DEVELOPMENT AND IMPLEMENTATION OF COMPUTER INTEGRATED PRODUCTION PLANNING SYSTEM FOR JOB SHOP COMPANY

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ABSTRACT

Since the introduction of the computer in the manufacturing floor, the competitiveness of the manufacturing industry has increased tremendously. Manufacturers have implemented many software packages in order to cope with the ever-challenging production world. Industries claimed difficulties in implementing the general-purpose computerized production planning system, such as MRP-II. This is due to too many parameters that have to be defined in the system [5,7]. Thus, the main objective of using computerized system in production planning could not be achieved.

The aim of this study is to help the job shop company in improving the effectiveness of the production plan and specifically to develop a computerized production planning system for a metal stamping company. After the weaknesses and main problems of the current production planning system have been identified, a computer system will be developed in order to improve the feasibility and effectiveness of the production plan.

Keywords: *Production Plan, Job Shop, Computerized Production Planning System.*

1.0   INTRODUCTION

The ever-increasing changes in the world had made the task of developing and running the production systems progressively complex [4]. Due to this, an effective and efficient production planning is crucial in today's competitive manufacturing environment. It is a difficult task to generate a good production planning in a manufacturing company especially in cases of job shop flow systems [2]. The problem arise when the company wants to practically utilise its capacity to cope with the ever-changing demand. As a result, the introduction of computers in production planning began in 1950s [3]. The purpose of applying computers in production planning system is to reduce production lead time, increase planning efficiency, enable an immediate feedback on production performance and to help plan for the full utilization of the production capacity [1].

2.0   CURRENT PROBLEM

A metal stamping company has been chosen as a case study. Observations were made to identify the problems. Based on the initial observation, the most problem is a production planning system implemented in the company. There is manual planning, poor planning method and also don't have proper system to monitor the progress of the process.

2.1   Manual Planning

The manual preparation of production plan is time consuming. Thus, in order to prevent a lot of time spent in preparing production plan, a complete production schedule (MPS) is not formed. Therefore, the information provided by the production plan of the company is very limited. Some products needed several stamping processes before completion but the planner did not mention this in the production plan. Furthermore, the detailed schedule, which indicates the schedule for each step was also not included in the production plan.

2.2   Planning Method

The production supervisor conducts the production based on experience only. Thus the planner could not review the production status especially the actual work in progress (WIP) of the system. Sometimes, when there are some insertions of jobs, which is urgently needed by the customer, the planner could not simply halt certain production and starts the urgent job, as he do not know the production status.

2.3   Regular Planning

Because the planning is done conventionally (based on experience) and manually, it is difficult for the production planner to perform the production planning or scheduling regularly. This inconvenienced the planner in preparing for the production activities of the company.

3.0   SYSTEM FRAMEWORK

The program is called Computer Integrated Master Production Scheduling System (CIMPSS). CIMPSS is a Master Production Scheduling program developed for application in the metal stamping company using Visual Basic version 6. The CIMPSS covers the major parts of capacity planning and production planning. This is to improve the productivity and production management efficiency of the company.

3.1   Elements of CIMPSS

The CIMPSS has all the basic elements as other computerized production planning systems, except for the materials and inventories related functions.   The basic elements are capacities, current production status, the purchase orders and some elements for the subsidiary functions.

3.1.1   *Capacities*

In CIMPSS, the manufacturing resources are defined according to the level of importance. At the metal stamping company, the most important resources are the

stamping machines. They are the most critical resource to be paid attention to during the master production scheduling.

The time capacity can be shown and updated in the CIMPSS according to every purchase order. The companies off days are entered before the scheduling activity starts. However the numbers of operators is not required to be input into the program. This is due to the less dominance of operators on capacity at the company.

3.1.2 Machines Work Loads

The machines' work load act as the feedback or response to the MPS. Any difference between the planned MPS and the actual progress will definitely mess up the rest of the orders. The main aspect considered here is the actual time that the work centers (machines) are available.

3.1.3 Purchase Order

The input to CIMPSS is the purchase order (PO) which contains all relevant information of the new order, such as product model, purchase order number, the quantity needed and the expected shipment date. Base on the capacity available, scheduling is done on the new order.

3.2 Input and Output of Program

All the input and output parameters of this program are developed according to the company needs as well as the scheduling theory. The input and output of the CIMPSS discussed here is specifically referred to the new order. Meanwhile, it is assumed that the current Master Production Schedule (MPS) had been keyed in to the capacity frame.

The inputs of the new order are,

    i.   Purchase Order Number

    ii.   Quantity Required

    iii. Shipment Date (Due Date)

    iv. Mould Size (Tooling Height) for each steps

    v.   UPH (Stamping Rate)

    vi.   Lead-time required (before and after stamping process)

    vii.   Customer's name (optional)

    viii.   Main supplier's name (optional)

After executing the scheduling process, the program output the proposed production schedule consist of,

    i.   Machine's job for each steps

    ii.   The daily production target for each steps

    iii.   The production start and end dates for each machine or step

3.3   Functional Concepts of CIMPSS

Initially, the CIMPSS program can only be implemented if the data (information) of work centres (the stamping machines) and the working capacity are established. The CIMPSS functioning procedure is shown in Figure 1.

3.3.1   The Scheduling Process

Only the new order processing procedures will be discussed here. The data is keyed in after being confirmed through the acceptance of PO. The sizes of moulds used determine which machine is to be used. The manufacturing lead-time is divided into two types, the stamping rate and the lead-time. The lead-time mentioned here is the total days needed for production except stamping. The stamping rate is the determining element in production scheduling. As for the lead-time, the planner has to determine this manually.

From the data entered, the total time needed to complete the products could be obtained. The program will generate the PO summary which states the number of days needed for each process, the minimum and maximum days required or possible for the stamping process, as well as the actual available stamping days. After this process, the program will proceed by sorting out the available machine. Then, the program will perform scheduling and the result will be displayed on screen. If there is no machine available for the new order, the user has to decide manually whether to modify the current MPS.
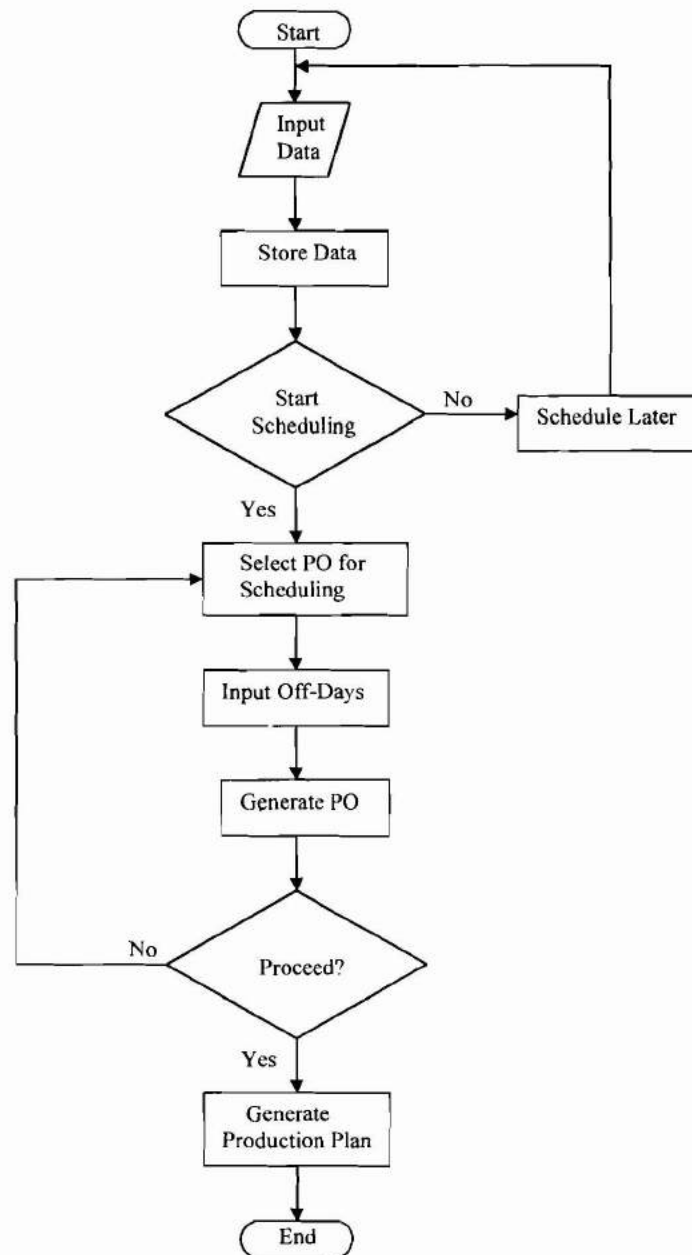
Figure 1 Flowchart of CIMPSS Overall Functioning Procedures

Some of the models are produced through a series of stamping processes. The program will assume that the output of the first step is the input for the second step and so on. The delivery date for the order is the output of the last step in the series of stamping processes. This delivery date includes all the lead-time entered.

The scheduling starts by computing the total quantity needed to be stamped each day, according to each stamping step. The daily target for the first step will be the input for the second step, and so on. Thus, the program will schedule when to start and which machine to use for the first step, followed by the second step and so on until the last step. If the final process finishes after the due date, the calculation of over time is done based on the difference between the due date and the completion date.

3.3.2   *Determining Available Working Days*

The program generates the PO summary during the process of scheduling. The main element of the summary is the working days. The stamping days available is obtained by calculating the number of days between the date when the user is performing the scheduling (stated as current date) and the due date of the PO (stated as due date) minus the lead times (both before and after the stamping process).

$$\text{Available Stamping Days} = (\text{difference between current date and due date}) - \sum \text{lead times}$$

The unit per hour (UPH) is multiplied with the daily working hours to obtain the daily output. The required quantity is then divided by this daily output to obtain the number of days per steps.

$$\text{Daily Output} = \text{UPH} \times \text{daily working hour}$$

$$\text{Days per steps} = \frac{\text{required quantity}}{\text{daily output}}$$

The maximum production days required is the sum of days needed for each step. As for the minimum production days required, some assumptions are made, which are,

i.   The output of the n step is the input of the $n+1$ step

ii.   The machines for each step are different.

From the assumptions above, if the number of days needed for step 1 and step 2 are the same, (let say 4 days) then the minimum number of days required by these two steps are the number of days needed for each step plus 1 (for this case, 4 +

1 = 5 days). The same concept applies to the case when the days needed by step 2 are more than step 1, (let's say 5 days) the minimum days required are the days needed by step 2 plus 1 (for this case 5 +1 = 6 days). Figure 2 and Figure 3 illustrate the details of these calculations.
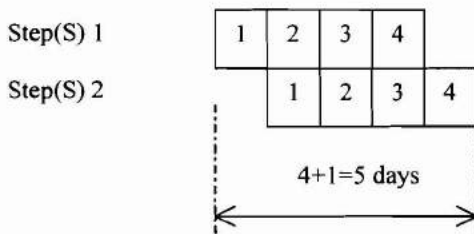
Step(S) 1					Step(S) 1				
	1	2	3	4		1	2	3	4

Step(S) 2 ... 1 2 3 4 ... 4+1=5 days

Step(S) 2 ... 1 2 3 4 5 ... 5+1=6 days

Figure 2 Calculation for Equal
Number of Days
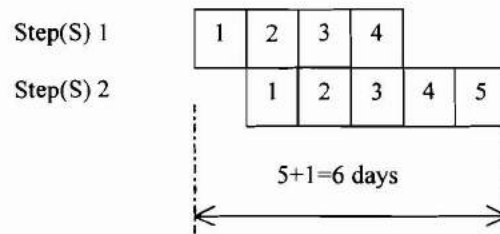
Figure 3 Calculation for Unequal
Number of Days (S2>S1)

If the number of days needed by the following steps is less than the preceeding step, the minimum number of days needed is the number of days needed by the preceeding step. For example, for step 1, the number of days needed is 5 days, and the number of days needed by step 2 is 3 days, the minimum number of days required will be 5 days, as shown in Figure 4.
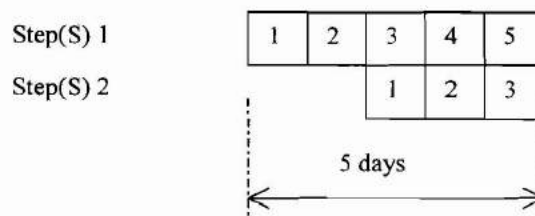
Step(S) 1   1 2 3 4 5

Step(S) 2   1 2 3 ... 5 days

Figure 4 Calculation for Unequal
Number of Days (S1>S2)

4.0   GENERAL APPLICATIONS OF CIMPSS

CIMPSS is developed for the production planning and scheduling of a job shop company. The CIMPSS however does not include the material requirement and inventory management in the master production scheduling. In implementing

CIMPSS in other industries, defining the machine is important. For example, the machines can be the injection-moulding machines for the plastics manufacturing company. As for the mould size, the size of injection mould is referred to. The UPH will be the output rate of the machine. The only difference here is the series of processes. There will be only one step for injection moulding machine to produce the plastic products. All the information regarding the capacity can be entered or modified from time to time in this program.

5.0   PROGRAM IMPLEMENTATION

5.1   Program Structure

Figure 5 shows the program structure of CIMPSS. The main modules found in the main menu are File, Order, Machines, Production Plan and About.
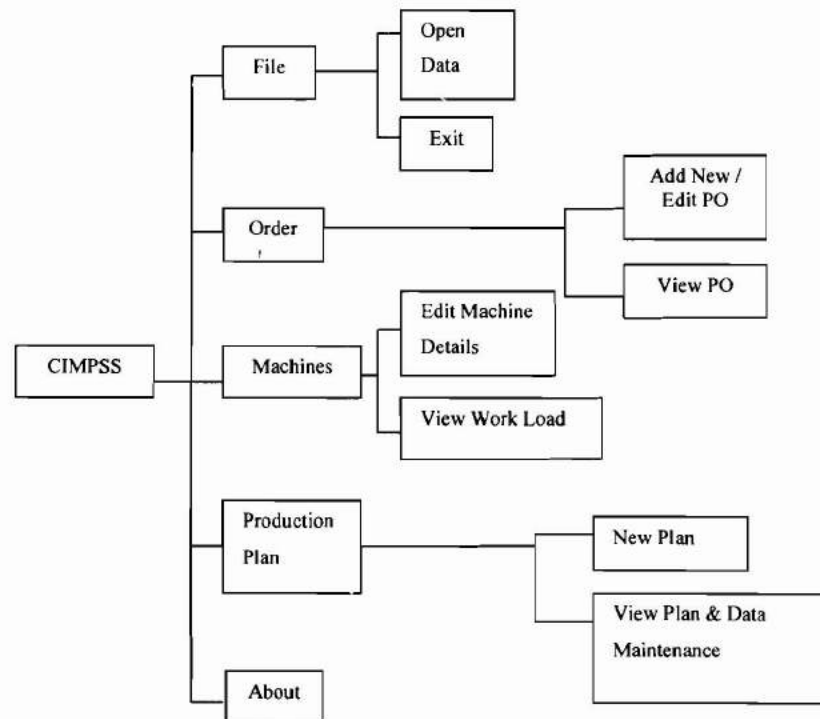
Figure 5 CIMPSS Program Structure

5.2   Program Data

5.2.1   Establish the Initial Data

The first task that needs to be completed is to key-in the machine details. These details are the machine name and number, as well as the machine's maximum stroke height. These data need only to be keyed-in once unless there are some changes to the stroke height of the machine or the machine is not used anymore. As time goes on, if the company increases the number of machines, the user can add the new machine details at any time. Figure 6 shows the Edit Machine Detail menu.
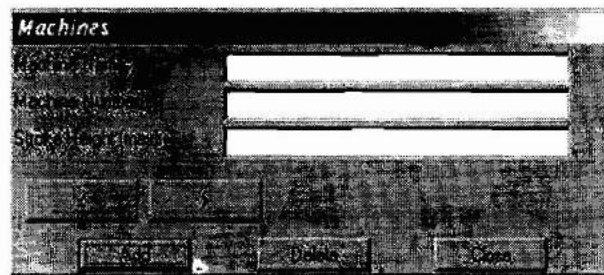
Figure 6 The Edit Machine Detail
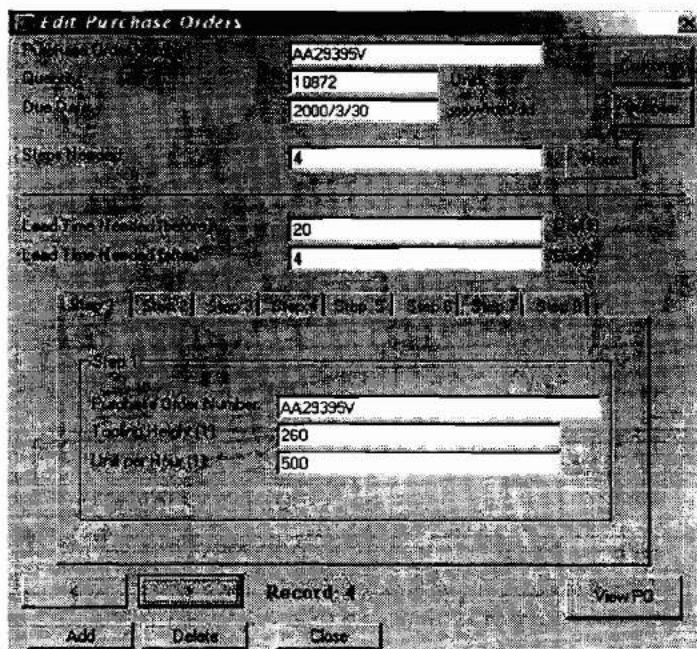
Figure 7 The Input Box of Purchase Order (PO)

5.2.2   Add/Edit Purchase Order

Before scheduling the purchase order, the detail of the purchase order must be keyed in. The details that need to be keyed-in are shown in Figure 7. After completing the purchase order, the user can view the completed PO and at the same time print out the PO. It is not necessary for the user to perform the production planning by using CIMPSS immediately, that is, PO process and the scheduling process may be done separately.

5.3   Production Plan

The production plan procedure starts by letting the user choose the type of PO required for scheduling. After selecting the desired PO to be planned, the second step of the procedure is determining the off-days of the company between the current date and the PO due date. Saturdays and Sundays are default off-days of the program. The user needs only to key-in other off days which are not a Saturday or Sunday.

5.3.1   Example

An example is used to explain the usage of CIMPSS. The data keyed-in are shown below,

PO Number   : AA29395V

Planning Date	: 1 Feb. 2000	Steps Needed	: 4
Due Date	: 30 Mac. 2000	Quantity	: 10872
Lead Time (Before)	: 20 Days	Lead Time (After)	: 4 Days

(Step 1) Tooling Height	: 260	UPH	: 500
(Step 2) Tooling Height	: 265	UPH	: 500
(Step 3) Tooling Height	: 200	UPH	: 380
(Step 4) Tooling Height	: 200	UPH	: 450

The first and second steps of the scheduling are shown in Figure 8 and Figure 9 respectively. Based on the given information, CIMPSS will generate the PO Summary as shown in Figure 10.
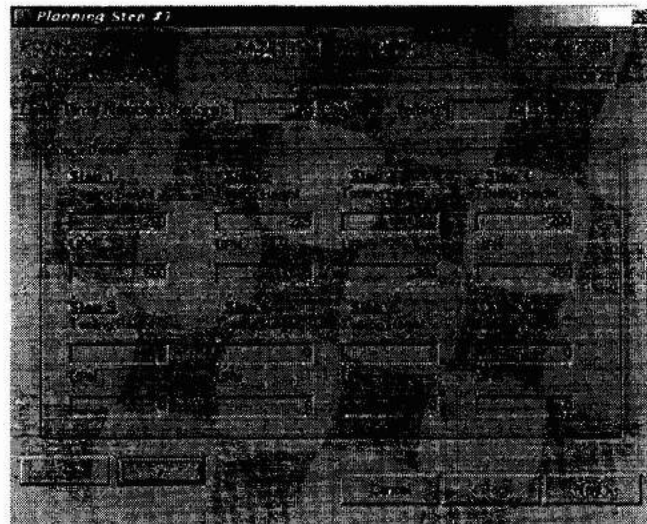
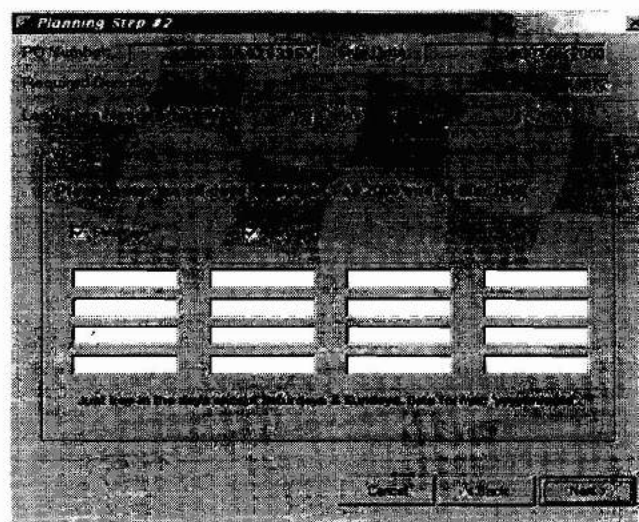Figure 8 Step 1-Select the PO for Planning

Figure 9 Step 2-Input the Off-Days

After viewing the summary, the user may proceed to perform the scheduling or edit the PO. Once the user is satisfied with the summary and no further modification of the PO is required, he can then perform the scheduling by clicking the Next button. The results are shown in Figure 11. The result shows that the process number one (step 1) is done by machine number 15 with the daily output of 4000 unit, from 22 February 2000 to 25 February 2000, followed by the second process and so on.
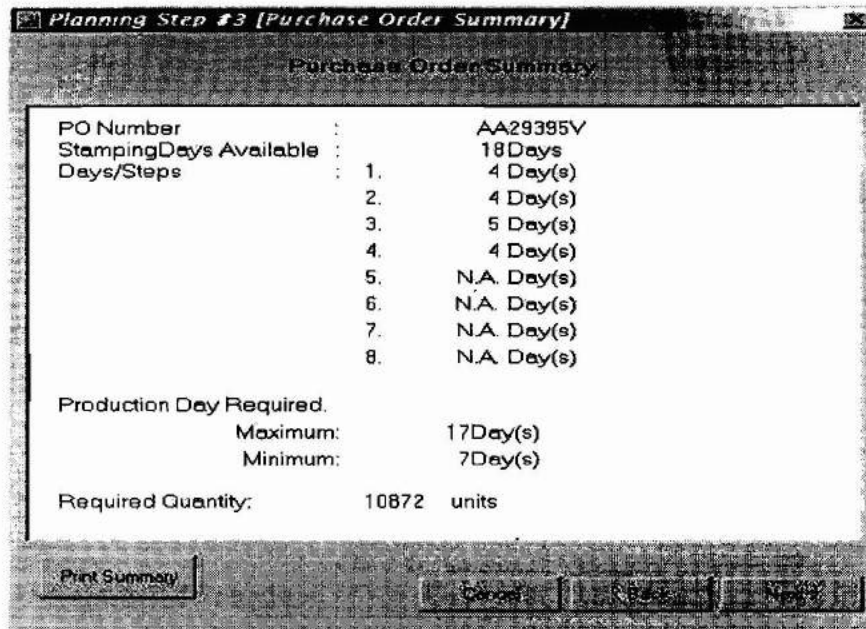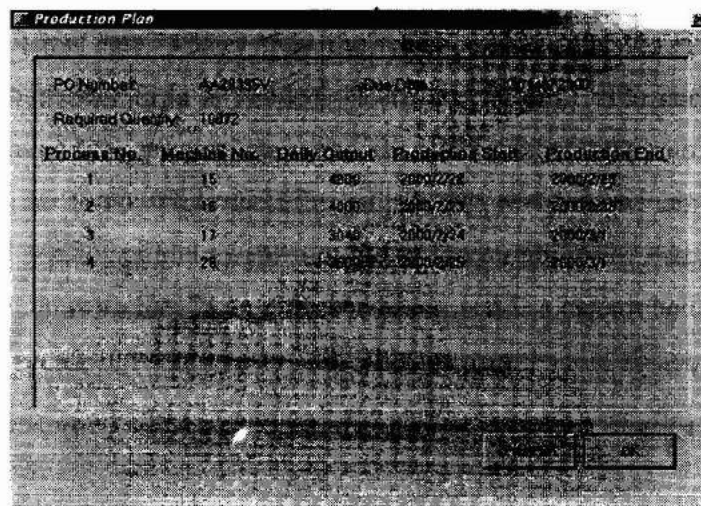
Figure 10 PO Summary

Figure 11 The Production Plan

5.4   Viewing the Workload

The user may also view each machine workload from time to time. Figure 12 shows the workload of machine number 16, with the assigned job of PO number AA29395V and process number 2 starts from 23 February 2000 to 28 February 2000.
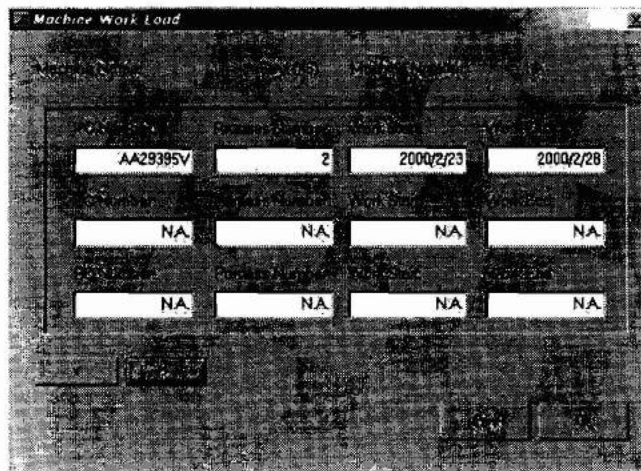
Figure 12 Machine's Workload

5.5   Uncompleted Schedule

The scheduling processes may not always produce results according to the planner's wish. Sometimes, there may not be enough machines available for the PO, or the planned completion date is later than the required due date. Figure 13 shows an example of when over time is needed. There are 14 days difference between the completion date and the required due date, thus, the total of 112 hours is needed for over time in order to complete the PO on time. Figure 14 shows an example when the scheduling process is not completed due to unavailability of machines. There is only one machine available. Thus, the scheduling process cannot be completed. The planner has to decide himself how to solve this problem.
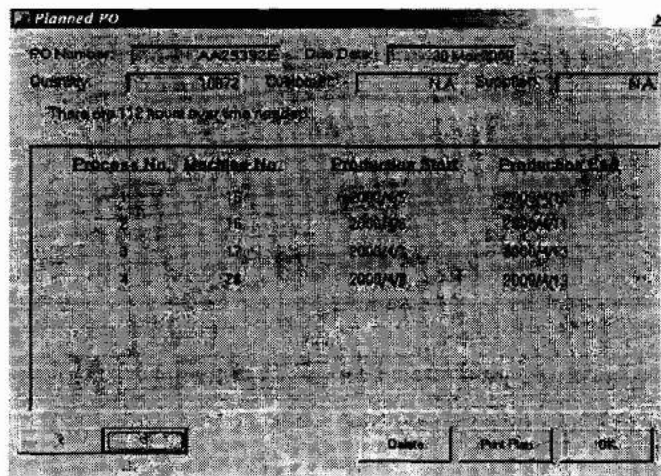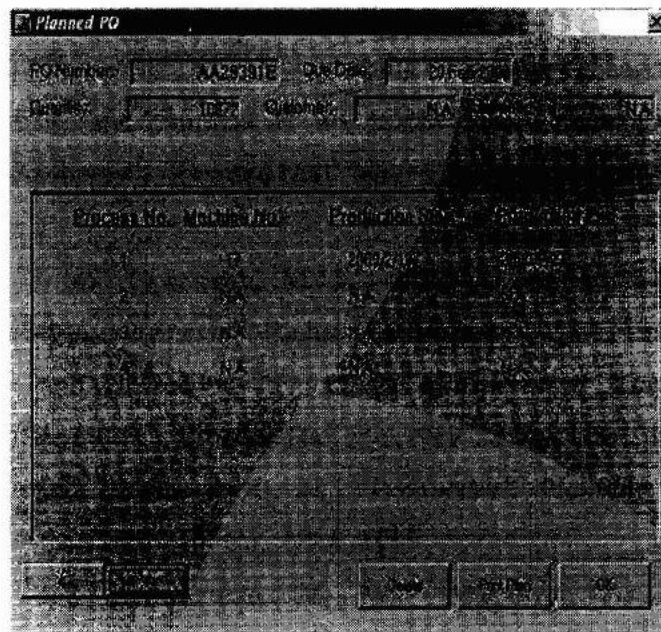

Figure 13 Over Time Suggestion

Figure 14 No Machines Available

6.0 CONCLUSION

The computerised production planning system, CIMPSS is developed to replace manual production planning system. The objective of CIMPSS developed here is to assist planning and scheduling of this metal stamping company. However the CIMPSS may also be used in other job shop companies. Further case studies need to be done in order to make the complete production planning and scheduling system. The CIMPSS also provides viewing functions, so that the user can easily review the production status of the company.

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