gross profit on sales, (2)Operating income on sales, and explain why this situation happened.

2-37. Management Accounting

(Unit : 1 Million BDT)

	Company A	Average in same sector
Sales	522.3	612.5
Sales cost	431.5	526.7
Gross profit	90.8	85.8
Operating expense	76.5	65.7
Operating profit	14.3	20.2

2-38. Management Accounting

Answer

	Company A	Average in same sector
Gross profit on sales	17.4%	14.0%
Operating profit on sales	2.7%	3.3%

Reason : Operating expenses like indirect labor, indirect expenses are much higher than average.

2-39. Management Accounting

(2) Profitability

III. Year-on-year sales ratio
= Sales this year / Sales last year

IV. Labor share
= Labor cost / (sales – cost of sales)

V. Fixed cost increase ratio
= Fixed cost this year / Fixed cost last year

2-40. Management Accounting

(3) Efficiency

I. Receivable turnover
II. Inventory turnover
III. Fixed asset turnover

※ Turn over = $\dfrac{\text{sales}}{\text{Rec. or Inv. or F/A}}$

Higher is better!

2-41. Management Accounting

(3) Efficiency

I. Receivable turnover period
II. Inventory turnover period
III. Fixed asset turnover period

※ Turn over period = $\dfrac{\text{Rec. or Inv. or F/A}}{\text{sales}} \times 365$

Lower is better!

2-42. Management Accounting

(4) Safety

I. Current ratio
II. Fixed ratio
III. Fixed long-term compliance rate
IV. Capital adequacy ratio
V. Management safety factor

2-43. Management Accounting

(4) Safety

I. Current ratio

$$\text{Current ratio} = \frac{\text{Current asset}}{\text{Current liability}}$$

Current ratio shows short-term ability to pay of a company.
150% or more is preferable.

2-44. Management Accounting

(4) Safety

II. Fixed ratio

$$\text{Fixed ratio} = \frac{\text{Fixed asset}}{\text{Capital}}$$

Fixed ratio shows long-term ability to pay of a company.
100% or less is preferable.

2-45. Management Accounting

(4) Safety

III. Fixed long-term compliance rate

$$\begin{array}{l}\text{Fixed long-term}\\ \text{Compliance rate}\end{array} = \frac{\text{Fixed asset}}{\text{Capital + Fixed liability}}$$

Fixed long-term compliance rate shows long-term ability to pay of a company.
100% or less is preferable.

2-46. Management Accounting

(4) Safety

IV. Capital adequacy ratio

$$\text{Capital adequacy ratio} = \frac{\text{Capital}}{\text{Total assets}}$$

Capital adequacy ratio shows soundness of capital structure of a company.
40% or more is excellent.

2-47. Management Accounting

(4) Safety

V. Management safety factor

$$\text{Management safety factor} = \frac{\text{Income before tax}}{\text{Gross profit}}$$

Management safety factor shows how percentage sales decrease makes pre-tax profit zero.
15% or more is preferable.

6. 金型技術向上支援プログラム（プラン 5）教材

Plastic Injection Mold

JICA Expert
Makoto Nakazawa

Training Contents

1. Basics of mechanical drawing
2. Understanding of assembly drawings
3. Designing and drafting of part drawings
4. Exercise of designing part drawings
5. Procedure of designing molds

---

1. Basics of mechanical drawing

Why is drawing necessary?

With 3D-CAD and 3D printers, it became an era in which products can be made without a two-dimensional drawing.

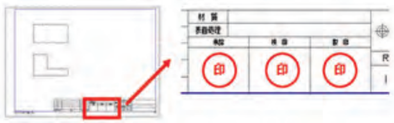
3D printer

Because the drawing is a means of "information transmission", it is necessary for the next processes that follow manufacturing (inspection and management).

There are common ways of writing (rules) in drawings (third angle system)

"Evidence" confirmed by people involved in design

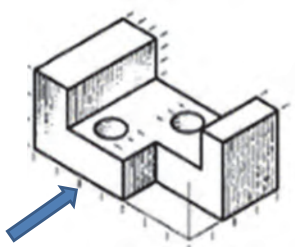
Need for product number and product drawing number management



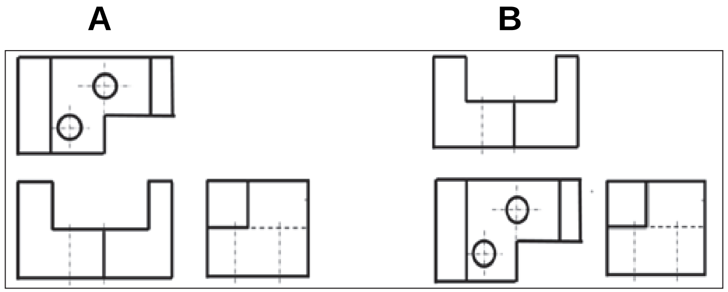
---

1. Basics of mechanical drawing

Writing (rules)



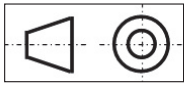
Question:
Which is a drawing prepared by using a third angle system, A or B?

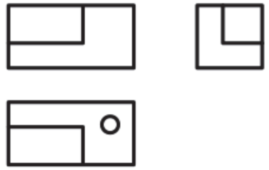


1. Basics of mechanical drawing

Writing (rules)

First angle system **Europe**



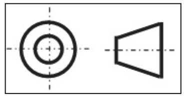


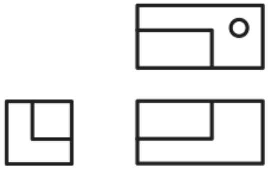
Front view

Left side view

Plan view

Third angle system **America （JAPAN）**





Plan view

Left side view

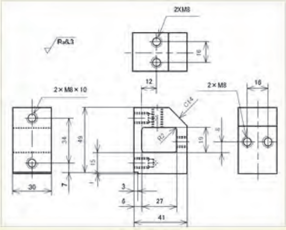
Front view

---

1. Basics of mechanical drawing

Writing (rules)

Difference between paintings and drawings

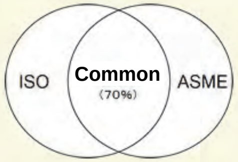


Emphasis on sensitivity:
Different interpretations in different people

Emphasis on commonality:
Interpretation must be common to all people

ISO (International Organization for Standardization)
ASME (American Society of Mechanical Engineers)

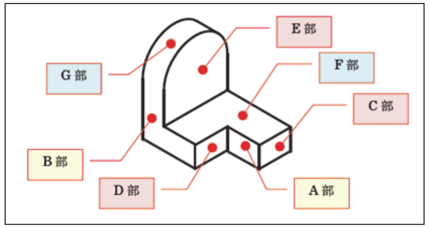
Relationship between ISO and ASME



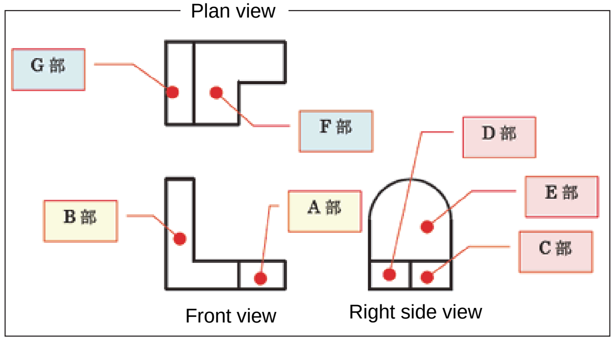
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

---

1. Basics of mechanical drawing



Three-dimensional shape to be used for projection drawings



Layout of projection drawings using third angle system

Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

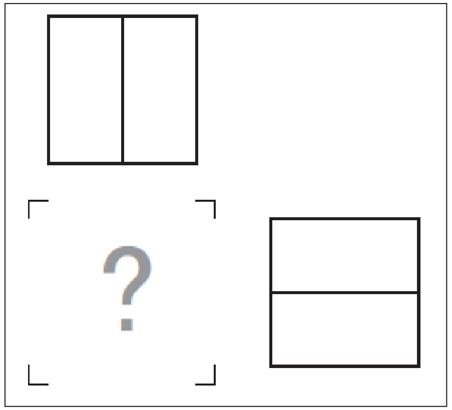
---

1. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Level 1: Question

Image a front view from these 2 projection drawings



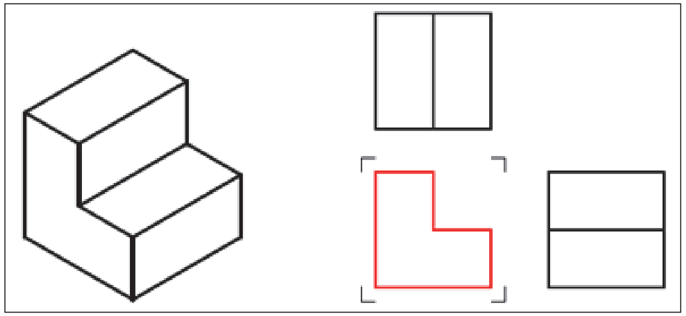
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

1. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Level 1: Sample answer to question

Image a front view from these 2 projection drawings (Example)



Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

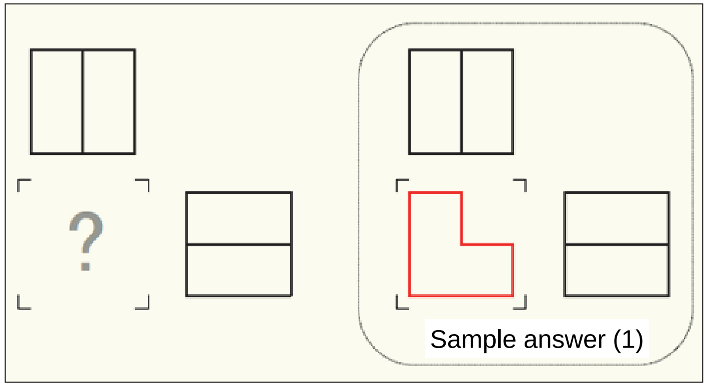
---

1. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Level 2: Question

Create a shape other than sample answer (1)



Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

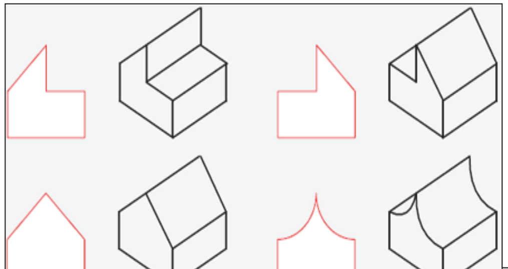
---

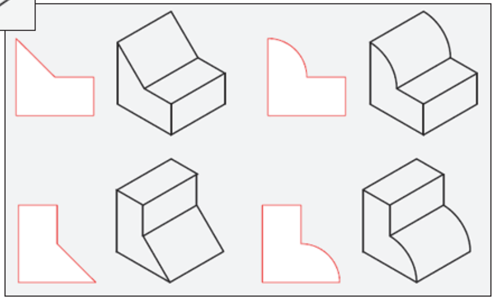
1. Basics of mechanical drawing

Not to be distributed

Creating shape from insufficient projection drawing

Level 2: Sample answer to sample question





www.otsuka-shokai.co.jp

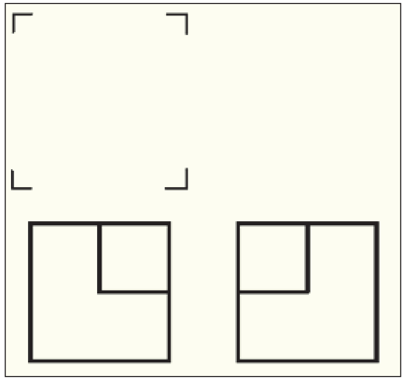
---

1. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Level 3: Exercise

Create a possible shape from projection drawings of front and right side views



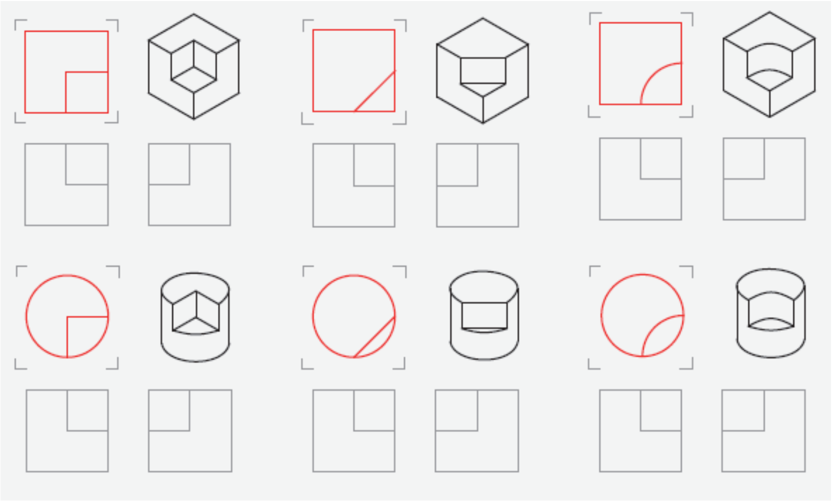
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

1. Basics of mechanical drawing

Not to be distributed

Creating shape from insufficient projection drawing

Level 3: Sample answer to exercise



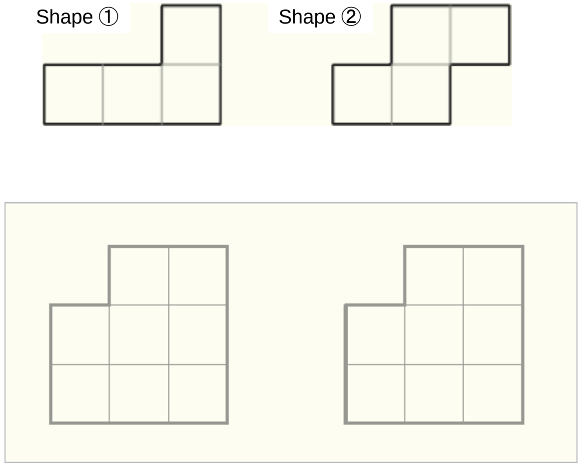
www.otsuka-shokai.co.jp

---

1. Basics of mechanical drawing

Lay out a 2D drawing in your head

Level 1: Exercise



Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

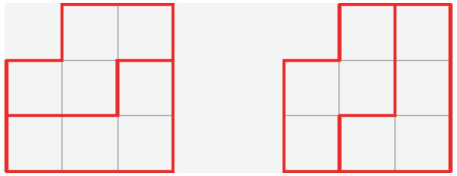
---

1. Basics of mechanical drawing

Not to be distributed

Lay out a 2D drawing in your head

Level 1: Sample answer to exercise



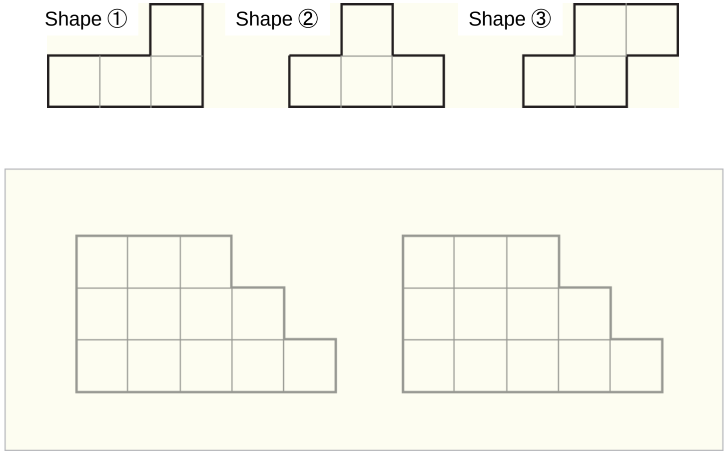
www.otsuka-shokai.co.jp

---

1. Basics of mechanical drawing

Lay out a 2D drawing in your head

Level 2: Exercise

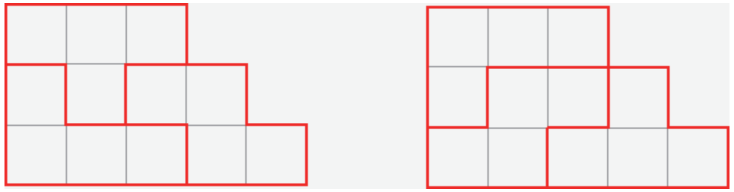


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

1. Basics of mechanical drawing

Lay out a 2D drawing in your head

Level 2: Sample answer to exercise

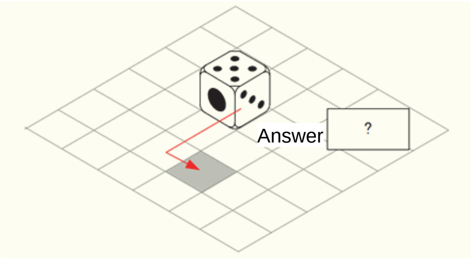


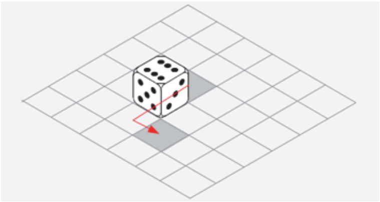
---

1. Basics of mechanical drawing

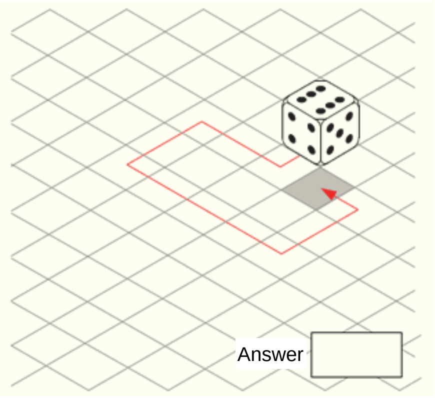
Move a 3D shape in your head

Level 1: Exercise





Level 2: Exercise



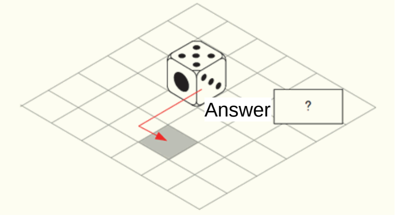
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

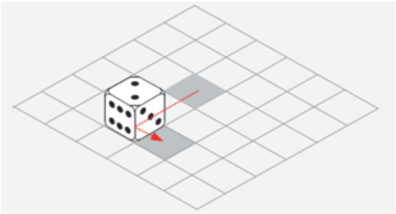
---

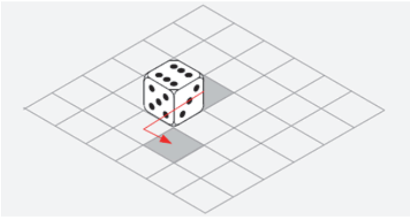
1. Basics of mechanical drawing

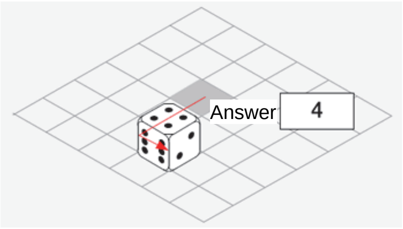
Move a 3D shape in your head

Level 1 exercise: Sample answer







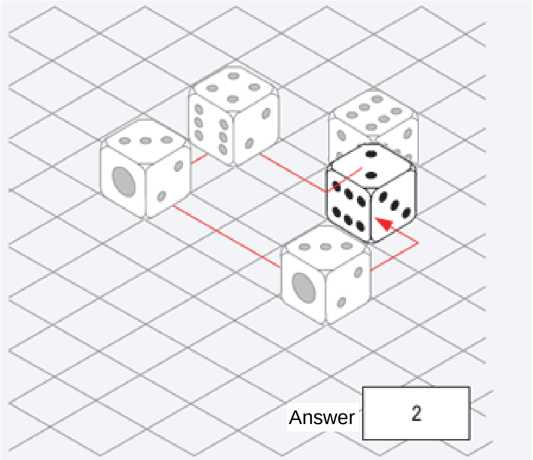


---

1. Basics of mechanical drawing

Move a 3D shape in your head

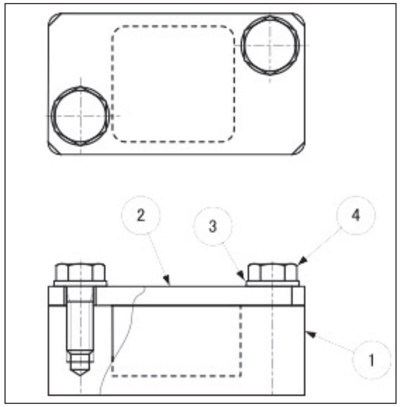
Level 2 exercise: Sample answer



1. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

① Case (1)
② Cover (1)
③ Washer (2)
④ Bolt (2)



Question (1) Paint lines indicating the washer in red.
Question (2) Paint lines indicating the bolt in red.
Question (3) Paint lines indicating the cover in red.
Question (4) Paint lines indicating the case in red.

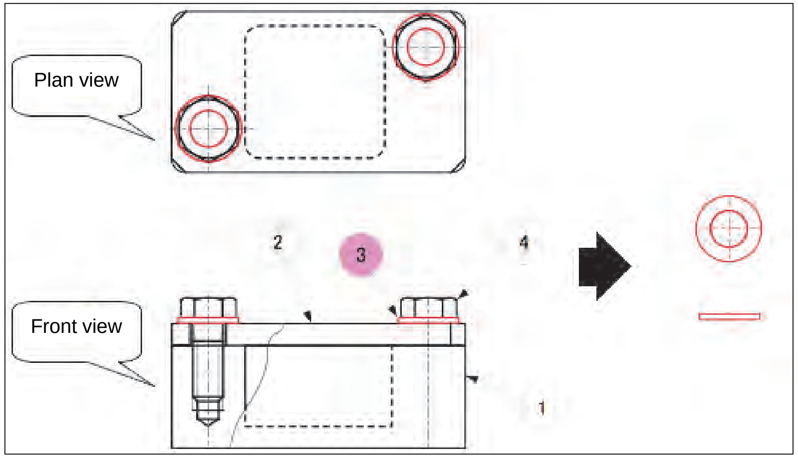
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

---

1. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (1) Paint lines indicating the washer in red. **Sample answer**



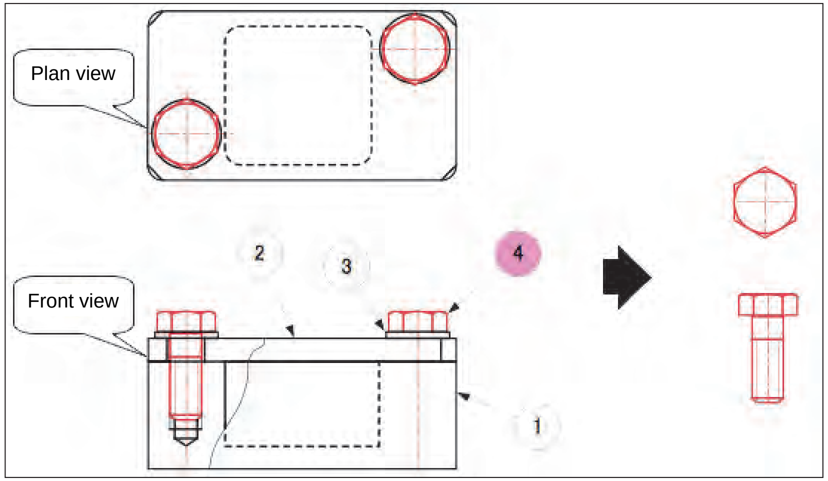
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

---

1. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (2) Paint lines indicating the bolt in red. **Sample answer**



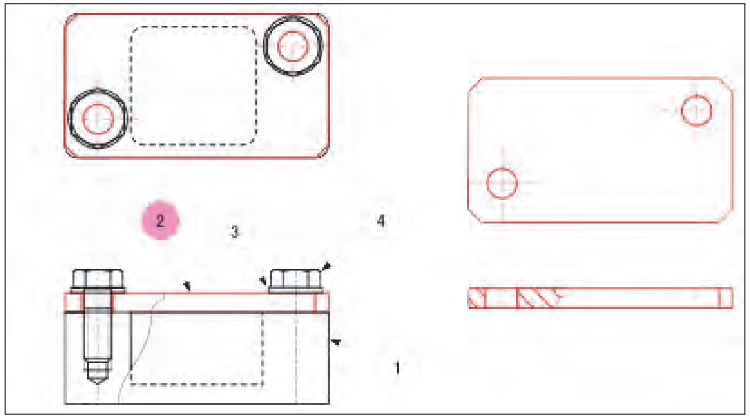
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

---

1. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (3) Paint lines indicating the cover in red. **Sample answer**

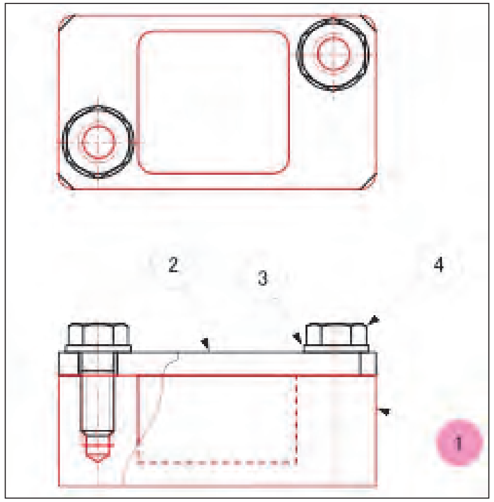


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

1. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (4) Paint lines indicating the case in red. **Sample answer**



Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

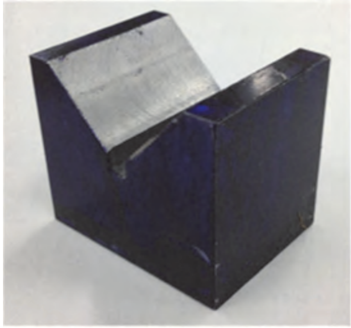
1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

Practice drafting a rough drawing in freehand

You can draft a rough drawing by observing the following 3 points:

- Consider the size proportions.
- Do not be afraid to make a mistake, as you can erase it with an eraser and re-draft the drawing.
- Do not be ashamed of bending lines.



V-shaped block

Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

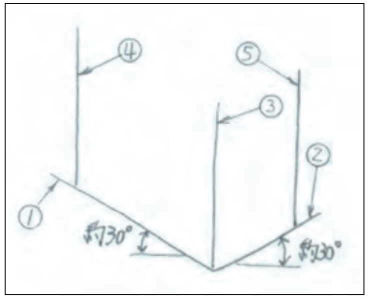
1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

[Step 1]

Let’s start with drafting a straight line, a basic of contours. At this point, it is better to become able to draw a line inclined by about 30 degrees to make an isometrical drawing.

Start from the bottom straight line of the V-shaped block, and then draw the vertical lines that will be standards in the vertical direction.



V-shaped block

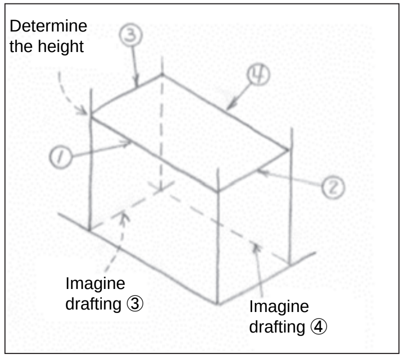
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

[Step 2]

To draw the top surface of the V-shaped block, image an inclination of the line from the bottom surface, and sketch a contour while considering the height and depth.



V-shaped block

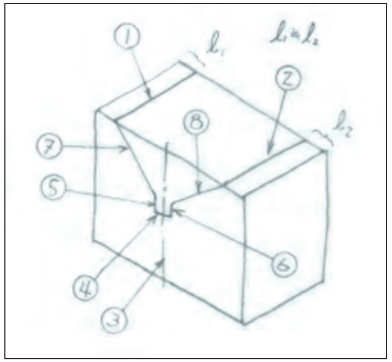
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

[Step 3]

Next, draw a V-shaped part. To make a V-shaped part symmetrical, first draw the top surface symmetrically. Then, determine the position in the bottom of the V-shaped part by drawing a center line, and draw diagonal lines.



V-shaped block

Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

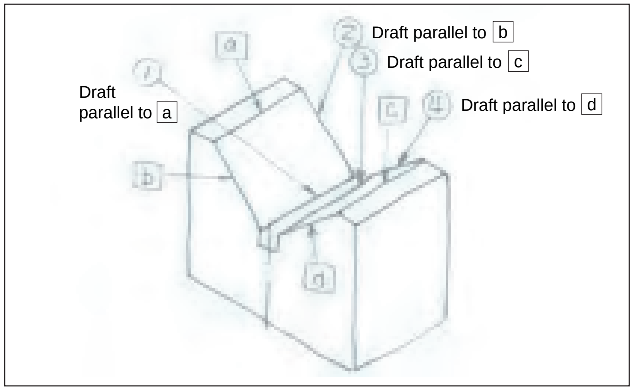
---

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

[Step 4]

Draw a line in the depth direction from the bottom of the V-shaped part to draft a V-shape surface at the back.



Draft parallel to a

Draft parallel to b

Draft parallel to c

Draft parallel to d

V-shaped block

Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

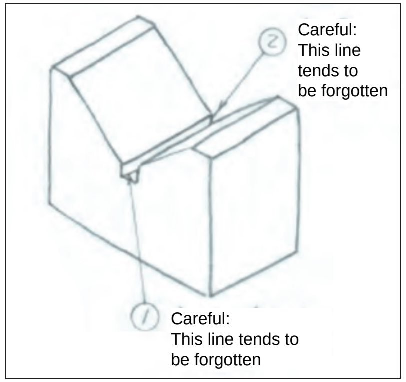
---

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

[Step 5]

Draw a line in the depth direction from the bottom of the V-shaped part to draw a V-shape on the back, and complete the drawing.
Pay attention not to omit minor lines like this.



Careful: This line tends to be forgotten

Careful: This line tends to be forgotten

V-shaped block

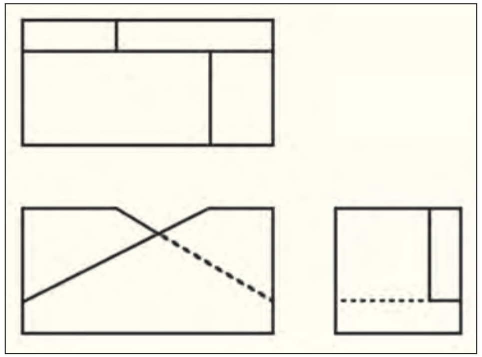
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

---

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

Exercise of drafting rough drawing-1

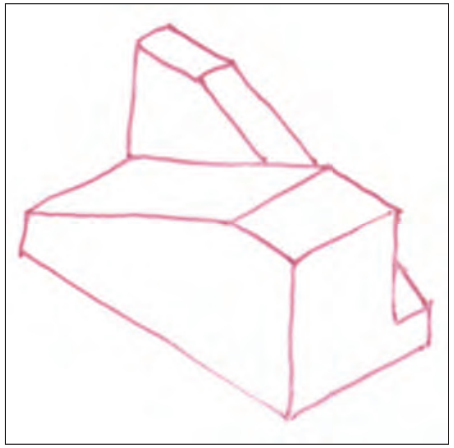


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

Exercise of drafting rough drawing-1 Sample answer

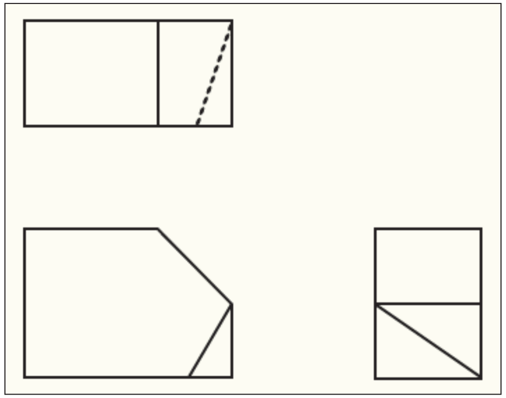


---

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

Exercise of drafting rough drawing-2



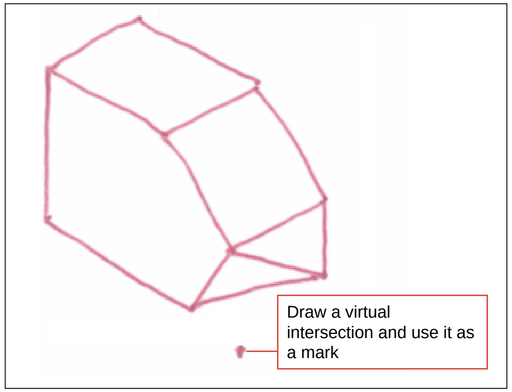
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

---

1. Basics of mechanical drawing

Draft a rough drawing by utilizing your spatial ability

Exercise of drafting rough drawing-2 Sample answer



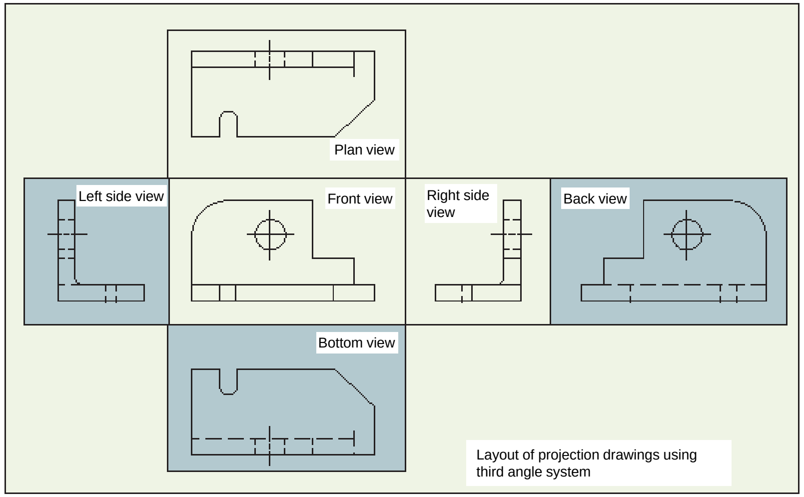
Draw a virtual intersection and use it as a mark

---

1. Basics of mechanical drawing

How to read/make drawings ①

- **A mechanical drawing is based on trihedral drawings using a third angle system**

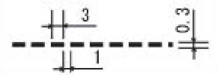
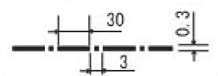
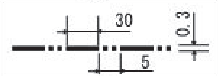


Layout of projection drawings using third angle system

1. Basics of mechanical drawing

How to read/make drawings ②

- **Types of lines (solid, narrow, dashed, long-dashed dot, long-dashed double-dot)**

Types of lines		Explanation	Use	Name by use
Thick solid line		Continuous line with the thickness of 0.7 mm	Indicates the shapes of visible areas of the target object	Contour line
Thin solid line		Continuous line with the thickness of 0.3 mm	Used to enter dimensions, leader lines or their descriptions.	Dimension line, projection line, leader line
Narrow dashed line		Line consisting short lines	Indicates the shapes of invisible areas of the target object	Hidden line
Narrow long-dashed dot line		Line consisting of lines and single dots	Indicates the center of the figure or the track of the center position	Center line
Narrow long-dashed double dot line		Line consisting of lines and double dots	Indicates adjacent areas or tools and others for reference	Imaginary line

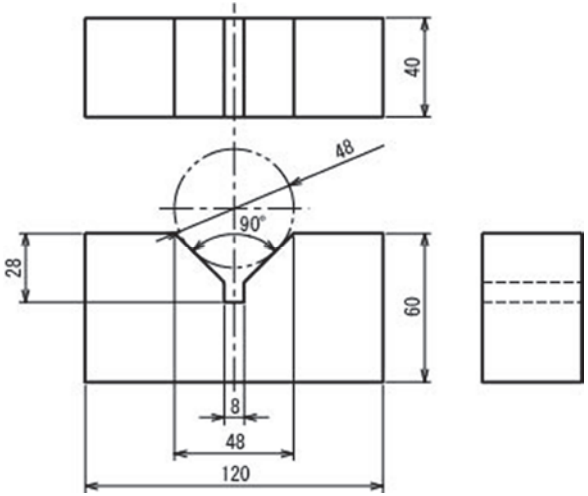
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

1. Basics of mechanical drawing

How to read/make drawings ③

- **Types of lines (Example: V-shaped block drawing**



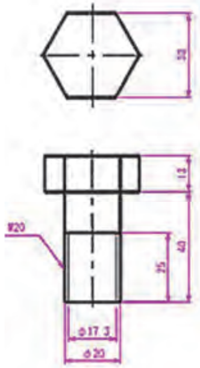
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

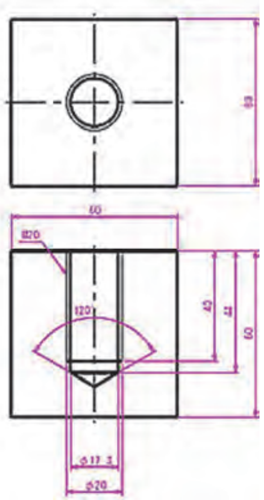
1. Basics of mechanical drawing

How to read/make drawings ④

- **Thread drawing**
  (Male thread and Female thread)



(a) Hexagonal bolt (male thread)



(b) Female thread

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

1. Basics of mechanical drawing

How to read/make drawings (Exercise-1)

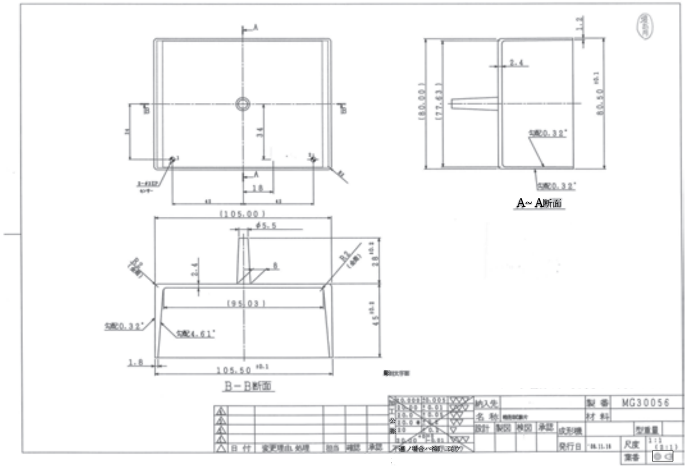
Prepare sundries (cup, case, etc.), roughly sketch and measure dimensions of them to prepare a product drawing.

Product name	**Material**
Scale	Third angle system
Name	Preparation date

1. Basics of mechanical drawing

How to read/make drawings (Exercise-2)

- Check the product drawing, and draft rough drawings

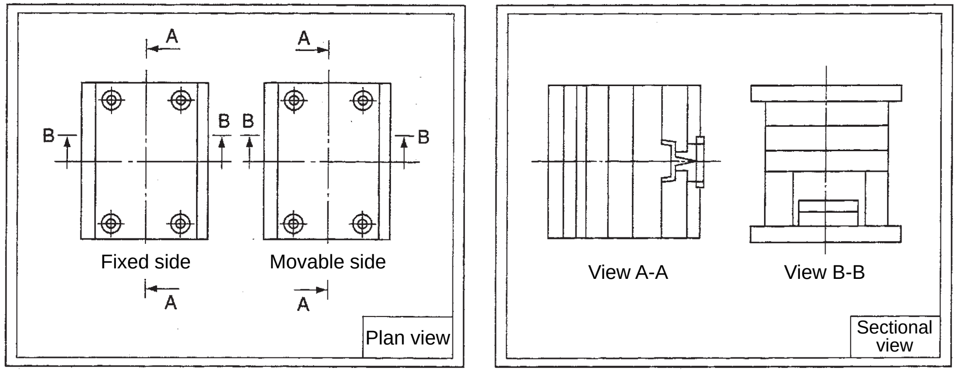


---

2. Understanding of assembly drawings

Structure of mold assembly drawings

- Mold assembly drawings are generally expressed by a fixed side plan view, a movable side plan view, and sectional views in 2 orthogonal directions (A-A, B-B).



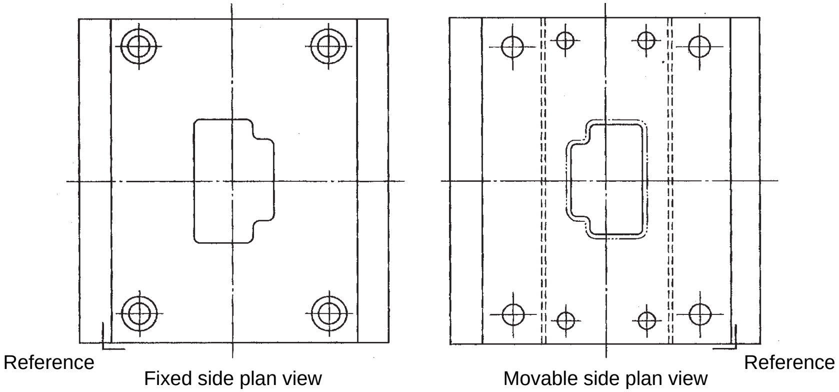
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

2. Understanding of assembly drawings

Drawing assembly plan views

- Plan views for mold assembly drawings are prepared by opening the fixed and movable sides, and draft drawings from individual PL (parting line) sides.
- Pay enough attention that the fixed and movable sides are linearly symmetrical.

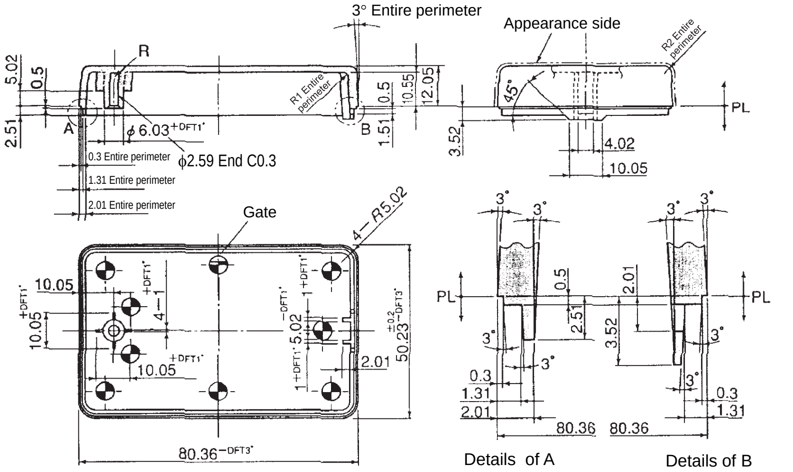


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

2. Understanding of assembly drawings

Understanding product drawings

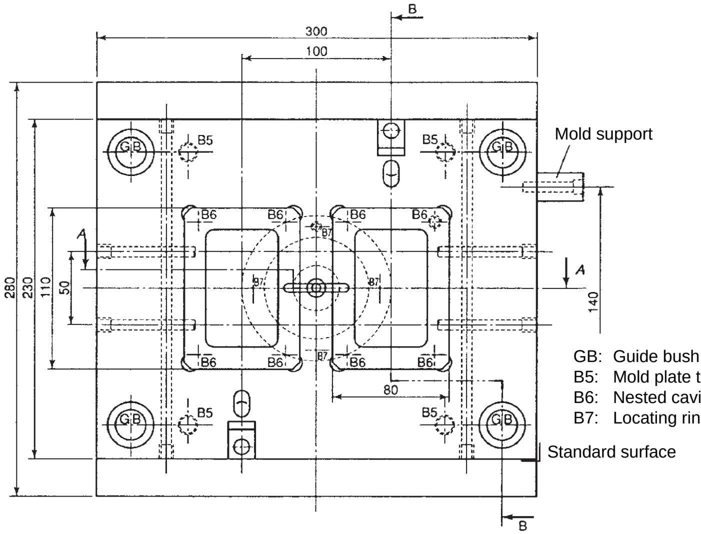


(Note)
For the ejector pin and gate positions, see the detailed drawing in the Attachment.

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

2. Understanding of assembly drawings

Understanding assembly plan views ①



Mold support

GB: Guide bush
B5: Mold plate tightening bolt
B6: Nested cavity fixing bolt
B7: Locating ring fixing bolt

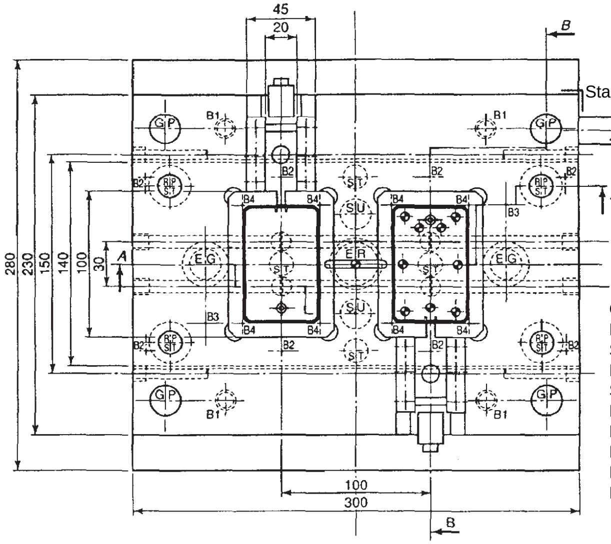
Standard surface

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

2. Understanding of assembly drawings

Understanding assembly plan views ②



Standard surface
Mold support

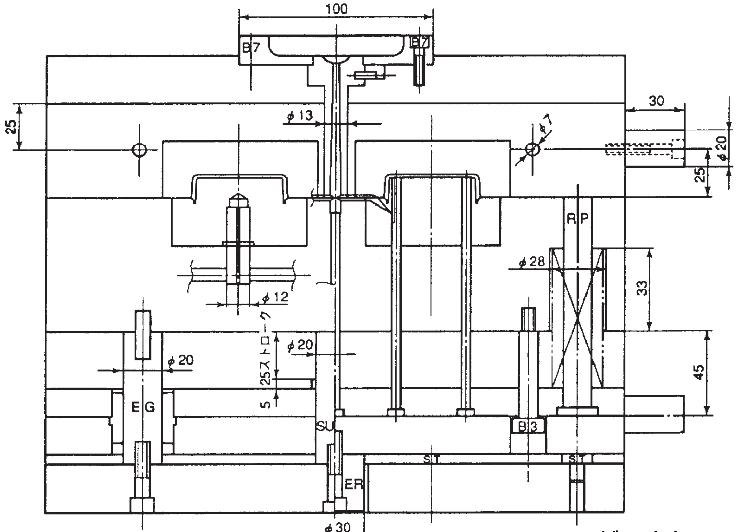
GP: Guide pin
RP: Return pin
ST: Stop pin
EG: Ejector guide
SU: Support pillar
ER: Ejector rod
B1: Mold plate tightening bolt
B2: Ejector plate fixing bolt
B3: Ejector assembly bolt
B4: Nested core fixing bolt

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

2. Understanding of assembly drawings

Understanding assembly sectional views ①



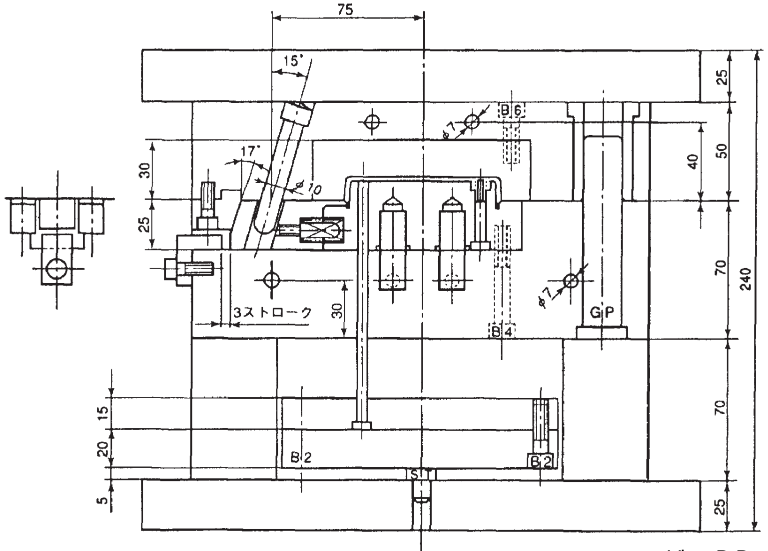
View A-A

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

2. Understanding die assembly drawings

Understanding assembly sectional views ②



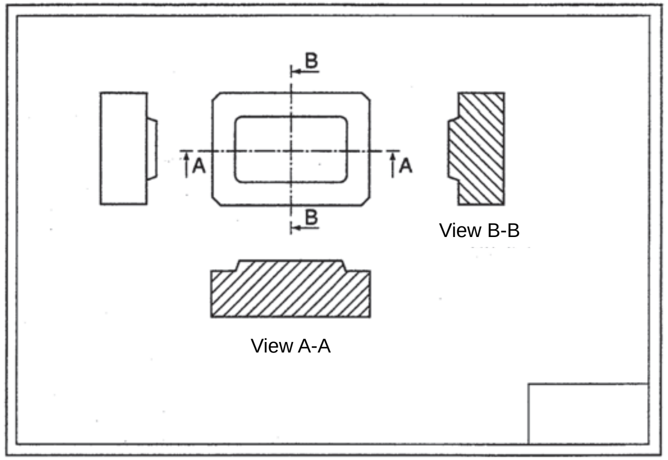
View B-B

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

3. Designing and drafting part drawings

Drafting mold part drawings ①

- Drawing of nested cavities and cores



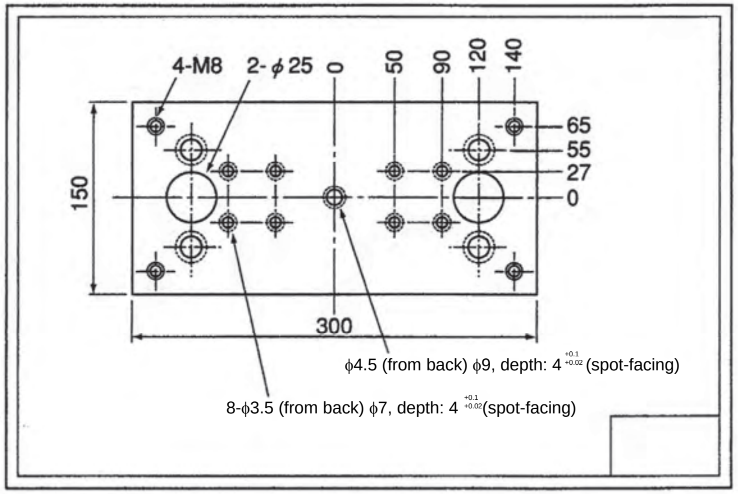
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

3. Designing and drafting part drawings

Drafting mold part drawings ②

- Drafting mold plates



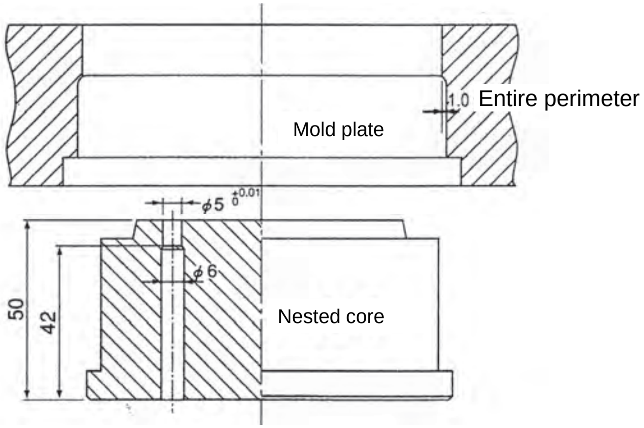
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

3. Designing and drafting part drawings

Drafting mold part drawings ①

- Considering machinability (undercut processing)



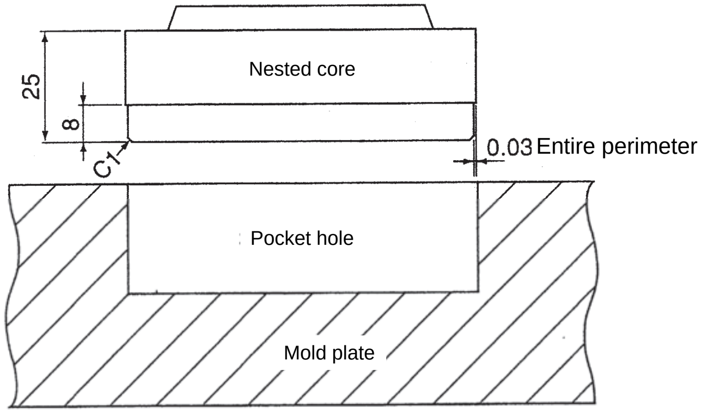
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

3. Designing and drafting part drawings

Drafting mold part drawings ②

- Considering assembly/disassembly performance (press-fit introduction area)

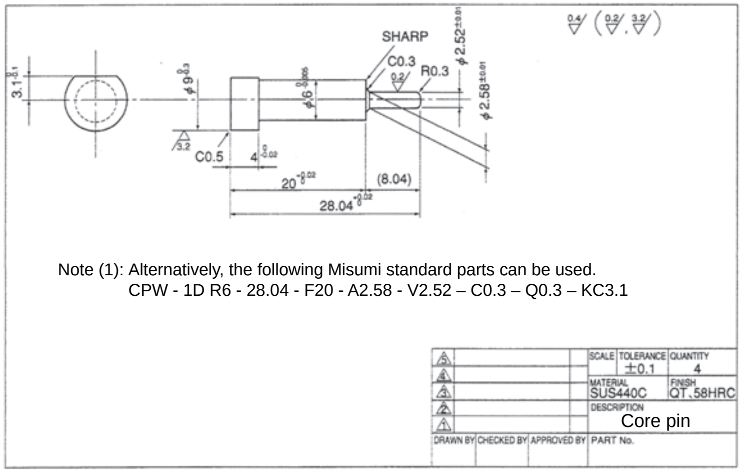


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

3. Designing and drafting part drawings

Drafting mold part drawings ③

- ➢ Considering dimensional tolerances (for fittings, etc.)



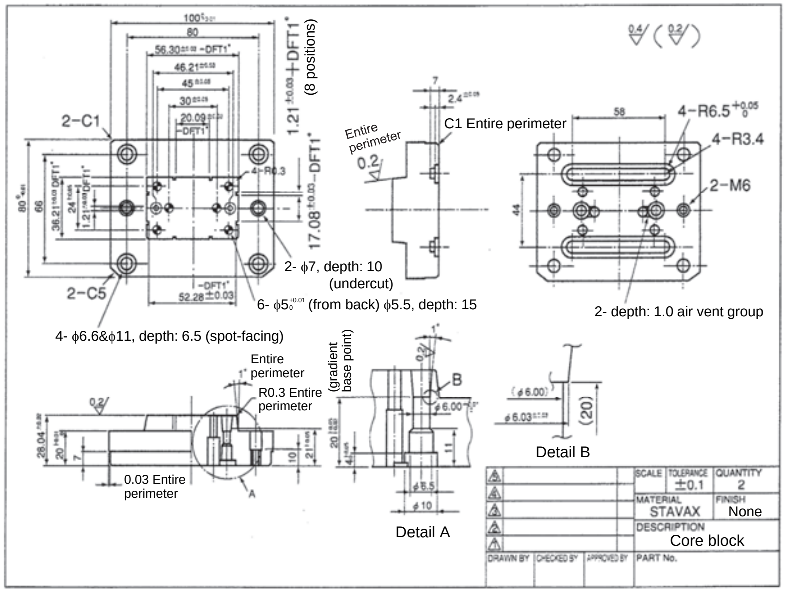
Note (1): Alternatively, the following Misumi standard parts can be used.
CPW - 1D R6 - 28.04 - F20 - A2.58 - V2.52 – C0.3 – Q0.3 – KC3.1

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

3. Designing and drafting part drawings

Example of nested core part drawing



Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

4. Exercise of designing part drawings

Exercise of designing mold part drawings

- ➢ Design the following part drawings by looking at (reading) the assembly drawing for a mold of a paper knife (plan and sectional views)
  - ① Movable side mold plate
  - ② Nested core
- ➢ Design the following part drawings by looking at (reading) the assembly drawing for a mold of a coaster (plan and sectional views)
  - ① Movable side mold plate
  - ② Nested core

---

4. Exercise of designing part drawings

Understanding mold assembly drawings (practical exercise)

- ➢ Explain the mold structure by looking at (reading) the assembly drawing for a mold of a paper knife (plan and sectional views)
  - ① Explain the meanings of solid and dashed lines on the plan view.
  - ② Explain the mold structure (plate structure, cavity/core structure, runner/gate system, ejector, etc.) from sectional views.
- ➢ Explain the mold structure by looking at (reading) the assembly drawing for a mold of a coaster (plan and sectional views)
  - ① Explain the meanings of solid and dashed lines on the plan view.
  - ② Explain the mold structure (plate structure, cavity/core structure, runner/gate system, ejector, etc.) from sectional views.

5. Exercise of designing die part drawings

Exercise of designing die part drawings

- Design the following part drawings by looking at (reading) the assembly drawing for a paper knife die (plan and sectional views)
  ① Movable side die plate
  ② Nested core

- Design the following part drawing by looking at (reading) the assembly drawings for a coaster die (plan and sectional views)
  ① Movable side die plate
  ② Nested core

---

5. Procedure of designing molds

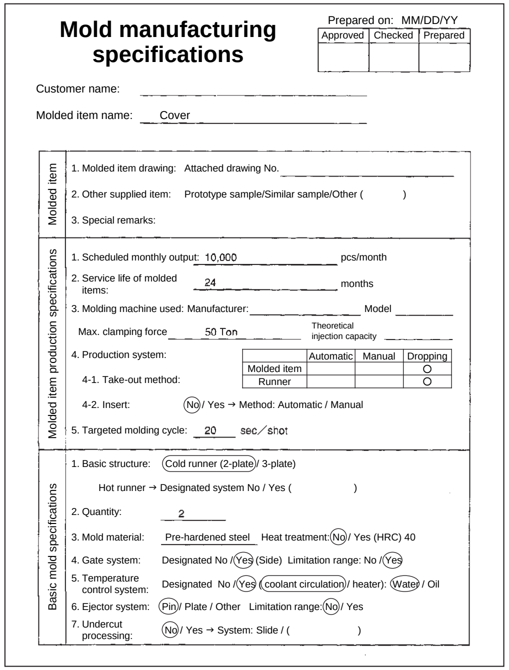
1. Reviewing customer (user) specifications
2. Reviewing basic mold structure
3. Designing cavities and cores
4. Designing entire mold layout
5. Designing mold structure
6. Example of a slide core-structured mold
7. Example of a angular core-structured mold

---

5. Procedure of designing molds

1) Reviewing customer specifications

- Mold manufacturing specifications
  - Molded item (product) specifications
  - Molded item production specifications
  - Basic mold specifications



Mold manufacturing specifications

Prepared on: MM/DD/YY

Approved	Checked	Prepared

Customer name:

Molded item name: Cover

Molded item

1. Molded item drawing: Attached drawing No.
2. Other supplied item: Prototype sample/Similar sample/Other ( )
3. Special remarks:

Molded item production specifications

1. Scheduled monthly output: 10,000 pcs/month
2. Service life of molded items: 24 months
3. Molding machine used: Manufacturer: Model
   Max. clamping force 50 Ton Theoretical injection capacity
4. Production system:
   4-1. Take-out method:

	Automatic	Manual	Dropping
Molded item			○
Runner			○

   4-2. Insert: [✓ No] / Yes → Method: Automatic / Manual
5. Targeted molding cycle: 20 sec／shot

Basic mold specifications

1. Basic structure: [✓ Cold runner (2-plate] / 3-plate)
   Hot runner → Designated system No / Yes ( )
2. Quantity: 2
3. Mold material: Pre-hardened steel Heat treatment: [✓ No] / Yes (HRC) 40
4. Gate system: Designated No / [✓ Yes] (Side) Limitation range: No / [✓ Yes]
5. Temperature control system: Designated No / [✓ Yes] ([✓ coolant circulation] / heater): [✓ Water] / Oil
6. Ejector system: [✓ Pin] / Plate / Other Limitation range: [✓ No] / Yes
7. Undercut processing: [✓ No] / Yes → System: Slide / ( )

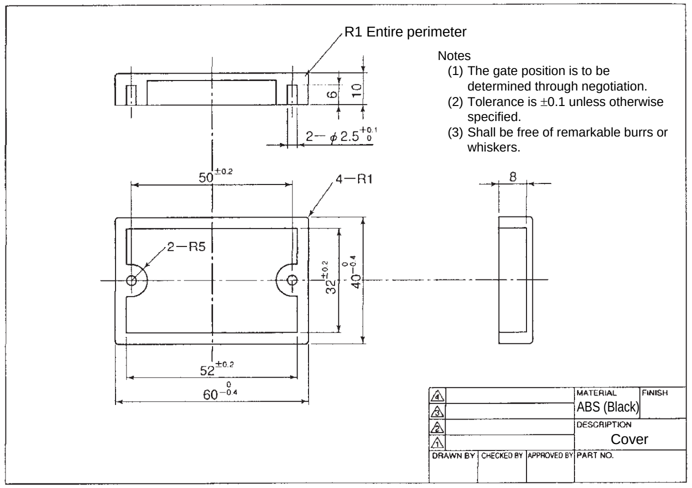
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

1) Reviewing customer specifications (product drawing) Example ①

- Main review items
  - Molding quality
  - Productivity
  - Unknown areas in drawing
- Points
  - Forecast process flows
  - Uniform wall thickness/thin wall thickness



Notes
(1) The gate position is to be determined through negotiation.
(2) Tolerance is ±0.1 unless otherwise specified.
(3) Shall be free of remarkable burrs or whiskers.

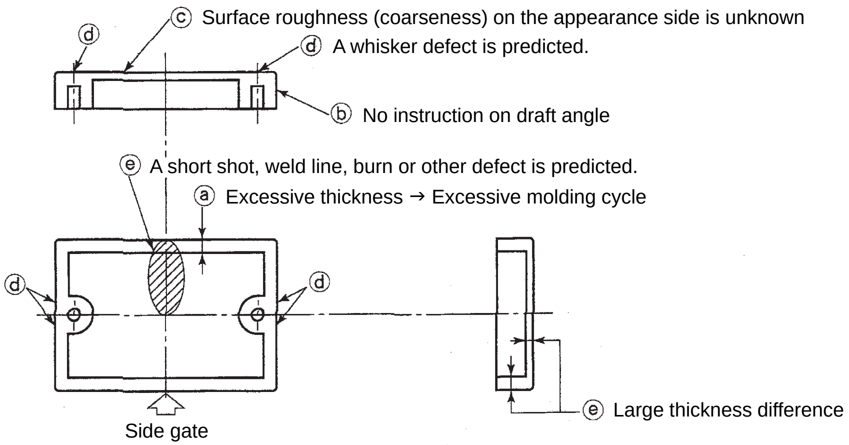
Product drawing example

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

5. Procedure of designing molds

1) Reviewing customer specifications (product drawing) Example ②

- Review details



ⓒ Surface roughness (coarseness) on the appearance side is unknown

ⓓ A whisker defect is predicted.

ⓑ No instruction on draft angle

ⓔ A short shot, weld line, burn or other defect is predicted.

ⓐ Excessive thickness → Excessive molding cycle

ⓔ Large thickness difference

Side gate

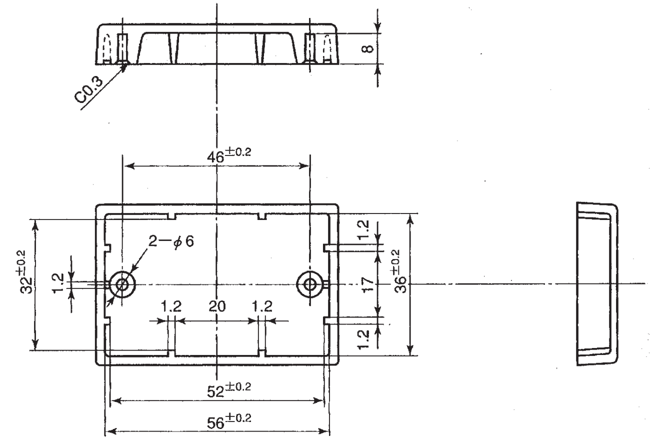
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

1) Reviewing customer specifications (product drawing) Example ③

- Shape and changed dimensions after review

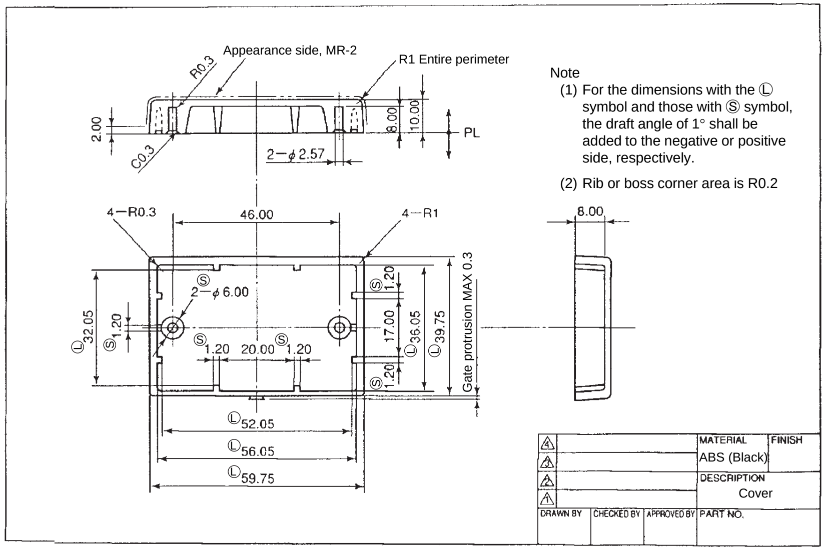


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

1) Basic dimensional drawing (target dimensions) for molded item



Note

(1) For the dimensions with the Ⓛ symbol and those with Ⓢ symbol, the draft angle of 1° shall be added to the negative or positive side, respectively.

(2) Rib or boss corner area is R0.2

		MATERIAL	FINISH
4		ABS (Black)	
3			
2		DESCRIPTION Cover	
1			
DRAWN BY	CHECKED BY	APPROVED BY	PART NO.

Example of basic dimensional drawing for molded item

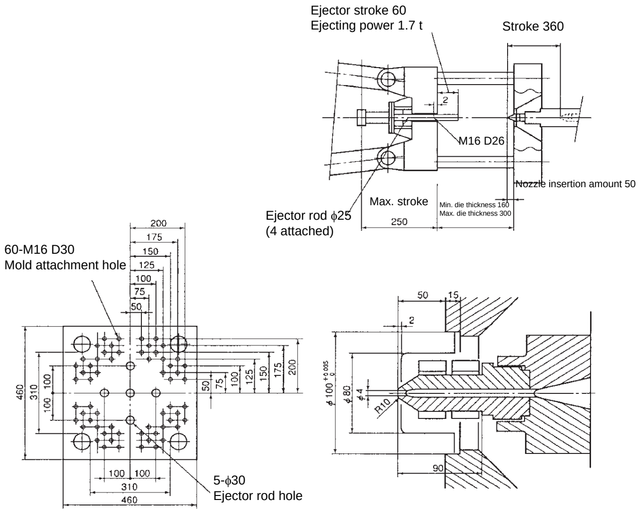
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

2) Reviewing production specifications (related to molding machine)

- Main review items
  - Tie bar internal width
  - Mold fixing bolt
  - Locating ring
  - Nozzle touch
  - Ejector



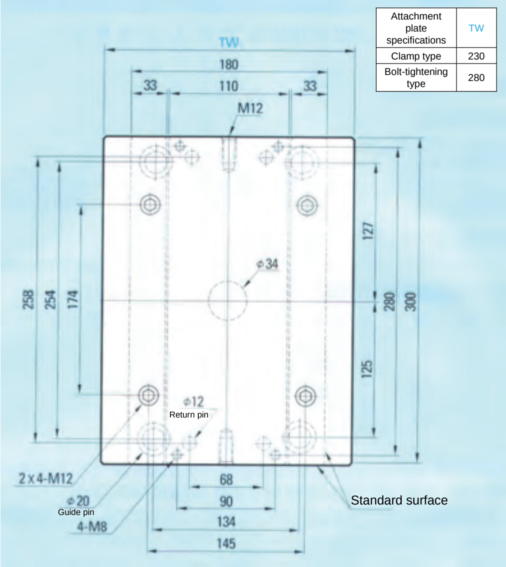
Example of die installation specifications for molding machine with the die tightening force at 50 t (From JSW catalog)

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

5. Procedure of designing molds

2) Reviewing basic mold structure (mold base)

- Determine basic mold base structure
- Generally, select from commercial standard specifications



Attachment plate specifications	TW
Clamp type	230
Bolt-tightening type	280

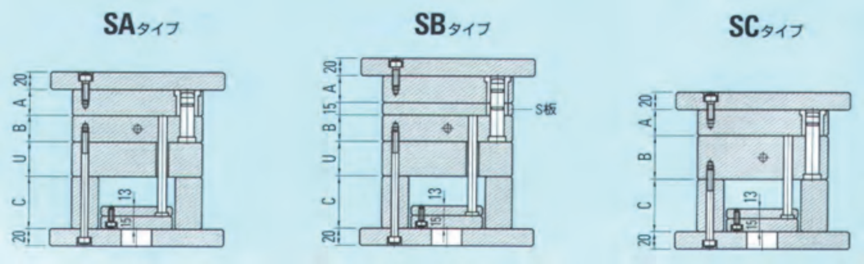
Source: Futaba Corporation, “Blue Book”

---

5. Procedure of designing molds

2) Reviewing basic mold structure (selection of commercial mold base)

- With receiving plate, without stripper plate
- With receiving and stripper plates
- Without receiving and stripper plates



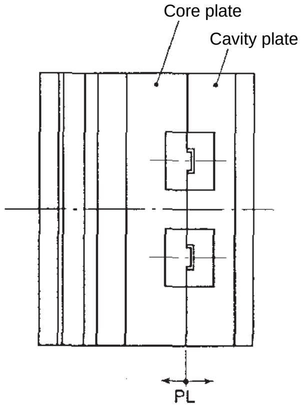
Source: Futaba Corporation, “Blue Book”

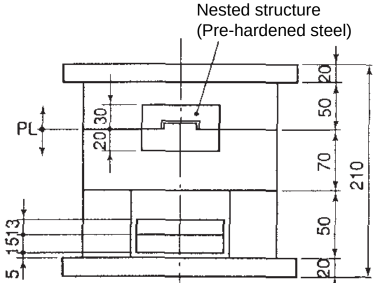
---

5. Procedure of designing molds

2) Reviewing basic mold structure (mold base and nested items)

- After determining the basic mold base structure, review the cavity and pocket hole for the nested core.



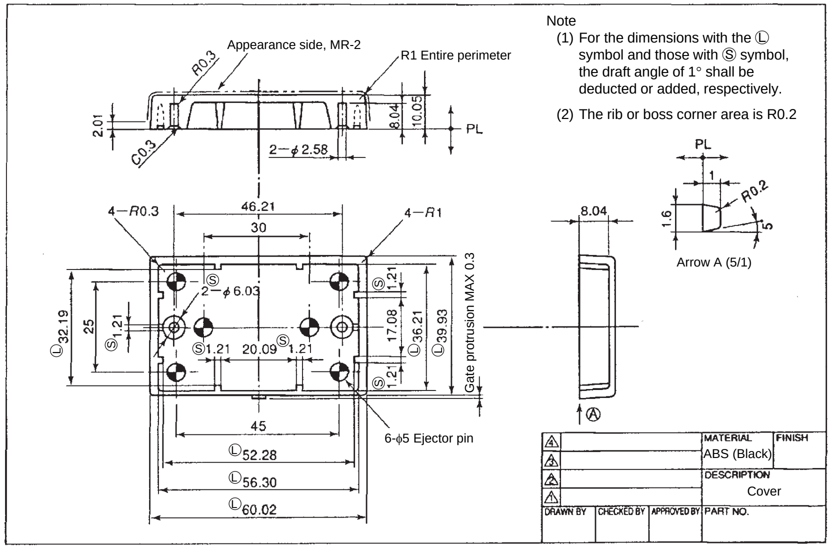


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

3) Designing cavities and cores (basic dimensional drawing)



Note
(1) For the dimensions with the Ⓛ symbol and those with Ⓢ symbol, the draft angle of 1° shall be deducted or added, respectively.
(2) The rib or boss corner area is R0.2

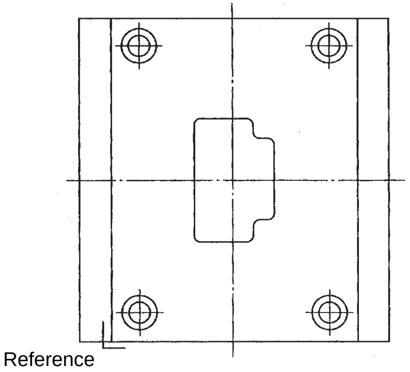
Example of basic dimensional drawing for cavities and cores

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

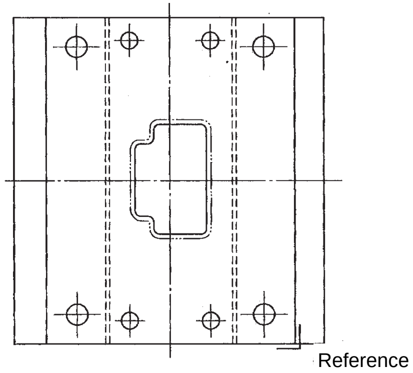
5. Procedure of designing molds

3) Layout designing (drawing assembly plan views)

- Plan views for mold assembly drawings are prepared by opening the fixed and movable sides, and project figures from individual PL (parting line) sides. Thus, pay enough attention that the fixed and movable sides are linearly symmetrical.



Fixed side plan view



Movable side plan view

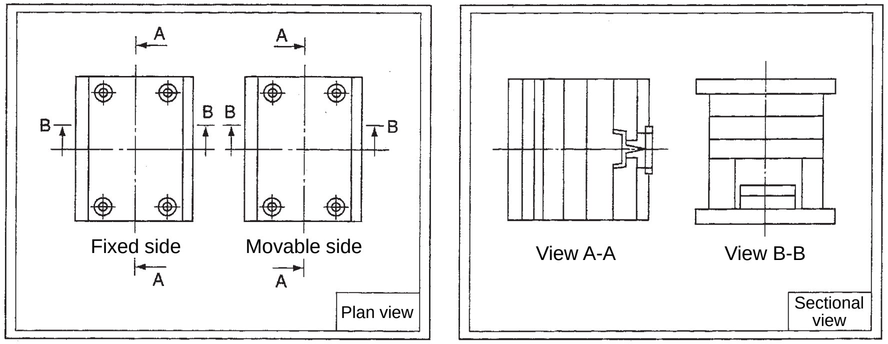
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

3) Layout designing (layout in assembly drawing)

- The following example shows how to lay out the mold assembly drawings to a sheet of paper of large size (such as A0 or A1). The fixed and movable sides of the sectional view shall be laid out on the top/right or bottom/left, respectively.



General layout of plan and sectional views

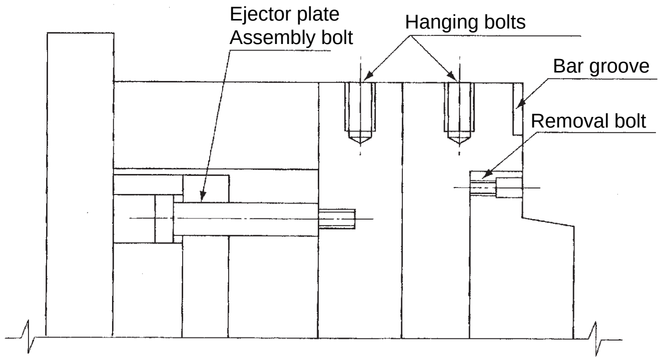
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

Considerations in designing mold structure

- Maintainability
- Mold-workability (easiness of machining)
- Safety on handling



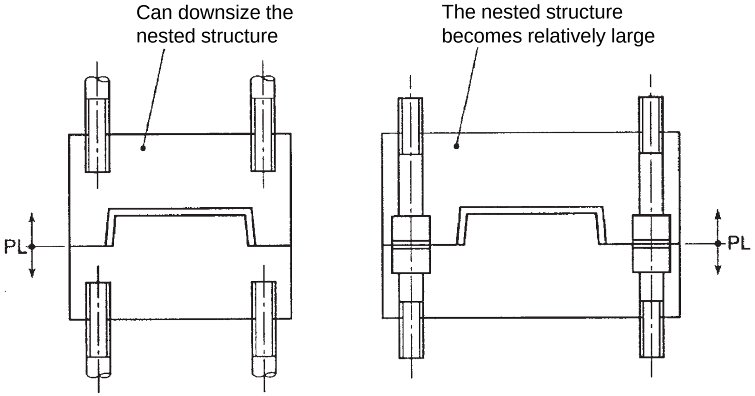
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

3) Designing cavities and cores (nested and fixed structure)

- Review a nested and fixed structure. In the following example, generally the structure (a) is selected as it can downsize the nested structure. When prioritizing the maintainability, the structure (b) which is fixed with bolts on the PL side shall be selected.



(a) Fixed with bolts on the back side

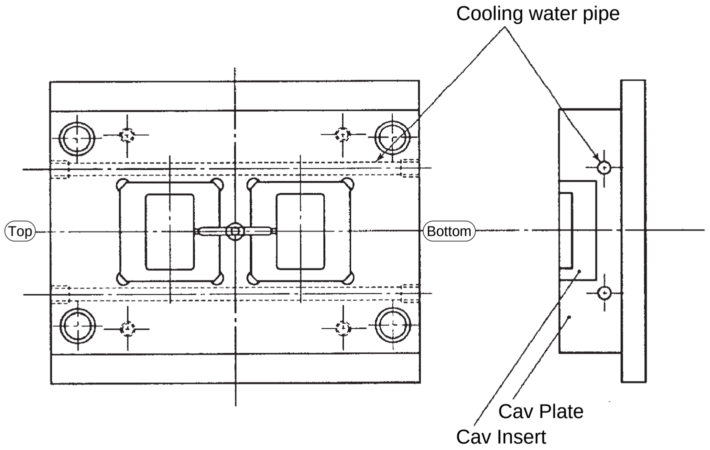
(b) Fixed with bolts on the PL side

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

5. Procedure of designing molds

4) Designing layouts (for nested structures/bases)

- The following figure shows an example of cavity layout considering the nested structure, mold base strength, and temperature control (2 pocket holes)



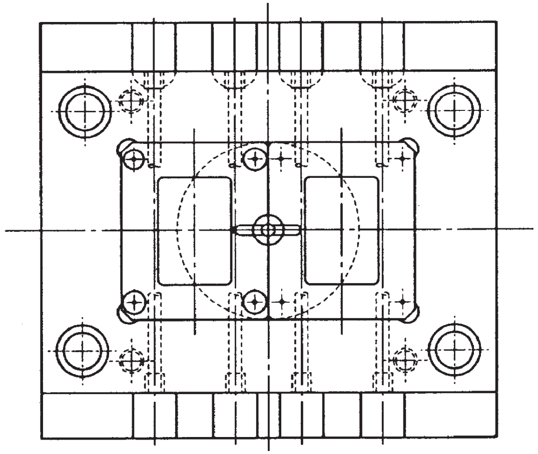
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

4) Layout design example (fixed side)

- Finalize the design fixing 2 nested structures in 1 pocket with bolts on the PL side and 4 cooling water pipes in the lateral direction.



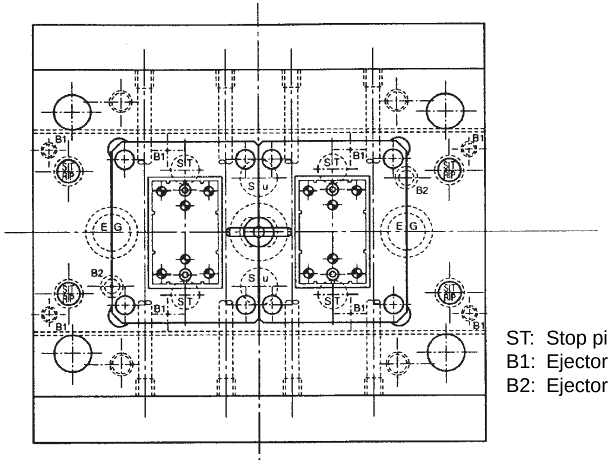
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

4) Layout design example (movable side)

- On the movable side, lay out parts while paying attention to the interference with a cooling pipe, ejector pin, bolt, etc.



ST: Stop pin
B1: Ejector plate fixing bolt
B2: Ejector assembly bolt

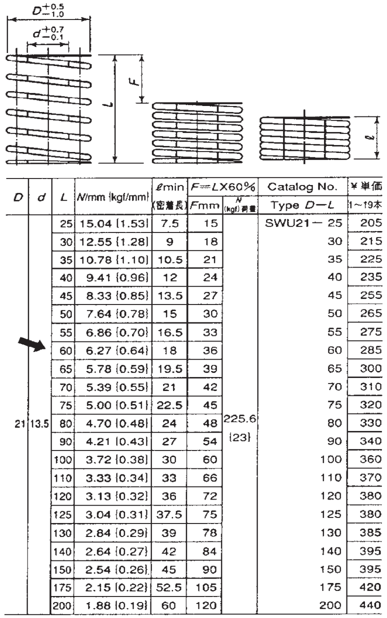
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

4) Actual example of selecting return spring

- Selecting procedure
  - ① Calculate the ejector plate (top/bottom) weights. W_e=6.06 (kg)
  - ② Calculate the spring force per spring F_s= 2W_e /4=3.03 (kgf)
  - ③ Calculate the spring constant (initial deflection: 8) N= 3.03/8=0.38 (kgf/mm)
  - ④ Calculate the deflection during use: 17+8=25 (mm)
  - ⑤ Calculate the free spring length (L) L=(17+35)+8=60 (mm)
  - ⑥ In commercial standards (L=60), F_s=5.12 (kgf)



D	d	L	N/mm {kgf/mm}	ℓmin (密着長)	F=LX60%		Catalog No.	¥単価
					Fmm	N (kgf) 荷重	Type D−L	1~19本
21	13.5	25	15.04 {1.53}	7.5	15	225.6 {23}	SWU21− 25	205
		30	12.55 {1.28}	9	18		30	215
		35	10.78 {1.10}	10.5	21		35	225
		40	9.41 {0.96}	12	24		40	235
		45	8.33 {0.85}	13.5	27		45	255
		50	7.64 {0.78}	15	30		50	265
		55	6.86 {0.70}	16.5	33		55	275
		60	6.27 {0.64}	18	36		60	285
		65	5.78 {0.59}	19.5	39		65	300
		70	5.39 {0.55}	21	42		70	310
		75	5.00 {0.51}	22.5	45		75	320
		80	4.70 {0.48}	24	48		80	330
		90	4.21 {0.43}	27	54		90	340
		100	3.72 {0.38}	30	60		100	360
		110	3.33 {0.34}	33	66		110	370
		120	3.13 {0.32}	36	72		120	380
		125	3.04 {0.31}	37.5	75		125	380
		130	2.84 {0.29}	39	78		130	385
		140	2.64 {0.27}	42	84		140	395
		150	2.54 {0.26}	45	90		150	395
		175	2.15 {0.22}	52.5	105		175	420
		200	1.88 {0.19}	60	120		200	440

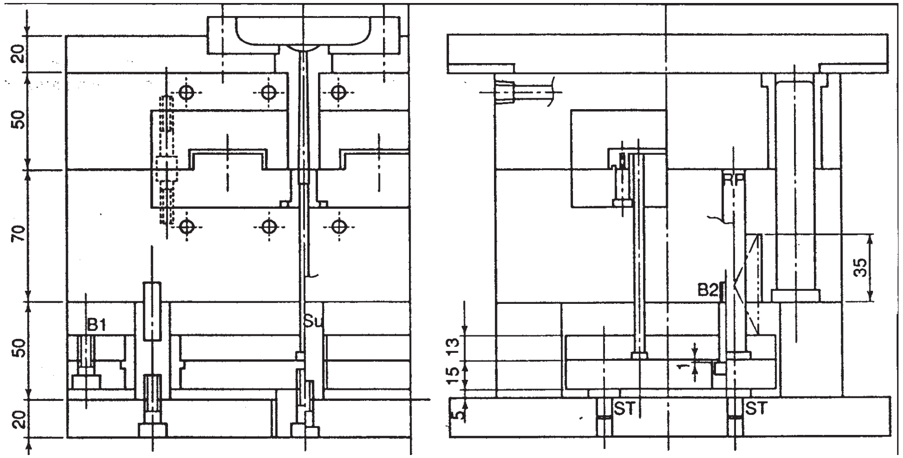
図 5.42 市販コイルスプリング規格からの選択
（ミスミ Face より）

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

5. Procedure of designing molds

5) Example of design of mold structure

- Display the thickness, operating stroke, etc.

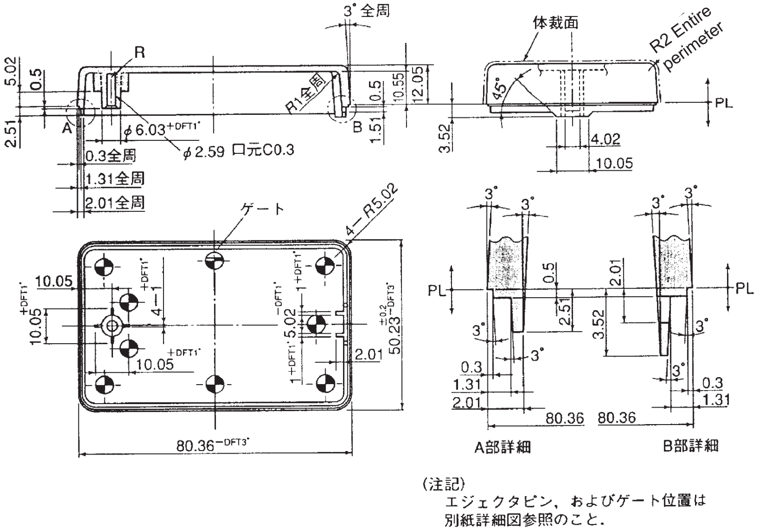


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

6) Slide core-structured mold (basic dimension drawing for cavity/core)



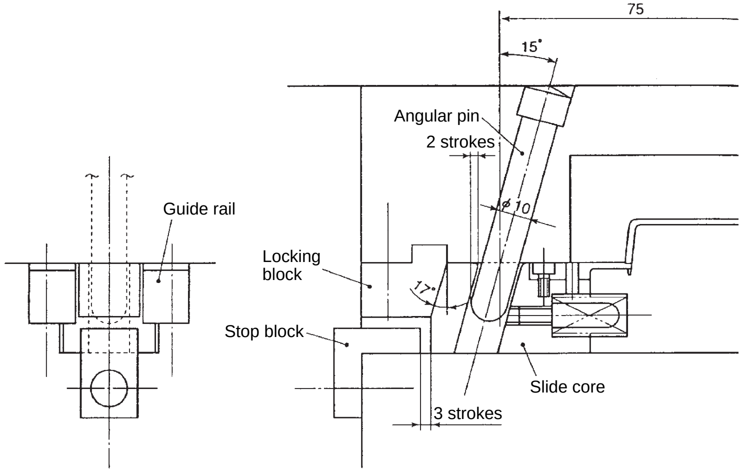
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

6) Reviewing slide core structure

- For slide core-structured molds, first review slide core-related matters to determine dimensions.



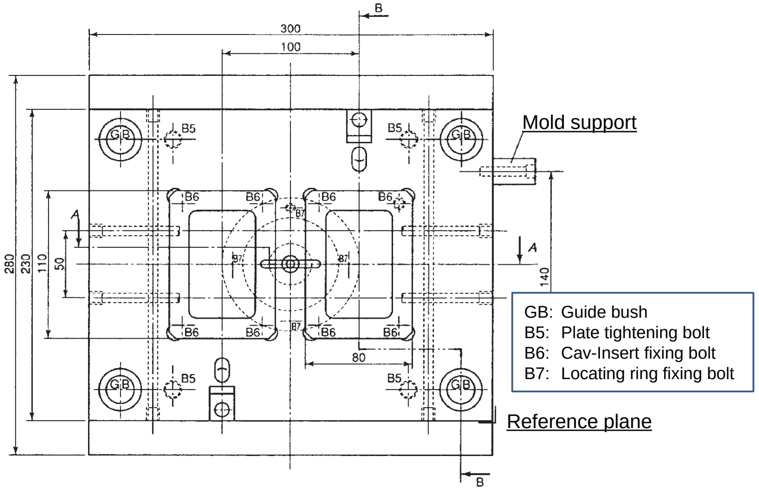
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

Example of layout design (fixed side)

- Determine the layout while paying attention to interference with the cooling circuit.

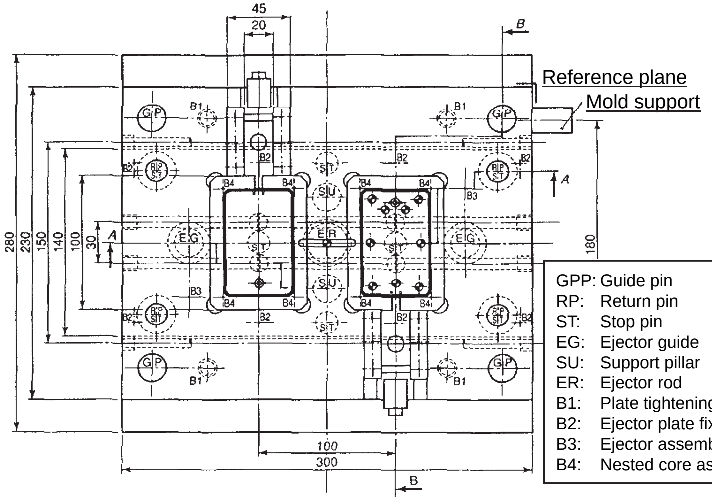


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

5. Procedure of designing molds

Example of layout design (movable side)

- Shall be slidable in the lateral direction to secure the operational reliability



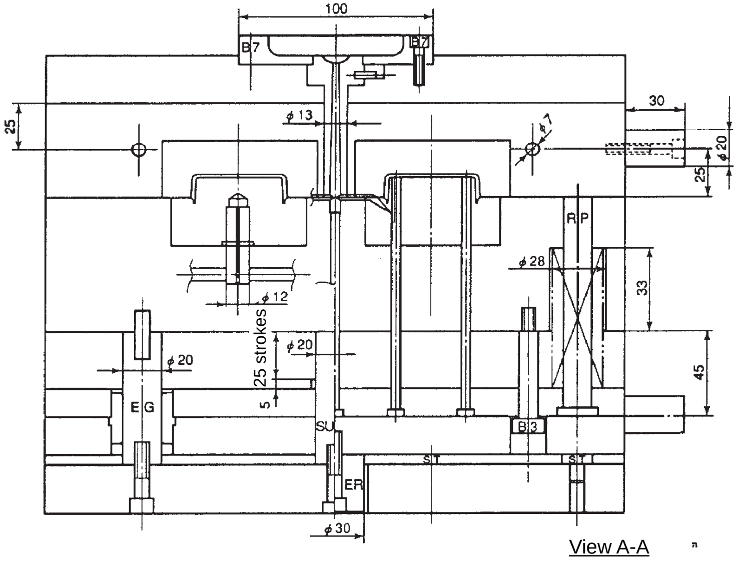
GPP:	Guide pin
RP:	Return pin
ST:	Stop pin
EG:	Ejector guide
SU:	Support pillar
ER:	Ejector rod
B1:	Plate tightening bolt
B2:	Ejector plate fixing bolt
B3:	Ejector assembly bolt
B4:	Nested core assembly bolt

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

Example of mold structure design (View A-A)



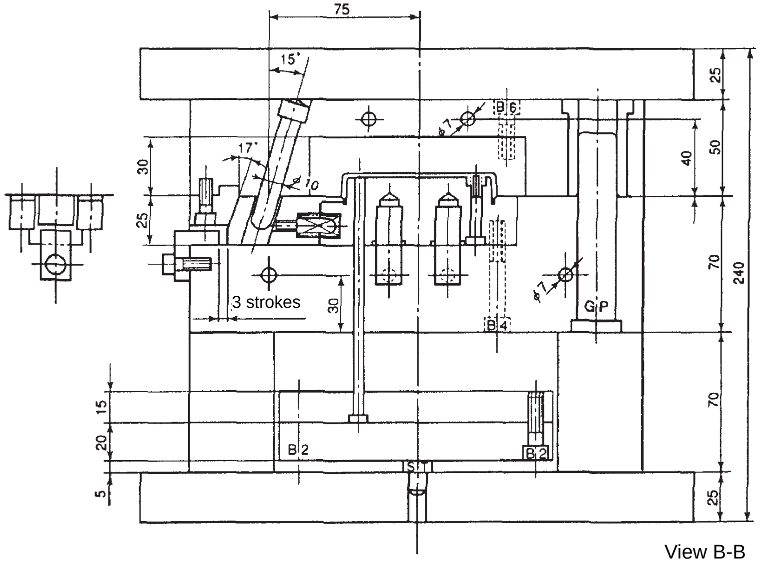
View A-A

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

Example of mold structure designing (View B-B)



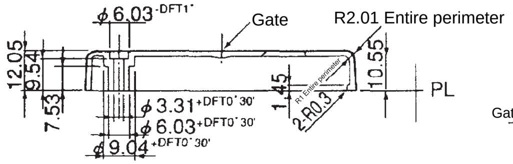
View B-B

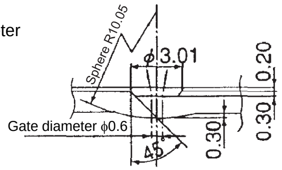
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

---

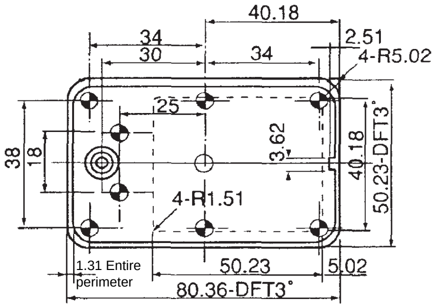
5. Procedure of designing molds

6) Angular core-structured mold (basic dimension drawing for cavity/core)





Gate area details (5/1)



(Note)

1. Gate protrusion: Max. 0.3
2. General tolerance: ±0.1
3. R: 0.2 or less, unless otherwise specified
4. Molding materials: Fire-retardant ABS (black)
5. For +DFT and -DFT, the draft angle shall be added to the positive or negative side, respectively.

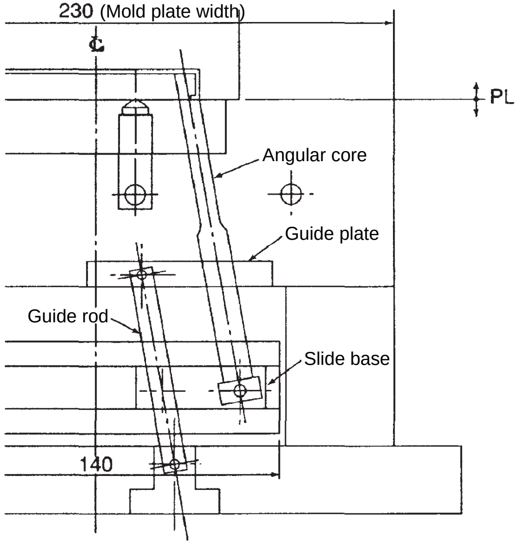
Basic dimensional drawing for cavities and cores

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

5. Procedure of designing molds

6) Reviewing angular core structure

- For angular core-structured molds, first review angular core-related matters to determine dimensions.



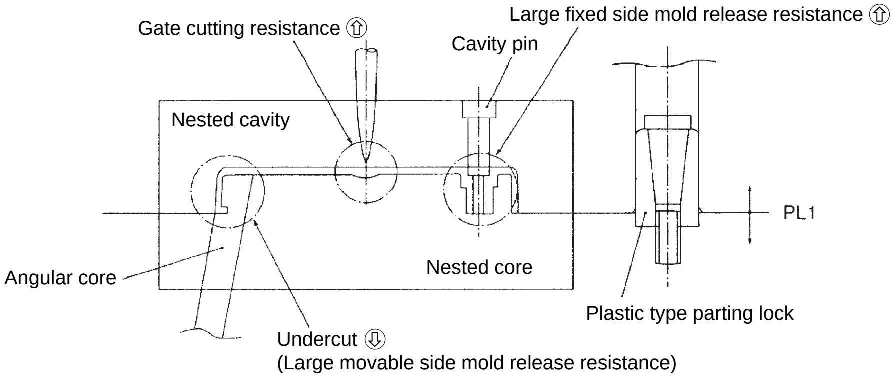
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

Reviewing mold release balance

- For 3-plate molds, review mold release balance to consider the necessity of parting locking.



* ⇧ and ⇩ indicate the direction of force applied to molded items when opening the die.

Example of parting lock installation against mold release defect

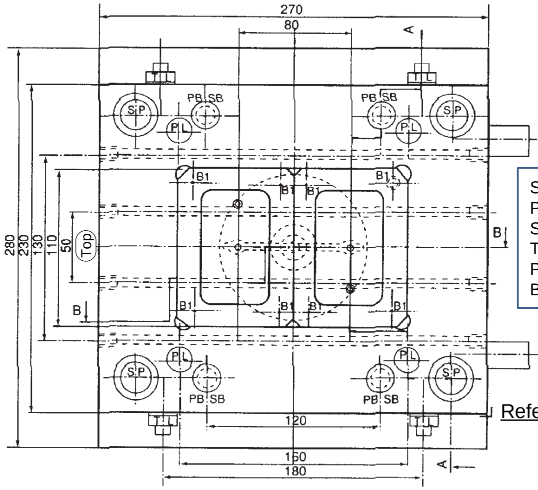
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

Example of layout design (fixed side)

- Determine the layout while paying attention to interference with the cooling circuit.



SP: Support pin
PB: Plastic bolt hole
SB: Stop bolt
TL: Tension link
PL: Parting lock hole
B1: Nested cavity fixing bolt

Reference plane

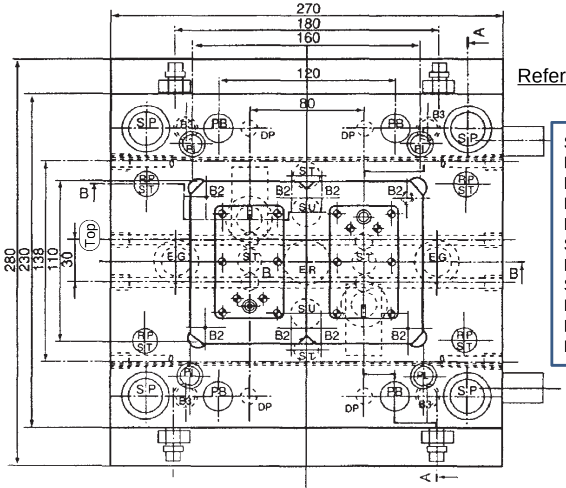
Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Procedure of designing molds

Layout design example (movable side)

- Determine the layout while paying attention to interference with the cooling circuit.



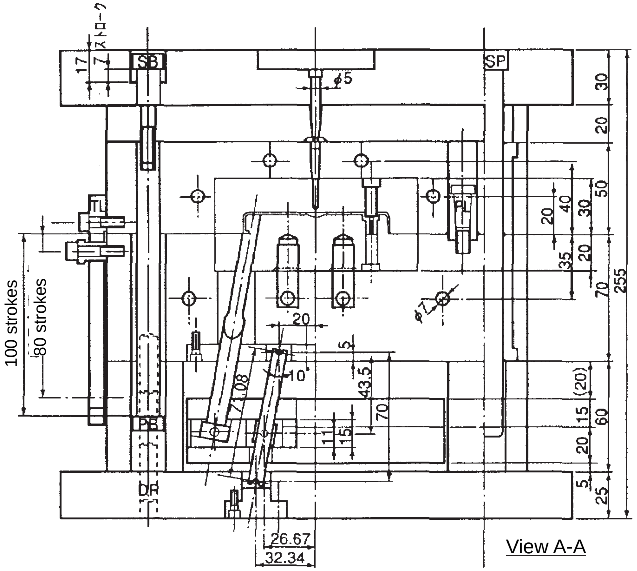
Reference plane

SP: Support pin
PB: Plastic bolt hole
PL: Parting lock
RP: Return pin
EG: Ejector guide
SU: Support pillar
ER: Ejector rod
ST: Stop pin
B2: Nested core fixing bolt
B3: Plate tightening bolt
DP: Knock pin

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

5. Mold designing procedure

Mold structure designing example (View A-A)



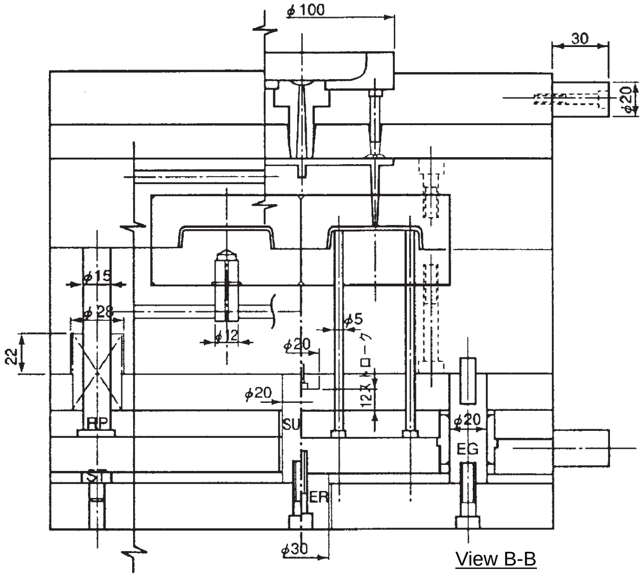
View A-A

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

---

5. Mold designing procedure

Mold structure designing example (View B-B)



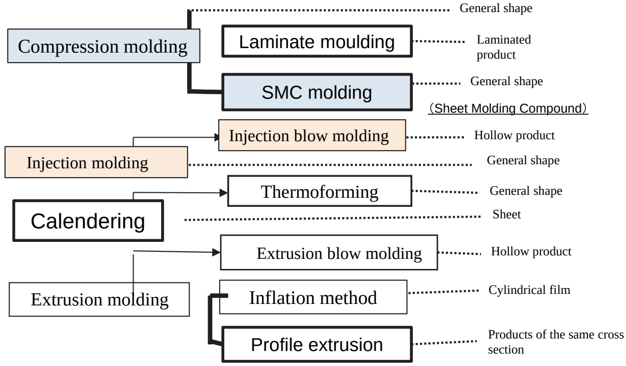
View B-B

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

No-2

Injection Molding System

2-1. Main molding method-1

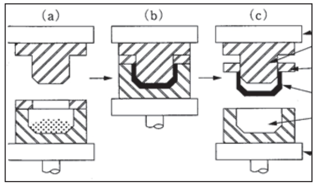


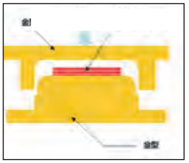
Compression molding
- Laminate moulding .... Laminated product
- SMC molding .... General shape (Sheet Molding Compound)
- .... General shape

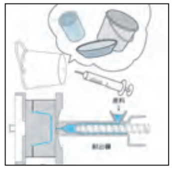
Injection molding
- Injection blow molding .... Hollow product
- .... General shape

Calendering
- Thermoforming .... General shape
- .... Sheet

Extrusion molding
- Extrusion blow molding .... Hollow product
- Inflation method .... Cylindrical film
- Profile extrusion .... Products of the same cross section





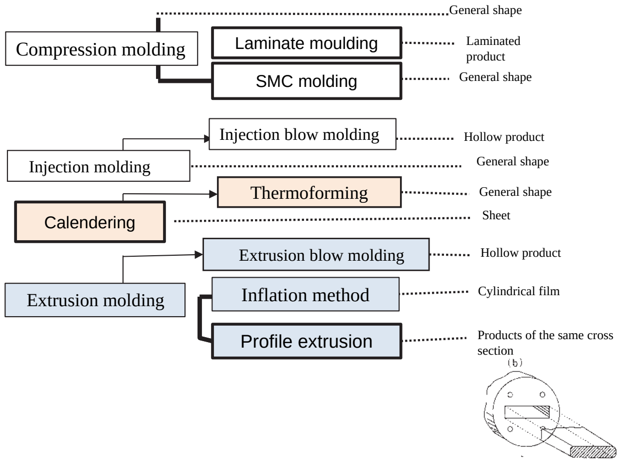


（Sheet Molding Compound）

Reference: Website of The JAPAN PLASTICS INDUSTRY FEDERATION, www.jpif.gr.jp/2hello/conts/dekiru2_c.htm

成形法の種類　圧縮成形/射出成形

2-2. Main molding method-2



Compression molding

Laminate moulding .... Laminated product

SMC molding .... General shape

.... General shape

Injection blow molding .... Hollow product

Injection molding .... General shape

Thermoforming .... General shape

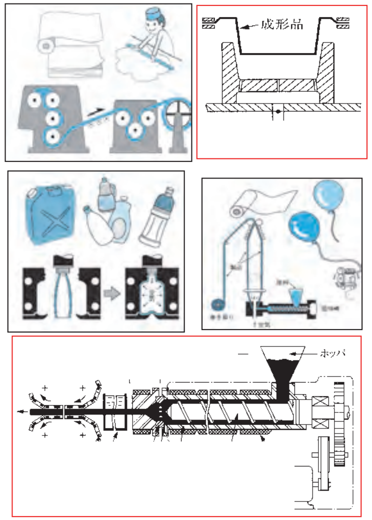
Calendering .... Sheet

Extrusion blow molding .... Hollow product

Inflation method .... Cylindrical film

Extrusion molding

Profile extrusion .... Products of the same cross section

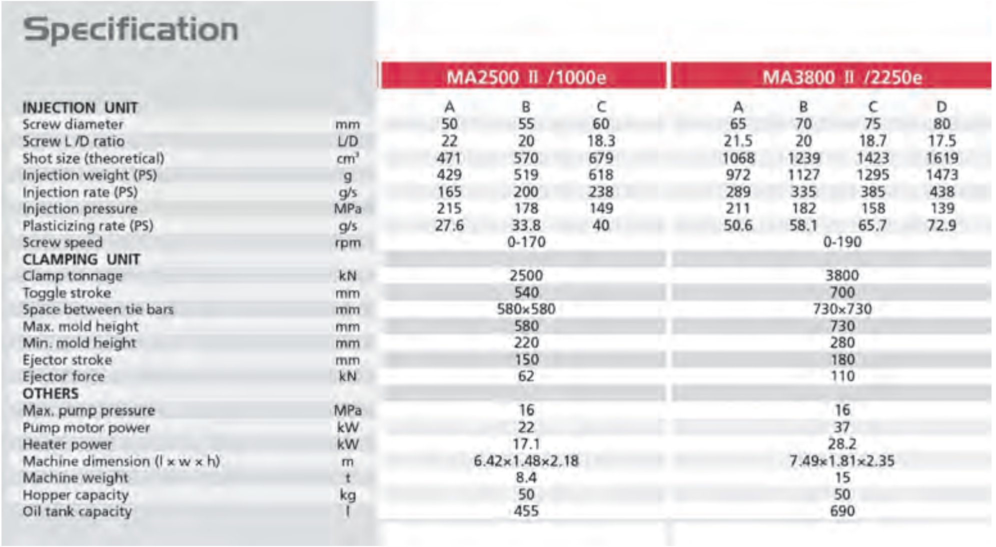


成形法の種類　カレンダ成形(熱成形)/押出成形

Reference: Website of The JAPAN PLASTICS INDUSTRY FEDERATION, www.jpif.gr.jp/2hello/conts/dekiru2_c.htm

---

2-3.Injection molding machine Specification



Specification

		MA2500 Ⅱ /1000e			MA3800 Ⅱ /2250e			
		A	B	C	A	B	C	D
INJECTION UNIT								
Screw diameter	mm	50	55	60	65	70	75	80
Screw L /D ratio	L/D	22	20	18.3	21.5	20	18.7	17.5
Shot size (theoretical)	cm³	471	570	679	1068	1239	1423	1619
Injection weight (PS)	g	429	519	618	972	1127	1295	1473
Injection rate (PS)	g/s	165	200	238	289	335	385	438
Injection pressure	MPa	215	178	149	211	182	158	139
Plasticizing rate (PS)	g/s	27.6	33.8	40	50.6	58.1	65.7	72.9
Screw speed	rpm		0-170			0-190		
CLAMPING UNIT								
Clamp tonnage	kN		2500			3800		
Toggle stroke	mm		540			700		
Space between tie bars	mm		580×580			730×730		
Max. mold height	mm		580			730		
Min. mold height	mm		220			280		
Ejector stroke	mm		150			180		
Ejector force	kN		62			110		
OTHERS								
Max. pump pressure	MPa		16			16		
Pump motor power	kW		22			37		
Heater power	kW		17.1			28.2		
Machine dimension (l × w × h)	m		6.42×1.48×2.18			7.49×1.81×2.35		
Machine weight	t		8.4			15		
Hopper capacity	kg		50			50		
Oil tank capacity	l		455			690		

source：HAITIAN catalog

2-4. Injection Molding System

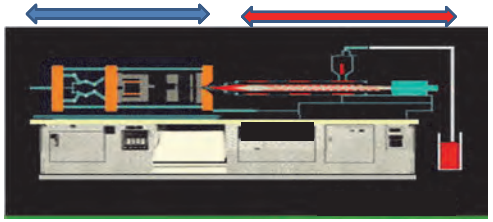
Mold Clamping Device

For Mold opening and closing, Product protruding

Injection Device

For Plasticizing, Metering, Injection

画面を見て1～5の質問に答えなさい



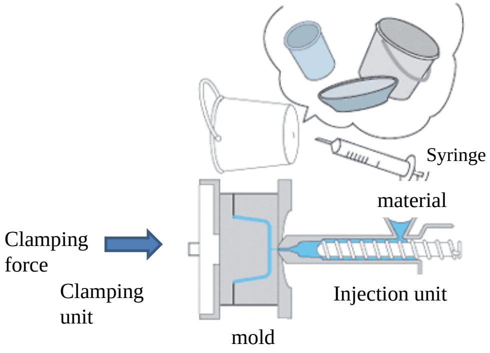
1. The number of parts to be molded　取り数　（　　　　　　　　　　　）
2. Type of material　　　材料名　（　　　　　　　　　　　）
3. Molding cycle time (seconds)　　成形サイクル　（　　　　　　　　　　　）
4. Types of gates　　Gate仕様　（　　　　　　　　　　　）
5. Types of mold clamping mechanism　型締機構の種類（　　　　　　　　　　　）

Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

2-5. Injection molding system

Injection molded products always have a gate

The injection-molded product always have a flow entrance (or a gate) of resin.
Thus, there is a trace of a gate on the molded product surface, which resembles a trace of a needle after injection by a syringe.



Material

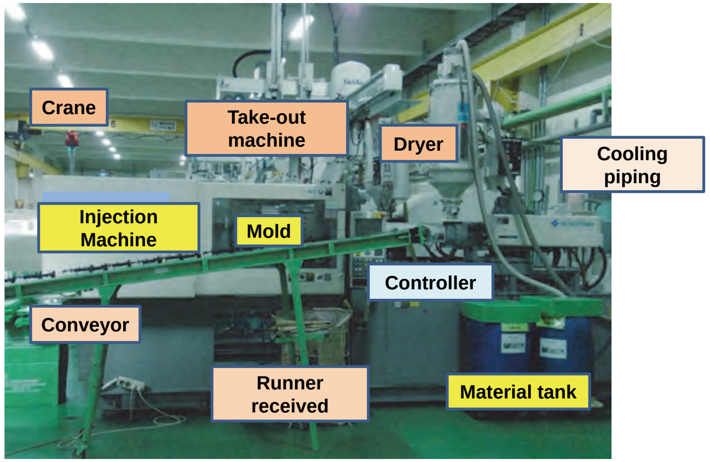
Mold

Injection Machine

Reference: Website of The JAPAN PLASTICS INDUSTRY FEDERATION, www.jpif.gr.jp/2hello/conts/dekiru2_c.htm

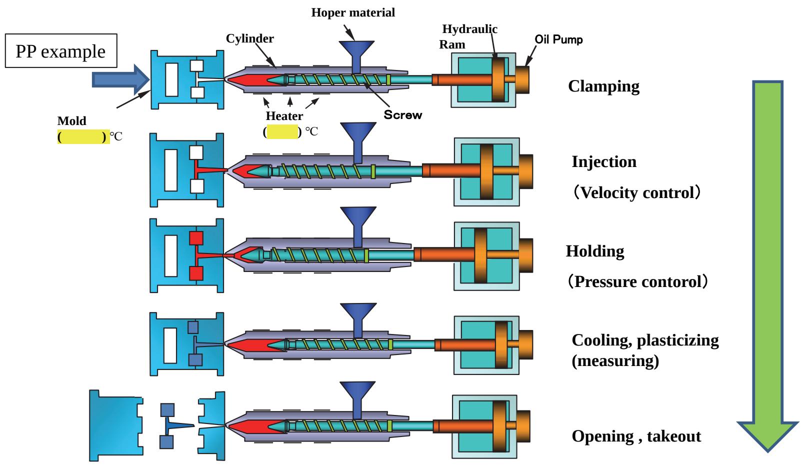
2-6. Injection molding system

Outline of peripheral equipment



2-7. Injection molding system

Injection Process



Clamping

Injection
（Velocity control）

Holding
（Pressure contorol）

Cooling, plasticizing
(measuring)

Opening , takeout

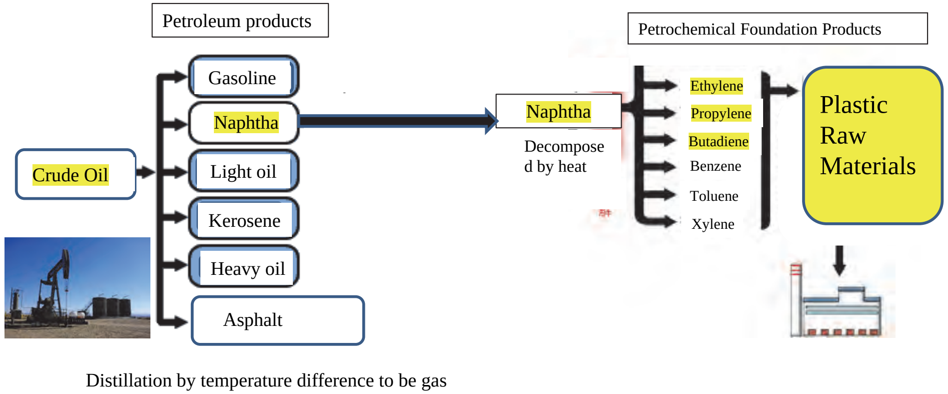
No-3

Plastic Resin

3-1. What is plastic? ：Raw Materials for Plastic

Naphtha (Raw Materials for Plastic）

Naphtha is obtained by separating crude oil by a distillation apparatus: those having a boiling point range of about 35 - 80 ℃ are called light naphtha. Naphtha is often used as raw materials for ethylene plants in the petrochemical industry



Distillation by temperature difference to be gas

Reference: Website of Plastic Library, Plastic Waste Management Institute, http://www.pwmi.jp/tosyokan.html

3-2. What is plastic? ：Monomer polymer

poly propylene → polypropylene

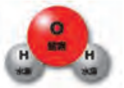
Greek language

(1) Monomer

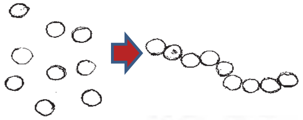
Unit material with a small molecular weight. Monomer generates polymer by combining each other or monomer addition reaction (addition polymerization) e.g. Polyprene

(2) Polymer

Chain-like structured macromolecule which is principle component of plastic. Chemical reaction repeatedly bonds monomers and forms polymer. Generally, polymer has 10,000 or more molecular weight. e.g. Polypropylene

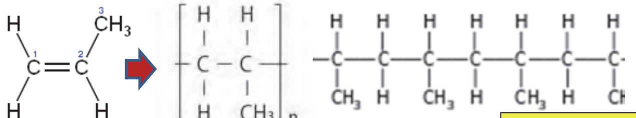


Polymer is compared to the molecule of water.
The molecule of water (H 2 O) consists of two atoms of hydrogen (H) and oxygen (O)



Monomer:
Small and discrete unit

Polymer:
Monomers combined like a long chain



Propylene

$(C_3H_6)_x$

Polypropylene

Reference: Website of Plastic Library, Plastic Waste Management Institute, http://www.pwmi.jp/tosyokan.html
Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/plastic/

3-3. Plastic Resin (Thermosetting and Thermoplastic)

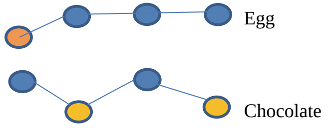
- Thermosetting resin is often compared to an Egg, by its state change.
- Thermoplastic resin is often compared to a Chocolate.

Melting point of chocolate？（ ℃）

Molding temperature ＞Melting temperature

Example of state change

	Beginning	Drop into a heated frying pan 100℃	Cool a frying pan 20℃	Heat a frying pan again 100℃
Egg (Thermosetting)	Colloidal liquid	Solid/hardened	Solid/hardened	Solid/hardened
Chocolate (Thermoplastic)	Solid/hardened	Melting/Liquid	Solid/hardened	Melting/Liquid



3-4. Plastic Resin (Thermosetting and Thermoplastic)

Process difference

1． Thermosetting resin

Heat softening

material → Molecular weight increase → The molecule begins to be three-dimensional (gelled) → Completion of three-dimensionalization = mesh structure →

Hardening

High temperature mold temperature molding temperature

Molding in high temperature mold: with chemical reaction

Molded article

The molded article temperature is the same as the mold temperature and is high temperature

2． Thermoplastic resin

Heat forming temperature

material →

Plasticized melting

Solidify

No chemical reactions occur

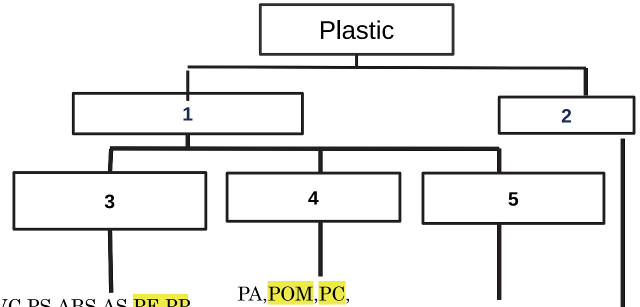
The material is cooled and solidified

The temperature of the molded article is the same as the mold temperature and is normal temperature

---

3-5. Enter the appropriate words in the blanks from 1 to 5

Practice Question-



- Engineering plastics
- Thermoplastic
- General purpose plastic
- Thermosetting
- Super engineering plastics

PVC,PS,ABS,AS,PE,PP, PMMA,PET,

PA,POM,PC, m-PPE,PBT, GF-PET,

PPS,LCP,PSF, PES,PAR,PEEK, PI,PAI

PF,UF,MF,UP ,DAP,EP,SI, PUR,PI

3−6. Types and characteristics of the plastic

Features of Crystalline resin and Non-crystalline resin in Thermoplastic

Crystalline Resin

①Opaque ②High heat resistance ③Excellent solvent resistance
④Easy to warp ⑤ Large shrinkage rate

- E.g.: PP, PE, POM, PA, PBT, PET, PPS, LCP, PEEK, PTFE,

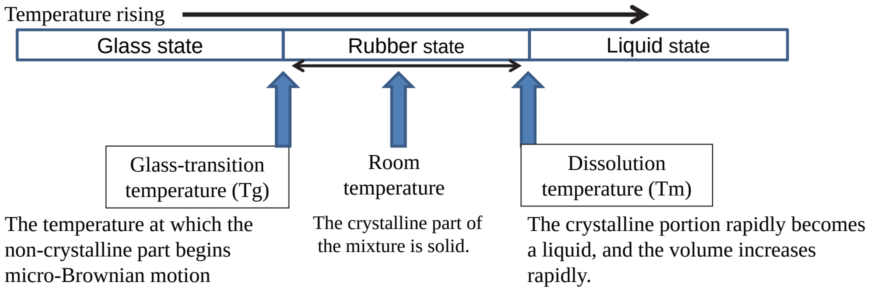
Non-Crystalline Resin

①Transparent ② Low chemical resistance ③Low Fluidity
④ Small shrinkage rate

- E.g.: PMMA, PVAC, GPPS, PC, m-PPE, PSU, PESU, PAR, PAI, PEI, PI

3-7. Types and characteristics of the plastic

Thermal Behavior of Crystalline Resin



Temperature rising

Glass state | Rubber state | Liquid state

Glass-transition temperature (Tg)

The temperature at which the non-crystalline part begins micro-Brownian motion

Room temperature

The crystalline part of the mixture is solid.

Dissolution temperature (Tm)

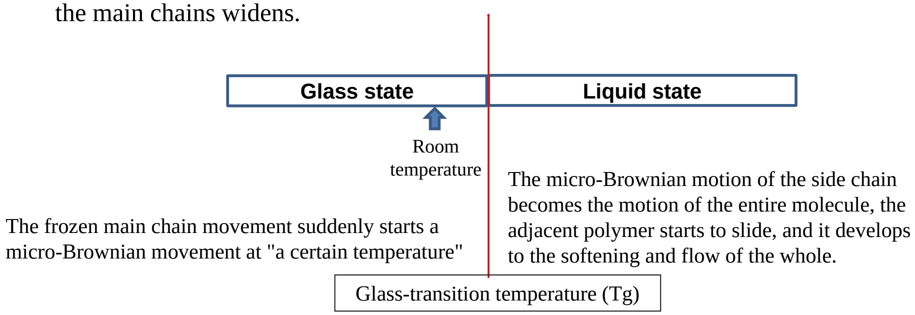
The crystalline portion rapidly becomes a liquid, and the volume increases rapidly.

Crystalline plastic quickly transits to the melt with a narrow temperature width when it exceeds the melting point of the crystal.

3-8. Types and characteristics of the plastic

Thermal Behavior of Non-crystalline Resin

The glass state rapidly transitions to the rubber state.
Softening with an amorphous polymer progresses over a wide temperature range. This weakens one of the intermolecular forces and the distance between the main chains widens.



Glass state | **Liquid state**

Room temperature

The frozen main chain movement suddenly starts a micro-Brownian movement at "a certain temperature"

The micro-Brownian motion of the side chain becomes the motion of the entire molecule, the adjacent polymer starts to slide, and it develops to the softening and flow of the whole.

Glass-transition temperature (Tg)

3-9. Types and characteristics of the plastic

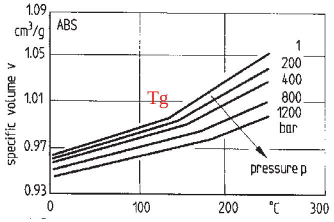
PVT behavior pressure・Specific volume・temperature

The specific volume (reciprocal of density)

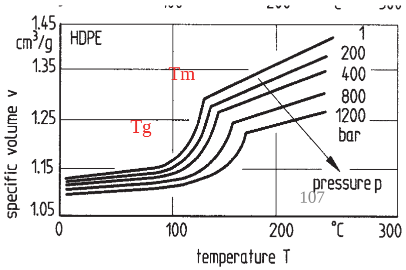
One of characteristics of polymer.
Specific volume is shown as a P - v - T figure, as a function of pressure and temperature.

P - v - T behavior of crystalline and Non-crystalline materials

ABS (Non-crystalline resin)



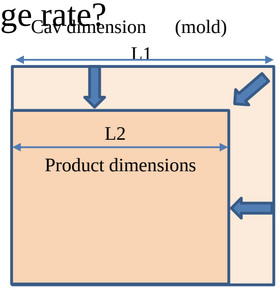
HD-PE (Crystalline resin)



Reference: Gerd PÖtsch Walter Michaeli, (1995) Injection Molding An Introduction, p.36, Hanser

3-10. Shrinkage rate

L1 dimension contracted to L2 dimension. What is the shrinkage rate?



Shrinkage rate= (L1 - L2)/ L1

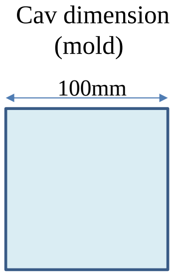
For example
L1＝100mm
L2＝99.8mm

＝(100-99.8)/100
＝0.002
2/1000 or 0.2%

3-11.Shrinkage rate

Practice Question-6

You have molded products with different resin by using the same mold.
Please check the dimensions of each product.



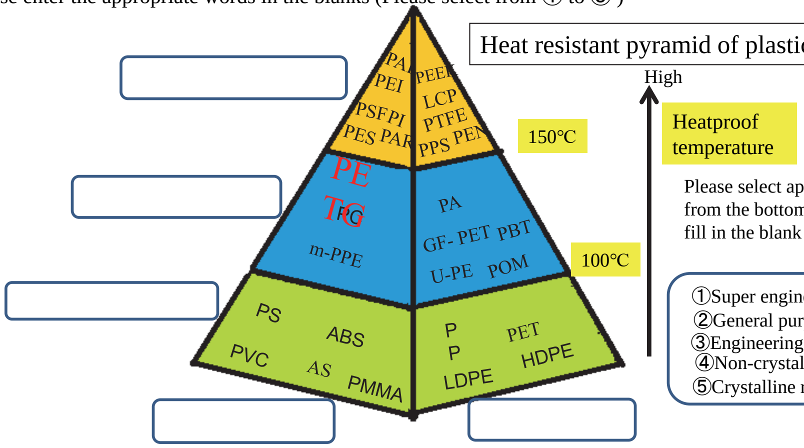
Material	Shrinkage	A molded article dimension
PP	18/1000	
PS	5/1000	

3−12. Types and characteristics of the plastic

Practice Question-7

Classification with long term heat resistance temperature

Please enter the appropriate words in the blanks (Please select from ① to ⑤)



Heat resistant pyramid of plastic

Please select appropriate words from the bottom column and fill in the blank space

①Super engineering plastics
②General purpose plastic
③Engineering plastics
④Non-crystalline resin
⑤Crystalline resin

3-13. Thermoplastic (Polymer and Abbreviation)

General Purpose Plastic

•PVC	Poly Vinyl Chloride
•PE	Poly Ethylene
•PP	Poly Propylene
•PS	Poly Styrene
•ABS	Acrylonitrile Butadiene Styrene
•AS	Acrylonitrile Styrene
•PMMA	Poly Methyl Methacrylate
•PET	Poly Ethylene Terephthalate

3-14. Thermoplastic (Polymer and Abbreviation)

Engineering Plastics

- PA6 Poly Amide 6
- PA66 Poly Amide 66
- POM Poly Oxy Methylene
- PC Poly Carbonate
- GF-PET GF-Poly Ethylene Terephthalate
- m-PPE modified-Poly Phenylene Ether (denaturated-PPE or denaturated PPO)
- PBT Poly Butylene Terephthalate
- U-PE Ultra High Molecular Weight Poly Ethylene
- PETG polyethylene terephthalate glycol

3-15. PETG polyethylene terephthalate glycol

ビスフェノールA（BPA）／Bisphenol A

PETG樹脂 **Bisphenol A(BPA）**が含まれていない
（Eastman Tritan™コポリエステル EX401）
メーカー：Eastman Chemical Company
比重1.17 荷重タワミ 温度0.455MPa 109℃（D648）
全光線透過率 91% D103 65℃4H 220～290℃ 15～30℃

BPA free

PETG (コポリエステル) は、PET を共重合したものです。重合過程で第 2 のグリコールを追加して共重合します。その結果、分子構造は不規則になり、樹脂は透明な非晶性になります。

source：Eastman Chemical Company catalog

3-16. Thermoplastic (Polymer and Abbreviation)

Super Engineering Plastics

- PEEK Poly Ether Ether Ketone 240℃
- PPS Poly Phenylene Sulfide
- PPSU Poly Phenyl Sulfone
- PSU Poly Sulfone
- PESU Poly Ether Sulfone
- PAR Poly Arylate
- PAI Poly Amide Imide 250℃
- PEI Poly Ether Imide (ULTEM®)
- LCP Liquid Crystal Polymer
- PTFE Poly Tetra Fluoro Ethylene
- PCTFE Poly Chroro TriFluoro Ethylene
- PVDF PolyVinylidene DiFluoride

3-17. Thermosetting Plastic (Polymer and Abbreviation)

- PF Phenol Formaldehyde (Bakelite)
- UF Urea Formaldehyde (Urea resin)
- MF Melamine Formaldehyde
- EP Epoxy
- UP Unsaturated Polyester
- SI Silicone
- PUR Poly Urethane

3-18. Thermosetting molding: Compression molding system (Thermoplastic)

	Products	**Materials**	**Characteristics**
1	Knob of pot	Phenol (PF)	• Heatproof temperature: 150℃
2	Dishes/Plates /Bowl	Melamine (MF)	• Low thermal conductivity: Food does not cool off easily • Scratch-resistant: Surface is hard • Heat sterilization /disinfection can be applied
3	Ashtray	Melamine (MF)	• Thermal deformation temperature 180 ℃, Not burnable
4	Bottle cap	Poly Propylen (PP)	• High productivity

1

2

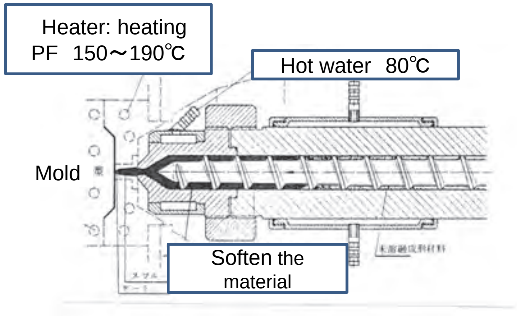
3

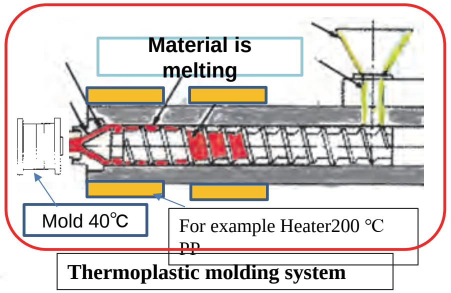
4

3-19. Thermosetting resin: Injection molding system

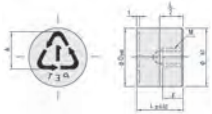
Appearance is the same

- Inject the softened material into the mold
- Harden with pressure and heat of injection (mold temperature)





3-20. Plastic Recycling Mark



Recycling mark indicates the type of plastic to sort out and use as a recyclable resource. For example, Japan has a system of selective collection of used plastic products (e.g. PET bottles) .

1 2 6

No-4

Mold

4-1. Positioning of mold in injection molding

Molds are one of the production factors necessary for producing molded articles

In fact

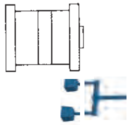
It is the most important production factor that is said to affect 80 to 90% of the quality and cost of molded articles

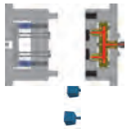
---

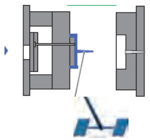
4-2. Classification of injection mold

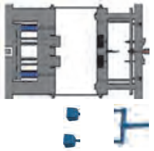
Injection mold (Runner system)
- Cold runner mold
- Hot runner mold

Cold runner mold (Plate structure)
- 2- plate mold
- 3- plate mold


Cold runner mold


Hot runner mold


2- plate mold

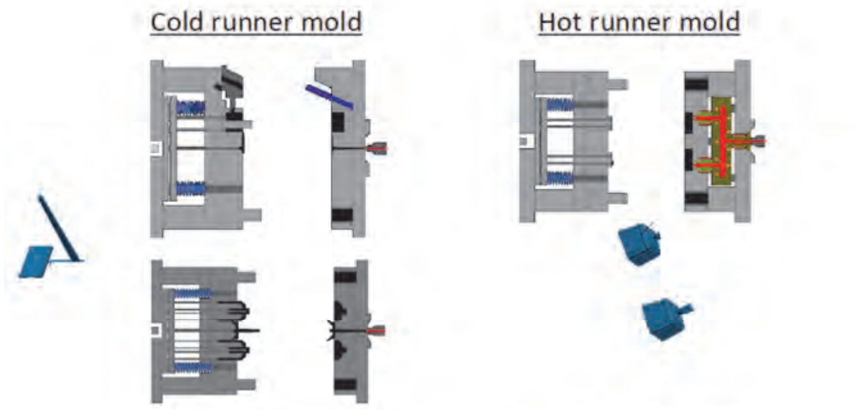

3- plate mold

Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html

---

4-3. Classification of injection mold



Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html
Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

4-4. Classification of function and basic structure of injection mold

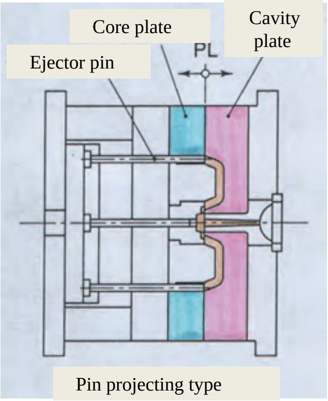
Comparison of Runner Method Feature

Item	Cold Runner	Hot Runner
Material Yield	Material yield is bad since unnecessary runners are formed	Material yield is good since only necessary molded parts are formed
Molding Cycle	Particularly, 3-plate molds are slow in molding cycle and low in productivity	Productivity is high with minimum molding cycle required
Quality of Molded Articles	Failure due to insufficient molding pressure or non-uniformity is likely to occur	"Burn" or "silver streak" due to inappropriate resin-melt temperature is likely to occur
Molding Material	No constraint on molded material	Difficult to apply to temperature sensitive materials and materials with high resin-melt temperature
Cost, Delivery Time	Lower cost and shorter delivery time comparing with Hot Runner (in general)	Higher cost and longer delivery time comparing with Cold Runner (in general)

4-5. Classification of function and basic structure of injection mold

Cold runner 2-plate mold: structure and features (1)

- 2-plate mold consists of two main plates：a cavity plate and a core plate
- All gating type molds other than the pinpoint gate type are 2-plate structure
- 2-plate molds are generally cheaper in mold cost and faster in molding cycle, comparing with 3-plate molds



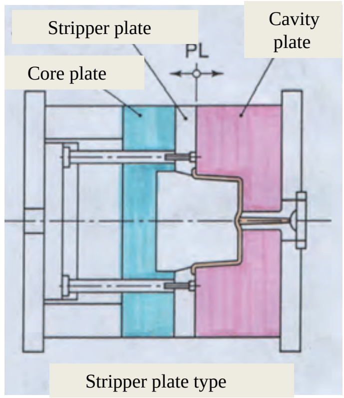
Pin projecting type

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.33, NIKKAN KOGYO SHIMBUN,LTD.

4-6. Classification of function and basic structure of injection mold

Cold runner 2-plate mold: structure and features (2)

- The mold structure composed of a cavity plate, a core plate and a stripper plate is also 2-plate mold
- 2-plate mold is characterized in that molded articles and runners are taken out from the same PL surface



Stripper plate type

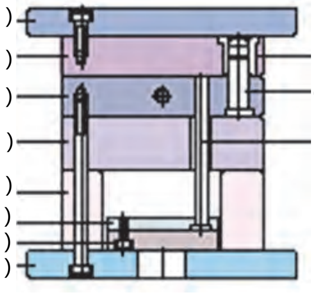
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.33, NIKKAN KOGYO SHIMBUN,LTD.

4-7. Structure and components of injection mold

Practice Question-8

Please select each name from the table on the right and answer by the number

2-Plate Type･Mold-Base



Q1 (　　)
Q2 (　　)
Q3 (　　)
Q4 (　　)
Q5 (　　)
Q6 (　　)
Q7 (　　)
Q8 (　　)
Q9 (　　)
Q10 (　　)
Q11(　　)

①	**Guide Pin**
②	**Parallel Block**
③	**Return Pin**
④	**Ejector Retainer Pate**
⑤	**Core Plate**
⑥	**Guide Bushing**
⑦	**Cavity Plate**
⑧	**Top Clumping Plate**
⑨	**Bottom Clumping Plate**
⑩	**Support Plate**
⑪	**Ejector Pate**

Reference: Futaba Electronics Industry Co., Ltd. WEB page, www.futaba.co.jp/product

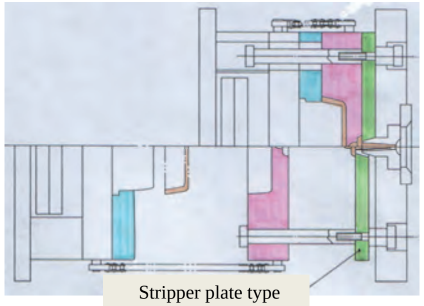
---

4-8. Classification of function and basic structure of injection mold

Cold runner 3-plate mold: structure and features

- 3-plate mold consists of three main plates: a cavity plate, a core plate and a runner stripper plate

- The pinpoint gate type mold has 3-plate structure
- 3-plate mold is characterized in that molded article and runner are taken out by different surface
- Both mold cost and molding cost are higher than 2 plate molds



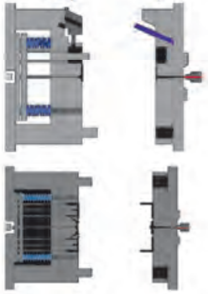
Stripper plate type

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.147., NIKKAN KOGYO SHIMBUN,LTD.

4-9. Classification of function and basic structure of injection mold

Which mold is 2-plate mold or 3-plate mold?

Q1 (   )



Q2 (   )

①	3-plate mold
②	2-plate mold

Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

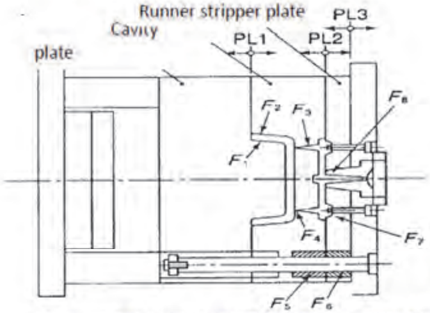
4-10. Classification of function and basic structure of injection mold

- Which is the correct opening order for 3- plate mold? (   )

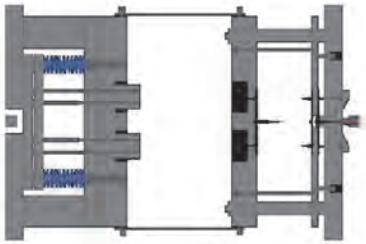
1) ①PL1→②PL2 →③PL3

2) ①PL2→②PL1 →③PL3

3) ①PL3→②PL2 →③PL1



Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.34, NIKKAN KOGYO SHIMBUN,LTD.



Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

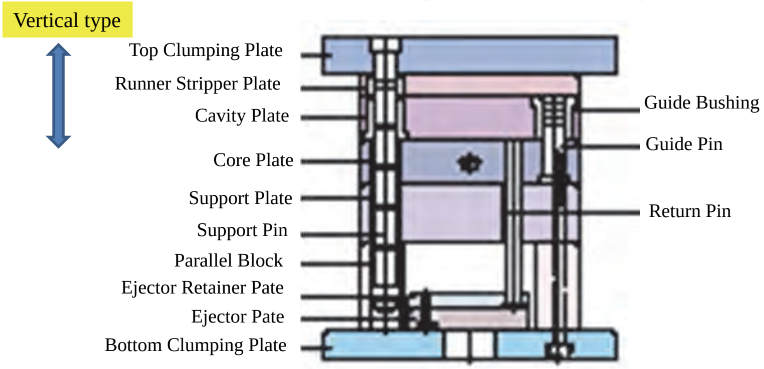
4-11. Mold base 2-Plate & 3-Plate

Reference: Futaba Electronics Industry Co., Ltd. WEB page, www.futaba.co.jp/product

---

4-12. Structure and components of injection mold

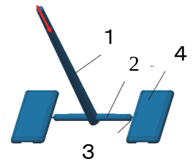
3-Plate Type・Mold-Base(1)

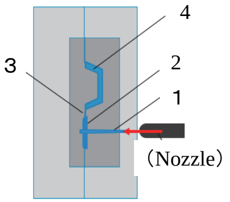


Reference: Futaba Electronics Industry Co., Ltd. WEB page, www.futaba.co.jp/product

4-13. Resin flow path and its name

Nozzle (Inject from the nozzle) → Sprue → Runner → Gate → Injection product (Cavity)

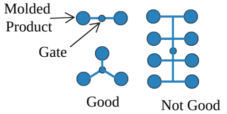




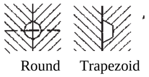
1	**Sprue**
2	**Runner**
3	**Gate**
4	**Injection product** (Cavity)

Runner Arrangement

Distance between each molded product and the gate should be same



Runner Cross-section



1. Sprue

The first flow path of the resin flow which enters into the mold

・Cross-sectional shape is circular・The side is inclined

2. Runner

Flow path to a mold product part in the mold*・ Cross-sectional shape is circular or trapezoid

3. Gate

Entrance to the molded product part・ Mark of the gate remains on the surface of the molded product

*A mold product part is a space and sometimes expressed as a cavity

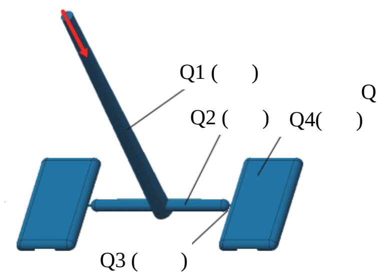
Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html

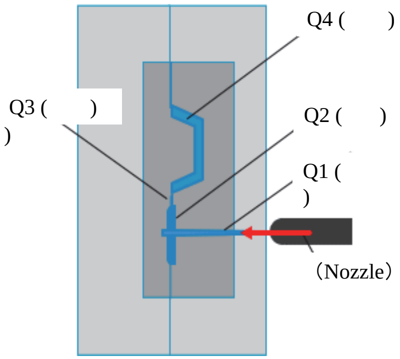
---

4-14. Resin flow path and its name

Practice Question-11

Please choose appropriate name from the table on the right





①	Gate
②	Runner
③	Injection product (cavity*)
④	Sprue

*Note: A mold product part is a space which will be filled by melted resin. This space is sometimes expressed as a cavity.

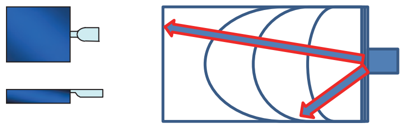
Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html

---

4-15. Resin flow

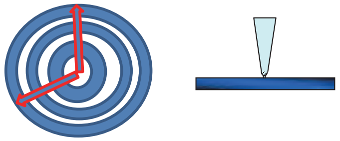
There are two types of resin flow in the mold: Bar flow and Radial flow

In Side Gate → Bar Flow



Mold gate system : Side-gate
Flow Length: Different
(e.g. Flat plate parts)

In Pin-point Gate → Radial Flow



Mold gate system: Pin-point gate, Direct gate
Flow Length: Same
(e.g. CD, caps, etc.)

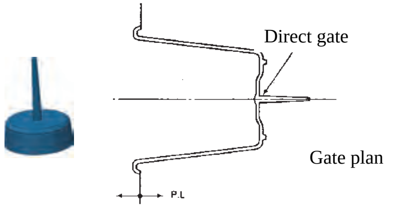
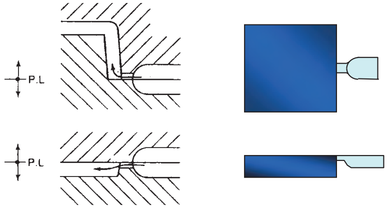
4-16. Gate Function and type of gate

Gate Function
①Gate Sealing function ②Heat generation function
③ Rectification function ④ Simplification function of finish machining
①ゲートシール機能②発熱機能
③整流機能④仕上げ加工の簡略化機能

Runner System	Type of Gate	Flow restriction	Mold	Gate cutting
Cold runner	①Direct gate	Non-limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	② Side gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	③ Overlap gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	④ Fan gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑤ Film gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑥ Disk gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑦ Ring gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑧ Tab gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑨ Submarine gate	limiting gate	2 Plate Mold	Automatic cutting gate
Cold runner	⑩ Pin-Point gate	limiting gate	3 Plate Mold	Automatic cutting gate
Hot runner	Various gates 色々なゲート	Non-limiting gat	2 Plate Mold	(Mechanism · temperature) バルブ・加熱でon一off

4-17. Mold gate systems

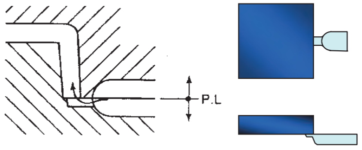
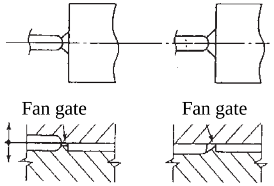
Features and applications of various gate systems ①

System	①Direct gate	②Side gate
Schematic Diagram		
Features · Applications	▪ Single cavity mold (1 piece) only ▪ Low pressure loss ▪ Gate cutting trace is large ▪ Suitable for large size /depth molded products	▪Mold processing is easy → Low cost ▪ Possible to deal with multiple cavity mold (multiple pieces) ▪Easy gate disconnection ▪Most commonly used

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.59, NIKKAN KOGYO SHIMBUN,LTD.

4-18. Mold gate systems

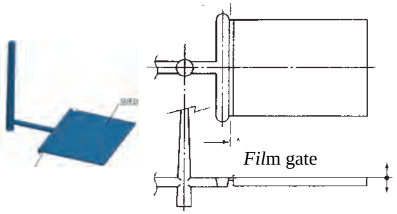
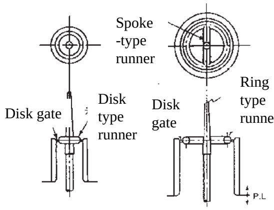
Features and applications of various gate systems ②

System	③Overlap gate	④ Fan gate
Schematic Diagram		
Features · Applications	▪ Cross-sectional shape is same as side gate ▪ Jetting is hard to occur ▪ There is no gate trace on the side of the molded product ▪Gate disconnection is somewhat difficult	▪Molten resin flows uniformly ▪Warpage and distortion are less likely to occur ▪Gate disconnection is somewhat difficult

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.59, NIKKAN KOGYO SHIMBUN,LTD.

4-19. Mold gate systems

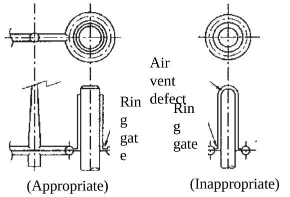
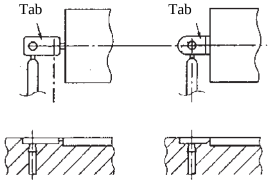
Features and applications of various gate systems ③

System	⑤ Film gate	⑥ Disk gate
Schematic Diagram		
Features · Applications	▪Molten resin flows uniformly ▪Warpage and distortion are less likely to occur ▪Gate cutting type required	▪Basically one piece ▪No failure regarding Weld Line ▪Good air exhaustion in a cavity ▪Gate cutting type required

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.59. NIKKAN KOGYO SHIMBUN,LTD.

4-19. Mold gate systems

Features and applications of various gate systems ④

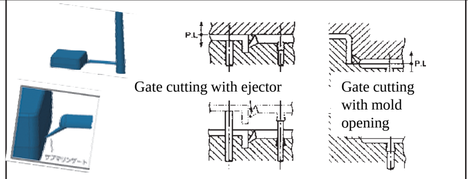
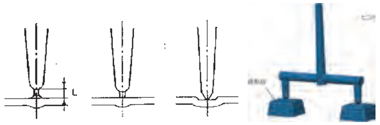
System	⑦ Ring gate	⑧ Tab gate
Schematic Diagram		
Features · Applications	▪Cylindricity is relatively good ▪In molded products with CAP shape, air vent is poor and defects are likely to occur ▪ Gate cutting type required	▪Absorption of internal distortion of gate part by tab ▪is often used for transparent molded articles ▪ Gate cutting type required

http://d-engineer.com/mold/gatesyurui.html）

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.61, NIKKAN KOGYO SHIMBUN,LTD.

4-20. Mold gate systems

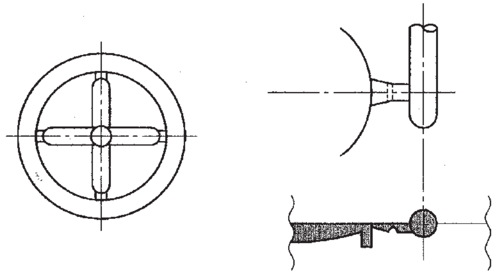
Features and applications of various gate systems ⑤

System	⑨ Submarine gate	⑩ Pin Point gate
Schematic Diagram	 Gate cutting with ejector Gate cutting with mold opening	
Features · Applications	▪Automatic cutting gate ▪Applied to small molded items ▪Limitation in fiber-reinforced resin use ▪Mold cost is relatively low	▪Automatic cutting gate ▪Suitable from small molded items to large molded items ▪Limitation in fiber-reinforced resin use ▪Mold cost is relatively high

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.62-63, NIKKAN KOGYO SHIMBUN,LTD.

4-21. Mold gate systems

Derived types of side gates and fan gates

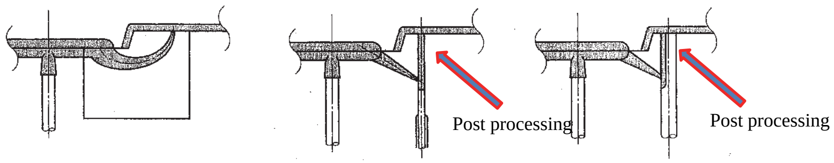


(a) Spoke gate (b) Restated Gate

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.62-63, NIKKAN KOGYO SHIMBUN,LTD.

4-22. Mold gate systems

Derived type of submarine gate



Banana gate

Method by full length cutting of small ejector pin

Method by partial cutting of large ejector pins

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.214, NIKKAN KOGYO SHIMBUN,LTD.

4-23. Mold gate systems

Gate size ① : How to calculate

Formula

▪For Pinpoint-Gate: To Calculate Pinpoint-Gate's Circular Sectional Dimensio●

$d = nkA^{1/4}$ d : Gate size (mm)

▪For Side-Gate: To Calculate Side-Gate's Rectangular Cross Section Dimensi■

$h = nt$ h : Gate depth (mm)

$w = nA^{1/2}/30$ w : Gate width (mm)

Variables

n : Material constant

k : Wall thickness coefficient : $(0.1\sim0.15)t^{1/2}$

t : Basic wall thickness (mm)

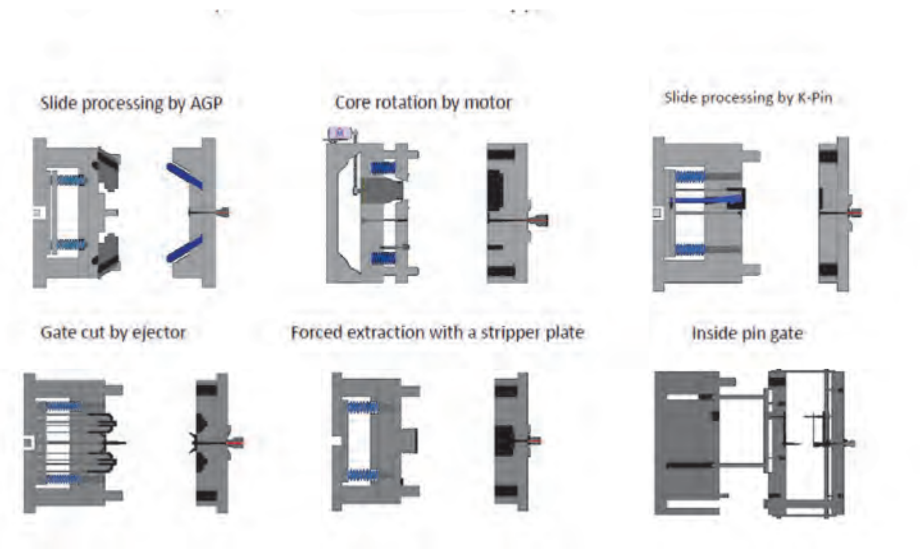
V : Volume of moldings (mm^3)

A : Deployment area of moldings (mm^2) : (V/ t)

Material constant			
	High flow	**Medium flow**	**Low flow**
Material	PE/PS/AS Pp/ABS	POM/PBT PA/m-PPE	PMMA/PC PVC/PPS
n	0.6	0.7	0.8

Material constant (n) : Indicator for the difference of liquidity in three stages

4-23. Example of varius mold type



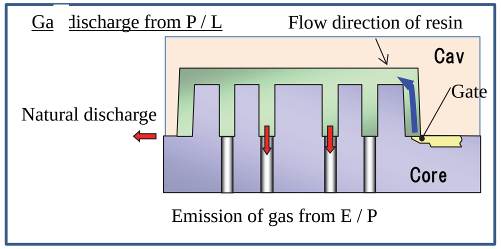
Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

4-24. Venting of mold

Before filling resin, there is air in the mold. A structure / mechanism is necessary to discharge gas generated from air and resin.

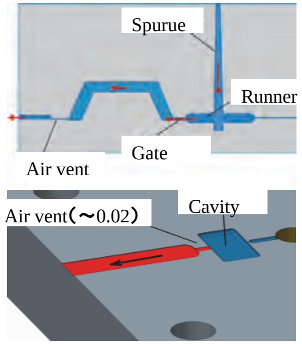
⇒Air vent of PL part (depth of filling terminal part ~ 0.02 mm)

A device that sucks air and gas inside a mold using a vacuum pump.



P/L : Parting line

E/p : Ejector pin

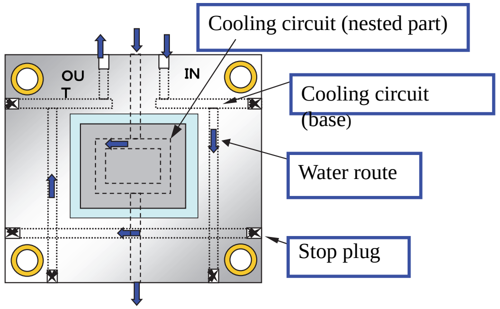


Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html

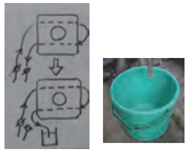
---

4-25. Heat exchanger / Cooling circuit of Mold

1) Mold is a heat exchanger ⇒ Mold temperature controller · Cooling water used for adjustment
2) The cooling efficiency greatly affects the molding cycle. Cooling circuit design is important
3) Flow path will be narr ved by rust etc.
Maintenance of circuit is necessary ⇒ Periodic check of cooling water flow rate is necessary.



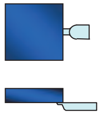
Cooling flow check

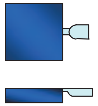


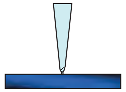
4-26. Typical gate system example

Practice Question-13

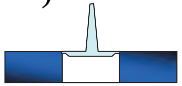
Please select the gate specification from the table on the right.

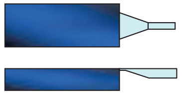

Q1 ( )

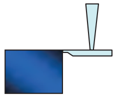

Q2 ( )


Q3 ( )


Q4 ( )


Q5 ( )

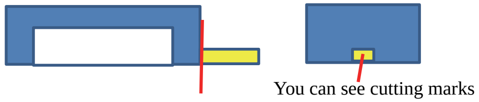

Q6 ( )


Q7 ( )

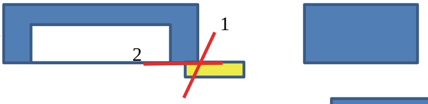
①	Pin Point Gate
②	Side Gate
③	Disk Gate
④	Fan Gate
⑤	Submarine Gate
⑥	Pinpoint + Side Gate
⑦	Overlap gate

4-27.代表的ｹﾞｰﾄ方式例　Typical gate system example

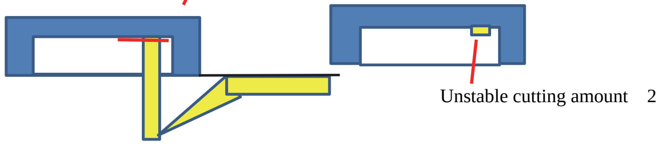
Side gate



Overlap gate

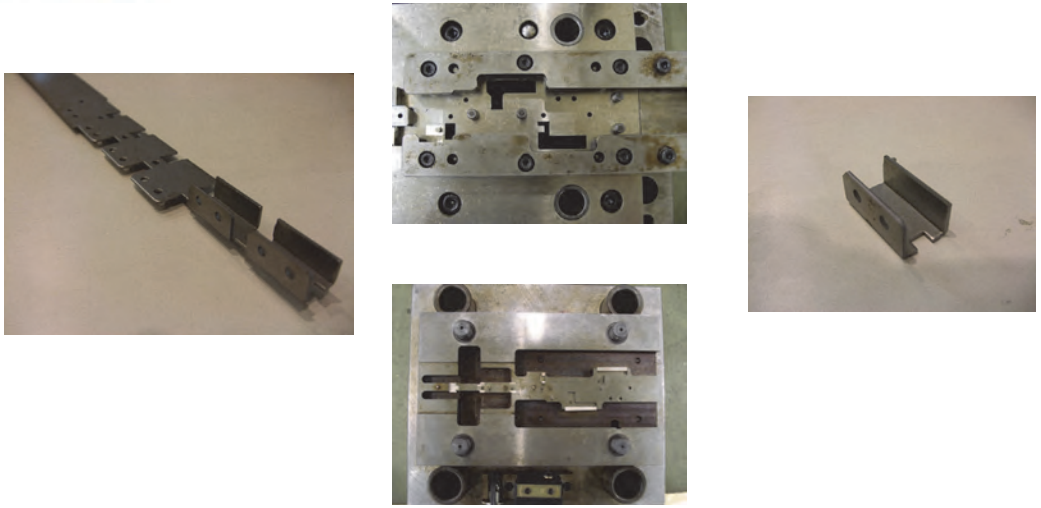


Submarine Gate



Banana gate

Side gate	**Cutting marks**
Overlap gate	**2 times cut**
Submarine Gate	**Unstable cutting amount**
Banana gate	



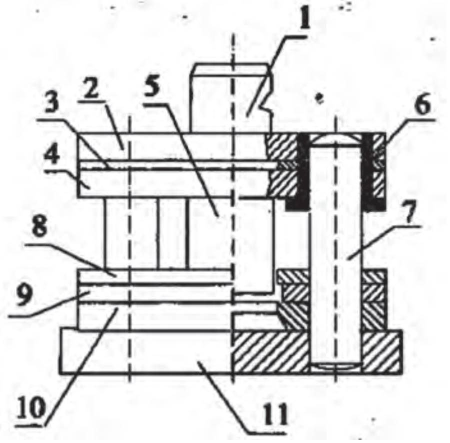
BASIC DIE COMPONENTS

In die design, it is important to consider every detail carefully such as: holding both punch and die in position, finding how to position the stock for blanking or other operations, arranging how to strip the stock from the punch, and providing a device for ejecting the workpiece.

Most dies are constructed of several basic components, including the die set (upper shoe, lower shoe and guide posts), the die itself, the punch, a stripper plate, heel blocks, screws, dowels, and keys. Dies also need a knockout plate and knockout pin, a backing plate, a stop block, a pilot, gages, a pressure pad, and drawing pads, as well as the devices used to secure them—shoulder bolts, keepers, and retainers; and gas, coil, or urethane springs.

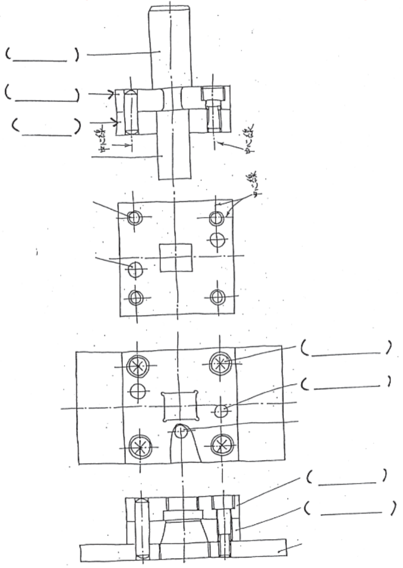
Simple dies

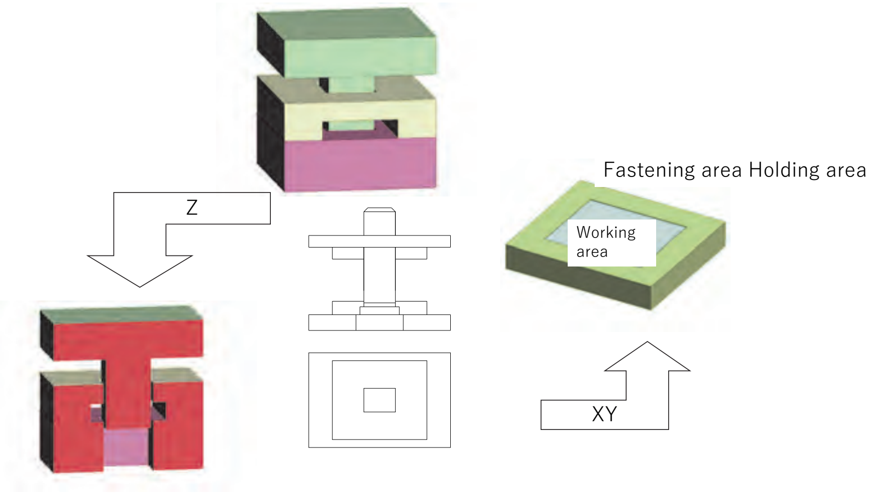
- Simple dies are dies designed to perform only one specific operation like blanking, punching, notching, trimming etc.
- The die may be provided with all the usual elements including stop pins which are used for proper indexing of the metal strip.

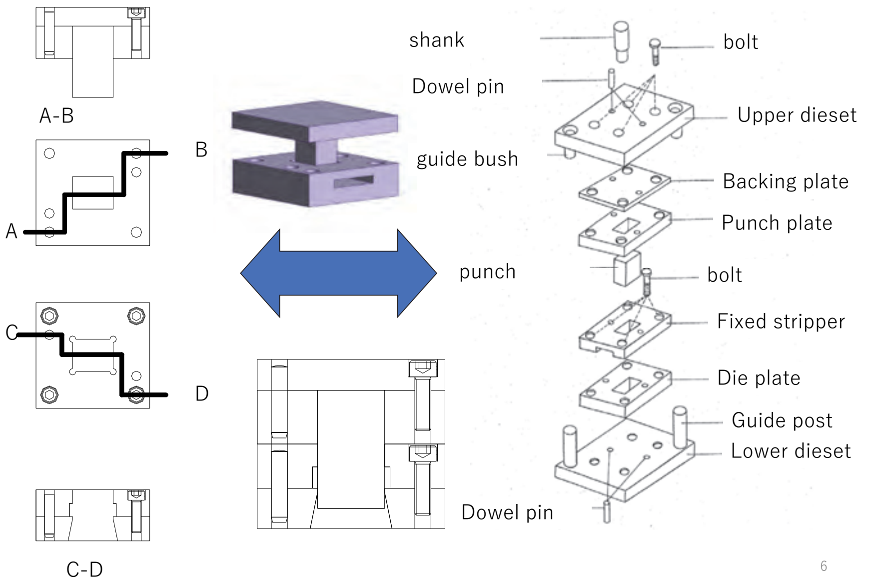


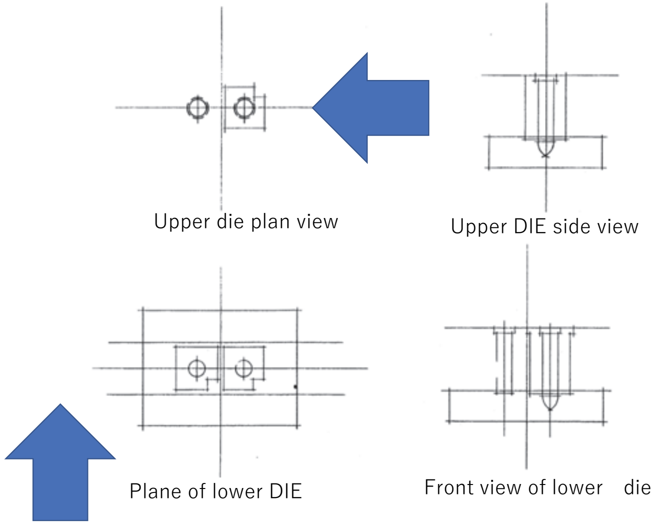
1 -shank
2 -shank holder
3 -backing plate
4 -punch holder
5 -punch
6 -guide post bushing
7 -guide post
8 -stripper
9 -guide rail
10-die block (PLATE)
11-die shoe (DIE HOLDER)

Consider the placement of DIE design drawings.



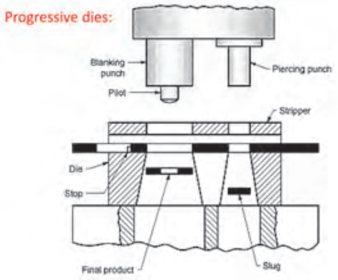






Progressive dies－1

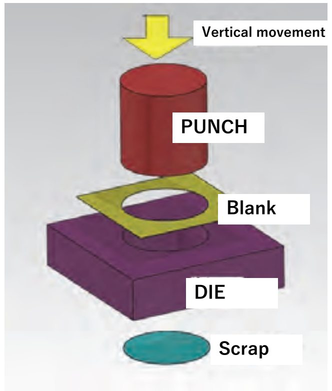
- When the quantity of pieces to be produced is large, more complex dies are often used to increase production rate. Dies included in this category are progressive, compound and combination dies.
- A progressive die uses two or more punch and die sets located at different stations to perform a number of operations simultaneously in one stroke of the ram.
- The sheet is moved progressively from one station to the other till at the last station a complete job is obtained.



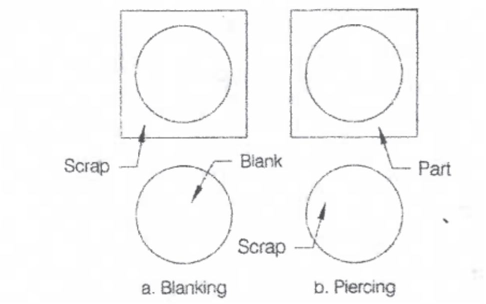
Press Working Dies:

Progressive dies – 2

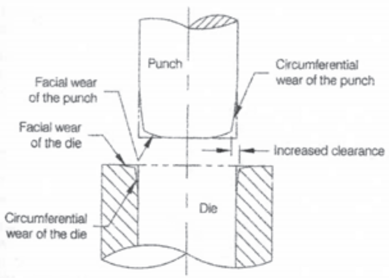
- A simple two-stage progressive punch and blanking die used for making washers is in fig.
- The metal strip is introduced from one end and is advanced till the first station where a hole is punched in the first stroke of the ram.
- The metal is now advanced to the next stage, the correct distance being set by the stop shown.
- As the ram moves down for its next stroke the pilot on the blanking punch enters the hole pierced at the previous station to locate the sheet.
- The working punch itself moves down to remove the completed washer.
- In the mean time a new hole has been pierced at the first stage.
- In each subsequent stroke of the ram two operations are performed one at each station and one job is completed at the last station.
- Straight pieces of metal are fed manually maintaining a slight pressure on the strip as it passes through the die.



PIERCING



In blanking, the piece is cut off from the sheet and it becomes a finished part.
In piercing, the cutout portion in scrap which get disposed off while the product part travels on though the remainder off the die.



The wear of tooling considerably alters the cutting conditions, raising the demand for press as well.

Up to 50 percent increase in tonnage has been observed with some parts.

The punch-and-die clearance enlarges, with subsequent damage to the surface of the parts, which becomes rough and uneven.

Excessive friction, followed by an increase in temperature during the die operation, only speeds up the destruction process.

BASIC DIE COMPONENTS

The die set (Fig. 5.1) consists of an upper shoe, a lower shoe, and guide posts. These shoes are accurately aligned to each other by guide posts that ride in guide bushings.

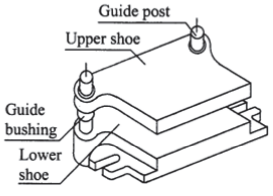


Fig. 5.1 *Die set.*

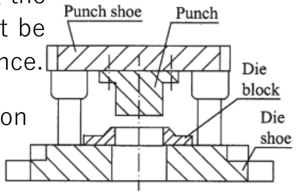
The guide posts are press-fitted into the lower shoe or die shoe, whereas the guide bushings are press-fitted into the upper shoe or punch shoe.

An accurate slip fit is maintained between the bushing's inside diameter and the guide post's outside diameter. In rare cases, the positions of the guide posts and guide bushings are reversed.

Die sets are made in a variety of shapes and sizes to meet most needs.

Upper and Lower Shoes

- The upper and lower shoes serve as the foundation for mounting the die components that will do the work desired. These parts must be machined so that they are parallel and flat within a critical tolerance.
- Two, three or four guide posts are used for alignment, depending on the size of the die set and the accuracy required.



- Most die shoes are made from cast iron, cost steel, and rolled steel. Aluminum alloys also are a popular die shoe material. Aluminum is one-third the weight of steel and can be machined very quickly. Aluminum alloys absorb shock well, making them a good choice for blanking and punching dies.
- The die shoe thickness is based on how much force can be expected during cutting and forming. For example, a coining die, one that compresses metal by squeezing it between upper and lower die sections, requires a much thicker die shoe than a simple bending die does.

Guide Posts and Bushings

- Guide posts, sometimes referred to as "guide pins," constitute, with guide bushings, the guide assembly.
- They are precision-ground components, often manufactured within tolerances of 0.003mm. Inside the guide bushing is a channel for lubrication; however, the channel is sometimes made in the guide post.

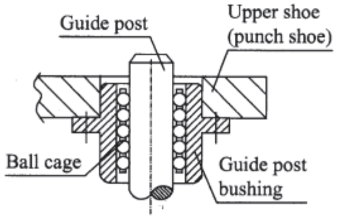
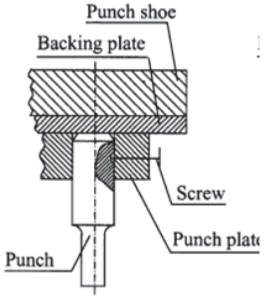


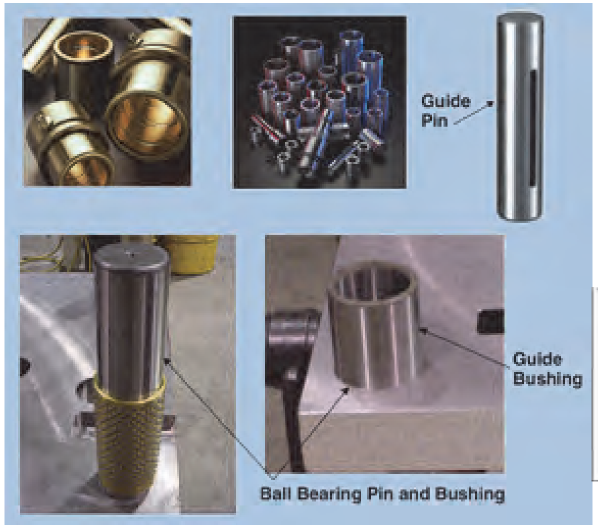
Fig. 5.2 *Guide post assembly with ball cage.*

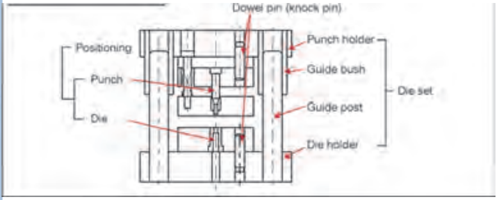
- The best guidance and the most precision are achieved if a ball cage die set is installed in the guide bushing, as shown in Fig. 5.2.
- Guide post assemblies maintain the upper and lower die shoes in alignment and sometimes provide the spring force for opening the die.
- Guide posts are made from hardened tool steel, whereas bushings are often made from a special wear-resistant material called aluminum-graphite bronze that helps to reduce the friction and wear that occur to the posts and bushings.

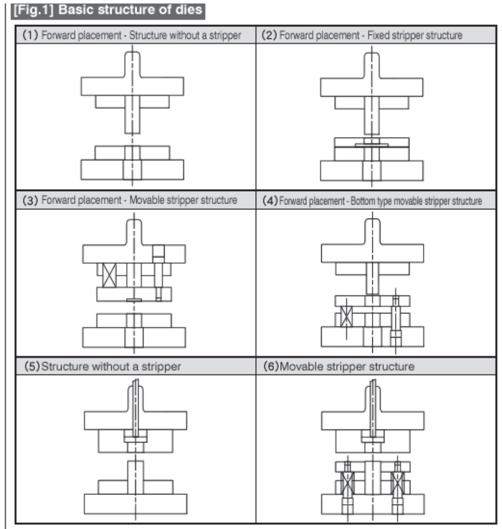
Backing Plate

- Quite often, die blocks and cutting punches are separated from the die and punch shoe by backing plates whose function it is to prevent the punches and dies from becoming embedded in the soft shoes.
- Also, backing plates help maintain an accurate location of segments for sectioned dies and punches.
- The backing plate is made of cold-rolled mild steel, oil-hardened.







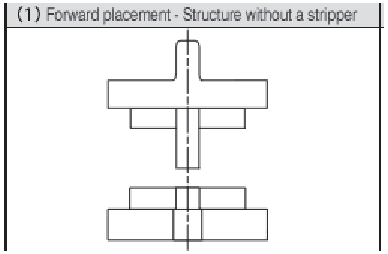


The basic structure of a die can be organized in an orderly manner according to the position relationship (top or bottom) between the punch and the die, the presence or absence and the method of using a stripper. The complex structure of a compound die is a combination of these basic structures.

This is whether the stripper is on the punch side or on the die side, and whether it is of the movable type or of the fixed type.

(1) Forward placement - Structure without a stripper

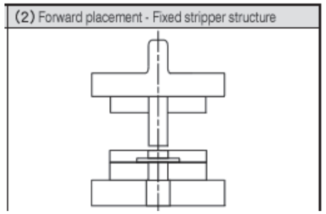
- This is used for work in which the material pressure plate is not necessary and there is no worry of the material biting the punch.
- This is used in quite a large number of applications. For example, this is used in V-shaped bending dies, extruding and dropping type dies that do not need a wrinkle preventing pressure plate, etc.



---

(2) Forward placement - Fixed stripper structure

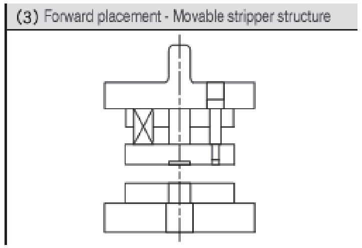
- This is a structure in which the stripper is on the die side and is fixed to the die. A typical use of this type of structure is the die for blanking work.
- This is used when a material pressure plate is not necessary but the material is likely to bite the punch.
- This is also used in dies for progressive bending or extruding work.
- Although the structure is simple and easy to use, the working part of the material cannot be seen because it is covered by the stripper, the unnecessary part of the stripper is cut out thereby making the working part visible.



---

(3) Forward placement- Movable stripper structure

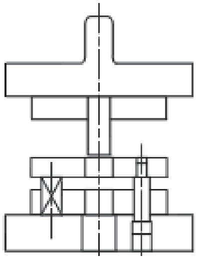
- This is usually called the movable stripper structure, and is a very well known structure. This is the type in which the stripper is movable and is on the punch side.
- This structure is used when a material pressure plate is required and also the material bites the punch.
- This structure is used very frequently in hole punching dies or progressive punching work.
- This is also considered to be a type of die structure for precision work. In a die for precision work, the stripper is guided by a stripper guide post (pin) thereby restricting the movement of the stripper.
- Further, the punch tip is guided by the stripper thereby enhancing the relationship between the punch and the die.



（4） Forward placement - Bottom type movable stripper structure

- This is a structure in which the stripper is movable and is on the die side.
- This structure is used during bending work when a material pressure plate is not required but is necessary to take out the product that has gotten stuck to the punch.
- This is because it is possible to create a space for inserting the material into the interior of the die by making the stripper movable.
- This is also used for progressive extruding work.

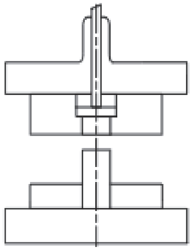
orward placement - Bottom type movable stripper structure



（5） Reverse placement - Structure without a stripper

- This is a structure in which the punch is below and the die is above.
- In a reverse placement structure, a knock out is always necessary in the die.
- A knock out is a part for the purpose of ejecting a product from the die that has gotten inside the die.
- This structure has no stripper and is frequently used in trimming dies for extruded products.

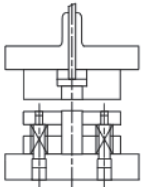
(5)Structure without a stripper



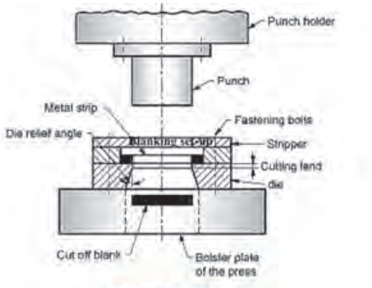
（6） Reverse placement - Movable stripper structure

- This is a structure in which a movable stripper is attached on the lower punch side. This structure is used for work requiring a material pressure plate.
- In addition, since the material passes by sliding over the top surface of the stripper, this surface is also used as a material guide. Since a knock out can also be used as a material pressure plate, it is frequently used for work requiring flatness, or in dies for extruding work.
- Even with the same work, the quality changes when the die structure is changed. This is in cases such as when a material pressure plate is not used although it was necessary. On the other hand, care should be taken because the die can be made expensive by pressing the material when a material pressure plate is not required.
- The structure should be designed to match the functions necessary for the work.

(6)Movable stripper structure

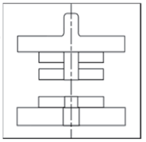


- The die for press work is made of a top die and a bottom die. If the relationship between the top die and the bottom die is not correct, either the press work cannot be made properly or repairs will become necessary early on.
- This relationship is created by what are called guides. Such guides are called die matching guides or cutting edge matching guides.
- The well known form of such a guide is a die set. However, a die set is one form of a cutting edge matching guide. The various forms of guides are explained below while referring to the figures.



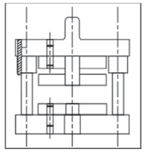
Blanking set-up

(1) Structure without a guide



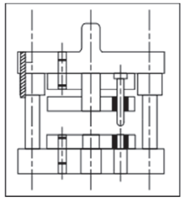
- Although is it may appear strange that this structure appears in the explanation of guides, there are dies with a structure in which the relationship with the die is created directly by the punch.
- Further, this structure shows the basic form of a die. Guides are secondary structures. Because of the presence of guides, it becomes easy to install the die in the pressing machine, or the assembly of the die becomes easy, or the accuracy during press operation (the dynamic accuracy) becomes better.
- The die can be used even if there are no guides and the pressing work can be carried out.

(2) Outer guide structure (die set structure)



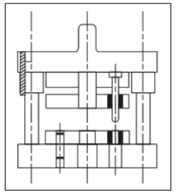
- This is the most basic guide structure. This was developed for the purpose of making the assembly of the die and the installation of the die in the pressing machine easy.
- This structure is called the outer guide structure because the guiding is done on the outer side of the plate. The relationship between the punch and the die is established by a coupling using a dowel pin (knock pin).
- The accuracy of the relationship between the punch and the die is determined by how the dowel pin is inserted

(3) Additional inner guide structure



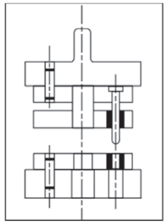
- This is a structure that is a die set structure to which an inner guide (sub-guide) has been added. A guide that is inside the plate and guides the movement of the die relative to the punch is called an inner guide.
- The inner guide restricts the movement of the stripper plate and increases the accuracy. The inner guide determines the relationship between the punch and the die. The accuracy increases because the relationship between the punch and the die is maintained without needing a coupling through a dowel pin.
- On the other hand, it is difficult to manufacture. Since a dowel pin is present in this structure, there may be problems due to interference between the outer guide and the inner guide.

(4) Structure without a dowel pin



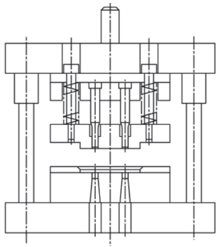
- Interference with the dowel pin may occur if an inner guide is added to a die set structure. In order to avoid this interference, it is better to remove the dowel pin, and hence this is a structure in which the top or the bottom dowel pin has been removed.
- It is very common to remove the dowel pin from the top die.

(5) Inner guide structure



- A guide is a part that establishes the relationship between the punch and the die. A dual structure is one in which the guiding is done by both an outer guide and an inner guide.
- The inner guide structure is one in which there is only one guide that is the inner guide that can guide directly while eliminating the outer guide.
- This structure is suitable for small dies. In a large guide, separating the top and the bottom is very difficult.

As shown in Fig. , the position adjustment of the relationship between the punch and the die is made using a guide for the die set and an appropriate clearance is maintained between them.



A die set makes it easy to establish the relationship between the punch and the die, and also makes it easy to install the die in press machine. Compared to the age in which die sets were not used, dies have brought in great changes.

In a die with the movable stripper structure shown in Fig. , the material is kept pressed by the stripper and the pressing is done so that it does not get deformed.

The die structure is used very often in product formation applications that require relatively accurate shapes. In accurate formation, very often the formed shape becomes finely detailed, and since even the punch shape becomes weak, one would desire to strengthen the punch.

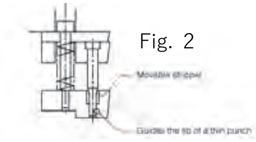
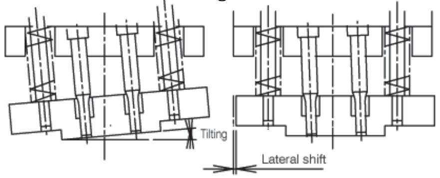


Fig. 2

As an idea for strengthening the punch, as shown in Fig. 2 , a lot of people thought that it becomes difficult for the punch to break if the weak tip of the punch is guided by the stripper and they have implemented this structure.

However, in the structure of Fig. , there is a movement of the stripper as shown in Fig. 3 and the stripper damages the punch that it is guiding.

Fig. 3



Since the original function of the stripper is to peel off the material that has got adhered to the punch, although there was no problem even if did some slightly strange movement.
However, in order to guide the tip of the punch, it is necessary that the stripper maintains horizontality and only carries out up and down movement, a stripper guide was placed between the stripper and the punch plate as shown in Fig. 4.

Fig. 4.

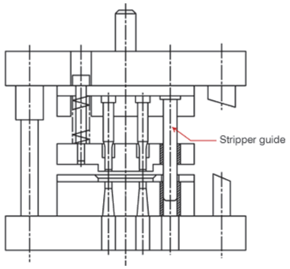
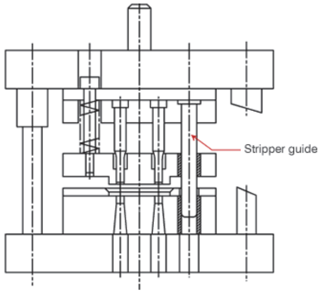


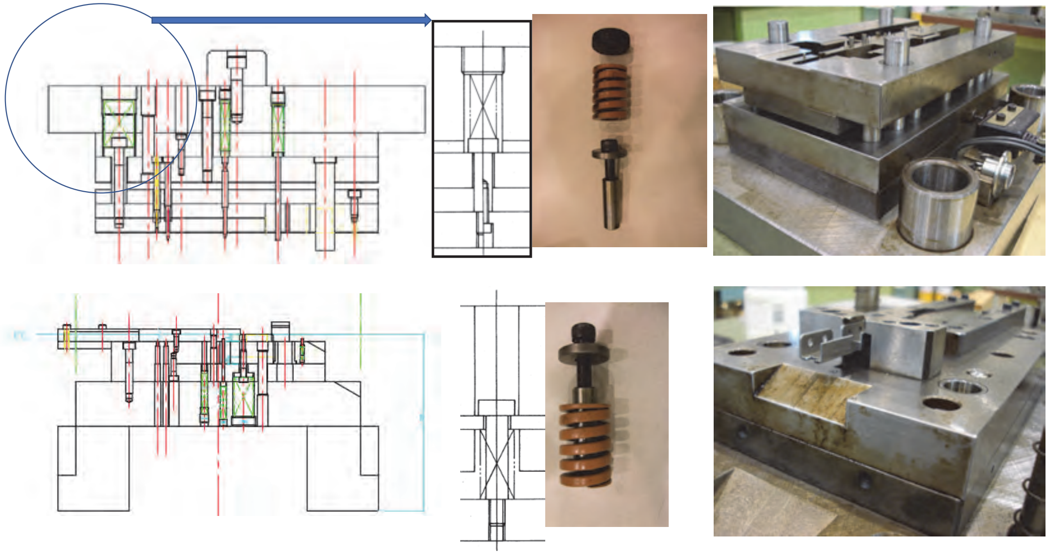
Fig. 5



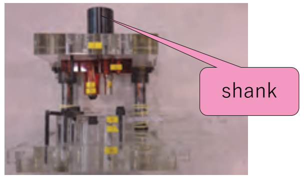
The relationship between the top mold and the bottom mold is maintained by the guide post bush of the die set, and since the stripper guide only restricts the behavior of the stripper it is also called a "sub-guide".

When one starts using the stripper guide, the die life gets extended compared to the conventional dies, stable press operation is obtained.

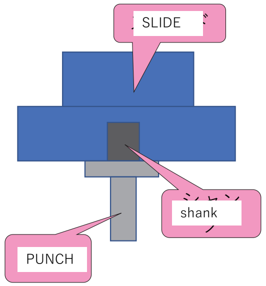
In addition, by making the stripper guide penetrate up to the die as shown in Fig. 5, the accuracy of the die becomes better, and this has become the mainstream punch and die structure for precision forming.

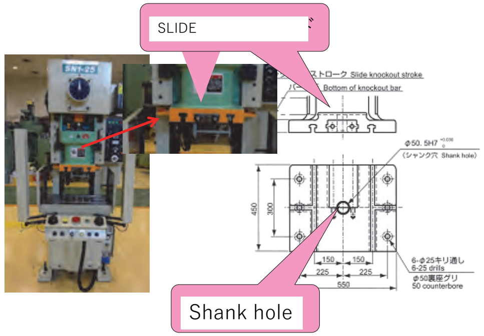


*Used to attach the upper DIE to the slide of the press.
*The shank is inserted into a shank hole provided in the slide of the press and fixed to the slide by the shank press.



- Used to attach the upper DIE to the slide of the press





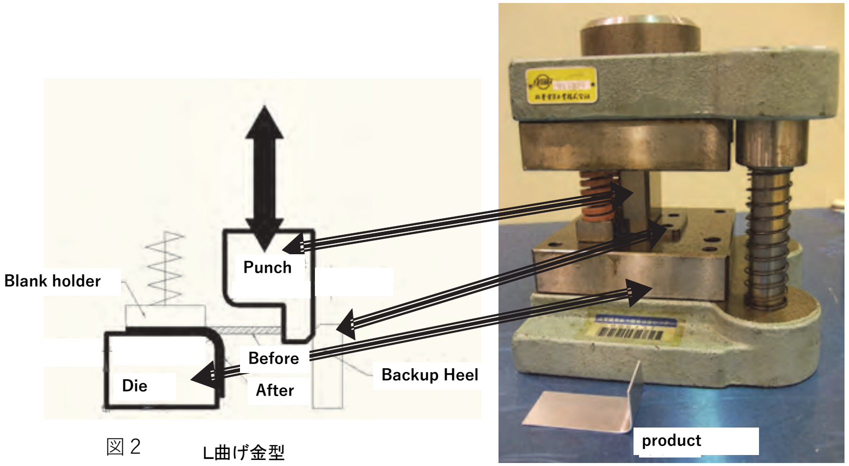
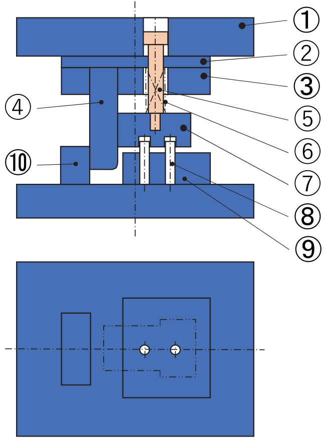


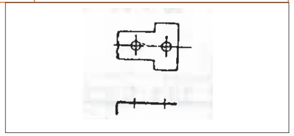
図２　　L曲げ金型

L-Bending Die



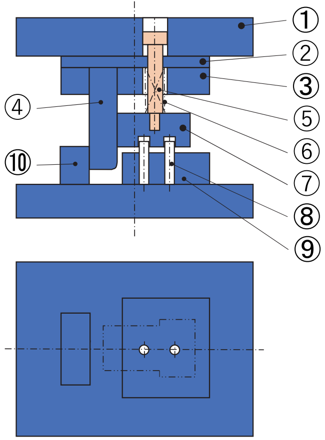
Plan view for lower die

part number	part name
1	Upper dieset (Punch Holder)
2	Backing plate
3	Punch plate
4	Punch
5	Stripper bolt
6	Spring
7	Blank holder
8	Location pin
9	Die
10	Backup block(Heel)



Blank and product shape

L-Bending Die

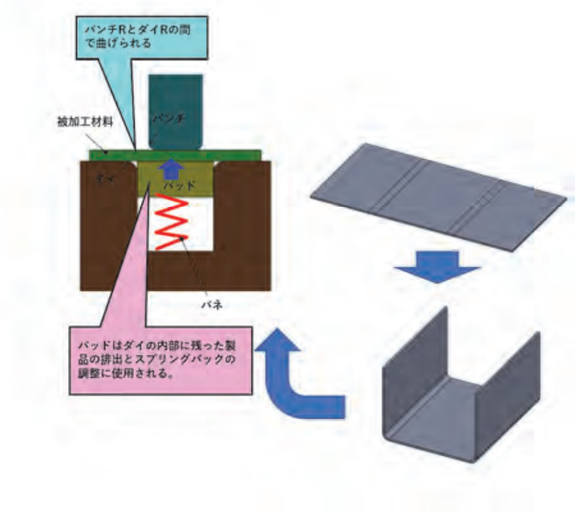


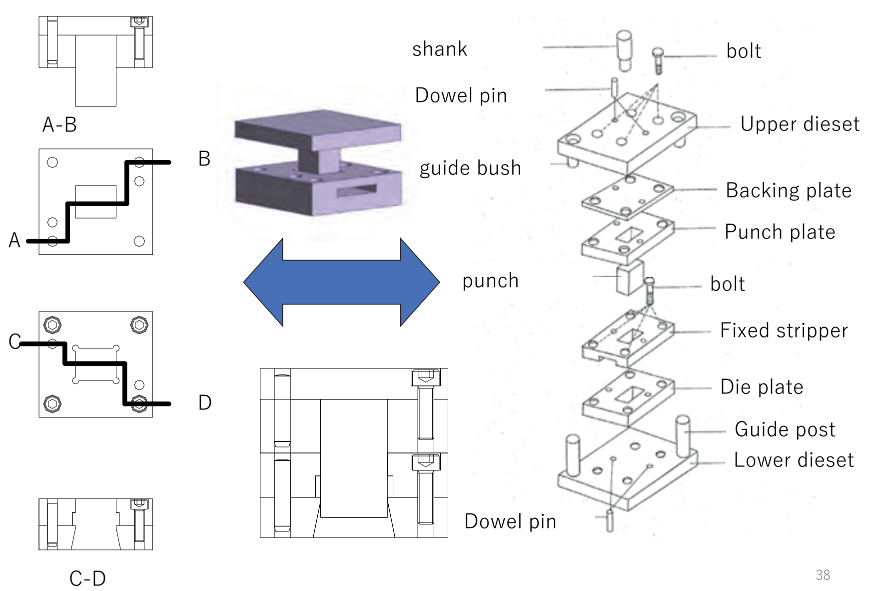
Plan view for lower die

part number	part name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

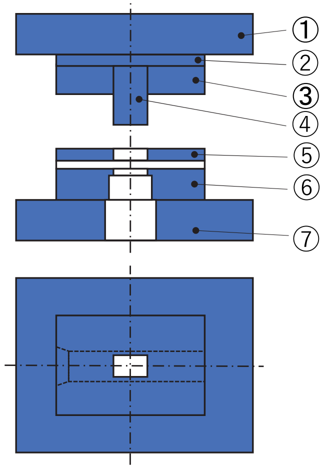
Blank and product shape

図３　U曲げ金型



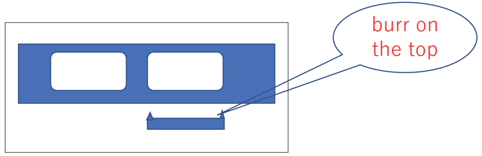


Structure for blanking DIE



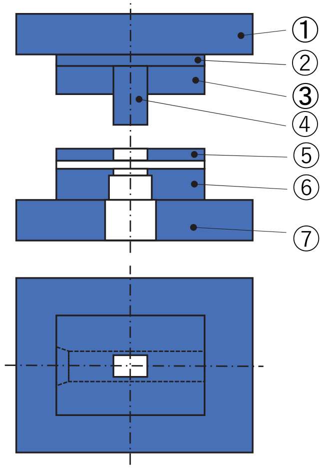
Plan view for lower die

part number	part name
1	Upper dieset (Punch Holder)
2	Backing plate
3	Punch plate
4	Punch
5	Fixed stripper plate
6	Die plate
7	Lower dieset (Die Holder)



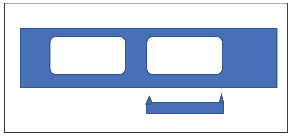
Blank and product shape

Structure for blanking DIE



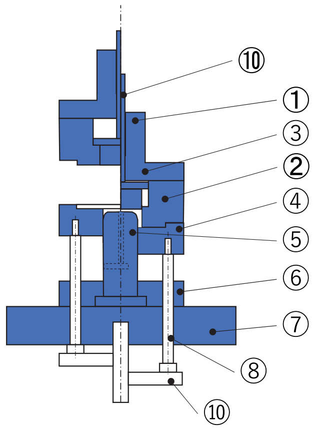
Plan view for lower die

part number	part name
1	
2	
3	
4	
5	
6	
7	



Blank and product shape

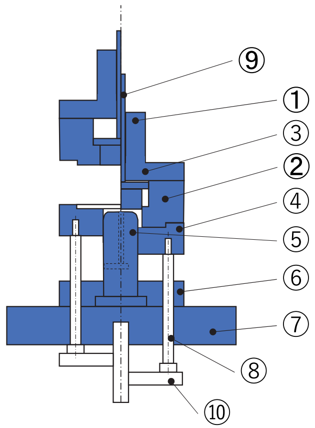
Drawing Die
(Inverted knockout –ejected drawing die with blank holder)



part number	part name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

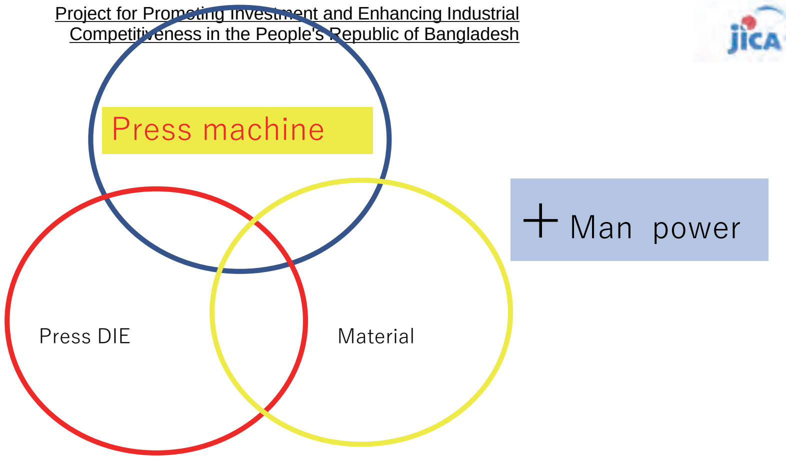
Blank and product shape

Drawing Die
(Inverted knockout –ejected drawing die with blank holder)

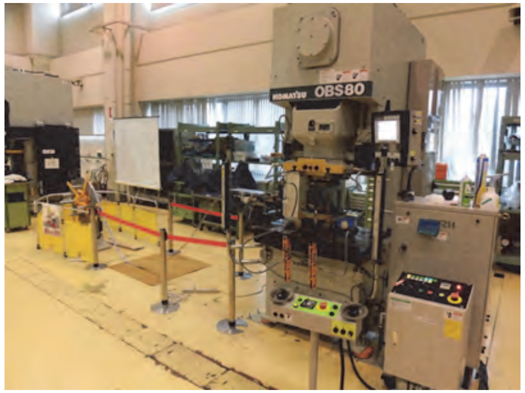


part number	part name
1	shank
2	Die
3	Die holder with Shank
4	Blank holder
5	punch
6	Punch plate
7	Punch holder(Lower holder)
8	Stepped bolt
9	Knockout lod
10	Die cushion

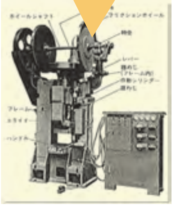
Blank and product shape



Three elements of Press working

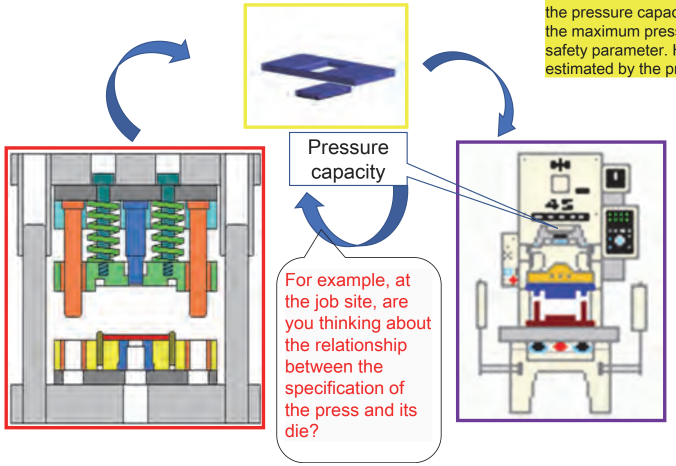


Press machines are classified as follows.
① Classification by slide drive power
Machine press
Hydraulic press
Pneumatic press
② Classification by the number of slides
③ Classification by slide drive mechanism
④ Classification in frame format



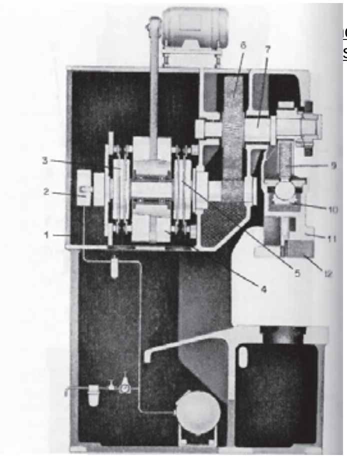
Identification of different types of the press and their forms

One of the measures to express the capacity of the press is the pressure capacity. The pressure capacity is understood as the maximum pressure that a press can generate within its safety parameter. However, the stamping capacity cannot be estimated by the pressure capacity alone.

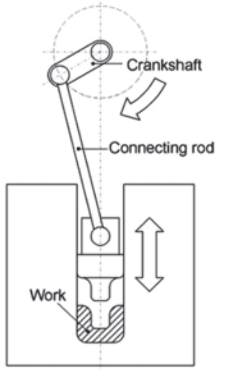


For example, at the job site, are you thinking about the relationship between the specification of the press and its die?

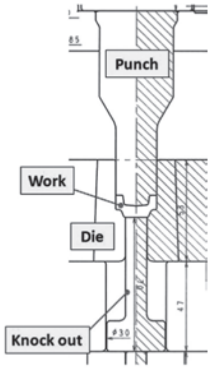
The 3 elements of the print are as follows:
1 ： Material to process
2 ： Press
3 ： Die
Therefore, for stamping it is necessary to know well not only the press but also the characteristics of the die and material to be processed. This is somewhat akin to the fact that car performance is not just understood by its displacement.



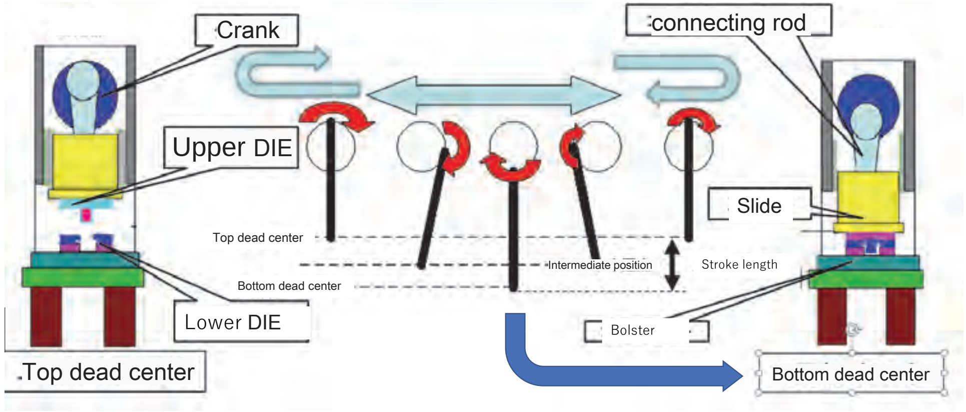
Sectional view of the press mechanism with reduction gears: (1) Frame. (2) Control valve. (3) Clutch and brake. (4) Flywheel. (5) Clutch and brake. (6) Reduction gearing (7) Eccentric shaft. (8) Slide stroke adjustment. (9) Slide adjustment. (10) Overload safety device. (11) Slide. (12) Clamping block. *(Reprinted with permission from Müller Weingarten AG, Germany.)*



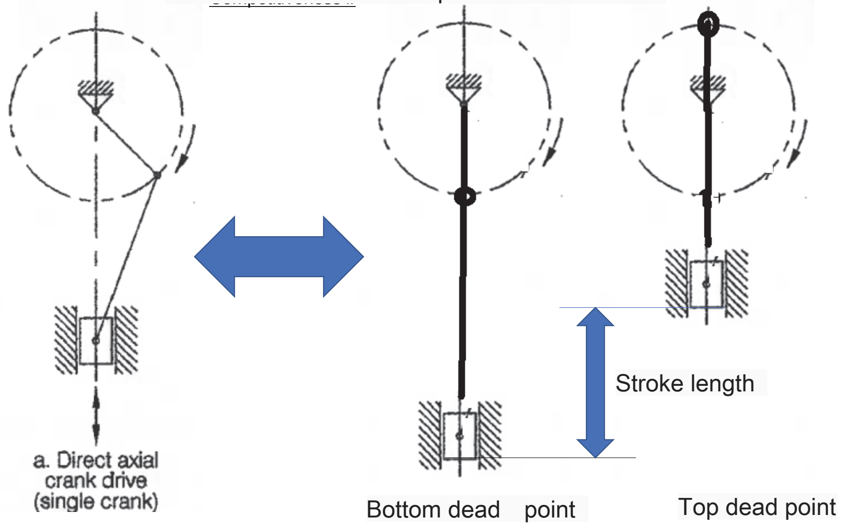
(a) Crank-press type forging machine



(b) Forging die

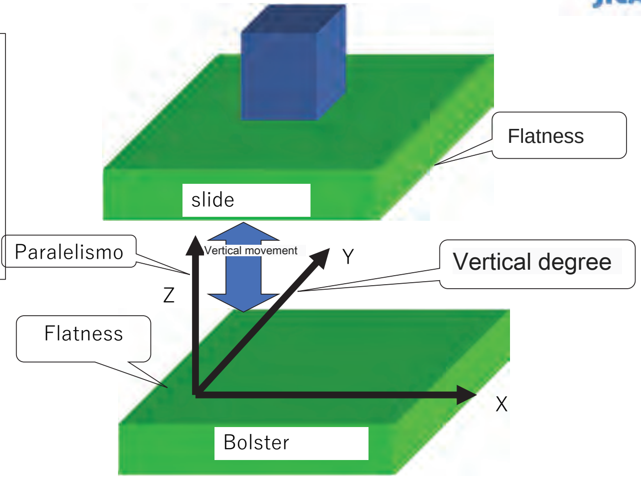


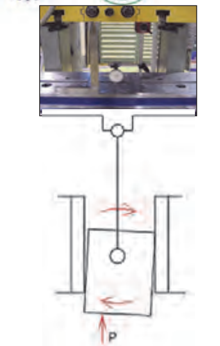
Basic movement of crank press machine



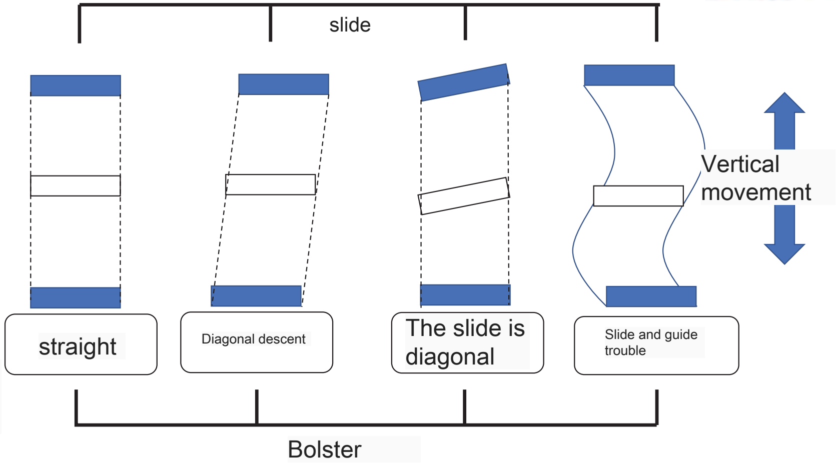
The important point about the press movement

Performing "vertical movement" up and down while "slide" is "parallel" to "bolster"



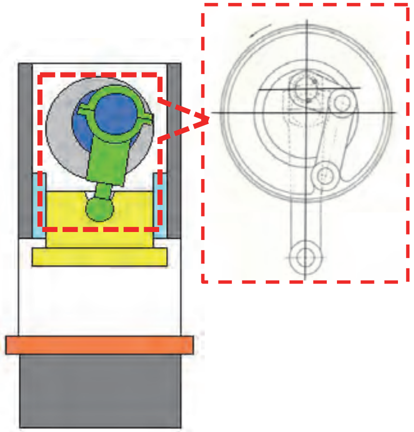


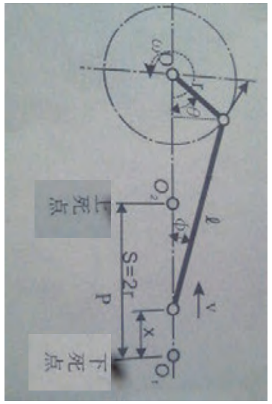
The slide moves up and down along the guide. There is a lubrication gap between the guide and the slide.



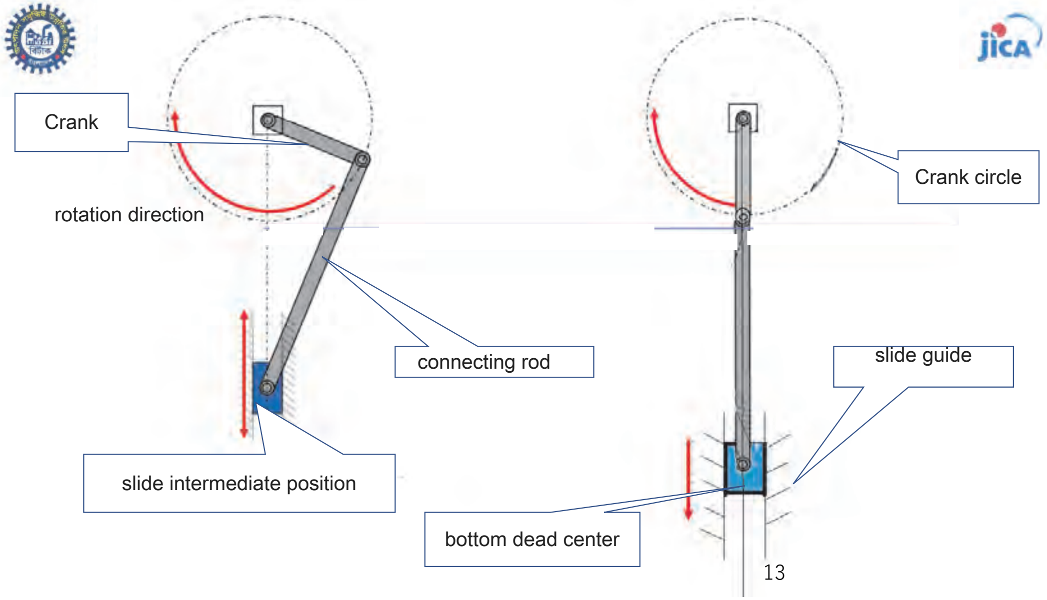
The state of slide descent may change. It is important to understand the causes of these and the importance of precision inspection of press machines.

Top dead center and bottom dead center of slide movement





With the crank mechanism that moves the slide up and down, there will be no rotational force at the top and bottom ends of the slide, where the crank mechanism is aligned. The top dead center of the piston is the top dead center, and the bottom dead center is the bottom dead center.



Crank

rotation direction

connecting rod

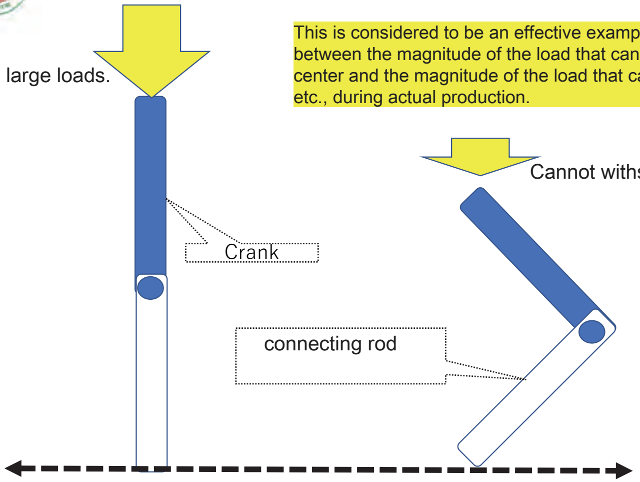
slide intermediate position

Crank circle

slide guide

bottom dead center

This is considered to be an effective example when explaining the difference between the magnitude of the load that can be withstood at the bottom dead center and the magnitude of the load that can be withstood at the midpoint, etc., during actual production.



Can withstand large loads.

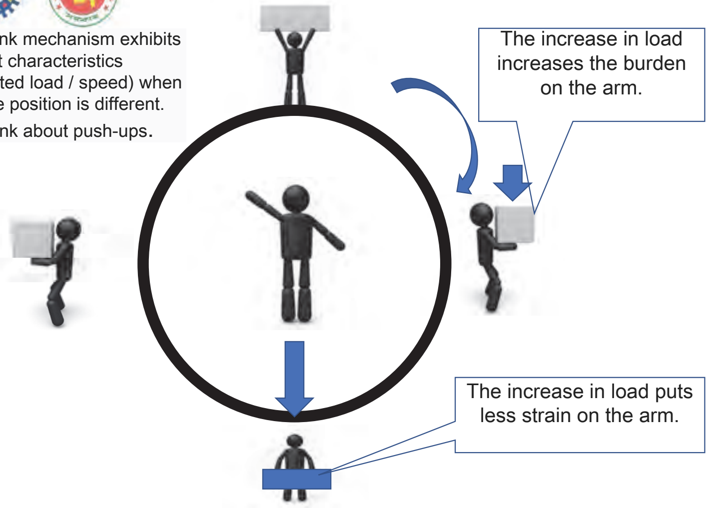
Cannot withstand a large load.

Crank

connecting rod

The crank mechanism exhibits different characteristics (generated load / speed) when the slide position is different.

Let's think about push-ups.



The increase in load increases the burden on the arm.

The increase in load puts less strain on the arm.

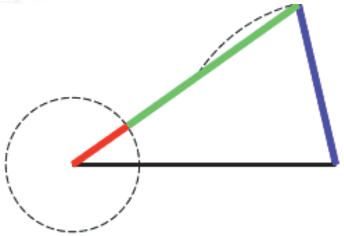
Cannot withstand a large load.

Middle of top dead center and bottom dead center (middle position of vertical movement)

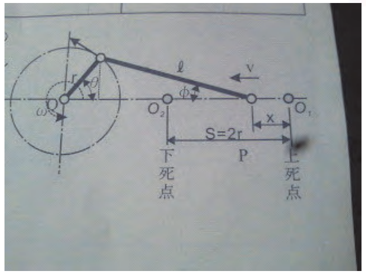
Can withstand large loads.

Top dead center (top of vertical movement)

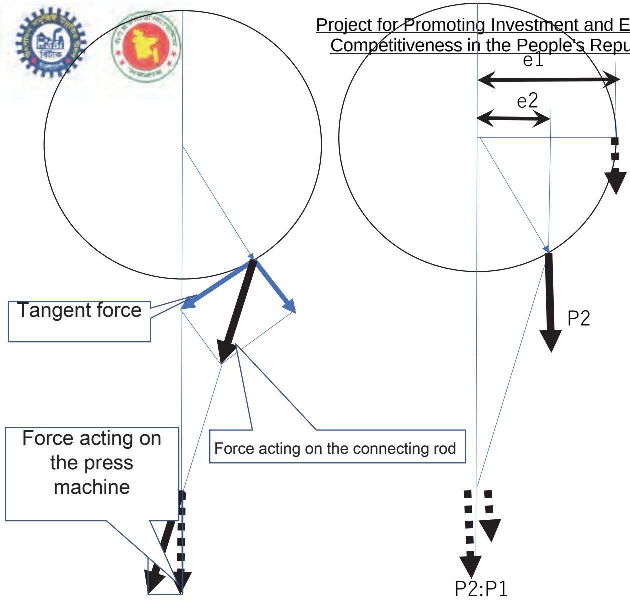
Bottom dead center (bottom of vertical movement)



There is always a "dead point" in the link mechanism. There is no problem if the power works only on the red rod, but for example, when trying to change the direction of swinging. If the links are in the relationship shown in the figure, even if you apply force to the blue bar on the side that normally receives power and shakes its head, only the force in the compression direction is applied to the red bar.

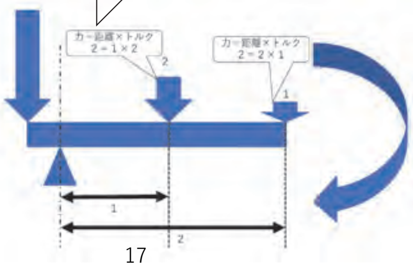


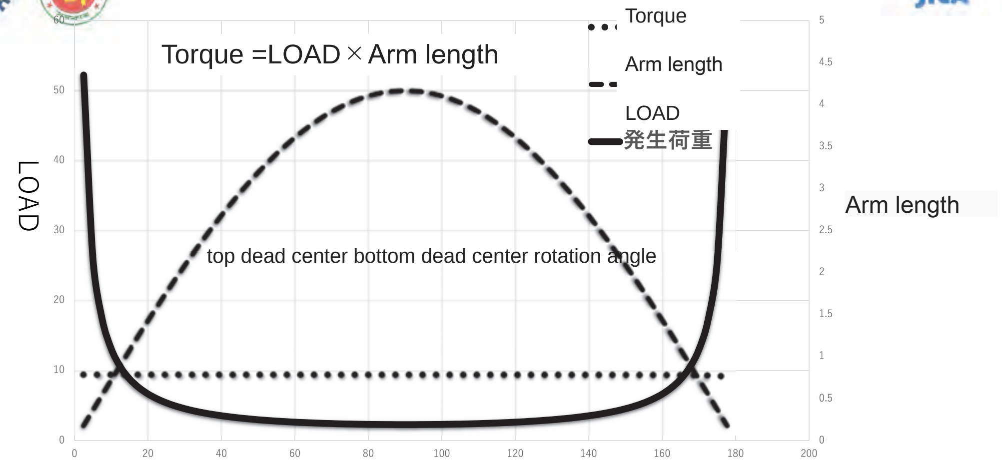
In a piston-driven crank, there are two such positions in the piston stroke. The top dead center is when the piston is at the top and the connecting rod and crank are in a straight line, and the bottom dead center is when the piston is at the bottom.



Torque=Force× distance
P1×e1=P2×e2
・Since the torque is constant, the longer the arm (e), the less the force.

This means that if the stroke length is different, the force (generated load P) will be different.





top dead center rotation angle bottom dead center

Stroke position

$$s=r(1-\cos\alpha)$$

Generated pressure

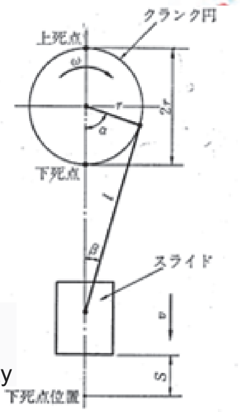
$$P=\frac{T}{s\cdot\sqrt{\frac{2r}{s}-1}}$$

$$T=P_0\cdot H\sqrt{\frac{2r}{H}-1}$$

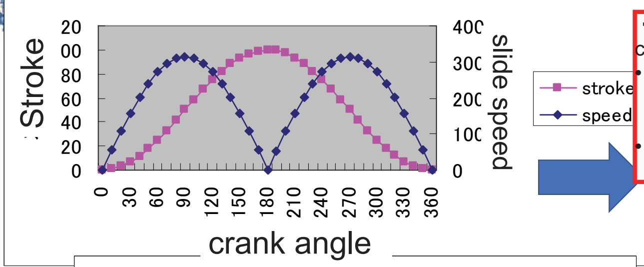
T: Torque
H: torque capacity
P_0 : pressure capacity

Slide speed

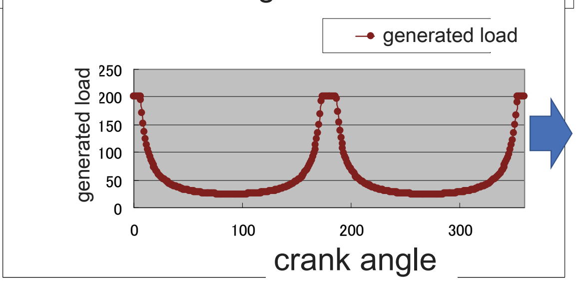
$$v=\frac{\pi n}{30}\cdot s\cdot\sqrt{\frac{2r}{s}-1}$$



クランクプレスの運動機構

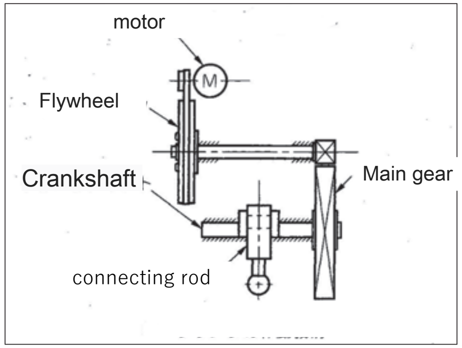


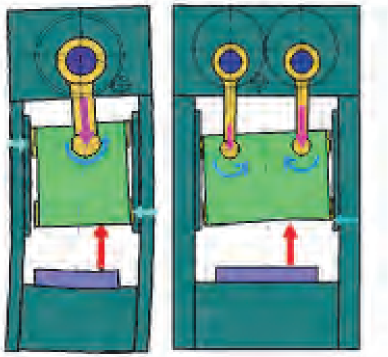
・The movement speed of the slide changes depending on the stroke position.
- The slide speed is slow at bottom dead center and fastest in the middle of the stroke length.
- The maximum slide speed is not used in press working.



＊The generated load differs depending on the crank angle position.
＊Theoretically, an infinite load is generated at bottom dead center. However, in this state, the press machine is damaged.
＊Set the upper limit of the generated load, build the structure of the press machine that can withstand the load, and install a mechanism to stop the press machine when the upper limit load is generated.

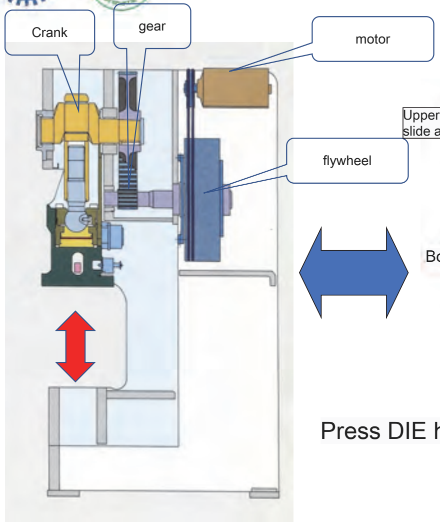
Crank mechanism



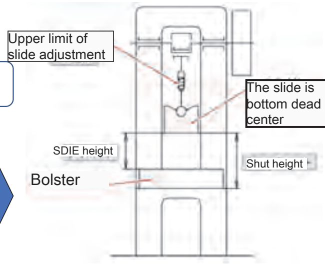


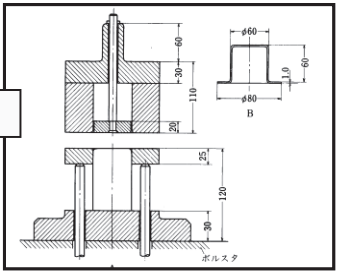
Single crank press machine

double crank press machine



Consider the die height of the press machine to which this die is attached.





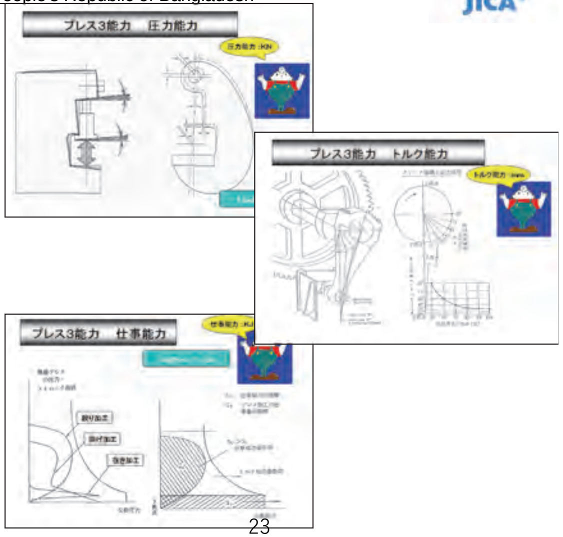
Press DIE higher than die height cannot be installed

---

① "Pressure capacity" Structural members such as the frame of the press machine are against the working load The pressure limit that can withstand safety and enable stable press production Displayed as "pressure capacity".

② "Torque capacity" In a mechanical press, the position where the slide can generate the nominal capacity above the bottom dead center is shown, and the relationship with the pressure that can be generated by the position of the slide is called "torque capacity", and "torque capacity" for each press machine Display as a diagram.

③ "Energy capacity" Pressing does the work equivalent to the product of the pressing force (kN) and the distance the slide descends (mm). The working energy that can be released by the press machine at the number of strokes per minute is called "energy capacity" and is displayed as a "working energy diagram".



プレス3能力　圧力能力

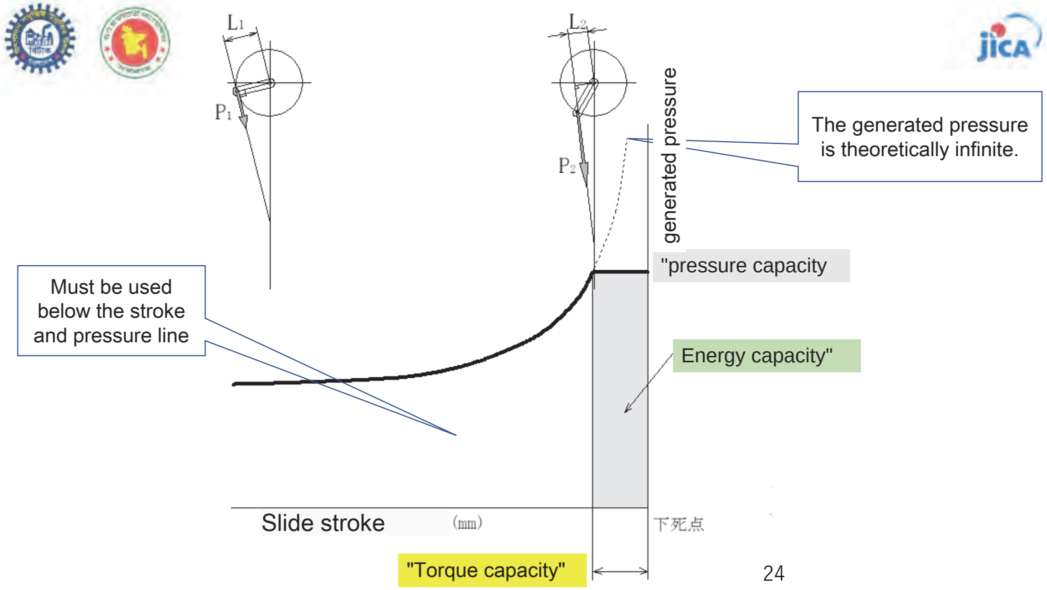
圧力能力：KN

プレス3能力　トルク能力

トルク能力

プレス3能力　仕事能力

仕事能力：KJ



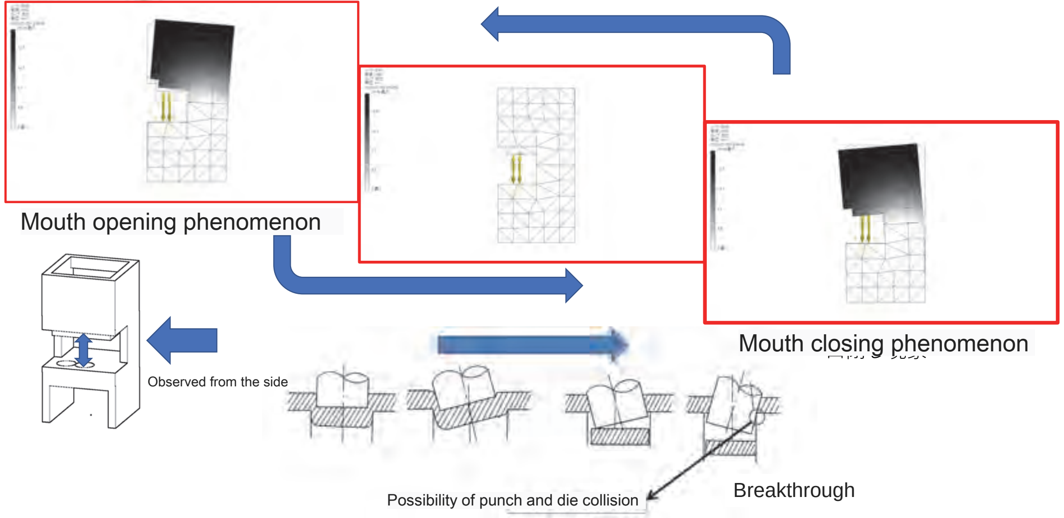
The generated pressure is theoretically infinite.

"pressure capacity

Must be used below the stroke and pressure line

Energy capacity"

"Torque capacity"



Mouth opening phenomenon

Observed from the side

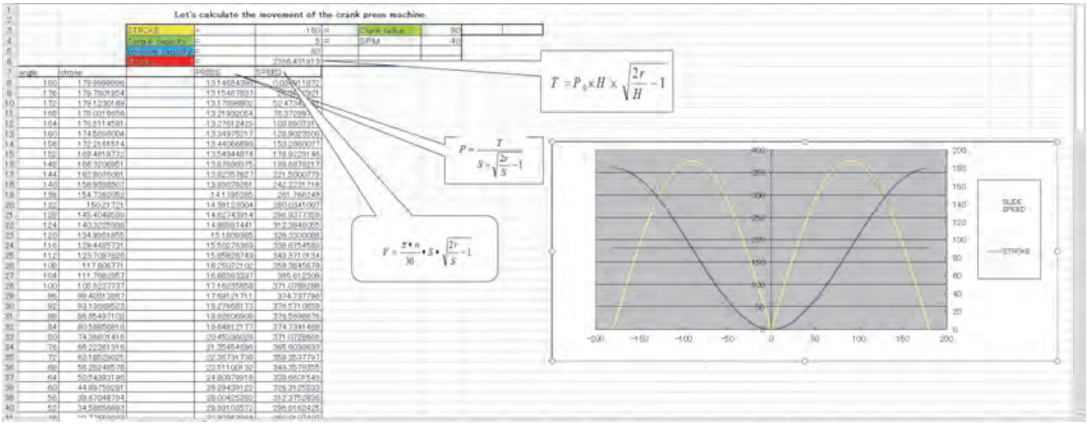
Mouth closing phenomenon

Possibility of punch and die collision

Breakthrough

"Breakthrough" is prominent in the shear of thick plates, as shown in the figure. During processing, when the upper mold (punch) comes into contact with the material to be processed, pressure is applied. Naturally, a reaction force acts against the pressing force due to the shear resistance. This reaction force causes elastic deformation in the frame of the press machine to open the bolster and the mouth of the slide on the front surface of the press machine. After that, the shearing process proceeds, and the maximum shearing force required for shearing is shown immediately before a crack is formed in the work material. After that, the shear force decreases sharply. That is, the energy stored by the elastic deformation by the completion of shearing cannot be consumed by the instantaneous completion of shearing, so that it is consumed as kinetic energy that vibrates. The phenomenon caused by this is that within the range of elastic deformation, the frame of the press machine behaves like closing the mouth due to the reaction of the mouth expanding due to elastic deformation before the completion of shearing. Although the amount of deformation is small, a phenomenon of vibration that repeats opening and closing of the mouth appears for a short time.

Let's simulate the movement of the press machine. (Practice task)



Let's calculate the movement of the crank press machine

STROKE = 180 = Crank radius 90

Torque capacity = 5 = SPM 40

pressure capacity = 80

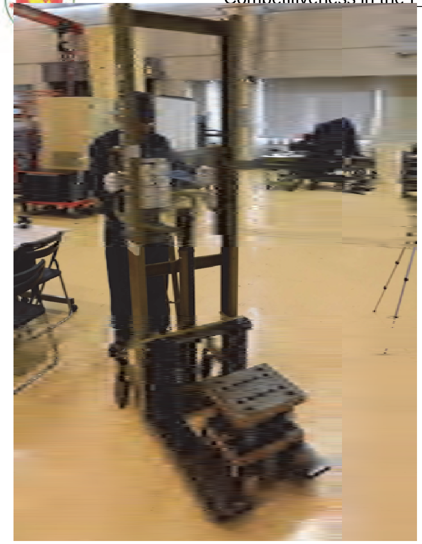
Torque = 2356.431813

angle | stroke | PRESS | SPEED

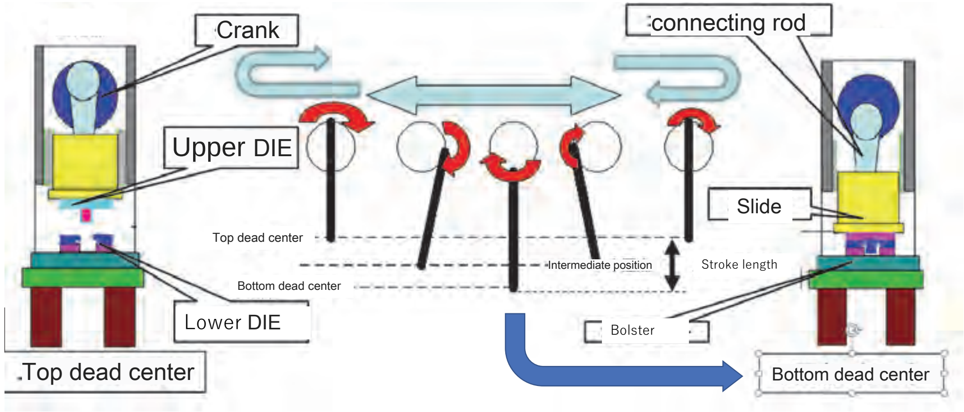
$$T = P_0 \times H \times \sqrt{\frac{2r}{H} - 1}$$

$$P = \frac{T}{S \cdot \sqrt{\frac{2r}{S} - 1}}$$

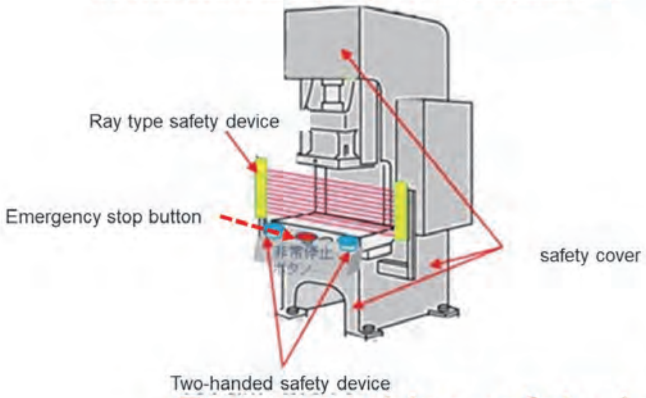
$$V = \frac{\pi \cdot n}{30} \cdot S \cdot \sqrt{\frac{2r}{S} - 1}$$



Why lower position for lift when transporting the mold?



The friction clutch enables inching movement and sudden stop.



Press machine safety device

7.　射出成形技術向上支援プログラム（プラン 6）教材

Program for Enhancement of Injection Molding Technologies

version2

Participant name：

Table of Contents

Version2（Dec/2020）

The products around us are made of various materials. First, let's sort out the relationship between products and materials.

No-1

Products and Materials

1-1. Pease fill the blanks below.

- **What are the materials which consist of these cups (No.1-No.6)?**
- **What is the No. of easy-to-break cups?**
- **Since when did we start using these cups?**

Practice Question-1

Product name	Materials	When did we start using? (e.g. 1990s)
CUP	1.	
	2.	
	3.	
	4.	
	5.	
	6.	

1.

2.

3.

4.

5.

6.

1-2. Various materials and plastics

このコップはどんな材料で出来ていると思いますか？

Practice Question-2

Special materials and products

1-3. Various materials and plastics

Plastic products around us are made of various materials

⬇

Plastic products around us has been made by various molding method

⬇

There is a gate part in the injection molded article, and it is made by various metal mold structures.

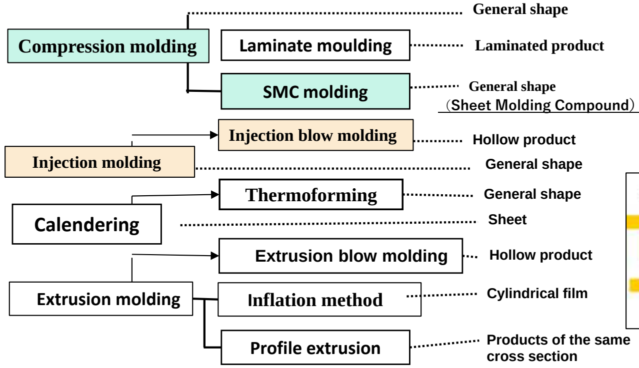
Plastic products are made by various molding methods (equipment).

Learn about various molding methods (equipment) and injection molding process

No-2

Injection Molding System

2-1. Main molding method-1



Compression molding .... General shape

- **Laminate moulding** .... Laminated product
- **SMC molding** .... General shape （Sheet Molding Compound）

Injection molding .... General shape

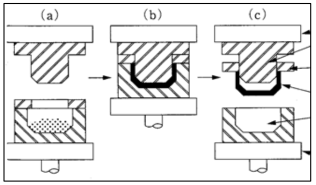
- **Injection blow molding** .... Hollow product

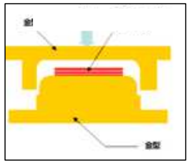
Calendering .... Sheet

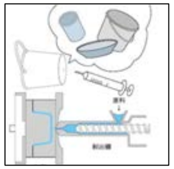
- **Thermoforming** .... General shape

Extrusion molding

- **Extrusion blow molding** .... Hollow product
- **Inflation method** .... Cylindrical film
- **Profile extrusion** .... Products of the same cross section



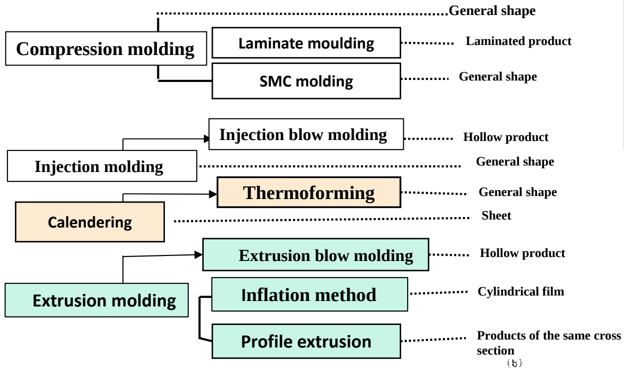


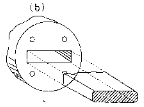


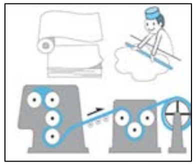
（Sheet Molding Compound）

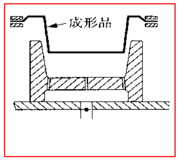
成形法の種類　圧縮成形/射出成形

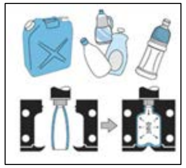
2-1. Main molding method-2

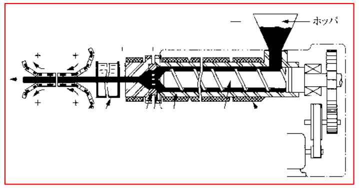








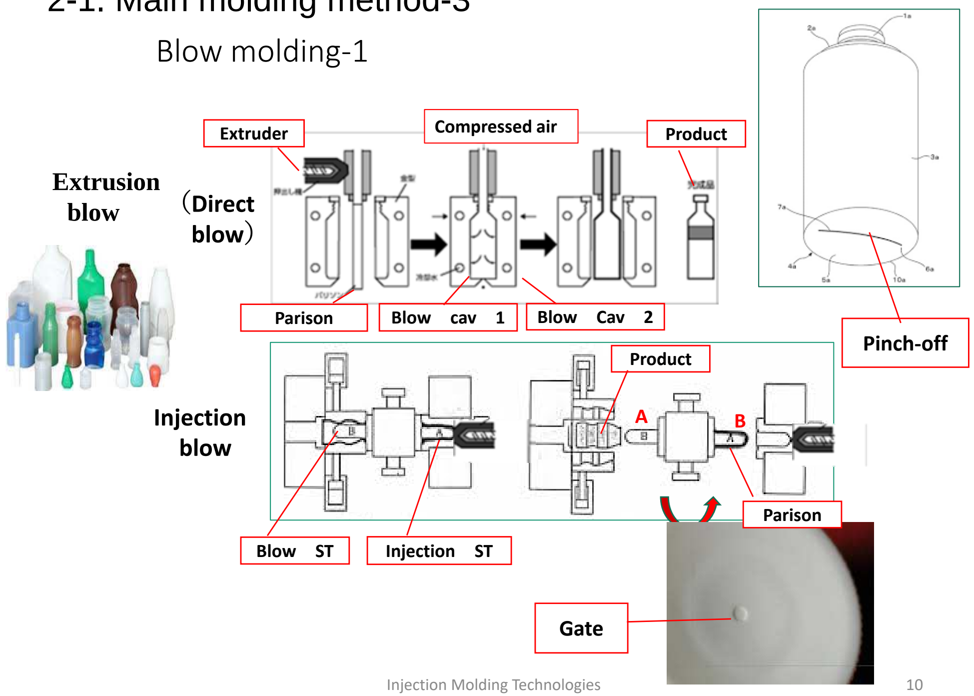




成形法の種類　カレンダ成形（熱成形）/押出成形

2-1. Main molding method-3

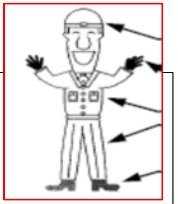
Blow molding-1



2-2. Main molding method-

Hazard source in molding operation

.成形作業における危険源



Hazardsource　⇒ Potential source to cause harm

危険源　⇒　危害を引き起こす潜在的根源

1 . Mechanical hazardsource ⇒ Crushing, cutting

機械的危険源　⇒押しつぶし、切断　など　　1600KN　1500bar

大きな力・圧力・駆動する。 Large force · pressure · drive　負傷するリスク

2 . Electrical hazardsource⇒ Contact burn, electric shock

.電気的危険源　⇒接触による火傷、電気ｼｮｯｸ　　230v　感電するリスク

3 . Thermal hazards ⇒ burns　Cylinder and resin temperature

.熱的危険源　⇒火傷　ｼﾘﾝﾀﾞ－・樹脂温度　　260°C　火傷をするリスク

＊Strict observance of work rules　作業ルールの厳守

＊Periodic inspection · Daily inspection　定期/日常点検・安全装置の確認

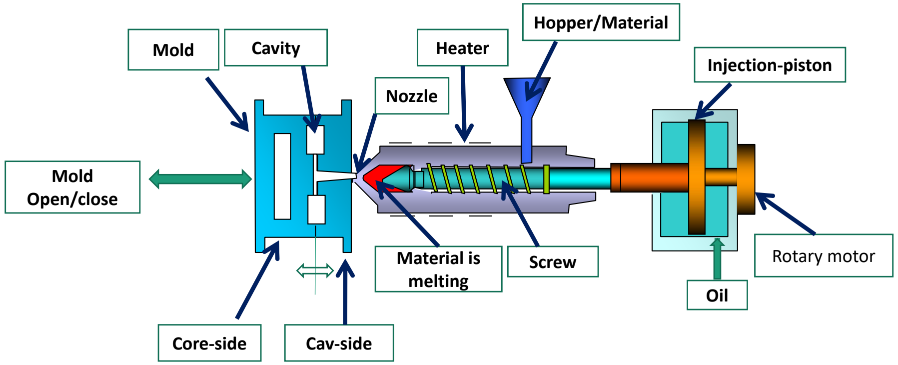
＊Machine stop at the time of work · Power off　作業時の機械停止・電源OFF

＊Master of Emergency Stop Method　緊急停止方法の習得

safety first　！　　Are you observing the rules?

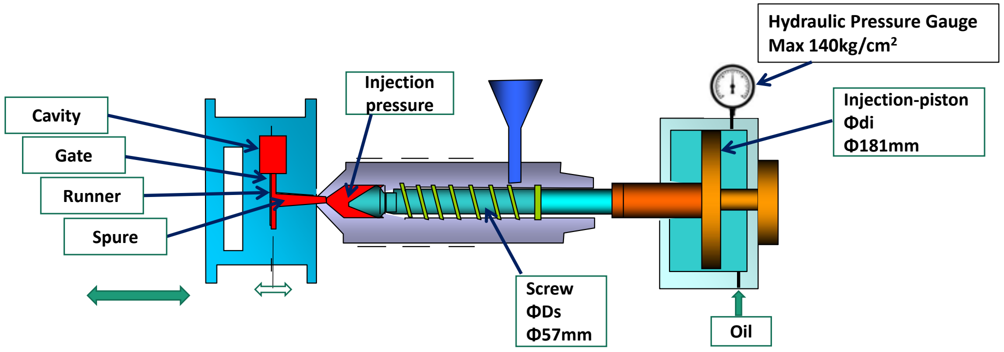
2-3. Injection molding system-1

Injection Molding Machine (Hydraulic Type)



2-3. Injection molding system-2

Injection Molding Machine (Hydraulic Type)



Injection Pressure＝ （Di^2/Ds^2） x 140＝ （$18.1^2/5.7^2$） x140≒1400kg/cm²

Cavity	Gate	Runnner	Spure	Injection pressure	Hydraulic pressure
				1400 kg/cm²	140 kg/cm²

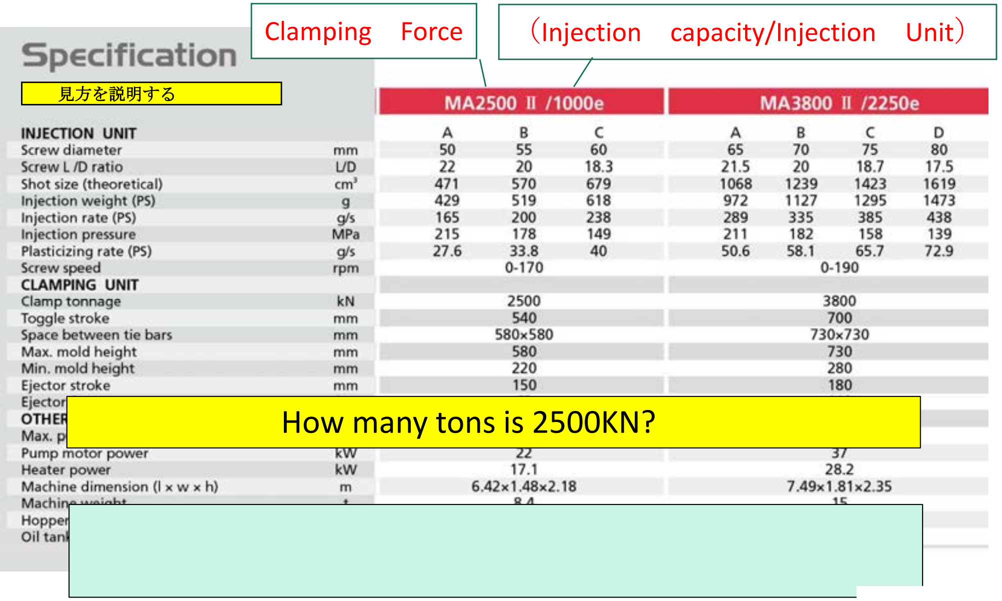
2-3. Injection molding system-3

Practice Question-3

Injection molding machine Specification

Clamping Force

（Injection capacity/Injection Unit）



Specification

見方を説明する

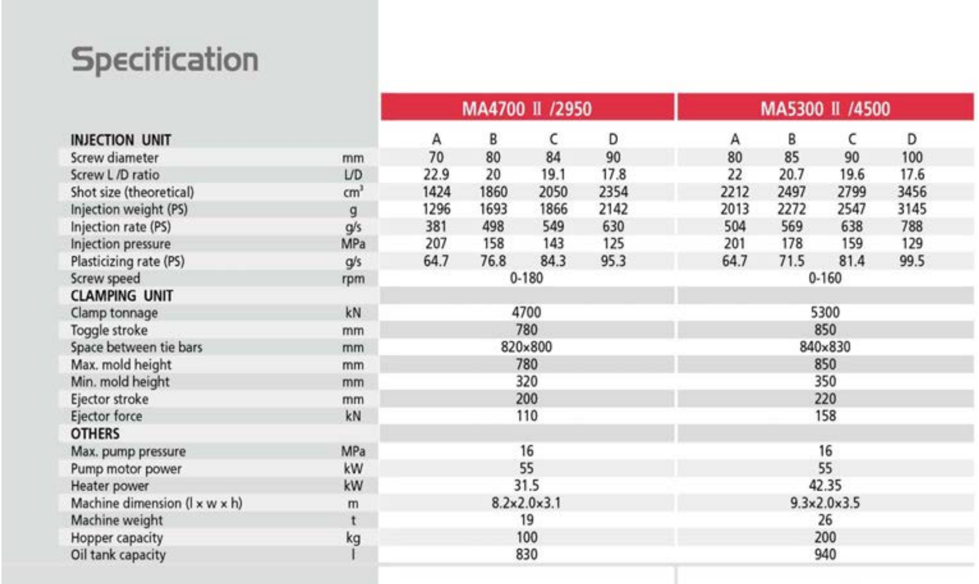
		MA2500 Ⅱ /1000e			MA3800 Ⅱ /2250e			
INJECTION UNIT		A	B	C	A	B	C	D
Screw diameter	mm	50	55	60	65	70	75	80
Screw L /D ratio	L/D	22	20	18.3	21.5	20	18.7	17.5
Shot size (theoretical)	cm³	471	570	679	1068	1239	1423	1619
Injection weight (PS)	g	429	519	618	972	1127	1295	1473
Injection rate (PS)	g/s	165	200	238	289	335	385	438
Injection pressure	MPa	215	178	149	211	182	158	139
Plasticizing rate (PS)	g/s	27.6	33.8	40	50.6	58.1	65.7	72.9
Screw speed	rpm	0-170			0-190			
CLAMPING UNIT								
Clamp tonnage	kN	2500			3800			
Toggle stroke	mm	540			700			
Space between tie bars	mm	580×580			730×730			
Max. mold height	mm	580			730			
Min. mold height	mm	220			280			
Ejector stroke	mm	150			180			
Ejector								
OTHER								
Max. p								
Pump motor power	kW	22			37			
Heater power	kW	17.1			28.2			
Machine dimension (l × w × h)	m	6.42×1.48×2.18			7.49×1.81×2.35			
Machine weight	t	8.4			15			
Hopper								
Oil tank								

How many tons is 2500KN?

Source: HAITAN co, Catalog diversion.

2-3. Injection molding system-4

Injection molding machine Specification



Specification

		MA4700 Ⅱ /2950				MA5300 Ⅱ /4500			
INJECTION UNIT		A	B	C	D	A	B	C	D
Screw diameter	mm	70	80	84	90	80	85	90	100
Screw L /D ratio	L/D	22.9	20	19.1	17.8	22	20.7	19.6	17.6
Shot size (theoretical)	cm³	1424	1860	2050	2354	2212	2497	2799	3456
Injection weight (PS)	g	1296	1693	1866	2142	2013	2272	2547	3145
Injection rate (PS)	g/s	381	498	549	630	504	569	638	788
Injection pressure	MPa	207	158	143	125	201	178	159	129
Plasticizing rate (PS)	g/s	64.7	76.8	84.3	95.3	64.7	71.5	81.4	99.5
Screw speed	rpm	0-180				0-160			
CLAMPING UNIT									
Clamp tonnage	kN	4700				5300			
Toggle stroke	mm	780				850			
Space between tie bars	mm	820×800				840×830			
Max. mold height	mm	780				850			
Min. mold height	mm	320				350			
Ejector stroke	mm	200				220			
Ejector force	kN	110				158			
OTHERS									
Max. pump pressure	MPa	16				16			
Pump motor power	kW	55				55			
Heater power	kW	31.5				42.35			
Machine dimension (l × w × h)	m	8.2×2.0×3.1				9.3×2.0×3.5			
Machine weight	t	19				26			
Hopper capacity	kg	100				200			
Oil tank capacity	l	830				940			

Source: HAITAN co, Catalog diversion.

2-4. Injection Molding System

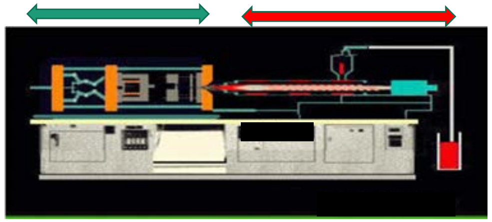
Practice Question-4

Mold Clamping Device

For Mold opening and closing, Product protruding

Injection Device

For Plasticizing, Metering, Injection



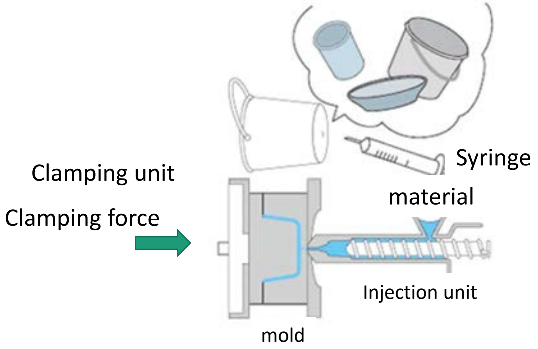
1． The number of parts to be molded 取数 （ ）
2． Type of material 材料名 （ ）
3． Molding cycle time (seconds) 成形サイクル （ ）
4． Types of gates Gate仕様 （ ）
5． Types of mold clamping mechanism 型締機構の種類（ ）

Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

2-5. Injection molding system

Injection molded products always have a gate

The injection-molded product always have a flow entrance (or a gate) of resin. Thus, there is a trace of a gate on the molded product surface, which resembles a trace of a needle after injection by a syringe.



Material

Mold

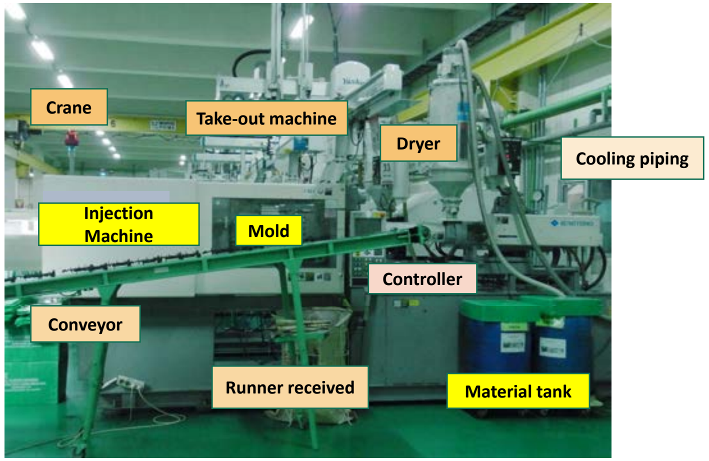
Injection Machine

Reference: Website of The JAPAN PLASTICS INDUSTRY FEDERATION, www.jpif.gr.jp/2hello/conts/dekiru2_c.htm

---

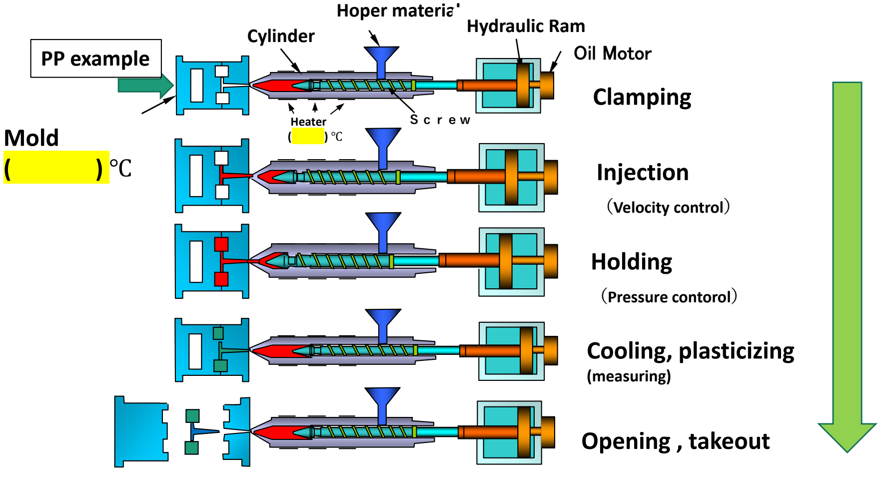
2-6. Injection molding system

Outline of peripheral equipment



2-7. Injection molding system

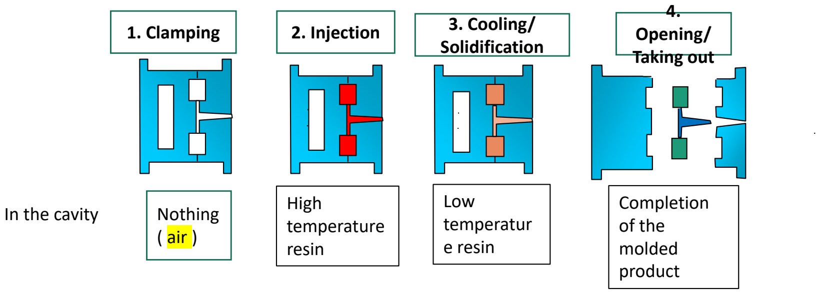
Injection Process



2-8. Injection Molding System

Pour the molten resin into the mold, cool/solidify and take it out

1. Clamping: Close the mold with mold clamping force
2. Injection: Inject heated molten resin into the mold
3. Cooling and solidification: Cool down and solidify molten resin
4. Opening/taking out: Open the mold and take out the product



There are many types of plastic materials
Learn about material characteristics and classification

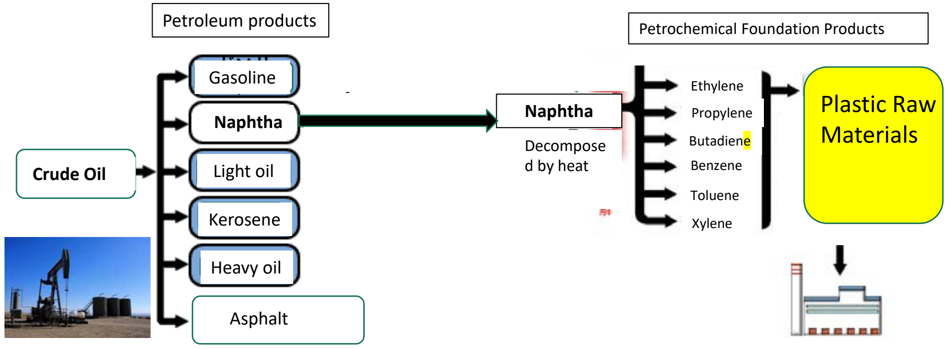
No-3

Plastic Resin

3-1. What is plastic? ：Raw Materials for Plastic

Naphtha (Raw Materials for Plastic）

Naphtha is obtained by separating crude oil by a distillation apparatus: those having a boiling point range of about 35 - 80 ℃ are called light naphtha. Naphtha is often used as raw materials for ethylene plants in the petrochemical industry



Petroleum products

Petrochemical Foundation Products

Crude Oil

Gasoline

Naphtha

Light oil

Kerosene

Heavy oil

Asphalt

Naphtha

Decompose
d by heat

Ethylene
Propylene
Butadiene
Benzene
Toluene
Xylene

Plastic Raw Materials

Distillation by temperature difference to be gas

Reference: Website of Plastic Library, Plastic Waste Management Institute, http://www.pwmi.jp/tosyokan.html

---

3-2. What is plastic? ：Monomer polymer

poly propylene → polypropylene
Greek language

(1) Monomer

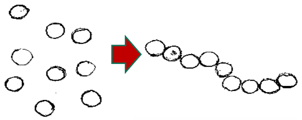
Unit material with a small molecular weight. Monomer generates polymer by combining each other or monomer addition reaction (addition polymerization) e.g. Polyprene

(2) Polymer

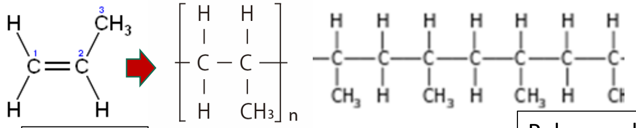
Chain-like structured macromolecule which is principle component of plastic. Chemical reaction repeatedly bonds monomers and forms polymer. Generally, polymer has 10,000 or more molecular weight. e.g. Polypropylene

Polymer is compared to the molecule of water.
The molecule of water (H 2 O) consists of two atoms of hydrogen (H) and oxygen (O)

Monomer:
Small and discrete unit



Polymer:
Monomers combined like a long chain



Propylene

$(C_3H_6)_x$

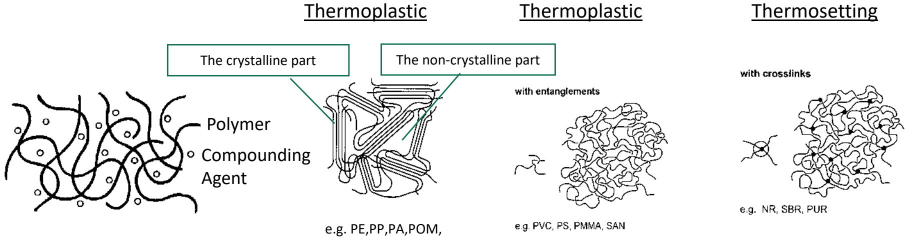
Polypropylene

Reference: Website of Plastic Library, Plastic Waste Management Institute, http://www.pwmi.jp/tosyokan.html
Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/plastic/

3-3.Construction of plastic

(1) The principal component of plastic is polymer or prepolymer

(2) The compounding agent as an auxiliary material will be selected according to the type of polymer and/or the required performance of the plastic product . Polymer and compounding agent will be compounded to become plastic.



Polymer and Compounding agent

Crystallization structure

Non crystallized structure

Three-dimensional network structure

Reference: Osaka Research Institute of Industrial Science and Technology, (2009) Plastic Reader, p.5, Plastic Age

3-4. Compounding Agent (Additive)

Compounding agent will be used when polymer or prepolymer alone can not meet required performance.

1) Main ingredients of compounding agent are as follows.

Plasticizers, Stabilizers, Lubricants, Antioxidants, Flame retardants, Colorants, Antistatic agents, Curing agent, Foaming agent, Filling/Reinforcing material (glass fiber, carbon fiber), Antibacterial agent.

2) The nucleating agent is added to the crystalline polymer which becomes a crystal nucleus. This controls the size of crystalline and crystallization rate in the mold which affects physical properties, transparency, molding cycle shortening, etc.

3) The cross-linking agent forms a three-dimensional network structure. It is also called curing agent as it cures/hardens curable resin (e.g. Thermosetting resin)

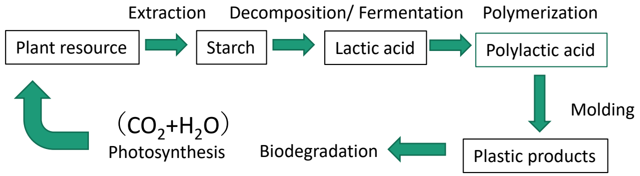
3-5. Biodegradable Plastic and Biomass Plastic

Biodegradable plastics: are also called "green plastics" because microorganisms can decompose it. This has been developed to solve the problem: normal plastics do not decompose spontaneously.

Biomass plastics: are plastics made from biological resources such as plants. One of them is polylactic acid*. These are applied to products including tableware, garbage bag films, etc. as PLA Heat resistance and shock resistance have improved.

*Polylactic acid has both characteristic of Biodegradable plastic and Biomass plastic.

Production and decomposition cycle of polylactic acid



3-6. Features of thermoplastic

（1） Rigidity

It does not deform

It does not deform by applying force

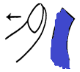
（2） Elasticity

Deform by applying force

Return to original form after removing force

（3） Plasticity

Deform by applying force



Stay deformed after removing force

（4） Liquidity

It does not have its own shape

Reference: Isao Sato, (2001) Illustrated Trivia Plastic, p.20, Natsume

---

3-7. Plastic Resin (Thermosetting and Thermoplastic)

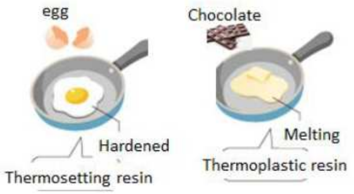
- Thermosetting resin is often compared to an Egg, by its state change.
- Thermoplastic resin is often compared to a Chocolate.

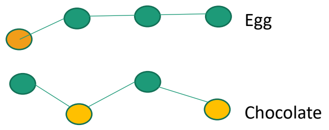
Melting point of chocolate？（ ℃） Molding temperature ＞Melting temperature

Example of state change

100℃ 20℃ 100℃

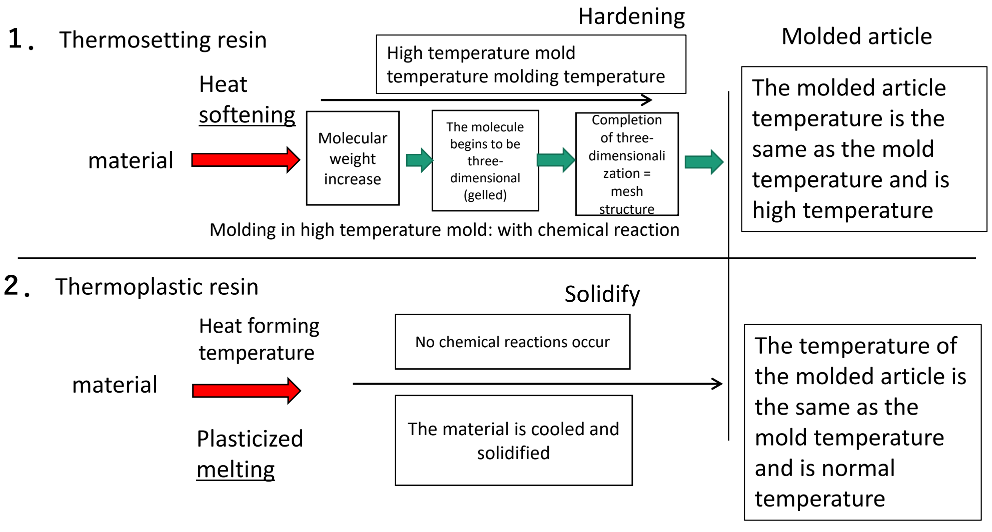
	Beginning	**Drop into a heated frying pan**	**Cool a frying pan**	**Heat a frying pan again**
Egg (Thermosetting)	Colloidal liquid	Solid/hardened	Solid/hardened	Solid/hardened
Chocolate (Thermoplastic)	Solid/hardened	Melting/Liquid	Solid/hardened	Melting/Liquid





3-8. Plastic Resin (Thermosetting and Thermoplastic)

Process difference



1． Thermosetting resin

Heat softening

material

Hardening

High temperature mold temperature molding temperature

Molecular weight increase

The molecule begins to be three-dimensional (gelled)

Completion of three-dimensionalization = mesh structure

Molding in high temperature mold: with chemical reaction

Molded article

The molded article temperature is the same as the mold temperature and is high temperature

2． Thermoplastic resin

Heat forming temperature

material

Plasticized melting

Solidify

No chemical reactions occur

The material is cooled and solidified

The temperature of the molded article is the same as the mold temperature and is normal temperature

---

3-9. Plastic Resin (Thermosetting and Thermoplastic)

Advantage	• The resin is light (specific gravity 0.9 to 2.5) • Easy to shape and likely to be cost reduction
Disadvantage	• Easy to burn: Low heat resistance →Special materials have been developed to cover disadvantage

Question : Which material has a specific gravity of 0.9 ?

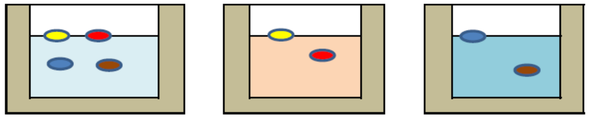
3-10. Classification of plastic samples using liquids of different densities

Practice Question-5

What are the names of the four color materials ?

	Liquid (Density)	Observation of Materials
①	Water (1g/cm^3)	Two are in a floating state Density is less than water
②	50% Aqueous ethanol solution (0.92g/cm^3)	One is floating Density is less than 0.92
③	20.28% Salt solution (.15g/cm^3)	One is floating Density is less than 1.15

	Specific Gravity
🔴	0.94～0.97
🟡	0.90～0.91
🟠	1.16～1.21
🔵	1.04～1.06



① Water 1g/cm^3

②50% Aqueous Ethanol Solution 0.92g/cm^3

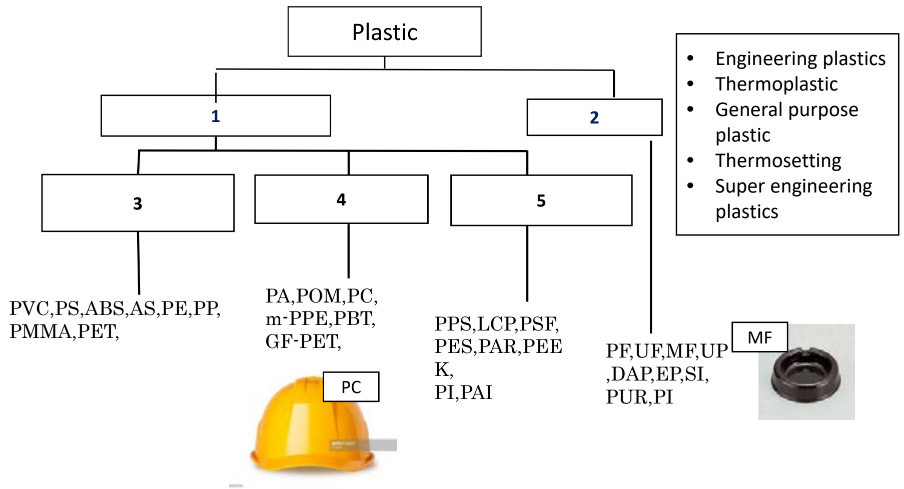
③20.28% Salt Solution 1.15g/cm^3

	Material Name
🔴	?
🟡	?
🟠	?
🔵	?

GPPS・ABS・PP・LDPE

3-11. Enter the appropriate words in the blanks from 1 to 5

Practice Question-6



Plastic

1

2

3

4

5

PVC,PS,ABS,AS,PE,PP, PMMA,PET,

PA,POM,PC, m-PPE,PBT, GF-PET,

PPS,LCP,PSF, PES,PAR,PEEK, PI,PAI

PF,UF,MF,UP ,DAP,EP,SI, PUR,PI

- Engineering plastics
- Thermoplastic
- General purpose plastic
- Thermosetting
- Super engineering plastics

3-12. Types and characteristics of the plastic

Features of Crystalline resin and Non-crystalline resin in Thermoplastic

Crystalline Resin

①Opaque ②High heat resistance ③Excellent solvent resistance
④Easy to warp ⑤ Large shrinkage rate

- E.g.: PP, PE, POM, PA, PBT, PET, PPS, LCP, PEEK, PTFE,

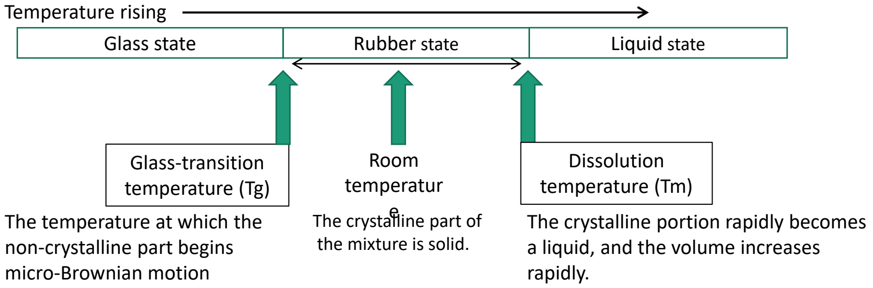
Non-Crystalline Resin

①Transparent ② Low chemical resistance ③Low Fluidity
④ Small shrinkage rate

- E.g.: PMMA, PVAC, GPPS, PC, m-PPE, PSU, PESU, PAR, PAI, PEI, PI

3-13. Types and characteristics of the plastic

Thermal Behavior of Crystalline Resin



Temperature rising

Glass state | Rubber state | Liquid state

Glass-transition temperature (Tg)

The temperature at which the non-crystalline part begins micro-Brownian motion

Room temperature

The crystalline part of the mixture is solid.

Dissolution temperature (Tm)

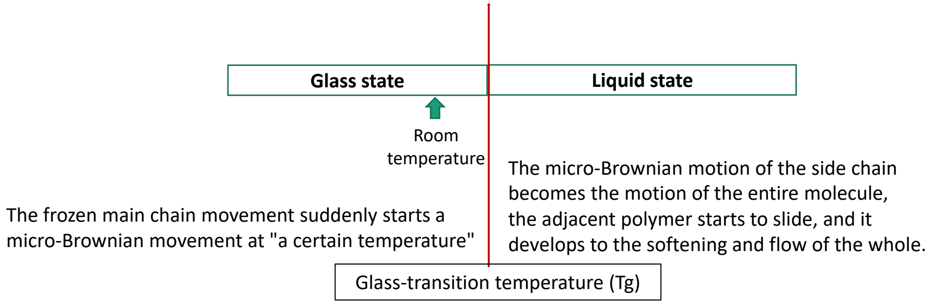
The crystalline portion rapidly becomes a liquid, and the volume increases rapidly.

Crystalline plastic quickly transits to the melt with a narrow temperature width when it exceeds the melting point of the crystal.

3-14. Types and characteristics of the plastic

Thermal Behavior of Non-crystalline Resin

The glass state rapidly transitions to the rubber state.
Softening with an amorphous polymer progresses over a wide temperature range. This weakens one of the intermolecular forces and the distance between the main chains widens.



Glass state | **Liquid state**

Room temperature

The frozen main chain movement suddenly starts a micro-Brownian movement at "a certain temperature"

The micro-Brownian motion of the side chain becomes the motion of the entire molecule, the adjacent polymer starts to slide, and it develops to the softening and flow of the whole.

Glass-transition temperature (Tg)

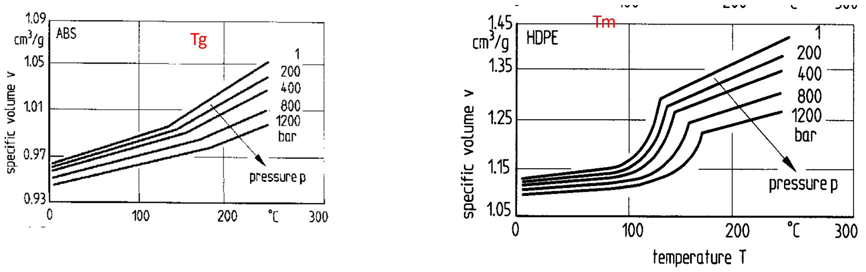
3-15. Types and characteristics of the plastic

PVT behavior pressure・ Specific volume・ temperature

The specific volume (reciprocal of density)

One of characteristics of polymer.
Specific volume is shown as a P - v - T figure, as a function of pressure and temperature.

P - v - T behavior of crystalline and Non-crystalline materials



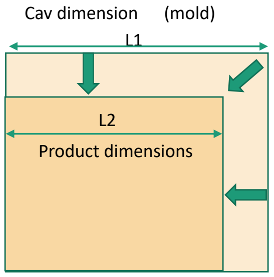
ABS (Non-crystalline resin)

HD-PE (Crystalline resin)

Reference: Gerd PÖtsch Walter Michaeli, (1995) Injection Molding An Introduction, p.36, Hanser

3-16. Shrinkage rate

L1 dimension contracted to L2 dimension. What is the shrinkage rate?



Shrinkage rate= (L1 - L2)/ L1

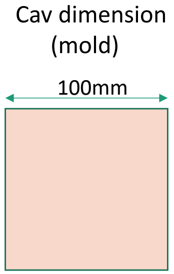
For example
L1＝100mm
L2＝99.8mm

＝(100-99.8)/100
＝0.002
2/1000 or 0.2%

3-17.Shrinkage rate

Practice Question-7

You have molded products with different resin by using the same mold.
Please check the dimensions of each product.



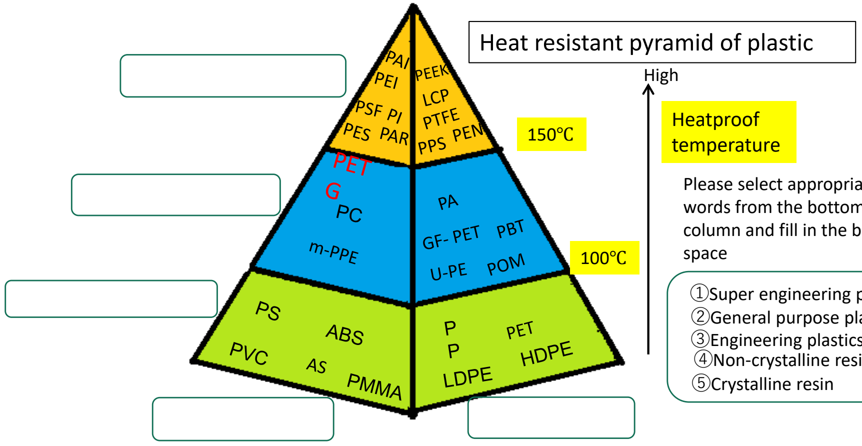
Material	Shrinkage	A molded article dimension
PP	18/1000	
PS	5/1000	

3-18. Types and characteristics of the plastic

Practice Question-8

Classification with long term heat resistance temperature

Please enter the appropriate words in the blanks (Please select from ① to ⑤)



Please select appropriate words from the bottom column and fill in the blank space

①Super engineering plastics
②General purpose plastic
③Engineering plastics
④Non-crystalline resin
⑤Crystalline resin

3-19. Thermoplastic (Polymer and Abbreviation)

General Purpose Plastic

•PVC	Poly Vinyl Chloride
•PE	Poly Ethylene
•PP	Poly Propylene
•PS	Poly Styrene
•ABS	Acrylonitrile Butadiene Styrene
•AS	Acrylonitrile Styrene
•PMMA	Poly Methyl Methacrylate
•PET	Poly Ethylene Terephthalate

3-20. Thermoplastic (Polymer and Abbreviation)

Engineering Plastics

- PA6 Poly Amide 6
- PA66 Poly Amide 66
- POM Poly Oxy Methylene
- PC Poly Carbonate
- GF-PET GF-Poly Ethylene Terephthalate
- m-PPE modified-Poly Phenylene Ether (denaturated-PPE or denaturated PPO)
- PBT Poly Butylene Terephthalate
- U-PE Ultra High Molecular Weight Poly Ethylene
- PETG polyethylene terephthalate glycol

3-21. Thermoplastic (Polymer and Abbreviation)

Super Engineering Plastics

- PEEK Poly Ether Ether Ketone 240℃
- PPS Poly Phenylene Sulfide
- PPSU Poly Phenyl Sulfone
- PSU Poly Sulfone
- PESU Poly Ether Sulfone
- PAR Poly Arylate
- PAI Poly Amide Imide 250℃
- PEI Poly Ether Imide (ULTEM®)
- LCP Liquid Crystal Polymer
- PTFE Poly Tetra Fluoro Ethylene
- PCTFE Poly Chroro TriFluoro Ethylene
- PVDF PolyVinylidene DiFluoride

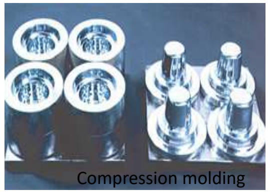
3-22. Thermosetting Plastic (Polymer and Abbreviation)

- PF Phenol Formaldehyde (Bakelite)
- UF Urea Formaldehyde (Urea resin)
- MF Melamine Formaldehyde
- EP Epoxy
- UP Unsaturated Polyester
- SI Silicone
- PUR Poly Urethane

3-23. Thermosetting molding: Compression molding system

Compression molding machines and examples


A



B


C


D

A: Compression molding machine
B: Mold
C: High-frequency heating machine and tablet
D: Plastic plates for school lunch (Melamine resin products)

3-24. Thermosetting molding: Compression molding system (Thermoplastic)

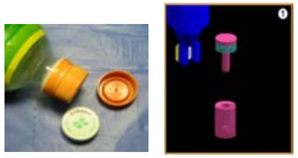
	Products	Materials	Characteristics
1	Knob of pot	Phenol (PF)	• Heatproof temperature: 150℃
2	Dishes/Plates/ Bowl	Melamine (MF)	• Low thermal conductivity: Food does not cool off easily • Scratch-resistant: Surface is hard • Heat sterilization /disinfection can be applied
3	Ashtray	Melamine (MF)	• Thermal deformation temperature 180 ℃, Not burnable
4	Bottle cap	Poly Propylen (PP)	• High productivity

1

2

3

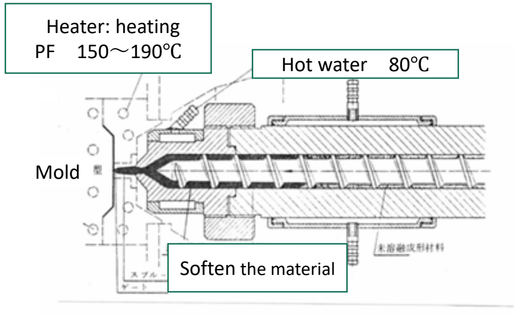
4



3-25. Thermosetting resin: Injection molding system

Appearance is the same

- Inject the softened material into the mold
- Harden with pressure and heat of injection (mold temperature)

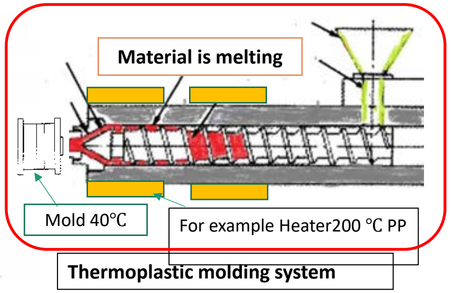


Heater: heating
PF 150～190℃

Hot water 80℃

Mold

Soften the material



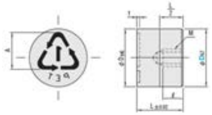
Material is melting

Mold 40℃

For example Heater200 ℃ PP

Thermoplastic molding system

3-26. Plastic Recycling Mark



Recycling mark indicates the type of plastic to sort out and use as a recyclable resource. For example, Japan has a system of selective collection of used plastic products (e.g. PET bottles) .

1

2

6

3-27. Recycled material ratio and change of its characteristics

The table shows the relationship between the regeneration frequency and the strength of the glass fiber reinforced polycarbonate.

The strength will decrease since glass fiber is crushed by repetition of regeneration. However, by adding 30% recycled material to the new material, the strength does not decrease even if it is regenerated.

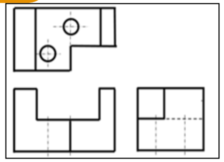
Classification	No. of regeneration	Mean fiber length (μm)	Flexural strength (Kgf/cm²)	Flexural modulus (Kgf/cm²)
New material	-	241	1220	36,000
100% Recycled materials	1	187	1130	33,700
	2	154	1070	31,600
	3	146	1040	30,900
	4	140	1110	30,200
30% Recycled materials	1	-	1180	34,700
	2	-	1180	34,700
	3	-	1180	34,700
	4	-	1180	34,700

Reference: Shinichi Honma, (1992) Polycarbonate Resin Handbook, p479, Nikkan Kogyo Shimbun Co., Ltd.

There are rules in the drawing method.
Learn the basics of drawing

No-4

Mechanical Drawing



4-1. Basics of mechanical drawing

Why is drawing necessary?

With 3D-CAD and 3D printers, it became an era in which products can be made without a two-dimensional drawing.

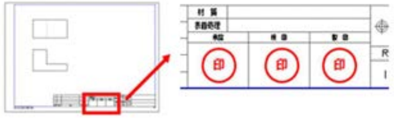
Because the drawing is a means of "information transmission", it is necessary for the next processes that follow manufacturing (inspection and management).

3D printer

There are common ways of writing (rules) in drawings (third angle system)

"Evidence" confirmed by people involved in design

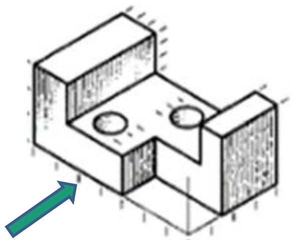
Need for product number and product drawing number management



4-2. Basics of mechanical drawing

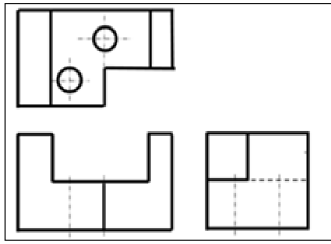
Practice Question-9

Writing (rules)

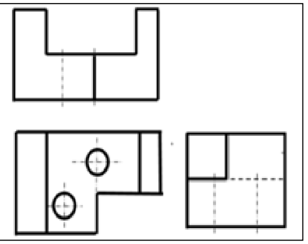


Question:
Which is a drawing prepared by using a third angle system, A or B?

A



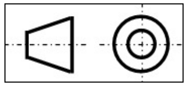
B

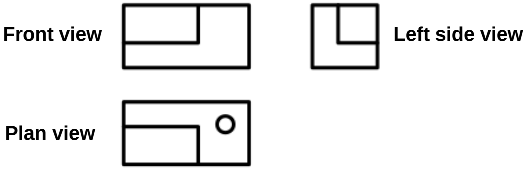


4-3. Basics of mechanical drawing

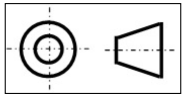
Writing (rules)

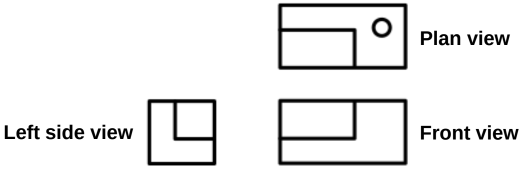
First angle system **Europe**





Third angle system **America （JAPAN）**

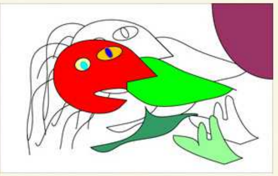




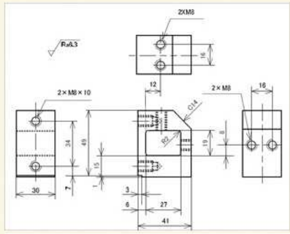
4-4. Basics of mechanical drawing

Writing (rules)

Difference between paintings and drawings



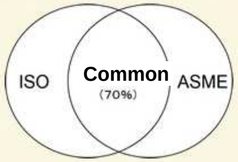
Emphasis on sensitivity: Different interpretations in different people



Emphasis on commonality: Interpretation must be common to all people

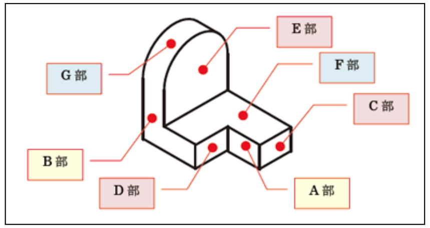
Relationship between ISO and ASME

ISO (International Organization for Standardization)
ASME (American Society of Mechanical Engineers)

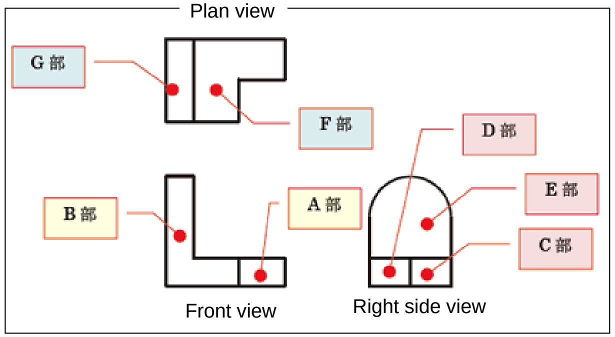


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-5. Basics of mechanical drawing



Three-dimensional shape to be used for projection drawings



Layout of projection drawings using third angle system

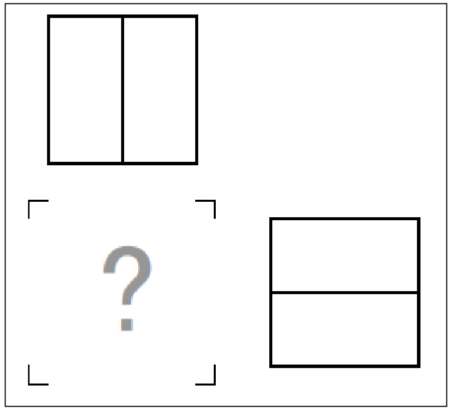
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-6. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Level 1: Question

Image a front view from these 2 projection drawings



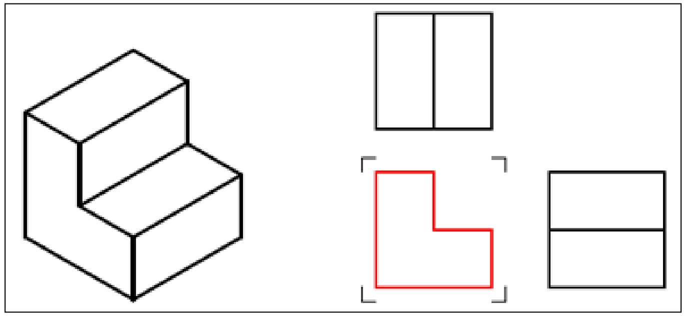
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-7. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Level 1: Sample answer to question

Image a front view from these 2 projection drawings (Example)



Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

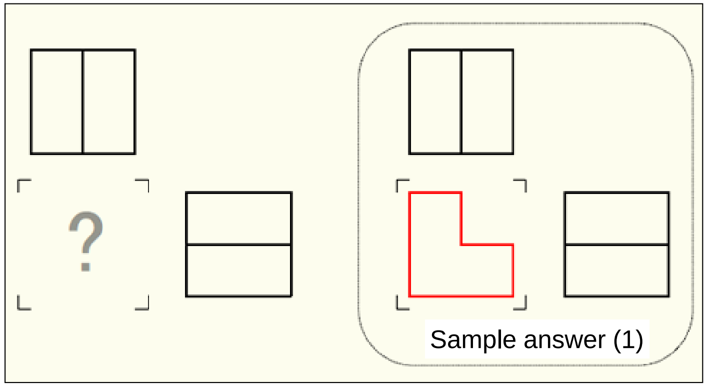
4-8. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Practice Question-10

Level 2: Question

Create a shape other than sample answer (1)



Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

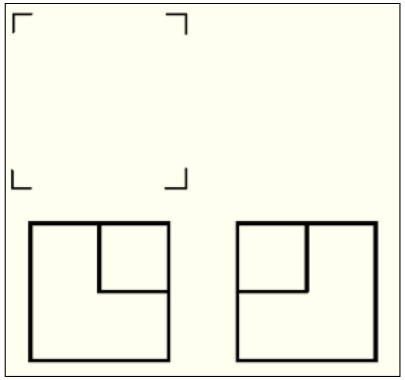
4-9. Basics of mechanical drawing

Creating shape from insufficient projection drawing

Practice Question-11

Level 3: Exercise

Create a possible shape from projection drawings of front and right side views



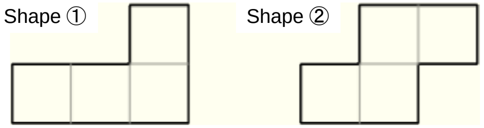
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

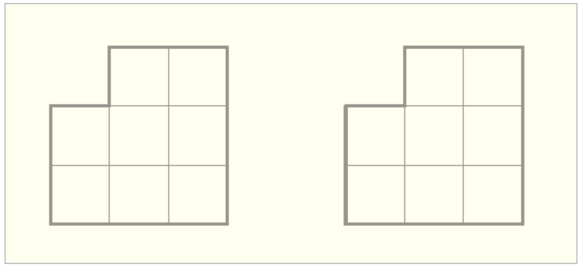
4-10. Basics of mechanical drawing

Lay out a 2D drawing in your head

Practice Question-12

Level 1: Exercise





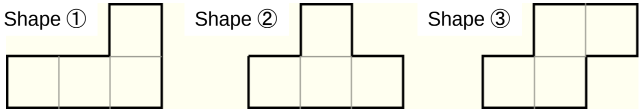
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

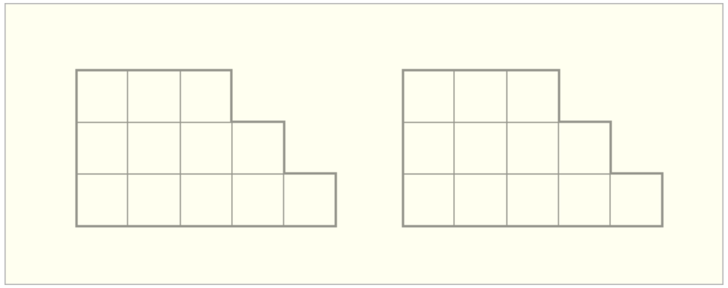
4-11. Basics of mechanical drawing

Lay out a 2D drawing in your head

Practice Question-13

Level 2: Exercise





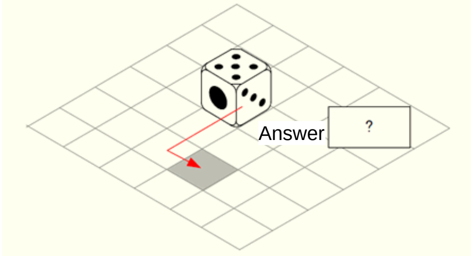
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

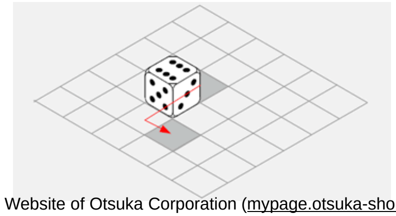
4-12. Basics of mechanical drawing

Practice Question-14

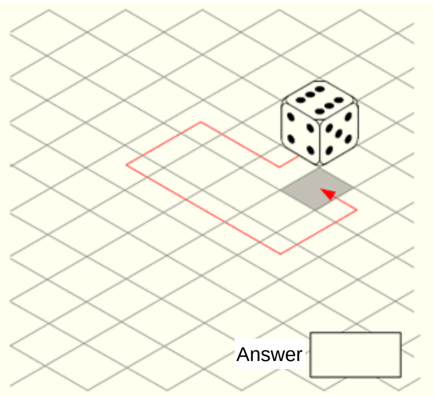
Move a 3D shape in your head

Level 1: Exercise





Level 2: Exercise

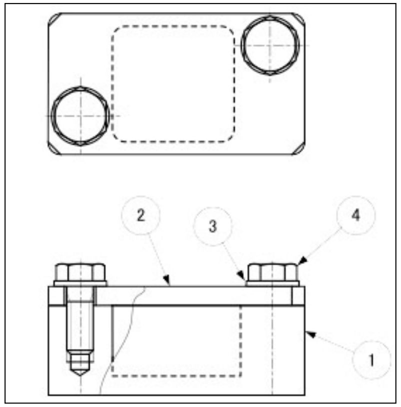


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-13. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

① Case (1)
② Cover (1)
③ Washer (2)
④ Bolt (2)



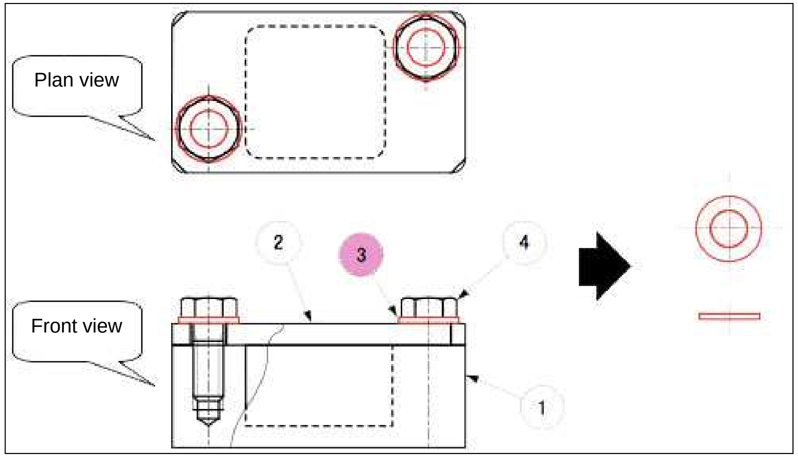
Question (1) Paint lines indicating the washer in red.
Question (2) Paint lines indicating the bolt in red.
Question (3) Paint lines indicating the cover in red.
Question (4) Paint lines indicating the case in red.

Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-14. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (1) Paint lines indicating the washer in red. **Sample answer**

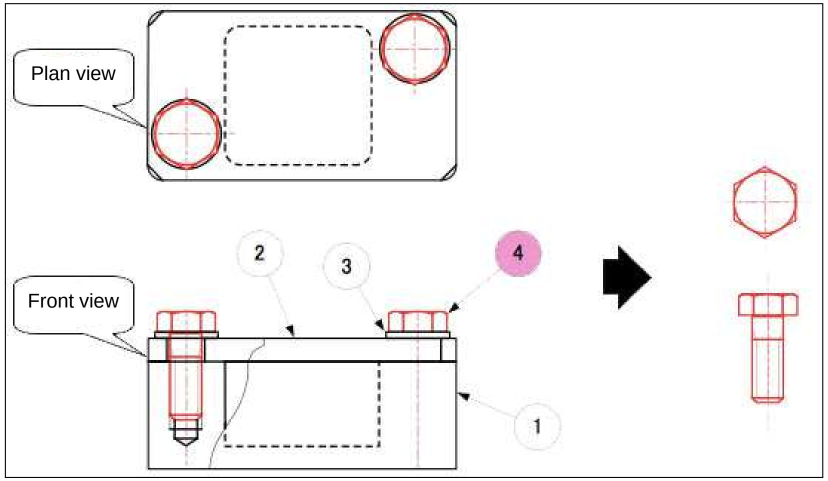


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-15. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (2) Paint lines indicating the bolt in red. **Sample answer**

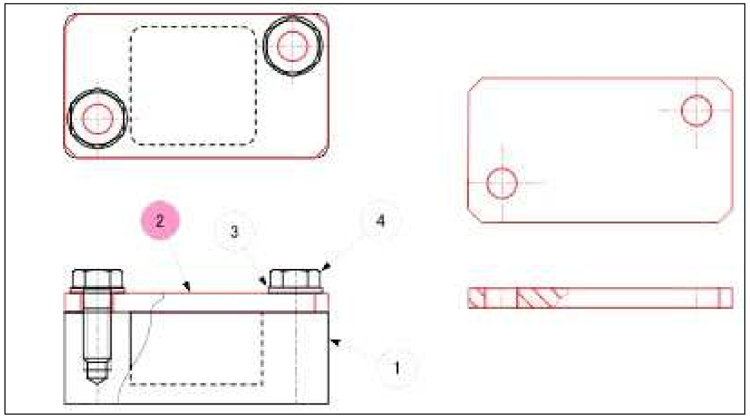


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-16. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (3) Paint lines indicating the cover in red. **Sample answer**

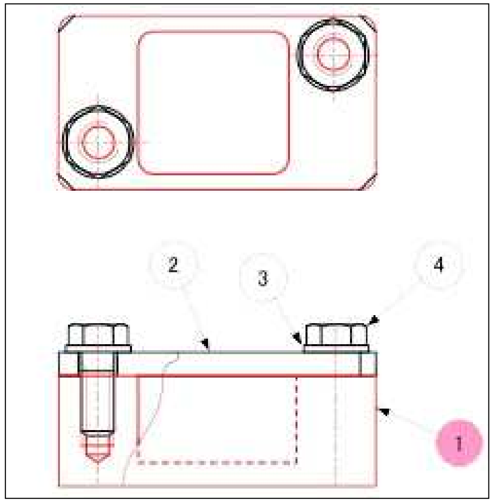


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-17. Basics of mechanical drawing

Identify a shape from an assembly drawing having intersecting lines

Question (4) Paint lines indicating the case in red. **Sample answer**



Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

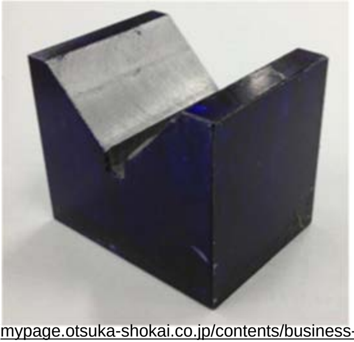
4-18. Basics of mechanical drawing-1

Draft a rough drawing by utilizing your spatial ability

Practice drafting a rough drawing in freehand

You can draft a rough drawing by observing the following 3 points:

- Consider the size proportions.
- Do not be afraid to make a mistake, as you can erase it with an eraser and re-draft the drawing.
- Do not be ashamed of bending lines.



V-shaped block

Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

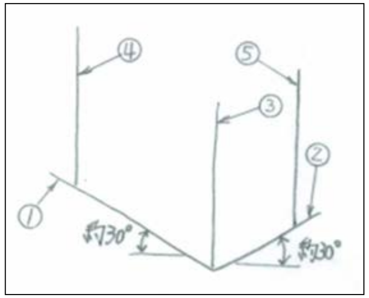
4-18. Basics of mechanical drawing-2

Draft a rough drawing by utilizing your spatial ability

[Step 1]

Let’s start with drafting a straight line, a basic of contours. At this point, it is better to become able to draw a line inclined by about 30 degrees to make an isometrical drawing.

Start from the bottom straight line of the V-shaped block, and then draw the vertical lines that will be standards in the vertical direction.



V-shaped block

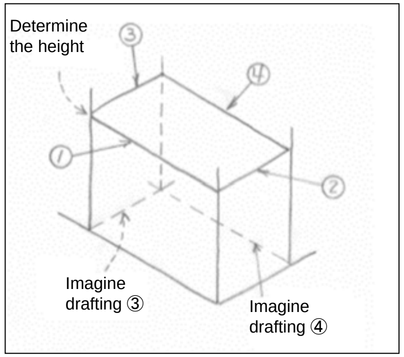
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-18. Basics of mechanical drawing-3

Draft a rough drawing by utilizing your spatial ability

[Step 2]

To draw the top surface of the V-shaped block, image an inclination of the line from the bottom surface, and sketch a contour while considering the height and depth.



V-shaped block

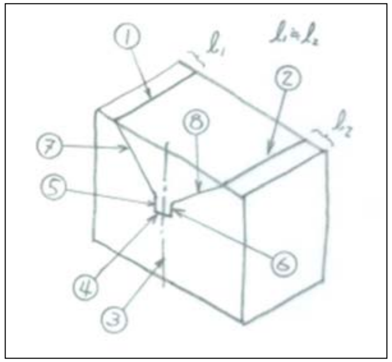
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-18. Basics of mechanical drawing-4

Draft a rough drawing by utilizing your spatial ability

[Step 3]

Next, draw a V-shaped part. To make a V-shaped part symmetrical, first draw the top surface symmetrically. Then, determine the position in the bottom of the V-shaped part by drawing a center line, and draw diagonal lines.



V-shaped block

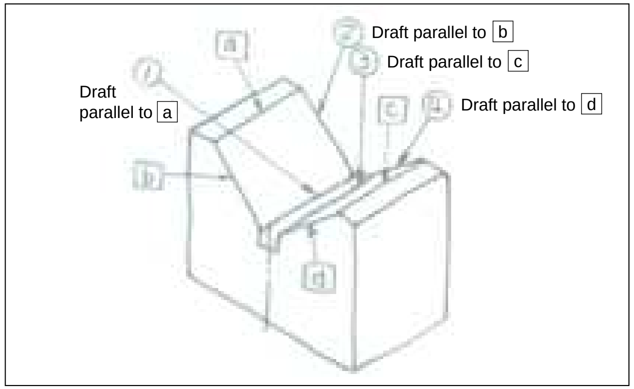
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-18. Basics of mechanical drawing-5

Draft a rough drawing by utilizing your spatial ability

[Step 4]

Draw a line in the depth direction from the bottom of the V-shaped part to draft a V-shape surface at the back.



V-shaped block

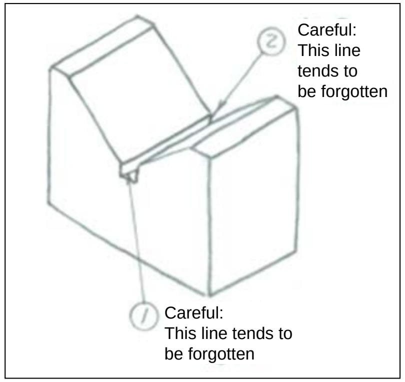
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-18. Basics of mechanical drawing-6

Draft a rough drawing by utilizing your spatial ability

[Step 5]

Draw a line in the depth direction from the bottom of the V-shaped part to draw a V-shape on the back, and complete the drawing.
Pay attention not to omit minor lines like this.



V-shaped block

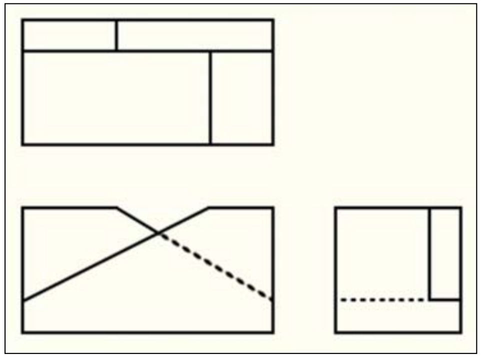
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-19. Basics of mechanical drawing

Practice Question-15

Draft a rough drawing by utilizing your spatial ability

Exercise of drafting rough drawing-1



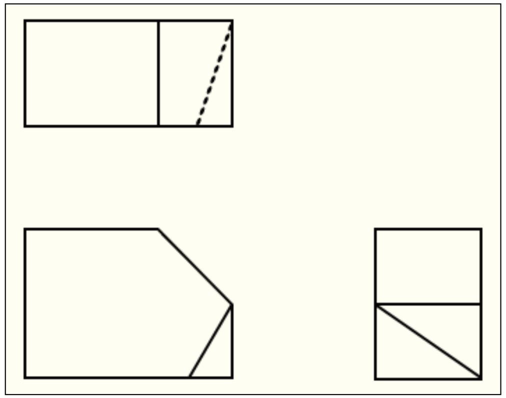
Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-20. Basics of mechanical drawing

Practice Question-16

Draft a rough drawing by utilizing your spatial ability

Exercise of drafting rough drawing-2

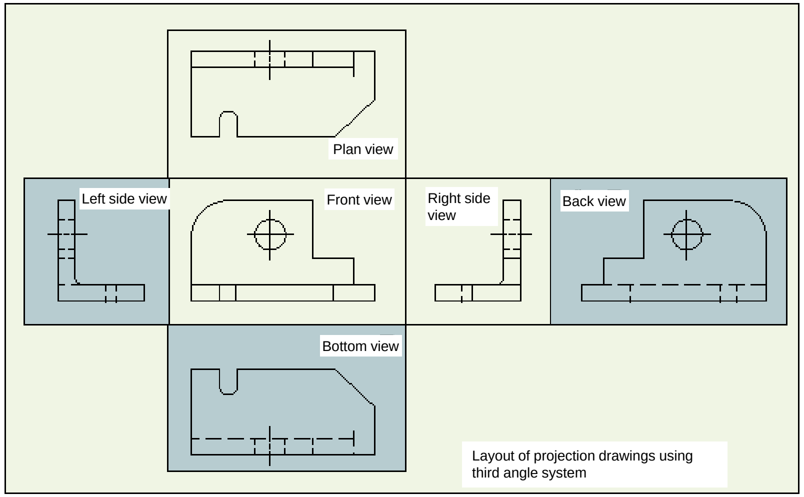


Source: Website of Otsuka Corporation (mypage.otsuka-shokai.co.jp/contents/business-oyakudachi/cad-lecture)

4-21. Basics of mechanical drawing

How to read/make drawings ①

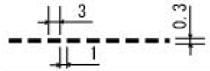
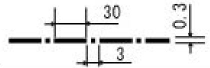
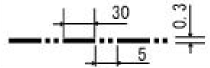
- **A mechanical drawing is based on trihedral drawings using a third angle system**



4-22. Basics of mechanical drawing

How to read/make drawings ②

- **Types of lines (solid, narrow, dashed, long-dashed dot, long-dashed double-dot)**

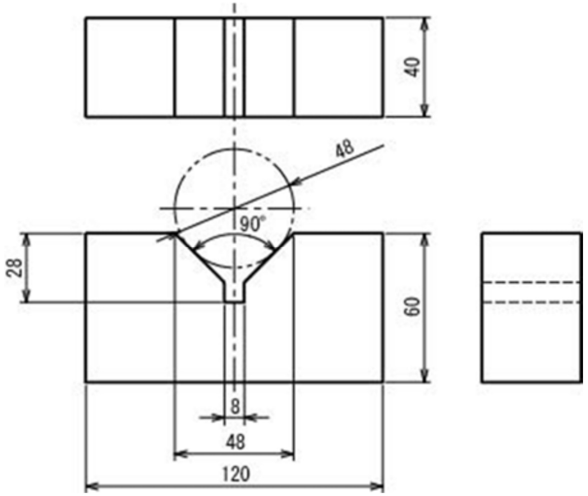
Types of lines		Explanation	Use	Name by use
Thick solid line		Continuous line with the thickness of 0.7 mm	Indicates the shapes of visible areas of the target object	Contour line
Thin solid line		Continuous line with the thickness of 0.3 mm	Used to enter dimensions, leader lines or their descriptions.	Dimension line, projection line, leader line
Narrow dashed line		Line consisting short lines	Indicates the shapes of invisible areas of the target object	Hidden line
Narrow long-dashed dot line		Line consisting of lines and single dots	Indicates the center of the figure or the track of the center position	Center line
Narrow long-dashed double dot line		Line consisting of lines and double dots	Indicates adjacent areas or tools and others for reference	Imaginary line

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

4-23. Basics of mechanical drawing

How to read/make drawings ③

- **Types of lines (Example: V-shaped block drawing**

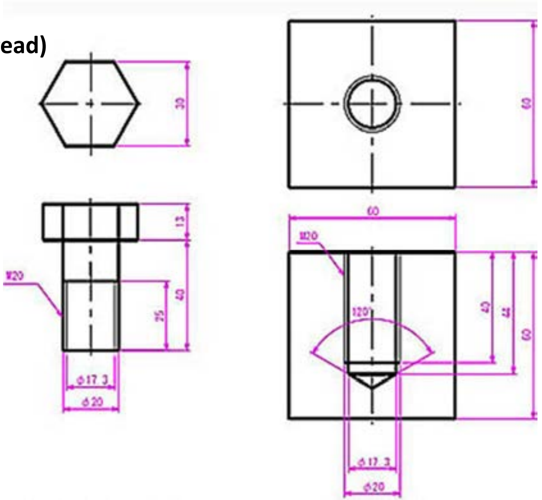


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

4-24. Basics of mechanical drawing

How to read/make drawings ④

- **Thread drawing**
  (Male thread and Female thread)



(a) Hexagonal bolt (male thread)

(b) Female thread

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

4-25. Basics of mechanical drawing

How to read/make drawings (Exercise-1)

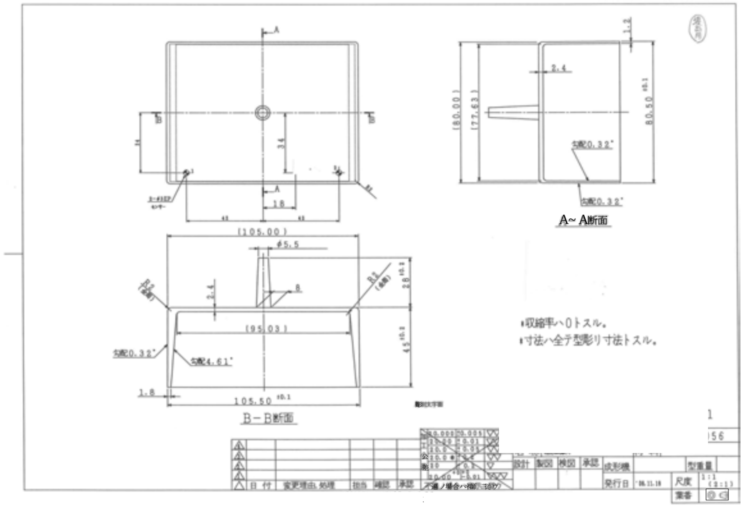
Prepare sundries (cup, case, etc.), roughly sketch and measure dimensions of them to prepare a product drawing.

Product name	**Material**
Scale	Third angle system
Name	Preparation date

4-26. Basics of mechanical drawing

How to read/make drawings (Exercise-2)

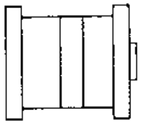
- Check the product drawing, and Implementation of drawing work



Learn the basics of molds, gate types / features

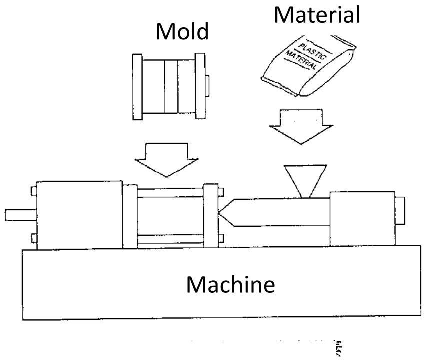
No-5

Mold



5-1. Positioning of mold in injection molding

- **Productivity = Production / input**
- **Production: molded articles**
- **Input ：3M+1M**
  - **Hard①　Machine**
  - **Hard②　Mold**
  - **Hard③　Material**
  - **Soft ①　Method**



5-2. Positioning of mold in injection molding

Molds are one of the production factors necessary for producing molded articles

In fact

It is the most important production factor that is said to affect 80 to 90% of the quality and cost of molded articles

---

5-3. Function and principle of mold (Ideal condition)-1

№	Function	Principles (Ideal condition)
1	Shape imparting function	① Cavity and core shall have predetermined size and shape (initial accuracy) ② The positions of the cavities and the cores are proper, and they do not change from shot to shot (repetition accuracy) ③ Mold has sufficient strength and rigidity (pressure resistance strength, rigidity) ④ Mold is maintained prescribed shape and dimensions during required period (life)
2	Heat exchange function	①Cooling must be done uniformly (accuracy after heat shrinkage) ②The molded product should be quickly cooled (cost)

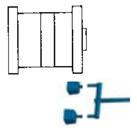
5-4. Function and principle of mold (Ideal condition)-2

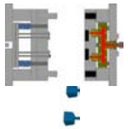
№	Function	Principles (Ideal condition)
3	Flow path forming function	① The flow path must be properly sized and shaped (quality / cost)
4	Release function	① Removal resistance is sufficiently small (quality / cost) ② The demolding mechanism must have sufficient strength and durability
5	Exhaust function	① The air inside the cavity can be exhausted quickly at injection (quality)
6	Other	① Cavity and core are always clean (quality)

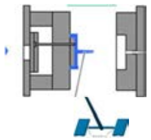
5-5. Classification of injection mold

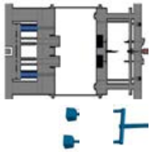
Injection mold (Runner system)
- Cold runner mold
- Hot runner mold

Cold runner mold (Plate structure)
- 2- plate mold
- 3- plate mold


Cold runner mold

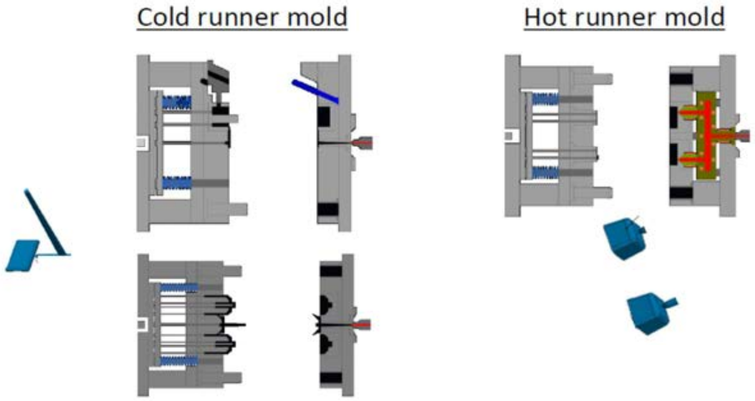

Hot runner mold


2- plate mold


3- plate mold

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html
Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

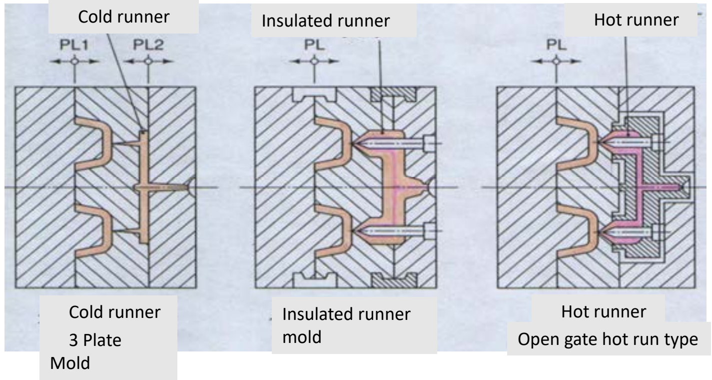
5-6. Classification of injection mold



Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html
Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

5-7. Classification of function and basic structure of injection mold

Reference diagram of runner method



Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.31, NIKKAN KOGYO SHIMBUN,LTD.

5-8. Classification of function and basic structure of injection mold

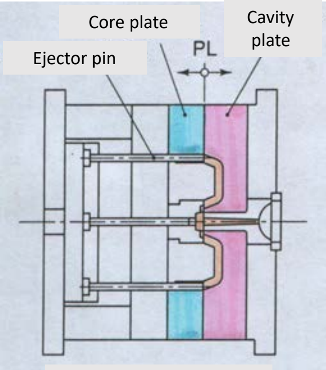
Comparison of Runner Method Feature

Item	Cold Runner	Hot Runner
Material Yield	Material yield is bad since unnecessary runners are formed	Material yield is good since only necessary molded parts are formed
Molding Cycle	Particularly, 3-plate molds are slow in molding cycle and low in productivity	Productivity is high with minimum molding cycle required
Quality of Molded Articles	Failure due to insufficient molding pressure or non-uniformity is likely to occur	"Burn" or "silver streak" due to inappropriate resin-melt temperature is likely to occur
Molding Material	No constraint on molded material	Difficult to apply to temperature sensitive materials and materials with high resin-melt temperature
Cost, Delivery Time	Lower cost and shorter delivery time comparing with Hot Runner (in general)	Higher cost and longer delivery time comparing with Cold Runner (in general)

5-9. Classification of function and basic structure of injection mold

Cold runner 2-plate mold: structure and features (1)

- 2-plate mold consists of two main plates： a cavity plate and a core plate
- All gating type molds other than the pinpoint gate type are 2-plate structure
- 2-plate molds are generally cheaper in mold cost and faster in molding cycle, comparing with 3-plate molds



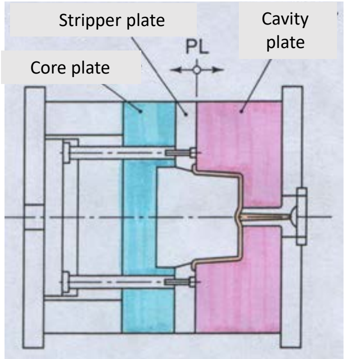
Pin projecting type

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.33, NIKKAN KOGYO SHIMBUN,LTD.

5-10. Classification of function and basic structure of injection mold

Cold runner 2-plate mold: structure and features (2)

- The mold structure composed of a cavity plate, a core plate and a stripper plate is also 2-plate mold
- 2-plate mold is characterized in that molded articles and runners are taken out from the same PL surface



Stripper plate type

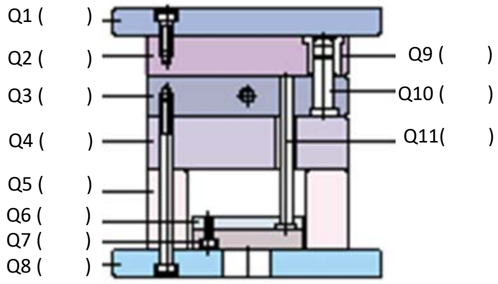
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.33, NIKKAN KOGYO SHIMBUN,LTD.

5-11. Structure and components of injection mold

Practice Question-17

Please select each name from the table on the right and answer by the number

2-Plate Type・Mold-Base



①	**Guide Pin**
②	**Parallel Block**
③	**Return Pin**
④	**Ejector Retainer Pate**
⑤	**Core Plate**
⑥	**Guide Bushing**
⑦	**Cavity Plate**
⑧	**Top Clumping Plate**
⑨	**Bottom Clumping Plate**
⑩	**Support Plate**
⑪	**Ejector Pate**

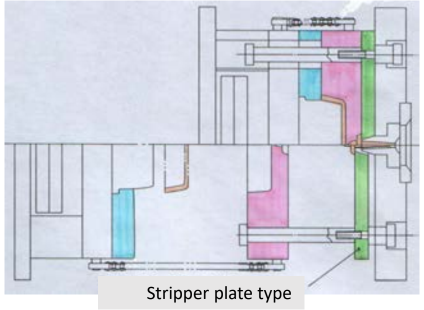
Reference: Futaba Electronics Industry Co., Ltd. WEB page, www.futaba.co.jp/product

5-12. Classification of function and basic structure of injection mold

Cold runner 3-plate mold: structure and features

・3-plate mold consists of three main plates: a cavity plate, a core plate and a runner stripper plate

- The pinpoint gate type mold has 3-plate structure
- 3-plate mold is characterized in that molded article and runner are taken out by different surface
- Both mold cost and molding cost are higher than 2 plate molds

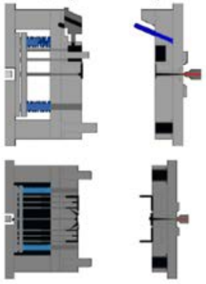

Stripper plate type

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.147., NIKKAN KOGYO SHIMBUN,LTD.

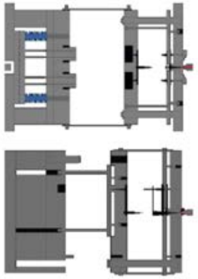
5-13. Classification of function and basic structure of injection mold

Which mold is 2-plate mold or 3-plate mold?

Q1 (   )



Q2 (   )



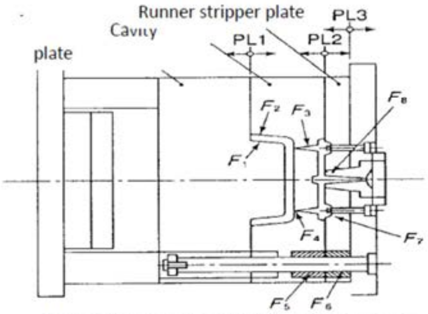
①	3-plate mold
②	2-plate mold

Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

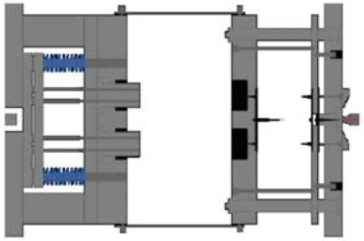
5-14. Classification of function and basic structure of injection mold

Practice Question-18

- Which is the correct opening order for 3- plate mold? (   )
  1) ①PL1→②PL2 →③PL3
  2) ①PL2→②PL1 →③PL3
  3) ①PL3→②PL2 →③PL1



Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.34, NIKKAN KOGYO SHIMBUN,LTD.



Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

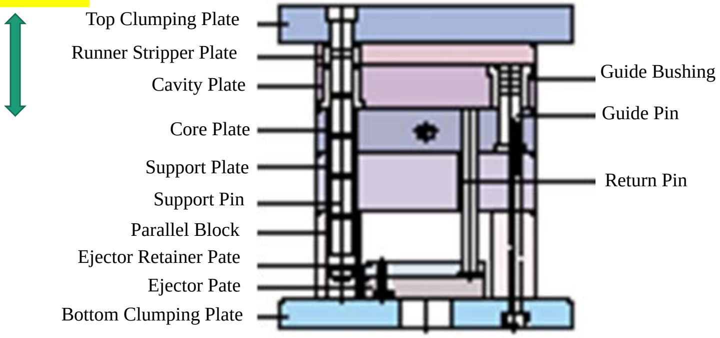
5-15. Mold base 2-Plate & 3-Plate

Reference: Futaba Electronics Industry Co., Ltd. WEB page, www.futaba.co.jp/product

5-16. Structure and components of injection mold

3-Plate Type・Mold-Base(1)

Vertical type



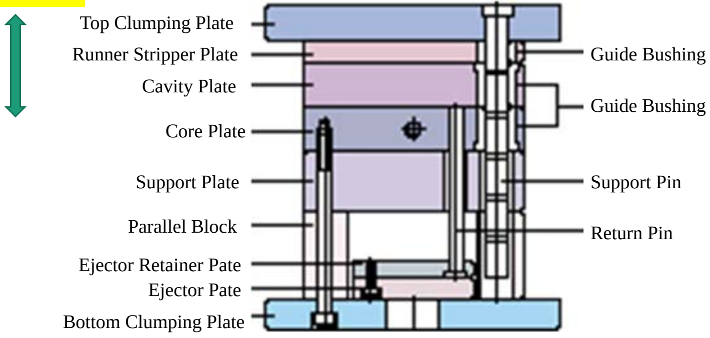
Reference: Futaba Electronics Industry Co., Ltd. WEB page, www.futaba.co.jp/product

---

5-17. Structure and components of injection mold

3-Plate Type・Mold-Base(2)

Vertical type

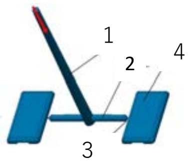


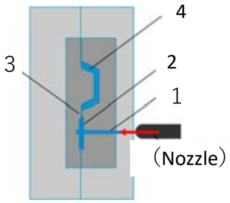
Reference: Futaba Electronics Industry Co., Ltd. WEB page, www.futaba.co.jp/product

---

5-18. Resin flow path and its name

Nozzle (Inject from the nozzle) → Sprue→ Runner → Gate
→ Injection product (Cavity)

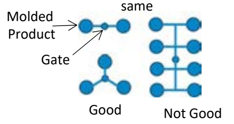




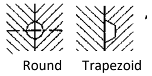
1	**Sprue**
2	**Runner**
3	**Gate**
4	**Injection product** (Cavity)

Runner Arrangement

Distance between each molded product and the gate should be same



Runner Cross-section



1. Sprue
   The first flow path of the resin flow which enters into the mold
   ・ Cross-sectional shape is circular・The side is inclined
2. Runner
   Flow path to a mold product part in the mold*・ Cross-sectional shape is circular or trapezoid
3. Gate
   Entrance to the molded product part・ Mark of the gate remains on the surface of the molded product

*A mold product part is a space and sometimes expressed as a cavity

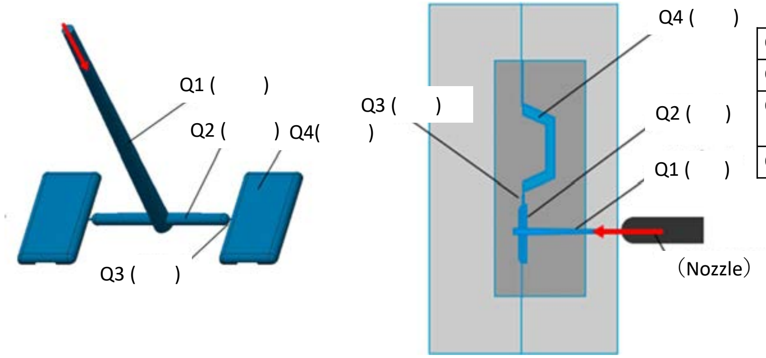
Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html

---

5-19. Resin flow path and its name

Practice Question-19

Please choose appropriate name from the table on the right



①	Gate
②	Runner
③	Injection product （cavity*）
④	Sprue

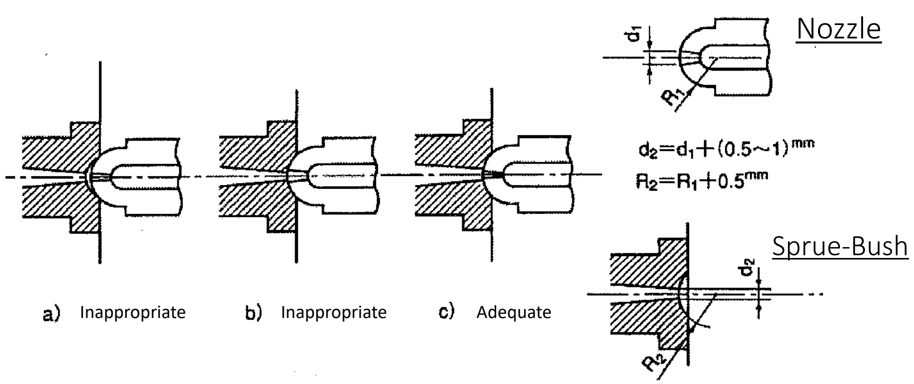
*Note: A mold product part is a space which will be filled by melted resin. This space is sometimes expressed as a cavity.

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html

5-20. Structure and components of injection mold

Key point of nozzle contact part (Sprue Bush) design

Check nozzle specification of the molding machine which you plan to use



$d_2=d_1+(0.5\sim1)^{mm}$

$R_2=R_1+0.5^{mm}$

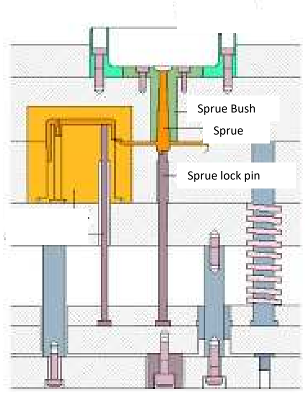
a) Inappropriate b) Inappropriate c) Adequate

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.141, NIKKAN KOGYO SHIMBUN,LTD.

5-21. Structure and components of injection mold

Sprue-Bush · Sprue-lock pin

Sprue Bush



Sprue-Bush

A cylindrical part that fits into the mold. Sprue bush works as a path for transferring molten plastic injected from a nozzle.
It consists of a pedestal to contact a tapered sprue hole and an injection molding machine nozzle.

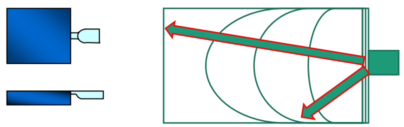
Sprue-lock pin

Sprue lock pin is for pulling out the resin which is cooled and solidified at the sprue in the mold. In other words, it is to pull out resin from the fixed side of the mold.

5-22. Resin flow

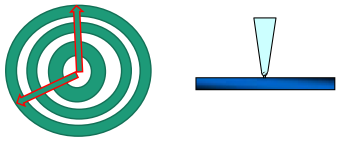
There are two types of resin flow in the mold: Bar flow and Radial flow

In Side Gate → Bar Flow



Mold gate system : Side-gate
Flow Length: Different
(e.g. Flat plate parts)

In Pin-point Gate → Radial Flow



Mold gate system: Pin-point gate, Direct gate
Flow Length: Same
(e.g. CD, caps, etc.)

5-23. Gate Function and type of gate

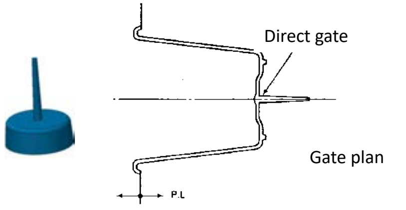
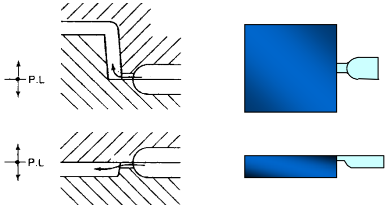
Gate Function

①Gate Sealing function ②Heat generation function
③ Rectification function ④ Simplification function of finish machining

Runner System	Type of Gate	Flow restriction	Mold	Gate cutting
Cold runner	①Direct gate	Non-limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	② Side gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	③ Overlap gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	④ Fan gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑤ Film gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑥ Disk gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑦ Ring gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑧ Tab gate	limiting gate	2 Plate Mold	Non-automatic cutting gate
Cold runner	⑨ Submarine gate	limiting gate	2 Plate Mold	Automatic cutting gate
Cold runner	⑩ Pin-Point gate	limiting gate	3 Plate Mold	Automatic cutting gate
Hot runner	Various gates 色々なゲート	Non-limiting gate	2 Plate Mold	(Mechanism · temperature) バルブ・加熱でon－off

5-24. Mold gate systems

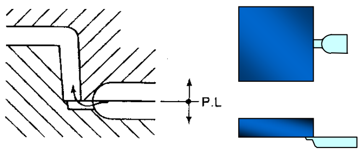
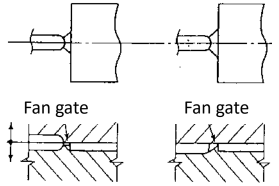
Features and applications of various gate systems ①

System	①Direct gate	②Side gate
Schematic Diagram		
Features · Applications	・Single cavity mold (1 piece) only ・Low pressure loss ・Gate cutting trace is large ・ Suitable for large size /depth molded products	･Mold processing is easy → Low cost ・Possible to deal with multiple cavity mold (multiple pieces) ･Easy gate disconnection ･Most commonly used

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.59, NIKKAN KOGYO SHIMBUN,LTD.

5-25. Mold gate systems

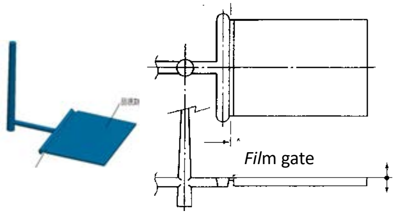
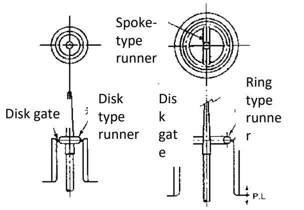
Features and applications of various gate systems ②

System	③Overlap gate	④ Fan gate
Schematic Diagram		
Features · Applications	・Cross-sectional shape is same as side gate ・Jetting is hard to occur ・There is no gate trace on the side of the molded product ･Gate disconnection is somewhat difficult	･Molten resin flows uniformly ･Warpage and distortion are less likely to occur ･Gate disconnection is somewhat difficult

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.59, NIKKAN KOGYO SHIMBUN,LTD.

5-26. Mold gate systems

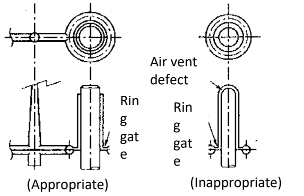
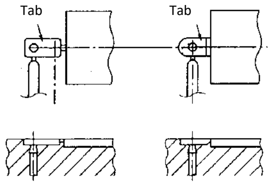
Features and applications of various gate systems ③

System	⑤ Film gate	⑥ Disk gate
Schematic Diagram		
Features · Applications	･Molten resin flows uniformly ･Warpage and distortion are less likely to occur ･Gate cutting type required	･Basically one piece ･No failure regarding Weld Line ･Good air exhaustion in a cavity ･Gate cutting type required

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.59. NIKKAN KOGYO SHIMBUN,LTD.

5-27. Mold gate systems

Features and applications of various gate systems ④

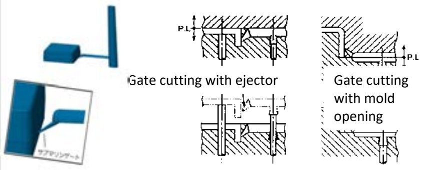
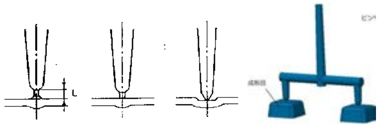
System	⑦ Ring gate	⑧ Tab gate
Schematic Diagram		
Features · Applications	･Cylindricity is relatively good ･In molded products with CAP shape, air vent is poor and defects are likely to occur ・ Gate cutting type required	･Absorption of internal distortion of gate part by tab ･is often used for transparent molded articles ・ Gate cutting type required

http://d-engineer.com/mold/gatesyurui.html）

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.61, NIKKAN KOGYO SHIMBUN,LTD.

5-28. Mold gate systems

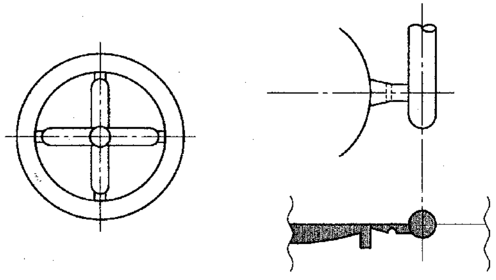
Features and applications of various gate systems ⑤

System	⑨ Submarine gate	⑩ Pin Point gate
Schematic Diagram		
Features · Applications	・Automatic cutting gate ・Applied to small molded items ・Limitation in fiber-reinforced resin use ・Mold cost is relatively low	・Automatic cutting gate ・Suitable from small molded items to large molded items ・Limitation in fiber-reinforced resin use ・Mold cost is relatively high

Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.62-63, NIKKAN KOGYO SHIMBUN,LTD.

5-29. Mold gate systems

Derived types of side gates and fan gates

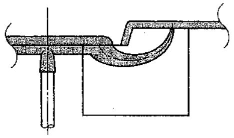


(a) Spoke gate (b) Restated Gate

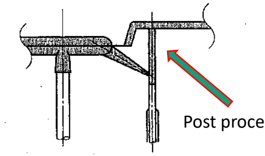
Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.62-63, NIKKAN KOGYO SHIMBUN,LTD.

5-30. Mold gate systems

Derived type of submarine gate

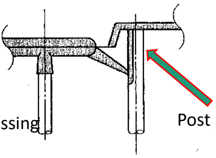


Banana gate



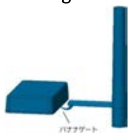
Post processing

Method by full length cutting of small ejector pin



Post processing

Method by partial cutting of large ejector pins



Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/gatesyurui.html

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.214, NIKKAN KOGYO SHIMBUN,LTD.

5-31. Mold gate systems

Gate size ①: How to calculate

Formula

・For Pinpoint-Gate: To Calculate Pinpoint-Gate's Circular Sectional Dimension

$d = nkA^{1/4}$ d : Gate size (mm)

・For Side-Gate: To Calculate Side-Gate's Rectangular Cross Section Dimensions

$h = nt$ h : Gate depth (mm)

$w = nA^{1/2}/30$ w : Gate width (mm)

Variables

n : Material constant

k : Wall thickness coefficient : $(0.1 \sim 0.15)t^{1/2}$

t : Basic wall thickness (mm)

V : Volume of moldings (mm^3)

A : Deployment area of moldings (mm^2) : (V/ t)

Material constant

	High flow	Medium flow	Low flow
Material	PE/PS/AS Pp/ABS	POM/PBT PA/m-PPE	PMMA/PC PVC/PPS
n	0.6	0.7	0.8

Material constant (n) : Indicator for the difference of liquidity in three stages

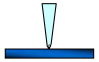
5-32. Mold gate systems

Practice Question-20

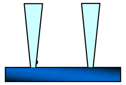
Gate size ②

Please calculate the gate size of the molded product shown on the figure.
There are three conditions as follows.

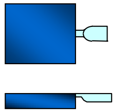
(1) Pin point gate (1 point)

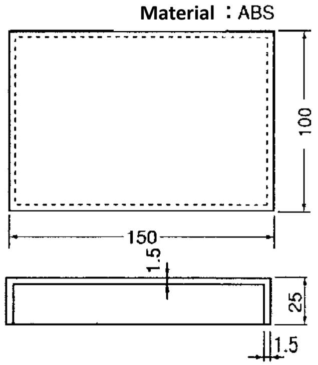


(2) Pin point gate (2 point)

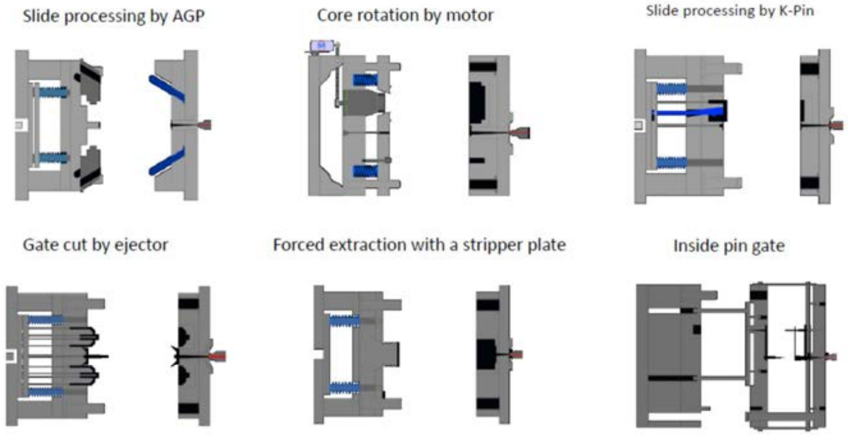


(3) Side gate (1 point)





5-33. Examples of various mold type



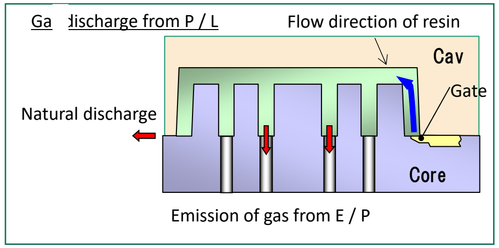
Reference: Plastic Injection Molding, Mold Animation, www.geocities.jp/tukuba777

5-34. Venting of mold

Before filling resin, there is air in the mold. A structure / mechanism is necessary to discharge gas generated from air and resin.

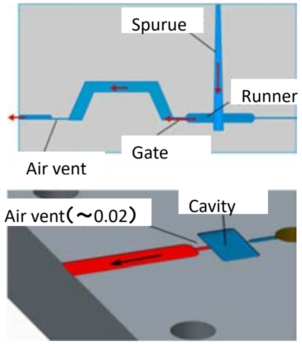
⇒Air vent of PL part (depth of filling terminal part ~ 0.02 mm)

A device that sucks air and gas inside a mold using a vacuum pump.



P/L ：Parting line

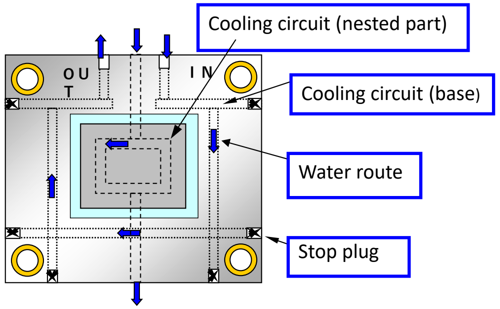
E/p ：Ejector pin



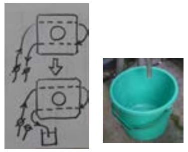
Reference: MONO Web, Basic Knowledge for Engineers, http://d-engineer.com/mold/surage.html

5-35. Heat exchanger / Cooling circuit of Mold

1) Mold is a heat exchanger ⇒ Mold temperature controller · Cooling water used for adjustment
2) The cooling efficiency greatly affects the molding cycle. Cooling circuit design is important
3) Flow path will be narrowed by rust etc.
   Maintenance of circuit is necessary ⇒ Periodic check of cooling water flow rate is necessary.



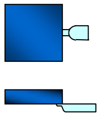
Cooling flow check

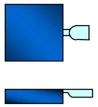


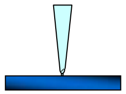
5-36. Typical gate system example

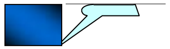
Practice Question-21

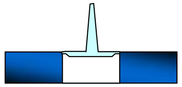
Please select the gate specification from the table on the right.

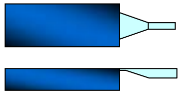

Q1 (   )

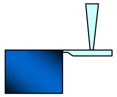

Q2 (   )


Q3 (   )


Q4 (   )


Q5 (   )


Q6 (   )

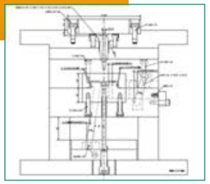

Q7 (   )

①	Pin Point Gate
②	Side Gate
③	Disk Gate
④	Fan Gate
⑤	Submarine Gate
⑥	Pinpoint + Side Gate
⑦	Overlap gate

Learn the basics of mold drawing

No-6

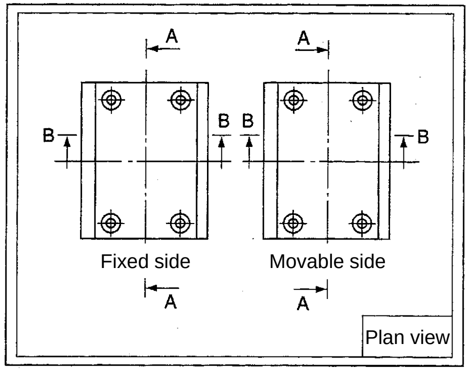
Mold Assembly Drawing

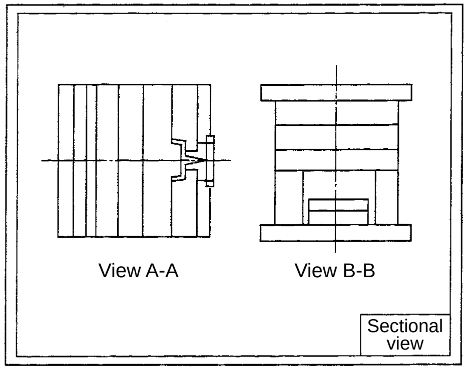


6-1. Understanding of assembly drawings

Structure of mold assembly drawings

- Mold assembly drawings are generally expressed by a fixed side plan view, a movable side plan view, and sectional views in 2 orthogonal directions (A-A, B-B).



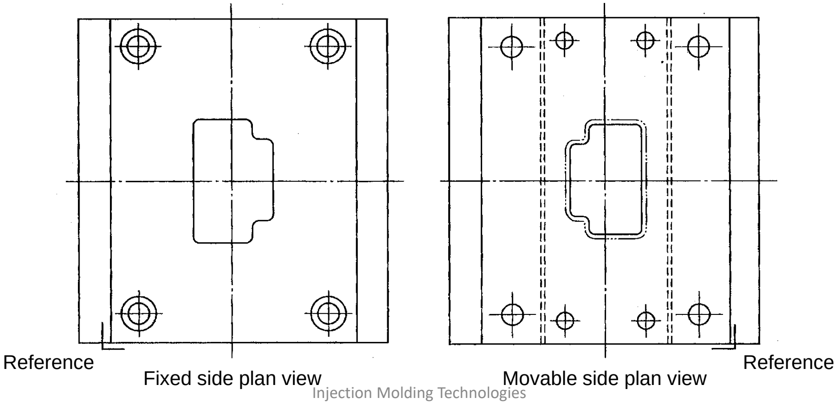


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

6-2. Understanding of assembly drawings

Drawing assembly plan views

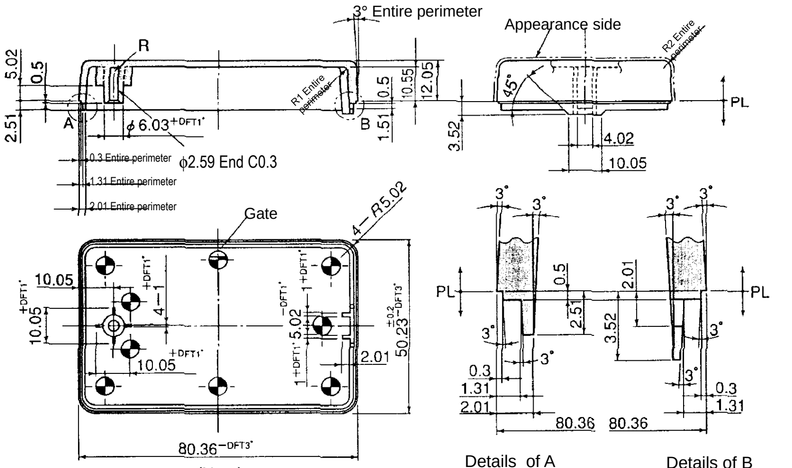
- Plan views for mold assembly drawings are prepared by opening the fixed and movable sides, and draft drawings from individual PL (parting line) sides.
- Pay enough attention that the fixed and movable sides are linearly symmetrical.



Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

6-3. Understanding of assembly drawings

Understanding product drawings

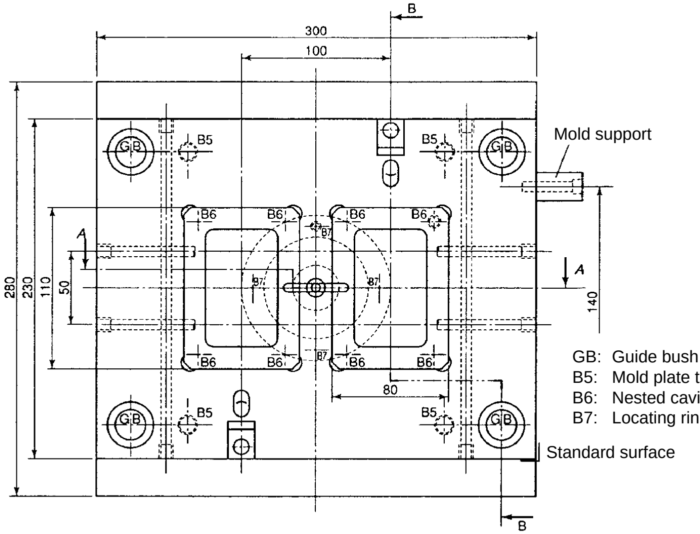


(Note)
For the ejector pin and gate positions, see the detailed drawing in the Attachment.

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

6-4. Understanding of assembly drawings

Understanding assembly plan views ①

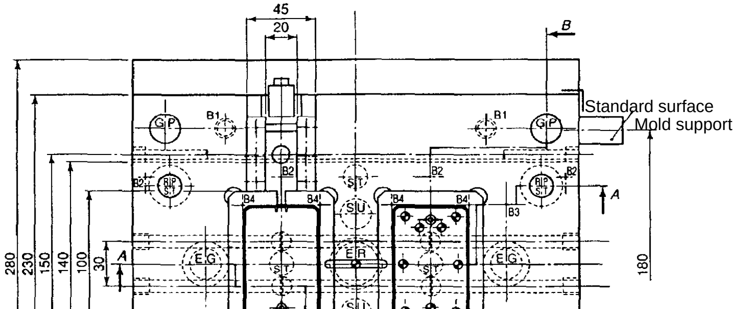


GB: Guide bush
B5: Mold plate tightening bolt
B6: Nested cavity fixing bolt
B7: Locating ring fixing bolt

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

6-5. Understanding of assembly drawings

Understanding assembly plan views ②

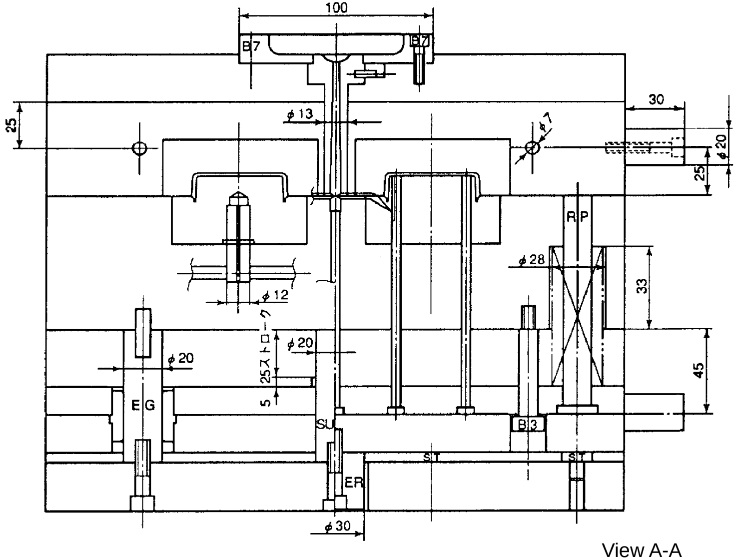


GP: Guide pin
RP: Return pin
ST: Stop pin
EG: Ejector guide
SU: Support pillar
ER: Ejector rod
B1: Mold plate tightening bolt
B2: Ejector plate fixing bolt
B3: Ejector assembly bolt
B4: Nested core fixing bolt

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

6-6. Understanding of assembly drawings

Understanding assembly sectional views ①

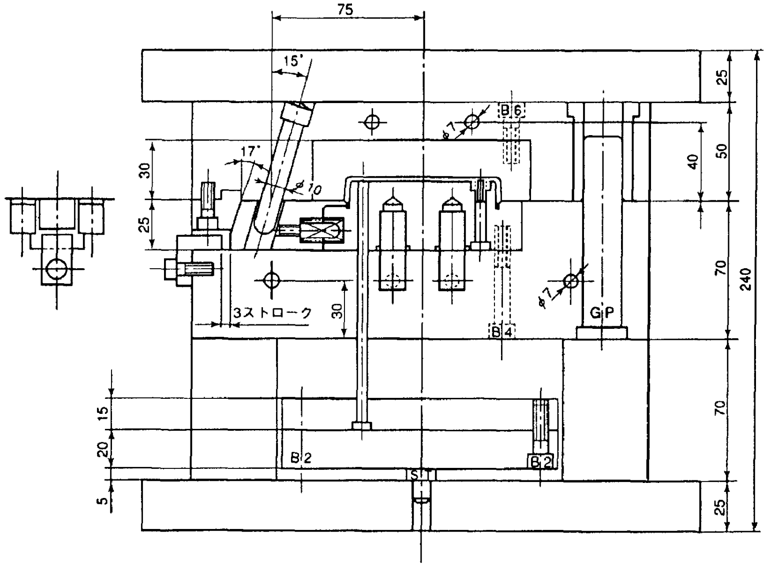


View A-A

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

6-7. Understanding die assembly drawings

Understanding assembly sectional views ②



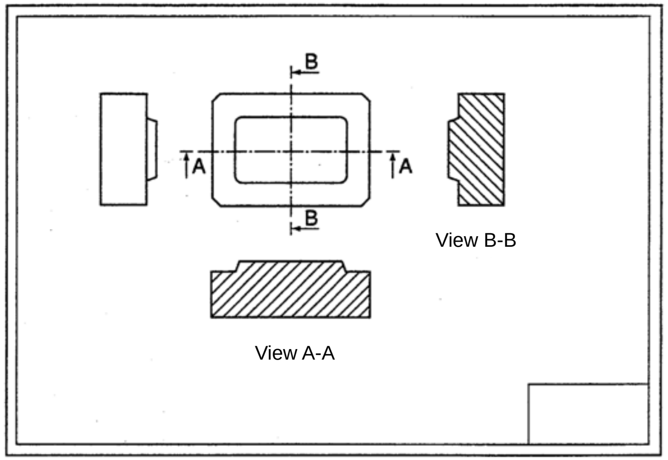
Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

View B-B

6-8. Designing and drafting part drawings

Drafting mold part drawings ①

- Drawing of nested cavities and cores

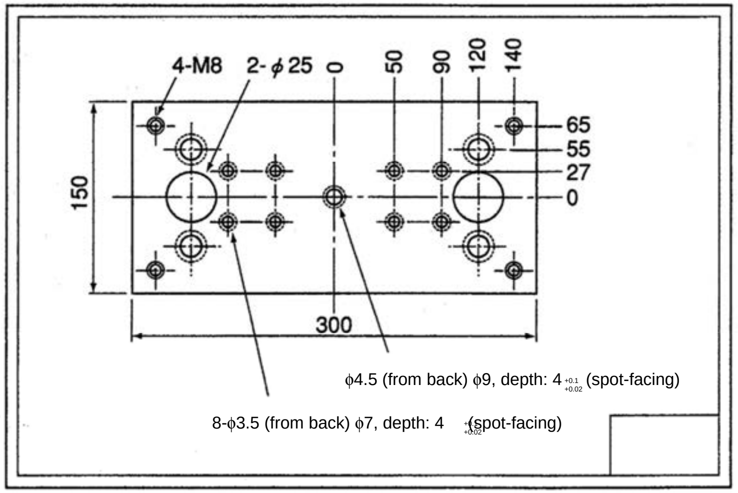


Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

6-9. Designing and drafting part drawings

Drafting mold part drawings ②

- Drafting mold plates



ϕ4.5 (from back) ϕ9, depth: 4 $^{+0.1}_{+0.02}$ (spot-facing)

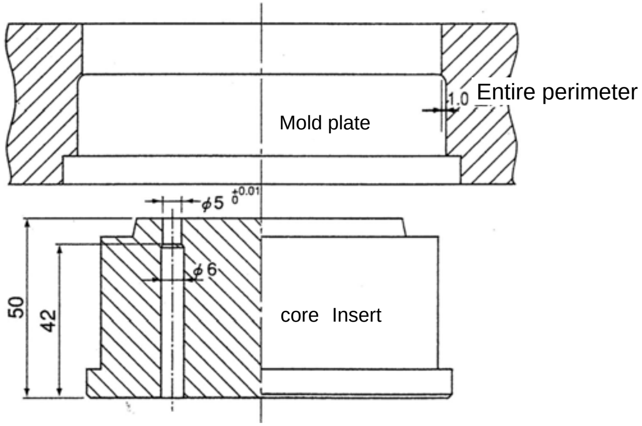
8-ϕ3.5 (from back) ϕ7, depth: 4 $^{+0.1}_{+0.02}$ (spot-facing)

Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

6-10. Designing and drafting part drawings

Drafting mold part drawings ①

- Considering machinability (undercut processing)

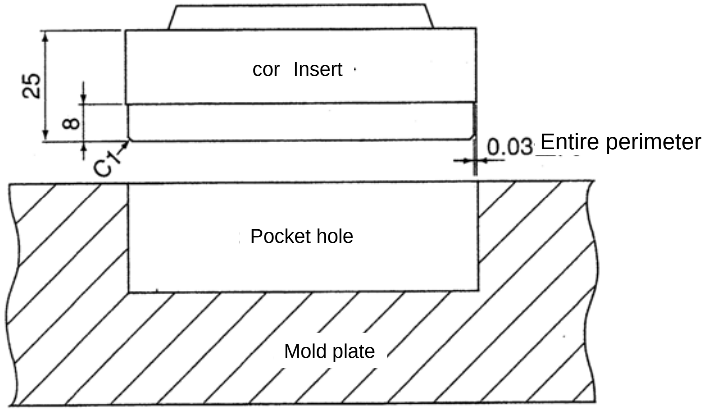


Source: Yuichi Fukushima "Designing Plastic Injection Mold", Nikkan Kogyo Shimbun, Ltd.

6-11. Designing and drafting part drawings

Drafting mold part drawings ②

- Considering assembly/disassembly performance (press-fit introduction area)

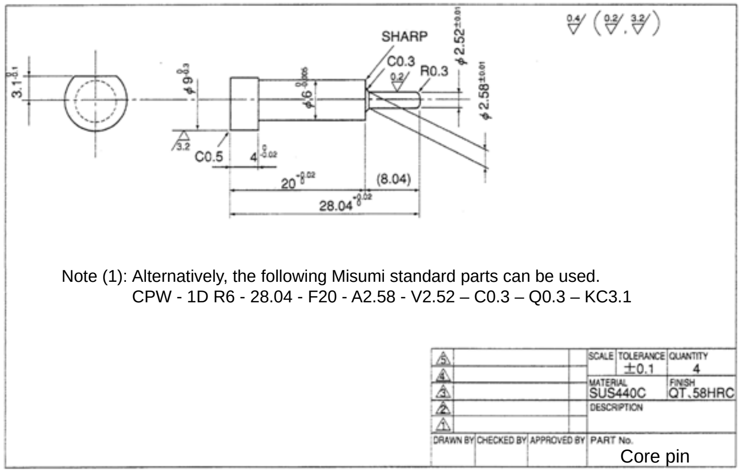


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

6-12. Designing and drafting part drawings

Drafting mold part drawings ③

- Considering dimensional tolerances (for fittings, etc.)

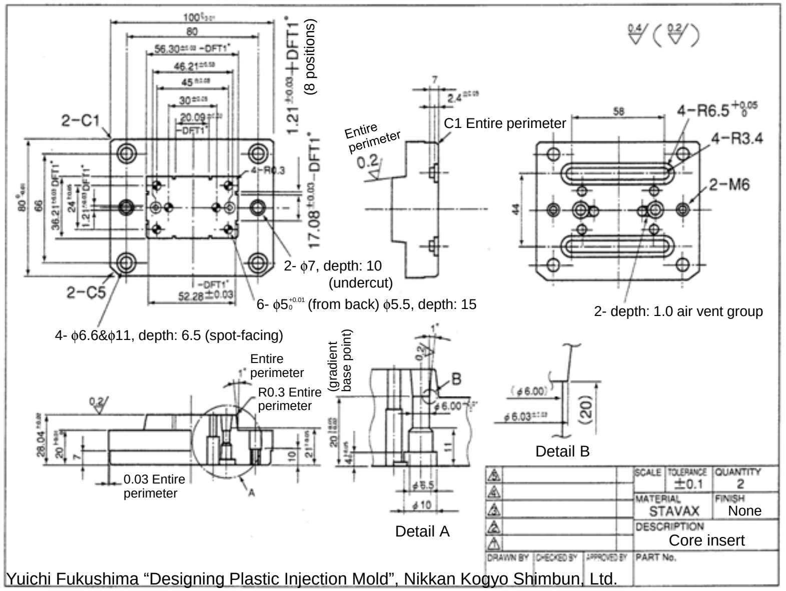


Note (1): Alternatively, the following Misumi standard parts can be used.
CPW - 1D R6 - 28.04 - F20 - A2.58 - V2.52 – C0.3 – Q0.3 – KC3.1

Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

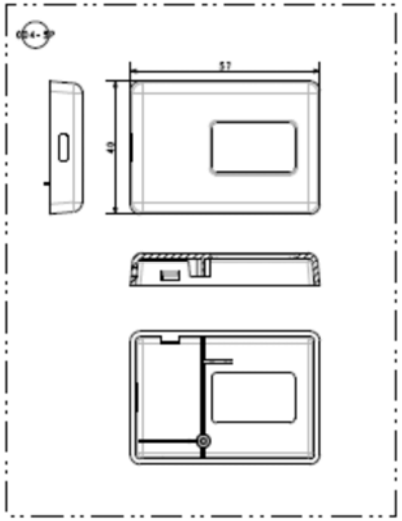
6-13. Designing and drafting part drawings

Example of core Insert part drawing

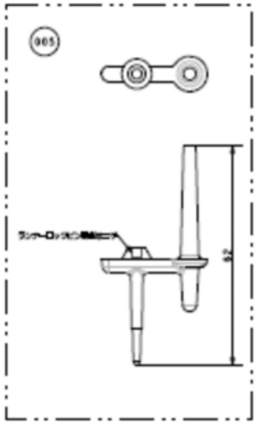


Source: Yuichi Fukushima “Designing Plastic Injection Mold”, Nikkan Kogyo Shimbun, Ltd.

6-14. Designing and drafting part drawings（Product / Mold）

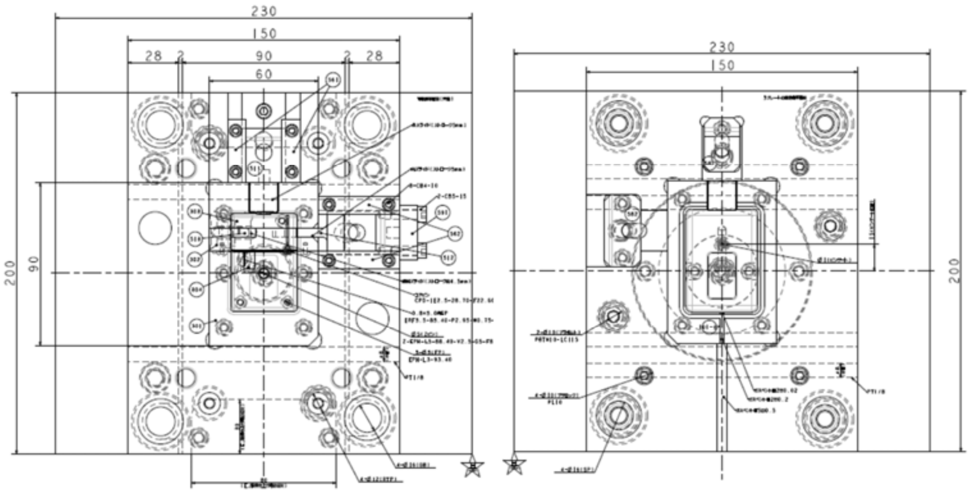


Product

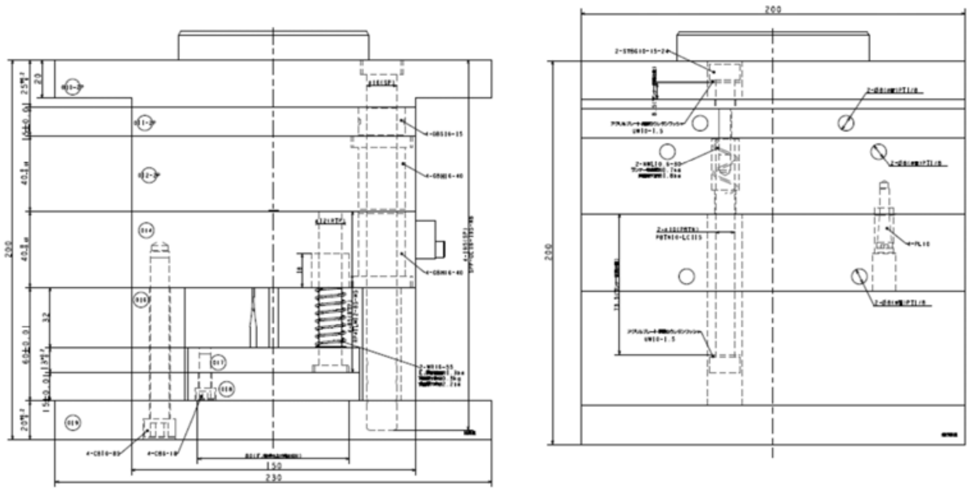


runner

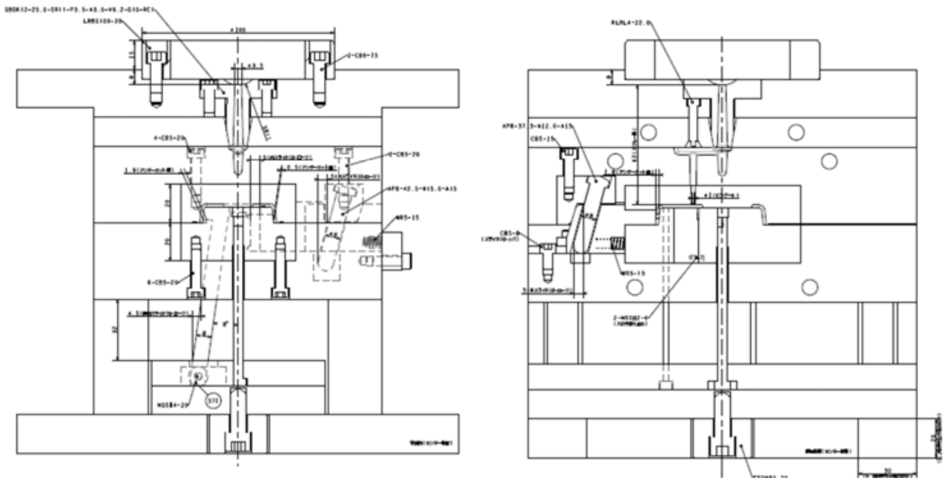
6-15. Designing and drafting part drawings（Product / Mold）



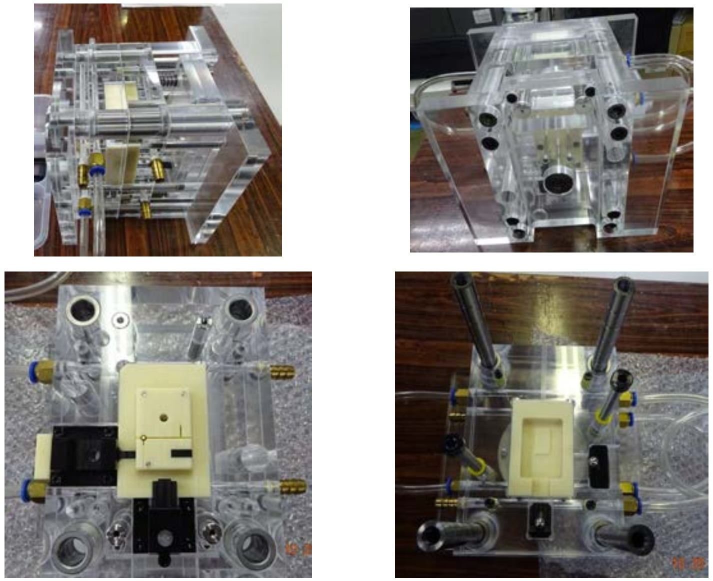
6-16. Designing and drafting part drawings（Product / Mold）



6-17. Designing and drafting part drawings（Product / Mold）



6-18. Designing and drafting part drawings（Product / Mold）



Learn about the structure and specifications of hydraulic circuits and screws from the basic structure of injection molding machines.

No-7

Injection Molding Machine

7-1. Classification of Injection Molding Machine

	Category	Typical Classification 1	Typical Classification 2	Typical Classification 3
1	Drive system	Hydraulic type	Electric type	Hybrid type
2	Clamping mechanism	Toggle	Direct pressure	Toggle +Direct pressure
3	Injection mechanism	Plunger	Pre-Plunge	Screw
4	Structure	Horizontal type	Vertical type	other

7-2. Hydraulic Type Injection Machine

Basic knowledge of hydraulic pressure ～ Pascal's principle

Regardless of the shape of the container, the fluid in the closed/airtight container transmits the pressure received at a certain point (per unit area) to all other parts of the fluid without loss

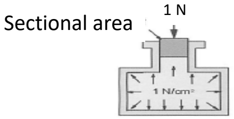
(see Figure 1).

Hydraulic devices can generate great clamping force by applying Pascal's principle.

If the force F (see Figure 2) is 10 N and A 2 / A 1 = 10 times, the force generated in A 2 is 100 N.

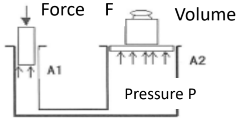
In an actual hydraulic device, a pump is the part which the force F is applied. The part A 2 corresponds to the mold clamping cylinder/the injection cylinder.

Figure 1



A force of 1 N per 1 cm ^{2} transmits on any surface of fluid inside the container

Figure 2



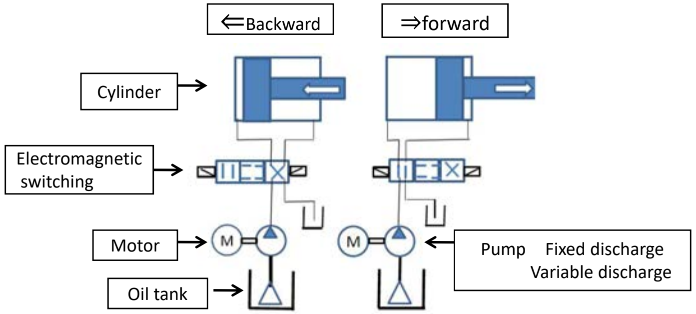
F＝10N
A2/A1＝10
V＝10N x 10＝100N

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-3. Hydraulic Type Injection Machine

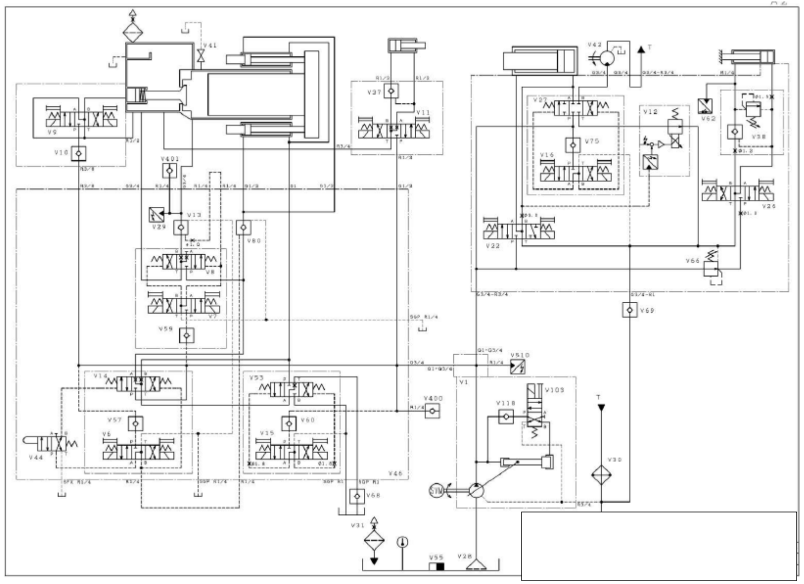
The hydraulic pump is driven by the electric motor, and sends pressure oil to each cylinder to operate each mechanism.



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-4. Hydraulic Type Injection Machine

Hydraulic circuit diagram



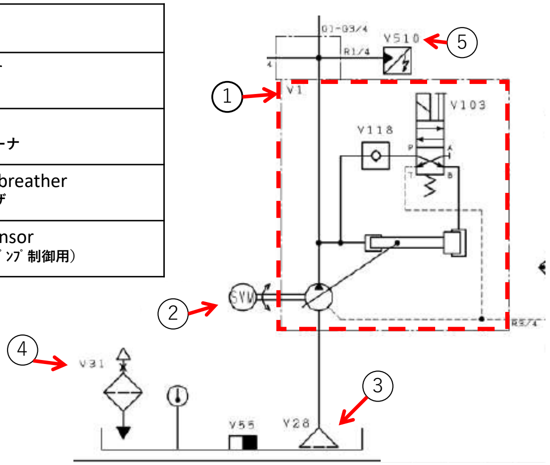
Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-5. Hydraulic Type Injection Machine

Hydraulic circuit diagram（pump）

①	V 1	**Pump** ポンプ
②	S Y V	Servomotor サーボモータ
③	V 2 8	Oil strainer オイルストレーナ
④	V 3 1	Filling port breather 給油口ブリーザ
⑤	V 5 1 0	pressure sensor 圧力センサ（ﾎﾟﾝﾌﾟ制御用）



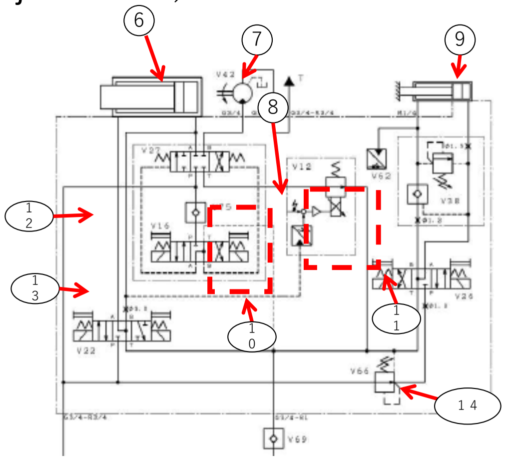
Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-6. Hydraulic Type Injection Machine

Hydraulic circuit diagram(Injection unit）

⑥		**Injection cylinder** 射出ｼﾘﾝﾀﾞｰ
⑦	V 4 2	Oil motor ｵｲﾙﾓｰﾀ
⑧	V 5 1 0	pressure switch 圧力ｽｲｯﾁ（P2）
⑨	V 2 8	Unit moving cylinder 射出装置移動ｼﾘﾝﾀﾞｰ
⑩	V 1 2	pressure regulating valve 電磁圧力調整弁。背圧
⑪	V 3 8	Pilot type check valve ﾊﾟｲﾛｯﾄ型逆止弁
⑫		Four-way selector valve 四方切換弁
⑬		Solenoid valve 電磁切換弁
⑭	V 6 6	Pressure reducing valve 減圧弁



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-7. Hydraulic Type Injection Machine

Hydraulic circuit diagram (Hydraulic safety circuit・Door valve)

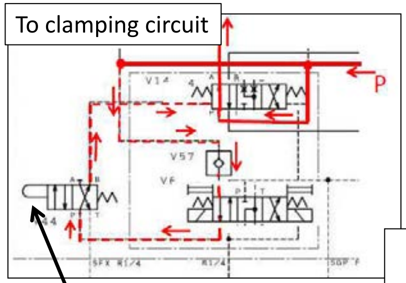
Mold clamping state

The pilot circuit conduct and the four-way selector valve operates

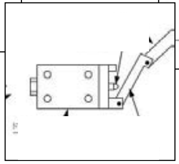
Safety door opened during Mold clamping

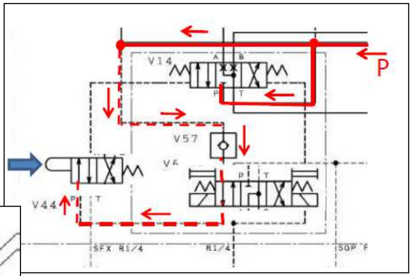
The pilot circuit is shut off by the operation of the door valve and the four-way selector valve is in the neutral state

To clamping circuit



Door valve





Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-8. Hydraulic Type Injection Machine

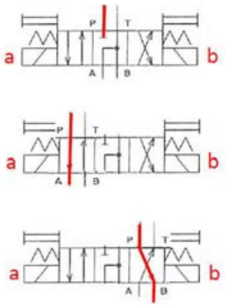
Hydraulic circuit diagram　(Solenoid valve）

Excitation and flow direction of coil
コイルの励磁と流動方向

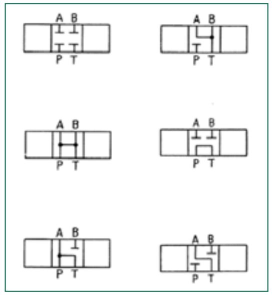
Neutral　P stop
中立　　Pｽﾄｯﾌﾟ

a Energization　P→A
a通電　　　　P→A

b Energization　P→B
b通電　P→B



Type of channel
流路の種類



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

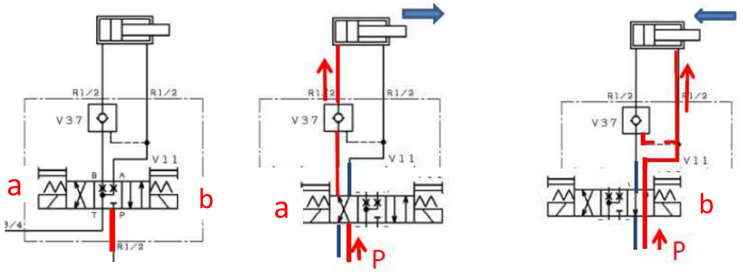
7-9. Hydraulic Type Injection Machine

Hydraulic circuit diagram　(Ejector circuit）

State of the solenoid off
ソレノイドoffの状態

The coil a is excited and Ejector forward
ｺｲﾙa　励磁し突出前進

The coil b is excited and protrudes backward
ｺｲﾙb　励磁し突出後退



P　From the pump

Why is V37 necessary?
V37が必要な理由は？

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-10. Hydraulic Type Injection Machine

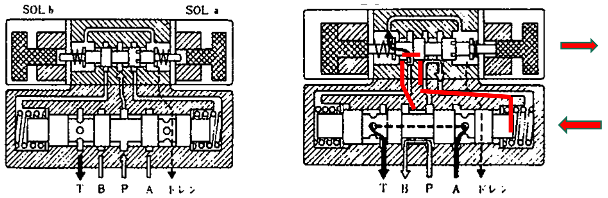
Hydraulic circuit diagram　(Four-way selector valve)

Used in combination with solenoid valve
Flow rate　Four-way valve＞Solenoid valve

Sol b Energization

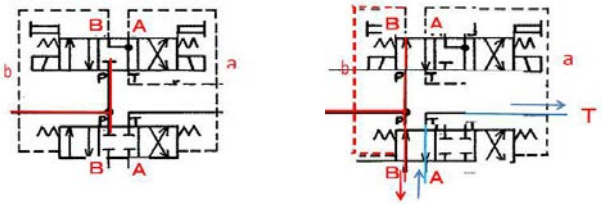
Solenoid valve

Four-way valve



Solenoid valve

Four-way valve



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

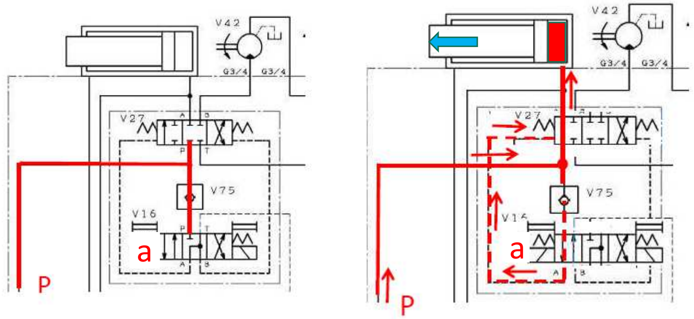
---

7-11. Hydraulic Type Injection Machine

Hydraulic circuit diagram　(　Injection prosess　)

State of the solenoid off
ソレノイドoffの状態

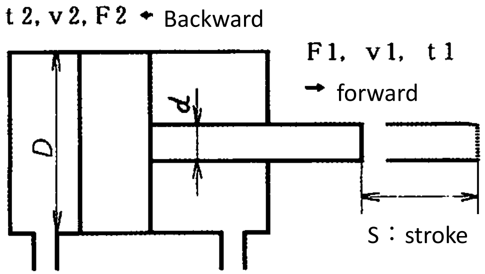
The coil a is excited and the injection Forward
ｺｲﾙa　励磁し射出前進



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-12. Hydraulic Type Injection Machine

Relationship between force and speed of hydraulic cylinder
油圧ｼﾘﾝﾀﾞ の力と速度の関係



There are two methods of increasing the force, increasing the pressure or increasing the area.
大きな力を出すためには、圧力を高くするか、面積を大き出くするかの２つの方法がある。

The speed becomes slower when the cylinder area is increased, and the speed becomes faster when the cylinder area is made smaller
シリンダ面積を大きくすると速度は遅くなり、小さくすると速度は速くなる

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-13. Hydraulic Type Injection Machine

Relationship between force and speed of hydraulic cylinder
油圧ｼﾘﾝﾀﾞ の力と速度の関係

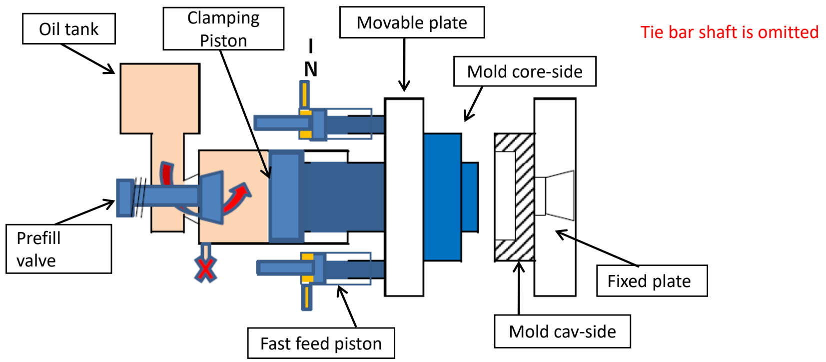
	forward	Backward
force (kgf)	$F1 = P \times \frac{\pi D^2}{4}$	$F2 = P \times \frac{\pi (D^2 - d^2)}{4}$
velocity (cm/sec)	$V1 = \frac{Q}{\frac{\pi D^2}{4}}$	$V2 = \frac{Q}{\frac{\pi (D^2 - d^2)}{4}}$
time (sec)	$t1 = \frac{S}{V1}$	$t2 = \frac{S}{V2}$
	D：Outer diameter of rod(cm） d ：Inner diameter of cylinder（cm） 1kgf=9.8N ＊ 1kgf/cm^2= 0.098Mpa P： hydraulic pressure (kgf/cm^2) ＊ 1ℓ ＝ 1000 cm^3 Q：Flow rate (cm^3/sec) S：stroke (cm)	

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-14. Mold clamping mechanism: Hydraulic type direct pressure method

When pressure oil is sent to the fast feed piston, the movable platen moves to the fixed platen side. At that time, the prefill valve is opened and the hydraulic fluid in the oil tank moves to the mold clamping cylinder side



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

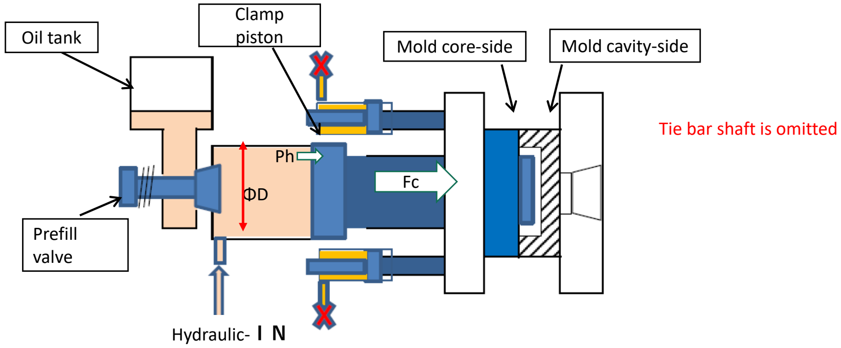
---

7-15. Mold clamping mechanism: Hydraulic type direct pressure method

When mold closing is completed, the prefill valve is closed and pressure oil is sent to the mold clamping cylinder, causing clamping force.

Clamping force (Fc)＝ A x Ph ＝πD² ・Ph/4

（Please note: A＝Piston projected area）

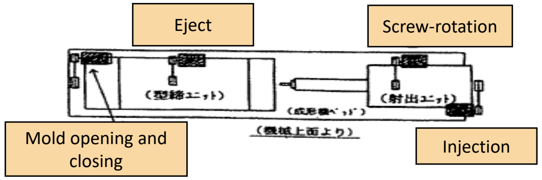


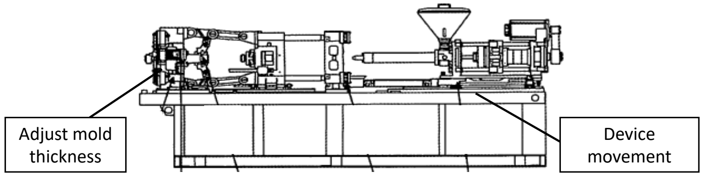
Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-16. Electric type Injection-machine

Servomotor is used for each drive section.

e.g. Four servomotors are applied in following figure



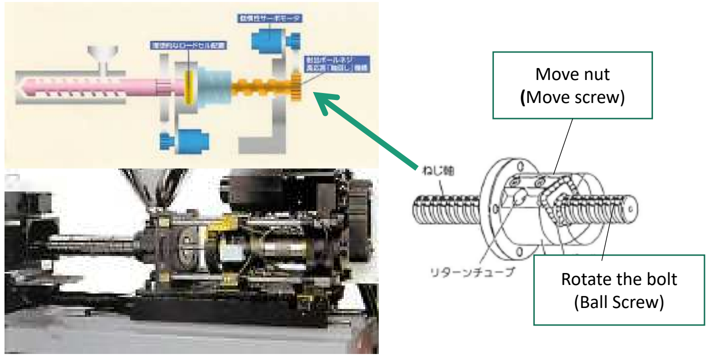


Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-17. Electric type Injection-machine

Ball screw rotation provides screw movement

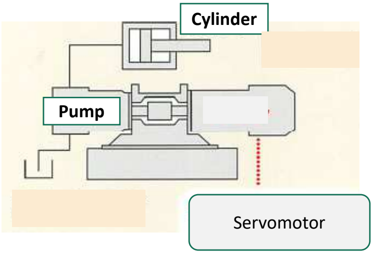


Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-18. Hydraulic hybrid specification

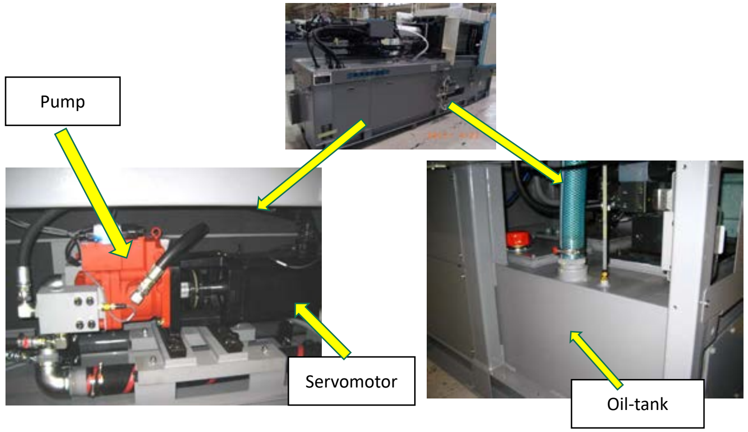
In the hybrid type, the servomotor rotates when it is necessary. The rotation speed controls the flow rate while the torque control manages the pressure.



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

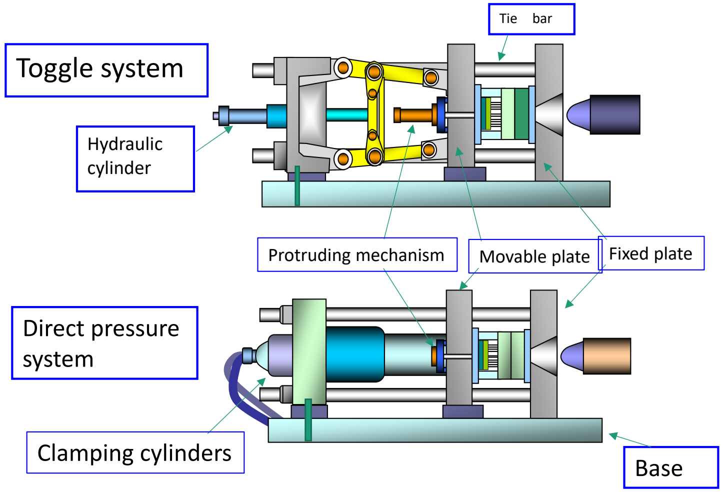
7-19. Hydraulic hybrid specification: Hydraulic Servomotor・Pump



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-20. Mold clamping mechanism

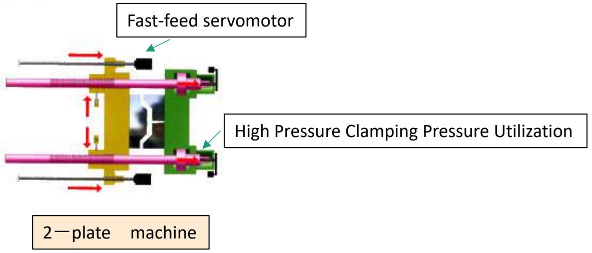
Toggle system and direct pressure system



7-21. Combined mold clamping mechanism: Servomotor + Hydraulic

Integration of mold opening /closing by servo motor drive and hydraulic high pressure mold clamping

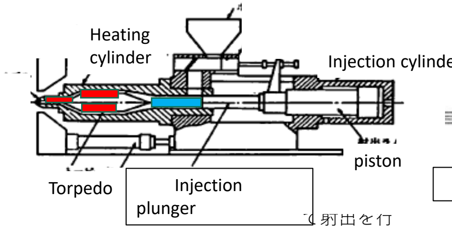
Mold clamping force	**12700 KN （1300Tonf）**
Injection capacity	Φ115 6040g （PS）
Injection pressure	180MPa



Reference: Website of TOSHIBA MACHINE CO., LTD., www.toshiba-machine.co.jp/jp/product

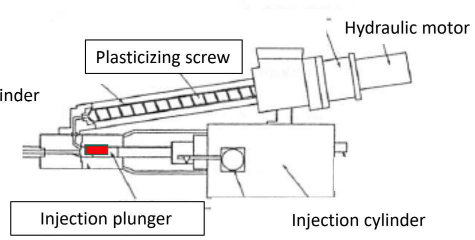
7-22. Classification by injection device：

<u>Plunger type injection molding machine</u>



<u>Plasticization, Injection→ Plunger</u>

<u>Screw pre-plasticizing injection molding machine</u>



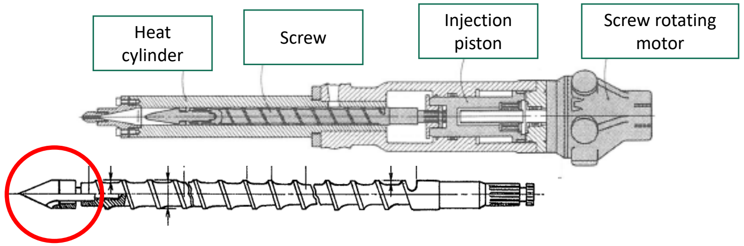
<u>Plasticization→Screw, Injection → Plunger</u>

Reference: Website of Sodick Co., Ltd., www.sodick.co.jp

7-23. Injection device : Screw

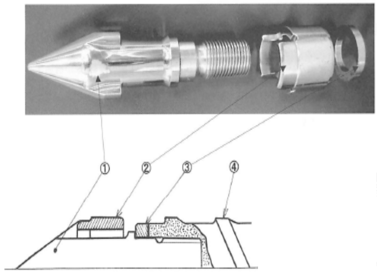
1) Injection mechanism of plasticizing the molding material with the screw and injecting by moving the screw forward. Currently, the majority of molding machines are inline screw type (First-in First-out).

<u>Plasticization, Injection→Screw</u>

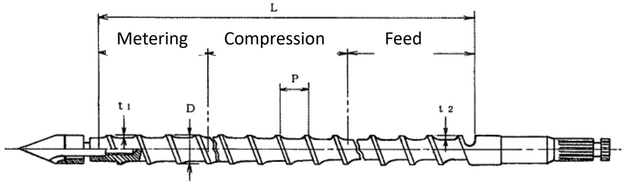


Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-24. Injection device : Screw



①	Torpedo
②	Ring valve
③	Seat rings
④	Screw body



L／D

P／D

Screw effective length =t_2／t_1

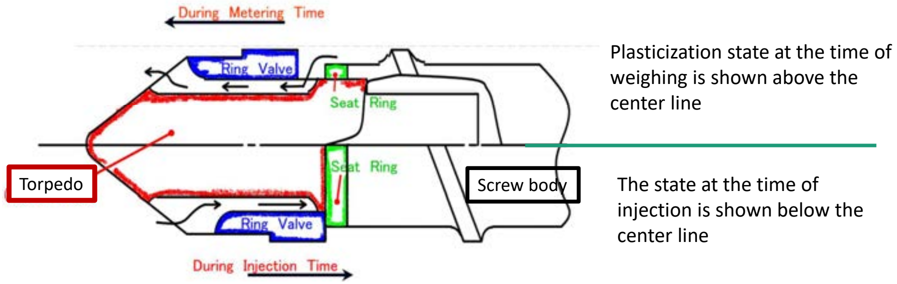
L = Screw effective length

D = Screw diameter

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

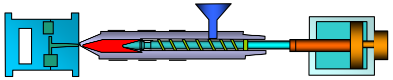
7-25. Screw tip part

If the backflow prevention function deteriorates, troubles such as short shot or resin burning occur.



Plasticization state at the time of weighing is shown above the center line

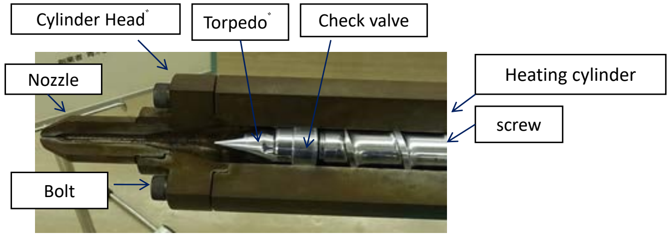
The state at the time of injection is shown below the center line



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-26. Screw tip part

Cross section of inline screw structure

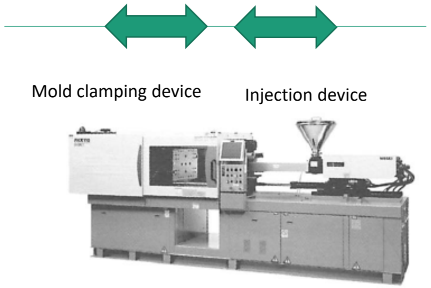


Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-27. Classification of molding machines by configuration

Horizontal type

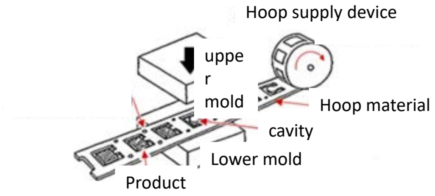
1. The injection device and the mold clamping device are arranged on a horizontal straight line.
2. Molded parts can fall automatically or can automatically be taken out by using the a takeout-machine. The horizontal type is more common.



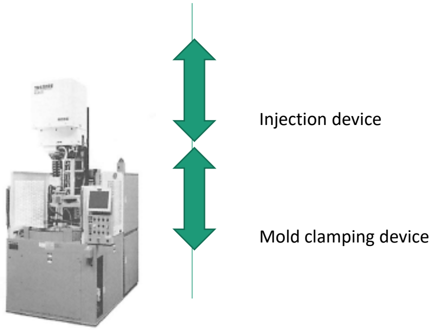
Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-28. Classification of molding machines by configuration Vertical type

1. The mold opens and closes vertically.
2. Easy and stable metal insert work.
3. Suitable for long hoop molding.
4. Machine installation requires less space, comparing with a horizontal type.



Reference: Website of MISUMI Group Inc., www.misumi.co.jp

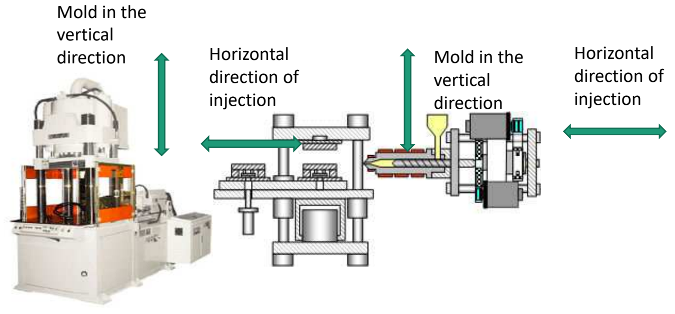


Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-29. Classification of molding machines by configuration

Molding machines of various specifications are produced according to the production method.



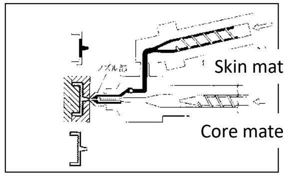
Reference: Website of Direct Industry, www.directindustry.com

Reference: Website of Sanjo Seiki Co., Ltd., www.sanjo.co.jp

7-30. Special molding machine

1. Two-color molding machine
2. Multi-color molding machine
3. Etc.

Molding of same material Same color / different color	Different material molding Use compatibility



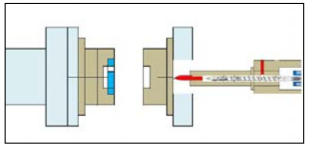
Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

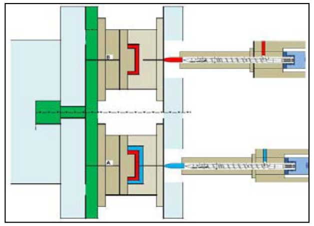
7-31. Special molding machine

2 color molded item

1. Two color molding by insert method

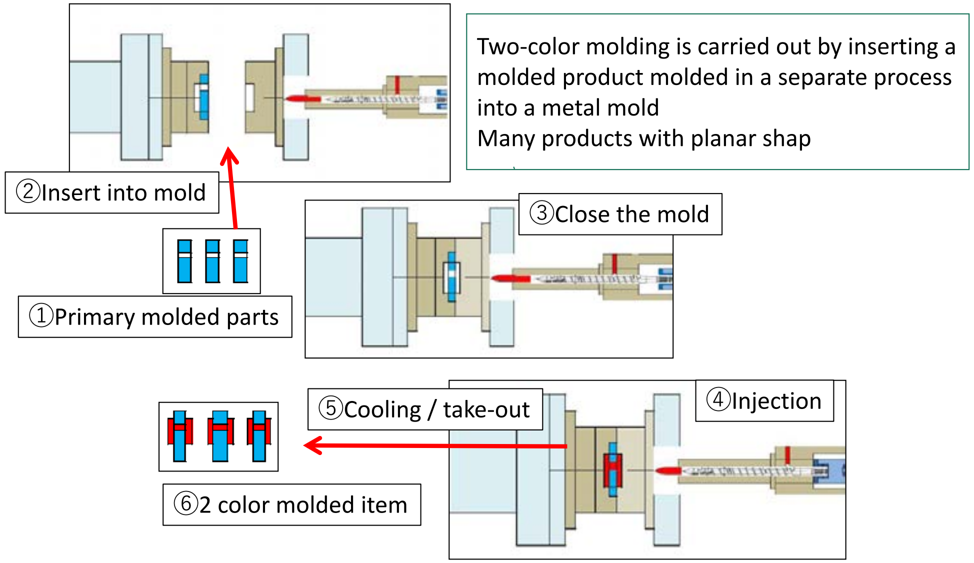


2. Two-color molding with two-color molding machine



7-32. Special molding machine

1． Two color molding by insert method



Two-color molding is carried out by inserting a molded product molded in a separate process into a metal mold
Many products with planar shap

②Insert into mold

①Primary molded parts

③Close the mold

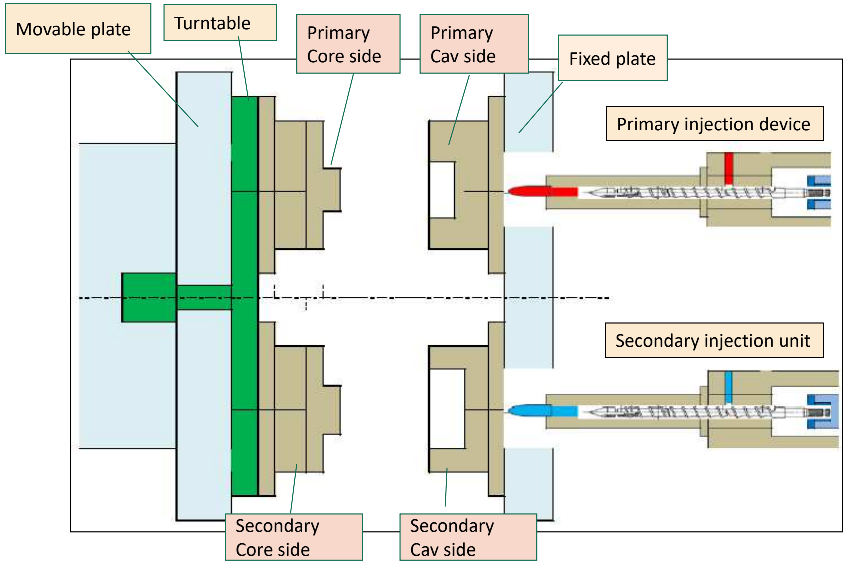
④Injection

⑤Cooling / take-out

⑥2 color molded item

7-33. Special molding machine

2. color Injection molding machine



Movable plate

Turntable

Primary Core side

Primary Cav side

Fixed plate

Primary injection device

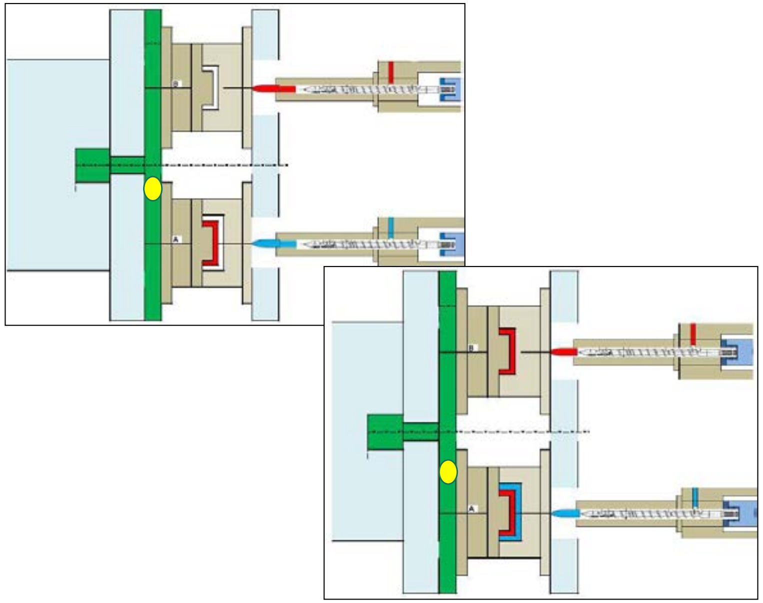
Secondary injection unit

Secondary Core side

Secondary Cav side

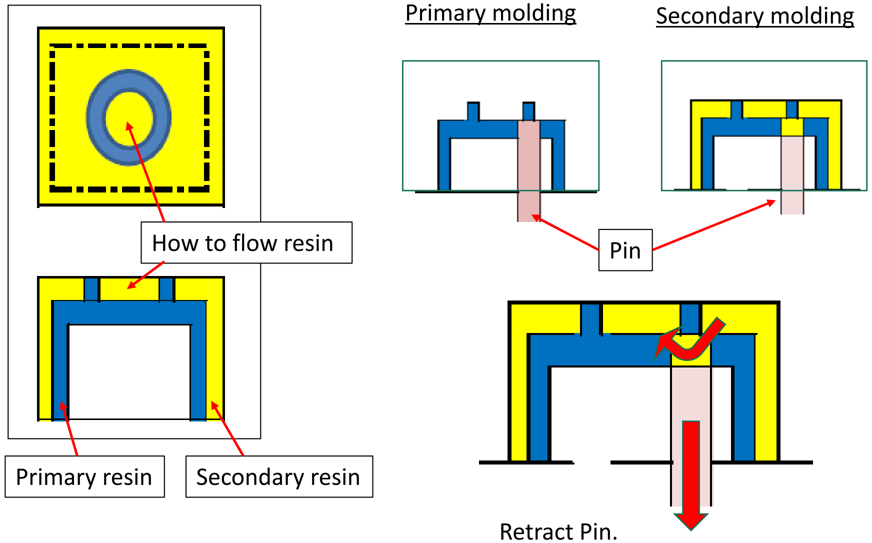
7-34. Special molding machine

2 .color Injection molding machine



7-35. Special molding machine

2. color Injection mold



How to flow resin

Primary resin

Secondary resin

Primary molding

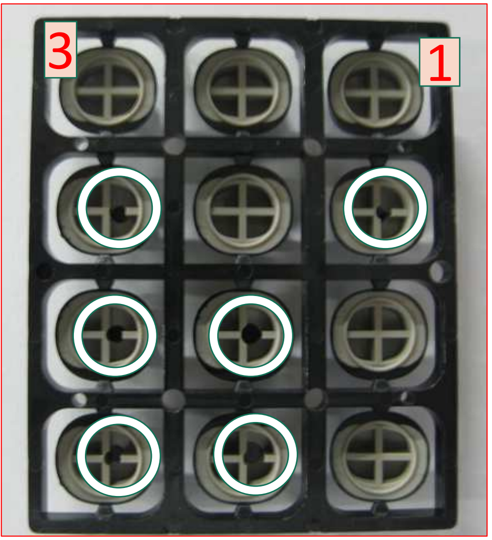
Secondary molding

Pin

Retract Pin.
To form a flow path

7-36. Special molding machine

2 .color Injection mold　（The numbers）



7-37. Molding machine specification-1　ZE3600 (Example)

①	Mold clamping force	KN(tonf)	3600(360)
②	Clamping stroke	mm	700
③	Mold thickness (min)	mm	250
④	Mold thickness (max)	mm	710
⑤	Mold open Daylight(max)	mm	1410
⑥	Tie bar interval　(H x V)	mm	820x820
⑦	Minimum mold size　(H x V)	mm	540x540
⑧	Locate ring diameter	mm	200
⑨	Ejection stroke	mm	160
⑩	Distance at the nozzle	mm	50
⑪	Machine size (L x W x H)	m	7.92x2.1x2.44
⑫	Pump pressure (max)	MPa	14

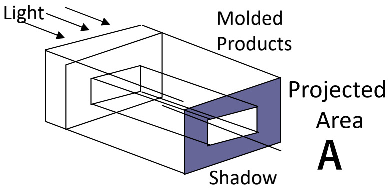
（1MPa＝10bar＝10.2　kg/cm², 　1KN＝0.102　Ton ｆ）

7-38. Why is clamping force required?

Ｆｃ　≧　Ｐm　x　Ａ　x　1.25
Ｆｏ＝Pm　ｘ　A

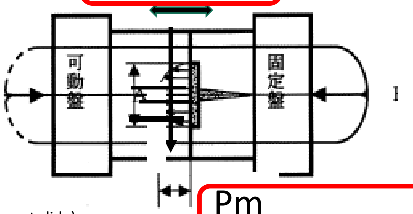
A　Projected Area

The area of the molded product surface which contacts the gate. If light is applied on a molded product from the mold clamping direction, the area of the shadowed surface is a projected area (see figure at the right side)



Fo
Force to open the mold

Fc
Clamping force



Pm
Average mold internal pressure

Fc＜Fo

Fc＞Fo

(For definition of Fo, see the next slide)

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-39. The number of cavities in a mold and required mold clamping force

1. Mold Internal Resin Pressure generates force (Fo) to open P/L surface. When the mold PL surface opens, resin leak (flash/burr) occurs.
   Fo　→Force which changes according to injection conditions

2. Mold clamping force (Fc) should be bigger than the product force (in-mold resin pressure　multiplied by the projected area).　Fc　→ Settings can force

Fc ＜ Fo

Fc ＞Fo

Mold opening force
Force to open the mold

7-40. The number of cavities in a mold and required mold clamping force

A＝25cm²
Pm＝400kg/cm²

1cav
w＝25 g

Practice Question-22

Product		Required Force to open the mold **Fo**	Required injection amount **W**	Required molding machine specification
Mold A 1cav	🟩	( ) **Tonf**	( ) **g**	Clamping force 12.5tonf or more Injection volume 35g/shot or more
Mold B 4cav	🟩🟩 🟩🟩	Force to open the mold ( ) **Tonf**	( ) **g**	Clamping force 50tonf or more Injection volume 143g/shot or more

A＝projected area
Pm＝Average internal pressure
w＝Product weight

70% or less of the injection volume

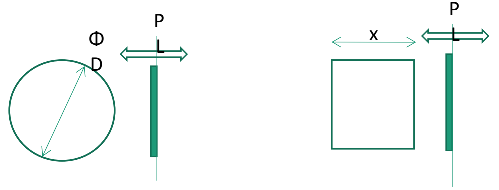
- $Fc \geqq Pm \times A \times 1.25$
- $Fo = Pm \times A$

7-41. Projected area and mold clamping force (Fc)

Practice Question-23

What is the projected area that can be molded by a molding machine with a mold clamping force (Fc) of 80 tons?

Calculated at inside pressure of 450 kg / cm ²



Circle shape

ϕD＝

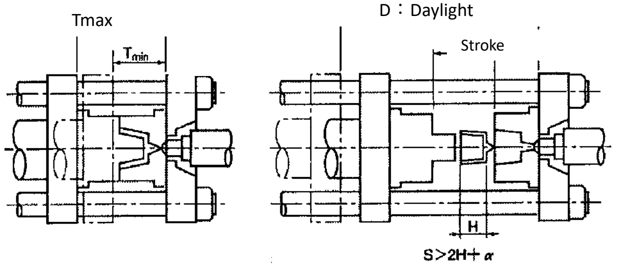
Square shape

X＝

7-42. Major Specifications of Injection Molding Machine-1

Mold thickness · Mold clamping stroke (S) · Maximum mold opening distance (D)

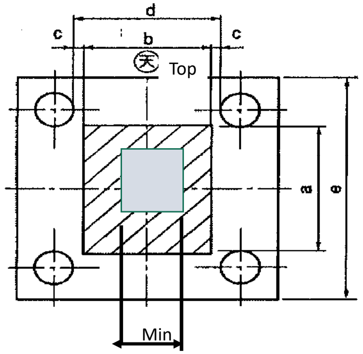
Tmax〔Mold thickness (max)〕
Tmin〔Mold thickness (min)〕



Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.62-63, NIKKAN KOGYO SHIMBUN,LTD.

7-43. Major Specifications of Injection Molding Machine-2

Tie bar interval (d), Mold type width (b)



Clamping force	＜200ᵗ	200ᵗ＜
$d-b_{max}$	10ᵐᵐ	20ᵐᵐ
C_{min}	5ᵐᵐ	10ᵐᵐ
a_{max}	e	

Reference: Yuichi Fukushima, (2002) Mold Design for Plastic Injection Molding, p.62-63, NIKKAN KOGYO SHIMBUN,LTD.

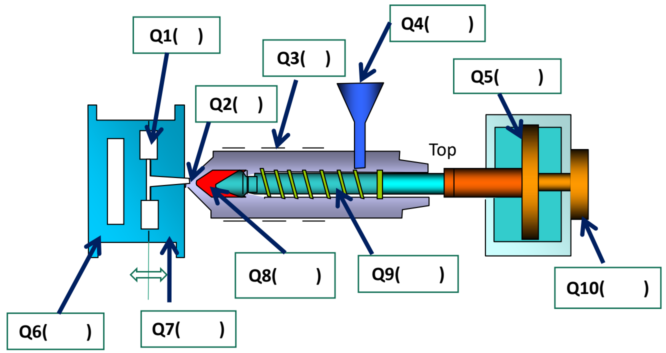
7-44. Main Specifications of Injection Molding Machine-3

Model name		ZE3600（3600KN≒367tonf） 1KN＝0.1019tonf			MA1600
Injection unit		1400			540
Screw diameter	mm	55	60	65	45
Screw L/D		21.8	20	18.5	
Injection volume	cm^3	617	735	863	320
Injection pressure	MPa	214	180	153	169
1MPa＝10bar＝10.197kgf/cm^2	bar	2140	1800	1530	1690
	kg/cm^2	2182	1835	1560	1723
Injection rate	g/sec	346	411	483	148
Injection speed	mm/sec	160			93
Pump pressure（max）	MPa	14 (142.7 kg/cm^2)			

7-45. Name of injection device

Practice Question-24

Please choose the name of each device from the right column and answer by number

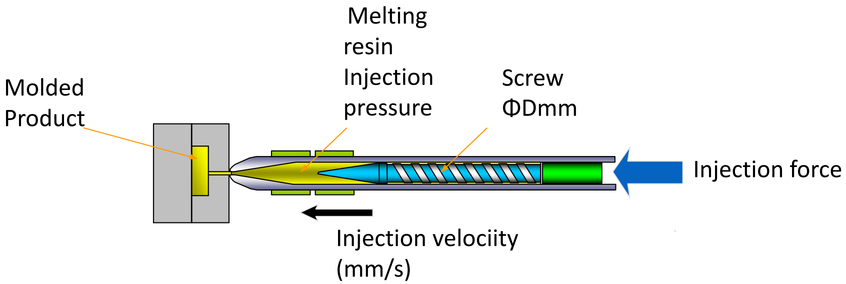


①	Melted material
②	Heater
③	Injection Piston
④	Screw
⑤	Cavity
⑥	Nozzle
⑦	Rotary motor
⑧	Hopper
⑨	Fixed side
⑩	Movable side

7-46. Major Specifications of Injection Molding Machine-4

- ➢Injection pressure (MPa (kgf/cm^2))
- ➢Injection rate (cm^3/s)

＝Screw cross section x Injection velocity



Melting resin

Injection pressure

Screw ΦDmm

Molded Product

Injection force

Injection velociity (mm/s)

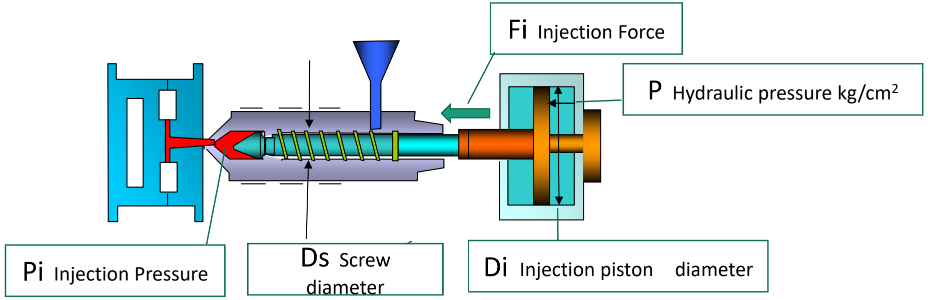
7-47. Major Specifications of Injection Molding Machine-5

$$射出力(Fi)＝\frac{\pi Di^2}{4} \times P \ (kgf／cm^2)$$

(Injection Force)

$$射出圧力(Pi)＝\frac{Di^2}{Ds^2} \times P \ (kgf／cm^2)$$

(injection pressure)



Fi Injection Force

P Hydraulic pressure kg/cm^2

Pi Injection Pressure

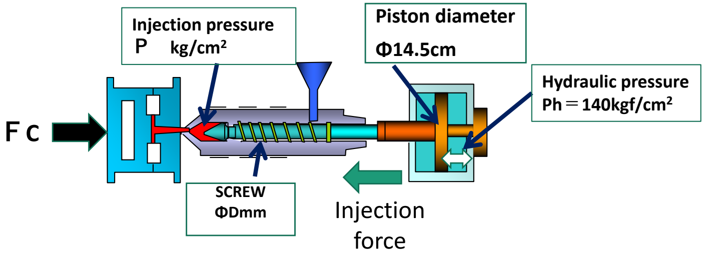
Ds Screw diameter

Di Injection piston diameter

7-48. How to calculate injection pressure

1. Calculate from following information: Injection cylinder piston diameter: Φ 14.5 cm
   Hydraulic pressure: Ph $= 140$ kgf / cm ^{2}
   Screw diameter: Φ 36 mm
2. Injection force $= \pi \times 14.5^2 \times 140/4$
3. Injection pressure (P)
   The value obtained by dividing the injection force by the screw cross-sectional area.

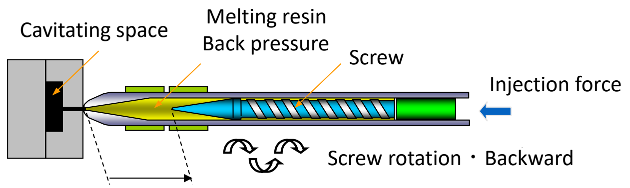
Injection pressure (P) $= (\pi \times 14.5^2 \times 140/4) / (\pi \times 3.6^2/4)$
$= 14.5^2 \times 140 / 3.6^2$
$= 2270$ kgｆ/cm ^{2}



7-49. Major Specifications of Injection Molding Machine-6

- Injection volume (cm ^{3}) ＝ Screw movement length x Screw cross section
- Plasticizing ability (kg/h): Weight of plasticizable resin per hour

The calculation criterion in PS is a value obtained by dividing the total resin mass by the total screw rotation time, when purging ten times at a resin temperature of 210 ℃. or more, with 50% stroke.

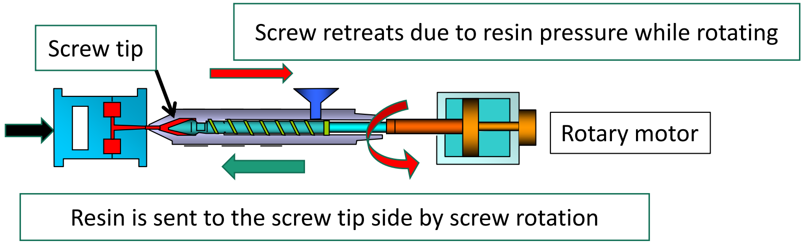


Screw movement length (L)＝Residual resin length (Lc)＋ Injection stroke length (Li)
(Cushion resin length) (Weighing stroke)

7-50. Why does screw move backward?

1. Resin sent by screw rotation is molten/plasticized and moves to the screw tip.
2. The pressure generated by resin at the screw tip pushes the screw. (back pressure setting required)

When the supply material runs out, no resin is sent to the tip. Therefore, the screw stops retreating.



7-51. Why does resin melt?

1. Feed

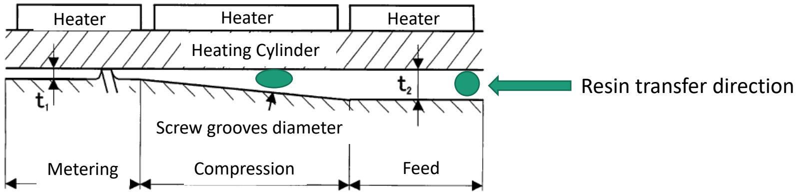
Resin dropped from the hopper is softened due to shearing by the screw rotation and due to heating, to be sent to the compression part.

2. Compression

Resin that receives volume compression melts by shearing and heating to be mixed.
It is then sent to the metering section.

3. Metering

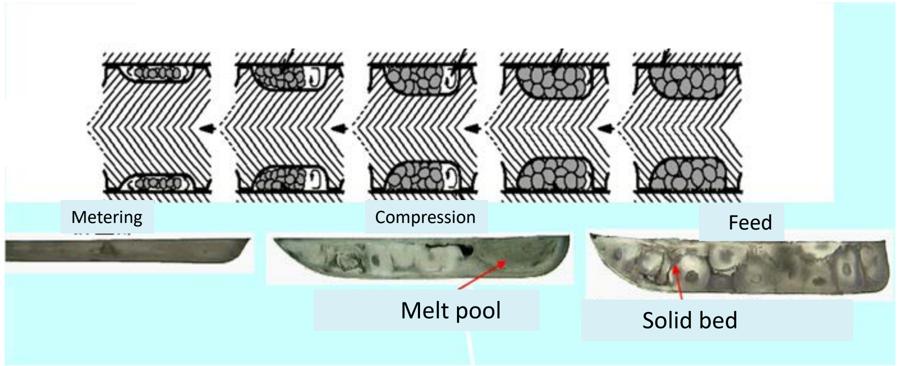
Melted resin sent to the Metering is further mixed to be homogenized. It is then sent to the screw tip.



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

7-52. Why does resin melt?

Observation of molten state in heating cylinder



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-53. Why does resin melt?

Change in molding conditions and resin temperature

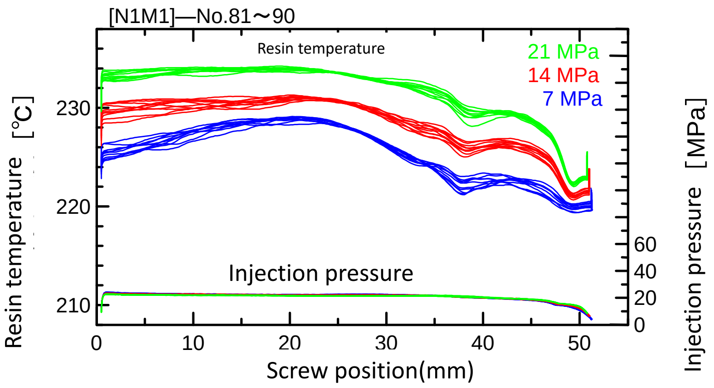
	Resin temperature 樹脂温度	Variation in temprerature 樹脂温度のバラつき
Screw rotation speed スクリュ回転速度 低 Low	⬇	⬇
Screw back pressure スクリュ背圧 高 Hight	⬆	⬇
Heating cylinder temperature 加熱筒温度 高 Hight	⬆	⬇
Molding cycle 成形サイクル 短 short	⬇	⬆

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

7-54. Why does resin melt?

Change in molding conditions and resin temperature



Influence of back pressure
7MPa,14MPa,21MPa

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

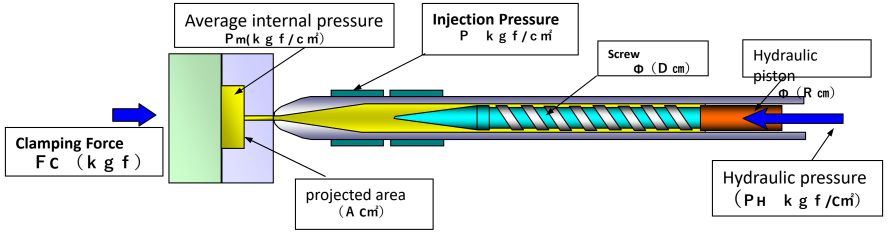
7-55. H-PVC exclusive Injection molding machine

Since shearing heat during plasticization is over-generated, the temperature rises to above the cylinder set temperature ➡ Temperature control by forced cooling

Cooling fan

7-56. Clamping process

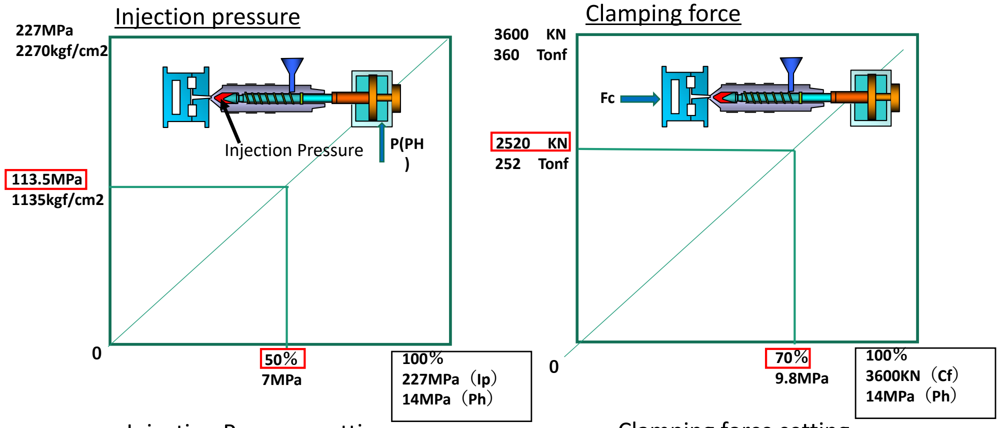
1. It is necessary to set the mold clamping force so that it does not lose the product of the product area of the product and the resin pressure inside the mold.
2. The pressure of the resin in the mold depends on the molding conditions, kind of the resin, and the product wall thickness. Estimate the resin pressure inside the mold and obtain the required mold clamping force



Injection Pressure $P\ (kgf) = P_H\ (kgf/cm^2) \times (R^2\,cm \div D^2 cm)$

Clamping Force $F_C\ (kgf) \geqq P_m\ (kgf/cm^2) \times A\ cm^2 \times 1.25$

7-57. In the case of a molding machine set with %, it is important to know the maximum ability (force, pressure, speed)



Injection Pressure setting

Clamping force setting

＊Knowing the unit of the set value→％,MPa,KN,bar、 etc

7-58. Injection pressure and mold internal pressure

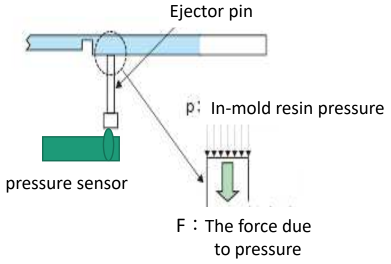
It is difficult to calculate the internal pressure of the cavity because the type of resin, the structure/dimensions of the mold closing part, the shape and conditions of the cavity, etc. differ greatly.

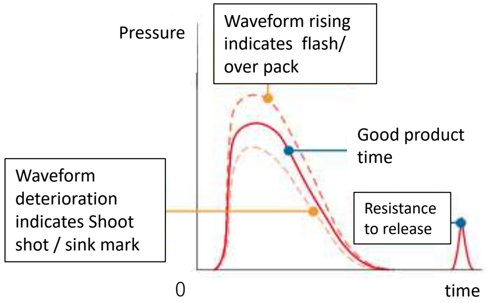
However, in general the loss of injection pressure in the cavity is about 30 to 50% It is said that there is

Setting

Resinas	Resin temperature ℃	. Injection pressure kg/cm²	Internal pressure of the cavity kg/cm²
ＰＥ	180～300	600～1400	230～320
ＰＰ	200～300	600～1400	220～320
ＰＳ	180～315	700～1700	260～320
ＰＣ	280～320	800～1500	270～300
ＡＢＳ	200～280	700～1500	330～440
ＰＡ	230～300	800～1500	240～450

7-59. Measuring system of mold internal pressure





Reference: Website of Futaba Electronics Industry Co., Ltd., www.futaba.co.jp/product

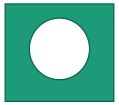
7-60. Required mold clamping force calculation

Practice Question-25

Calculate the necessary clamping force of the mold

Product A:
External Diameter: ϕ55mm
Internal Diameter: ϕ15mm

Product B:
Exterior Dimensions: 55mm x 55mm
Internal Diameter : ϕ15mm



Products: the number of cavities	Interior pressure of the cavity	Mold clamping force required (Tonf)
Product A: 2 cavities	PC 300kgf/cm^2	
Product A: 4 cavities	PA 450kgf/cm^2	
Product B: 2 cavities	PS 320kgf/cm^2	
Product B: 4 cavities	ABS 440kgf/cm^2	

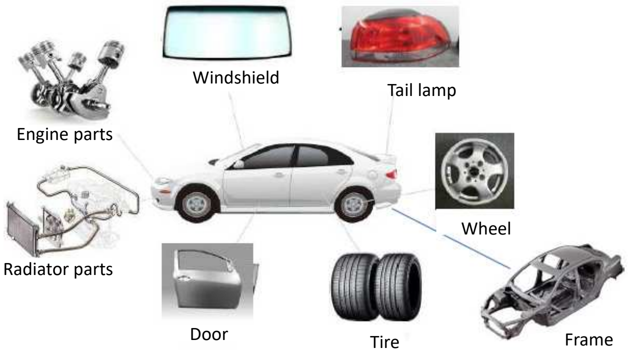
Learn an overview of plastic products used in the automotive industry

No-8

Automobile Parts

8-1. Three major materials constituting automobile parts (Iron · aluminum · plastic）

Metal material (**iron** · **aluminum**)
Non-metal material (ceramic, rubber, **plastic**)



8-2. Three major materials constituting automobile parts (Iron · Aluminum · Plastic)

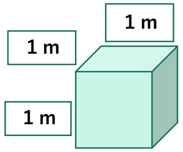
Iron (Steel)-Steel plate・Special steel・Cast steel

1. The steel plate is used the most and accounts for 40% of total weight.
2. Special steels are used for each unit of main components such as engine, drive and chassis, accounting for about 17%.
3. Cast steel is used less due to lightening such as aluminization of cylinder block.
（specific gravity Fe 7.8 、AL 2.68 ≒ 1/3 ）

Body Frame
Steel plate

Engine parts
Special steel

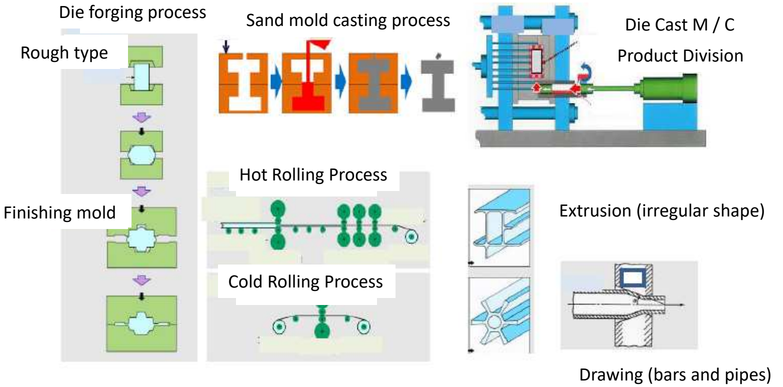
Cylinder block
Cast steel/ **aluminum**



1m x 1m x 1m
Fe=7.8Tonf
AL=2.68Tonf
H^2O= ？ Tonf

8-3. Three major materials constituting automobile parts (Iron · aluminum · plastic)

Aluminum processing method


Die forging process

Rough type

Finishing mold

Sand mold casting process

Die Cast M / C

Product Division

Hot Rolling Process

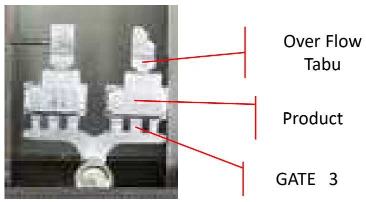
Cold Rolling Process

Extrusion (irregular shape)

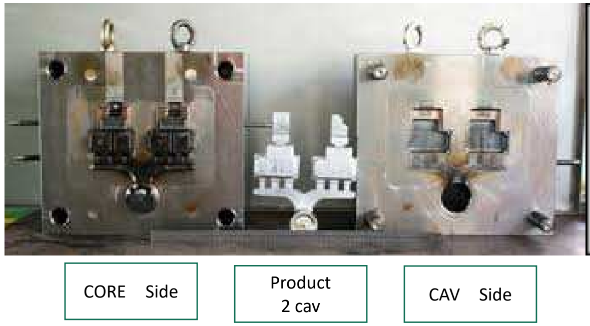
Drawing (bars and pipes)

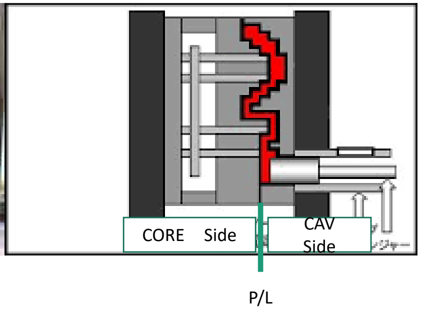
Source: Website of Japan Aluminum Association

8-4. Aluminum (AL) die casting



AL Melting temperature **660℃**





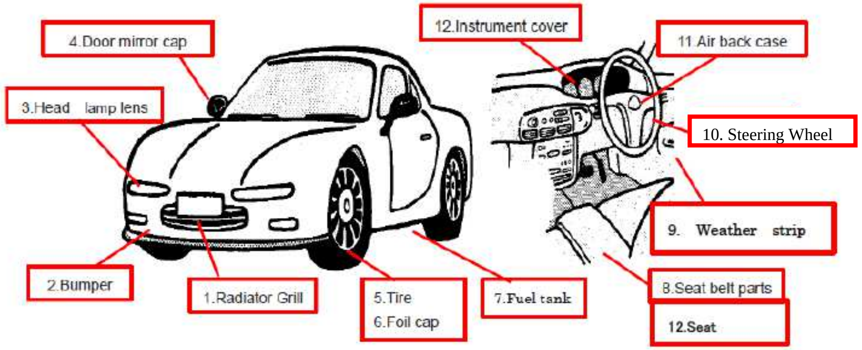
8-5. Three major materials constituting automobile parts (Iron · aluminum · plastic）

Examples of plastic auto parts

Used parts / materials are different depending on manufacturer, vehicle type, etc.

8-6. Molding of automobile plastic parts

Plastic Auto Parts (Example)



Used parts / materials are different depending on manufacturer, vehicle type, etc.

8-7. Molding of automobile plastic parts

Automobile parts and materials used (Example)

	Parts name	Materials	Feature
1	Radiator Grill	ABS	Plating
2	Bumper	PP (EPP*)	Painting
3	Head lamp lens	PC	Weatherability
4	Door mirror cap	PA	Painting
5	Tire	SBR	Compression molding
6	Wheel cap	ABS	Plating
7	Fuel tank	HDPE	Multilayer blow
8	Seat belt parts	PBT	
9	weather strip	TPE	Extrusion molding
1 0	Steering Wheel	ABS	Metal insert molding
1 1	Air back case	TPE	
1 2	Seat	UPR	Foam molding

*Expanded Polypropylene

Used parts / materials are different depending on manufacturer, vehicle type, etc.

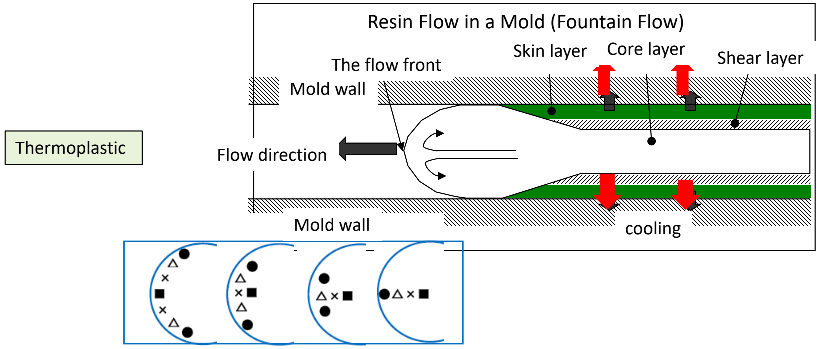
Learn about resin flow in molds

No-9

Resin Flow in Mold

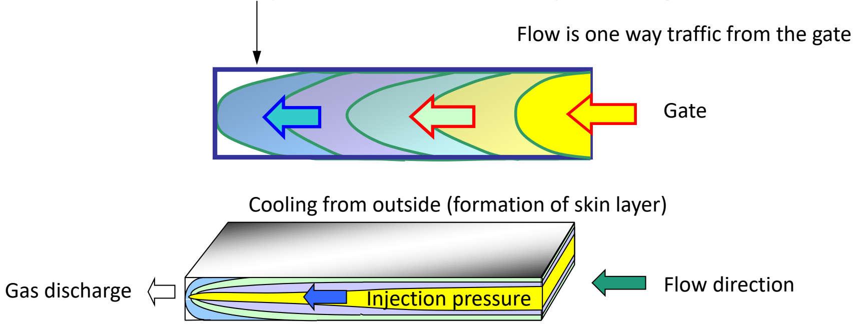
9-1. Resin flow in a mold -1

Heated resin becomes the flow condition and injected into the mold. Resin contacting both wall surfaces of the mold cools down and solidifies while the resin flow advances in the mold. The filling is completed by repeating this process.

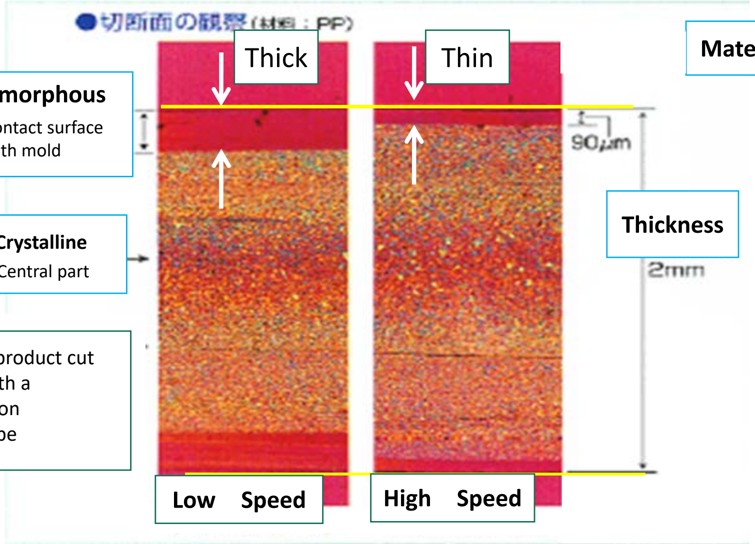


9-2. Resin flow in a mold -2 (Change in flow of resin in mold)

As the resin temperature decreases, the viscosity increases while the flow velocity slows down.
Thus, it is necessary to increase the injection pressure.



9-3. Resin flow in mold-3 (Observation of resin)



Material PP

Amorphous
Contact surface with mold

Crystalline
Central part

Thickness

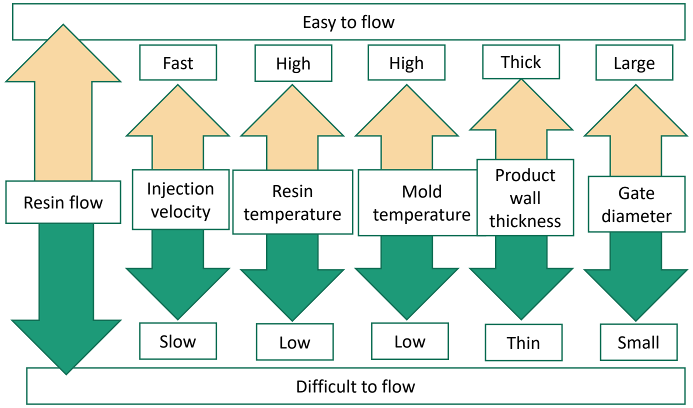
Observe product cut pieces with a polarization microscope

Reference:Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

9-4. Resin flow in mold-4
(Relationship between resin flowability and factors)

Example of how to read following figure:
Increasing resin temperature and/or mold temperature improves resin flow



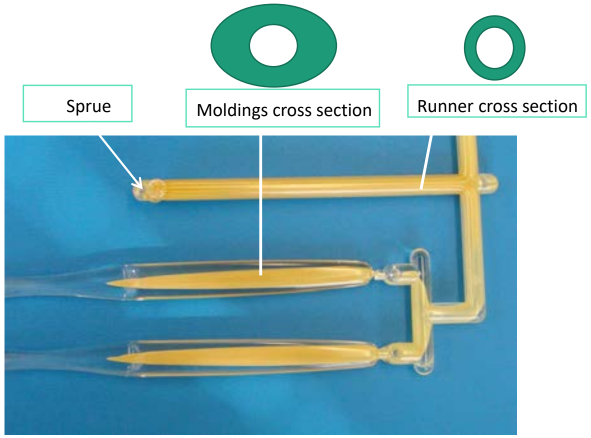
Easy to flow

Fast — Injection velocity — Slow
High — Resin temperature — Low
High — Mold temperature — Low
Thick — Product wall thickness — Thin
Large — Gate diameter — Small

Resin flow

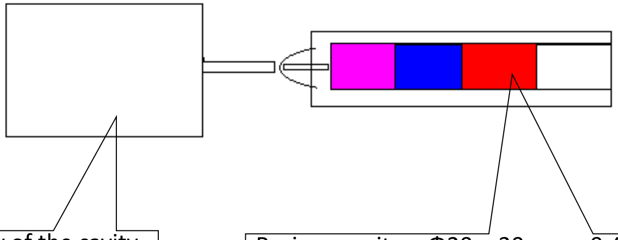
Difficult to flow

9-5. Resin flow in mold-3



Reference: NISSEI School Textbook

9-6. Resin flow in mold-8
(Schematic diagram of resin flow in mold)



Capacity of the cavity
28.26 cc

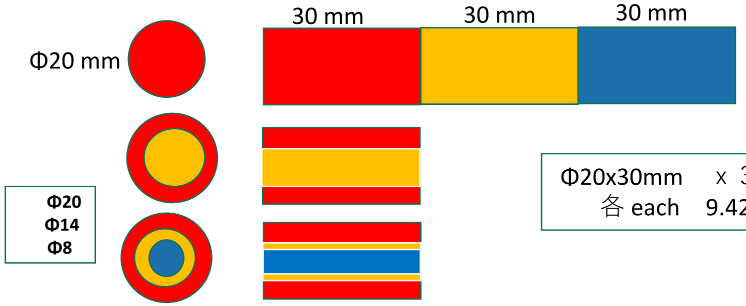
Resin capacity Φ20 x 30mm＝9.42cc
Total 9.42 x 3＝28.26 cc

9-7. Resin flow in mold-3

Practice Question-26

Φ20の金型内に3色を順番に流した場合の流動長さを考えなさい。ただし2色目（黄色）はΦ14、3色目（青色）はΦ８とする

Consider the flow length when three colors are flowed in order in the mold of Φ20. However, it is assumed that the second color (yellow) is Φ 14 and the third color (blue color) is Φ 8



30 mm

30 mm

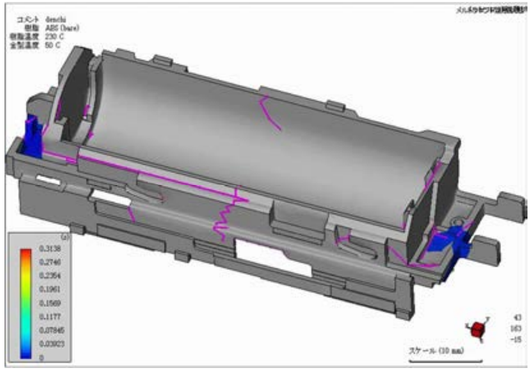
30 mm

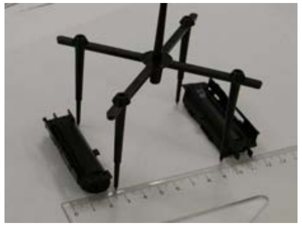
Φ20 mm

Φ20
Φ14
Φ8

Φ20x30mm　x ３color
各 each　9.42cc

9-8. Resin flow in mold-8　simulation





Short shot sample

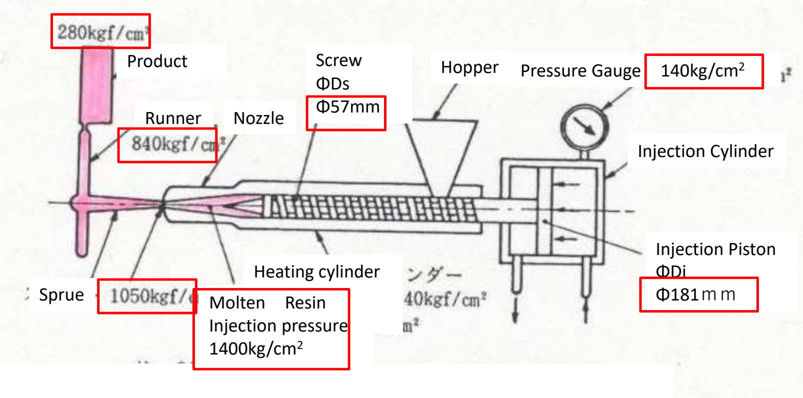
Learn about resin pressure in the mold and measurement examples

No-10

Mold Internal Pressure and

Measurement System

10-1. Relationship between injection pressure and mold internal pressure



280kgf/cm²

Product

Screw
ΦDs
Φ57mm

Hopper

Pressure Gauge

140kg/cm²

Runner

Nozzle

840kgf/cm²

Injection Cylinder

Heating cylinder

Injection Piston
ΦDi
Φ181ｍｍ

Sprue

1050kgf/c

Molten　Resin
Injection pressure
1400kg/cm²

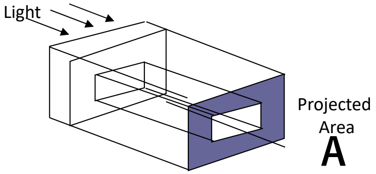
Injection Pressure＝（Di^2/Ds^2）x 140＝（$18.1^2/5.7^2$）x140≒1400kg/cm^2

10-2. Relationship between mold clamping force and mold internal pressure

A Projected Area

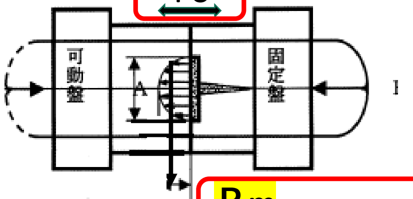
成形品に型締方向の光をあてた影の面積
The area of the shadow generated (see figure at the right side)
when light is applied to the mold clamping direction of the molded product

$$F_c \geqq P_m \times A \times 1.25$$
$$F_o = P_m \times A$$



Fo

Fc Clamping Force



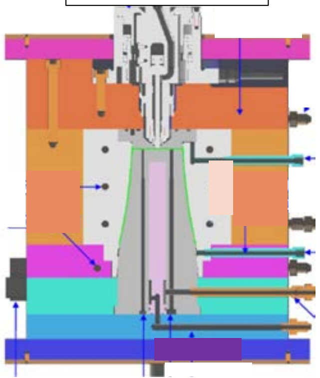
P m Average mold Internal Pressure

Fc＜Fo

Fc＞Fo

10-3. Example of internal pressure measurement of a cup mold

Hot Runner Valve Gate



pressure sensor

Holding pressure

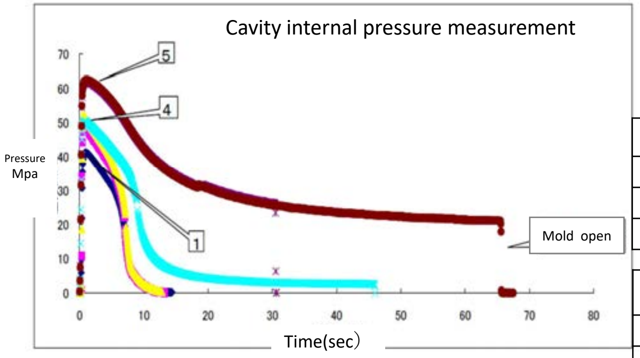
Mold internal pressure

Display the time axis →

Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

10-4. Example of internal pressure measurement: Influence of resin temperature and mold temperature



Molding conditions
Filling time: 5.5 sec
Holding pressure: 82 MPa
Holding time: 5.5 sec

	Cylinder temperature	**Mold temperature**	**Inner pressure peak**
1	250℃	40℃	40MPa
4	290℃	40℃	50MPa
5	290℃	99℃	63MPa

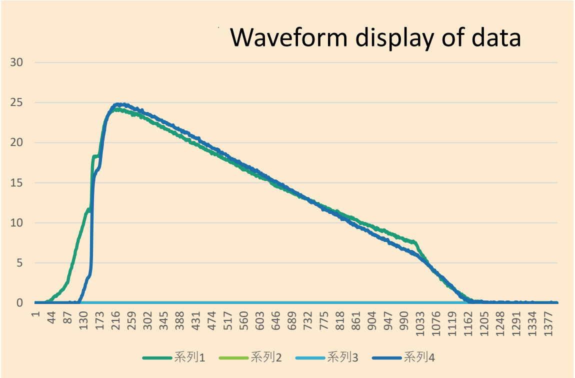
	Actual internal pressure / Set internal pressure
1	40/82＝48%
4	55/82＝67%
5	63/82＝76%

10-5. Example of internal pressure measurement: Influence of resin temperature and mold temperature

Preliminary test 20181020

Acquisition data

0.99	23.5	23.6
0.995	23.6	23.8
1	23.7	23.8
1.005	23.7	23.8
1.01	23.8	23.9
1.015	23.8	24
1.02	23.9	24.1
1.025	24	24.2
1.03	23.9	24.2
1.035	23.9	24.4
1.04	23.9	24.4
1.045	24	24.3



10-6. Example of internal pressure measurement:

Molding practice contents

injection molding machine	HAITIAN MA1600 Max claming force 1600 KN 160 tonf	Mold clamping force set value 1600 x 125/140＝1428 KN 142 tonf
Material	PS	Recycled material mixing ratio?
Mold	cold runner 2 cavi	
	Submarine gate	The gate is cut with automatic
	EP ２	Sensor assembly
1Mpa＝10 bar＝10.19 kg/cm^2		

10-7. Example of internal pressure measurement:

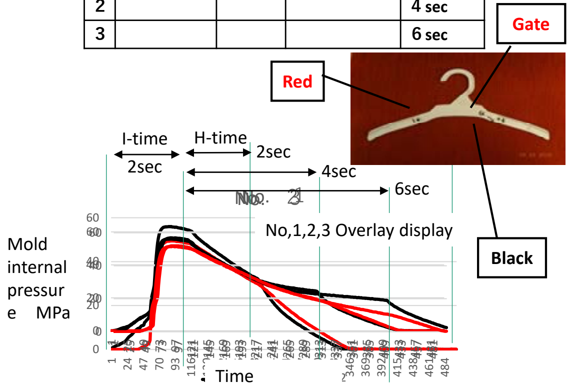
No	I・P	I・time	H・P	H・p time	Product weight
1	７０ MPa	２ sec	40 MPa	2 sec	33.52 g
2	↓	↓	↓	4 sec	33.57 g
3				6 sec	33.57 g
4			５５MPa	2 sec	
5			↓	6 sec	33.86 g
6			65MPa	2 sec	33.22 g
7			75MPa	2 sec	33.27g

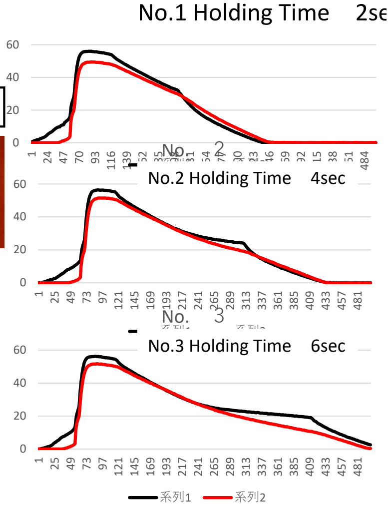
Change holding pressure and holding pressure time

10-8. Example of internal pressure measurement:

Holding time and Mold internal pressure

	I・P	I-time	H・P	H-time
1	７０MP a	2 sec	４０ MPa	2 sec
2				4 sec
3				6 sec





＊保圧時間がながいほど型内圧が保持される

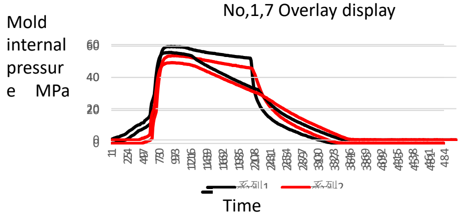
The longer the pressure holding time is, the lower the pressure drop of the molding pressure

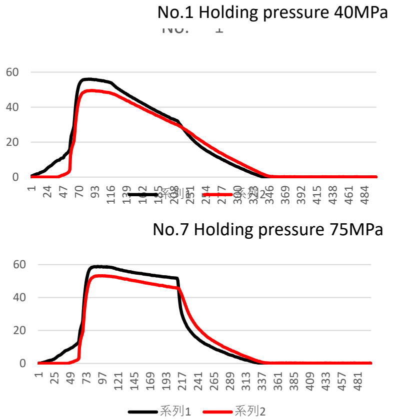
---

10-9. Example of internal pressure measurement:

Holding pressure and Mold internal pressure

	I・P	I-time	H・P	H-time
1	７０MPa	2 sec	４０ MPa	2 sec
7	７０MPa	2 sec	７５MPa	2 sec





＊The higher the holding pressure is, the higher the mold internal pressure is

＊The higher the holding pressure is, the higher the mold pressure is and the lower the pressure drop

＊保圧力が高いほど内型圧は高く圧力降下も少ない

Learn about molding defects classification and improvement measures

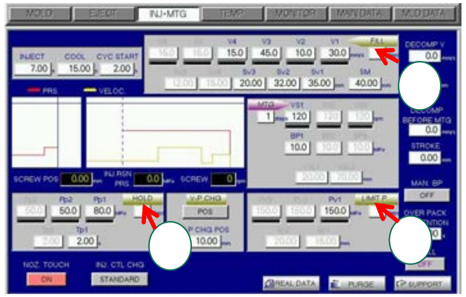
No-11

Molding Defect and Measures

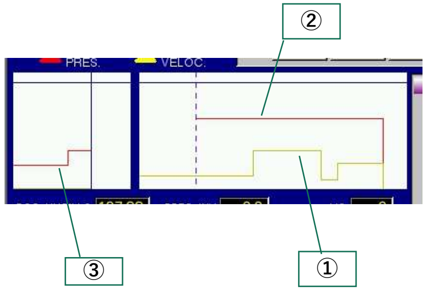
11-1. Injection velocity · Injection pressure · Holding pressure setting-1

Practice Question-27

Set up multistage control to improve molding quality		
① **Injection velocity**	(　？　)	Stage
② **Injection pressure**	(　？　)	Stage
③ **Holding pressure**	(　？　)	Stage



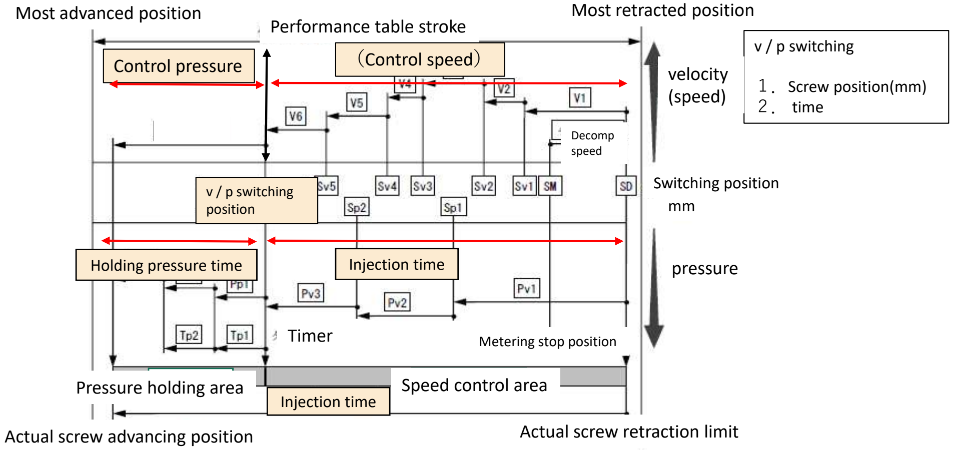
INJECT 7.00 COOL 15.00 CYC START 2.00
V4 15.0 V3 45.0 V2 10.0 V1 30.0
Sv3 20.00 Sv2 32.00 Sv1 35.00 SM 40.00
DECOMP V 0.0
MTG 1 VS1 120
BP1 10.0
DECOMP BEFORE MTG 0.0
STROKE 0.00
SCREW POS 0.00 INJ.RSN PRS 0.0 SCREW 0
Pp2 50.0 Pp1 80.0
Tp1 2.00
P CHG POS 10.00
Pv1 150.0



Reference: Website of NISSEI PLASTIC INDUSTRIAL CO., LTD., www.nisseijushi.co.jp

---

11-2. Injection velocity · Injection pressure · Holding pressure setting-2


Most advanced position
Performance table stroke
Most retracted position
Control pressure
(Control speed)
velocity (speed)
v / p switching
1. Screw position(mm)
2. time
Decomp speed
v / p switching position
Switching position mm
Holding pressure time
Injection time
pressure
Timer
Metering stop position
Pressure holding area
Speed control area
Injection time
Actual screw advancing position
Actual screw retraction limit

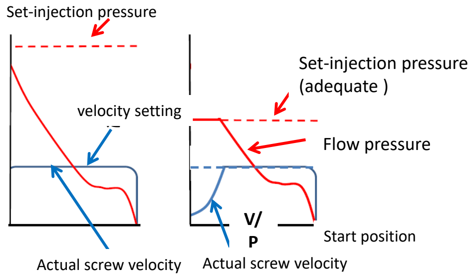
Reference: NISSEI School Textbook

11-3. Injection velocity · Injection pressure · Holding pressure setting-3

Force is required to move things at a certain velocity.

Naturally, this is same when you need to move flowing resin into the mold

When the flow pressure reaches the set-injection pressure, the flow pressure becomes under control and screw velocity decreases sharply. (see right side figure below)

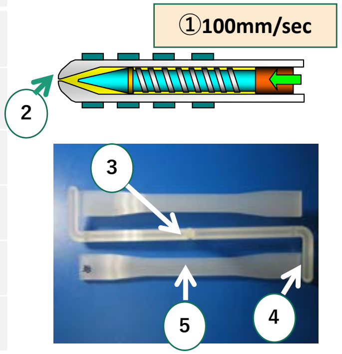


Reference: NISSEI School Textbook

11-4. Injection velocity・Injection pressure・Holding pressure setting-4

Screw velocity and flow front velocity

(ASTM D638 mold)		
	Sectional area mm²	Flow front velocity mm/sec
①**Screw**	**Φ32** **803.8**	Setting value **100**
②**Nozzle**	**Φ3** **7.1**	**x 113.2**
③**Runner**	**4.5x4.5** **20.3 x2**	**x 19.8**
④**Gate**	**2.7x19** **51.3 x2**	**x 7.8**
⑤**Cavity**	**4x13** **52 x2**	**x 7.7**



Reference: NISSEI School Textbook

11-5. Injection molding defects and molding condition adjustment

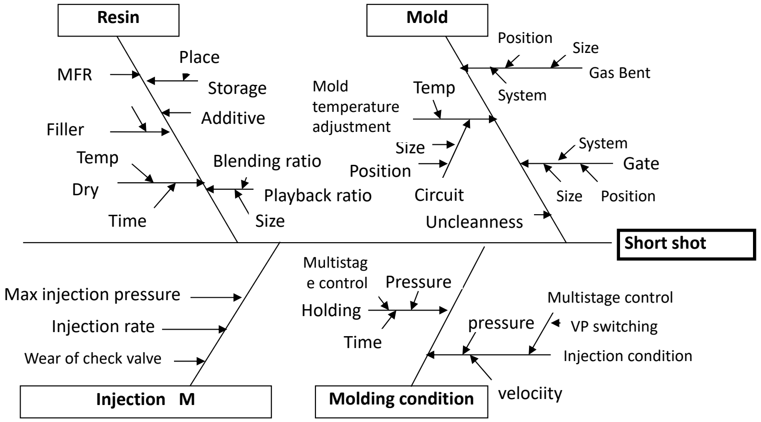
- Various factors can be considered as a cause of molding defects generated in the molding process. In general, factors can be broadly classified into following 4 items.

Major Factors of Molding Defects
Molding Equipment
Molds
Materials
Molding Conditions

- Please note that multiple factors often causes molding defect.

Thus, it is difficult to obtain the satisfactory molded products after implementing one countermeasure (improvement measure).

11-6. Characteristic factor diagram of molding failure (Example of Short-shot)



11-7. Relationship between molding failure and mold

Classification / Defective phenomenon	Material			Molding process					Mold		
	Foreign Object	Moisture	Recycled materials	Plasticization	Injection	Holding	Cooling	Take-out	Gate	Air	Dirt
Black Spot	○		○	○							○
Silver Streak		○	○	○							○
Property Deterioration		○	○	○							
Color Unevenness		○	○	○							
Discoloration		○	○	○							
Burning			○	○						○	
Flow Mark					○		○		○		
Weld Line					○	○			○	○	○
Jetting					○				○		
Short Shot					○	○	○		○	○	
Gloss Defect					○	○	○				
Internal Strain					○	○		○	○		
Resin leak/Flash					○	○					
Sink Mark						○	○		○		
Void		○		○	○	○	○		○		
Warping					○	○	○	○	○		
Dimension Problem						○	○		○		
Crazing			○			○		○			
Release Defect						○		○			

○Strong influence as a cause of defects

11-8. How to identify the defective molding factor

1. Confirmation of occurrence process of molding defect
   - By using the short shot method, consider the in-mold flow of resin and the defect generation process.

2. Confirm change in molding defect
   - Observe the appearance of defects by extremely changing general factors such as injection speed and pressure

3. Observe the state of resin plasticization by purging

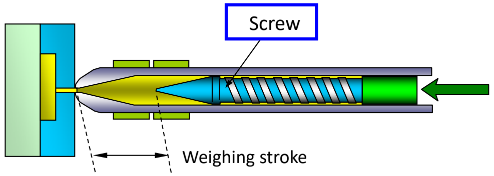
   e.g. whether drying defect or burning occurred

4. Also, consider alternative countermeasures in terms of molds, molding equipment, peripheral equipment, materials, etc.

11-9. How to identify the defective molding factor

Confirmation by short shot method

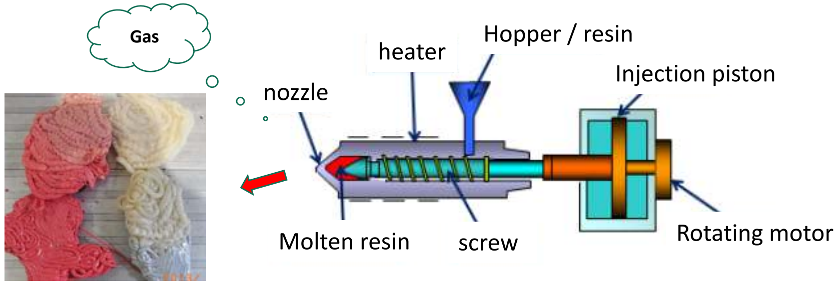
Gradually increase the weighing stroke from the short shot and check the position of the defect occurrence



11-10. How to identify the defective molding factor

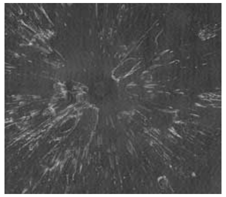
Observe the state of resin plasticization by purging operation

Observe gas generation condition and resin condition.
Is it foaming from the beginning? Did it get bubbles or foaming on the way?



11-11. How to identify the defective molding factor

Molding defect related to material drying conditions



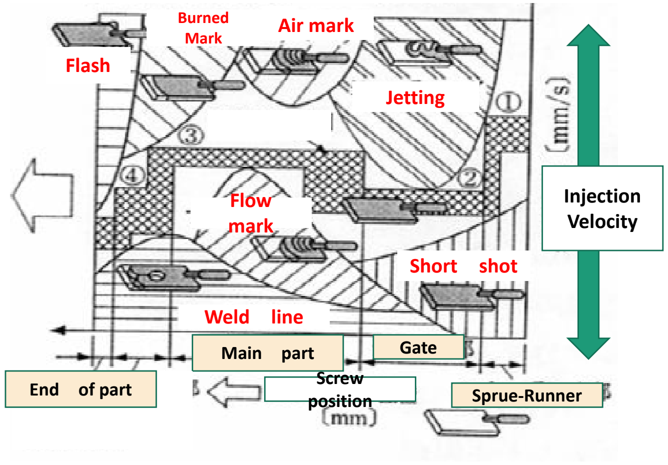
Silver streak

Characteristic	Willow like streams appeared on molding surface . Occurred in the entire molded product immediately after passing through the gate.
Cause	• Inadequate drying temperature and time • Hot air volume of a dryer is low • Clogging of an air filter • Inappropriate hopper capacity (short drying time) • Failure of a temperature controller
Counter-measures	• Revision and optimization of drying conditions • Adjustment of dry air volume • Cleaning of an air filter • Hopper capacity optimization • Repair of a temperature controller

Reference: Website of t-umg Co., Ltd., https://www.t-umg.com/jp/corporate/index.html

11-12. Injection velocity・Injection pressure・Holding pressure

Major molding defects in the injection process



11-13. How to identify the defective forming factor

Molding defect related to injection condition： Short shot

Phenomenon and cause	• Short shot is the state which the mold cavity can not be filled completely • Cause: Insufficient amount of resin, insufficient filling pressure.

Molding equipment factor	• Filling is insufficient • Injection pressure / speed is low • The resin temperature is low and the fluidity is insufficient • The pressure loss of the nozzle part is large
Material factor	• Resin has poor fluidity
Mold factor	• Low mold temperature, Thin cavity thickness • Small sprue / runner / gate • Air exhaust failure, insufficient gas vent
Molding condition factor	• Increase injection speed/ pressure, increase holding pressure • Adjust clamping force and/or injection speed at the end of filling

Reference: Website of mutsumikako Co., Ltd., http://www.mutsumikako.co.jp/soshikizu.html

---

11-14. How to identify the defective molding factor

Molding defect related to injection condition: Jetting

Phenomenon and cause	• Flow pattern of resin which can be formed near the gate • Cause: The flow front of resin solidifies when it flies out of the gate

Molding equipment factor	• Flow-front speed is too fast when it passes through the gate
Material factor	• Flow of resin is too smooth
Mold factor	• Small gate cross-sectional area
Molding condition factor	• Set the injection speed as multistep speed control, and slow down the speed setting at the time of passing through the gate

Reference: Website of t-umg Co., Ltd., https://www.t-umg.com/jp/corporate/index.html

---

11-15. How to identify the defective molding factor

Molding defect related to injection condition: Flow Mark

Phenomenon and cause	• A wave pattern that appears perpendicular to the flow direction. • Cause: The flow front speed is slow.

Molding equipment factor	• Resin temperature is low and liquidity is insufficient • A nozzle is cold • Injection pressure is low, Injection speed is slow
Material factor	• Resin flow is not smooth enough
Mold factor	• The mold temperature is low. • Inadequate mold cooling circuit. • The cold slug pool is small.
Molding condition factor	• Increase injection speed and injection pressure • Adjust the holding pressure switch position (try delaying)

11-16. How to identify the defective molding factor

Molding defect related to injection condition: Weld Line

Phenomenon and cause	• A linear surface pattern formed at the confluence point of the split resin flows • Cause: The merged resin flow's viscosity is high, Injection pressure at the confluence point is low, Air is trapped at the end of the mold, etc.

Molding equipment factor	• Resin temperature is low and liquidity is insufficient • Injection pressure is low, Injection speed is slow. • A nozzle tip is cold
Material factor	• Resin flow is not smooth enough, Resin solidification is fast • Volatiles and moisture are high in materials.
Mold factor	• The mold temperature is low, Exhaust has fault • The flow length from the gate position is long • The amount of release agent is large
Molding condition factor	• Increase injection speed. Increase injection pressure, Increase holding pressure • Adjust the mold clamping force and the injection speed at the end of filling to release air

---

11-17. How to identify the defective molding factor

Molding defect related to injection condition: Air Mark

Phenomenon and cause	• Air mark appears at the projected area of the molded product (a convex part of the molded product or ashadowed part in a diagram) • Cause: Trace of air entrainment forms air mark

Molding equipment factor	• Flow front speed is fast
Material factor	• High material viscosity
Mold factor	• Air vent is insufficient
Molding condition factor	• Reduce mold clamping force and injection speed to release air

---

11-18. How to identify the defective molding factor

Molding defect related to injection condition : Burned Mark

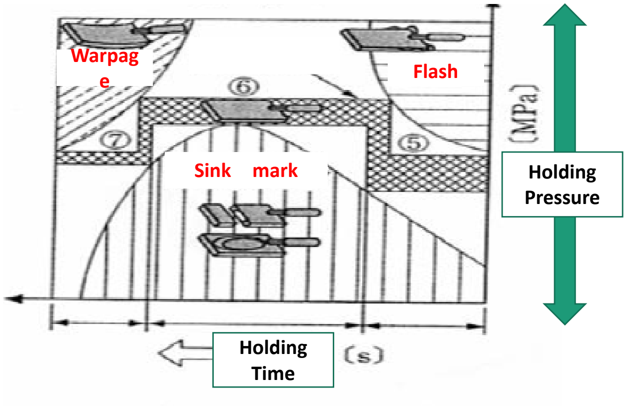
Phenomenon and cause	• Burning mark appears at the end of the filling position • Cause: In case gas release inside the mold is insufficient, the remaining gas is adiabatically compressed by the resin pressure: it becomes high temperature and burning occurs.

Molding equipment factor	• Injection speed is too fast • Clamping force is too high, air release is insufficient
Material factor	• The amount of lubricants is too much
Mold factor	• Exhaust has fault • High mold temperature • Oil is attached in the mold
Molding condition factor	• Reduce resin temperature and screw rotation speed • Adjust mold clamping force to release air • Decrease injection speed at before filling

---

11-19. Injection velocity · Injection pressure · Holding pressure

Major molding defects in the pressure holding process



11-20 How to identify the defective molding factor9

Molding defect related to pressure holding condition : Flash

Phenomenon and cause	• Material sticks out of the parting line (PL) in holding pressure process (In case flash appears on the whole molded product)

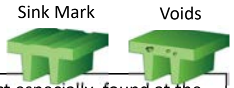
Molding equipment factor	• Insufficient mold clamping force, Holding pressure is high. The resin temperature is high.
Material factor	• Insufficient material viscosity
Mold factor	• Projected area is too large The mold temperature is too high. Lack of rigidity.
Molding condition factor	• Lower holding pressure at the first stage to form a skin layer, and adjust holding pressure at the second stage to form product's shape. (Note: time and pressure applied on the first stage are related to flash and sinks)

Reference: Website of mutsumikako Co., Ltd., http://www.mutsumikako.co.jp/soshikizu.html

---

11-21 How to identify the defective molding factor

Molding defect related to pressure holding condition: Sink Mark



Phenomenon and cause	• A concave shape appears on the surface of the molded product especially found at the thick part with a large amount of volume shrinkage • Causes: Sink mark appears when the skin layer is weak (On the other, if it is strong, voids generate inside the molded product). This relates to the cooling rate of the surface of the molded product.

Molding equipment factor	• Injection pressure / Holding pressure is low • The resin temperature is high
Material factor	• Shrinkage rate of the material is high • The fluidity of the resin is too smooth
Mold factor	• The mold temperature is too high. • Temperature of the mold is uneven • Runner gates are small, There is a thick part in the mold
Molding condition factor	• Increase the holding pressure and the pressure holding time.

Reference: Website of Fuji Manufacturing Co., Ltd., www.fujimfg.co.jp/ApplicationMoldinjection.html

---

11-22 How to identify the defective molding factor

Molding defect related to pressure holding condition: Warpage

Phenomenon and cause	• Warpage is deformation and twisting of the molded product • Cause: Residual stress or overfilling caused by pressure unevenness during cooling. Sometimes it is difficult to take counter-measures as shape of the molded product is often relating.

Molding equipment factor	• The filling pressure / holding pressure is high. • Lack of resin melting, temperature is low. • The filling speed is slow.
Material factor	• Large orientation distortion
Mold factor	• The mold temperature is high • Cooling is not uniform • Uneven protrusion, Poor mold release, Gate is too big
Molding condition factor	• Adjust the injection speed / injection pressure and lower the holding pressure, in order to increase resin temperature and to shorten the filling time . (Set temperature difference between the cavity temperature and the core temperature)

Case study
Observe plastic products and learn about questions

No-12

What You Can See From the

Molded Product (Case Study)

12-1. Why does the mouth of a PET bottle look white?

Practice Question-28

1	Molding method ?
2	Material name **?**
3	Why are they white?

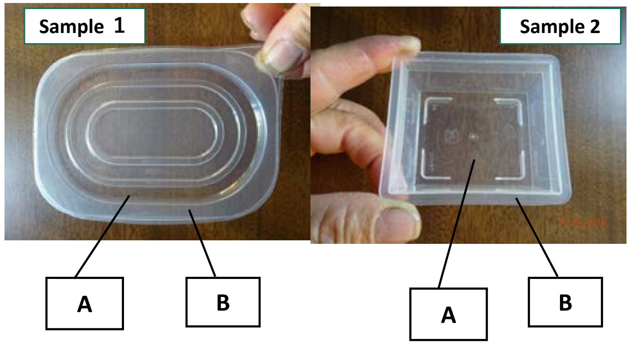
⇩

1	
2	
3	

12-2. Why is it different in colour?

Practice Question-29

What makes product colour different between part A and part B?



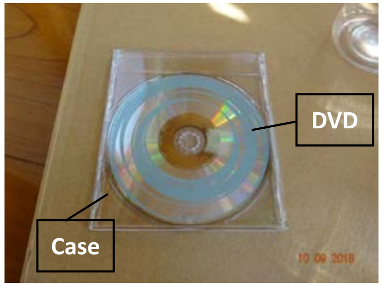
1	Molding method ?
2	Material name?
3	Why is it different in color?

⇩

	Sample 1	**Sample 2**
1		
2		
3		

12-3. Think about molding system

Practice Question-30



CASE

1	Molding method ?
2	Material name **?**
3	What is the gate specification?
4	How to place cavities?

⇩

1	
2	
3	
4	

DVD

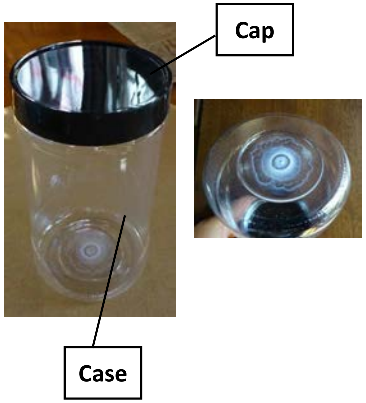
1	Molding method ?
2	Material name **?**
3	What is the gate specification?
4	Molding cycle (sec)?

⇩

1	
2	
3	
4	sec

12-4. Think about molding system

Practice Question-31



CAP

1	Molding method ?
2	Material name ?
3	What is the gate specification?
4	How to release the cap screw part?

⇩

1	
2	
3	
4	

CASE

1	Molding method ?
2	Material name ?
3	Why is the bottom part of a case white?

⇩

1	
2	
3	

8.　自動二輪車裾野産業振興計画案

Supporting Industries Development Plan
for Motorcycle Sector in Bangladesh
(5th Draft)

July 2020

Component 3 Team
JICA-BIPIC Project

Table of Contents

This draft plan is proposed by the component 3 team of the JICA-BIPIC project. It is based on the current situation survey and analysis, and also the lessons from ongoing action plans under the JICA-BIPIC project. The current draft is expected to constitute a basis on which the Ministry of Industries will formulate the formal draft of “the Supporting Industry Development Plan for Motorcycle Sector” for collection of the public opinion and finalization.

List of Abbreviations

ACAMA : Automobiles Components & Accessories Manufacturers' Association
AP : Action Plan
BCSIR : Bangladesh Council of Scientific and Industrial Research
BDS : Business Development Service
BEIOA : Bangladesh Engineering Industry Owners Association
BEZA : Bangladesh Economic Zone Authority
BIDA : Bangladesh Investment Development Authority
BITAC : Bangladesh Industry & Technology Assistance Center
BMAMA : Bangladesh Motorcycle Assemblers & Manufacturers Association
BPGMEA : Bangladesh Plastic Goods Manufacturers & Exporters Association
BRTA : Bangladesh Road Transport Authority
BSCIC : Bangladesh Small & Cottage Industries Corporation
BSTI : Bangladesh Standards and Testing Institution
CBU : Complete Build-up Unit
CKD : Complete Knock Down
CNC : Computerized Numerical Control
GDP : Gross Domestic Products
ISO : International Organization for Standardization
JICA : Japan International Cooperation Agency
JV : Joint-venture
LE : Light Engineering
MIDP : National Motorcycle Industry Development Policy
MMEAB : Motorcycle Manufacturers & Exporters Association of Bangladesh
MOI : Ministry of Industries
NIP : National Industrial Policy 2016
NBR : National Board of Revenue
NPO : National Productivity Organization
OEM : Original Equipment Manufacturers
PP&PDC : Pilot Plant and Process Development Center of BCSIR
QCD : Quality, Cost and Delivery
SCITI : Small & Cottage Industries Training Institute
SIDP : Supporting Industry Development Plan for Motorcycle Sector
SIs : Supporting Industries
SMEs : Small & Medium Enterprises
SMEF : Small & Medium Enterprises Foundation
SRO : Statutory Regulatory Order
VAT : Value-added Tax

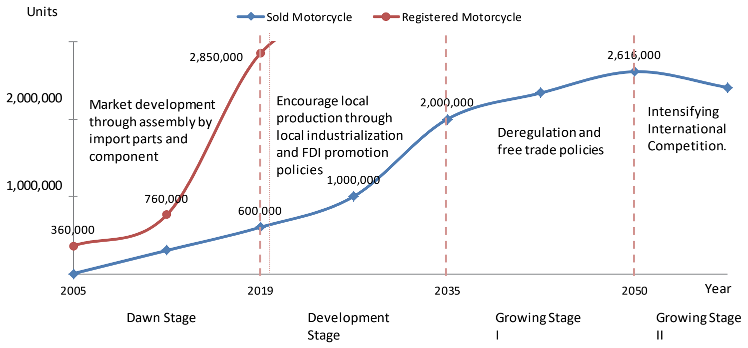
Supporting Industries Development Plan for Motorcycle Sector in Bangladesh (5th Draft)

1. Introduction

1.1 Background

The Bangladesh economy has grown in a steady pace at a compound annual growth rate of 7.36% for the recent five years (2015-2019), achieving one of the highest growing rates in Asia. To ensure continued economic growth in the coming years, the Government of Bangladesh is determined to strive to promote and diversify the industrial sector, and took up the motorcycle sector as a promising industry.

In 2017, the Ministry of Industries (MOI) formulated "the National Motorcycle Industry Development Policy (MIDP)[1]" which set forth policy measures and action plans to develop the motorcycle sector. The policy has been enforced since 11 September 2018. Although the growing annual motorcycle sales and the accumulated registered number reached more than 600,000 units and 2,850,000 units respectively in 2019, it is still 1/20 of those in India in terms of the ownership ratio among population. Thus, MIDP anticipates further increase in annual sales, a million units by 2027. It can be seen from the figure below that the industry has passed the dawning stage entering the development stage to become the major industry of Bangladesh.



Source: JICA Project Team

Figure 1 Development Phases of Motorcycle Sector of Bangladesh

---

[1] The current document abbreviates the National Motorcycle Industry Development Policy as MIDP, and this document, the Supporting Industry Development Plan for Motorcycle Sector (draft) as SIDP likewise.

1.2 Objective and Positioning of Supporting Industries Development Plan (SIDP) for Motorcycle Sector

The primary objective of the Supporting Industries Development Plan for Motorcycle Sector (SIDP) in Bangladesh is to strengthen local parts suppliers and other supporting industries such as die/mold industries, thereby to develop the competitive and sustainable motorcycle sector in the country.

SIDP complements MIDP. While MIDP presents the overall picture of the motorcycle sector development, lists measures to expand the motorcycle market, and improve business environment of the sector, SIDP provides for measures to develop parts suppliers and promote backward linkage with related industries. Furthermore, SIDP also supports acceleration policy of local production process and vendor development actives of MIDP. SIDP is a plan for ten years from 2020 to 2030.

Highlight of the National Motorcycle Industry Development Policy (MIDP)

The Government of Bangladesh has been implementing MIDP, which aims to achieve the following goals;

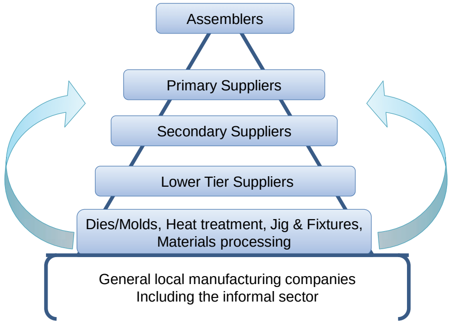
- to raise motorcycle production up to one million units by 2027,
- to raise local procurement ratio from the current 10% to 50% by 2027, and
- to supply quality motorcycle to domestic and overseas markets at competitive prices

Accordingly, the policy assigns the government to commit to the following particulars;

- enhancement of technical skills of workforce by public training institutions,
- attainment of scale of economy in view of reducing production cost,
- removal of investment and business barriers, and
- acceleration of local production (localization)

1.3 Concept of Supporting Industries Development

In general, supporting industries development involves taking a series of policy measures and actions to develop a backward linkage from a specific target industry located at the top of the supply chain. These measures and actions are designed to enhance technological and managerial capability of all the actors along this linkage so that the supply chain as a whole will be able to make the industry more competitive. It requires upgrading of the capacity of not only the potential parts-suppliers but also other supporting industries including material/sub-parts suppliers, heat/surface treatment service providers, die/mold makers, jig/fixture producers, and machining services providers, among others. From these perspectives, the supporting industries in SIDP are defined to cover suppliers of parts, components, materials and processing services for manufacturing of motorcycles. According to the industry classification in Bangladesh, a large proportion of the supporting industries belong to the light engineering (LE) industry or the plastic industry; thus the development of supporting industries for the motorcycle sector also largely involves that of LE and plastic industries.



Source: JICA Project Team

Figure 2 Structure of Supporting Industries

2. Current Situation and Issues

2.1 Motorcycle Sector in Bangladesh

(1) Market Size

The motorcycle sector is the new frontier for the entire industrial sector in Bangladesh and also the fastest growing industry over the last decade. There are 13 motorcycle assembling companies in Bangladesh (hereinafter referred to as “Manufacturers”); out of which 11 companies are actually in operation, as of January 2020. They utilize production technology and accept capital participation from overseas motorcycle assembling companies including those in India and Japan, and they are operating in the form of either Completely Built-up (CBU) or Complete Knock-Down (CKD).

Table 1 shows trend of motorcycle registration number in Bangladesh. There are about three million motorcycles in the country now and one million unit annual sales are expected by the year of 2027 (600,000 units in 2019).

Table 1 Number of Registered Motorcycles in Bangladesh

Year	Upto2011	2012	2013	2014	2015	2016	2017	2018	2019
Year-wise	873,873	101,588	85,808	90,685	240,358	332,057	326,550	395,603	406,897
Cumulative	873,873	975,461	1,061,269	1,151,954	1,392,312	1,724,369	2,050,919	2,446,522	2,853,419

Source: Bangladesh Road Transport Authority (BRTA)

Despite the upward thrust the industry is experiencing now, there still remain some key issues that need to be dealt with if the motorcycle sector remains as a catalyst for industrial growth in the long run. First is to reduce the sales price of the motorcycle to expand local market. The price difference between India and Bangladesh for the same model is 170% - 200% higher in Bangladesh now. Although the Bangladesh government has reduced supplementary duties on CKD parts import for several times, the recent governmental decision on reduction of the motorcycle registration fees, one of the most significant factors that prevents the market expansion, has not been enforced yet; rather, the supplementary duty on the registration fees actually increased this year. As a result, the difference of total purchasing costs between the two countries is unlikely to widely narrow down in the foreseeable future. The best solution is to produce motorcycle parts locally. If local parts suppliers can produce motorcycle parts locally at lower price, the price of motorcycles will fall within the purchasing range of the low-middle income buyers in Bangladesh. Thereby, the sales are expected to expand widely, then leading to further growth of the industry.

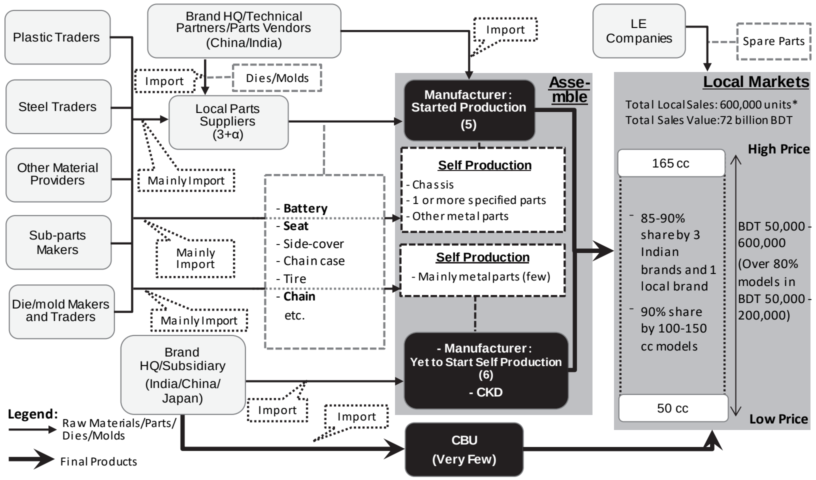
(2) Procurement of Parts and Materials for Production

While several Manufacturers in Bangladesh have taken localization initiatives with some local LE industry companies since around 2015, only three to four companies have been able to continue supplying parts such as batteries, seats, and drive-chains for motorcycles so far. Those parts suppliers are also members of the Automobiles Components & Accessories Manufacturers' Association (ACAMA) that is an association of automobile and motorcycle parts suppliers in Bangladesh. Meanwhile, there are small-scaled companies (non-ACAMA member) including in the informal sector that produce motorcycle spare-parts only for the after-market.

Most of the motorcycle parts including spare-parts are consequently imported in Bangladesh. The import sources concentrate in India and China where the brand headquarters or subsidiaries and the technical collaboration partners of Manufacturers are located. Raw materials and dies/molds for the parts produced by Manufacturers are also imported in virtually all the cases.

Currently, a backward linkage from Manufacturers hardly exists in Bangladesh. The motorcycle sector in Bangladesh has a pressing need to foster its supporting industries, parts suppliers in particular, to develop itself in a continuous and sound manner. That is, it is necessary to develop the industrial structure where the backward linkage firmly supports the assembly industry.

Figure 3 illustrates a generalized recent composition of the supply chain of the motorcycle sector in Bangladesh.



*80% of sold motorcycle are locally manufactured.

Source: JICA Project Team

Figure 3 Supply Chain of Motorcycle Sector in Bangladesh

(3) Major Issues of Local Parts Procurement

In general, Manufacturers would obtain benefits from local parts procurement regarding price and delivery time. Accordingly, most of Manufacturers show willingness to procure as many parts as possible from the local suppliers, if possible. Local parts procurement, however, has not progressed yet in the Bangladeshi motorcycle sector. The following issues prevent or will prevent Manufacturers from actively procuring the parts from local parts suppliers.

a. Large number of models with small market size

The large number of motorcycle models competes in a small market, thereby reducing the demand for each part as the motorcycle parts vary with models. Currently, there is only one model with annual production of more than 100,000 units in Bangladesh. In general, mass production of manufacturing products leads to cost reduction. The small demands then discourage the potential parts suppliers and also foreign parts suppliers from venturing into the parts market. Even if they did, they would face difficulty to operate the mass production due to the small market size. This would prevent enhancement of price competitiveness of the parts which largely require scale economy effects and experience effects. As a result, Manufacturers would likely avoid local parts procurement until the purchasing cost becomes almost the same as or lower than the imported parts.

Meanwhile, large production volume of a part used for the same motorcycle model obviously leads to cost reduction of a parts supplier, contributing eventually to cost reduction of a Manufacturer. Therefore, narrowing-down of the models produced or standardization of the parts used for the multiple models would help reduce production cost of Manufacturers. Especially for the latter, Manufacturers are expected to take proactive measures to enhance design capabilities required for such the standardization.

b. Quality of products

The LE and plastic companies, the main supporting industries for the motorcycle sector in Bangladesh, do not have adequate capacity to produce the parts meeting strict requirement set by Manufacturers regarding safety, durability, and performance and appearance quality. Especially, inadequate accuracy, finishing and painting, low-quality dies/molds and insufficient heat treatment facilities are the main factors creating this situation.

c. Cost of imported raw materials and dies/molds

At present, most of LE and plastic companies in Bangladesh use imported dies/molds and raw materials when producing the products targeting the market requiring relatively high quality. The cost of dies/molds and raw materials constitute the largest part of their total manufacturing cost. Although the domestic production cost is relatively low, the high cost of importing such materials for manufacturing the parts is the main factor that lessens the cost competitiveness of the local parts over the imported parts. The cost analysis of domestic motorcycle parts indicates that import charges account for more than half of production cost, and therefore reduction of the import charges is the key factor to use domestic parts. In addition, the current preferable import tax on motorcycle parts applied to the designated Manufacturers, though widely helping to lessen the motorcycle price, weakens the comparative price advantage of the local parts over the imported parts at the same time.

d. Issues of delivery

Import of raw materials and dies/molds takes one and half to two months and about two months respectively. In case of dies/molds making, it takes more days for consultation and adjustment work with foreign suppliers. All of these factors bring about a concern of Manufacturers as to whether they would be able to receive necessary amounts of the ordered parts within the specified delivery time from local LE and plastic companies.

2.2 Technologies and Quality of Motorcycle Parts Industry

(1) Challenge in Development of Parts Industry

The supporting industries including parts suppliers for the motorcycle sector mostly belong to the LE industry or the plastic industry. Since the motorcycle parts industry itself has not yet been formed in Bangladesh, the following outlines the main challenges for LE and plastic industries to become a parts supplier, except the challenges related to die/mold technologies which are addressed later. Table 2 summarizes the challenges.

Table 2 Challenges in Development of Motorcycle Parts Industry

Supply Chain	Challenges		Industry
1) Raw materials	a	Low quality of local steel	LE
	b	Difficulty in procuring appropriate imported steel	LE
2) Production	a	Limited experience in press-working and forging	LE
	b	Inadequate knowledge, technologies and facilities for industrial plastic-parts processing	Plastic
	c	Low accuracy and low quality of finishing	Both
	d	Limited knowledge and implementation of production and quality management	Both
	e	Lack of Inadequate automation of machines	LE
3) Marketing	a	Shortage of information and opportunity to know and meet foreign companies	Both
4) Business/Financial Management	b	Insufficient investment capital	Both

Source: JICA Project Team

1) Challenges in Raw Materials

a. Low quality of local steel

Insufficient and non-standardized hardness, inadequate facilities for material testing, limitation of facilities and technologies for heat treatment, and lack of locally-made hard steel and alloy steel together cause local steel to be of low quality.

Optimizing steel characteristics according to its processing and usage entails alteration of physical and chemical properties of the steel, especially by heat treatment. Nonetheless, local mild steel from scraps of decommissioned ships cannot be hardened by heating. Even for the steel for which heating is effective, appropriate material testing in advance and knowledge and technology for the optimal processing conditions according to the steel composition, both of which are still limited in Bangladesh, are required.

These constraints make Manufacturers highly unlikely to accept use of local steel as raw materials for the parts of their products at this point.

b. Difficulty in procuring appropriate imported steel

Use of local steel as raw material is not realistic for supplying parts to Manufacturers, given their strict quality requirements. Imported steel is, however, more costly than local steel while the importation generally requires large amount of purchase at a time and 1.5 to 2 months of delivery time. These constraints make it unrealistic for local LE companies to import the steel by themselves or even through trading agencies, and thus, they usually buy the imported steel at local stores. Yet, since the companies face the difficulty in finding specified type of the imported steel at local stores, they are often forced to buy the similar type of the steel, causing the steel composition to be less adequate for the product than what it should be.

These factors heighten hurdles for LE companies in Bangladesh to procure imported steel according to their needs and customers' needs both by importation and at local stores.

2) Challenges in Production

a. Limited experience in press-working and forging

The number of LE companies in Bangladesh applying press-working and forging processes is very limited. Yet, promotion of motorcycle parts suppliers in Bangladesh requires increase in the number of the companies able to perform press-working/forging processes and accumulation of experience and technical capacity of them.

Insufficient experience with press-working/forging on the company side enlarges the expectation for technical support agencies especially BITAC to develop and extend the press-working and forging technologies across the country. Nonetheless, facilities and technologies of BITAC in this field are also limited.

b. Inadequate knowledge, technologies and facilities for industrial plastic-parts processing

Plastic companies in Bangladesh have insufficient understanding of what technologies and facilities should be in place for industrial parts processing. Industrial parts processing is usually ordered on a small-lot-production basis for wide variety of products, in contrast to mass production of small varieties currently operated by the plastic companies. The small-lot production of wide varieties of plastic industrial parts entails knowledge and technologies, especially for resin replacement of injection molding that requires different temperature control and efficient mold changeover, which is not experienced well by plastic companies in Bangladesh to date. Further, complete removal of factors creating defective appearance including burrs and compliance with dimensional tolerance, which are not required in the current products, are strictly required for the motorcycle parts.

Meeting these strict requirements necessitates skills in the measurement and fine adjustment of molding conditions with knowledge of proper positioning and speed control of a heating cylinder screw, and flowing route and speed of resin inside the molding machine. These skills and knowledge still need improvement for plastic companies in Bangladesh.

c. Low accuracy and low quality of finishing

Generally, LE and plastic companies in Bangladesh have a limited number of employees with the formal technical education and training, while low-quality requirement from the current markets cause these companies not to have strong awareness for quality improvement. Especially, inadequacy of proper knowledge and awareness regarding a) use and understanding of a drawing, b) use, maintenance and calibration of measuring equipment, c) maintenance of machines, and d) re-grinding of cutting tools, are significant factors generating low accuracy and low quality of finishing in local LE and plastic products.

d. Limited knowledge and implementation of production and quality management

LE and plastic companies need to satisfy the required quality and quantity of the parts, and to deliver them by specified time in order to continue the transaction with the motorcycle assembling companies, while realizing the manufacturing cost designated by the customers and leaving margin for profit. For ensuring the required quality, they need to implement strict quality and production management. Notwithstanding, LE and plastic companies in Bangladesh generally have limited knowledge, awareness and practice of such management technologies.

The production and quality management system covers a wide range of management activities. Given the present experience of LE and plastic companies in Bangladesh in systemized and firm management activities, it is not realistic for them to introduce high-level and comprehensive management activities simultaneously.

KAIZEN including 5S is effective as the first step to enhance quality-awareness and to establish the strict and sustaining production and quality management system. Many of LE and plastic companies in Bangladesh, however, do not implement KAIZEN at present and recognition of KAIZEN is small in these industries.

e. Inadequate automation of machines

Basically, LE companies in Bangladesh, except foundries and bicycle makers, produce the small varieties of products in small volume. This is partly due to lack of automated machines including CNC machines. Further, non-standardized product quality, low product accuracy and low quality of finishing are caused partly by production by manual work and conventional old machines.

Introducing the new and automated machines to the present LE companies in Bangladesh is apparently a big challenge; nonetheless, these machines are indispensable to satisfy strict requirements of Manufacturers, for their production volume, quality, cost and delivery time.

3) Challenges in Marketing

a. Shortage of information and opportunity to know and meet foreign companies

LE and plastic companies in Bangladesh consider a lack of information and opportunity to know and meet foreign companies to be the most serious challenge in developing linkage with foreign manufacturers. LE and plastic companies in Bangladesh are generally not proactively attempting to acquire such information and opportunity by themselves. They basically have not actively diversified their customers so far and thus do not have much experience of new customer exploration. Therefore, these companies would face difficulty in finding opportunities to market themselves to Manufacturers without external support to create such opportunities or to facilitate the proactive marketing activities by the companies themselves.

4) Challenge in Business and Financial Management

a. Insufficient investment capital

LE and plastic companies in Bangladesh consider difficulty in access to long-term finance with lower interest to be the most challenging issue in their business operation. Especially, inadequate automation of machines and limited space for production for LE companies cannot be effectively solved without improving the access to long-term finance. At present, however, there is no public support provided to the companies to improve the access whereas conditions of the bank loans are not friendly for them, especially for the companies with low-value fixed assets (low collateral value).

(2) Promising Parts for Localization

As mentioned earlier, only three to four companies have managed to supply motorcycle parts on a continuous basis so far, despite some efforts made in the past 4-5 years to promote local parts production. Moreover, none of these suppliers have ever transacted with major Indian or Japanese Manufacturers. These facts prove that technological capabilities of local LE and plastic industries are still far from satisfying QCD standards of the international manufacturers.

From the perspective of cost advantage, most of manufacturing industries in Bangladesh depend on the imported raw materials and intermediate goods, and therefore the cost for materials is relatively high. However the in-house production cost such as labor cost, utility cost, etc., is relatively low compare to India and China and it can compensate for high material cost. If the import costs of raw materials and intermediate goods including the tariffs can be reduced, sales prices of the local parts will become highly competitive.

Table 3 classifies the promising motorcycle parts that are supposed to be manufactured locally. Basically, the items of level 1 which are relatively low in terms of technical processing difficulty and investment cost could be immediately manufactured in Bangladesh, and after that, the technical difficulty level and investment cost gradually rise to 2, 3 and 4. In particular, level 4 items are the core parts of a motorcycle, and the local industries need to develop and acquire skills and know-how to produce these parts through mid and long-term efforts.

Table 3 Level of Difficulty in Parts Localization

Technical Difficulty	Level 1	Level 2	Level 3	Level 4
Parts	◆ Pedal ◆ Seat ◆ Stand ◆ Sari guard ◆ Tail lights cover ◆ Turn signal cover ◆ Head light cover ◆ Spokes ◆ Number plate ◆ Handle bar ◆ Fender ◆ Side cover ◆ Body cover ◆ Cowl Assy. ◆ Chain case ◆ Battery case	◆ Shaft-drive ◆ Chain-drive ◆ Clutch lever ◆ Throttle ◆ Sprocket ◆ Propeller shaft ◆ Muffler ◆ Battery ◆ Break lever ◆ Wheel ◆ Shock absorber ◆ Screw ◆ Nut	◆ Transmission ◆ Air cleaner ◆ Horn Switch ◆ Tire ◆ Suspension ◆ Front folk ◆ Break drum ◆ Disk break ◆ Speedometer ◆ Fuel meter ◆ Fuel tank ◆ Head lights ◆ Shift lever ◆ Wire harness	◆ Air intake ◆ Intake manifold ◆ Exhaust pipe ◆ Steering dumper ◆ Variable exhaust system ◆ Head tube ◆ Aluminum die-casting parts ◆ Heat-resistant oil seal ◆ Precision gear ◆ Precision forging parts

Source: JICA Project Team

In view of promising parts for localization in the Bangladeshi contexts, the plastic industry, and thus the plastic parts, is more competitive than the LE industry and the parts, suggesting an idea that priority for the localization may be given first to the plastic parts. Further, there has been a trend that materials of various motorcycle parts are shifting from metal to plastic for enhancing fuel efficiency and drivability; the motorcycle industry in Bangladesh may also consider following this trend. From these perspectives, relatively many plastic parts are classified as Level 1 in Table 3.[2]

2.3 Die and Mold Industries

(1) Current Situation and Challenges of Die and Mold Industries

The products produced by Bangladeshi die/mold companies are predominantly plastic molds and only a small number of them deal with dies/molds used for LE products, especially dies for press-working and forging process. It should be noted that the materials and technology involved are different for producing molds for plastics and dies for press-working and forging processes which are frequently required for motorcycle parts and components. Dies/molds made of local mild steel are inferior to those produced abroad in terms of the number of shots, or product durability. Further, there is difficulty in steel import and in finding specific imported steel required for a particular die/mold at local stores. In addition to these, the problems in Table 4 regarding die/mold designing and processing of local die/mold makers are causing them to remain in low-quality.

---

[2] Yet, there remains a challenge in producing painted plastic parts as plastic painting facilities require large investment.

Table 4 Problems in Die/Mold Processing

Problems	
A	Insufficient of planning of the process from designing to prototype evaluation
B	Production from the sample (lack of ability to read and write a drawing)
C	Insufficient of structure designing, processing planning and planning of constituting parts
D	Insufficient of ability to design and process complicated form of dies/molds
E	Insufficient of pre-production evaluation of quality
F	Inadequacy of processing of cooling circuits and gas vents
G	Insufficient quality of surface polishing (roughness of die/mold surface)
H	Insufficient of measurement of finished products and lack of measuring instruments

Source: JICA Project Team

Import of the die/mold, for example, from China takes about two months for delivery while import duty is only at 1% of effective rates. These factors suggest if users of a Chinese die/mold can bear the delivery time, they are not willing to order to the local die/mold manufacturers. Today's low import duty on dies/molds is good for users but is severe for the local die/mold manufacturers.

(2) Current Situation of BITAC and Role in Development of Local Die/mold industries

BITAC is a public technical supporting institution in Bangladesh for the manufacturing industries including die and mold industries. BITAC's major activities are providing technical training, R&D, and production of import substitutes (i.e. spare parts production) which includes fee-based processing service such as heat treatment. It also serves as a test center for private enterprises. Its training is composed of its own programs and those conducted as a part of Skills for Employment Investment Program (SEIP) and Skills and Training Enhancement Project (STEP), both of which are funded by donor projects.

Most of its machines and equipment in BITAC are old and not maintained well, obtained from the 1960's to the 1980's, and many of them are out of order, lack precision, or in a questionable condition whether they satisfy required accuracy. However, they have been replaced or newly installed by new machines and equipment for the last one or two years, and therefore it is expected that the scope of activity will be further expanded thanks to the improvement of facilities. The staff can operate machines but basically some of them still need to improve the applied and advanced technology. To become able to provide technical and consultation services for private enterprises, BITAC needs to learn theories on factor technology like mold-making and plastic processing and then deepen it through practice with machinery which meets the needs of the times.

The management of BITAC considers upgrading of technical expertise of its staff and installment of up-to-date machinery which is necessary to become able to provide technical support for the private sector. BITAC intends to achieve them first, and then to develop a technical support system built up on a network of technical support institutions and of experts in universities. In particular, BITAC is preparing for opening the Tool Institute in July 2020 which is equipped with fully new die/mold-making and testing tools and machinery to strengthen its die/mold making capacity and testing functions. Although there is still room for capacity building as a technical supporting institution, BITAC is the only institution that can provide technical support to the die and mold industries, and therefore, BITAC is expected to become a core supporting institution to the industry after the Tool Institution starts operation.

Finally, it is essential for BITAC to repeatedly learn, in addition to basic production skills and advanced technologies, production management technologies that help further enhance capabilities for their technical guidance to local parts suppliers and the supporting industries which need to produce products meeting required specifications in a stable manner. Moreover, BITAC needs to strengthen the following programs to the clients.

- Open up program of the latest facilities and equipment to the local companies
- Training program for fostering CAD/CAM and mechatronics experts using new facilities
- Joint product development program with private companies

2.4 Financial Access

(1) Current Situation and Challenges of SME Finance

Many LE and plastic companies face limited access to finance in Bangladesh. Especially, local manufacturing companies with employees of 31-120 persons which are expected to be the potential parts- suppliers and supporting companies (e.g. die/mold companies), face significant difficulty in access to mid- and long-term finance for investing in machinery automation and expanding their production space (this situation is called “Missing Middle Problem”). This is because cottage and micro companies, though having a little demand for finance, can access micro finance, while medium-scaled companies are rather creditable and a good market for loans from financial institutions. At present, however, there is no concessional financial scheme provided to the companies of the missing middle zone.

(2) Needs for Financial Service in Supporting Industries Development

In general, provision of the financing schemes for facility expansion or new investment is one of the key factors to proceed to the further stage for development of the supporting industries including parts suppliers. Almost all machineries and equipment for manufacturing of motorcycle parts, dies and molds have to be imported from other countries and the cost is high in Bangladesh. Moreover, these are up-front investment. There is absolutely needs for long-term capital on hand to invest. Further, the financing scheme should be a concessional loan with low interest, long-repayment period and relaxed collateral setting. Introduction of such the new financing schemes is desired to promote the supporting industries in Bangladesh.

2.5 Foreign Direct Investment

(1) Current Situation of FDI and Necessity to Attract Investment from Foreign Parts Suppliers

To realize industry diversification, Bangladesh needs to increase the manufacturing share of the GDP; however, the investment in the manufacturing sector, except mainly the garment industry and partially food processing, chemical and cement-making has remained small. Especially, the investment in the assembly-type manufacturing industry has been lagging behind these industries. For instance, FDI to transportation equipment (and metal-processing industry) have remained as low as 1% of total FDI inflow.

The Bangladesh government formulated the National Industrial Policy 2016 (NIP) that stipulates the investment promotion as one of its key elements. NIP identifies several strategic sectors for industrial diversification, such as leather, ICT, pharmaceutical, agro-processing, agricultural machinery, garment, ship-breaking and building, and light engineering; however, it does not clearly describe the measure to develop them. The motorcycle sector may be a part of LE industries, but there is no clear definition and investment promotion policy for the motorcycle sector in NIP. The government and private stakeholders have the common understanding that the motorcycle sector is the promising industry in Bangladesh now and needs more foreign direct investment in the sector.

Development of the local supporting industries through foreign direct investment especially joint venture business would enable the existing local manufacturing companies to improve their capability such as technology (including machine upgrading), skills, and management and thereby they would be able to become parts suppliers or supporting companies by improving their potentials. In many cases, a foreign company forms joint ventures with local companies (or 100% foreign owned) to adopt the conditions (or to obtain benefits from various incentives) set by the government of the recipient country which wants the former to transfer technology to the latter.

(2) Factors that Encourage Foreign Parts Suppliers

To attract many foreign companies and promote technical transfer to local companies from them, promotion activities such as targeted promotion and introduction of a set of schemes to encourage foreign direct investment including provision of appropriate incentives need to be conducted. It might be necessary as well to appeal to the existing Manufacturers in Bangladesh to bring their partner parts suppliers to Bangladesh to promote the technology transfer. This is because, in most cases in the motorcycle sector, a foreign parts supplier makes investment in new market other than home country based on the request from the parent motorcycle assembling companies or companies with strong business relationship at home. Therefore, a foreign parts supplier which is planning overseas investment conducts a feasibility study and makes investment plans together with those motorcycle assembling companies in home countries. They collate information on market and investment climate of destination countries. From this point of view, promotion activities to the parent company or customer motorcycle assembling companies of suppliers are key and very important.

(3) Needs for Promotion of FDI

At present, the motorcycle and parts industries are not defined as the high priority sector in NIP despite LE industry is defined as the high priority sector, and therefore, the industries are not entitled to corporate income tax exemption[3]. Reduction of tariff rates under SRO 155 for Manufacturers and parts suppliers is one of a few preferential treatments for the industries. While reviewing these tariff incentives and preferential treatments, the government will continue to improve the provision of the better investment environment for the potential foreign investors especially in the following points.

- Providing attractive investment incentives

For example, special treatment for import of used equipment from factories in China, India, and ASEAN countries, tariff reduction on imported raw materials which are required for parts production, corporate income tax reduction according to the amount of investment, etc.

- Providing investment information in an easy-to-understand way

For example, clear and organized information on relationship between investment conditions and incentives rendered as per the conditions, Bangladeshi companies as a potential counterpart of a joint venture, custom clearance procedure in Bangladesh, etc.

---

[3] In case of a foreign company invest in economic zones or export processing zones, they will be applied some preferential treatments such as income tax exemption.

3. Policy Measures and Action Plans

3.1 Vision and Mission

(1) Vision

In the next ten (10) years by 2030, Bangladesh will create supporting industries that will be a solid industrial base for development of the internationally competitive motorcycle sector; thereby contribute to the national economy in terms of GDP and creation of employment.

(2) Mission

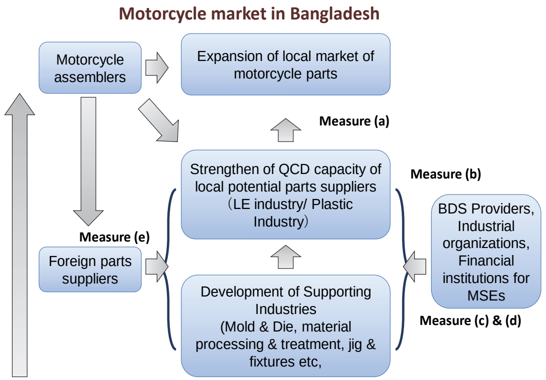
The Government of Bangladesh shall commit itself and extend necessary measures to develop the local supporting industries for the motorcycle sector in close collaboration with the private sector.

3.2 Measures for Development of Supporting Industries

Although there are a variety of issues to address to promote supporting industries for the motorcycle sector in Bangladesh, the following are considered to be the main measures.

(a) To develop and secure the market size with profitability for the parts industry;
(b) To cultivate awareness of skill improvement and business management required for the parts industry and apply those in a consistent manner to meet Quality, Cost, and Delivery (QCD) requirements set by Manufacturers.
(c) To develop local die/mold industries and strengthen testing facilities and expertise.
(d) To improve SME finance
(e) To promote business relationship with foreign supporting industries companies including parts-suppliers.

Especially, the measures (a) and (b) above are urgently required for development of the supporting industries for the motorcycle sector in Bangladesh. The measures (c), (d) and (e) are also addressed here because they are essential for the market expansion and capacity development for the parts supplier to meet the market needs in terms of QCD and confidence of Manufacturers.



Source: JICA Project Team

Figure 4 Development Direction and Measures

3.3 Expansion of Motorcycle Parts Market

(1) Measures to Expand Motorcycle Market

The first measure, creation of a large motorcycle parts market, largely depends upon industrial policy and tariff policy of the government as well as a marketing strategy and sales capability of Manufacturers and sales agencies. It is difficult for parts suppliers to open up a business opportunity all by themselves at present. MIDP deals with motorcycle market expansion, and the MIDP Coordination Council[4] monitors progress of the measures stipulated under the policy. Therefore, SIDP shall highlight the need to continue and/or speed-up the following actions:

- Extension of the validity period of the Statutory Regulatory Order (SRO) 155
- Reduction of tariff rates on imported raw materials and intermediate goods used for motorcycle and their parts production
- Reduction of the motorcycle registration cost (e.g. registration fees, road tax VAT)
- Development and introduction of motorcycle purchasing loan products by financial institutions with more preferable conditions

Some Manufacturers started producing a few parts after NBR had issued SRO 155 which gave duty benefits to the recognized Manufacturers. However, almost all Manufacturers have surplus production capacity and some of them have been struggling to keep the utilization rate

---

[4] The MIDP Coordination Council is the group of appointed people chaired by the industry minister for implementation and review of the progress of MIDP.

since they invested in anticipation of large demand. Sales expansion of domestically-built motorcycles is necessary to increase the domestic demand of motorcycle parts. To achieve the former, not only self-efforts by Manufacturers but a regulatory structure conducive to boosting the sales of domestically-built motorcycles is needed.

(2) Measure to Expand Motorcycle Parts Market and to Develop Supporting Industries

In addition to expansion of the motorcycle market, MOI will take the following actions from 1) to 3) to expand the motorcycle parts market and to develop the parts suppliers. Action of 4) is for developing the supporting industries to support expansion of the parts market.

1) Promoting parts localization policy to reduce sales price of domestic motorcycles
2) Supporting local potential parts suppliers to improve their capabilities (to meet QCD requirements set by Manufacturers)
3) Reducing import tariffs on imported raw materials and intermediate goods for making motorcycle parts (to reduce from the current 5% - 25% to1%)
4) Improving business environment of the supporting industries including parts suppliers (e.g. fostering of die/mold industries, mitigation of financial burden)

Details of actions are described in the following sections.

3.4 Promotion of Parts Localization

A motorcycle is composed of hundreds of parts (around 800 in case of the one with a 125 cc engine) whose production requires a wide variety of technologies. It is essential for parts to be locally produced in order to contribute to the reduction of motorcycle sales prices. It is also necessary to formulate and follow the pace of receiving foreign investment and technology transfer, and resulting improvement made by local companies in terms of QCD levels. The following action plan will be implemented to promote localization of motorcycle parts.

Various countries have adopted various ways to localize motorcycle parts. Among them, two different calculation methods of the localization have been often adopted; one is to measure an achievement ratio of the localized parts, and the other is to calculate by the number of the localized parts used in a product. Of the two, the former consists of several approaches including that to measure a value added ratio of the localized parts, total weight ratio of them, and their occupancy ratio in an assembled motorcycle. Nonetheless, all of them have different drawbacks in calculation in terms of complexity and lack of clarity.

On the other hand, another localization method, which is based on a parts-list designated for the localization according to the technological difficulty (or a compulsory deletion method), is clear and fair to all motorcycle assembling companies. Further, this method, by effectively using the import ban on the designated parts, could easily promote a scale merit of parts production for the local suppliers. As a result, almost all ASEAN countries have eventually adopted the compulsory deletion method, even if they had applied the ratio calculation methods at the beginning of their localization process. Although the difficulty of adopting of the deletion method lies in the consensus building among the stakeholders, the Bangladeshi government will adopt an appropriate localization method of motorcycle parts while adequately reflecting on the opinions of the supporting industries as well as Manufactures which purchase the localized parts.

Title	**AP 1: Implementation of Parts Localization Program**
Objective and Outline	To expand the local motorcycle-parts market through a parts localization program, contributing ultimately to expansion of the local motorcycle market by reducing parts procurement costs.
Implementation Period	10 years from the starting year. The content of the localization program and the timing of implementation will be decided by the Motorcycle Supporting Industries Development Committee (See Chapter 4 for the details of this Committee).
Implementing Agencies	MOI, NBR, and relevant industrial associations (BMAMA, MMEAB, ACAMA)
Target	Local Manufacturers, local and foreign parts suppliers
Activities and Step	MOI will discuss the content of the localization program such as deletion method with NBR and relevant industrial associations (Bangladesh Motorcycle Assemblers & Manufacturers Association (BMAMA), Motorcycle Manufacturers & Exporters Association of Bangladesh (MMEAB), and Automobiles Components & Accessories Manufacturers' Association (ACAMA)). NBR adjusts their tariff policy in tune with the agreement made by the associations. Setting the duration of this action plan for ten years, MOI, based on the discussion above, will determine when to start it. Although a certain market size is necessary to start this action plan, it appears that no specific market size has triggered the launch of a localization program in other countries. One of feasible options is, as the first stage, to encourage voluntary efforts by Manufacturers to locally procure the parts which require lower degree of processing for production and which cost high for transportation among metal processing parts and plastic parts. Which items to promote local production next shall be decided subject to the degree of sophistication of required technology and investment cost.
Budget	The program is promoted by the private companies
Indicator	After the start of this plan, yearly achievement will be measured by either the number of deletion-items or percentage (on a VAT base) of localized items.

3.5 Support for Production Technologies and Quality Management

SIDP aims mainly for the local potential parts suppliers to be recognized as the genuine suppliers satisfying the needs of their clients. Thus, these potential suppliers need to develop quality/production/delivery management system to meet strict criteria set by Manufacturers. The following shows major areas and elements that Manufacturers evaluate first when selecting their parts suppliers:

- Design: appropriate documentation control of drawings with a standardized form
- Raw materials: stock control with thorough application of the first-in first-out method
- Processing: setting and control of process conditions for every item, data collection on daily production and defects followed by analysis of the collected data, machine/tool maintenance and documentation of the maintenance record
- Quality control: inspection at every process and documentation of the inspection record
- Quality management system (QMS): development, application, and timely revision of QMS at every process from acceptance of raw materials to shipping
- Cost management: calculation of production cost, aggregated from the cost incurred at each process
- Continuous improvement: root cause analysis on defects and failure, implementation of countermeasures, and continuous monitoring
- Training: continuous training and documentation of the training record
- Others: traceability control, customer management, management philosophy, mid-term and long-term vision/business plan

The areas and elements mentioned above are the indicators for daily works which are to be achieved and necessary to become a real parts supplier. During the trial production period of prototypes, the parts suppliers need to keep improving their technological and managerial capability under the guidance of the expected customers (Manufacturers).

(1) Strengthening of Technology Competitiveness

To promote development of supporting industries and business relations between the industries and motorcycle manufacturing companies, the government shall support upgrading of technological capability of the LE and plastics industries.

Title	**AP 2: Program for Strengthening of the Competitiveness of Local LE and Plastic Industries**
Objective and Outline	To enhance competitiveness of local companies to become parts suppliers and other supporting industries for the motorcycle sector, thereby developing world-level local supporting industries.
Implementation Period	From October 2020 for five years as the first phase.
Implementing Agencies	MOI, Bangladesh Industry & Technology Assistance Center (BITAC) and Bangladesh Council of Scientific Research (BCSIR)
Target	Potential parts suppliers and supporting companies in LE and plastic industries
Activities and Step	This action plan intends to make a team of experts available on a regular basis for a certain period of time to the selected LE/plastics companies with potential in terms of growth and technical upgrading as parts suppliers and the companies in other supporting industries for the motorcycle sector including those making dies and molds. BITAC and BCSIR form a team to visit and advise each company. Tentatively, BITAC and BCSIR invite foreign experts who specialize in press working, injection molding, and SME management and they repeatedly advise the local experts assigned to help upgrade processing technology and management technology of the selected companies. For three years from the start, these consulting services will be provided as TOT rendered from the foreign experts to BITAC and BCSIR experts. For implementing this plan, BITAC will establish a specific section which is managing this plan in cooperation with BCSIR under the supervision of MOI. BITAC and BCSIR will assign those staff as the local experts of the plan. In parallel, it shall provide consulting services on the other areas such as heat treatment, surface treatment, and jig production as well as basic technical training for workforce in the LE industry. In addition, BITAC and BCSIR will make their facilities available for these supporting industries.
Budget	MOI secures a budget for the implementation of the plan.
Indicator	This action plan provides mainly on-site guidance and training services for 15 cases a year on average and to achieve a total of 40 to 50 successful cases (leading to real business sales to the motorcycle sector) will be achieved within 5 years.

(2) Improvement of Quality and Productivity

Some view that, given the wide availability of advanced machine tools, Bangladesh can readily manufacture products meeting international standards. However, introduction of advanced hardware alone never enables companies to produce items which meet QCD required by international manufacturers.

Once transactions with Manufacturers start, cost is the most critical factor. Parts suppliers need to build capacity to improve their productivity and calculate costs, which requires upgrading of technology in production and management, so that they can cope with cost reduction requests to be made by Manufacturers in the future. They also need to be able to carry out a value analysis to meet the request from Manufacturers through improving the products value.

KAIZEN, which has developed in the manufacturing sector in Japan as a set of approaches and methods to improve quality and productivity, is now recognized as a means to develop human skills and discipline to improve the quality of life and work. Not only the LE and plastic industries but also the whole industries call for the efforts to improve the quality of work. Introduction of KAIZEN in a company will obviously realize “change for better” in the current business operation of typical Bangladeshi companies.

Even the large plastic companies, which are exporting molded products, have a significant room for improvement of their production management and quality control compared to the international standards. It is beyond question that SMEs which currently target the domestic market need to strive hard to upgrade management technology to the international level if they aim to trade with internationally renowned companies. The following action plan will be implemented to enhance management technologies of LE/plastic companies.

Title	**AP 3: Program for KAIZEN (Quality and Productivity Improvement)**
Objective and Outline	To promote a change of mindset to create better working environment, develop human resources capable to produce items in compliance with international standards, and foster local potential companies to be equipped with world-level management structures and systems
Implementation Period	From October 2020 continuously.
Implementing Agencies	National Productivity Organization (NPO), Small & Medium Enterprises Foundation (SMEF), and Small & Cottage Industries Training Institute (SCITI).
Target	Potential parts suppliers and supporting companies in LE and plastic industries
Activities and Step	This plan consists of training, seminars, workshops and on-site consulting services on KAIZEN to LE and plastics industries to improve their management capability and develop human resources who promote KAIZEN with an ultimate goal to transform the mindset of industrial workforce (including top management) for international competition. The National Productivity Organization (NPO) and the Small & Medium Enterprises Foundation (SMEF), both of which are under MOI, shall conduct this plan with their budget. The Small &. Cottage Industries Training Institute (SCITI) shall also promote KAIZEN to micro enterprises in the LE and plastic industries.
Budget	MOI secures a budget for the implementation of the plan.
Indicator	Seminars and workshops of five to six times will be held every year for free, and over 300 local people will participate in the training programs in total. On the other hand, consultation services on site will be conducted on a fee basis. Productivity ratio of the Kaizen implemented companies will increase by 20-25%.

(3) Strengthening of Testing Function

The Bangladesh Standards Testing Institution (BSTI) provides testing and certification services for industrial items. However, companies often ask these services to universities due to constraints in equipment and human resource of the public organization including BSTI. BSTI does not provide any testing services for motorcycle parts at present. Whenever motorcycle and parts manufacturers in Bangladesh need parts-testing, they ask for it from Indian companies or institutions[5]. The following action plan will be implemented to strengthen testing function for industrial products

Title	**AP 4: Enhancement of Functions of Testing and Certification Center(s)**
Objective and Outline	To promote industrial standards, especially those related to parts and materials of automobiles including motorcycle parts and accessories, and assure quality of industrial products of Bangladesh with conformance tests
Implementation Period	From October 2020.
Implementing Agencies	MOI, Bangladesh Standards Testing Institution (BSTI), and BITAC.
Target	Local manufacturing industries, BSTI
Activities and Step	This action plan first aims to make BSTI better equipped in terms of equipment and human resources focusing on testing of motorcycles and their parts. BSTI will make a facility expansion plan, and then discuss it with MOI and BITAC. BITAC will undertake some testing and inspection function in the areas where BITAC can utilize the existing facilities. The Motorcycle Industry Development Policy (MIDP) states an idea of establishing an automobile testing center by referring to the Thailand Automotive Institute (TAI). Basically the function of BSTI and TAI is different since TAI is an industry association having testing function. On the other hand, there is a public testing institution namely, the Thai Industrial Standards Institute (TISI) in Thailand. TISI and TAI have been closely cooperating with each other in testing and certificating of some automobile parts and accessories. Therefore, referring to this Thai case, BSTI, BITAC and newly-established automobile testing center will demarcate the roles while ensuring cooperation with each other. Further, BSTI shall officially adopt the outsource testing of the parts and final products to assembly-type manufacturers while referring to the Thai method. MOI is already working on how to secure funds for establishing a similar testing center and continue to strive for the realization of the establishment, asking for support from international organizations. MOI will expand testing facilities and equipment to meet industrial needs.

---

[5] Exhaust test under the emission control regulation is formally done by the Bangladesh Road Transport Authority (BRTA). And the Bangladesh Council of Scientific and Industrial Research (BCSIR) provide testing services for some imported industrials goods.

Budget	MOI, BSTI, and the Ministry of Finance (the Government of Bangladesh) secure a budget.
Indicator	The number of testing and inspections items and cases but it will be decided when the detail plan is finalized. Five different types of testing services (methods) will be established every year.

3.6 Support for Die and Mold Industries

Dies and molds play an essential role in press working, casting, forging, and plastics molding, thus holding the key to reliable supply of numerous products. It is therefore significant to establish a unit specialized in promotion of supporting industries within BITAC, which will then provide consulting services and technical guidance for die/mold making, together with provision of processing technology to local companies. BITAC will also conduct a training program in human resource development in the die/mold industries. The following action plan will be implemented to support development of the local die/mold industries

Title	**AP 5: Program for Nurturing Die/Mold Making Technicians and Engineers**
Objective and Outline	To nurture die/mold making technicians and engineers. Topics of the training will include knowledge of plastic resin/steel including those used for industrial parts, processing conditions, finishing and improvement of defects especially for industrial parts molding.
Implementation Period	From October 2020 for 5 years.
Implementing Agencies	- BITAC (a main implementing agency) - Pilot Plant and Process Development Center (PP & PDC), BCSIR - Bangladesh Institute of Plastic Engineering and Technology (BIPET) (a supporting agency)
Target	- Technicians and engineers of specialized die/mold making companies and LE/plastics companies
Activities and Step	The plan will comprise both classroom and onsite practical training on basic and applied topics. These topics will include the following: - Characteristics and processing conditions of various types of steel - Knowledge and techniques of heat/surface treatment and alloy designing/metallurgy - Basics of drawings and applied knowledge of die/mold drawings - Knowledge and techniques of processing/machining including CNC machine operation - Processing accuracy - Maintenance and troubleshooting of dies/molds, etc. - Both dies/molds for LE products (especially dies for pressing) and molds for plastic products will be taken up in the training. Training of basics (theories) of die/mold-making will be provided for both the products together, while practical training of processing technologies will separately be rendered. Whereas the training is supposed be conducted twice (two days) per week over the two-month period (15 times), the actual schedule will be elaborated after discussion with the companies. The main training venue will be at the Tool Institute of BITAC.
Budget	Participants in the training need to pay fees (the amount will be decided later).
Indicator	- Two hundred (200) technicians will be trained in the program by the end of action plan implementation for 5 years. - More than 30 dies/molds prototypes will be developed for the local industry for 5 years.

3.7 Introduction of Long-Term Finance Schemes

As mentioned earlier, many of LE and plastic companies have limited access to long-term finance. Especially, companies defined as small companies which have employees of 31-120 persons, face significant difficulty in access to it. The following action plan will be implemented to facilitate SMEs’ access to long term finance

Title	**AP 6: Support in Establishing Two-step Loan for SMEs**
Objective and Outline	To support SMEF in establishing a low-interest, long-term two-step loan for LE and plastic SMEs to make capital investment in producing import substitution products, export products, parts of motorcycles and automobiles, and dies/molds. SMEF will provide this loan through the participating financial institutions (PFIs).
Implementation period	Starting planning of a scheme in October 2020.
Implementing Agencies	- SMEF - PFIs collaborating with SMEF
Target	- SMEs in LE and plastic companies
Activities and Step	The Ministry of Finance, MOI and Bangladesh Bank are responsible for raising the loan fund. The loan in Bangladesh would flow from the Ministry of Finance or Bangladesh Bank to MOI, SMEF, PFIs and then borrowers. (1) Step 1 (Implementation schedule cannot be assumed at this point) a. MOI and SMEF with support from the Bangladesh Bank will design the two-step loan. ➢ Main target will be small companies (with employees between 31 and 120). ➢ Terms and conditions of the loan will be elaborated based upon the existing public loan schemes of SMEF. ➢ The loan will target only capital investment to purchase new machines/equipment for modernization of production facilities, not for

	the second-hand machines. b. MOI will coordinate with the Ministry of Finance, Bangladesh Bank, SMEF, the financial institutions interested in this scheme etc. c. SMEF will set up the implementation system. (2) Step 2 (Implementation schedule cannot be assumed at this point) a. SMEF will select PFIs. b. SMEF will consider whether technical services will be provided in conjunction with the loan according to the progress of other action plans.
Input	- The repayments from the original loan will be accumulated at SMEF as revolving funds. - The Bangladesh Bank provides a supplementary portion.
Budget	The total fund amount will be decided when design of the loan is elaborated in Step 1 in consideration of the available amount of SMEF' revolving fund. The total number of the loan executed will be 200 or over every year.
Indicator	- The loan will be accessed by 200-250 companies every year. - Ratio of non-performing loan (the ratio will be decided by SMEF).

3.8 Promotion of Investment of Foreign Parts Manufacturers

To upgrade skills and management techniques of local supporting industries especially potential parts suppliers, effective promotion of foreign investment is also essential. In Bangladesh, the Bangladesh Investment Development Authority (BIDA) is responsible for promotion of foreign investment, and the Bangladesh Economic Zones Authority (BEZA) develops and manages economic zones in view of generating more spillover effects of investment for industrialization in the country, while the National Board of Revenue is responsible for taxation policy. Therefore, BIDA, BEZA, NBR and MOI will implement promotion strategies and activities in collaboration focusing on motorcycle and parts industries as well as their supporting industries.

To attract more foreign companies and expose local companies to advanced techniques, the investment promotion activities, such as targeted promotion and provision of a set of appropriate incentives, need to be conducted. It might be necessary as well to appeal to the existing Manufacturers to bring their partner parts suppliers to Bangladesh to promote the technology transfer.

Title	**AP 7: Strategic Investment Promotion Activities Targeting Foreign Supporting Industries**
Objective and Outline	To expose local companies to advanced techniques and facilitate industrial upgrading
Implementation Period	From October 2020.
Implementing Agencies	BIDA, BEZA, NBR and MOI
Target	Foreign motorcycle assembling companies and foreign parts suppliers.
Activities and Step	Step 1. MOI will formulate a foreign investment promotion plan for the motorcycle and parts industries. MOI will formulate the promotion plan for implementation. The promotion plan targets selected countries and covers strategies, promotion methods, utilization of local embassies, the number of promotion events, etc. The following points are specially considered as the attractive promotion plan. a. Special treatments for import of used equipment from factories in other countries. b. Tariff reduction on imported raw materials and intermediate products which are required for parts production. c. Corporate income tax reduction according to the amount of investment Step 2. MOI will secure a budget, and request cooperation from BIDA, BEZA, NBR, MOFA (Ministry of Foreign Affairs to cooperate with embassy staffs), and the related organizations. The foreign investment promotion programs are implemented by BIDA and BEZA in Bangladesh. Meanwhile, MOI, in this plan, will make plans of foreign investment promotion focusing on the target industries or target areas and implement it in collaboration with BIDA and BEZA, while MOI and NBR will collaborate in tax-related issues. MOI will ensure that it will work together with these organizations from an early stage. Step 3. MOI will discuss with the organizations above to set rules and prepare incentives. MIDP provides for an initiative to develop an automobile components manufacturing park/cluster, which is under discussion with the Bangladesh Small and Cottage Industries Corporation (BSCIC), BEZA and BEIOA. MOI shall make the best use of this automobile components manufacturing park/cluster project for investment promotion. Step 4. MOI will work with foreign motorcycle and parts associations In major motorcycle manufacturing countries such as India, Thailand and Japan, solid organizations which were established by automotive manufacturers including motorcycle and their parts suppliers have been operating for many years. For instance, the following associations actively work with their counterparts in other countries to exchange information and co-operation in trade matters. As a stepping stone to attract foreign parts suppliers, the relevant local industry associations in collaboration with the government will contact these counterparts overseas. - Automotive Components Manufacturers Association of India (ACMA) - Thai Automotive Industry Association (TAIA) - Japan Auto Parts Industries Association (JAPIA)

	Step 5. MOI, in collaboration with BIDA and BEZA as well as the embassies and associations in respective countries, will organize investment promotion seminars and individual promotion activities to the foreign companies. It is important to always hear and check the needs and problems from the potential foreign investors and the local industry to make the effective investment promotion plan.
Budget	Firstly, MOI will secure budget for implementation of the plan. Some program budgets of BIDA and BEZA will be used for implementation of the plan as well.
Indicator	Number of investments in the targeted areas. More than five new foreign investment projects will be approved every year.

Table 5 Outline of the Action Plans

Title	AP 1 Implementation of localization program	AP 2 Program for strengthening of the competitiveness of LE & plastic industries	AP 3 Program for KAIZEN	AP 4 Enhancement of functions of testing and certification center	AP 5 Nurturing Die/mold Making	AP 6 Support in Establishing Two-step Loan for SMEs	AP 7 Strategic investment promotion activities targeting foreign supporting industries
Objective and Outline	To expand the local motorcycle-parts market through a parts localization program, contributing to expansion of the local motorcycle markets by reducing parts procurement costs.	To enhance competitiveness of local companies to become parts suppliers and other supporting industries for motorcycle sector, thereby developing world-level local suppliers.	To promote a change of mindset to create better working environment, develop human resources capable to produce items in compliance with international standards, and foster local potential companies.	To promote industrial standards, especially those related to parts and materials of automobiles including motorcycle parts and accessories, and assure quality of industrial products of Bangladesh with conformance tests	To nurture die/mold making technicians and engineers.	To support SMEF in establishing a low-interest, long-term two-step loan for LE and plastic SMEs to make capital investment in producing import substitution products, export products, parts of motorcycles and automobiles, and dies/molds.	To promote technical transfer from foreign companies to local companies
Implementing Agencies	MOI NBR BMAMA, MMEAB, ACAMA	BITAC NPO BCSIR	NPO SMEF SCITI	MOI, BSTI BITAC	BITAC, BCSIR-PP & PDC, BIPET	Bank of Bangladesh SMEF Participating financial institutions	MOI BIDA BEZA
Target	Local motorcycle assembling companies and (potential) parts suppliers.	Local (potential) parts suppliers and supporting industries	Manufacturers, parts suppliers and supporting industries	BSTI, BITAC and local manufacturing companies	Technicians and engineers of LE/plastic companies	SMEs in LE/plastic companies	Foreign manufacturers
Implementation Period	Preparation period; October 2020 10 years from the start year.	Preparation period; From October 2020, Implementation for 5 years	From October 2020 continuously,	(already under consideration on this plan by MOI) Implementation period; October 2020 -	From October 2020 for 5 years	Preparation period; From October 2020	Implementation period; From October 2020
Fund Sources	MOI and Private companies	MOI budgets for BITAC and NPO	MOI budgets for NPO, SMEF and SCITI	MOI, MOC	MOI, BITAC (collecting a participation fees)	Bank of Bangladesh, (in some part from PFIs)	BIDA, BEZA
KPI	After started the plan, yearly achievement will be measured by either the number of deletion-items or percentage (on a VAT basis) of localized item.	On-site guidance and training services for 15 cases a year. And 40 to 50 successful cases (leading to real business sales to the motorcycle sector as parts or processing support business for the parts suppliers) will be achieved within five years.	Seminars and workshops of five to six times will be held On-site consultation services will be conducted on a fee basis. Productivity ratio of the KAIZEN implemented companies will increase by 20-25%.	Testing services at new center will start sequentially from July 2024. The number of testing and inspections items and cases which will be decided when the plan is finalized. Five different types of testing services (methods) will be established every year.	- Two hundred (200) technicians will be trained in the program by the end of action plan implementation for 5 years. - More than 30 Die/mold prototypes will be developed for the local industry for 5 years.	- The loan will be accessed by 200-250 companies every year. - Ratio of non-performing loan (the ratio will be decided by SMEF).	Number of investments in the targeted areas. More than five new foreign investment projects will be approved every year.

4. Implementation System

4.1 Establishment of Motorcycle Supporting Industry Development Committee

As an entity to discuss, implement and manage SIDP, the Motorcycle Supporting Industry Development Committee consisting of the following members shall be established under the Minister of Industries. Suggested committee members are those of the already existing MIDP Coordination Council for development of motorcycle industries with representatives of the LE and plastics industries.

The committee convenes quarterly to monitor if SIDP is properly implemented and to determine actions if needed. The committee can establish the technical sub-committees when a need for consultation on technical matters and proposals to the committee arises. The committee also utilizes domestic and foreign technical experts including donner agencies.

01.	Honorable Minister, Ministry of Industries (MOI)	Chairperson
02.	Secretary, MOI	Member
03.	Secretary, Ministry of Finance	Member
04.	Chairman, National Board of Revenue	Member
05.	Chairman, Bangladesh Tariff Commission	Member
06.	Secretary, Ministry of Commerce	Member
07	Director General, Bangladesh Industrial Technical Assistance Center	Member
08.	Managing Director, SME Foundation	Member
09.	Deputy Governor, Bangladesh Bank	Member
10.	Executive Member, BIDA	Member
11.	Deputy General, Bangladesh Standards & Testing Institution	Member
12.	President, Federation of Bangladesh Chamber of Commerce & Industries (BCCI)	Member
13.	President, Bangladesh Motorcycle Assemblers & Manufacturers Association	Member
14.	President, Motorcycle Manufacturers & Exporters Association of Bangladesh	Member
15.	Chairman, Bangladesh Steel Engineering Corporation	Member
16.	President, Bangladesh Engineering Industry Owners' Association	Member
17.	President, Bangladesh Plastic Goods Manufacturers & Export Association	Member
18.	President, Automobile Components & Accessories Manufacturers' Association	Member
19.	Additional Secretary, MOI	Member
20.	Specialists of Motorcycle sector nominated by the Govt. (2 parsons)	Member
21.	Joint Secretary (Policy), Deputy Secretary (Policy) MOI	Member Secretary

4.2 Implementation of SIDP

(1) Work Procedure

1) Once every six months the committee holds the meeting. The committee monitors whether SIDP is being properly implemented and if there is any problem in implementing the plan, then it recommends for proper solution.

2) Secretary, MOI convenes additional meeting as per situational demand.

3) Secretary, MOI coordinates with MIDP Coordination Council and to form a joint meeting as per situational demand.

4) The committee nominates the new members if needed.

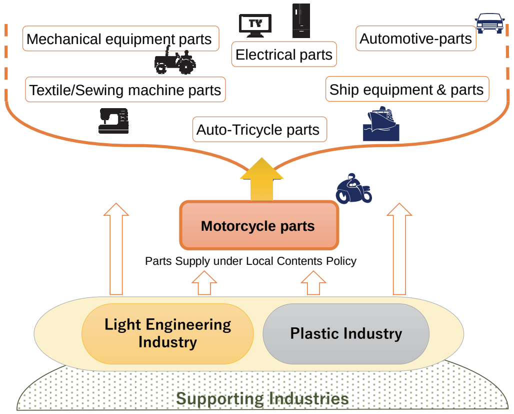
(2) Popularization of SIDP

1) MOI considers declaring SIDP as a national industry development plan in 2020.

2) MOI in cooperation with public and private print and electric media undertakes a campaign about the plan to sensitize all relevant stakeholders, business community and the general people.

4.3 Future Scope of Supporting Industries Development

SIDP is primarily intended for development of supporting industries for the motorcycle sector, but its scope can be extended to that for other assembly sectors which also need backward linkages with the LE industry and the plastic industry. Figure 5 presents the conceptual idea. Starting with the promotion of domestic production of motorcycle parts, the government shall pursue the same for production of machine parts, parts for electrical tricycles, automotive parts, and then parts for other assembly industries, with an ultimate goal to make the local parts industry more diversified and competitive.



Source: JICA Project Team

Figure 5 Future Scope of Supporting Industry Development in Bangladesh