8-2 Modernization of the Production Processes

8-2-1 Receiving of Raw Materials

Raw materials are received separately by the Bus I Division, Bus II Division, and Passenger Car Seat Division. The bus divisions do not have any major problem with purchasing management since annual order quantities are predefined by the contract with IKARUS and almost all the raw materials are procured domestically.

Last year, the Passenger Car Seat Division had problems with production capacity and management support both inside and outside the company because production continued to increase more rapidly than planned. This discredited the company with its clients and suppliers. At present, it has strained business relations with some suppliers. This needs mending quickly.

It seems the causes of the problem include the failures to get a correct understanding of the quantities of materials in inventory and to respond to the changes in the production plan (increased production) of passenger cars flexibly and quickly. Some improvements have been made as described in Section 5-1-3 "Present State of Receiving." Subsequently, the improvements listed below should be made.

The items common to all the divisions involved in the production of seats which should be improved are as follows:

1) Improvements common to all divisions

(1) Consolidation of receiving operations

It is necessary to consolidate the procurement and receiving operations currently performed separately by individual divisions. Details are discussed in the section dealing with production management.

(2) Reinforce unit control

In order not to disturb the smooth flow of production, it is important to have a full understanding about the quantities of each article in storage and where they are located. First of all, the methods of storage must be examined. The basics of maintaining these methods are 5S activities. The items which should be improved with respect to storage methods are as follows:

(a) Make articles easier to take out and put back (for example, save labor by using racks).
(b) Make it easier to tell what is stored in each location (clear definition of locations).
(c) Improve storage efficiency by making use of narrow spaces (effective utilization of space)

(d) Prevent damage to loads and load shifting caused by stacking (articles should be protected with pallets or containers).
(e) Standardize types and holding capacities of packages whenever possible to make it easier to understand the quantities.
(f) Use first-in first-out (provision of a fixed entrance and exit).

(3) Improvement of the management of goods movements

Once the warehouses have been put in order, the management of goods movements should be reviewed to make it more accurate. Goods receipts can be recorded in books based on the statements of delivery without any problem. The important thing is to clearly define procedures for issuing goods. First, storekeepers should be appointed. A goods issue slip should be created every time goods are actually issued, and recording in the ledger should be based on these slips. Currently, these slips are processed manually and supplement computer processing in much the same way as writing a memo. However, the processing of these slips should be computerized to make it more reliable.

Even if goods movements are managed correctly, differences can arise between book and physical inventories over the course of one month. These differences, if left unattended, may result in missing parts or dead stock. A company-wide stocktaking can be carried out at settling time. However, stocktakings for managing purchases should be carried out whenever necessary, to increase the accuracy of inventories. The stock of the materials stored in the warehouses and listed in the books should be compared once a month as a rule. If there are any inventory differences, the books should be revised to reflect the actual inventory quantities when ordering for the next month.

(4) Improvement of acceptance inspections

The acceptance inspections of materials are carried out when the goods are counted in each division. Almost no articles have been rejected during acceptance inspections. Basically, acceptance inspections should be replaced by the quality assurance of the suppliers. For inspection purposes objects can be classified into the following three groups, which allow inspections to be done selectively so reducing the number of man-hours required.

(a) Articles for which acceptance inspection is unnecessary
- Articles from suppliers whose quality assurance systems have been established and which have been free from defects for a long period.
- Articles that are inspected during production processes:
  Raw materials, steel sheets, steel bars, polyurethane raw materials, bolts, nuts, sewing thread, and adhesives

(b) *Articles for which sampling inspection is sufficient*

- Mass-produced articles whose production methods are stable
  Press-worked parts, welded parts, painted parts, slide rails, reclining equipment, buckles, and resin moldings

(c) Articles for which acceptance inspection is necessary

- Articles in which defects have been detected previously
- Articles produced at the beginning of production or just after a process change - Articles produced in medium quantities intermittently at intervals of two months of more

Based on the above classification, decide the characteristics to be inspected and establish acceptance inspection standards. Also, records should be kept for defective parts. If no defective parts are found, consider whether the acceptance inspection should be abandoned after inspecting the production processes of the suppliers and giving guidance to them or change the classification of the articles concerned from class (c) to class (b) or (a).

Articles that appear to be defective are left in the storage place for rejected parts for a considerable time. Establish a rule for handling defective parts in order to speed up the method of disposing of defective parts and countermeasures to prevent their recurrence.

(5) Review and improvement of computer systems for managing purchases

IMAG is actively working on the introduction of computers, as illustrated by the installation of SYMIX. The field of quality control in particular is highly computerized. In view of the fact that a fierce sales war is in progress on the passenger car market, changes in order information by car type cannot be avoided. For the purpose of ordering materials and parts a few months in advance based on such changeable information, it is important to rely on human decisions and management procedures should be strengthened so as to check that deliveries are strictly in accordance with changed instructions.

For this purpose, improvements or reforms should be made to give a more flexible response. Pushing ahead with computerization without such fundamental reforms may result in a deterioration of the business structure. It is important to build a computer-aided system in which man is the master, rather than to create a system dominated by computers.

2) Improvements to be made by Bus I Division

(1) Countermeasure against odd lengths and surplus materials

When delivered, pipe materials have a length equivalent to integral multiples of the size of the cut pipe plus a 3-mm margin for cutting. Unevenness of cutting, and changes in cut length due to fractional variations in the length of different production lots may cause the last piece of pipe to be shorter than the regular length, resulting in its being wasted. Although there is no need to provide an excessive allowance, 100 mm should be allowed for in the length of each cut pipe, to allow for it to be gripped. It is important to determine the optimum length by adjusting the margin, based on actual results, so that there is no waste.

(2) Countermeasures against rusting

Steel materials are delivered once or twice a month separately for bus and passenger car seats. Some products remain in storage for as long as two months. Since there is no wall on one side of the warehouse, some of the materials get rusty due to exposure to the weather. The simplest way is to put sheets over the materials that are likely to be stored for an extended period. The most effective way is to reduce lead times by increasing the number of deliveries. Based on the principle of a free economy to "buy good items at low cost," efforts should be made to reduce the costs and increase the number of deliveries by purchasing the steel materials for bus and passenger car seats together.

(3) Size and weight reduction of pallets and dollies

Generally, order units and production lots are large, which increases the quantities, sizes, and weight of the containers and packages. This can cause problems in carrying out production activities smoothly without waste. When making pallets, dollies, and the like in future, it is important to see that they are small, neat and easy to handle.

3) Improvements to be made by Bus II Division

(1) The materials warehouse for bus seats makes effective use of a narrow space. However, rolled sheets of PVC leather and harness parts are stored in pallets or iron boxes stacked on top of each other, making first-in first-out difficult. It is impossible to see the contents of the stacks of iron boxes. Since the volume handled in a day is not large, racks should be employed, and the iron boxes should be replaced with small containers in which the contents can be seen for easy management.

(2) Urethane raw materials are delivered by a tank lorry and kept in storage tanks. Delivered quantities are checked by using the weight difference between the loaded and empty

lorry. Since this measurement is not error free, the quantities should be double-checked using the graduations marked on the storage tanks. The measuring device provided with the storage tanks is out of order now: it should be repaired immediately.

4) Improvements to be made by the Passenger Car Seat Division

85% of the manufacturing costs of passenger car seats, are material costs. Therefore, it is not too much to say that the profits of IMAG depend on the materials procurement department. As described in the paragraph "Improvements common to all divisions," organizational reforms are necessary so that this important operation can be concentrated in one department devoted to reducing the purchase cost of materials. Unless IMAG buys raw materials at prices lower than the market prices available to its competitions, it cannot secure profits or compete with rival companies. To purchase materials at low prices, the company must be trustworthy and have good business prospects.

When purchasing cloth, IMAG places orders and Magyar Suzuki pays the maker for the purchased cloth. IMAG pays Magyar Suzuki only for the quantity used each month. This system is employed to ease the burden on IMAG because the cloth has a long lead time, and orders must be placed three months in advance, involving additional expenses. This means simply that risks caused by changes in car types or the like are borne by Magyar Suzuki, the client. Such unnatural arrangements only impair the trust between the three companies. It is important to develop trusting relations with clients and suppliers alike.

The tentative measures that should be taken are as follows. The cloth maker should make preparations and produce goods based on informal quantities given three months in advance, and then make the delivery based on formal orders placed by IMAG one month in advance. The cost should be paid by IMAG to the cloth maker. Magyar Suzuki should guarantee, to some extent, the quantities it gives informally three months in advance. Efforts should be made to return to a normal arrangement with the consent of the cloth maker.

8-2-2 Metal works

1) Working Hours

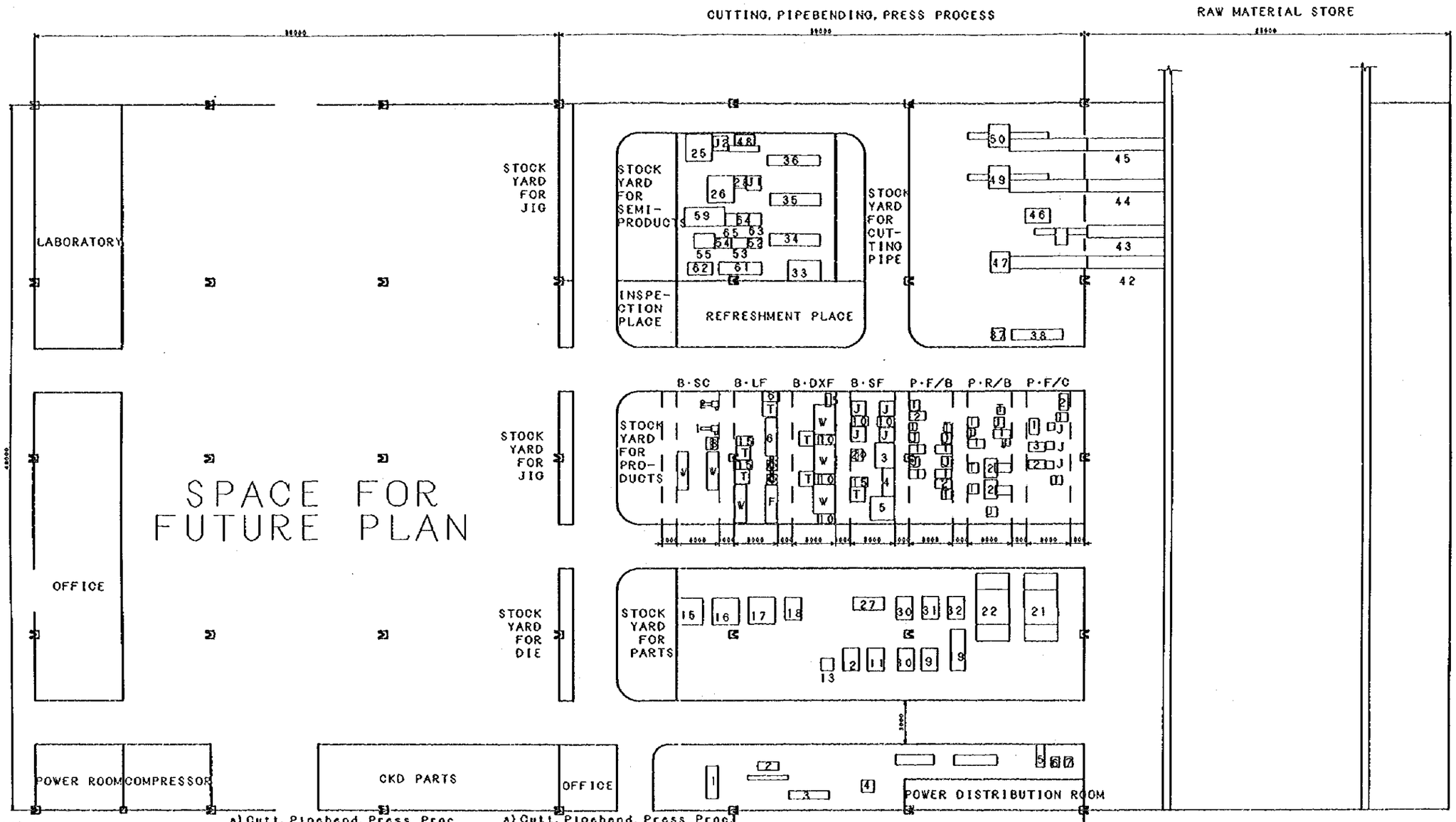
The daily working time is four hundred fifty (450) minutes and is now divided into five periods with a minimum length of fifty five (55) minutes and a maximum length of one hundred fifteen (115) minutes. In order to meet company's current aim, the system of five work periods has to be changed to four. The use of four periods makes it easier to arrange each lot of workpieces, and can also be expected to further improve the productivity of the process, since intervals between the inspections of the operating machinery and checks of the workpieces at the working

place can be done more evenly. For specific consideration, two shift plans giving the arrangement of the workings time are tabulated as follows:

Work plan (Shift A)		Work plan (Shift B)	
6:00 ~ 7:35	95 minutes/run	14:00 ~ 15:35	95 minutes/run
7:35 ~ 7:40	5 minutes/break	15:35 ~ 15:40	5 minutes/break
7:40 ~ 9:40	120 minutes/run	15:40 ~ 17:40	120 minutes/run
9:40 ~ 10:00	20 minutes/break	17:40 ~ 18:00	20 minutes/break
10:00 ~ 12:00	120 minutes/run	18:00 ~ 20:00	120 minutes/run
12:00 ~ 12:05	5 minutes/break	20:00 ~ 20:05	5 minutes/break
12:05 ~ 14:00	115 minutes/run	20:05 ~ 22:00	115 minutes/run

2) Factory Layout

For Bus I Division, rearrangement of the layout of in achieves in the production line is the first consideration, so that Bus I Division can handle a possible increase of orders for passenger-car seats as well as accepting firm orders for bus-seats although these have suffered a sharp drop in quantity. The basic concept to be used in this layout is to arrange and install the production line machinery so that the necessary amount of material is always available whenever it is needed and with no losses due to in-process inventories. The arrangement should also minimize the distances over which parts must be moved between machines and, at the same time, space must be provided for easy maintenance of the machinery. A layout plan is shown on Fig. 8-2-1. The plan makes it possible to increase the present production and it can also provide factory-space for possible future increase in production. At the same time, corrective action should be taken to improve other facilities as electrical supplies, compressed-air, and industrial water services as well as those required to meet safety and sanitation regulations.



B·SC:BUS Semi-comp.
B·LF:BUS Leg Frame
B·DXF:BUS Deluxe Frame
B·SF:BUS Std. Frame
P·F/B:Passe. Car Front Seat Back
P·R/B:Passe. Car Rear Seat Back
P·F/C:Passe. Car Front Seat Cush.
R:Rack
W:Working Bench
T:Table
S:Shoot
J:Jig
F:Flat Plate

a) Cutt. Pipebend. Press Proc.
3 Press Brake
4 Coner Notching Machine
6 Drilling Machine
7 Drilling Machine
8 Coil Feeder
9 Mecha. Press (Pin Crutch)
10 Mecha. Press (Pin Crutch)
11 Mecha. Press (Pin Crutch)
12 Mecha. Press (Pin Crutch)
13 Rivetting Machine
15 Mecha. Press (Ain Crutch)
16 Mecha. Press (Pin Crutch)
17 Mecha. Press (Ain Crutch)
18 Mecha. Press (Pin Crutch)
19 Mecha. Press (Coil Feeder)
20 Coil Feeder
21 Plate Shearing Machine
22 Plate Shearing Machine
25 Mecha. Press (Ain Crutch)
26 Mecha. Press (Ain Crutch)
27 Oil Hydraulic Press Brake
28 Butt Welder for Passa. Car
29 Handle Bending Machine
30 Oil Hydraulic Press (Ousion)
31 Oil Hydraulic Press (Ousion)
32 Oil Hydraulic Press

a) Cutt. Pipebend. Press Proc.
33 2head Pipe Bending Mach.
34 Pipe Bending Machine
35 Pipe Bending Machine
36 Pipe Bending Machine
37 Cutting Machine
38 Pipe Feeder
39 Cutting Machine
41 Pipe Feeder
46 Pipe Cutting Machine
47 Mecha. Press
48 Pipe Bending Machine
49 Pipe Cutting Machine
50 Pipe Cutting Machine
53 Drilling Machine
54 Frame Bending Mach.
55 Frame Drilling Mach.
56 Frame Cutting Mach.
57 Drilling Machine
58 Drilling Machine
61 Frame Bending Mach.
62 Frame Bending Mach.
63 Drilling Machine
64 Air Hydr. Corking Mach.
65 Mecha. Press
67 Handle Polishing Mach.

b) Bus Seat Frame Proc.
1 Spot Welder
2 Spot Welder
3 Spot Welder
4 2head Pipe Bending Machine
5 4head drilling Machine
6 8head drilling Machine
7 Legframe Drilling Machine
8 Drilling Machine
9 CO2 Arc Welder
10 CO2 Arc Welder
11 CO2 Arc Welder
12 CO2 Arc Welder
13 CO2 Arc Welder
14 CO2 Arc Welder
15 CO2 Arc Welder
16 CO2 Arc Welder
17 CO2 Arc Welder
18 CO2 Arc Welder
19 Drilling Machine

b) Bus Seat Frame Proc.
20 Drilling Machine
21 Belt Polishing Mach.
22 Drilling Machine
23 Drilling Machine

c) Passe. Seat Frame Proc.
1 CO2 Arc Welder
2 Spot Welder
3 Portable Spot Welder

Fig. 8-2-1 Bus Workshop Division Machine-Layout Plan

3) Cutting Work Process

At present, frames for bus and railway seats as well as those for passenger cars, are cut piece by piece by a metal saw. This kind of saw is generally popular because it can cut any sectional form of steel or metal, whether angular or round or tubular, but it generally leaves a relatively large number of burrs on the cut surface. Drawing specifications often require that a cut surface should be "free from any burrs", and debarring must be done as a finishing process after cutting. Considering that an increased production of passenger-car seats is very likely in future, it is recommended that debarring should be discontinued and a new cutting device that produces less burrs should be employed, especially when round pipes are being cut. Before employing such a cutting machine, the following points should be considered:

(a) Consideration must be given to the finishing process after cutting. For this a cutting-off tool should be used to cut off burrs.

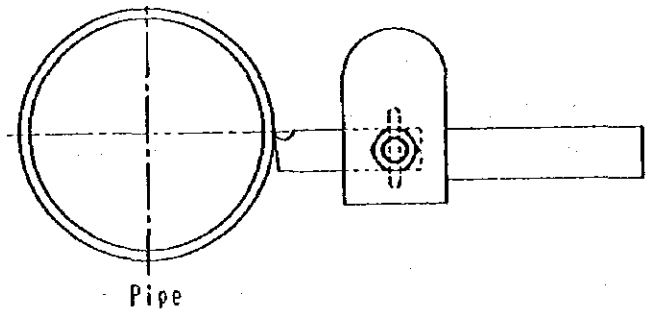


Fig. 8-2-2 A Cutting-off Tool

(b) For introduction of new pipe cutter, considering workability is the latter stage, a disc blade should be employed as it produces fewer burrs.

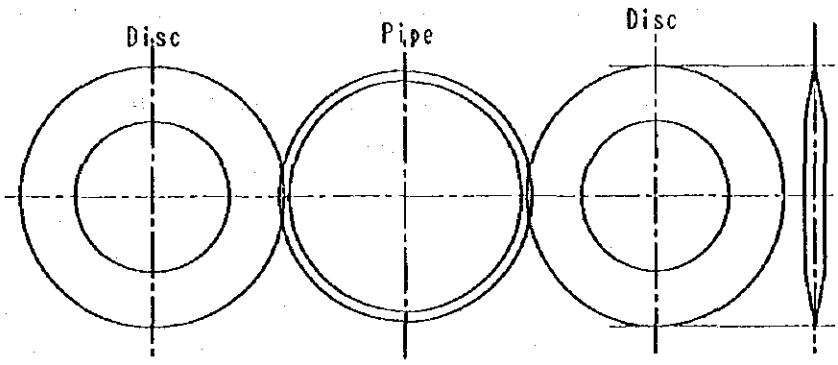


Fig. 8-2-3 A Disc Blade

4) Pipe Bending Work Process

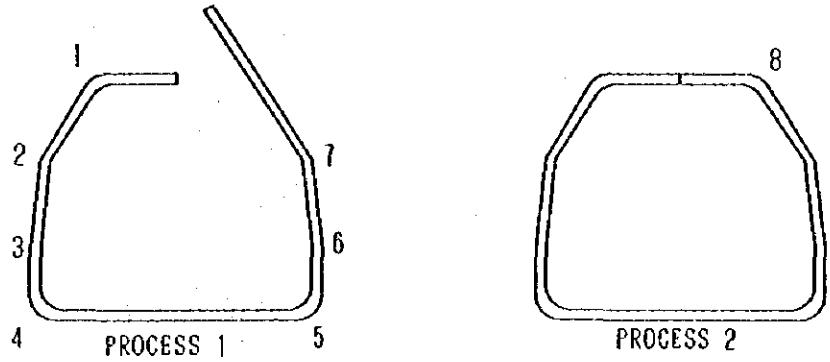
(1) Improvement of the Present Work Method

In the present work process, every seat frame is made into a dislocated shape like a spring washer at the final bending stage so that the mandrels which were but in the pipes before bending can be removed. The mandrels are needed to prevent flattening of the pipe during bending on a universal pipe bender. This method, however, requires a lot of time and labor to correct the distorted shape after removal of mandrels. To eliminate this correction process, it is recommended to introduce the following new method, which separates the present process into two parts, and simply makes use of the already-installed press benders. Pipes for seat-frames are formed into a closed loop by making a total of eight bends in sequence but if only seven bends are made the loop will remain open and the mandrels may by easily removed. In this way pipe-frames can be made without any distortion if the present pipe bender is used for the first seven bends and the last bend is done on the press bender which requires no mandrels. The press bender is a universal type press which can be used for pipe-bending by employing various molds to give the required outer-diameters, bend-radius and angles of the pipes to be worked. This bender needs no mandrels and is a vertical press, with an up-and-down sliding motion and a bed which supports the required mold. It is also hydraulically driven and so the operating speed can be freely adjusted to suit the conditions of the work.

Since all except the last bend can be done on the pipe bender without any interference between the workpieces and the machine or die only the cost of one mold for the press bender is involved. This allows the correction process to be eliminated. A plan for the Pipe-frame Making Process improvements is shown in Fig. 8-2-4.

1st Job: In order to avoid any interference between the workpiece and the die, a maximum of seven successive bends should be done using the conventional pipe bender. (DWG. 1)

2nd Job: The final bend should be made on the installed press bender and in this way, the correction process can be eliminated. (DWG.2)



(DWG.1) (DWG.2)

Fig. 8-2-4 Plan for Improvement in the Pipe-frame Making Process

(2) Modernization of the Pipe Bending Process

Modernization of this process should be planned and put into practice in order to keep up with possible increases in the output of automakers as well as to make preparation for a possible future use of robots for the welding process. For this purpose, the first step is to choose a type of equipment which will give a better productivity than the present process. The pipe bender presently employed, as mentioned-above, is a "compression bending" device which needs mandrels to be used. This equipment has the disadvantage that it takes much time to remove the mandrels out of the bend pipes. To solve this problem, it is recommended that a "draw bending" machine should be used as this does not require a mandrel inside the pipe. Changing to this type of machine will save working time and such a machine can bend pipes smoothly even if there are some burrs inside the pipes. The second step is to improve the accuracy of the finished work. If welding robots are to be employed, an accuracy in the range of 0.5 mm is required. Taking the foregoing into account and in order to make further cost-reductions, it will be advisable to use a twin-head NC pipe bender which is a draw bending type that can make bends simultaneously at two places.

(a) Compression Bending Machine

This bender is a device in which the workpiece is fixed to a stationery block on one side. The other side is in contract with a rotating die which presses against it and bends the workpiece as it rotates. However, this type is not suitable for accurate bending and cannot make bends at close intervals.

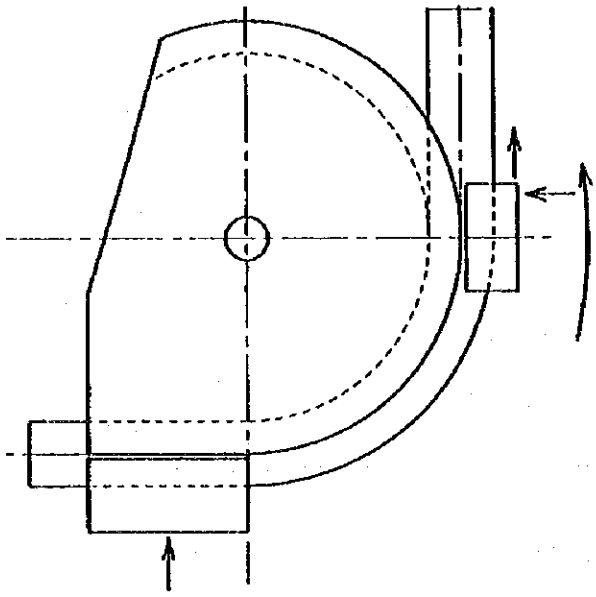


Fig. 8-2-5 Compression Bending Machine

(b) Draw Bending Machine

This bender is a machine which draw-bends a workpiece which has been clamped into a formed block with a die. This type can easily bend thin-walled pipes around small radius with less risk of deforming them into and elliptical shape. It is usually applied for precision bending.

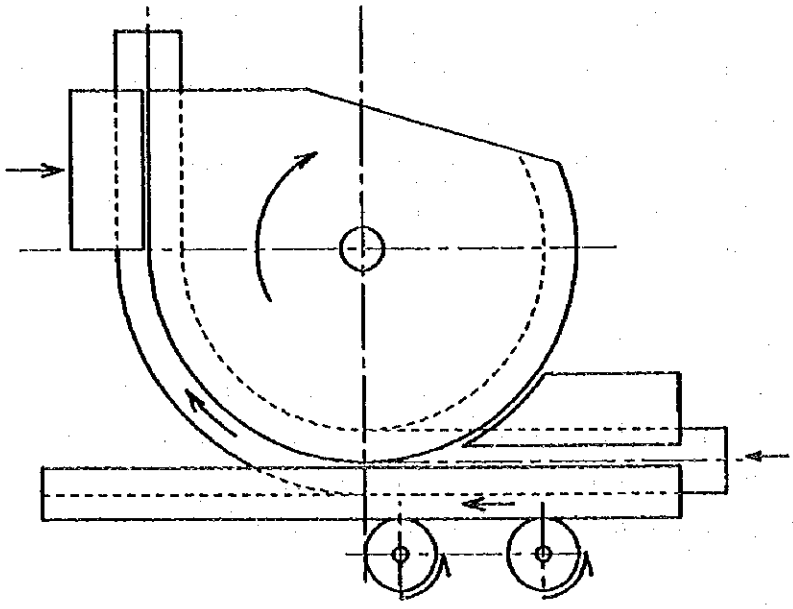


Fig. 8-2-6 Draw Bending Machine

(c) Twin-head NC Pipe Bending Machine

This machine can be controlled by the NC system to work simultaneously at two parts of the workpiece. By rotating a center-located clamp-die, it can make three-axis simultaneous motion including bending, feeding and twisting. So the machine has a very fast tact time. The Twin head NC Pipe Bending Device is shown in Photo (1).

(3) Modification of the Line Process for Passenger-car Seats

The machine tools in the workshop of the Bus I Division which is in charge of the production of seat-frames, are arranged, according to machine type. The Division combines the production of seat-frames for bus and railway use with those for passenger cars. Passenger cars require various types of frames, depending on the type and model of car, while both buses and trains need almost the same frames. To increase productivity, each production system should be separated.

At present, Magyar Suzuki has a limited range of production consisting of these models of one type of car. In the near future, however, an increase in the number of car types, specifications and models or a possibly changes of car models, can be expected. In order to cope resiliently with such possible changes, the layout of the Pipe Bending and Press Bending processes of the production line should be completely changed. A plan for the modified layout is shown in Fig. 8-2-7.

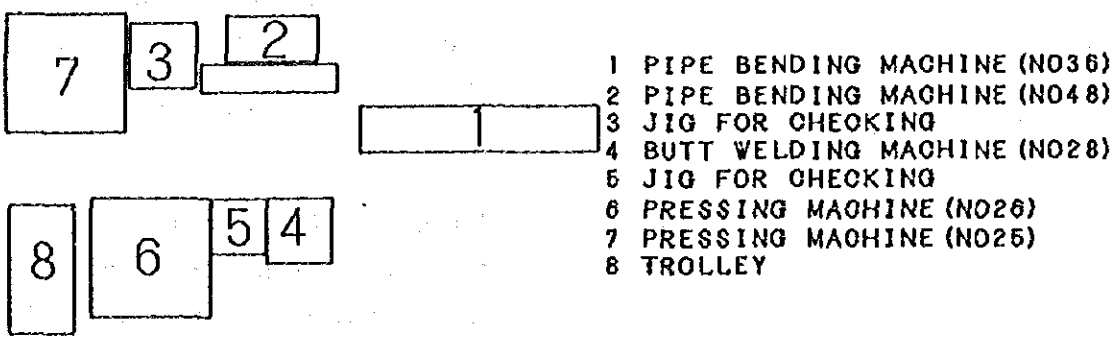


Fig. 8-2-7 Planned Layout of Pipe Working Processes for Passenger Car Seats.

5) Butt Welding

(1) Electric Power Monitor

Appearances of flaking or separation in spot welds are assumed to have been caused by voltage fluctuations. For a resistance but welder, voltage fluctuations are serious cause of welding failures, which can affect the ability to maintain a steady uniform work quality. Appropriate corrective action should be taken by measuring the line voltage. The resistance butt welder

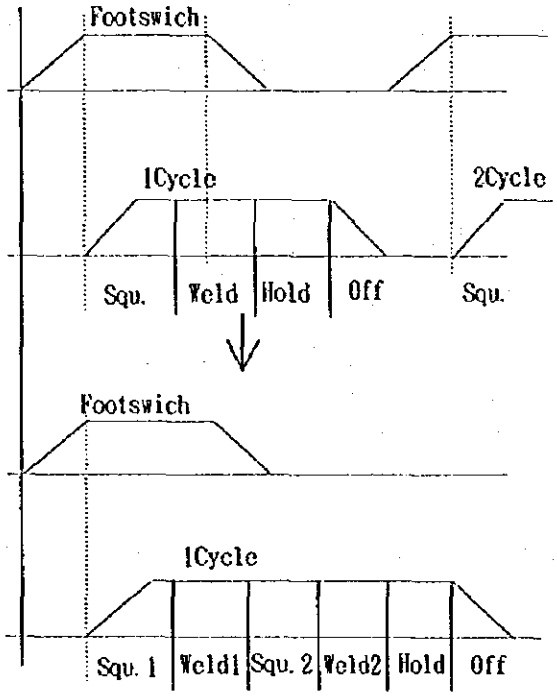
needs to be equipped with an electric voltage detector which can be used to stop welding work, when the voltage fluctuates by more than 10%.

(2) Remedies for Welding Failures

The contact between an electrode and a workpiece is maintained by lapping using sandpaper wrapped around a pipe. Since this procedure often produces gaps between the electrodes and pipes, however, it is difficult to weld the whole peripherally uniformly because current passes down one side, when the power is switched on. A good method of maintaining the contacts is to periodically exchange the electrodes, of which a spare set must be kept in readiness, and to re-shape used electrodes by a machining method such as an end milling machine.

(3) Improved Controller

Some welding failures may be caused by dirty or non-parallel surfaces of the workpiece which is being welded. To prevent such failures, the surfaces must be made completely clean and parallel by switching power on once. Then welding begins when power is switched on for the second time. To use this method, it is necessary to modify the controller of the welder.



[Single Welding Method]
One cycle of welding, consisting of application of pressure, welding, retention and release is carried out when the foot switched is pressed.

[Double Welding Method]
One cycle of welding consisting of the initial application of pressure, the first welding operation, the second application of pressure, welding, retention and release is carried out when the foot switch is pressed.

Fig. 8-2-8 Double Welding Method

(4) Installation of a Stopper

The accumulation of a very small amount of oil or dust on the pipe surface, where it is gripped by the welding electrodes, sometimes causes welding failure since it allows the workpiece to slide, when pressure is applied to the welding electrode. As a corrective measure, it is necessary to install a stopper to prevent the workpiece from moving in the opposite direction. During the first on-the-spot inspection, the installation of such a stopper was suggested as one of items to be improved. The resulting modification can be seen in photograph (2) referred to above.

6) Press Working Process

Since most presses presently in use were installed about twenty years ago, they are expensive to repair and maintain. A more serious matter is that, six of them have some difficulty in performing a normal operation because their built-in clutches, are of the pin-clutch type, and are unable to apply a braking force on the reciprocating movement of the slide. Instead of these presses which have safety problems, small-sized presses should be employed to prevent the operators being involved in accidents. For the Press Working Process, the most efficient working method is to use a single-framed combination die-set on a press fitted with a coil-feed device. This method is suitable for producing 600,000 workpieces or more a month. It is necessary to take into account that it may be required to increase production in future, because the present of the machines is less than 10 per cent of the rated output.

(1) *Repair of Molds or Dies*

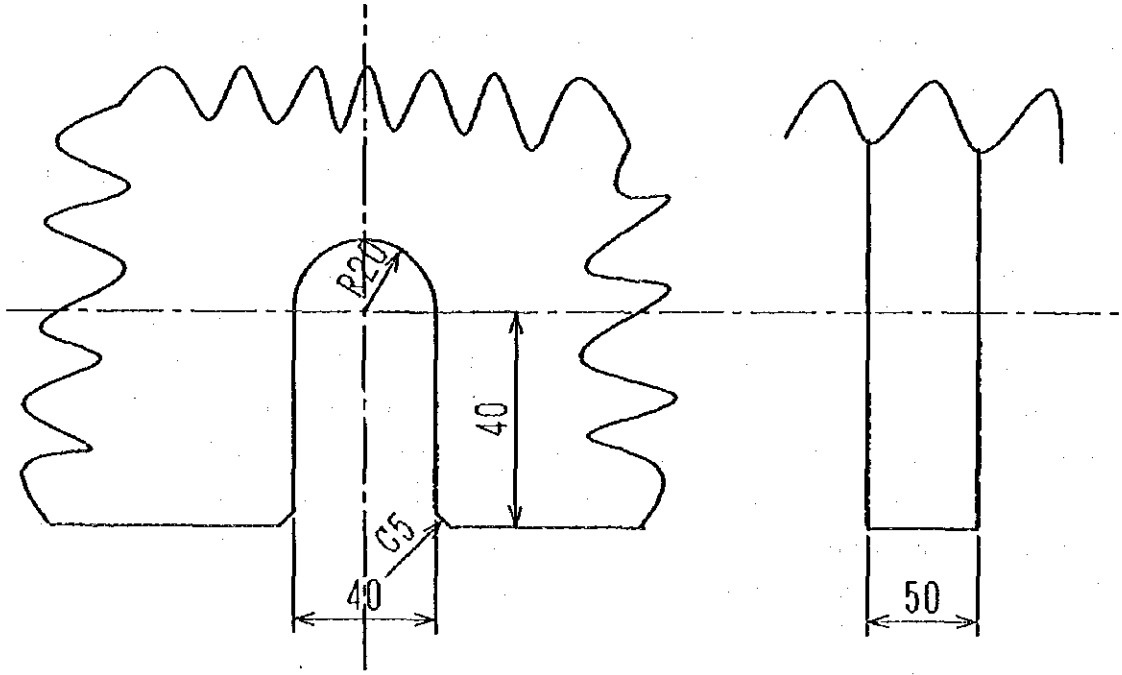
Molds are manufactured based upon mold-drawings modeled on work-piece-drawing specifications. As the final shape of the workpiece depends on the workability of the raw material, they often have different shapes and dimensions from those shown on the drawings. Because parts are misaligned with mating components, corrections have to be made during the welding and assembly process.

(a) To avoid making corrections by hammering when assembling frames for rear seat backs, changes should be made to the mold. In such cases, it is recommended that worn molds should be repaired by weld build up so that the cost may be reduced.

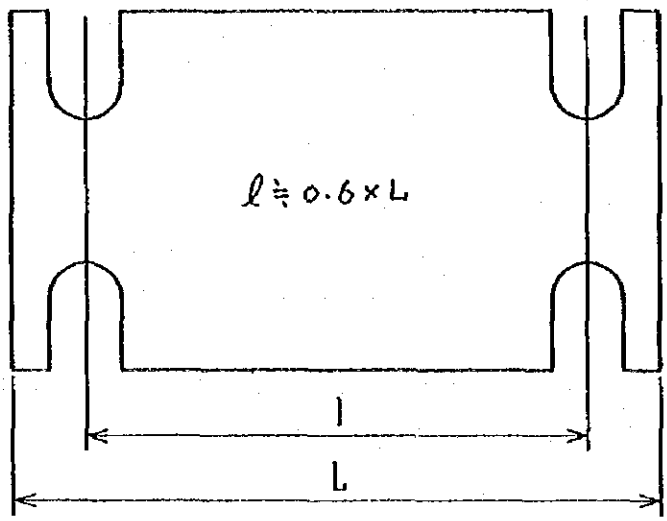
(b) Changes must be made to the mold, when the pressed parts for seat-frames give large clearances between mating parts.

(2) Improvements to the Clamps

Many clamps have to be used when a mold is installed in a press, which takes much time. This is because U-shaped notches have not been provided from the start to engage with the T-slots on the press. Such U-shaped notches should be provided on the molds, as shown in Fig. 8-2-9, to reduce the time for installing the mold.



U-Slot Dimensional View



U-Slot Arrangement

Fig. 8-2-9 Arrangement and Dimensions of U-Slot

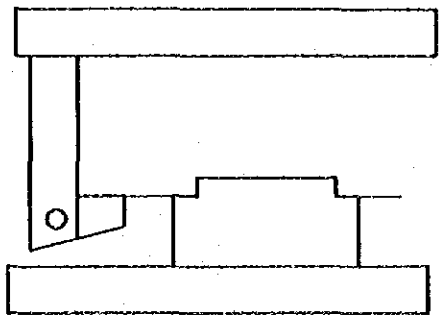
Table 8-2-1 The Number of U-Slots to be Provided

Weight of Upper Mold	The number of clamping devices to be installed
Under 2 tons (not including 2 tons)	4
Between 2 and 5 tons (but not including 5 tons)	6
More than 5 tons	8

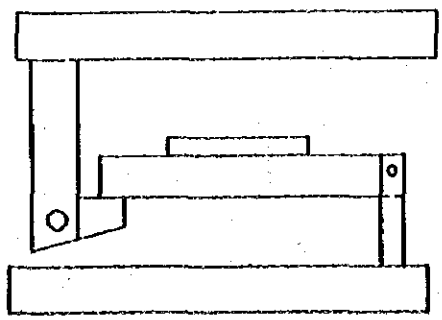
(3) Discharging Device

If workpieces in the mold are automatically discharged, all the worker has to do is to supply materials, and then much working time can be saved. Some examples of discharging devices are given below:

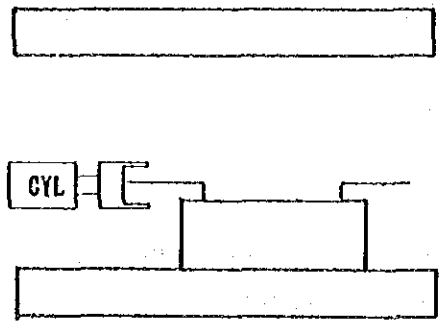
(a) A device can be used which directly hooks on to the workpiece and lift it up. It costs the least.



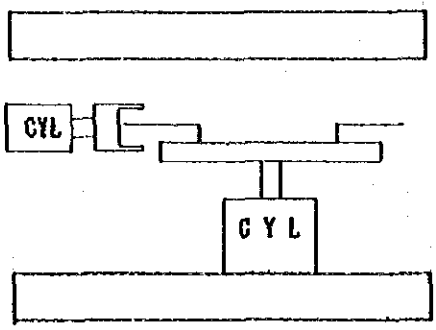
(b) It is possible to hook onto a chute-frame which is embedded in the die and fixed at the right hand side, and then lift it up. As there is a hook installed on the upper side of the die, this device is useful when it is difficult to slide the workpiece. It may be necessary to install a roller-conveyor on the upper side of the frame, depending on the size of the workpiece.



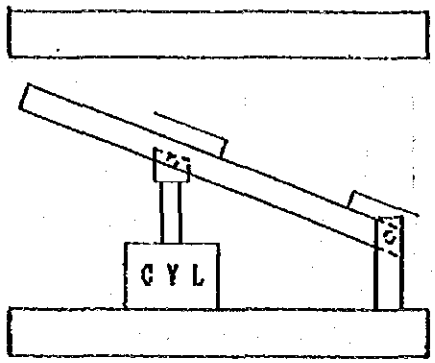
(c) By using an air cylinder, it is possible to slide the workpiece across the surface of the die, and then to discharge it. In order to make the air cylinder work, in synchronism with the press, it is necessary to install an encore-switch, control-circuits and a solenoid valve.



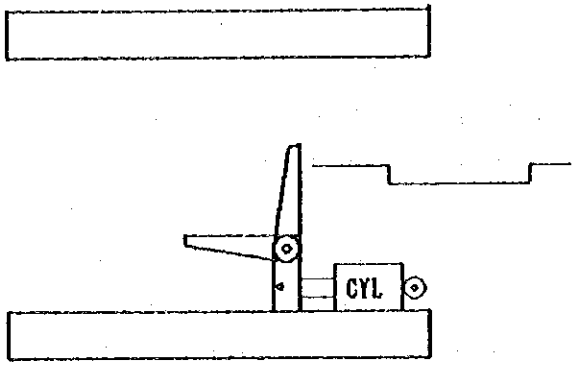
(d) By using air cylinders, it is possible to lift the workpiece up, move it crosswise, slide it across the surface of the die, and then discharge it. When the air cylinders are made to operate in synchronism with the press, it is necessary to install an encoder-switch, control-circuits and a solenoid valve.



(e) By using an air cylinder, it is possible to lift the chute-frame fixed to the right end of the die in a sloping direction, slide the workpiece across the surface and then discharge it. When the air cylinder is made to operate in synchronism with the press, it is necessary to install an encoder-switch, control-circuits and a solenoid valve.



(f) By using an air cylinder, it is possible to drive a chute-frame which can rotate through 90 degrees, and then to discharge the workpiece. When the air cylinder is made to operate synchronously with the press, it is necessary to install an encoder-switch, control-circuits and a solenoid valve.



7) Seat-frame Welding

Welding is done by skillful workers, and so is technically free from any faults. There are some processes, however, where welding is repeated two or three times at the same welding point. This shows that the workpiece was not properly installed in the jig. It is necessary to check the proper installation of the workpiece by shaking it a few times. When the clearances between the workpieces are found to be too large, which is one cause of welding defects, it is necessary to check for any possible clearances after setting the workpiece in the jig. In some cases, it may be necessary to change the dimensions or shape of the workpiece.

For some workpieces which require a lot of welds, remedial work to remove welding distortions has to be done after welding. Generally, since welding distortions are closely related to the way the workpiece is designed, it is rather difficult to solve such problems in a simple way. One way to solve this problem in the work place is to use a method in which the distortions are canceled out, by displacing the workpieces in an equal and opposite direction to the expected distortion prior to welding and then making the welds in a fixed sequence. This is called the predistortion method. Another example of the application of the predistortion method is to correct the welding distortions by adding one welding operation to each welding process. In another method, known as the symmetrical method, the order of welding is determined so that symmetrically located welds are done in sequence to minimize the weld distortion. It is necessary to reduce welding distortions by applying these methods to each work process on the spot.

(1) Welding Work Process for Seat-frames for Bus and Railway Use

(a) Improvement of the Production Line Layout

The productivity is now low, since it takes a long time to move workpieces from place to place because the welding work is done on a very long production line. Another reason is that the materials and parts are transported in large iron containers. A sufficient quantity of material can be supplied to each welding process if it is enough to fill a small bin located next to the jig where each welding worker can use it. The supply of materials and parts should be done by workers who are specifically designated for that job only. By employing small bins in which the quantity is sufficient to feed each process, it is possible to make the layout of the line relatively small. As a result, the distance workpieces have to be moved from process to process can be reduced, and at the same time the productivity of each process can be improved. The layout plan is given in Fig. 8-2-1 Bus Workshop Division Machine Layout Plan

(b) Re-checking of the Installation of Workpieces

To correct and improve any defective positioning of the installed work-piece, it is necessary to re-check the position in which the workpiece was set in the jig. When the first on-the-spot inspection was made, this re-checking method was suggested. Such improvements have been made. (Refer to Photo (3))

(c) Container for Stock to be used in the Production Line

Material and parts which are smaller in size than reclining brackets should be put in the container, which is shown in Photo (4). This container should hold sufficient material to supply the line for one day.

(d) Supply Platform

Parts which are used in large quantities can be supplied from a platform. An arrangement of such a platform is shown in Photo (5).

(2) Welding Process for Seat-frames for Passenger Cars

(a) Modification of the Production Line Layout. Since the welding process is done on a very long line, as described for the preceding bus-seats line, it takes much time to move the workpieces from one process to the next. So the productivity is now going down. It is necessary to make the distance between each process shorter by using small bins to hold the supply of materials and parts.

(b) Improvement of the Electrical Power Supply

As described earlier for the butt-welding process, the frequent occurrence of welding flaking or separation which seems to be attributable to the inadequate and out-of-date electrical supply system causes a serious problem in every welding process where

resistance-welders are used. To solve this problem, the best thing to do would be to provide an in-house generator to supply power for the sole use of these welders. As an intern measure, it is necessary to install voltage monitors at each welder, which will send a stop signal to the welder when the voltage fluctuates.

(c) Improvement of Working Conditions

Since the operating height of the welders used to weld square weld-nuts to reclining brackets for the seat-backs is too low, the workers work sitting on a chair. There is a risk they will suffer from back pains, because of working in a cramped position. Also it is not easy to operate the machine in this position. By providing a pedestal under each welder, the working height can be adjusted to allow the workers to work in a normal standing position. An idea for this improvement is shown in Photo (6).

(d) Improvement of Welding Hook Springs

In order to prevent the welds from flaking, a projection should be provided to help to concentrate the electric current into the hook spring, where the projection is located, as shown in Fig. 8-2-10. Such flaking or separation can be detected by conducting a caulking inspection immediately after completion of welding in the hook spring process. This is one of the surest ways to detect this kind of weld flaking.

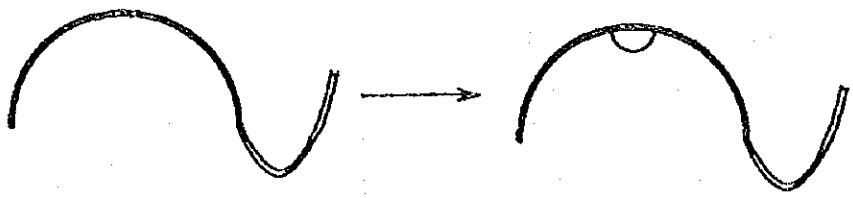


Fig. 8-2-10 A projection for the Hook Spring Welding Process

(e) Employment of Welding Robots

Since Magyar Suzuki is planning to produce 50,000 cars/year, a system should be created which can cope with such an increased production. To materialize this plan with the present workforce, it is absolutely necessary to use welding robots, and a specific plan should be prepared for further investigations. A possible arrangement for Welding Robots is shown in Fig. 8-2-11.

8) Wire-bending Process for Rear-seat of Passenger Cars

For the this process, it would be desirable to use an automated system in future to allow for a possible increase in production and the manufacturing process will need to be more accurate. For the wire-bending process, it is also necessary to employ a wire forming machine so that the dimensions of the finished product can be stabilized and the number of times that molds have to be changed may be reduced. For the welding process, it is necessary to employ welding robots, such as those described above. The other items which should be improved are as follows.

(1) Installation of Count Checkers

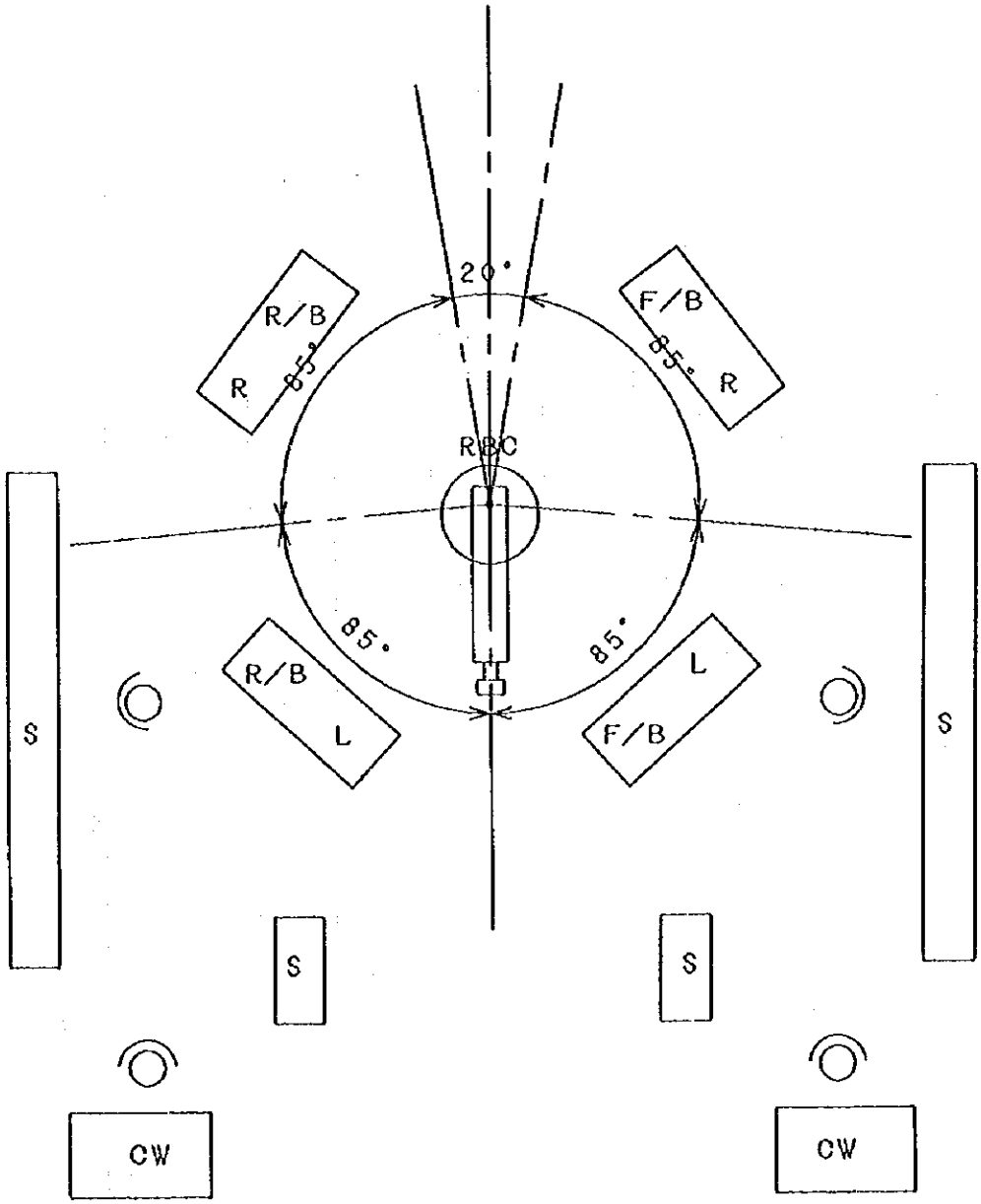
In spot welding a wire frame about sixty spot welds have to be made by each welder. At present, it is difficult to avoid missing welds because all the work is done manually. As a corrective measure, count-checkers should be installed to check the number of welds made by each welder.

(2) Care and control of Materials and Components

Raw materials and component parts that have become rusty, or covered with dust cause welding defects such as flaking or separation, during the resistance welding process. As a countermeasure, only the minimum necessary quantity should be kept in stock and the shelves on which the parts are stocked should be sheltered by covering them with special sheets. Refer to Photo (7).

(3) Improvement of the Factory Layout

Since the workshops in the present site are spaced apart, in-factory distribution is uneconomical and personnel waste a lot of time walking from one place to another. The productivity is reduced. Fig. 8-2-12 shows a plan for improving the layout of the rear seat production process.



RBS: WELDING ROBOT
S: SHOOT
CW: CO2 ARC WELDING
F/B·R: FRONT SEAT BACK RIGHT
F/B·L: FRONT SEAT BACK LEFT
R/B·R: REAR SEAT BACK RIGHT
R/B·L: REAR SEAT BACK LEFT

Fig. 8-2-11 A Possible Arrangement for Welding Robots

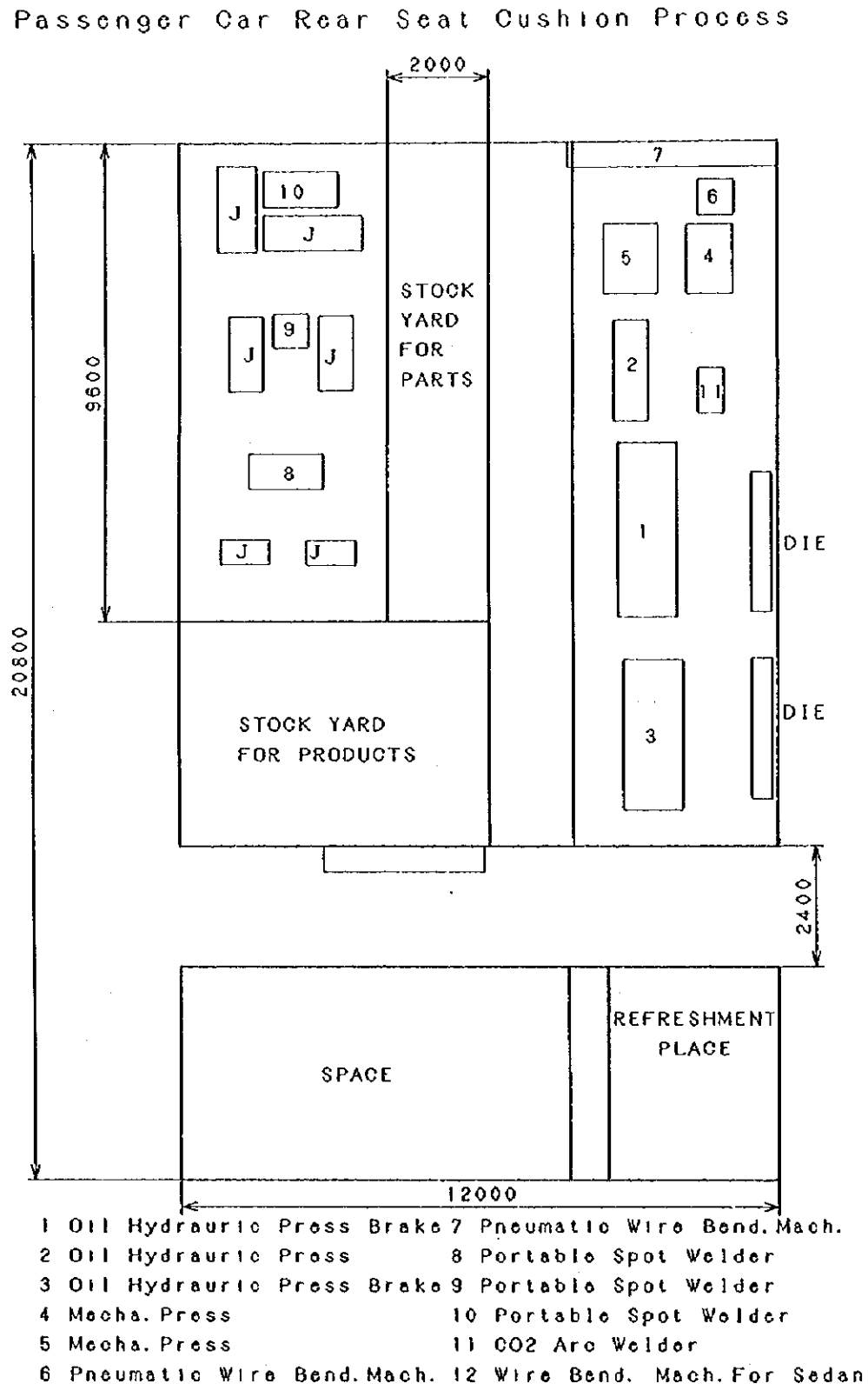


Fig. 8-2-12 A Planned Layout for wire frame working of Rear-seat Cushion Work Process for Passenger Cars

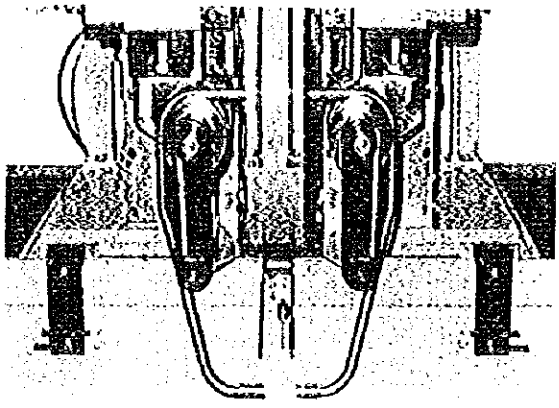


Photo (1) Twin Head Pipe Bending Machine

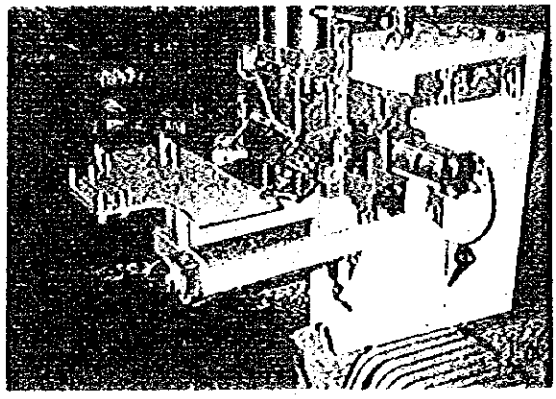


Photo (2) How to locate a stopper

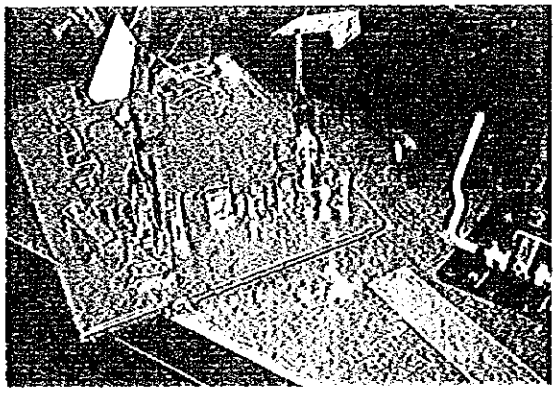


Photo (3) How to re-check the defective positioning of a workpiece

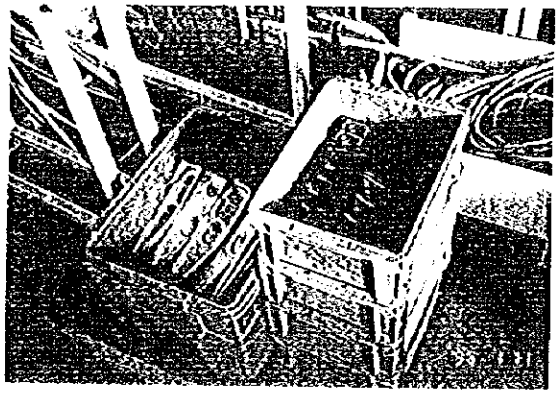


Photo (4) In-line Container for Stocks of Parts

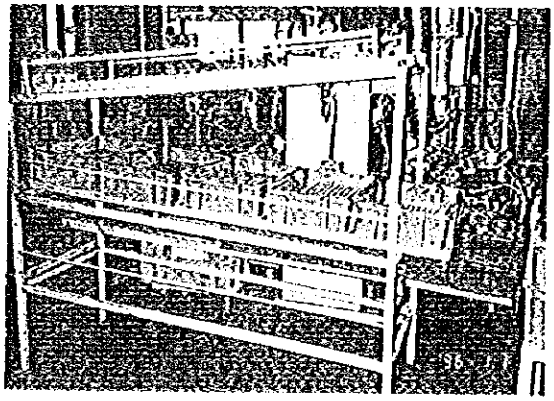


Photo (5) A Platform for Supplying Materials and Parts

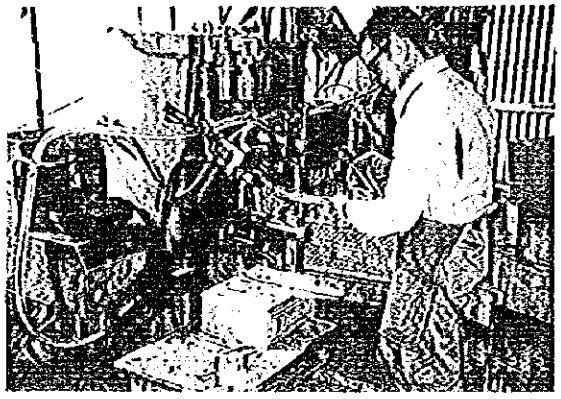


Photo (6) Operating a Spot-welder from a Standing Position

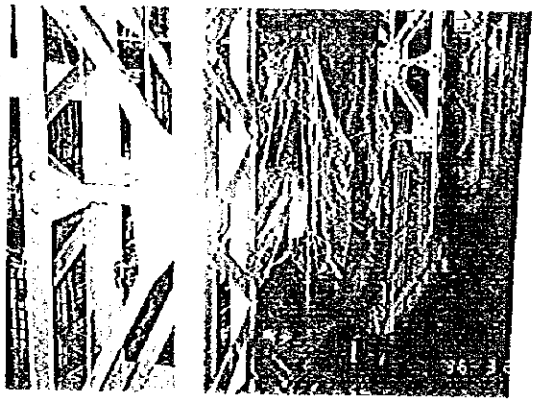


Photo (7) Examples of Protecting Shelves on which Parts are Stored

8-2-3 Sewing Process

The sewing process is divided into two lower-level processes: the cutting process and sewing process. Of the seat production processes, the cutting process has the largest ratio of material cost to total cost, while the sewing process requires the largest number of man-hours. Both of them are important processes that influence the manufacturing cost. In making improvements, emphasis should be placed on the reduction of expenses in the cutting process and on the enhancement of productivity in the sewing process.

In planning modernization, consideration should be given to mechanization, reduction of personnel, and improvement of yields to provide for future production increases and sales expansion.

1) Cutting process

The method of cutting should be selected according to the materials, thicknesses, patterns, and quantities of seat surfaces. Currently in IMAG, manual cutting is employed for cloth, and press cutting is employed for PVC. These methods are wasteful of material. To reduce costs, it is necessary to find ways of eliminating the waste of materials and increasing the yields.

(1) Methods of increasing yields

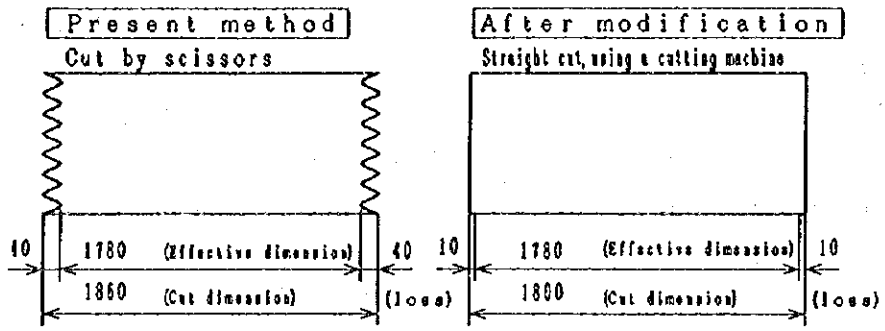
(a) Cutting process

All the PVC leather is processed by punching (die cutting). This method gives a lower yield than manual cutting since an allowance is required between the cutting dies. On the other hand, manual cutting requires more man-hours. The gains in yields and increases in man-hours for press working and manual cutting, should be compared and the method that gives the least cost should be selected. Different methods can be adopted for different types of cars.

(b) Spreading process

Rolled sheets are cut to length at both ends by two workers using scissors. This makes the cut ends of the sheets irregular (zigzag) and causes a loss of material. The loss of material can be reduced greatly by using a shearing machine instead of scissors. The expected results are shown in Figure 8-2-13.

(Example) In case of Sedan 5DR/GLx



Effectiveness

Cut dimension 1860→1800=▲60mm will be shortened.

Improvement of yield is 3.2% $\left(\frac{60}{1860}\right)$

Figure 8-2-13 Measures for Improving Cutting and Spreading Processes

(c) Marking

Since the pattern layout is done by manual working, both the operating performance and the yield are variable. Possible approaches to modernize the process include the dotted line powder technique, copy technique, and CAD/CAM technique. In view of the present volume of production and widespread use of cloth, the copy technique is most suitable for marking.

The specification of the copying machine is described in the section dealing with modernization of equipment. In this method the best full-size copy of the pattern layout drawing is placed in position over spread sheets of material and the sheets are cut together with the copy. This stabilizes and improves the man-hours required and the yield of the process.

If CAD/CAM is introduced, the copying machine will become unnecessary. Therefore, when considering the introduction of a copying machine, the time at which CAD/CAM will be introduced must also be taken into account.

(2) Improvement of operating performance

(a) Spreading process

In the spreading process, the rolls of material are mounted above the table. However, the position is too high, which makes the work fatiguing and dangerous. This arrangement should be changed to one in which the rolls are at floor level.

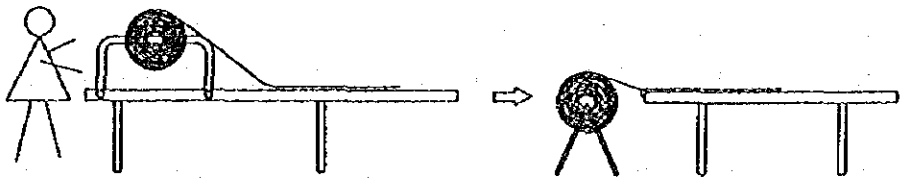


Figure 8-2-14 Changing of Setting Position of Material in Spreading Process

(b) Introduction of air tables

To improve the productivity of the spreading process, it is necessary to divide the work into a sequence of operations from spreading to pattern layout (or mounting of a copy), cutting, and the transfer of cut cloth. If air tables are introduced it will allow spread sheets to be transferred from one process to the next. Also, air tables can be adapted to a CAD/CAM system, when it is introduced in future.

(c) Introduction of automatic spreading machine

The manual spreading operation requires the workers to walk around constantly, and this is tiring. Although an automatic spreading machine will not change the speed of the spreading operation, the constant motion of the machine will make the work go more smoothly. Since the sheets will be cut automatically with a straight shearing machine, the cutting lines at both ends will be parallel to each other, resulting in better use of material. This machine can also be adapted to a CAD/CAM system, when it is introduced in future.

(d) Introduction of a packaging machine

The cut surface materials are bundled by a few workers using scrap material as string. Introduction of a packaging machine would improve the working environment.

(3) Integration of workshops

The bus seats and passenger car seats are produced in the shops of their respective divisions.

Since the cutting operations are common to both bus and passenger car seats, integration of the workshops would allow equipment, space, and personnel to be shared, so, avoiding waste.

When deciding the location of the combined workshop, the location of the warehouse for rolled sheets and the flow of materials should be taken into consideration.

(4) Introduction of CAD/CAM

The best method of improving the productivity and yield is to introduce a CAD/CAM system. When acquiring a system, there are various specifications, capabilities, and manufacturers to choose from. However, CAD/CAM systems are still very expensive. The cost should balanced against the quantity being produced and which may be produced in future.

When introducing CAD/CAM, the following points should be kept in mind.

(a) The purpose of its introduction is to improve yields, not reduce the labor. Although the number of direct workers can be reduced, a CAD operator and maintenance staff will be required. Reduction of the total number of personnel cannot be expected. The prime advantage of introducing CAD is increased yields. The more expensive the materials the company uses, the greater the benefit will be.

(b) A CAD system entails costs for maintenance and supply of materials. Consumables such as knives and grinding wheels are required and also films and working paper are necessary for each lot during operation.

(c) Since high precision machinery can get out of adjustment, it is important to select a vendor that provides attentive customer service.

2) Sewing process

The sewing is done by highly-skilled workers, all of whom are female. So there is no speed or quality problem. The reason why output per capita is low, in spite of this, is explained by the fact that the work is done in an uneven and wasteful manner. Also the workers cannot concentrate on their main work, as they have to stop to do subsidiary tasks such as transferring materials. Measures for making the best use of competent workers and improving productivity are discussed below.

(1) Appointment of staff exclusively for set-up

In the sewing process of passenger car seats, 56 workers do sewing in two shifts. Since there are no setup workers, the sewing workers themselves pick up materials and transfer semi-finished products, which interrupts their main work.

In the sewing process, one worker should be appointed exclusively to do set-up for every 15 workers doing sewing to allow the workers to concentrate on their main work and increase

the productivity per worker. Even in a shop with less than 15 workers, one fixed worker should be assigned to do set-up work, who can also do sewing if there is time to spare. In either case, it is important to establish a system in which workers can concentrate on their main work.

(2) Installation of a performance display board

The sewing operation consists of a series of careful manual operations that can make the workers tired. Therefore, the performance of the work is greatly influenced by the workers' motivation.

So that operations can continue evenly, small groups should be organized according to the type of work, the groups should be made aware of their own responsibility, and encouraged to compete with each another. An effective way of doing this is to install a performance display board that will allow the progress of work to be monitored at hourly intervals. This method involves setting a cycle time based on a standard operation and displaying the excess or short fall of the actual performance each hour so that both the supervisor and workers to see the progress at a glance.

It is also important that the workers encourage one another and work towards their goal, by monitoring the display board. Figure 8-2-15 shows a performance display board. Initially, manual entry could be done on a blackboard. Then, if it turns out to be effective, introduction of an electric display could be considered.

GYÁRTÓSOR

JANUÁR..........HAVI TERMELÉSIRÁNYÍTÁSI TERVE

munka, idő	TERV	1 / 29	30	31	2 / 1							Megjegyzés
8° ~ 9°	34	26	34	30								
9° ~ 10°	34 68	26 52	41 75	36 66								
10° ~ 11°	33 101	26 78	38 113									
11° ~ 12°	34 135	37 115	32 145									
12.45 ~ 1.45	34 169	40 155	39 185									
1.45 ~ 2.45	34 203	41 196	33 217									
2.45 ~ 3.45	34 237	36 232	33 250									
3.45 ~ 4.45	33 290	38 270	30 280									
összes elkészült darabszám		270	280									
1 Főre eső elkészült dbszám												

Figure 8-2-15 A Performance Display Board

(3) Improvement of production processes

(a) Elimination of temporary sewing

In the trimming process, a core is sewn in slit cloth to create a simple binding, which is sewn to a gusset in the next process. This operation is temporary sewing for facilitating the final sewing. However, it is wasteful to repeat the same operation twice. By using an attachment extender binding and core seam can be performed simultaneously, with the slitter and core fixed. This will allow to eliminate the operation of creating a simple binding, resulting in increased production.

(b) Installation of attachments and elimination of specialized sewing machines

Lap sewing and the sewing of folded surfaces require attachments "presser foot" and extender. Sewing machines equipped with such devices are specialized, resulting in idle time and the need to transfer materials. Inexpensive, removable attachments are available. An additional number of these attachments should be purchased and installed on machines as needed, to eliminate the loss of time due to waiting.

(c) Installation of an indicator to show remaining thread on the bobbin

During sewing, the bobbins must be replaced every 15 minutes. When sewing PVC leather or in the case of stitching in which the seam can be seen on the surface, if the thread on the bobbin runs out halfway, the needle marks will remain on the surface and it is impossible to sew it again.

Waste of material can be reduced by equipping the sewing machine with a remaining-thread indicator that will alert the worker with a buzzer when the thread is running out. The specification of the remaining-thread indicator is given in Section 8-5 "Modernization of the Production Facilities."

(d) Automation of sewing of rear bag

The sewing of rear bag which requires straight stitching, can easily be automated. The process can be automated by building an attachment for clamping the work and equipping existing sewing machines with it to allow automatic sewing by pressing a button. Since rear bag is sewn to the center of the cut part, the position is currently marked on each cut part with a felt-tipped pen. Automation will eliminate this operation. The specification of the automatic machine is described in Section 9-6 "Modernization of Equipment." However it may be a good idea to purchase an automated machine in order to learn the technologies used in its development.

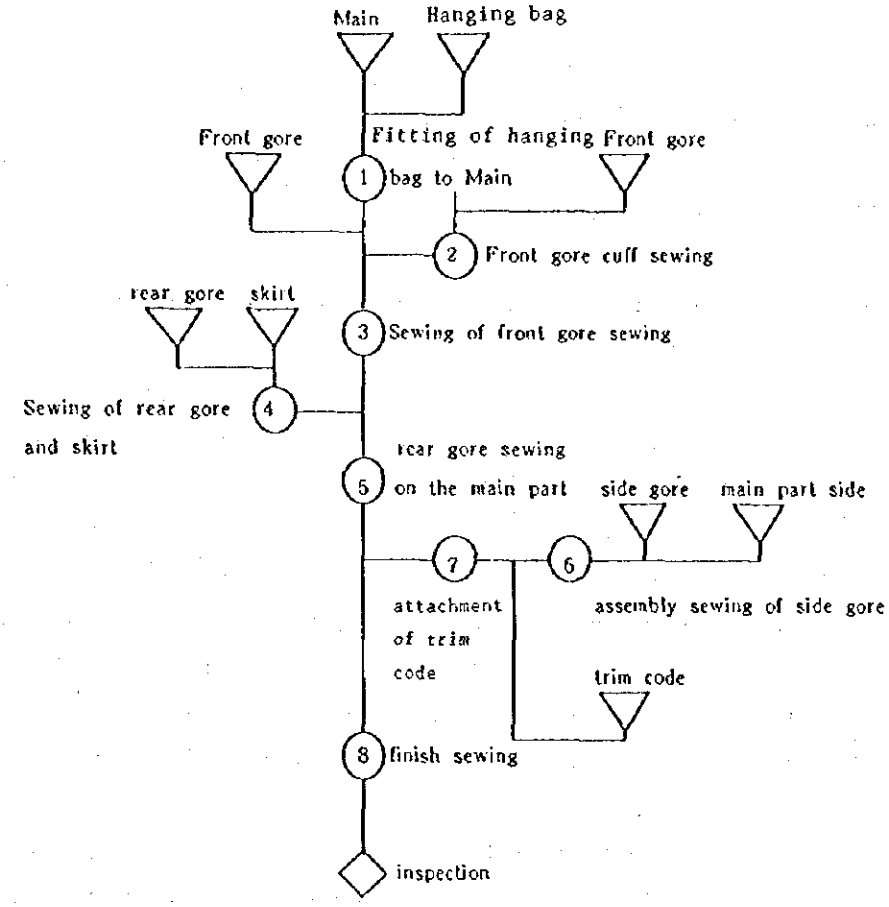
(4) Consideration of flow production

In the current method, each worker does the complete sewing of one item on a sewing machine in a sitting position. Since each worker is assigned material for 24 cars (one lot), parts or work-in-process for 24 cars are always piled up around her, resulting in an accumulation of stock and requiring additional tasks such transferring work-in-process. This hinders the progress of work and detection of problems. To correct this situation, the flow production method should be considered in which the processes are divided among the workers.

In flow production, zero floating stock is considered ideal, with only one product flowing on the line. However, sewing operations involve subsidiary tasks that even skilled workers cannot avoid, such as the replacement of bobbins or a broken thread. To balance the line under such conditions, the standard quantity of the in-process inventory should be three pieces.

Also, to establish a balanced line, work measurements must be taken. Work is measured as follows: take ten measurements of working time for each process using time analysis sheets, then carry out process analysis and time analysis using the average values of the measurements. Based on these analyses, analyze the balance of the line. Then make repeated improvements in the operations and analyses until the line is properly balanced. Figure 8-2-16 shows an example of the flow production method.

Production flow



Process layout

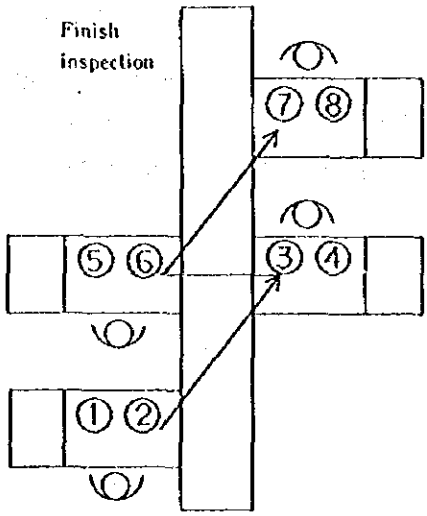


Figure 8-2-16 An Example of the Flow Production Method (separation of front seats)

Since sewing is done in a sitting position, the workers cannot move around and, thus, it is difficult for them to help one another. However, if the workers are divided into small groups and the lines are arranged in such a way that the workers sit facing each other, they can see the status of their work and help one another.

In multi-product small-lot production, flow production may reduce productivity due to time lost by frequent setups. Therefore, when selecting a production method, all the relevant factors must be taken into consideration.

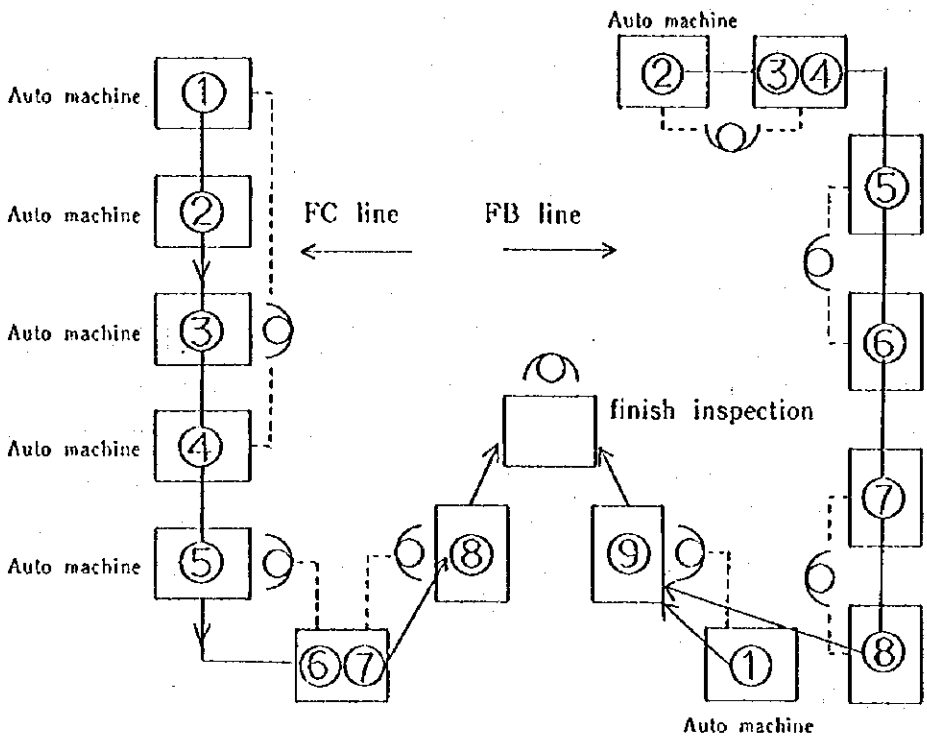
(5) Consideration of introduction of sewing machines operated from a standing position

The present sewing operators in IMAG are highly skilled. However, in order to provide for the future, it is necessary to consider the introduction of sewing machines operated from a standing position that will allow even inexperienced workers to do sewing.

The purpose of introducing sewing machines operated from a standing position is to increase the productivity per capita by automating the sewing machines used for simple processes so that even inexperienced sewers can look after several sewing machines and, thus, allowing the workers to help one another. Figure 8-2-17 shows a layout of lines of sewing machines operated from a standing position and a photo of an operation of this kind. (See photo (1))

In the production of automotive seats, each time a minor change is made to the automobiles, design and specification changes are required, which in turn require changes in the sewing processes as well as in the specifications of the automatic machines. Consideration of the re-building times and remodeling costs makes it necessary to build, remodel, and maintain automatic machines within the company. For this, it is essential to acquire expertise, and several men must learn the skills. This will take a considerable time: action must be taken now. A long-term modernization plan should be prepared and implemented.

Standing sewing machine line layout



FC process line

①Attachment of hung · bag onto the main part.
②Sewing of front gore cuff.
③Assembly sewing of front gore onto main part.
④Assembly sewing of rear gore and skirt.
⑤Assembly sewing of rear gore onto main part.
⑥Assembly sewing of side gore.
⑦Attachment of trim code.
⑧Finish sewing.

FB process line

①Attachment of hung · bag onto the main part.
②Attachment of felt onto pocket.
③Temporary attachment of pocket on inside of back.
④Attachment of ball · fringes.
⑤Sewing assembly of back inside upper portion onto back inside side.
⑥Sewing assembly of upper side to rear side.
Attachment of trim code on rear of back side.
⑦Sewing assembly of side on side gore , sewing of cuff.
⑧Sewing of lower gore and cuff.
⑨Finish sewing.

Figure 8-2-17 A Layout of Lines of Sewing Machines Operated from a Standing Position

8-2-4 Cushion Process

Although IMAG has a high level of expertise in polyurethane foaming, the productivity is rather low, contributing to high manufacturing costs. Ways of reducing the manufacturing cost are discussed below with emphasis being placed on improving the productivity.

1) Standardization of work procedures

(1) Short term Improvement Plan

At the time of our first field survey, a short-term improvement plan was proposed. It was suggested that the company should install a yellow lamp that comes on after 4.5 minutes of curing of injected raw materials to standardize the operation. This plan has already been implemented. In addition, to increase the productivity further, the molds should be opened automatically. This will help to reduce the number of man-hours and prompt the beginning of the next operation. Since automated mold opening involves some danger, a buzzer should be added to the yellow lamp to warn the workers.

(2) Establishment of cycle times

The method is as follows: measure the net working hours of the processes using time analysis sheets, establish the standard time of each process including the times for doing subsidiary tasks. Based on the standard times, the required number of workers are calculated from the required volume of production. Then the cycle times for each block are established and use them to manage the process.

The following paragraph lists the target values of the cycle times for molding work for passenger car seats when produced in large volumes.

(a) Target values of standard times by process (per mold)

Process	Standard time
Injection, mold clamping, injection-head cleaning	30 sec.
Cleaning of, and application of mold release agent to, gas holes in the cope	30 sec.
Mold removal, deburring, cleaning of the mold	40 sec.
Application of the mold releasing agent	20 sec.
Mounting of inserts	30 sec.
Standard working time per mold	150 sec.

(b) Target values of cycle times (front cushions of block A: 8 molds)

Standard time per mold	150 sec.
Total cycle time of block A	1,200 sec. (150 sec. x 8 molds)
Cycle time for two workers	600 sec. (10 min.) (1200 sec. / 2 persons)

The improvements that should be made to achieve the above target values are discussed below.

(a) Increase of traveling speed of injectors
The injectors are moved by driving chains. Their traveling speed is rather low, resulting in a long waiting time. The drive unit should be remodelled to increase the traveling speed.

(b) Reduction of waiting time caused by insufficient capacity of the injection system
Since one injection system serves four blocks, if two or more injection operations are required at the same time, one must wait. Two more metering pumps and two more machine tanks should be added to the injection system to reduce the waiting time. The addition of two more units will also allow the injection system to accommodate two types of raw material. Adoption of a light-weight material for the back cushions would help to reduce the cost. The specifications of the metering pump and machine tank are described in Section "Modernization of Equipment."

(c) Mechanization of the crushing (degassing) process
Different crushing processes are employed in four work areas. For cushions without inserts, roller crushing which has a high operating efficiency should be used, to make effective use of the existing equipment. For cushions with inserts, vacuum crushing should be used in all cases, and the air-hose technique and batting should be given up. The products should be brought to one place using belt conveyors. The newly introduced vacuum degassing apparatus should be remodeled so that it can treat two workpieces at a time.

2) Improvement of layout

Figure 8-2-18 shows a suggested layout of the cushion process for passenger car seats that are produced in large quantities.

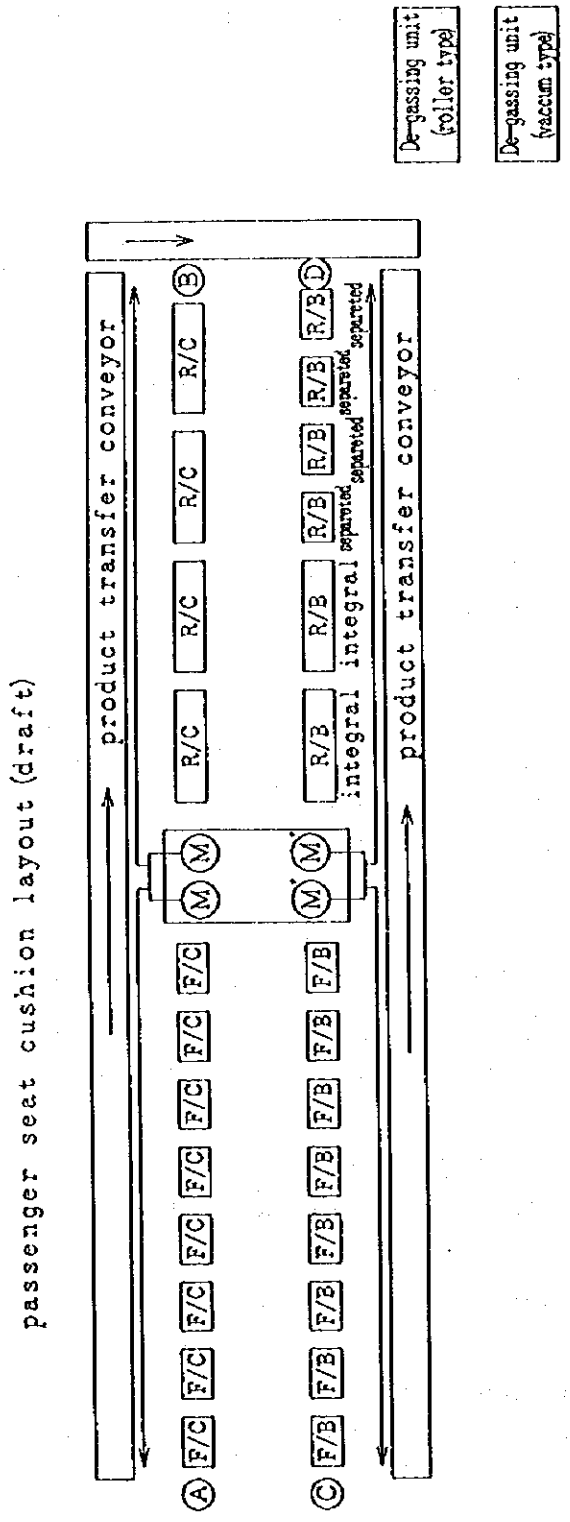


Figure 8-2-18 Suggested Layout of the Cushion Process for Passenger Car Seats

3) Cost reduction by reducing the weight of products

The process employs raw materials of the nontoxic diphenylmethane diisocyanate single type, and are produced using equipment of the cold cure type. This makes it difficult to produce cushions with a low specific gravity: the weight of the product is increased by more than 10% with a resultant cost increase. Measures to reduce the weight aimed at lowering costs are described below.

(1) The raw materials supplier should be asked to develop lightweight materials of the diphenylmethane diisocyanate single type. Jointly develop raw materials with a specific gravity of 0.06 or less. Also, a new raw materials supplier should be found and new raw materials should be actively developed for the purpose of cost reduction.

(2) From the viewpoints of prices and physical properties, a specific gravity of 0.04 or less is desirable for back cushions. However, this is difficult to achieve with the diphenylmethane diisocyanate single type. It is suggested to consider reducing the weight (reduction of specific gravity) by using a mixture of MDI and TDI to reduce the total cost. For that purpose, the working environment must be improved, for example, by providing ventilating equipment.

4) Introduction of turntable lines (or circle lines)

One of the best ways to increase productivity and reduce weight is by introducing turntable lines. As a reference, Figure 8-2-19 shows a suggested layout of circle lines for the production of passenger car seats.

(a) Goals

Production capacity (passenger car seats):	For 300 cars (two shifts)
Number of workers:	12 persons (two shifts)
Weight reduction:	10%

(b) Main specifications

Number of stations:	12 (rear seat cushion bases)

<Breakdown>

Injection station:	1 (automated by using a robot)
Curing stations:	7
Mold removal station:	1
Mold release application station:	1 (automated by using a robot)
Inserts mounting station:	2
Injector:	2 sets (2 heads, 4 metering pumps, 4 tanks)

Material types

For cushions:	Diphenylmethane diisocyanate single type (curing time: 4 min.)
For backs:	Mixture of MDI and TDI (curing time: 4 min.)

Capacity

Tact time:	34-40 min.
Daily production (one shift):	762 stations (dollies)
	= (8H x 60 min. x 60 sec.) / 34 sec. x 0.9 operating rate
Passenger car (one shift):	152 units
	= 762 dollies / 5 (No. of dollies per car)
Workers (one shift):	6 persons

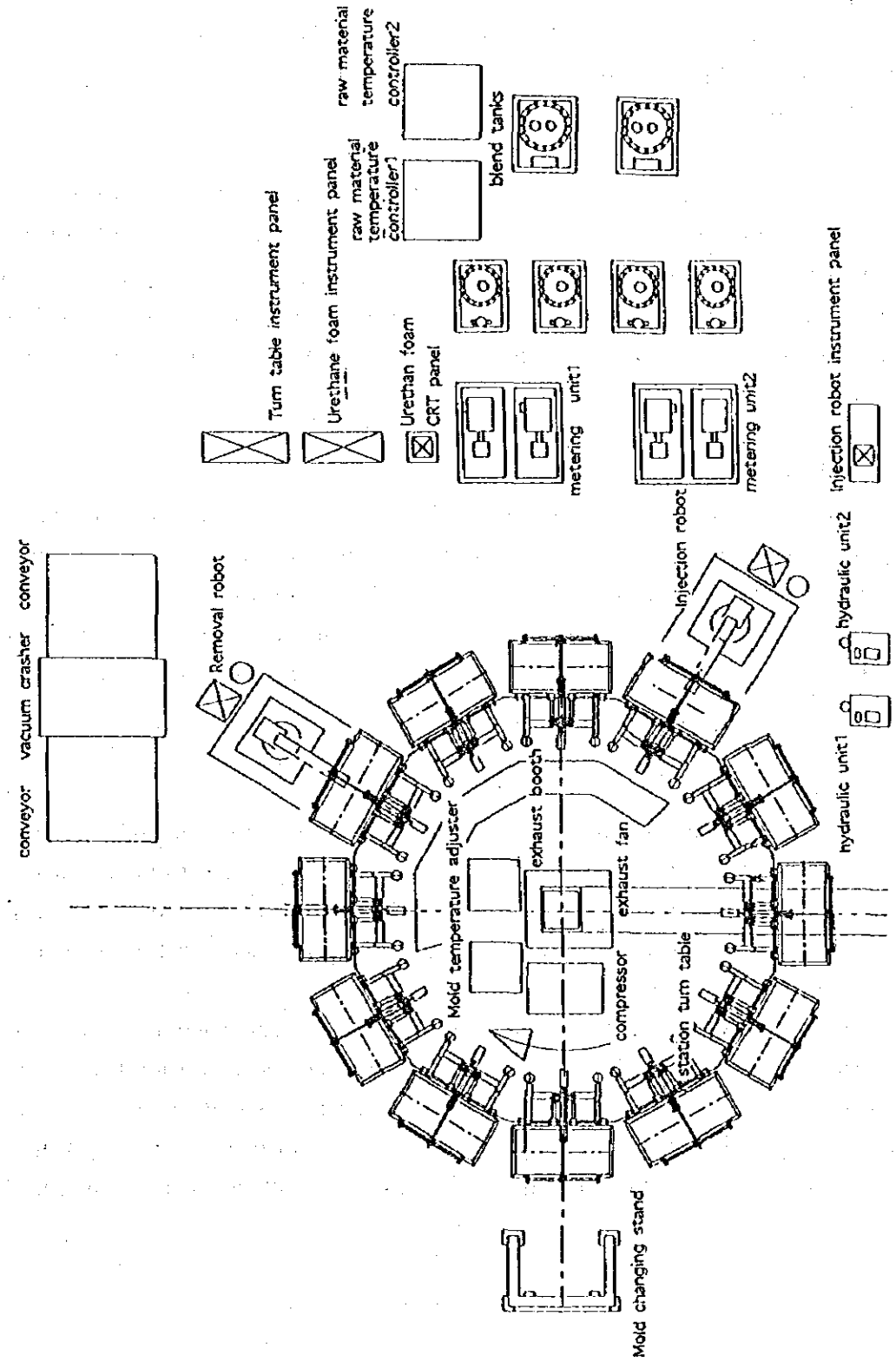


Figure 8-2-19 Conceptual Diagram of Circle Lines

8-2-5 Assembly Process

In the assembly process that is the final process in the production of automotive seats, top priority must be given to preventing defective parts from being delivered to the clients: the workers must develop a high awareness of quality control.

The assembly process has the second largest number of man-hours after the sewing process with 76 persons assigned to it. All the operations are performed manually. It is important to create an environment in which the workers can concentrate on working effectively by eliminating wasteful movements. In modernizing the assembly process, the company should put emphasis on the enhancement of productivity and the development of the quality consciousness described above.

1) Seats for buses

The company has drastically cut back production in a plant that was previously tuned to the mass production of buses. However, the basic production techniques and business support have remained unchanged. This has left latent strains and results in wastefulness in all areas. The company should thoroughly eliminate wastefulness, and review the functioning of its production lines and make improvements so that they can respond flexibly to the current order quantities.

(1) Production lines

The parts coming from preceding processes are temporarily stored on the hanger chain conveyor in accordance with the production plan. The workers pick up parts from the conveyor, assemble them, and return the finished products to empty hangers on the conveyor. The conveyor moves in a circle at a constant speed and is not timed properly to match the workers' pace, resulting in the workers wasting time, waiting.

When one unit is completed, it is unloaded from the hangers again and transferred to the finished-product (or semi-finished product) yard. These operations are wasteful. The use of chain conveyors appears rational, but actually, it offers little benefit with the present volume of production. By stopping the use of the chain conveyors, the company can increase its productivity. Figure 8-2-20 shows a suggested layout of the assembly process without a chain conveyor.

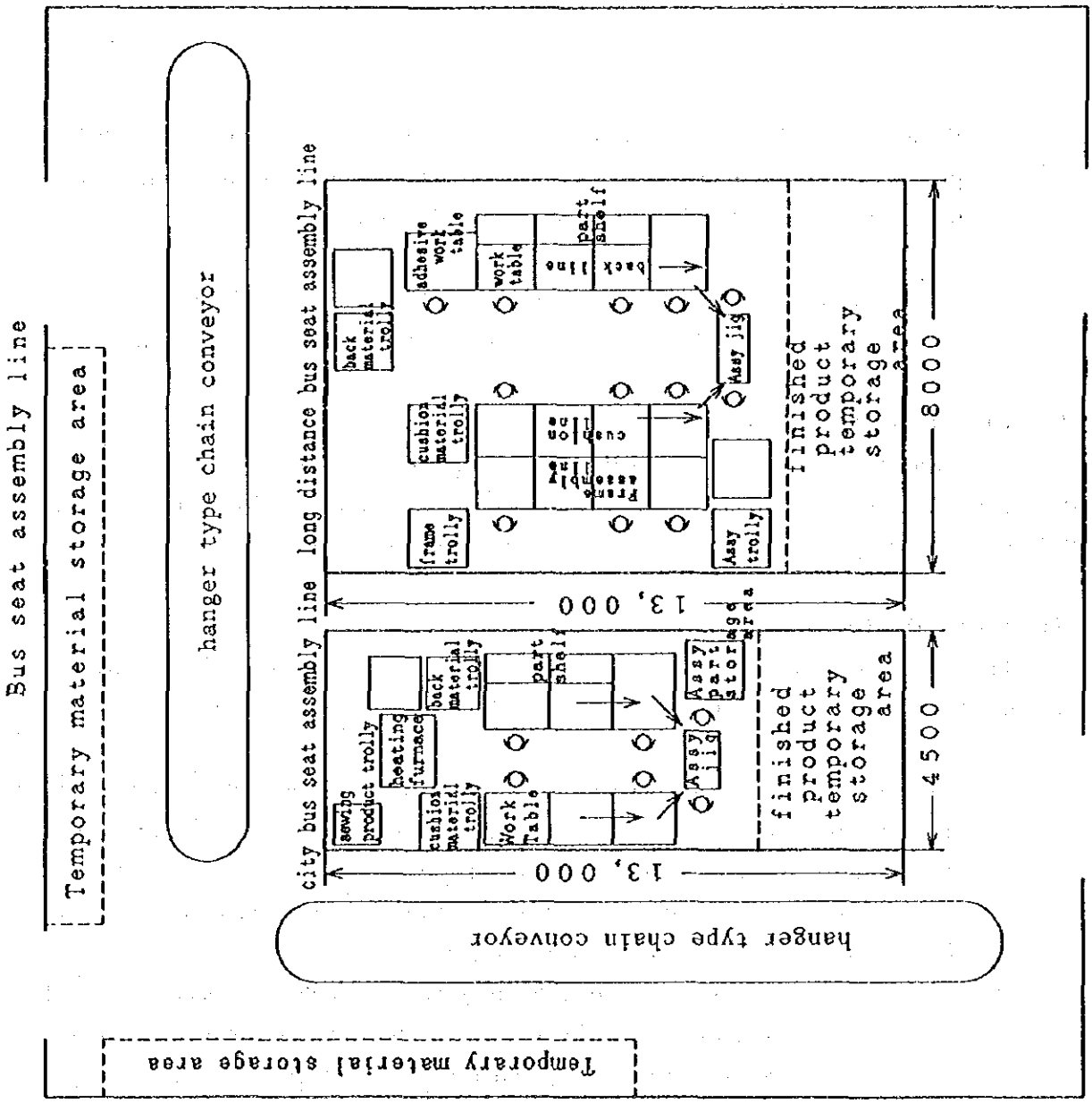


Figure 8-2-20 Suggested Layout of the Assembly Process without a Chain Conveyor

The purposes of this layout is as follows:

(a) The layout consists of two lines: the municipal bus line and the long-distance bus line. Although these lines are merely rows of work benches, they can be set up in various ways in response to orders, by simply changing the assembly jigs.

(b) By adopting flow production in which the various operations within the assembly process are divided among the workers, and by running the production continuously up to the final assembly, in-process inventories can be eliminated.

(c) By monitoring the progress of work shown on the performance display board, the staff can always check the balance of the line and try to increase productivity.

(2) Cushion bonding process

The cushion bonding process of seat backs for long-distance buses, which is currently done in a different shop, should be integrated with the assembly process and synchronized with the screwing of the plywood and frames, to reduce transportation losses.

(3) Standards for issuing of materials

In the assembly process, some idle time results from mismatches between the supply and demand of materials. To correct this situation, the following measures are suggested.

(a) To avoid idle time due to delays in the supply of materials, an exclusive setup staff should be appointed: a preliminary setup worker should be assigned to gather materials from the preceding processes and put them in the temporary storage area and an in-process setup worker should issue the materials from the temporary storage area. The division of their duties should be clearly defined.

(b) The issuing of materials is mainly done by forklifts. This should be gradually converted to using wheeled dollies (described in the section about the cushion process) so they can be handled manually. A flexible system is necessary that can easily accommodate frequent setup changes. The dollies currently used for frames are not suitable because they are difficult to remodel in a short period. It is also necessary to consider the working environment: for example, by using hand lifts and keeping forklifts out of the shop.

(c) It is suggested to minimize the size of the containers holding parts issued to the intermediate processes of the line and place them near the workers to make it easier for the workers to pick up and return the parts (reference photo (2): roller racks).

(d) The role of the setup staff who issue materials is to create an environment in which

the assemblers can concentrate on their work. It is important to train the setup staff and workers to exercise self-discipline, including the observation of the opening and closing hours.

(4) Improvement of operations

In the process of installing seat back plywood, pneumatic screw drivers were used for tightening minus-head screws. Since the tip of the driver was liable to slip off the slot in the screw heads, involving some danger, we proposed a remedy. Consequently, the screws were changed to Phillips screws, and both operating performance and safety have been improved.

2) Seats for passenger cars

The workers perform their operations properly according to the work standards, they are highly skilled, and there is no quality problem with the finished products. However, although flow production is used for the assembly process; the line is poorly balanced, inventories pile up between processes, and the flow is not stable. The company should implement a modernization plan that will permit stable flow production.

(1) Improvement of the front seat line

The operation analysis by process conducted in the short-term improvement plan revealed that the working time of the final assembly process was so long that an in-process inventory piled up in the previous process.

The following paragraphs describe ways of improving operations in the final process and remedies for some processes.

(a) Improvement of the final assembly process

(i) Four finished products are loaded on a dolly: after loading two products, the dolly is rotated a half turn to load the remaining two. Replacing the loaded and empty dollies is also part of the assembly process. This is done thirty times in a shift. To reduce the number of man-hours, a semi-automatic system should be considered that conveys and replaces loaded and empty dollies by using a simple half-turning device as it will be described later in "Modernization of Materials Flow."

(ii) In the assembly process, two workers carry out their operations using a single jig equipped with an error preventer. Since the final assembly process also serves as an inspection process, sometimes additional tasks such as making corrections arise. When one of the workers is engaged in such tasks, the other worker is idle. The present output, 240 units/day, is the limit that can be achieved with a single jig. The number of assembly jigs should be increased.

When adding new equipment, an assembly conveyor for carrying jigs should be considered to permit process allocation. The specification of the conveyor is described in the Section "Modernization of Equipment."

(b) Improvement of the individual processes

(i) If the final assembly process is improved as described above and the number of man-hours is reduced, the volume of in-process inventories in the previous process will be decreased. The in-process inventory in each process should be reduced to less than four pieces, with a target of one piece, and eventually the storage area used for in-process inventories should be reduced. For that purpose, the allocation of the processes should be reviewed and improved every time an excess or deficit of in-process inventories is encountered.

(ii) Regarding operations that require workers to walk long distances, the arrangement of work benches and furnishings should be reviewed to reduce space and avoid time wasted in walking.

(iii) Parts such as reclining equipment and slide rails must be placed so that the workers can pick them up and put them back easily: the installation of racks should be considered to improve the method of issuing parts. (See photo in Paragraph "(2) Roller racks")

(iv) The process of installing the buckle on the slide rail is done by a single worker. Since this process takes less time than the subsequent process because of the small number of man-hours, the work-in-process is held for a while. The process allocation should be reviewed so as to integrate this process into the process of installing the slide rail on the assembled seat in order to save space.

(v) To manage results, a performance display board should be installed so that the hourly progress of work can be monitored.

(c) Assembly lines

It is proposed a design for the front seat assembly lines which can accommodate future production increases and will further enhance productivity. This assembly line is actually used in a Japanese company for producing a passenger car seat with the same specification as that in IMAG.

Main lines (running one 8-hour shift)

(a) Workers: 10 persons

(b) Production capacity (target): 320 sets (640 seats)
(Tact time: 45 sec.)

(c) Main equipment items (one of each type)
"S" fixing speeder (special-purpose)
Covering machine (special-purpose)
Assembly conveyor (special-purpose)
Seven-meter belt conveyor
Four-meter belt conveyor

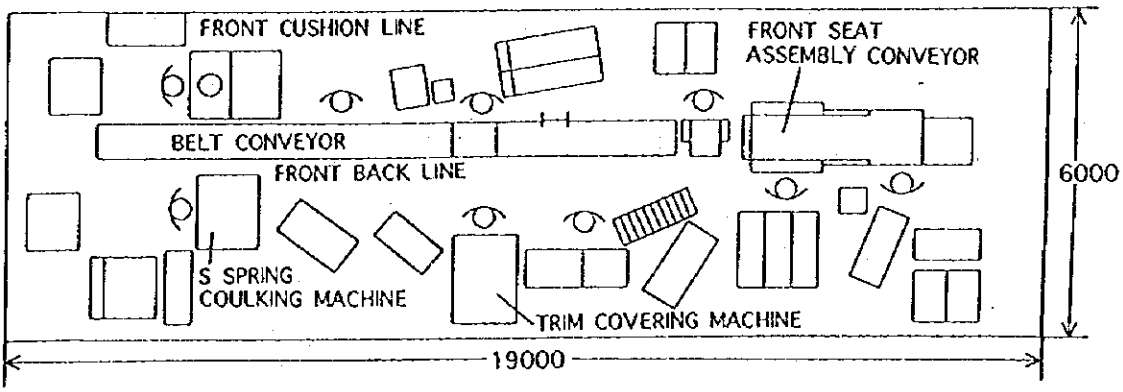


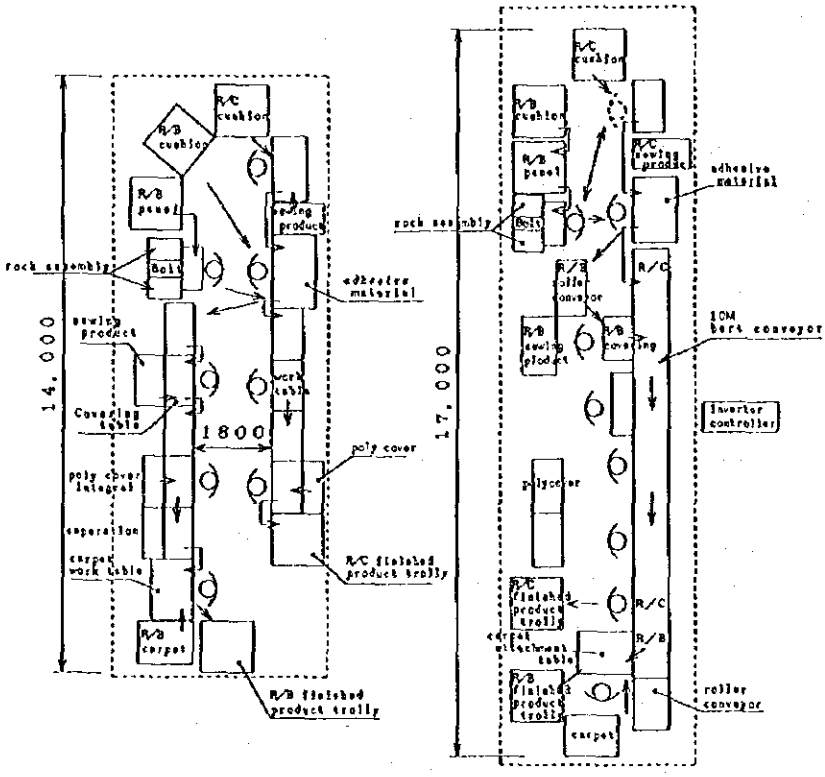
Figure 8-2-21 Suggested Design for Assembly Lines

(2) Rear seat line

Although the rear seat assembly line employs process allocation, it does not use flow production. Consequently, after each operation the workers have to return the assembled part to the dolly and pick up parts for the next operation, which involves wasted labor and movement. With the current layout, there are limits to what can be improved. The study team propose two designs for a new layout as shown in Figure 8-2-22. The features of these designs include:

Suggested design A: This design uses the work benches and furnishings currently in use. It can be implemented soon.

Suggested design B: This design aims at enhancing production and requires a belt conveyor (10 m) to be introduced and a tact time to be set.



Suggested design A Suggested design B

Figure 8-2-22 Suggested Design for an Improved Rear Seat Line

The following paragraph lists the points that should be kept in mind when making improvements to the rear seat line.

(a) Unnecessary labor and movement wasted when handling parts should be eliminated.
(b) In-process inventories should be eliminated and integrated work should be organized. (Inter-process floating stock should be reduced to zero, and cooperation between adjacent processes should be encouraged.)
(c) Production should be synchronized with the front seat line.
(d) The production goal should be set at 250 units with eight workers working one-shift.

8-2-6 Inspection Processes

1) Seats for buses

This department is logging behind other production departments in the preparation of standards and procedures. Necessary standards and procedures should be prepared, including the three basic documents: the work standard that deals with operations, the equipment check list for the processing conditions and maintenance of the equipment, and the product check sheet for checking processing quality.

(1) For important processes and products made by metal working, periodic inspections should be carried out based on the product check sheet and a record should be kept.

(2) In the cushion process, equipment plays a key role. The processing conditions should be controlled by means of the equipment check list. Also, the details and quantities of defective foaming should be entered in the product check sheet and a record should be kept.

(3) As a measure to prevent defective foaming due to insufficient curing in the cushion process, the mold opening devices should be automated by timer control to fix the time between injection and mold removal. Also, the work standard should be put in the shop so that the procedures for cleaning the molds and the quantity of the mold releasing agent to be applied can be standardized.

(4) The crushing operation after mold removal in the cushion process should be stabilized of good quality by mechanizing it. The crushing rollers and vacuum devices should be arranged in parallel. A conveyor should be used to make sure that the products are supplied to the crushing equipment within a certain time after mold removal to stabilize the quality. The pneumatic and batting systems should be given up.

(a) Crushing-roller degassing apparatus
This will be used if the inserts in the foamed part will not be deformed by the rollers.

(b) Vacuum degassing apparatus
This will be used if the frames of the inserts in the foamed part are likely to be deformed by the rollers.

(5) To ensure that the seat assembly process is properly inspected, it is recommended to install an error preventer that checks for missing parts and verifies tightening torques.

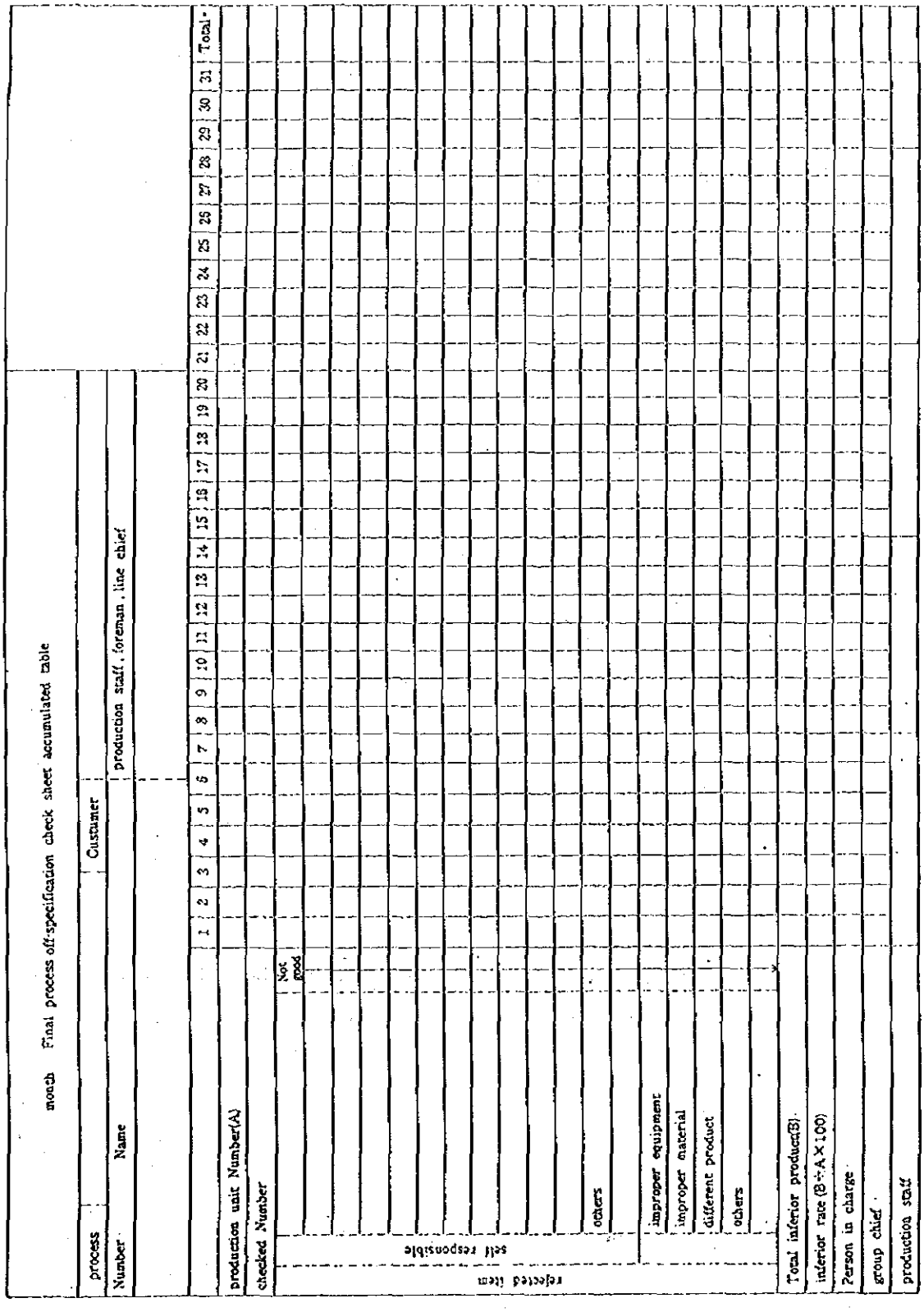
The specified range of the tightening torque should be displayed in the shop, and the error preventing functions should be checked by means of an equipment check list.

(6) A temporary storage area should be provided and indicated with a sign in which one set of seats (i.e., seats for one bus) can be stored, to prevent completed seats from being placed directly on the floor or being piled on top of each other. Also, the handling of the products should be standardized to prevent damage or contamination of the finished products caused by improper handling.

2) Seats for passenger cars

(1) The form of the check sheets for in-process defects in the seat assembly process should be standardized to ease the entry and counting of defects. An example of a check sheet is shown in Table 8-2-2.

Table 8-2-2 An Example of a Check Sheet of Passenger Car Seats Assembly Process



(2) For the assembly of parts important for safety in the seat assembly process, the specified range of the tightening torques should be displayed in a place in the shop where it can be easily seen.

(3) A daily check list of functions of fool-proof device to be checked should be displayed in the shop. An example of a check list is shown in Table 8-2-3.

Table 8-2-3 An Example of a Check List of Fool Proof Device

Daily checking card

Equipment Name

No

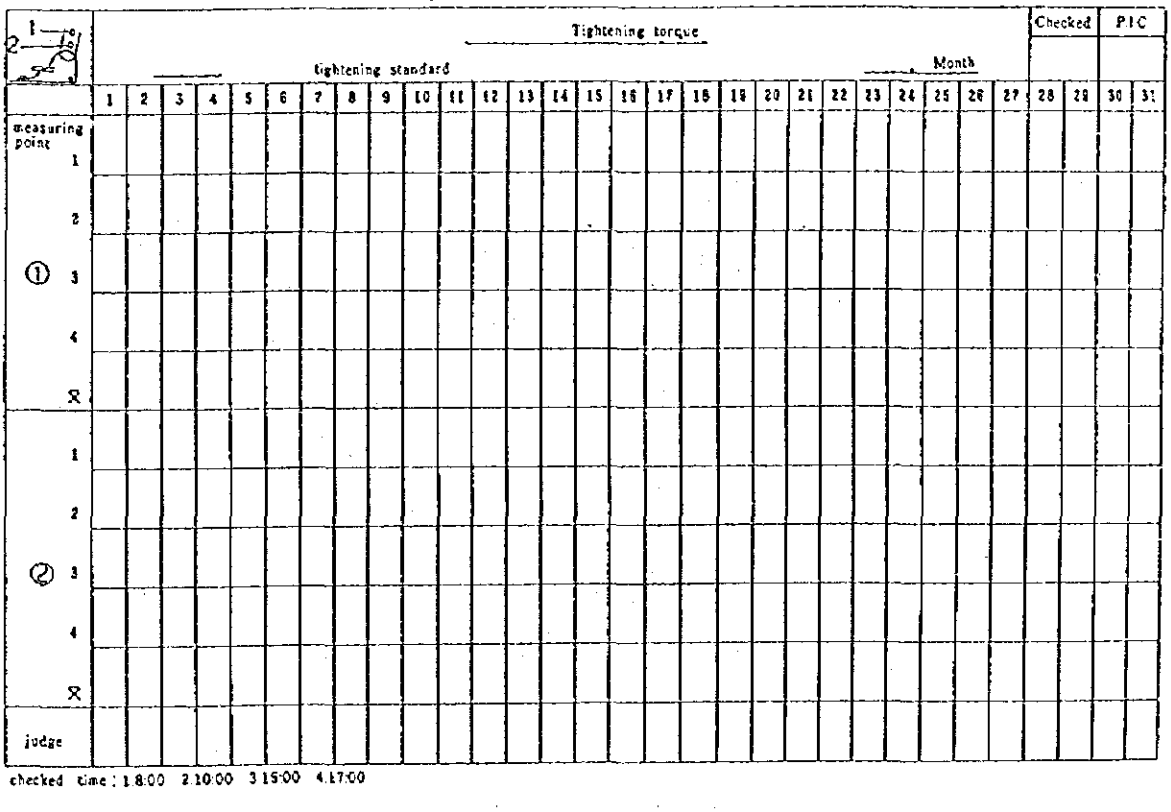
Date

No	Checked item \ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	29	29	30	31
1																																
2																																
3																																
4																																
5																																
6																																
7																																
	cheked person																															
	super visor																															

1.After checking, if normal ○. After checking, if abnormal but easy to remedy △.
After checking, if abnormal but difficult to repair ×.
2.If abnormal is found, report to supervisor and obtain instruction.
3.After checking, if abnormal but repaired, record on equipment maintenance card.

(4) The values obtained during the tightening torque checks should be displayed in the shop. An example of a list of torques is shown in Table8-2-4.

Table 8-2-4 An Example of a List of Torque Check



(5) A list of "quality check points" should be displayed in the shop in particularly important processes or where it is necessary to prevent recurrence of defects. An example is shown in Figure 8-2-23.

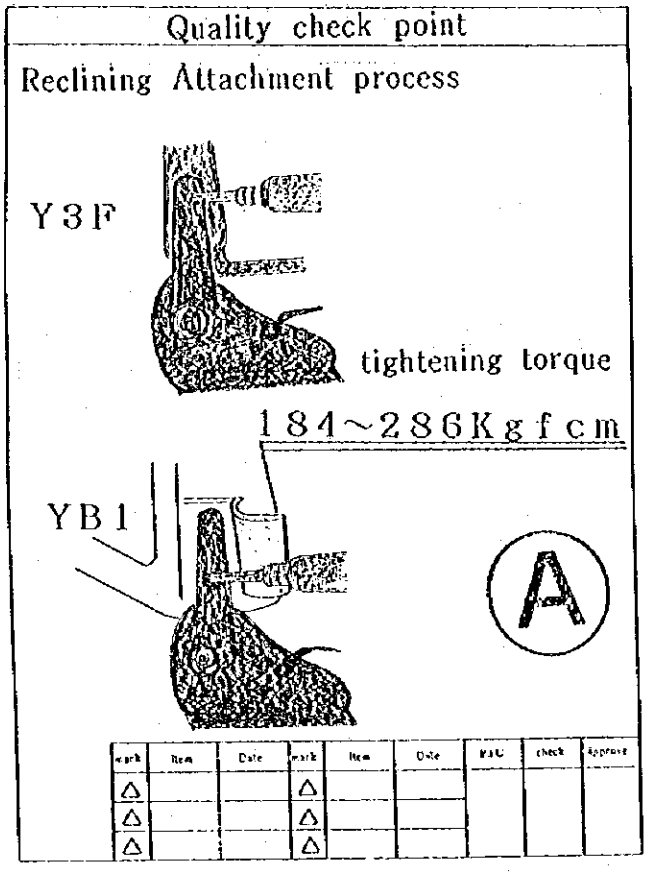


Figure 8-2-23 Quality Check Point

(6) Although the tightening torque of the slide rail is checked in the final inspection process of the front seat assembly process, functions of fool proof are not provided. Installation of a fool proof device will increase productivity.

(7) An inspection tool should be built for checking shapes in the processing of the wire frames for the rear seats, and sampling inspections should be made on the spot.

(8) In the assembly process of parts important for safety, the torques are checked in sampling inspections, using a torque analyzer. The introduction of a digital torque wrench with automatic measurement, recording, and statistical processing functions should be considered.

8-2-7 Flow of Materials

1) Shop layout

Since the existing shops of IMAG were designed for the mass production of seats of IKARUS buses, they are not well suited to the present production. It is not advisable at present to carry out major remodeling including reconstruction of the buildings. Figure 8-2-24 shows a suggested layout of the shops for increasing the productivity of the individual processes of seat production, making use of the existing buildings from the viewpoint of flow of materials. This layout will eliminate waste and save work space in each process.

2) Modernization of BUS I Division

The seat frames for buses and passenger cars are produced together in the BUS I Division. The seat frames undergo seven processes from the receipt of materials to completion, all of which are carried out in the same building with the exception of the painting process. Reduced quantities of seat frames are produced using the equipment and furnishings left from the times when buses were mass produced. This leads to some unreasonable and wasteful ways of working. The problems include the following three points:

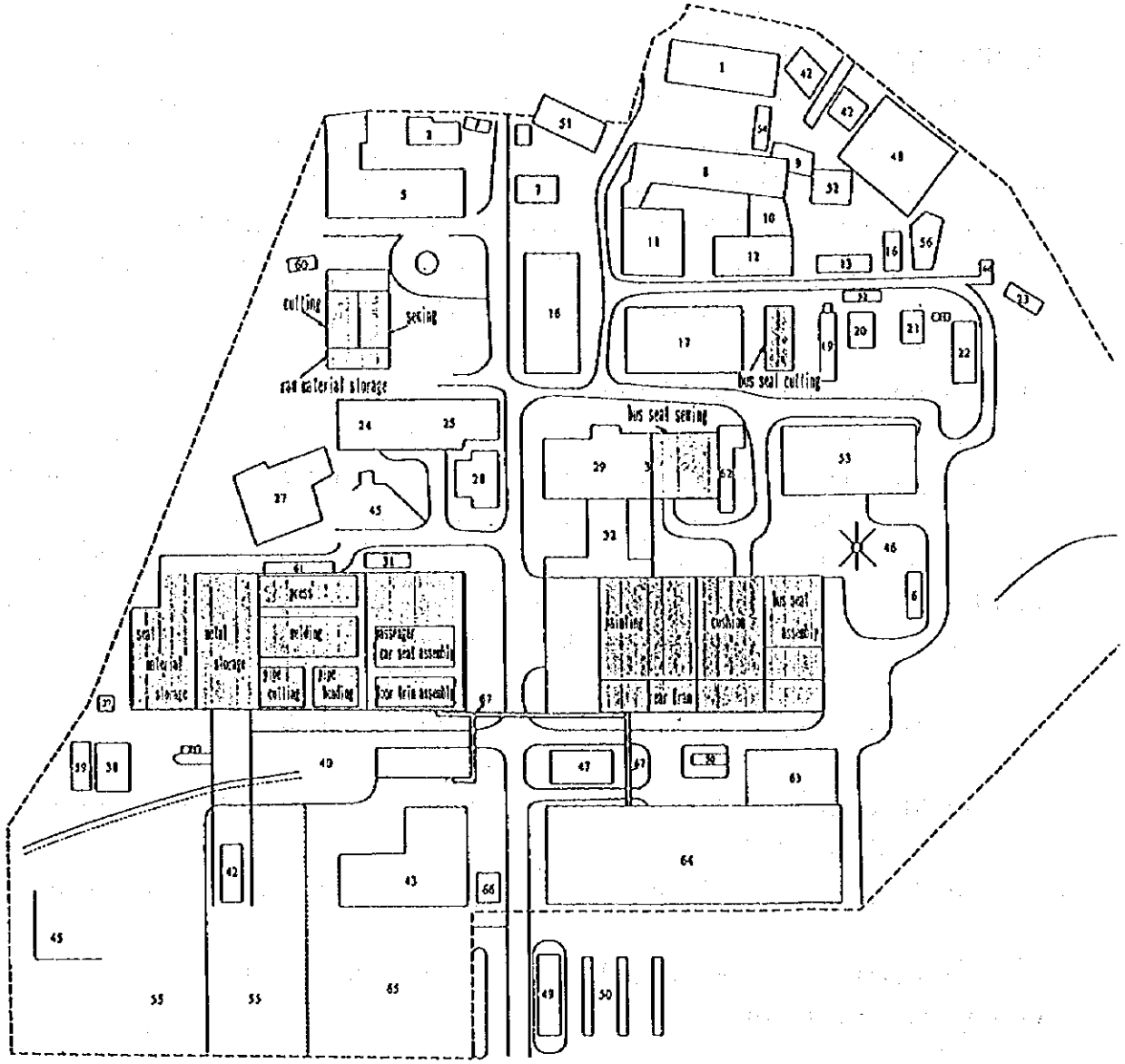
(a) The lot sizes are too large and are not adjusted to suit the quantities of materials received.
(b) The pallets and dollies are large and of irregular sizes, making it difficult to determine the floating stock correctly.
(c) The pallets and dollies are so heavy that they cannot be carried without a forklift.

Consequently, there is a large quantity of in-process inventory, and first-in first out is not used. The suggested remedies include:

(1) Remedies common to all the processes

(a) Method of determination of lot sizes

The lot size is determined by the quantity supplied to the first process which is the pipe cutting process, and it is the quantity of pipe material in one bundle, i.e., 240 pieces. However this lot size should be determined, by the delivery plan of the client. Regarding bus seats, the lot size should be fixed by the number of seats in one bus (approx. 40) and seats for several buses should be produced together. For passenger car seats, the lot size should be fixed as a multiple of the basic number 48, and operations and progress management should be done in step with the delivery plan of the client.



①Metal work shop shall be gathered and reduce the space for metal work.

②Passenger car seat assembly line shall be moved and marshalled.
(seat, door trim, roof)

③Cutting and sewing lines for passenger car seat shall be marshalled.
(1 set of press shall be moved.)

Note: Bus seat division remains unchanged.

Figure 8-2-24 Suggested Layout of the Shops in IMAG

(b) Unification of the types of pallets and dollies

The holding capacities of pallets and dollies should be determined by the lot sizes. The pallets and dollies should be remodelled step by step using standard shapes according to product type and process. In the pipe bending and butt welding processes, special-purpose dollies should be used through out, and iron boxes whose contents cannot be seen, should not be used. (See Photos (3) and (4).)

(c) The weight of pallets and dollies should be reduced to avoid the use of forklifts

It is suggested to reduce the use of forklifts by downsizing and reducing the weight of pallets and dollies, and to attach wheels to the dollies so that they can be moved by hand. Press worked parts should be placed in small boxes of a uniform size, and the small boxes can be stored in an iron box as required. (See Photos (5) and (6).)

(2) Improvement of the welding process

Small boxes, instead of the iron box currently in use should be used for issuing the press worked parts to the welding process. This will allow the parts to be supplied without using a forklift. This will also help the setup staff, and the idle time spent waiting for parts can be eliminated. The duties of the setup staff should be defined clearly so that production workers do not have to pick up parts and can concentrate on their own work.

(3) Improvement of the painting process

The finished products are stored in iron boxes after painting with newspaper used as cushioning material. This requires additional labor. Also, it is impossible to tell the quantities of products in the boxes. Special-purpose wheeled dollies, which have a long life cycle should be built for the frames. Cushioning material should be attached to the parts of the dollies where it is needed. This will save the labor of adding cushioning material each time.

The above improvements can reduce the floating stock between processes. The improvement of containers and dollies in particular will allow first-in first-out to be fully used. Forklifts should be kept out of the shops as far as possible to maintain a good working environment.

3) Modernization of BUS II Division

(1) The semidirect workers have a vital role

With the current quantity of production, one storekeeper and one materials handling worker are underemployed. In addition to managing the warehouse, the storekeeper should be assigned the tasks of issuing the cut parts to the sewing process, and the sewn parts to the assembly process. He (or she) should undertake the warehousing and management of the actual distribution in the entire sewing process. In receiving and issuing materials, the amount of work can fluctuate:

and sometimes several operations must be done simultaneously. The coordinator must be fully aware of the state of operations, and direct and support the standardization of setup operations. Semidirect workers must realize that one of their most important tasks is to create an environment in which the workers can concentrate to their own work.

(2) Integration of the cutting processes

The PVC leather for both passenger car and bus seats is cut in one location by the bus divisions because of the equipment involved, while the cloth for passenger car and bus seats is cut in two separate locations by the Passenger Car Seat Division and the bus divisions, respectively. The cut parts are transported from the bus divisions to the Passenger Car Seat Division 250 meters away. As described in Section 8-2-3 "Sewing Process," the integration of the cutting processes in one place will reduce distribution costs, and make effective use of space, personnel, and equipment.

(3) Improvement of the cushion process

(a) Warehouse for cushions

Since the urethane foam for cushions needs 24 hours for curing, a storage warehouse is required. At present, the cushions are put in special-purpose dollies and the dollies are stacked up for storage. However, since the dollies do not have wheels, they cannot be handled without a forklift. As cushions are light: wheels should be attached to the dollies, so that they can be handled by hand. At the same time, a second floor should be added to the warehouse, and forklifts should not be used. This will allow the width of the aisles to be reduced to 1/3, and provide enough storage space for first-in first-out. Also, the manual issue of parts to the assembly shop will allow them to be supplied in time and eliminate idle time.

(b) Method of transport to the Passenger Car Seat Division

Cushions are transported to the assembly shop of the Passenger Car Seat Division over a distance of 250 meters by a forklift 25 times a day. A two-shift system is employed, and working conditions can be hard at nighttime. A method for reducing the distance will be described later. For the time being, measures should be taken to reduce the frequency of transport. Two methods are discussed below: one is for building a simplified trailer that can carry two to three dollies at a time, and the other is for towing three to four wheeled-dollies at a time with a forklift.

(4) Flow of materials in the assembly process

It is necessary to establish rules that clearly define the duties of the setup staff in order to prevent the assemblers having to wait. If transport is done manually instead of by forklifts, as

described above, materials can be carried on time. It is important to create an environment in which the workers can concentrate on their work without increasing the number of setup staff.

4) Modernization of the Passenger Car Seat Division

(1) Improvement of the warehouse management

(a) Expansion of warehouse space

The space was insufficient for a warehouse that stores the materials for a monthly production of 4,000 sets of passenger car seats. Consequently, extra labor was needed for receiving and issuing materials, the correct quantity of the inventories was not properly known, and first-in first-out was totally impossible. As a result of a short-term improvement plan proposed by us, the space has been expanded as shown in Figure 8-2-25. Now it is possible to allot storage areas for each item, and the receiving and issuing of goods can be done without any trouble.

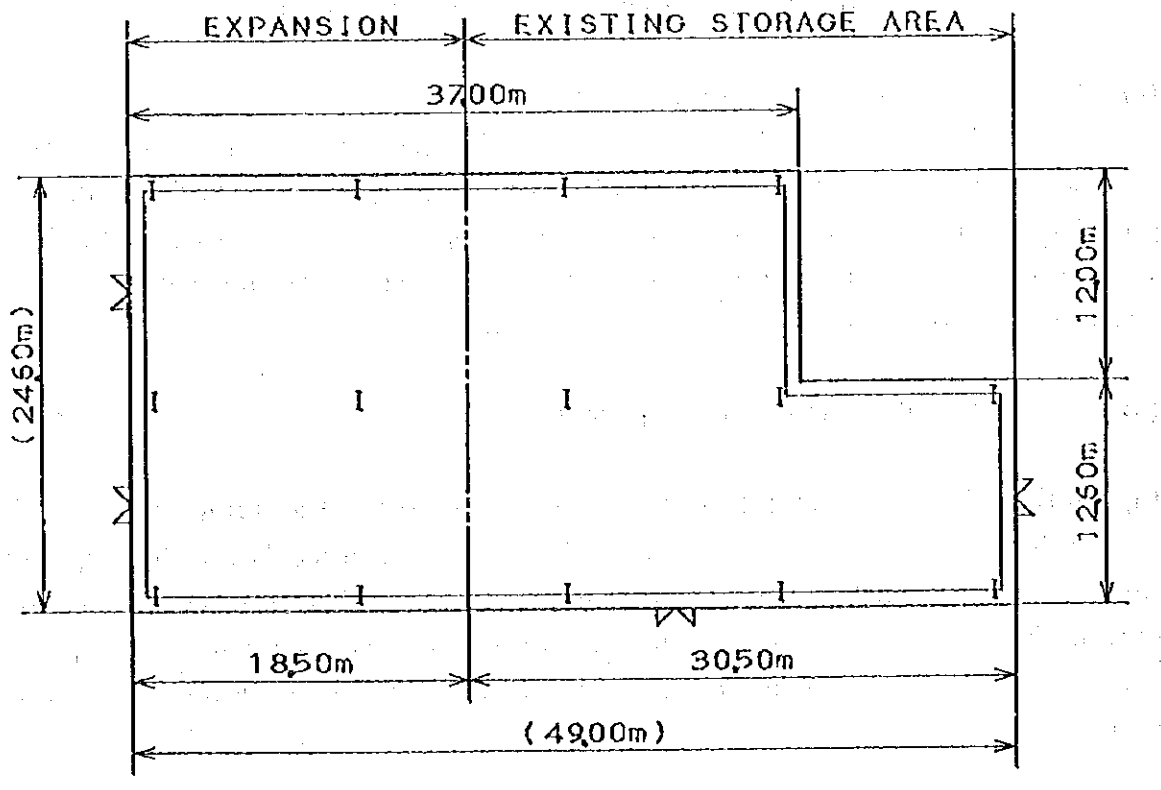


Figure 8-2-25 Improvement Plan for Materials Warehouse for Passenger Car Seats

(b) Establishment of visual management

The improvement to be made hereafter is to establish visual management in which storage areas are designated and marked to show the names of the articles, making it easier to tell "How much of any article is stored in which location." The articles should be arranged on the principle of first-in first-out. Prepare "First-in" signs and hang them on dollies and pallets to ensure that first-in first-out is practiced. As described in Section 8-2-1 "Receiving of Raw Materials," both dollies and pallets should be gradually remodeled and standardized to make it easier to handle them and to see the quantities of articles in them.

(c) Elimination of losses caused by transport

The materials for assembly and cutting are collected in the temporary storage area and then issued to individual processes. The cushions, frames, and cloth in particular are handled over long distances and require much time for transport. These materials are put in dollies or pallets and transported by forklift. As a tentative improvement, the approach of reducing the frequency of transport, described earlier in Paragraph 3)-(3) "Improvement of the cushion process" should be considered.

(2) Improvement of the sewing process

The sewing process, which continuously employs 20 or more workers, does not have a setup staff. Consequently, the workers themselves have to pick up materials. In view of the loss caused by this interruption of the work, it is advisable to appoint an exclusive setup worker. This worker can also manage the storage areas for cut parts and sewn parts. As a result, the practice of placing sewn parts directly on the floor can be abandoned.

(3) Improvement of the assembly process

(a) Clarification of the division of work between workers and setup staff

Although an exclusive staff has been appointed for issuing materials from the temporary storage area to the assembly shop, the workers themselves go to pick up materials. The division of work should be clarified and rules established to make sure that the setup worker supplies materials and the workers concentrate on their work. This can increase productivity and reduce in-process inventories.

(b) Improvement of the dollies for conveyance of finished-products

The special-purpose dolly for the finished front seats is a four-piece dolly. After loading two pieces, the dolly is rotated a half turn to load the remaining two. Then it is moved to the finished-product storage area. This operation is repeated 60 times each day. To proceed with rationalization, a semi-automatic system should be considered that conveys and replaces loaded

and empty dollies by the use of a simple half-turning device that the company can build by itself.

5) Rationalization of managing shipments

(1) Bus II Division

For the convenience of the client, seats for one bus (approx. 40 seats) are shipped in one container. Since the goods are loaded and unloaded in bulk, extra man-hours are required, and the efficiency of loading is not good. Special cushioning material (pads sewn from scrap cloth) should be used to reduce the time needed for loading and increase efficiency. In the case of the seats for types of cars that are ordered in stable quantities, special-purpose dollies should be built for finished-products and the products should be loaded on the dollies instead of in containers during the final process of assembly, to reduce the time required for loading. What is important is to have a positive attitude of proposing creative plans for improvements which will make things easier for the client and reduce the distribution costs. (See attached photo).

(2) Passenger Car Seat Division

The seats are loaded on special-purpose dollies and transported by truck five or six times a day. Since empty dollies are stored outdoors, there is a danger that they may soil the products. Also the place where the dollies are kept is far away. In addition, the place where the seats are shipped was a long way from the finished-product storage area, so that loading took a long time. However, the place where the trucks were loaded was changed as shown in Figure 8-2-26. As a result, the loading time was reduced by 67 minutes per day. Also, surplus dollies were removed and the required number of dollies are currently kept indoors near the assembly process.

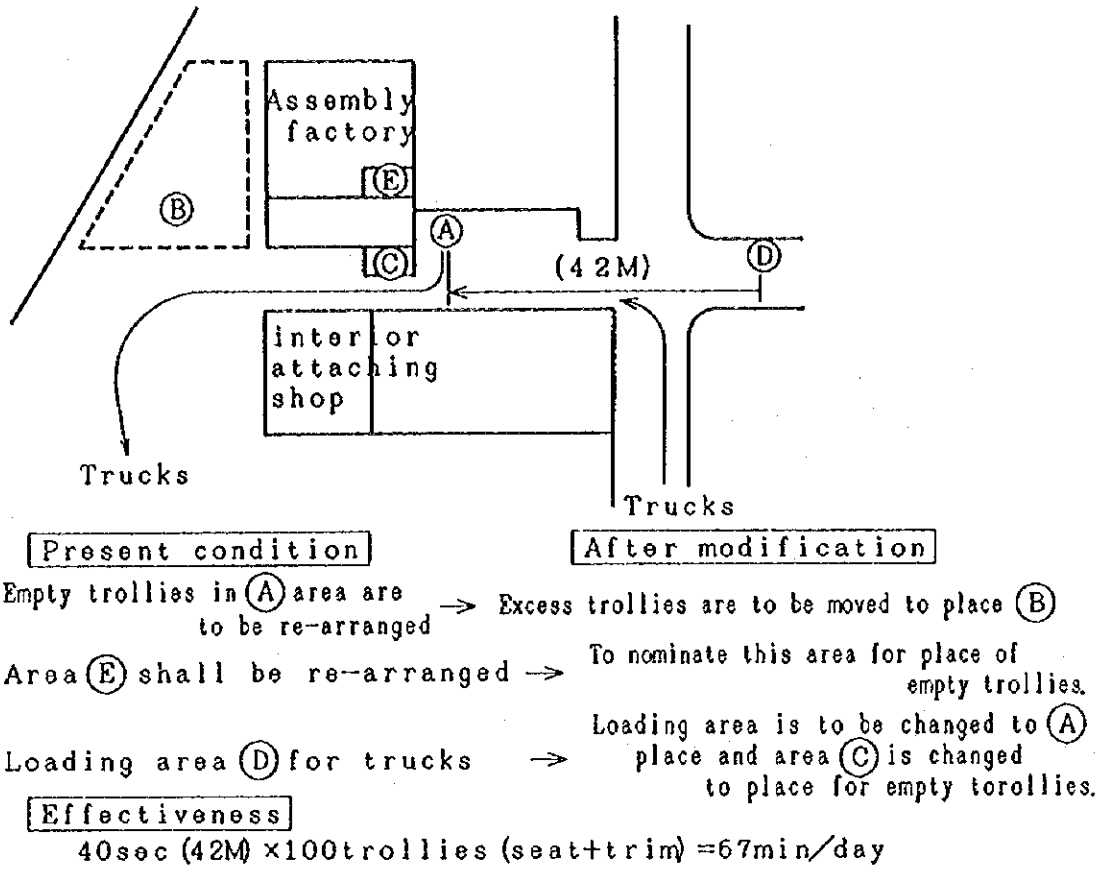
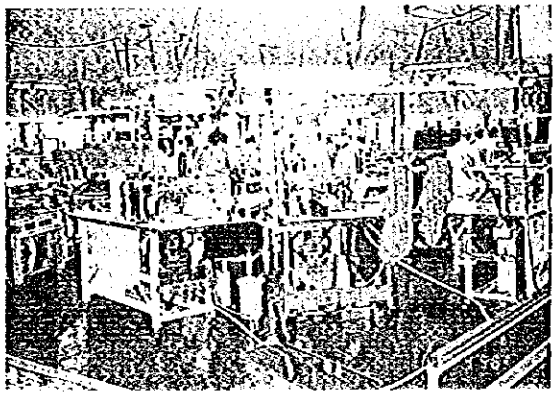
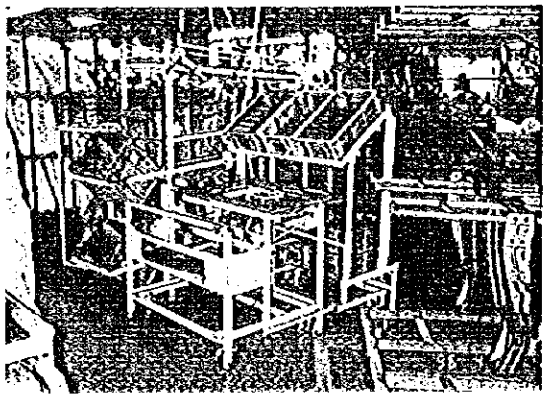


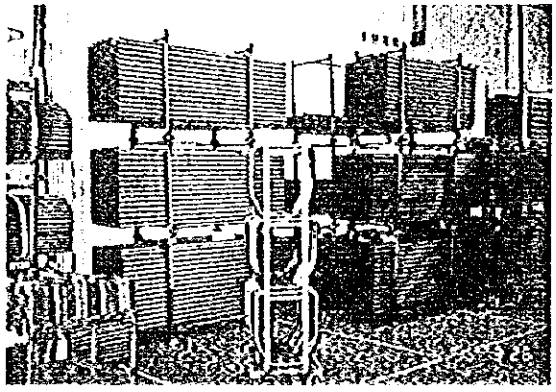
Figure 8-2-26 Example of Improvement: Changed Shipping Location for Finished Products



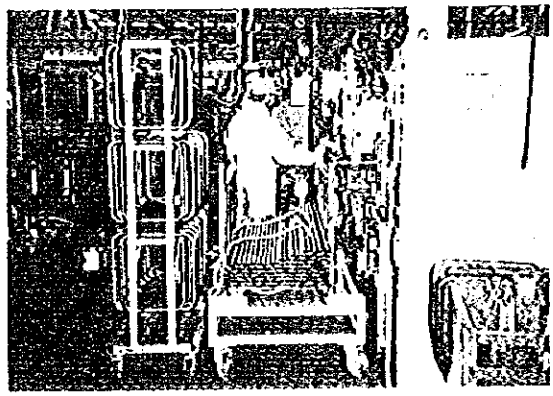
(1) Working conditions with sewing machine in standing position
(8-2-3 Sewing Process)



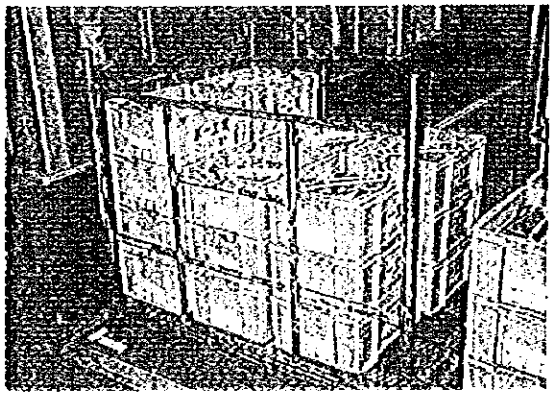
(2) Roller racks
(8-2-5 Assembly Process)



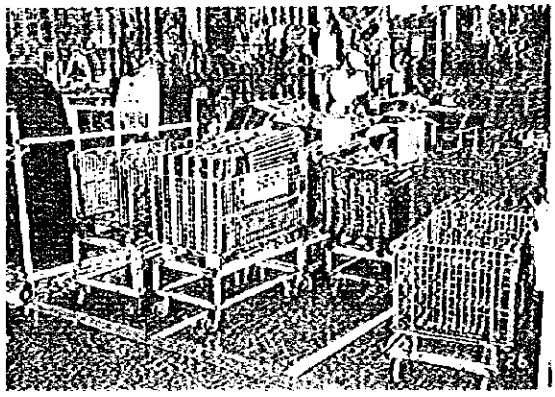
(3) Unification of pallets and dollies
(8-2-7 Flow of Materials)



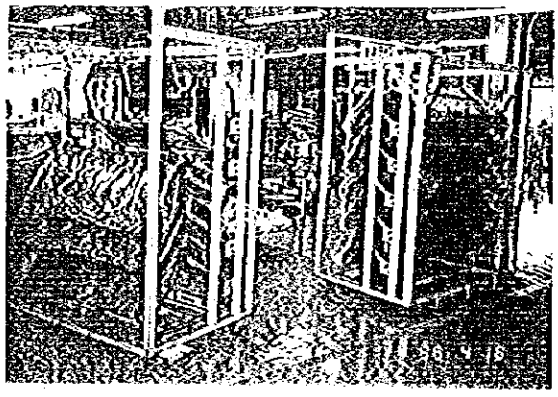
(4) Unification of Pallets and dollies
(8-2-7 Flow of Materials)



(5) Weight reduction of pallets and dollies
(8-2-7 Flow of Materials)



(6) Weight reduction of pallets and dollies
(8-2-7 Flow of Materials)



(7) Container for finished products
(8-2-7 Flow of Materials)