8-3 Modernization of Production Control

8-3-1 Product Development and Design

Hungary has been pushing forward with the transition to a market economy ahead of other East European countries. However, its domestic economy remains stagnant, having been dealt a severe blow by the dissolution of COMECON and confusion in the former Soviet Union, which was its major market. Many Hungarian companies are looking for new markets in West Europe. Under such circumstances, the Development Department of IMAG is charged with the task of rapidly developing products that meet the market needs for entering a new market. When the company enters a new market, it will face increased, diversified, and sophisticated user demands for design and quality. To meet these demands, it must boost its product development capabilities and modernize its design methods.

1) Enhancement of product development functions

The automobile industry responds to market demands quickly and accurately, and is always making design and technological innovations. Consequently, the automotive parts industry is forced to strengthen its development capabilities to keep up with the rapid progress in design and technology.

In the automotive parts industry, products such as seats are generally developed to specifications based on a basic design prepared by the automakers. Product development generally begins with a commodity scheme and a subsequent product project. However, when basic specifications are given by automakers (manufacturers of automobiles or railroad vehicles) as in the case of automotive seats, a commodity scheme is not necessary, and thus, product development usually begins with a product project. The Development Department of IMAG does not have such a product project function. It is recommended that the company should create structures and functions for carrying out the following activities.

When an order is received from an automaker, the actual composition of the product (seat) and the specific requirements the product must satisfy are planned in the product project. Table 8-3-1 shows the main items which should be planned.

Table 8-3-1 Items of Product Project

Item	Contents
Aims of development	Purpose of development. To make clear how to add attractiveness to the product. To foresee social environment, market environment and competition.
Model structure	To define model, production scale and variation for each grade of the products.
Basic dimension design, construction	To define important items within restricted dimensions (space, design, safety) and to define devices and construction of newly adopted products
Performance. quality	To define safety, amenity, endurance and stability
Cost target	Customers will decide the price of products in free market. To define a target cost for design, engineering, production and purchasing.
Development schedule	to define schedule for development concept, design decision, design, trial making and mass production. To establish effective schedule without too much overwork.

The flow of work from the product planning through the early stage of product development and the production preparation stage to sales is shown in Figure 8-3-1.

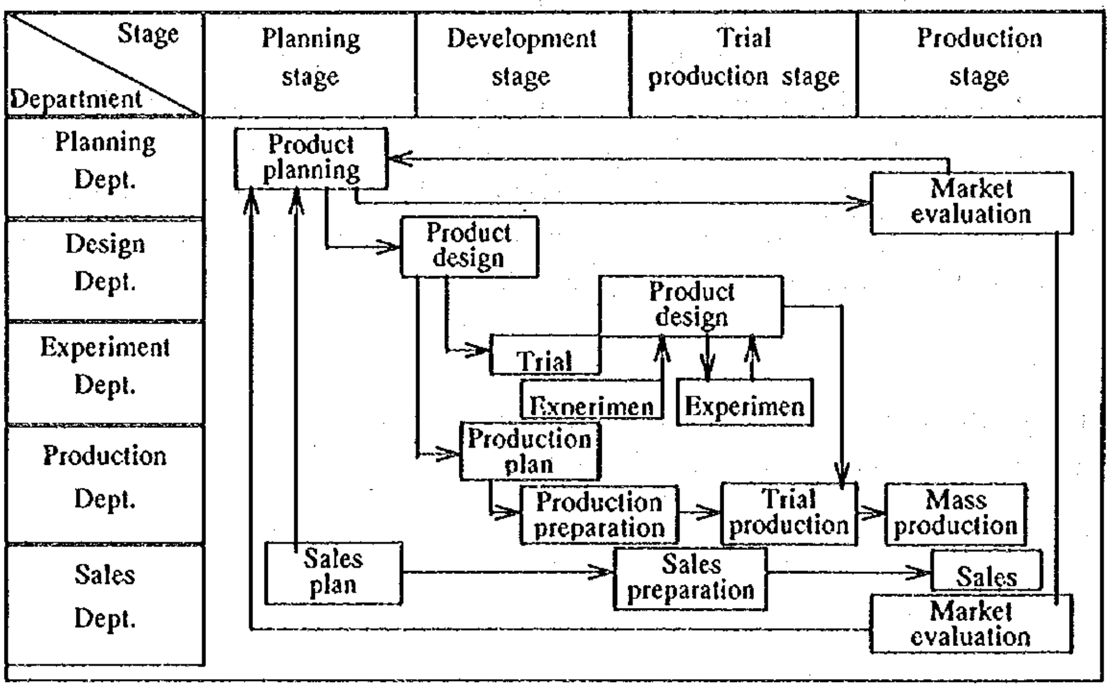


Figure 8-3-1 Flow of Work for Developing a New-product

Seventy percent (70%) of the cost of a product is said to be determined in the design stage. Figure 8-3-2 shows the relationship between decisions regarding costs and actual costs and the relationship between cost reduction efforts and effects in the process from the product project to production. It can be seen what an important role the product project and design play in the cost decision of a product.

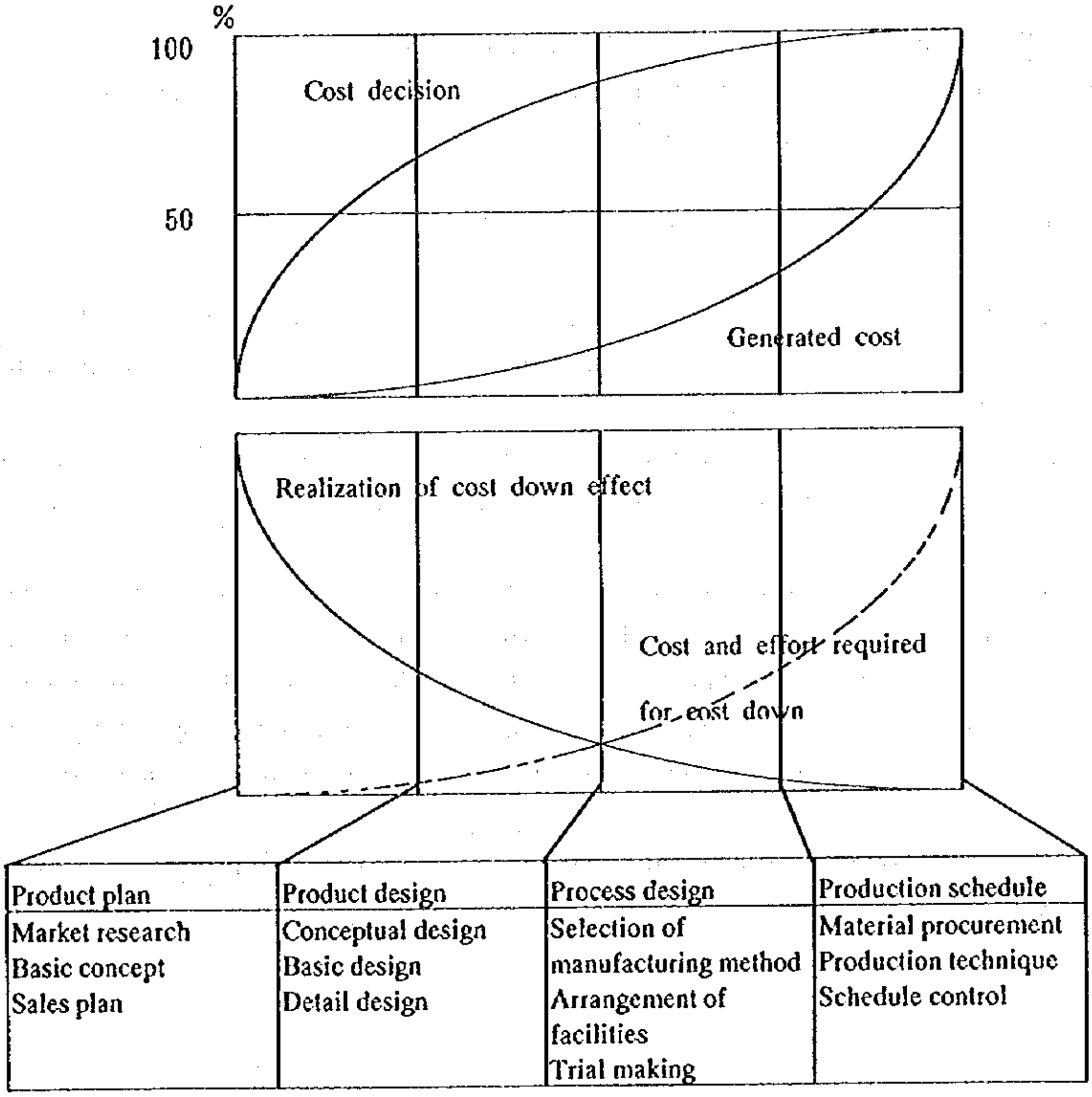


Figure 8-3-2 Relationship between Costing Decisions and Actual Costs of a Product

2) Design review (DR)

For managing reliability in the development and design stages, i.e., for the effective determination of a design specification, aimed at achieving a high reliability, it is necessary to carry out a design review (DR) at each milestone in the development stage and make scrupulous decisions. This is because the design control article in ISO 9001 stipulates that design reviews should be conducted as a management tool for verifying designs. The times when design reviews should be carried out and the items to be reviewed can be roughly classified as follows:

[Time]	[DR items]
(a) Concept stage	Discuss the basic specification for the purpose of achieving the quality goal (stable quality).
(b) Design stage	Review the reliability (durability, safety)
(c) Testing stage	Review test plans and evaluate prototypes (for ease of production and maintenance)

The general principles of design reviews include:

(a) The design review board should be composed of representatives of the Development, Production, Quality Assurance, and Purchasing Departments concerned with quality control as well as the best possible experts.

(b) The members should carefully study the specifications and related materials in preparation for the board meetings, and the review should be made using predetermined criteria according to a check list.

(c) All the problems revealed in the review should be recorded. The decisions concerning design changes are left to the individuals in charge of the design, but the ultimate responsibility lies with the design supervisor. The person who has the ultimate responsibility acknowledges the completion of each design review by signing his/her name. Without this signature, the development should not proceed to the next step.

An example of a DR check list for seat development (in the testing stage) is shown in Table 8-3-2.

Table 8-3-2 An Example of a DR Check List (in the testing stage)

Üléskiértékelés

1 :Modell neve : ____________
termék neve : ____________
2: kiértékelés időpontja : ____________
3: résztvevő neve : ____________

	Külső megjelenés ellenőrzési pontjai	jó ◎	átlag ○	rossz ×	megjegyzés
01	Varrat gyűrődés, foszlás				
02	Ülésfelület varratának foszlása, cérnaszakadás				
03	Ülésfelület varratának iránya egyenes-e ?				
04	Ülőfelület varrat vonalai párhuzamosak-e ?				
05	Varrás egyenletes-e ?				
06	Szegély látszik-e ?				
07	A belső párna, csővaz látszik-e ?				
08	Kényelmetlenség van-e ?				
09	A háttámla, ill. a háttámla és a fejtámasz között rés van-e ?				
10	Alkotóelemek pontosan *1 illeszkednek-e egymáshoz ?				
11	Rendellenes zörces van-e ? *2				
12	A háttámla hátradöntésekor van -e gyűrődés ?				
13	A háttámla előredöntésével összenyomódás van-e ?				
14	A fejtámla habosítás összeillesztési rojtjai ?				
15	Kézzel tapintható rendellenességek ?				
16	Az ülésnek vannak e csavarodásai ?				
17	Hibás alkatrész felhasználás van-e ?				
18	A műanyag alkatrészek minősége, illesztése ?				
19	Az ülés egészén vannak -e rendellenes gyűrődések, alakváltozások ? *5				
20	C profil, csővaz veszélyes lehet-e ? *4				
értékelés					

No.	mechanizmus ellenőrzési pontok ◎ jó ○ átlag × rossz	ülés előre hátra mozgatása	háttámla mozgatás	ülésmagasság állító *3	ülés	fejtám	kartám	ülésmozgató sín	megjegyzés
01	mozgatás								
02	zárás								
03	zárás kioldása								
04	ütközés (érintkezés)								
05	zajok, rezgések								
06	veszélyesség *4								
07	pontatlanság *2								
08	fogaskerék illeszkedés								
09	irányíthatóság, kezelhetőség								
10	strapabíróság								
	Egyéb megjegyzés								
értékelés									

Összértékelés

* 1 kézzel rázzuk meg

* 2 műbőr, illetve a rugó nyikorkása
* 3 próbáljuk ki fent és lent
* 4 gyakorlatban alkalmazzuk kezünket és lábunkat
*5 térdünket és könyökünket szorítsuk hozzá

The use of the above check list is not limited to the design review. It can also be used to evaluate the quality of mass-produced products or for making comparisons with the products of other manufactures.

As an example, during the second field survey, seven employees of IMAG used this check list on an experimental basis for an appearance evaluation (20 items) in which bus seats made by IMAG and the German company KIEL were compared. The results are shown below. The figures indicate the total of all the items as rated by all the evaluators.

(a) Of the 20 items checked, the number of ◎ marks for IMAG's product exceeded that for KIEL's only for the following three points.
   05: Irregularities in the outer seams of seat surfaces
   06: Exposure of tucked edges
   20: Danger from burrs on frames

(b) IMAG's product was rated poorly for the following points and got bad marks (X).
   03: Misalignment of stitches
   07: Exposure of urethane and frame contents
   09: Clearances between cushion and back, and between back and H/R
   10: Abnormal play
   11: Unusual noises
   12: Sags or wrinkles in seat surfaces when seat back is tilted backwards
   14: Exposure of parting line in pads
   15: Inclination and torsion of seats

These are the results obtained. The rating is factual, demonstrating the effectiveness of the check list. Thus, the following effects can be expected of a design review.

Appearance evaluation (◎ : good ; ○ : average ; X : poor)

KIEL			IMAG		
◎	○	×	◎	○	×
60	54	6	42	70	8

(a) Conducting design reviews without fail after important phases of the development helps to ensure quality targets are met at the beginning of mass production.
(b) Results of design reviews are persuasive enough to prompt subsequent action.

(c) A design review will work better if it is conducted by each division in parallel with engineering work (described in Section 8-3-5, Paragraph 4) in the concept or design drawing stage of development.

3) Standardization of design work

IMAG does not have company standards for design work. However, standardization of design is so necessary for the accumulation and upgrading of technology that the degree of standardization is said to indicate the technological level of a company.

An example of a company standard system is shown in Figure 8-3-3. The standards associated with product development and design are placed at a low level in this system and include design standards and product standards.

- Company standard
  - Business standard
  - Technical standard
    - Design standard
      - Drawing regulations
      - Design basis
      - Standard components
      - Standard materials
      - Surface finishing standard
      - Manufacturing standards, etc.
    - Product standard
      - Product code
      - Component code
      - Product marking method
      - Repair parts code, etc.
    - Manufacturing standard
    - Material standard

Figure 8-3-3 An example of a Company Standard System

The products which are mainly produced on an order basis such as bus seats can be roughly classified as follows:

(a) Products for which designs already exist
(b) Products for which design changes are required
(c) Products for which a new design is required

As can be inferred from this classification, the diversification of customer demands or needs for new products can be addressed in many cases by the application of existing technologies or partial changes to a design. Thus, companies must accumulate the data necessary for design purposes and have them available for designers to use at anytime.

IMAG accumulated a great deal of expertise in product development and design in the days when it belonged to IKARUS. It should not only use this expertise simply as past experience but should also systematize and standardize it to minimize the time and cost of making new designs and to improve the company's technological level.

4) CAD/CAM

This subject is discussed in Section 8-3-5 "Information Processing System."

8-3-2 Inventory Control

Although the production of bus seats decreased to 1,000/ year from a peak figure of 14,000/ year, part of the production facilities used at the peak time is still employed today just as it was. In contrast, the production of passenger car seats has been increasing rapidly since production started in 1992, and has reached 50,000 per year. In this transitional period, the solution of the inventory problem is one of the toughest challenges for IMAG because it has a large inventory.

1) Integration of both organizations and functions

The bus seats are produced by the Bus I and Bus II Divisions, while the passenger car seats are produced by the Passenger Car Seat, Bus I, and Bus II Divisions. However, the procurement of materials and control of inventories are carried out by the three divisions separately. This tends to increase expenses due to increased personnel and causes errors due to duplication of activities. The company should use its personnel and warehouse space more efficiently by reducing the number of inventory control staff for seats to a total of two at the most (for the bus divisions and Passenger Car Seat Division). It should also consider entrusting the inventory control for bus seats to the Bus Coordination Department.

2) Improvement of inventory control methods

Ideally, the inventory should be zero. However, since some inventories are inevitable, it is necessary to clarify the roles of individual inventories and manage and improve them carefully.

(1) Types and roles of inventories

Inventory is said to be a necessary evil, which means that it also brings benefits. The types of inventories and their benefits are described below.

(a) Process stock

This is required since the transfer of articles between processes (such as procurement, production, and shipment) takes time. Using process stock as a buffer makes it possible to separate individual processes and run them effectively.

(b) Safety stock

This is kept to prevent problems due to changing market demands for products. It makes it possible to respond to unpredictable market requirements promptly.

(c) Batch stock

Materials are accumulated and stored in batches so that production and purchasing can be done economically. Materials may be purchased at lower prices if bought in bulk, and producing products in batches can reduce their manufacturing costs.

(d) Seasonal stock

Products for which the demand changes seasonally are produced in advance and kept in stock. This stock allows production activities to be levelled.

In these ways, carrying inventories makes it possible to perform production activities efficiently. However, it also entails the operating costs of the warehouses (labor costs and equipment costs), interest changes, and insurance expenses. In addition, it leads to deterioration of quality during storage, obsolescence of products, and loss of value due to design changes.

Thus, in controlling inventories, it is necessary to clarify the purposes of the inventories and provide supplies smoothly in response to demand at minimum cost, while taking full advantage of the benefits described above.

(2) Methods for ordering and inventory control

The following concepts and methods are available for ordering and controlling inventories which can be used to determine the quantity of an inventory.

(a) Economical order quantity (EOQ)

The economical order quantity is the order quantity that minimizes the sum of the ordering cost and inventory cost. If the quantity required annually is D and the quantity of a single order is Q, then the number of orders per year is given by D/Q. As shown in Figure 8-3-4, if orders are placed at regular intervals, then the average quantity of the inventory in a year is given by 1/2 x Q.

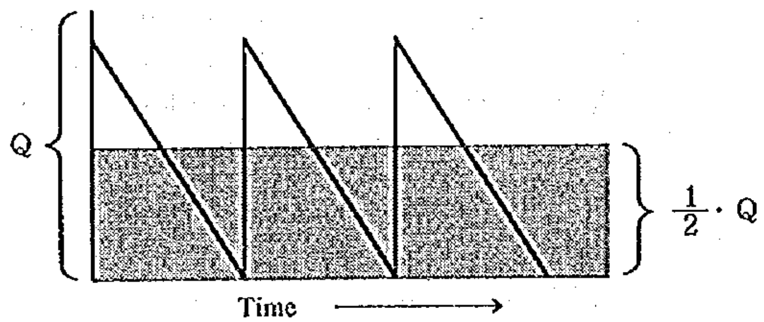


Figure 8-3-4 Changes in the Quantity of an Inventory

Now, if the cost for of a single order is a, and annual inventory cost per unit is b, then

Annual ordering cost = a × D/Q
Annual inventory cost = b × 1/2 × Q

Thus, the total annual cost C is given by
$C = a \times D/Q + b \times 1/2 \times Q$

Now, solving dC/dQ = 0 for Q and rearranging gives
$0 = -a \times D/Q2 + b \times 1/2 \qquad a \times D = b \times 1/2 \times Q2$

Hence
$Q = \sqrt{2aD/b}$

Thus, Q is the most economical order quantity (known as EOQ).

(b) Ordering systems

Inventory control can be roughly classified according to the ordering method as the fixed quantity ordering system and the fixed interval ordering system.

a) Fixed quantity ordering system
In this method the order quantity is set at a fixed value. The ordering point varies with the speed of use. Changes of inventory using the fixed quantity ordering system are shown in Figure 8-3-5.

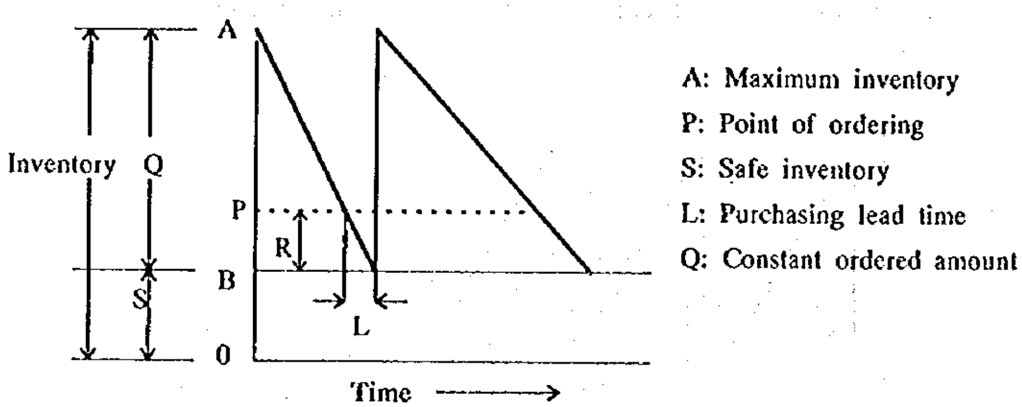


Figure 8-3-5 Changes of Inventory Using the Fixed Quantity Ordering System

In the figure, the amount of the inventory decreases gradually from the maximum inventory A, and when the ordering point P is reached, a fixed quantity Q is ordered. Since a lead time L is required between the order and the delivery, the inventory decreases further until it reaches point B. When the order is delivered, the inventory returns to point A again. S is the safety stock. From the figure,

OP = R + S

Newly the ordering point in the fixed quantity ordering system = average quantity used during the lead time + the safety stock

This means that if the lead time is short, only a small quantity of inventory is required at the ordering point.

b) Fixed interval ordering system
In this system, the ordering point is set in advance. When this point is reached, an order is placed. The delivery is made after a certain lead time. Figure 8-3-6 shows changes of inventory when using the fixed interval ordering system.

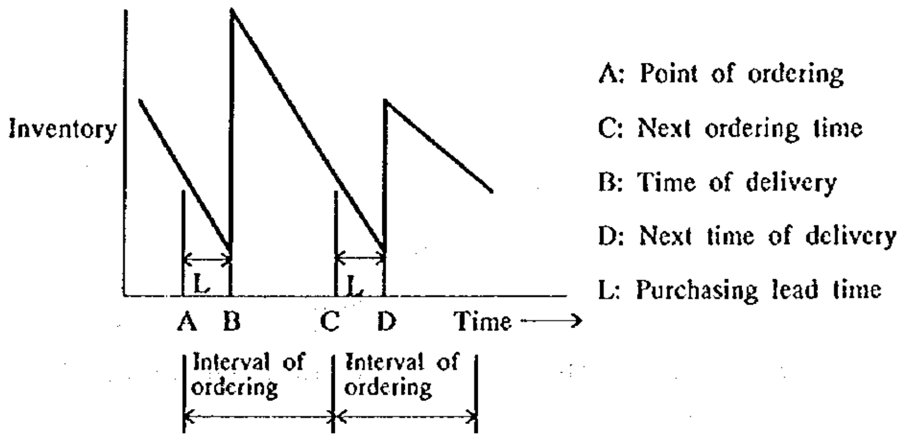


Figure 8-3-6 Changes of Inventory When Using the Fixed Interval Ordering System

In the figure, an order is placed when the ordering point A is reached, and delivery is made at point B after the purchasing lead time L. Thus, the order quantity at point A is determined by estimating the demand during the period A-D. The order quantity is given by the following formula.

Order quantity = forecasted average demand during the ordering interval and purchasing lead time + safety stock - effective stock at the time of ordering

where

Effective stock = stock in hand + unfilled orders - reserved quantity

Unfilled orders: quantity undelivered out of quantity ordered

Reserved quantity: quantity reserved for use out of the stock in hand

(c) ABC method

ABC control, which aims at selective control, classifies inventory items by monetary value so that individual categories can be managed differently. In Figure 8-3-7, the horizontal axis shows the percentage of items inventory plotted in the descending order of stock value during a certain period, and the vertical axis shows the cummulative value of the stock.

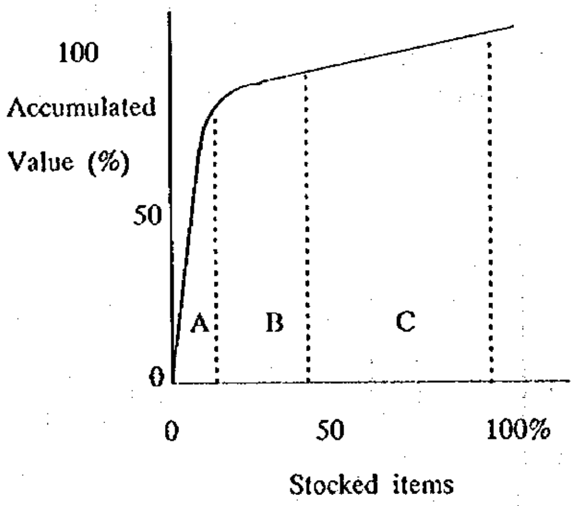


Figure 8-3-7 ABC Analysis of Goods in Inventory

In the figure, although A constitutes only a little more than 10% of the items, it accounts for 75% of the total value. In contrast, although C represents nearly 60% of the items, it accounts for only 5% of the total value. It is irrational to manage such an inventory uniformly. ABC control places emphasis on type A and pays the least attention to type C.

(3) Improvement of inventory control methods

Each of the three divisions engaged in the production of automotive seats orders each month the quantity, obtained by adding a safety margin to the quantity required in the month as calculated by the computer. Stock taking is done once in one to three months, depending on the type of material. However, this operation should be managed more closely. We make the following recommendations, based on Paragraphs (1) and (2) above.

(a) How to determine the safety stock
Specifying the volume of the safety stock as a percentage is not sufficient. It should be determined and fixed using one of the following variables depending on the characteristics (sizes, frequency of use, quality characteristics, etc.) of each item to be ordered and the situation of the supplier.

(1) Quantity of stock (number of goods), (2) Inventory days, (3) Inventory-sales ratio, (4) Shipment days, (5) Lot size, etc.

(b) How to specify the quantities of parts
The suppliers should be instructed to deliver in installments rather than all at once. The delivery intervals should be determined and fixed using one of the following variables for each supplier.

(1) Delivery interval in days, (2) On a specific day of the week, (3) Fixed term, etc.

Also, one of the following variables should be decided for use as the method for specifying the quantities of each part:

(1) Number of days ahead of delivery, (2) Contingency, (3) Lot size, (4) Division of order quantities among suppliers, etc.

(c) Definite orders
The above should be specified as preliminary notification. Then definite quantities should be used when placing orders. Orders can be placed at any of the following intervals.

(1) Daily, (2) Weekly, (3) At ten-day intervals, (4) Semimonthly, (5) Monthly

(d) Stocktaking
Apply selective control to the items which have unstable deliveries or for which the inventory quantities are small. Stocktaking of these should be done at regular intervals.

The calculations described in paragraphs a), b), and c) above can be done by the computer for inventory control.

3) Inventory reduction

There are required inventories and unrequired inventories. Paragraph 2) above describes how to improve methods of management only for required inventories. Being a necessary evil, an inventory itself does not increase added value. Therefore, we propose reducing not only the unrequired inventories, but also the required inventories.

(1) Inventory types

The types of inventory vary according to the method of classification. The types of required inventory were described in Paragraph 2), (1) above. Of these inventories, batch stock and seasonal stock are known as policy stock. Unrequired inventories include:

(a) Excess stock: Stock kept in excess of the standard stock quantity
(b) Usable stock: Stocks that can still be used among those which are nearly obsolete or deteriorated
(c) Long term storing stock: Stock that is used only occasionally and stored for a long time
(d) Obsolete stock: Stock of obsolete products
(e) Deteriorated stock: Stock that is unusable because its quality or value has deteriorated during an extended period of storage

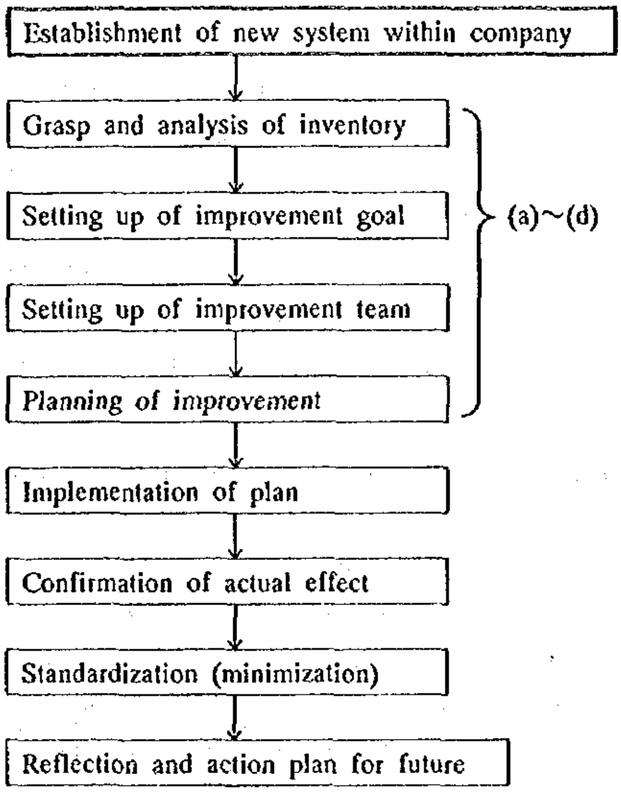
The classification of these stocks is shown in Table 8-3-3

Table 8-3-3 Classification of Stocks

Required inventory	Process stock	Running stock
	Safety stock	
	Policy stock	
Unrequired inventory	Excess stock	
	Usable stock	Sleeping stock
	Long term storing stock	
	Obsolete stock	Dead stock
	Deteriorated stock	

(2) How to proceed with inventory reduction

In order for inventory reduction to be effective, the company must establish concrete goals (time limit, monetary value, quantities, etc.) and adopt them as the business policy of the company, and executives must take the lead and direct the employees aggressively. It is recommended that a system for carrying out inventory reduction should be established first and then the inventory should be reduced step by step as shown in Figure 8-3-8.



(a) To confirm actual raw materials, semi-products and final products.

(b) To classify operating inventory, unnecessary inventory and dead inventory.

(c) To establish a schedule to throw away dead inventory and unnecessary inventory. Schedule should define date, method, volume and amount of throw away.

(d) To establish to reduction schedule for operating inventory. Schedule should define date, method, amount and volume of inventory.

Figure 8-3-8 How to Proceed with Inventory Reduction

8-3-3 Production Control

Production control should manage the process from production planning to actual production to ensure that the production is done according to the plan. Therefore, it has bearing not only on the preparation of production plans, but on the actual situation in the work shops.

1) Organization and functions

The production control responsibility of the three divisions engaged in seat production is to plan personnel assignments and daily schedules (planning function) based on the production order and the required number of men calculated by the computer, and ensure that the production is done as planned (controlling function) by using work orders, progress control, and actual product control. These functions are shown in Figure 8-3-9.

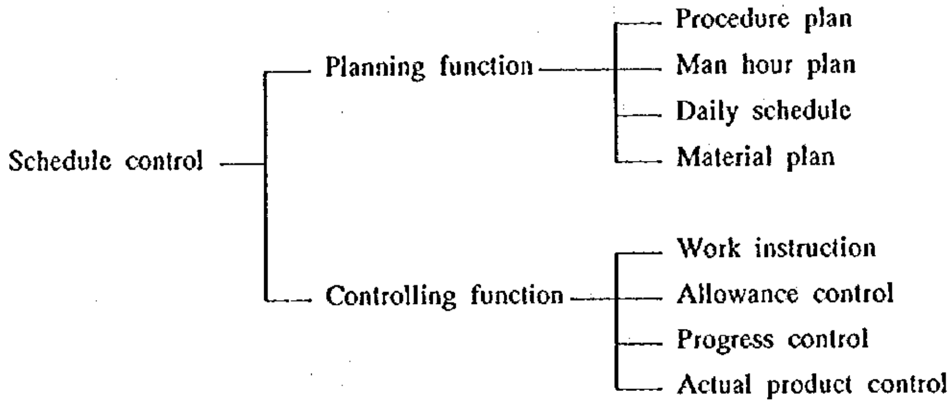


Figure 8-3-9 Functions of Production Control

As matters stand now, however, the only people engaged in production control in the three divisions are the production managers, the production coordinators, and a logistics engineer who supports production. There is no exclusive production control staff. The production managers draw up daily schedules and the production coordinators keep track of actual results; and nothing more. This arrangement cannot deal with accidents or with delays in preceding processes adequately, or improve working areas. It is necessary to clearly define the duties of each of the personnel engaged in production control and have them take responsibility for their work. For that, it is also necessary to develop the personnel. Table 8-3-4 shows suggested production control functions that should be provided to the seat production divisions, the contents of the work, and the sections in charge.

Table 8-3-4 Functions and Tasks of Production Control

	Work	Section in charge	Work contents
Planning function	Procedure plan (process design)	Technical section	Technical section will decide optimum production method and equipment in cooperation of production section
	Man-hour plan	Technical section (bus div.)	To define standard time and accurate man-hour plan
	Daily plan (standard)	Schedule control engineer	To establish daily plan to achieve maximum utilization of man and machine To set up correct lead time
	Material plan (raw materials, components, sub-contracted items)	Logistics engineer	To establish a purchasing plan considering quality, cost and delivery and a material plan considering material yield.
Controlling function	Work order (preparation, allocation and guidance)	Coordinator	To confirm absence of workers, condition of equipment and measuring instruments To prepare drawings, jig and tools, molds, work instructions
	Allowance control	Coordinator	To examine countermeasures for emergency and adjustment of schedule change
	Progress control	Coordinator	Early finding of abnormal conditions and establishment of counter-measures
	Actual product control	Coordinator	To establish a control method and rules To enhance working moral of all workers

(1) Planning function

Of the planning function tasks, the man hour plans and material plans are easy to standardize, and thus, easy to computerize. IMAG uses computers for the preparation of the man hour plans and material plans. The following paragraphs describe the procedure plans and daily schedules that are difficult to computerize.

(a) Procedure plan (process design)

Desirably, the procedure plan should be prepared by the Technical Section in cooperation with the Production Section. This plan specifies working methods (process sequences, contents of work), working conditions (machinery, tooling), standard times, etc., based on design drawings and specifications, when producing a new product, and provides the basis for subsequent production plans. Also, it is necessary to incorporate ideas as well as the results of studies and discussions into this plan. Then the plan should be summarized in a procedure sheet. Figure 8-3-10 shows a sample procedure sheet.

Page	Issued	Technical Dept.	Production procedure	Dept.Mgr.	Sect. chief	P.I.C.	Prepared by
	Date:						

No.	Process	Machine	Jigs tools	Work time: Stand. time	Work time: Actual time	Work time: Total	Number of workers	Remarks
1								
2								
3								
4								
5								
6								
19								
20								
	Total							

Remark, sketch	Material	Dimension	Material cutting	Material weight	Weight of completed product
	Model		Part No.		Name

Figure 8-3-10 A sample Procedure Sheet (for metal working)

(b) Man hour plan and daily schedule

Man hour plans are prepared by the Technical Sections (the Technical Sections of the bus divisions prepare their man hour plans in cooperation with the Joint Bus Department). Daily schedules are prepared by the schedule control engineers of each division. The man hour plan has the static character of coordinating the capacity with the load, while the daily schedule has the dynamic character of laying out tasks on a time axis. Thus, man hour plans are easy to computerize, and IMAG also manages its man hour plans by computer.

On the other hand, in preparing a daily schedule, the times required for inspection, waiting, and transportation must be added to the working times of the processes. The sum of the times required for processing, inspection, waiting, and transportation, which is referred to as the production period, varies with the production mode, load, quality of the plan, unexpected receipt or cancellation of orders, etc. Thus, the purpose of daily schedules is to incorporate these variable factors into the production period.

Also, daily schedules determine the standard days (the lead time) - i.e. the number of days prior to the completion of the product at which production should start. Standard days, which are a standard production period, vary with the daily schedules, as described above. The relationship between a production period and standard days is shown in Figure 8-3-11. Waiting time, which is generally said to reach as much as 50 to 80% of a production period, is a major uncertainty in the preparation of daily schedules. It is important to carefully study the actual situation, before drawing up or improving a daily schedule.

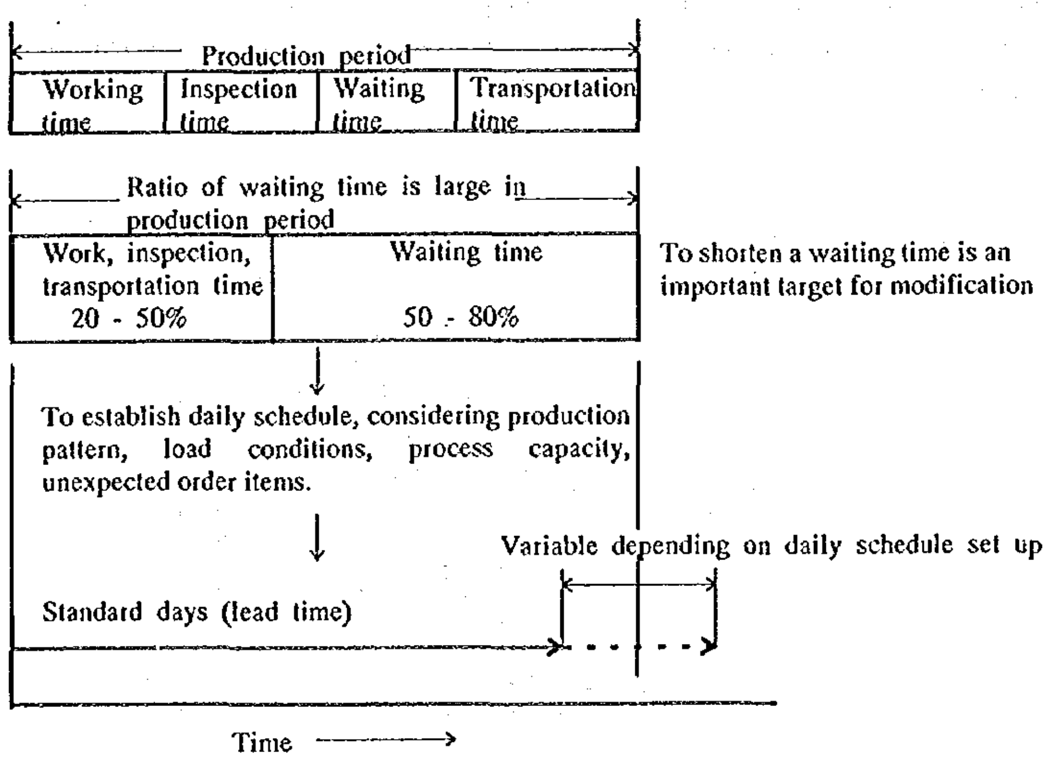


Figure 8-3-11 Production Period and Standard Days

(2) Controlling function

Production does not always proceed according to the production plan: there are often discrepancies between plans and actual results. The reasons include:

(a) Inaccuracy of plans
(b) Occurrence of accidents (equipment failures, injuries etc.)
(c) Delays in preceding processes
(d) Changes (in design, delivery times)
(e) Unexpected orders, cancellations

Thus, a controlling function is necessary in order to make adjustments to bring the actual results closer to the plan when a deviation occurs. The controlling functions that seem important - work orders and progress control - are suggested below.

(a) Work orders

A particularly important controlling function is the work order. Work orders, which are also referred to as dispatching, must clearly specify quality, delivery times, and quantities to ensure that the intention of the orders is conveyed properly. Generally, dispatching is carried out by using cards, written instructions, or terminals. A practical example of the effective use of dispatching is a dispatching board. Job cards are put into pockets on a dispatching board to assign jobs to workers or machines and give instructions about the work. A dispatching board is shown in Figure 8-3-12.

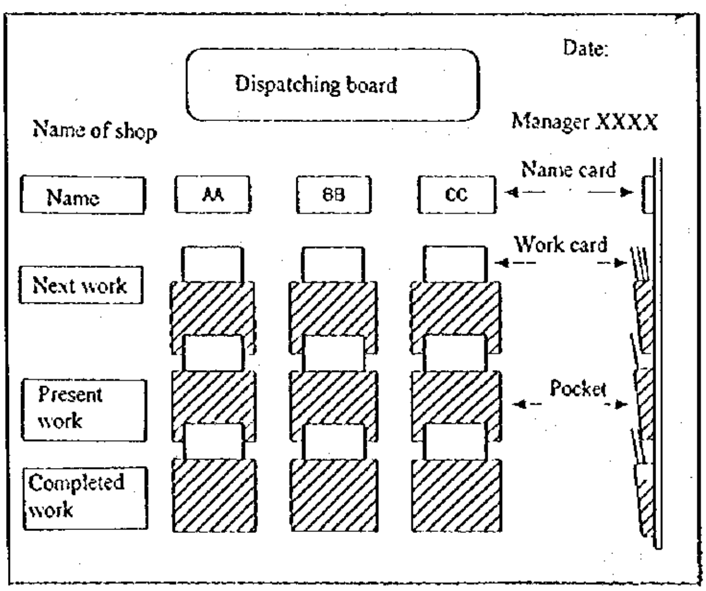


Figure 8-3-12 A Dispatching Board

Dispatching boards are widely used and provide an excellent method of visual management. One glance at a dispatching board is enough to tell the state of transfer of work between processes and the progress of operations, allowing the anybody concerned, to judge what is necessary (such as preparation of tooling or documents) or what action is needed.

(b) Progress control

Progress control, like work orders, is a very important function. For progress control, it is necessary to monitor the progress of work. The following two monitoring methods are available.

Which method to select depends on the production mode or manufacturing system or the objects being controlled.

a) Where (to which process) has production proceeded? ... Transient progress
b) How many pieces have been produced? ... Quantitative progress

An example of control method a) is a Gantt chart. The horizontal axis of this chart represents time with the lengths of the bars proportional to required times. Gantt charts are widely used for progress control in daily schedules. An example of the use of Gantt charts is shown in Figure 8-3-13.

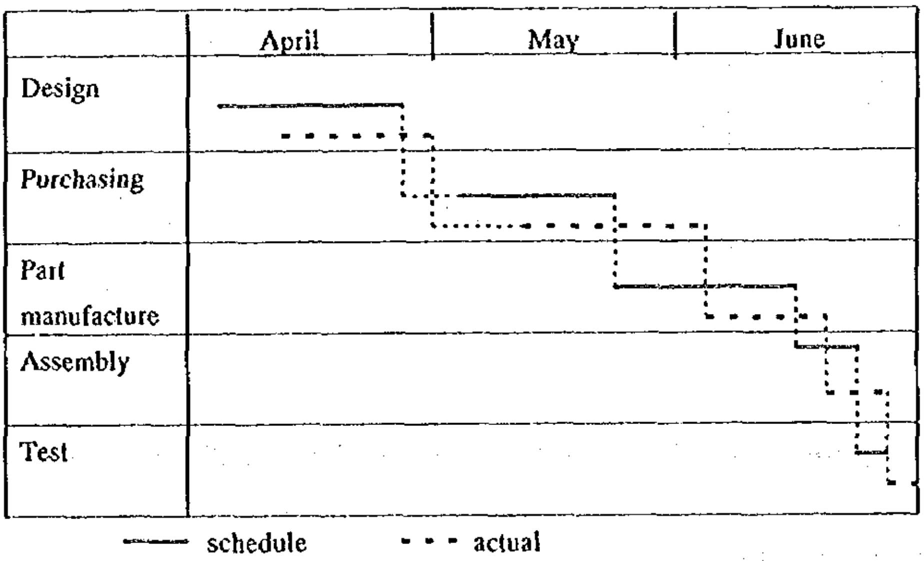


Figure 8-3-13 An example of the Use of Gantt Charts (transient progress control)

Control method b) is used when large quantities are continuously produced every day, as is the case with flow production. Oblique line graphs are suitable for this method. An example is shown in Figure 8-3-14.

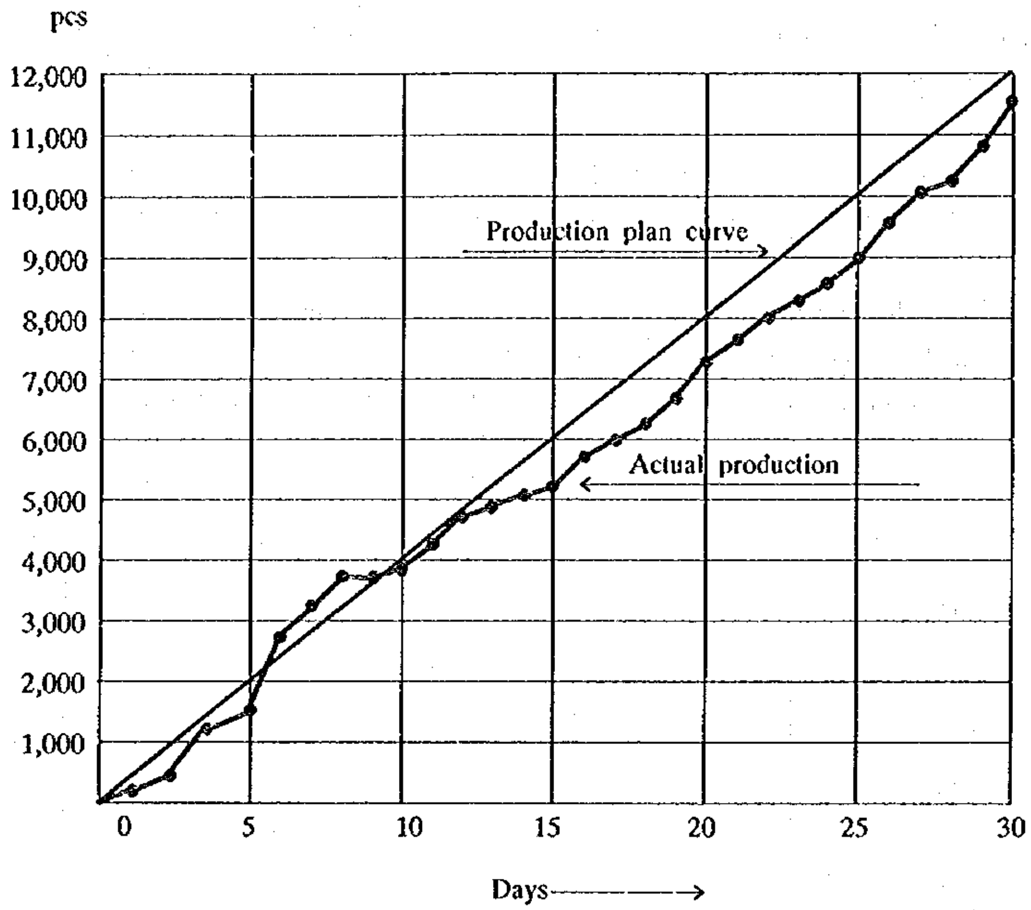


Figure 8-3-14 An Example of Quantitative Progress Control

8-3-4 Quality Control

IMAG has been striving to improve quality, being aware that quality control plays an important role in the modernization of its shops. To strengthen quality control, the company has reformed its organization and acquired the ISO certification. Subsequently, quality control manuals have been documented and action records are being kept. The fundamental objectives of quality control are to provide products of the quality that satisfies customers with respect to performance and appearance. Although IMAG has control standards in place as described above, one cannot say that they are functioning effectively in the production processes. As described in the sections about the present state and problems of the production processes, individual workers in IMAG have a very high level of skill. The quality-control challenge for IMAG is to make effective use of these skills to further improve the quality throughout the company.

1) Quality policy

For quality control, it is necessary first to establish a basic policy. IMAG's quality policy incorporates the president's wish to push forward with quality improvement on a company-wide basis. However, specific requirements and intentions, such as the basic philosophy of the top management, priorities to be given to quality, and the extent and standards to be aimed for, have not filtered down into the minds of all the employees. To tackle quality improvement throughout the company, it is necessary to establish a concrete quality improvement policy based on the following principles.

(1) Specific annual policy and evaluation

It is necessary to establish ambitious but attainable goals for specific objectives as an annual policy. Desirably, the goals should be specific figures in which many employees can take an interest. It is important that the results should be capable of being evaluated. Some measures should be devised to motivate the employees. A reward and punishment system can be effective. QC group activities are popular in Japanese companies, and systems are widely used in which the groups that contributed greatly to achieving goals are commended and awarded prizes. QC groups will be discussed later.

(2) Review by management

An ISO requirement requires managers, as one of their obligations, to review the quality systems of their companies. The company should address this review as an important matter to promote rather than as an obligation. It is recommended to specify a period and time limit, appoint a responsible person, creat a check list, and carry out review according to this list. An example of a check list is shown in Table 8-3-5.

Table 8-3-5 A Check List for Management Reviews

Review check list by management		
	Review items	Review contents
1	Policy of quality and goal for quality	If policy for quality is understood by each worker or not If goal for quality is achieved or not If the goal for quality is not achieved, additional measure is taken or not.
2	Evaluation by results of internal inspection for quality	If correcting treatment is taken and some effect is achieved If any necessary preventive measures are taken and positive effect is achieved If information concerning a preventive treatment is reported to the management
3	Claims from customers	If correcting treatment against claim is taken or not If any claim are reported or not
4	5S + safety	If neat arrangement and sweeping are well performed or not If workers are polite in manner If any labour accidents of employees are taken place or not
5	Inventory condition	If delivery delay is caused due to lack of inventory or not If inventory is exceeding an amount already established If any problem concerning storage control is caused or not
6	Off-specification product status	If work error or claims are caused by incorrect classification of off-spec products
7	Organization function	If any problems are occurred due to improper instruction and coordination If there are any problems set aside due to unclearness of responsibility and authority
8	Equipment	If there is any problem caused by incorrect maintenance of equipment If any equipment is used which are low in frequency of usage If any work is sub-contracted due to lack of suitable equipment
9	Technology and technique	If there is any problem such as work error or claim caused by lack of training of workers If education and training which will be needed in future is well defined or not

2) How to promote quality control

The following actions are necessary for IMAG to promote quality improvements.

(a) To detect problems and deal with them.
To analyze problems and investigate their causes.
To devise appropriate measures to deal with problems.
To maintain and standardize improvement procedures.

(b) To reduce variations in product accuracy.

(c) To reduce the percentage of defects.

In order to carry out these actions, it is necessary to introduce the following quality control activities.

(a) Source control
(b) PPM control
(c) QC group activities

To enhance quality consciousness within the company, vitalization of the workplace is very effective, i.e., everyone in the group should share a common purpose or goal, make a concerted effort toward it, and share a sense of achievement about the results, not to mention the necessity of acquiring knowledge and control techniques. The following paragraphs describe some of the activities currently used for quality control in Japanese companies. These activities will help to enhance quality consciousness in IMAG.

(1) Source control

This term compares the flow of processes to a river. This method controls the factors that directly affect quality characteristics by tracing a problem back to the process that caused it, locating the cause, and then taking action. It was developed based on the assumption that a problem that arises in a manufacturing process is attributable to a preceding process such as preparation, purchase, design, or projects. The further downstream a defect is found, the more widespread the problem will become and the greater the damage will be. In particular, if a defective product flows out into the market, it could prove fatal to the company. Tracing a problem back to its source makes it possible not only to solve the problem that occurred in the manufacturing site, but also to prevent recurrence of similar problems. This method is also effective in involving all the persons concerned when a problem arises.

(2) PPM control

This method originated from the view that the defect rate in the current automotive and electronic parts industries should no longer be discussed in terms of percent, but in terms of PPM (parts per million), with the target value set at zero and every effort should be made to achieve it.

In the manufacture of automobiles, one defective part can stop the entire automated line, causing serious damage. To prevent such a situation, it is necessary to set the process capability index at 1.6 to 1.7 during the designing of processes instead of approximately 1.33 as conventionally employed, and use 100% inspection instead of sampling inspection (changing from manual inspection to automatic measurements with increased reliability). Also at the manufacturing stage, in addition to preventive maintenance of the equipment, some method should be devised to prevent human errors including methods of unattended operation. These considerations and activities will be important when facing competition in the automotive parts industry.

(3) QC group activities

Many automobile and automotive parts manufactures in Japan are committed to QC group activities. In a QC group activity, also known as a small group activity, the members, under the direction of the group leader, take up tasks voluntarily, learn quality control through the process of problem solving, enjoy the satisfaction of achievement through actual practice, and the accumulation of real results.

QC activities are conducted by setting a target value for each department based on the policy of the entire company and by organizing QC groups. Actual activities employ the techniques shown below (called "QC tools" generically). In this way, the quality control rules and failure analysis techniques that IMAG is developing can filter down into the minds of all the workers.

(a) Graphs
(b) Pareto charts
(c) Check sheets
(d) Cause and effect diagrams
(e) Scatter diagrams
(f) Histograms
(g) Control charts

The curriculum currently provided by the Quality Assurance Department includes courses on some of the QC tools. Thus, the groundwork has been laid in IMAG for forming QC groups and putting them into action. However, it will take a long-term effort to establish and put QC group activities into practice. Also, the present organizational structure is not capable of handling activities that cover the entire company. The following paragraphs describe a recommended structure and method for pushing forward with QC group activities.

(a) Structure for promoting QC activities

It is recommended that a QC board should be first set up under the powerful leadership of the top management so that the lower branches of this board will support QC group activities (small group activities). Figure 8-3-15 shows a typical Japanese structure for promoting QC activities which can be applied to IMAG.

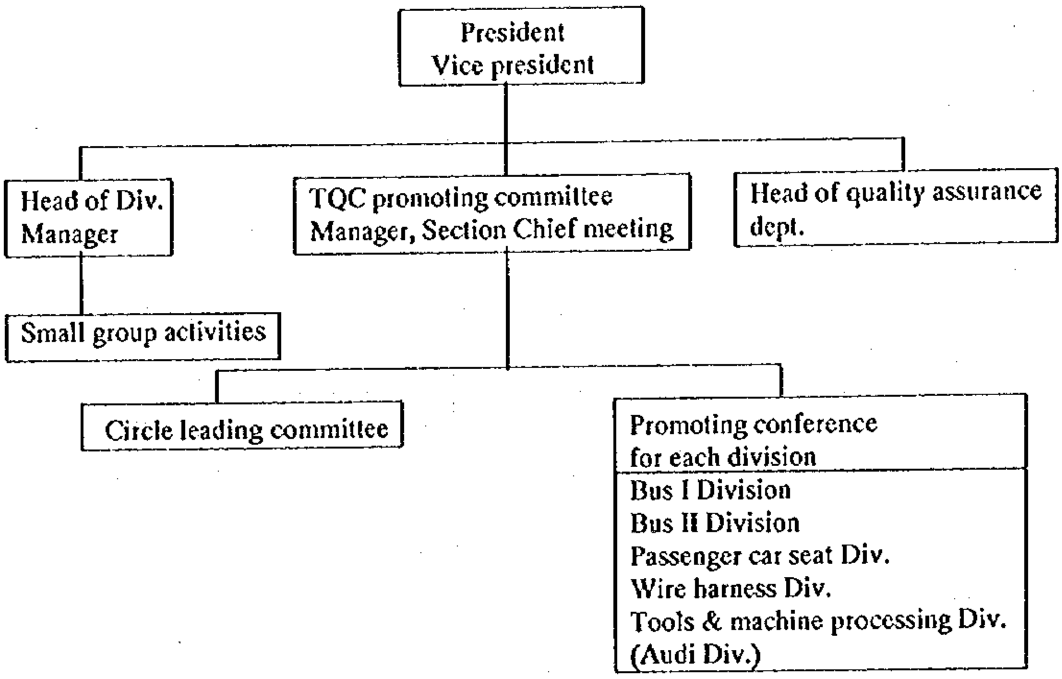


Figure 8-3-15 A Structure for Promoting TQC

(b) How to proceed with QC activities

A QC group should be organized in each shop of the individual divisions. An appropriate membership is about ten people. As shown in Figure 8-3-16, activities are based on the policies of the heads of divisions. When the policies of the heads of divisions have been drawn up, each section should determine items to be dealt with and target values for achieving the policies. The QC group in each shop should look for problems in their shop that will prevent the attainment of the section's target values, select a theme and target values for problem solving, and begin their activities. The group should follow the procedure shown in the figure below, confirm the results, devise countermeasures to prevent any recurrence, reflect on the development of the activities, and wind up the group activities. The results should be reported at a meeting within the division so that the members can derive satisfaction from accomplishing their goal. Further vitalization can be expected if excellent presentations are commended. Many companies in Japan adopt systems of commendation, in which certificates of merit and prizes are awarded.

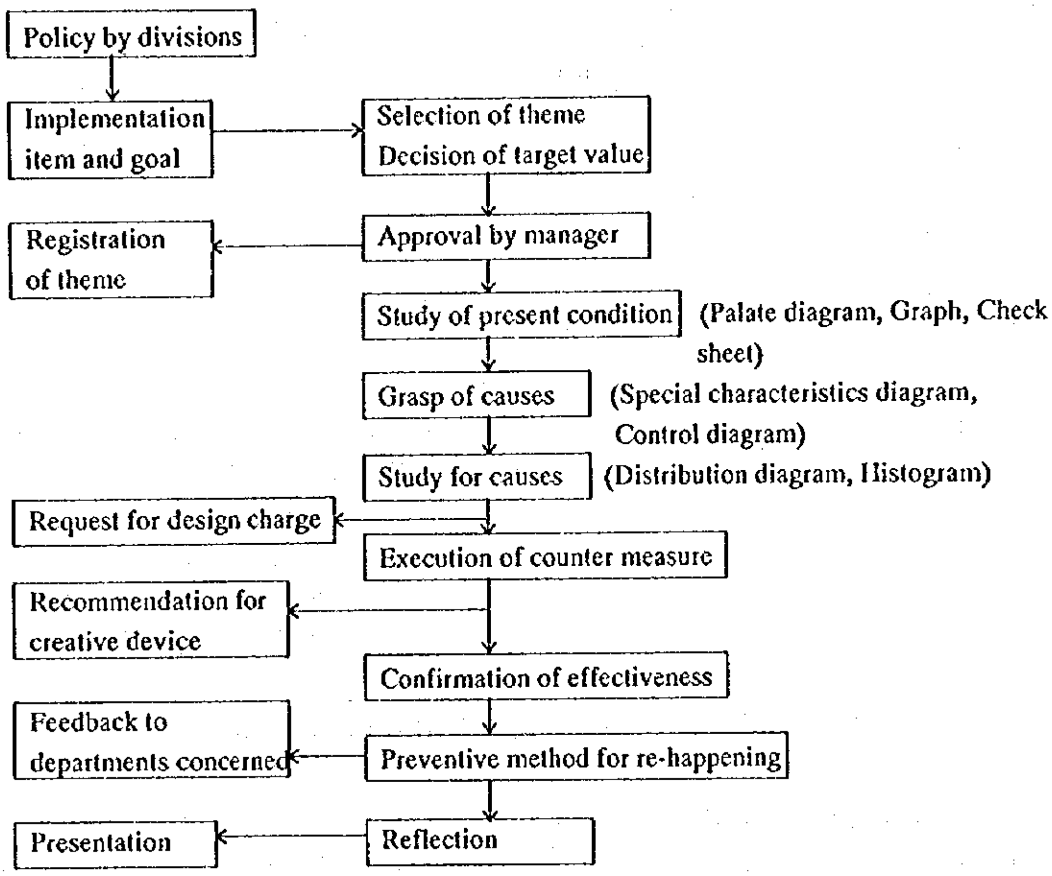


Figure 8-3-16 Flow of QC Group Activities

3) Quality control at manufacturing sites

Although inspections at manufacturing sites are performed faithfully according to the rules, the percentage of defects is not low. It is said that "quality is not produced by inspections, but built into the product during the manufacturing process," and so the quality control operations at the manufacturing stage play a very important role. Thus, the introduction of QC operation sheets and process specifications (work standards) will be useful in reducing the percentage of defects. QC operation sheets are effective for building high quality into the product during the manufacturing process, while process specifications provide information that the workers can rely on to do the operations correctly.

(1) QC operation sheets

A QC operation sheet, also known as a route sheet, is a list that summarizes information about who manages, what characteristics, by what method, at what time, and what the results should be, for all the processes from the stage of raw materials and parts to assembly and shipment, for the purpose of "building quality into the product during the manufacturing process." A QC operation sheet for the assembly of passenger car seats is shown in Table 8-3-6.

Table 8-3-6 A QC Operation Sheet

No.	Process	Check item	Criteria of judgment	Measuring device	Period of check	Control document	P.I.C	Action in case
1	F/C frame receiving inspection	Outside	No bars, crack	Visual	All 2%/mo.	SIS	Worker	Return to supplier
		Welding	No under-cut	Visual	2%/mo.		QC	
		Dimen-sion	Good Dimension	Jig scale	2/lot		Sub-Contr	
2 3	Slide rail, Outer, Inner Receiving inspection	Outside	Crack painting	Visual	All 2%/m	SIS	Worker QC	Return to supplier
		Moving condition	Smooth move	Hand feel	All		Worker	
4	Buckle receiving inspection	Outside	No scratch	Visual	All 2%/m	SIS	Worker QC	Return to supplier
		Coupling condition	Firm coupling	Hand feel	All 2%/m		Worker QC	
5	Reclining receiving inspection	Outside	No scratch	Visual	All 2%/m	SIS	Worker QC	Return to supplier
		Dimensi-on	Good dimension	Gage scale	N=3/m		supplier	
6	Head rest, receiving inspection	Outside	No scratch	Visual	All	HIS	Worker	Repair work
7	Counter-mat spring fitting	Fitting condition	To fit firmly	Visual	All	QC check point	Worker	Repair work
8	F/C pad set	Setting conditions	To set on right spot	Visual	All	QC check point	Worker	Repair work

(a) Purposes of QC operation sheets

The main purpose of QC operation sheets is to clarify the process sequence, control points, and persons in charge. This will allow early discovery of abnormalities and enable prompt countermeasures to be taken. At manufacturing sites, daily management is carried out according to the QC operation sheets, samples are taken and checked according to a predetermined procedure. Thus, QC operation sheets have the secondary effect of providing standards for process specifications. Also, the use of QC operation sheets during the training of new employees will allow the accurate knowledge and skills associated with production to be imparted.

(b) How to create QC operation sheets

Preferably, QC operation sheets should be created by the Quality Control Department with the help of the Technical and Production Sections. The following points should be observed in preparing QC operation sheets.

a) To clarify the purposes of preparation.
b) To clarify the control standards and quality characteristics of each process.
c) The control methods (standards, number of samples, measuring methods, etc.) of each process should be reasonable (Do not use standards when exceed the capabilities of the process, unrealistic frequency of measurements, or unrealistic numbers of samples).
d) To use the form of QC operation sheet that is suited to the product concerned.

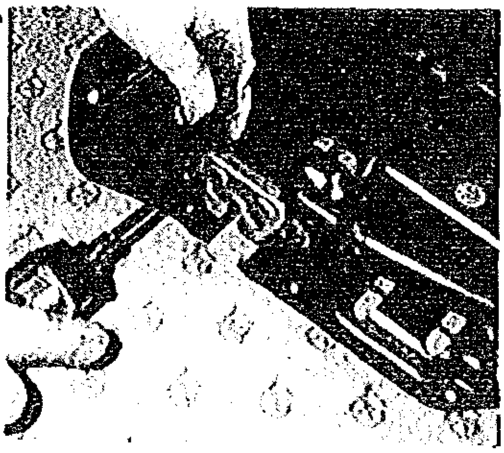
(2) Process specifications

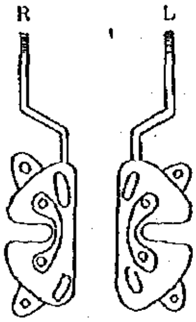
This is a document created for workers, based on the QC operation sheet. It illustrates the contents of the process, work procedures, and the key points of operations with the help of drawings and photos, so that the workers will work according to the rules. An example is shown in Figure 8-3-17. Preferably, this document should be created by the Production Section with the help of the Technical Section.

No. 1

Date	1996 - 3 - 4	Work standard sheet
Process	YE2 R/B Separate assembly Lock assembly fitting	

Sketch





No.	Process	Procedure	Work point
1	Lock assembly	To set rock assembly onto back	To make sure rock R and L is
	fitting	rock, and align to a securing hole,	correct.
		then secure by air driven at 2	
		places.	Air pressure to be 0.4 to 0.6 N.
			To make sure there is no inclined
			tightening, broken nor lack of
			tightening.

改訂欄	符号	年月日	改 訂 事 項	改訂	改訂欄	符号	年月日	改 訂 事 項	改訂
		. .					. .		
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HOUWA

Figure 8-3-17 An Example of a Process Specification

4) Test and Inspection equipment

Although basic test and inspection equipment is provided, it is insufficient for use in development work as well as routine inspection. Investments in the following equipment are necessary to enhance the development capacity and speed up development in the future.

(1) Existing equipment which has insufficient capacity

(a) Three-coordinate measuring machine: existing jigs are not sufficiently reliable and special-purpose jigs are necessary.

(b) Durability test machine for cushions: its functions are incomplete (no twisting mechanism)

(c) Fatigue tester for seat frames: testing capacity is insufficient as cornering of vehicles cannot be simulated

(2) Equipment which is necessary but has not been provided.

(a) Sitting 3D human phantom: required in order to determine basic shapes in seat design and development.

(b) Load test machine for seat frames: Essential for the development of new products

Specific recommendations concerning investment will be made later (Section 8-5-5 "Modernization of the Production Facilities").

8-3-5 Modernization of the Information Processing System

Information is an important resource for a company and is necessary for carrying out corporate activities effectively. Therefore, it is important for a company to create a mechanism for collecting, processing, and utilizing such valuable information on a timely basis and to build an information processing system that allows proper decisions to be made based on the information that has been obtained.

IMAG considers that the computerization of information processing is an important task and is building a system under the leadership of the Information Controlling Department. The system is being modernized with a lot of computers in use within the company. Based on the findings from our investigation into the present situation of the company, the following recommendations are suggested.

1) Organization and functions

(1) Information Controlling and Marketing Departments

The Information Controlling Department, which is in charge of operations concerned with information and information systems, also takes charge of operations associated with decision making and business management, as described in Chapter 7 "Problems with Business Management." However, it mainly handles internal (in-company) information and does not handle external information. External information such as market trends and sales forecasting is gathered by the Marketing Department, but the department does not have any function for managing such information. External information that can be used for business purposes is essential for decision making and the company should have an organization to manage the external information necessary for its business strategies. Judging from the present organizational structure, the Marketing Department should be provided with an organization for managing external information.

(2) Bus Coordination Department

The information about the orders for seats received from clients goes to the Bus I and Bus II Divisions through the Bus Coordination Department in the case of bus seats, and directly to the Passenger Car Seat Division in the case of passenger car seats. However, the computer systems for production planning, production management, and inventory control for automotive seats are managed and used separately by individual offices (divisions and departments). The computers do not belong exclusively to the division or department concerned. Later, it is suggested to integrate the computer systems concerned with bus seats and passenger car seats. If integration is adopted, the same systems will be managed and used by several offices, and it will be necessary to change offices responsible for the system. Here, it is recommended that the operations of the Bus Coordination Department should be reviewed in order to integrate the production management of automotive seats.

2) Computer systems

IMAG's state-of-the-art computer system, SYMIX, is not utilized to its full capacity since it is not used on a company-wide basis, but only for production management in the Passenger Car Seat Division. It should be connected to the other divisions as soon as possible. Also, many of the existing systems are not connected on-line. The systems should be integrated as described below.

(1) Technology System and Inventory Control System (KOROS)

The Production Management System (SYMIX) has better functions built into it than the Technology System and Inventory Control System (KOROS) have. The jobs done by the Technology System and KOROS should be integrated into SYMIX and the two old systems should be abandoned.

(2) Accounting System (DUNA)
The Accounting System (DUNA) should be connected on-line with SYMIX. For that, it is necessary to make changes to DUNA.
(3) Asset Recording System (TGR) and Manufacturing Equipment Register System (GYNYR)
These two systems should be connected on-line with DUNA.

These improvements will allow information to be transferred more quickly and more accurately and enable the company to change from paper-based to paperless communications.

3) *Improvement about Information systems*

(1) Information on received orders

At present, orders are received through three channels.

(a) The bulk orders from IKARUS are mailed to the Bus Coordinating Department.
(b) The orders for special items, and orders for bus seats from companies other than IKARUS are received by the Marketing Department (Various methods are used for receiving these orders).
(c) The orders from Magyar Suzuki are faxed to the Passenger Car Seat Division.
To process order intake information correctly, a single entry point should be used for orders. This will enable information to be accumulated and quickly analyzed for planning production in the next fiscal year as well as for issuing proper production orders.
Also, the computer systems should be connected on-line with those of IKARUS and Magyar Suzuki.

(2) Ordering system

In IMAG's ordering system, when a production plan is established, the break down into parts and the material requirements of the product are calculated by computer.

Requirements = order quantity x unit quantity

The actual distribution staff of each division determines the safety stock after checking the inventory, and orders the sum of the computed material requirements and the safety stock. In this way, ordering always involves human judgment. Thus, a material requirement planing (MRP) system would be useful for rationalize the ordering operations.

MRP or material requirement planing, used for products consisting of complex assemblies, is a technique for carrying out a series of operations - the calculation of material requirements, order allocation, lot-by-lot calculation, the determination of order timing and delivery, and ordering instruction - by computer. The computational procedures used in MRP are shown in Figure 8-3-18.

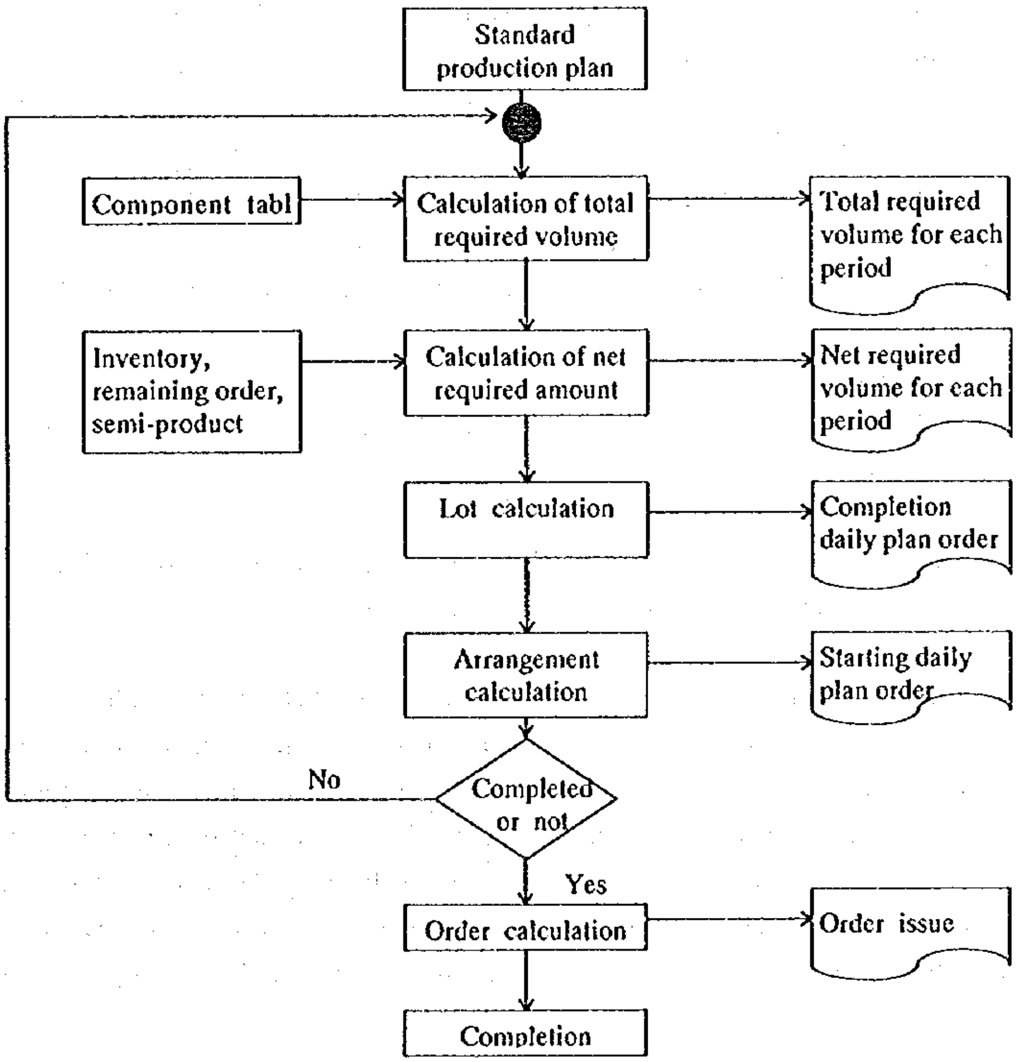

Figure 8-3-18 Computational Procedures used in MRP

The computational procedures used in MRP are as follows:

(a) Total required amounts
MRP calculates the requirements for the break down of parts, going down from the highest (the last process in the assembling sequence) to the lowest level.

Requirements = higher level order quantity x unit quantity

The total required amount is computed for each period.

(b) Net required volume
MRP calculates the net required amount for each period by subtracting the stock in hand, work-in-process, and open purchase orders from the computed total required amount for each period.

(c) Lot organization
MRP calculates the organization of the lots of the net required amount for each period, based on the ordering policy (periodic ordering, fixed quantity ordering, or ordering as required). The lots organized in this way are referred to as planned orders.

(d) Calculation of production start date
MRP calculates when production should be started, i.e., how many days are required to complete the product.

Steps (a) to (d) above are repeated for each level of the break down of parts, going down from the highest to the lowest level.

As can be seen from the explanation given above, IMAG calculates only Step (a) by computer. Steps (b) to (d) should be incorporated into the computer system. For reference, the ordering system of the passenger car seat manufacturer, Houwa Kogyo, is shown in Figure 8-3-19. It can be seen from the figure that the company orders a given automotive part based on a definite ordering policy, such as one day's safety stock, delivery on Tuesday and Friday, the lot size of 200 pieces, and ordering on Friday. The company breaks down the parts based on serial numbers (all the products are numbered serially for management) rather than by using MRP.

Receipt of order	Verbal order: Confirmation of 4 month order for previous month to month after the next month Confirmation: To confirm order of one week for 2 weeks in future
Delivery	Schedule: Planned delivery will be the amount of the confirmed order Actual: Actual sales revenue is confirmed when delivered. Progress: Control from order receipt to delivery of the product
Production Plan	Plan: Plan of 2 weeks ahead (= Confirmed order) Safe inventory = one day Inventory: To calculate theoretical stock against the production plan of that day
Calculation of required amount	Component development: Production plan x 2 set per car
Parts instruction	Verbal order: Delivery date of 2 weeks ahead to 2 months in future: Every Tuesday and Friday Delivery lot (lot size of 200pcs) will be verbally ordered Inventory: On every Friday, to calculate and confirm a theoretical inventory from that day to 2 weeks ahead.
Order	Confirmation: On every Friday, to confirm one week amount of 2 weeks ahead and to issue a detailed order sheet, statement of delivery and packing list
Receipt	Actual: To make input at the time of supply Progress: To confirm "Confirmation to Actual" at time of supply
Dispatching	Actual: To recover the packing list and that becomes the actual dispatching
Inventory	To calculate inventory of that date To carry out inventory checking every month

Figure 8-3-19 Ordering System used by Houwa Kogyo (parts for automotive seats)

(3) Processing of delivery information

IMAG uses manual keyboard entry to input data from the delivery notes. However, the method of input should be mechanized to speed up input and avoid input errors. In proceeding with mechanization, it is recommended that IMAG should adapt the method to make inputs to the advanced information processing method of the client, as shown in Table 8-3-7, instead of using a unique method.

Table 8-3-7 Information Service and Input Method

	Information Group	Input method
1	KANBAN* of Customer	To read in customer's bar-code directly or to read in IMAG's bar-code after processing
2	Customer's statement of delivery	The statement of delivery issued at the time of ordering will be read in on the necessary portion by means of OCR (Optical Character Reader)
3	Order sheet (Floppy disc)	To receive the floppy disc which customer made input and read in a necessary information
4	Order sheet (Telephone circuit)	To read in the information sent by transmission circuit from the host computer

* KANBAN method is a method of production to achieving a cost reduction by manufacturing a necessary amount of necessary products at necessary time of the agreed-upon specification. The manufacturing instruction (= KANBAN) is sent and received between each production line and the actual production is carried out by this KANBAN information only.

4) Technical information system

Although a 3D CAD system has been installed in the Development Department, it is not satisfactory for use as an information system. It will be necessary to shorten the product development cycles in the future, and advanced and speedy design techniques will be required.

(1) Concurrent engineering

Concurrent engineering is an approach in which persons in charge gather together from the development, production, sales, and other related departments and try to solve problems horizontally across the departments, making full use of computers. This will allow things to be examined horizontally for subsequent optimization. Also, performing tasks concurrently makes it possible to shorten development cycles. The approach aims at integrating information and speeding up its processing. Concurrent engineering is also referred to as company-wide engineering. Its structure is shown in Figure 8-3-20.

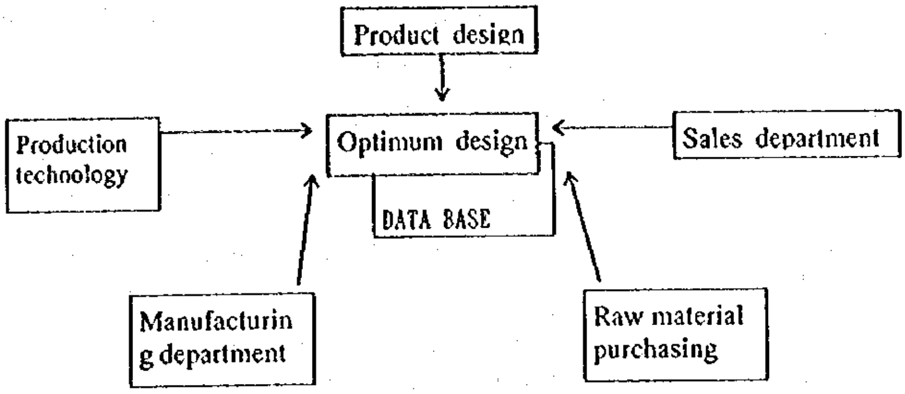

Figure 8-3-20 Company-Wide Engineering: Horizontal Support System

This system allows the technical or purchasing department to propose changes in product shapes or materials and proceed with equipment preparation and purchase planning in detail before product specifications or part drawings are complete.

The system also helps to greatly reduce the cost of products. Figure 8-3-21 indicates the ratios of the cost contributions from the various departments of a manufacturer. It shows how important it is to reduce costs at the design stage.

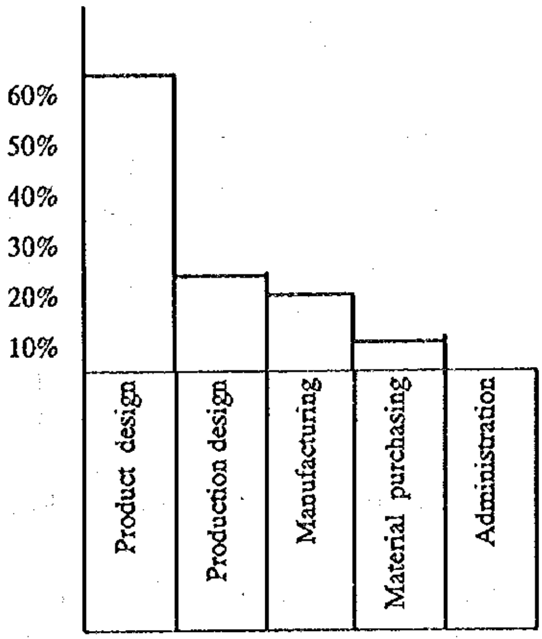

Figure 8-3-21 Contribution Ratios of Departments to Cost

(2) Deployment of CAD/CAM

CAD/CAM will play increasingly important roles in the development of expertise, improvement of business quality, and the construction of an integrated production system.

CAD/CAM is divided into CAD which is concerned with designing, and CAM which is concerned with manufacturing, and engineering management support, none of which is expected to have much effect if implemented separately. IMAG has a number of areas (such as the pattern layout of seats and cutting of cloth and leather) where CAM could have significant benefits, and it is recommended that the company deploy CAM together with CAD.

However, the introduction of CAD/CAM involves a considerable investment as well as development of human resources. CAD/CAM should only be introduced after a strategic plan and schedules have been worked out and the return on investment and the proper assignment of personnel should be carefully considered.

5) Utilization of OA equipment

OA equipment is not only indispensable for office work, but also plays an important role in information processing. Figure 8-3-22 shows the areas managed with CAD/CAM and OA in a company's flow of work. It can be seen how widely OA is used in a company's business.

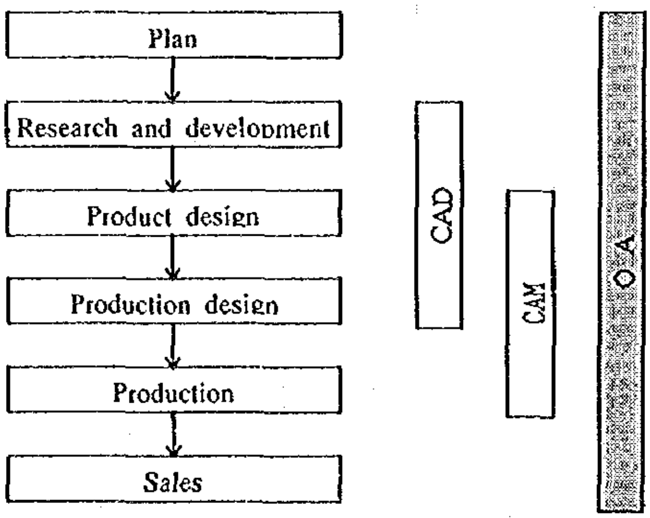

Figure 8-3-22 Areas Managed with OA in the Flow of Work

Figure 8-3-23 shows important control points in business. OA equipment, especially personal computers, can be powerful tools for information exchange in these activities, for which the telephone is insufficient to handle the large amount of information.

Since IMAG is equipped with the MAIL system and also possesses a lot of personal computers (PC), it is recommended that the company encourages more of its employees to use

PCs for exchanging and sharing information among departments as well as for rationalizing office work.

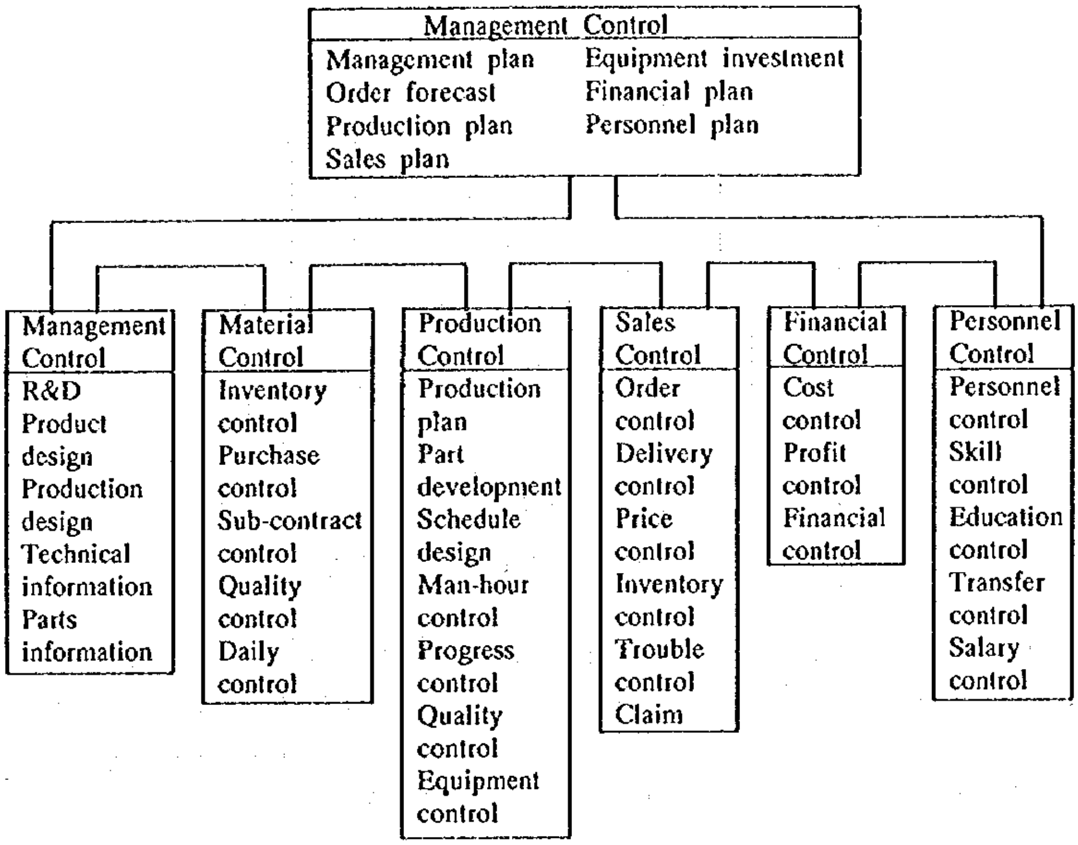

Figure 8-3-23 Important Control Points in Business

6) CIM (computer integrated manufacturing)

Although the concept of CIM (computer integrated manufacturing) is still being studied and has various definitions, it is generally understood to be "the automation and rationalization of all the corporate activities, including management, by computers and computer networks for the purposes of drastically speeding up the entire corporate operation and reducing its costs."

IMAG is tackling the modernization of its information processing system, which implies that the company is heading towards CIM. Thus, the concept of CIM should be kept in mind when constructing individual information systems.

Figure 8-3-24 shows the concept of CIM.

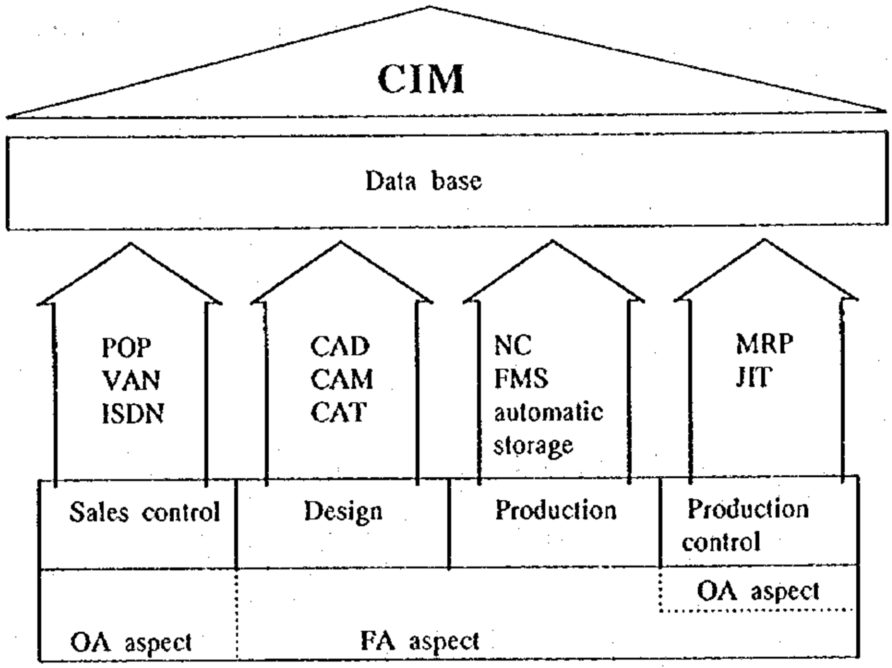

Figure 8-3-24 Concept of CIM

The construction of CIM is a task to be addressed in the distant future. However, since it cannot be accomplished in a short period, preparations for it should be started now, by incorporating many of its components while modernizing the information processing systems. The main tasks that should be addressed now are listed below.

(1) Expansion of databases

Expanded databases are the core of CIM construction. It is recommended to start building the databases from now on. They are necessary for the construction of a system that will store and retrieve information so that it can be provided to the company-wide management system that will cover the manufacturing, technical, and marketing areas.

(2) Promotion of standardization

It is recommended to standardize and unify FA machines, computers, and software so that they can all be interconnected.

(3) Improvment of reliability of mechanical systems

For the introduction of CIM, it is necessary to have very highly reliable automated mechanical systems such as computers, automatic assembly machines, and automated storage systems. When planning the installation of automated machines from now on, this point should be taken into consideration.

(4) Development of human resources

It is necessary to train and develop technicians as well as system engineers. Human resources should be systematically developed to produce and retain talented people.