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IMPROVEMENT
OF
PRODUCTION PLANNING AND CONTROL
AT
THE HEAVY MECHANICAL COMPLEX
STATE ENGINEERING CORP. TAXILA, PAKISTAN

- FINAL REPORT -

MAY, 1991

Ishikawajima-Harima Heavy Industries Co. Ltd,
TOKYO, JAPAN

SYNOPSIS

This is the summary report of the UNIDO Project, DP/PAK/84/026, short-term-consultation to the State Engineering Corporation (SEC), Islamabad, Pakistan. The project was started on April 1, 1991, by two (2) experts of Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan, and lasted until May 30, 1991.

In accordance with a restructuring program being carried out at SEC, which is aimed at improving management techniques, design functions, quality of products, quality control, customer services etc., the major objectives of the project were set to improve the operational conditions and performance of the Heavy Mechanical Complex (HMC) in Taxila. Consequently, this time, production planning and control were mainly focused on.

In the area of production planning and control, documentation system was reviewed, analyzed, and eventually, an up-to-date system was proposed and implemented. Practical formats to be routed, such as route card, job card, 'kanban' card, parts list and so on, were also proposed and put into use. The relevant people of HMC were trained in both phases, establishing system and operating system.

The capacity database of machines and equipments were reviewed and reestablished, which will help planners to select most appropriate equipment and/or machine to each process.

Production methods of various processes were also reviewed and analyzed. Eventually, improved methods of time calculation as well as improved method of determining condition of machining, were proposed.

The scheduling system was another major subject for the consultation. The overall scheduling system were proposed after reviewing the present system of HMC. Example schedules which compose the system was proposed and practiced by planners of HMC.

By routinely implementing the above functions in production planning and control organizations, the operational conditions and performance of the HMC will have the starting momentum of improvements.

In addition, some suggestions and consequent proposals were presented from view points of future production improvement and rationalization.

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1. INTRODUCTION

In order to achieve high productivity and become competitive in the market, for a manufacturer, having good resources is very vital. Human, facility and information are considered to be three major resources. This report is mainly focuses on information resource.

A big portion of information resource is, of course, design. Production planning and control department (PPC) processes the design information further, and generates new information that helps production department to manufacture products, control works, monitor performance, and feed back necessary data for the future management of the company.

Production planning and control information is also dedicated to utilize other resources effectively, human resource and facility resource, in manufacturing activities. Therefore, it is said that PPC has a major roll in total company activities in improving productivity.

Overall planning and control system, documents that are used in system's practical operation, capacity database of machinery and equipments, production methods planning including calculation of machining time, and schedules, all of which are essential to the productivity oriented information, are discussed hereinafter.

2. WORK SCHEDULE

The schedule of the consultancy worked out, after being mutually agreed between UNIDO, SEC, HMC and the experts at the beginning of the consultancy, is shown in Figure 1.

3. PRESENT SITUATION OF HMC

GENERAL

HMC is one of Pakistan's top all-round heavy industrial manufacturers, products of which are sugar plants, cement plants, boilers, overhead cranes, road rollers, etc.

It was founded in 1970 under technical and financial assistance of the People's Republic of China. Presently, therefore, most machineries in the shop are made-in-China. Heavy Foundry and Forge complex (HFF) has merged with HMC in 1990. Presently, HMC consists of 2 major works, one is mechanical works including both machining factory and steel fabrication factory, and the other is foundry and forge works. Figure 2. shows the layout plan.

'HMC' and 'HFF' , hereinafter, will refer mechanical works and foundry/forge works respectively unless otherwise stated specially.

HMC together with HFF has more than 5200 employees, 3200 for mechanical works and 2000 for foundry and forge works. 4100 employees out of total 5200 are workers, 2500 for mechanical works and 1600 for foundry and forge works.

HMC is laid out in an area of 213,000 square meters. It consists of following shops.

- (1) Fabrication shop
Dedicated to fabrication processes of welded structures, that covers from material preparation to assembling.
- (2) Machine shop
Machining operations are carried out.
- (3) Assembly shop
Locates inside machine shop, and dedicated to assembly works of equipments.
- (4) Heat treatment shop
- (5) Forge shop (medium and small size forging)
Manufactures medium and small size forgings which are not manufactured in HFF.
- (6) Galvanizing shop
- (7) Nonferrous shop
- (8) Other auxiliary shops

The annual turnover of HMC for the past 5 years are shown in table 1.

DESIGN

Figure 3. shows an organization chart of the Design and Engineering Department (DED) with number of engineers belonging to each section.

They are capable of designing 2 new design of sugar plants a year, and 1 new design of cement plant in 2 years.

DED consists of 7 sections. The organization seems to be a combination of two different types of structures, one is products oriented and the other is function oriented. Products oriented structure consists of 4 sections, (1) sugar mill section, (2) boiler section, (3) cement plant section and (4) general products section. Function oriented structure consists of 3 sections, (1) electrical section, (2) structure section, (3) CAD section. Each section has its own fixed number of engineers/designers.

Among products oriented sections, some potential inflexibility of manpower might be expected due to possible unevenness of work load between products. The present organization should be reviewed and changed if necessary.

To assemble project team, at case-by-case basis, within function oriented organization would be preferable for designing products with a wide variation like in HMC.

PRODUCTION PLANNING AND CONTROL

Figure 4. shows an organization chart of the Production Planning and Control Department (PPC) with number of engineers/planners belonging to each section.

PPC consists of following 3 major sections, each of which covers both HMC and HFF manufacturing activities.

- (1) Production planning
 - * Production scheduling including shop loading (Core Planning Group)
 - * Data processing for material control and production control (EDP Group)
 - * Method/procedure application planning (Technology Group)
 - * Man/machine hour planning (Technology Group)
 - * Cost estimation (Technology Group)

- (2) Production control
 - * Project management
 - * Progress monitoring
 - * Products dispatching
 - * Material handling

- (3) Material management
 - * Warehousing
 - * Material planning and expediting
 - * Sub-contracting

It is noteworthy that the scheduling function is carried out by the core planning group independently from the technology group which performs method/procedure planning, man/machine hour planning and cost estimation. One group's office is also apart more than 100 meters from the other's. As scheduling function is needed to have an extremely strong ties with method/procedure applied and man/machine hours expected, the present PPC organization is considered to have a chance to issue documents which contradicts each other.

Another remarkable fact is that fairly big portion of planning activities, especially in scheduling and method/procedure application planning, is being carried out by planning group of shop floor. Shop floor is seemingly selecting methods to be applied, determining work procedure, and executing works in accordance with its own convenience. In other words, it is to be said that PPC is not playing its most important role which is to instruct shop floor how to work and thereby to control works so that production activities can meet the requirements for company operation.

PRODUCTION DEPARTMENT

Figure 5. shows an organization chart of the Production Department with number of supervisors and workers.

Under the present organization, each section has the following groups.

- (1) Machine shop
 - * Machine shop
 - * Tool room
 - * Assembly shop
 - * Nonferrous shop

- (2) Fabrication shop
 - * Fabrication
 - * Welding & Pressure vessels

- (3) Auxiliary shops
 - * Forge shop
 - * Galvanizing, Sand blast & Paint shop
- (4) Maintenance shop
 - * Electrical maintenance
 - * Mechanical maintenance

Table 2. shows weight, manhours and H/T of both fabrication shop and machine shop for last 8 months. For that period, fabrication shop has produced 3,994 tons with 673,944 hours, 499 tons/month and 84,243 hours/month, machine shop produced 1,942 tons with 389,459 hours, 243 tons/month and 48,682 hours/month. As the total capacity of two shops is said to be 1,000 tons/month, the present operation would be 74 percent of its maximum. Transitions of manhours per ton for both fabrication shop and machine shop are presented in figure 6. The average H/T of past 8 months for fabrication shop was 169 hours/ton, and for machine shop was 202 hours/ton.

Figure 7. and figure 8. are rough layouts of fabrication shop and machine shop respectively.

4. PROBLEM IDENTIFICATION

At the beginning of the consultation, before presenting a recommended production planning and control system, overall problems which HMC was currently struggling with was surveyed and identified. Major problems identified, with their concrete phenomena, conceivable causes and/or solutions are;

- (1) **Material control**
 - * purchasing difficulty
 - * increasing stock
- (2) **Delay of work**
 - * lack of early stage warning
 - * insufficient progress visuality
- (3) **Cost overrun**
 - * lack of initial targeting
 - * insufficient cost tracking system

Problems relate to **material control** would be most serious. They will badly extend influences to other areas. Missing or shortage of material could easily delay works, and could eventually cause cost overrun. Purchasing difficulty, especially from abroad, results in extremely long lead time for imported materials. Domestic market also offers relatively long lead time. This inevitably brings about increasing inventory and/or stock materials, and thereby stagnates flow of cash.

Delay of work can be seen at many projects. At some projects, total delay of completion date to their original date set at contract are more than a year, which could result in serious dispute with customers. Any delay of works must be detected, as soon as it happens, so that necessary measures can be taken before it becomes irredeemable. Appropriate scheduling system and its operation will have the key to cope with this subject. Schedules can be good tools to give early warning signs through monitoring processes.

Cost overrun can be accepted by no means. However, from manufacturing cost standpoint, cost overrun seems just a natural result as it happens. PPC, as well as shop floor, has not given appropriate budget, target cost or man/machine hours, of each project, which PPC breaks down into shop-by-shop and/or machine-by-machine target hours so that every one of shop floor people can work under the same goal. Cost tracking system is also a subject to be improved, which will not only to present results of shop floor people's efforts but also to gives warning sign of possible cost overrun at early stage.

5. PRODUCTION PLANNING AND CONTROL SYSTEM

Figure 9. shows the production planning and control system which was recommended to HMC.

The system was produced and presented after studying the existing system. In designing the system, it was intended to esteem the existing system as much as possible in order not to make any unnecessary confusions. The system was also designed to cope with 3 major problems identified, material control, delay of works and cost overruns.

The system consists of 2 major portions, one is 'scheduling system' and the other is 'work information system'. Scheduling system implies;

1. Company master schedule (by PPC)
2. Dispatch schedule or final assembly schedule (by PPC)
3. Sub assembly schedule (by PPC)
4. Component processing schedule (by PPC)
5. Station by station loading schedule (by PPC)
6. Drawing list and release schedule (by DED)

The importance of scheduling system is not only to set up priority and timing of works most efficiently but also to monitor progress of works and to give a warning sign, if some delay happens, so that necessary counteractions can be taken. Therefore, scheduling system must be designed intending to cope with delay of works.

The proposed scheduling system is pretty similar to the existing one. Each of the above types of schedule is 'existing', however some are unlikely to be implemented consistently and in proper fashion. For instance, PPC is not preparing station by station schedule which is machine by machine loading schedule, and neither is shop floor planning group.

On the other hand, it is considered that imbalance between available manpower of HMC and projects put into work is a possible cause for delay. The total magnitude of work to be put into operation in a certain period of time have to be checked and verified that it will meet to available manpower of the period. Company master schedule, which is prepared by PPC, has to play a very significant role in connection of this matter.

In improving scheduling system in HMC, both 'company master schedule' and 'station by station loading schedule' are the first priority to be reviewed and redeveloped.

Work information system is the other important portion of production planning and control. After a drawing is issued from design department, PPC have to generate new information by processing it and adding new value to it for shop floor so that they can apply most appropriate methods and procedures, work most efficiently and safely, and return necessary control data/information back to PPC and/or other departments. Proposed kinds of information to be produced are;

1. Route card
2. Job card or work instruction card
3. Kanban card
4. Parts list
 - * Component list
 - * Detailed parts list - sub assembly -
 - * Detailed parts list - final assembly -
 - * Dispatch list
 - * Raw material list
5. Others
 - * Cutting list
 - * Pipe bending list
 - * etc.

b Route card and job card/work instruction card are tools which inform shop floor most appropriate methods, most efficient procedures and time allocated. They also provide means of returning data/information back to PPC or other relevant departments. Route card is supported by time estimation standards.

Those cards also play a significant role in cost allocation and accounting system. First, by verifying that hours calculated and allocated to each route card meet the budget, cost development can be watched from its early stage. Second, actual manhour data recorded and fed back to cost accounting system through route card will clearly picture the trend of cost in real time. To keep watching the direction of cost all the time is likely to be urgently necessary for HMC in order to control cost and consequently prevent cost overrun.

Kanban card will flow a new concept into shop floor control, while others are not quite new to HMC. Kanban card is an identification card that attached to one or a lot of parts throughout manufacturing processes in shops. It presents the latest status of material with which it goes so that everybody in shops can see whether or not each material is being processed on time, what the next process is, how more processes needed, and so on. Kanban card helps visualizing movements and flow of material within shops, thereby shop managers and supervisors can grasp the true status of shops at any instance.

Parts lists are designed after reviewing the present material listing system of HMC from a viewpoint of how to ease up material procurement difficulty.

In addition, importance of principal material list is also emphasized. Principal material list should be issued by DED at very beginning of each project, even before contract has been awarded. Necessary purchasing pre-notice can be given to manufacturer for the critical materials. Principal material list should be updated in accordance with progress of design, and finalized at the completion of project. Finalized list should further be fed back and restored to the cost estimation database for future contracts. Throughout the updating and finalizing processes, newly designed lists can contribute significantly.

6. WORK INFORMATION SYSTEM

ROUTE CARD

Figure 10. shows route card which has been presently being used in HMC. Figure 11. presents proposed route card which is a modified version of the present one.

The modification was made by neglecting columns for blank size of material, special tools, shop number and machine number and providing new columns for work center number, work order number, dates of start and completion, and actual hours.

JOB CARD & WORK INSTRUCTION CARD

Figure 12-a. and -b. show proposed job card, and figure 13-a. and -b. do work instruction card. Job card and work instruction card have basically the same role.

Job card is designed to be applied to works performed in machine shop. It breaks down each machining operation which is described on route card to levels of cutting, and gives most efficient cutting procedure and full detail of each cutting such as cutting speed, feed, depth and necessary tools/jigs/fixtures. Total operation time is also calculated and presented on. Job card is given to a machine operator by a supervisor as an order of work, while route card is retained at the office of shop floor.

Columns for recording are provided on the back so that daily operation can be recorded. Daily record of operation time is summarized after an series of operations is completed, and a column of actual hour on route card is filled out.

Work instruction has exactly same roles as job card, although it is designed to be applied to works performed in fabrication shop.

KANBAN CARD

Kanban card, "kanban" is a Japanese term means a sign-board, is shown in figure 14. It presents a route of a one or a lot of parts under manufacturing. At completion of each process of a route, a machine operator or supervisor in charge fills in the date of completion with his signature. This eventually presents the current status of parts in addition to other information such as next process, whole route, supervisors of processes finished.

Kanban card is to be contained in a vinyl bag and attached to parts by either a clip or a magnet. For many number of small parts, kanban card is to be attached on to a container which carry all parts together. Utilization of such container is recommended in Annex 3. On the other hand, for a big and heavy ones which are machined at heavy bay, kanban card can be posted on a board placed at each storage area. To designate storage areas beside each machine for parts, machined and before machined separately, is also recommended in Annex 3.

PARTS LISTS

Shown in figures from 15. through 19. are 'Component list', 'Detailed parts list - sub assembly -', 'Detailed parts list - final assembly -', 'Dispatch list' and 'Raw material list'. Figure 20. presents systematic scheme showing how parts lists relate with each other.

'Component list' is prepared covering one complete equipment or assembly of a project, or it sometimes covers even entire project. It lists all components both purchased and manufactured.

'Detailed parts list - sub assembly -' lists every component for a particular sub assembly.

'Detailed parts list - final assembly -' lists every sub assembly and component required for a final assembly.

Each detailed parts list is generated from component list by collecting components which have common 'next stage'. The column 'next stage' of component list indicates sub or final assembly which each component is installed on.

'Dispatch list' lists all assemblies and components which are dispatched to a customer.

'Raw material list' is produced by summarizing a component list by type of raw material. It is further compared with the stock material list or remainder list, proposed in Annex 3. in order to check availability of raw material. Raw material list also supplies data to principal material list for its updating.

Although each material list is produced in a format to be filled in by planner's writing, the entire system should be computerized. After design engineers input components for each equipment or assembly into component database, every other list can be outputted automatically.

7. PRODUCTION METHODS

For planners, in order to select proper production methods and work parameters and to produce work information such as route card and job card, knowing machines' capability and work practice is most vital.

First, machine/equipment database was reviewed and rearranged so that planners can quickly and easily refer to in selecting machines.

Then, by each machine or similar machine group, reference data for determining conditions of machining was produced. Machining time can be calculated thereby. The reference data will tremendously simplify the determining processes of machining conditions. It was also intended to derive maximum capability of a machine as much as possible.

MACHINE DATABASE

The present machine database being used in HMC is a book which binds every machine's operation manual together. It seems to be hard to read and too much unnecessary information in it.

The only pieces of information that needed in selecting a machine was discussed, chosen and rearranged in a simple format.

Machine database produced for every kind of machine is presented;

Lathe (horizontal)	Table 3.
Lathe (vertical)	Table 4.
Lathe (face plate)	Table 5.
Lathe (axle)	Table 6.
Planer	Table 7.
Plano miller	Table 8.
Milling machine	Table 9.
Boring machine (table type)	Table 10.
Boring machine (floor type)	Table 11.
Gear cutter	Table 12.
Drilling machine	Table 13.

MACHINING CONDITIONS

After machine database was produced, reference data for determining machining conditions for each type of machines were produced. They are;

Lathe	Data	1.
Vertical Lathe	Data	2.
Planer	Data	3.
Milling Machine	Data	4.
Boring machine	Data	5.
Gear cutter	Data	6.
Drilling Machine	Data	7.

The conditions were provided for 2 different kinds of material, SS41/S35C and FC. For each material, cutting speed (V m/min.), feeding (F mm/rev.), and cutting depth (T mm/cut) at every grade of cutting were given.

For example, in the case of lathe, data 1., lathes are classified into 3 groups, heavy duty, medium size and small size groups. Cutting conditions are shown in the table provided for each lathe group. Conditions for rough cutting on SS41 with one of heavy duty machines are V=55m/min., F=1.1mm/rev. Cutting speed 'V' is further converted to rpm. by a graph provided at the 2nd page. Cutting depth 'T' is determined in accordance with the graph at the 2nd page within the maximum depth allowed at each machine. On the graph, maximum cutting depth is determined by a combination of length and diameter of a work piece.

Conditions given to each type of machines are maximum value allowed. Therefore, operating machine with conditions more than specified would cause possible deterioration of machines, tools, or quality of products. To apply 90% of each specified value is recommended.

This must also be notified that every machining condition data was obtained referring the technical data which is being applied to machines in IHI. Although data have been chosen very carefully, there might be some potential danger that data might not fit to machines in HMC. Therefore all conditions must be carefully watched, reviewed and amended if any immoderate operation is found. Test cutting at each machine group, in order to assure that the proposed condition is moderate, is recommended.

PROCESSING TIME ESTIMATION

Data 8. presents how to calculate machining time from machining conditions determined.

The total machining time is defined as follows;

$$\text{TOTAL MACHIN'G TIME} = \text{NET MACHIN'G TIME} + \text{ADDITIONAL TIME I} \\ + \text{ADDITIONAL TIME II}$$

- * Net machin'g time : Net cutting time which is theoretically calculated from cutting conditions.
- * Additional time I : Supplementary time which is considered to be proportional to net machining time. Such categories of time as tool return, machine operation, DWG check, measuring, etc.
- * Additional time II : Another supplementary time which is considered to be independent from net machining time. Such categories of time as work piece loading and unloading, special measuring, etc.

2 different coefficients for additional time I were proposed. One is 0.25 for drilling machines, and the other is 0.15 for all other machines. Drilling machines need a lot of manual operations while other machines can be operated almost automatically after initial settings or dialing.

Most typical example for additional time II is material handling which includes loading and unloading of a work piece. Loading and unloading happens not only at beginning and at completion of machining but during a series of machining processes. Each set of loading and unloading is mostly dependent on how it is done. If it is done by operator's hands it would spend only few minutes, but if it needs crane handling it will take huge amount of time. Therefore, 3 steps of time for a set of loading and unloading were proposed in accordance with weight of work piece handled. They are;

Lighter than 30kg	0
From 30kg to 1ton	30 min/set
Heavier than 1ton	60 min/set

Since the coefficients and minutes per set of loading and unloading are proposed only for starting up the system, they all are subject to change. They should be periodically reviewed and updated collecting actual data. Time sampling study is also recommended to make the system more reliable.

8. SCHEDULING

In order to make work information system to function properly, scheduling system has to play a significant role. In other words, two systems must have a close linkage and exchange information each other.

MASTER SCHEDULE AND MANNING SCHEDULE

Master schedule is a most fundamental one among many schedules made by PPC. It determines company's overall activities for coming several months or even several years. It will determine company's destiny. Therefore, it has to be proven that the master schedule provides enough work load, but not too much, to keep work force busy all the time without big work load fluctuations. If it is not proven, master schedule cannot worth relying on it for company top management's and starting other scheduling activities based on it.

Therefore, master schedule is always to be associated with long-term manning schedule. The procedure of making long-term manning schedule is,

[Prerequisites]

- 1) Master schedule.
(preliminary one)
- 2) Manhour budget table for manufacturing.
(project by project)
- 3) Project by project standard manhour consumption curve, 'S'-curve, which is obtained from the data of the previous projects.
- 4) Available monthly man power data.
(working days, absentee and direct/indirect ratio)

[Procedure]

- 1) Draw expected manhour consumption curve referring both master schedule and the standard 'S'-curve. (the standard 'S'-curve may be amended in accordance with practical facts such as possible difficulty of material purchasing, producibility drop due to Ramadan, etc.)
- 2) Man-power loading (amounting).
 - a. To draw all 'S'-curves on a scheduling chart which covers several months or years depending on the present contents of the order book.

- b. To measure monthly manhour spending of each project at each month, and to make a table.
 - c. To add up manhour spending of all project by each month.
 - d. To draw a manhour amounting graph with available manhour line so that manpower shortage and/or surplus can be indicated on the graph.
 - e. To convert manhour to number of men in order to allocate required manpower for each month.
- 3) Leveling.
- a. To investigate the impact of indicated manpower shortage and/or surplus, and to seek necessary counter actions such as sub-contracting, manpower shifting from one factory to another, etc.
 - b. In the case of that none of the above countermeasures can solve the shortage and/or surplus, to amend the master schedule by sliding the events on the schedule within limits allowed.

DISPATCH SCHEDULE OR FINAL ASSEMBLY SCHEDULE

After the master schedule is fixed, the next step of the scheduling is to produce either dispatch schedule or final assembly schedule by each project. Dispatch schedule is made for projects which consists of several products with different dispatch date. Among those projects are sugar plants, cement plants and most of other projects produced in HMC.

Final assembly schedule is made for projects which becomes one final project such as road rollers and overhead cranes.

Figure 21. shows an example of a final assembly schedule actually implemented for a packaged boiler manufacturing in IHI. This presents timing when each sub assembly and/or component is to be sent to final assembly stage which is represented with a big line at the top of the chart.

SUB ASSEMBLY SCHEDULE

Sub assembly schedule is prepared after dispatch schedule or final assembly schedule is done. It looks pretty similar to final assembly schedule. It is a break down of a sub assembly work to each component. It presents a timing when each component is to be completed and issued to sub assembly stage.

COMPONENT PROCESSING SCHEDULE

After each component is given its completion date by a sub assembly schedule, component manufacturing schedule is made based on information given by a 'route card'. Considering operations and operation time given by a route card, each component's manufacturing schedule is represented on to the scheduling chart graduated with either days or weeks.

STATION BY STATION LOADING SCHEDULE

While scheduling for final assembly, sub assembly and component processing is project oriented activity, making station by station loading schedule is process oriented scheduling activity.

Station by station loading schedule is produced by each machine, by each group of machines, or by work stage such as cutting, bending, assembling and so on. The procedure of making station by station loading schedule for one of machines is;

[Prerequisites]

- 1) All component processing schedules for all projects.
- 2) Route cards which include operations on the machine.
(to know time estimated)

[Procedure]

- 1) By each week of a period to be scheduled, to pick up all components which is scheduled to be processed on the machine.
- 2) To add up operation time given by route card.
(work loading by each week)
- 3) To check evenness of week by week work load, and compare it with available machine time. To draw a work load amounting graph with available machine time line in order to make the check and comparison more visible.
- 4) Leveling.
 - a. To investigate the impact of indicated machine time shortage and/or surplus, and to seek necessary counter actions such as over time work, etc.
 - b. In the case of that no effective counter actions can be taken, to amend the component processing schedule.

This scheduling exercise is to be started implementing from heavy machineries in machining shop.

9. IMPLEMENTATIONS

In accordance with the proposed production planning and control system, trial implementation was carried out in both systems, work information and scheduling.

WORK INFORMATION SYSTEM

3 planners in the technology group of PPC was assigned to the implementation. They implemented the proposed system manually in order to assure that the system will functions right and to find any defects that should be corrected.

An electric overhead traveling (E.O.T.) crane and a steam drum of a boiler were selected as products for the trial implementation. For each products, a complete set of information, including material lists, route card, job card, etc., was generated. Annex 2. presents a one generated for an E.O.T. crane.

Through the trial implementation, despite some misunderstandings and confusions at the beginning of the trial, the planners have finally gotten accustomed to the new system. However, in order to avoid unnecessary confusion at the shop floor, to limit the entire application of the system only to machine shop works, for time being, is recommended.

The most important thing they learned from the trial was that, before starting to make information, everybody must have the common understanding about the manufacturing procedure of the product which is going to be planed. Figure 22. presents the chart which identifies work stages for manufacturing an E.O.T. crane. The chart will make the following points clear;

- * How many and what kind of sub assemblies are to be made?
- * At which stage each component should be installed?
- * In what units the final assembly will be disassembled?
- * etc.

To identify the work stages at the early stage of planning is advantageous not only to planning but also to designing. Having the common understanding among departments about the work stages of manufacturing makes subsequent designing and planning job significantly effective. Eventually it will result in the most efficient work at the shop floor.

SCHEDULE

A planner belongs to the core planning group was assigned to the trial implementation of scheduling. What he mostly concentrated was in establishing a scheduling procedure of company master schedule with manpower loading.

The scheduling procedure described in Chapter 8., 'Scheduling', was followed. The first result he obtained was a standard 'S'-curve of a sugar plant, figure 23. The 'S'-curve was produced based on manhour consumption data of three different sugar plants previously manufactured in HMC. The 'S'-curve was tentatively applied for every project other than sugar plants, although each type of project should have its own 'S'-curve.

Since manhour budget was not available to every project, man power loading was done assuming that the expected manhour was proportional to the weight of each project. Therefore, the trial implementation was not very practical. For the practical planning and scheduling, manhour budget and its updated spending must be provided and kept watching all the time. Work must be controlled by both manhour and weight.

10. FUTURE IMPROVEMENTS

The subjects for further improvements at HMC in both production planning/control and production are summarized;

PRODUCTION PLANNING AND CONTROL

- (1) For the technology group, the next step after establishing the work information system would be to make information very substantial. The information issued from the group will determine methods, procedure, and conditions of works. It must always be optimum so that shop floor can rely on and follow it without doubt. To make information most reliable, the technology group should hold a meeting in which methods and procedure for major items of a projects are discussed and agreed. Both design department and production department should be the attendees of the meeting. This meeting, of course, should be held at the earliest stage of designing. Thereafter, communication among three departments will be frequently held toward the common goal, higher productivity.

- (2) As it is stated at the previous chapter, every machining condition data must be carefully watched, reviewed and amended if necessary. This is not only for protecting machines and tools but for further improved work practices. Any standard must be always subject to updating.
- (3) To make cost accounting system more visible is one of major subjects for HMC. Manhour budget must be given to each project so that PPC can break it down and allocate onto route card so that production people can work toward the manhour goal. The result will be easily assessed and evaluated in order to encourage relevant people for further effort. The results of cost monitoring and tracking must be presented in real time and in more visible format. Cost must be kept watching all the time.
- (4) Enhancing the scheduling system would be absolutely first priority for more production oriented planning. Every planning will be finally issued with a schedule, informing shop floor when to work. PPC must thoroughly practice the scheduling system presented.
- (5) In order to solve the material problem, the following measures must be taken.
 - * To issue principal material list.
 - * To place the pre-notice of purchasing for those which have long lead time.
 - * To produce 'remainder list' in order to reduce unnecessary stocks of materials, Annex 3.
 - * To computerize entire material listing system including remainder list.

PRODUCTION

- (1) The concept of 'safety first' must be reconsidered in the shop floor control. The 'safety first' would never limit its effects within safety, but it will significantly extend over to quality of products and to even productivity. To be done immediately are;
 - * To clear up unnecessary materials. Any material which are not assigned to a specific job or not expected to be used within a certain period of time, for instance one week, should be brought out of shops. This is also suggested in Annex 3.
 - * To clean up shops. Although sweepers are sweeping common areas such as corridors and material storage area, each machine operator and his assistant should sweep the surroundings of their machine before ending their daily work. To keep work area clean all the time is the first step of 'safety'.

* Protection tools such as gas mask and goggles should be properly used. Managers and supervisors should advise and force workers to use.

- (2) In both shops, effective usage of jigs is unlikely to be satisfactory. Some examples of jig usages are recommended in Annex 3.
- (3) In fabrication shop, assembly works seem to be a bottle neck of the shop. Area usage planning should be carried every month. More effective area usage is proposed in Annex 3.
- (4) In both shops, stage inspection seems not to be functioning well. Slug unremoved after gas cutting, edges left uncut after drilling, etc. reveal this. Some times they are transferred to the next stage as they are, some times other grinding man finish them. Neither case is right. To send their products to the next stage with no work left is the responsibility of each work stage. This is also indicated in Annex 3.
- (5) There is a big room to be improved regarding the handling of materials within shops. As proposed in Annex 3. usage of containers for parts will improve the situation significantly.
- (6) To adopt 'improvement proposition system' is recommended. This is the system to pull out ideas for improvement from workers. Provide a format at a desk of supervisor so that workers can fill out and propose their ideas for making their work more effective, safer, with higher quality. Each idea will later be evaluated by engineers or managers, and determined whether it will be applied or not. If the idea is applied, prize should be given in accordance with its expected validity. The system will motivate people for improvement, which could result in much more pay back for the prizes given.

11. CONCLUSIONS AND RECOMMENDATIONS

Through the two month consultation in the area of production planning/control, we were convinced that HMC is capable enough of resolving major problems identified in the chapter 4., PROBLEM IDENTIFICATION.

The works accomplished this time, to develop the work information system and the production methods, were quite satisfactory, although there are still some portions remaining undeveloped. Moreover, it is considered that even the systems developed and practiced this time would further take several months more until they start functioning effectively. Persistent efforts in adjusting, updating and improving the systems will be indispensable.

It is also true, however, that the work information system is not all for resolving the problems but just a starting point to be followed by other activities. The future subjects proposed and summarized in the previous chapter, 10. FUTURE IMPROVEMENTS, are typical ones. The following details are recommendations for the most effective and practical implementation of the future subjects.

SCHEDULING SYSTEM

Since the scheduling system has a very close linkage with the work information system, it is mandatory first priority to enhance the scheduling system.

- (1) To start implementing company master schedule based on manning schedule.
- (2) To introduce and implement dispatch schedule or final assembly schedule, sub assembly schedule, component processing schedule and station by station loading schedule. These scheduling exercises are to be started at heavy machineries in machine shop.

METHOD IMPROVEMENTS

- (1) To establish capacity database and work practices for machines and equipments in fabrication shop.
- (2) To establish optimum work procedure for every typical unit of products produced in HMC. To train planners through this exercise.
- (3) To review the production facility, and to rearrange the flow route of works as well as to plan the renewal of machines and equipments.

BUDGET AND COST CONTROL SYSTEM

- (1) To review and enhance the budget and cost control system which consists of budgeting, monitoring, accounting and evaluating functions.
- (2) To review and enrich the estimation database.
- (3) To introduce the objective management method in respect to manhour, machine-hour and material budgeting.

MATERIAL CONTROL SYSTEM

- (1) To design remainder and inventory stock allocation system proposed in figure 20.
- (2) To computerize the parts listing system which was proposed and practiced under manual operation basis.
- (3) To implement the early estimation and pre-notice of material requirements by preparing the principal material list. To establish a system to update the list and to pile up data for succeeding projects.

Initial system design and consistent up-to-date approach is most essential for the above implementations because it is expected to take at least several years to implement all of them in full scale.

In addition, they have to be simultaneously implemented by adjusting and regulating the interface problems all the time because every item has a close interrelationship among each other.

It is, therefore, suggested that it is obviously more efficient and quicker to adopt proven know-how from other bodies than to attempt by HMC itself. Engineers and planners can be trained through the implementation processes.

In addition to the training given through the processes, to dispatch some key engineers/planners to overseas training program, for instance to Japan, would be very effective for HMC to make changes happen later.