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# An Education and Training Model for Manufacturing Resources Planning*

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*Manufacturing Resources Planning (MRP II) is recognized as being an effective management system that has an excellent planning and scheduling capability which can offer a dramatic increase in customer service, significant gains in productivity, much higher inventory turns, and a greater reduction in material costs. Many companies world-wide have attempted to implement MRP II systems. Many of them are now using MRP II with various levels of satisfaction. However, failure of MRP II implementation was in fact experienced by other companies. One of the major reasons of the failure of MRP II implementation is lack of understand and training of people. MRP II is a people system rather than a computer system. Furthermore, the major driving force for the adoption of MRP II system always comes from the management of the company. Thus the training must not only cater for engineers but also the managers. This paper proposes a generic training program for the engineers as well as management students with the objective to enhance their understanding on the operation principles of MRP II, the emphasis being on the observation of manufacturing in action rather than the familiarization of the canned software system. The training program is developed from major manufacturing projects organized by the local industry. It enables the students to assimilate the knowledge of MRP II planning and execution acquired from their academic study and apply them in an industrial environment.*

## INTRODUCTION

MANUFACTURING organisations can be broadly divided into sales, logistics, production, engineering and supporting functions. The development of Manufacturing Resource Planning (MRP II) links up all these functions together with a coverage much greater than what is being focused by traditional MRP (Material Requirements Planning). Because of its broad and far-reaching scope, MRP II should not be regarded as a simple system. Rather, it should be seen as a corporate way of life [1, 2].

According to *APICS Dictionary* [3], MRP II can be defined as 'a method for the effective planning of all resources of a manufacturing company'. Ideally, it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer 'what if' questions. It is made up of a variety of functions, each linked together; Business Planning, Production Planning, Master Scheduling, Material Requirement Planning and Capacity Requirement Planning. Output from these systems are integrated with financial reports such as the business plan, purchase commitment report, shipping budget, inventory projection in dollars, etc. In general, MRP II functions can be grouped into three macro elements, namely Top Management Planning, Operation Planning and Execution [4]. Figure 1 shows the framework of MRP II built up by these macro elements.

The theory of MRP II has been well discussed in many literatures. Focuses are normally put on concept, methodology, application and future development of MRP II. For instance, Landvater [5], Luscombe [6], Orlicky [7] and Plossl [8] discussed the detail MRP II mechanisms. Literature for specific MRP II scheduling functions are also found in Correll and Edson [9], Proud [10] and Van Veen [11]. Implementation management is discussed by Wallace [12] and Wight [13]. Cox and Clark [14], Burns [15] and White [16] identified the critical success factors associated with the success of MRP II implementation. More recent research, such as Ang [17] and Lau and Ip [18] also identified various problems encountered during implementation management. These problems can be classified into five areas: software, engineering, internal, customer and vendor, and training was considered the major solution to these problems. Wallace [12] identified five major factors that contribute to the success of MRP II projects; they are summarised into the following:

1. *People.* The major obstacle to successful implementation comes from the people side. A study on human variables of MRP II system implementation [19] concluded that managers considering or beginning implementation of an MRP II system should utilise the classical approach to organisation change and involve as many of the affected personnel as possible in

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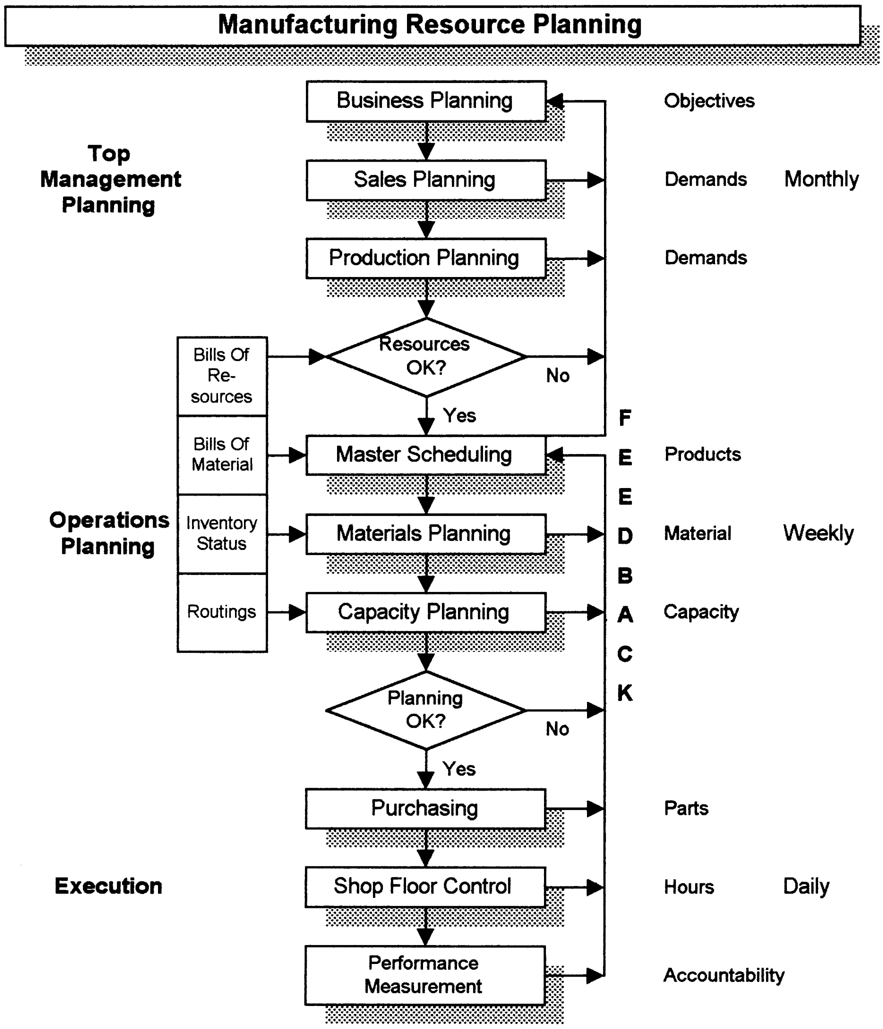


Fig. 1. Framework of a MRP II system.

the planning and implementation stage. Also, the channels of communication should be opened and education about the realistic benefit of MRP II should be stressed. Involvement in implementation is a powerful determinant for satisfaction. Involvement in the early stages of implementation helps to smooth the process and removes the fears of those less knowledgeable about information system.

2. *Training and Education.* This area has always been overlooked by management which result in inadequate and incomplete training. Since training and education also aim to change people's behaviour, inadequate education will lead to non-conformance to the objective of implementation.
3. *Data.* When inventory and bill-of-material (BOM) records can not be maintained at 95% to 98% accuracy, bad data makes it impossible to complete the key elements of MRP II, such as master production schedule (MPS).
4. *Management Involvement.* Most failures can be attributed to a lack of management involvement and poor attitudes toward the system [20] in which the management is unable to maintain the implementation project at the highest priority.
5. *Timing.* When the duration of implementation project is extended too long, e.g. more than two years, the chance of failure increases significantly as people's attention can not be prolonged to such a long implementation especially as the business environment is changing as well.

In this paper, the authors address the training and education in making a MRP II implementation successful. The training model is developed in the Industrial Training Center of the Hong Kong Polytechnic university. It is a multi-discipline training center for the provision of industrial training with structured program. It consists of 23 workshops covering the majority of engineering disciplines including Manufacturing, Mechanical, Civil, Electronic and Electrical, equipped with great varieties of facilities ranging from basic machinery to sophisticated equipment. The training philosophy of the Industrial Center is to expose the students to genuine industry-type atmosphere for training with 'real work projects' that are carefully selected from industry. In the design of the training program, MRP II is considered as a company-wide system that drives all of the business functions of a company that is involved in manufacturing a product. The MRP II system is an important means for operational planning and control for both engineers and managers.

## THE MRP II TRAINING PHILOSOPHY

As mentioned, the key reasons for failure of MRP II is the fact that the users do not accept the responsibility in the implementation process. In general, people will not accept responsibility for something they do not understand. Thus, for a MRP II system to succeed the users must be able to understand fully how the system works and hence unequivocally accept the responsibility. That is the objective of MRP II training. Education hence becomes the most important factor for MRP II success. Education develops an understanding of the concepts that govern and bind the different facets of a MRP II system. Training provides the 'How'. That is how to master and manipulate the system for the desirable output. Thus the MRP II training program should consist of generic education and application training. Generic education describes the MRP II process and provides some basic understanding of various modules that comprise a MRP II system. Application training shows how the system functions through the description of the data transactions and information flow within the system together with some 'hands on' practice.

The research by DiBello and Glick [21] showed that classroom instruction is an ineffective way to develop MRP II skills. But people can manage to develop such skills in the workplace through mastering the working process by solving problems encountered daily and acquiring expertise from each other or the equivalent of 'peer tutoring'. The learning process will be more effective if the training is coupled with an operational environment that the system users are familiar with. Thus, bringing the industrial atmosphere to classroom, group learning, and job-specific training materials should be an effective way to conduct MRP II training.

## TRAINING DESIGN AND DEVELOPMENT

*The training model*

Familiarity with the manufacturing environment is a preferred prerequisite for the MRP II training. However, the students usually have shallow experience with the manufacturing world. Thus the first two days of the training program is a pre-MRP II workshop to equip the students for the manufacturing environment, where the students learn statistical process control (SPC), industrial engineering (IE) techniques, assembly line balancing, and also have a visit tour to observe the manufacturing process available in Industrial Training Center.

Since the MRP II system involves a comprehensive computer program which has more than ten modules, the training program emphasizes the closed loop MRP II (a sub-system of MRP II that is mainly concerned with manufacturing planning and control). In the training program, the students are provided with an overview session for the operation principles of the closed loop MRP II and some 'hands on' practice for various modules in the system. The training also provides various opportunities for the student to tackle problems using the knowledge gained. Thus constructive problem-solving exercises are given to the students regularly. The model for the training program is shown in Fig. 2.

*Prototype product*

To ensure the coherent between the pre-MRP II workshop and the MRP II workshop, the training activities are constructed around two products, the photo frame and the chess set, designed and made by the Industrial Center. The elegant photo frame (see Fig. 3) consists of a pair of clear acrylic stands with four sets of eye-catching snapping pins to hold the 4R photo incorporating shiny locking knobs with identifiable logo, packed in an attractive presentation case. The distinctive chess set (see Fig. 4) is a product of state-of-art manufacturing technology by combining grace with solidity. It consists of a stylish chess pieces in gold and ebony with hand-made wooden chess board, packed in attractive presentation case.

*The pre-mrp II workshop*

In the design and development of the training program, a pre-MRP II training is provided. The objective of the workshop is to help the students

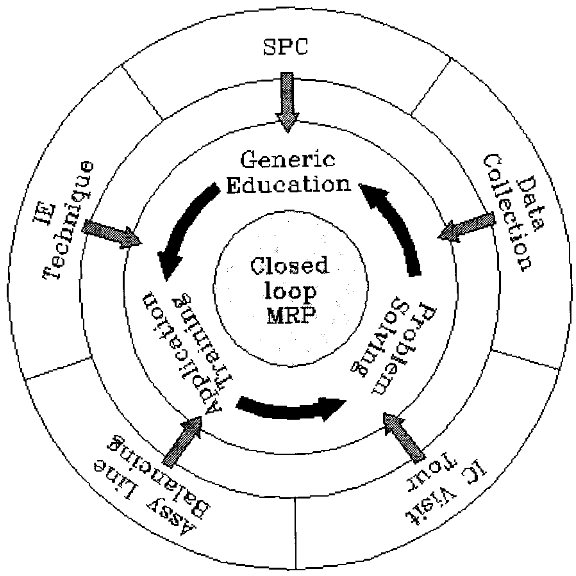


Fig. 2. Model for MRP II training.

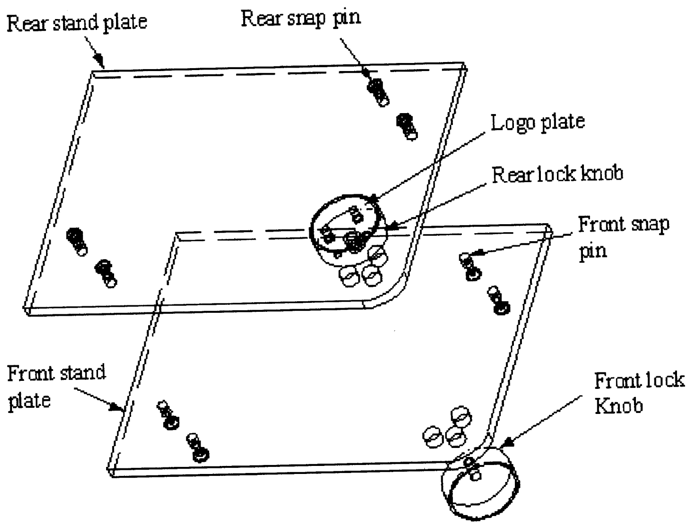


Fig. 3. The photo frame.

familiarize with the manufacturing environment that they will encounter in the MRP II workshop by the introduction of the manufacturing process for the photo frame and the chess set. The basic manufacturing concept is imparted as well. The topics covered and the details of the workshop are summarized as follows:

- *SPC (statistical process control).* The concepts and standards of quality control is introduced. Quality control (QC) techniques such as SPC, data collection methods and analysis, sampling method, etc., are also imparted. Students are requested to apply the basic QC technique to monitor the quality performance of the components for the two products.
- *IE (industrial engineering) technique.* Work study including method study and work measurement is introduced. Method study is applied to find out the most efficient assembly method for the photo frame among all possible alternatives through examination, recording and analysis. Work measurement is employed to establish the standard time for the assembly operations of the photo frame with time study.
- *Assembly line balancing.* The concept of flow-line assembly is introduced. Students are requested to make use of the results found in method study and work measurement to design a flow line for assembling the photo frame with maximum efficiency by evenly distributed the work load to every workstations in the flow line.
- *Industrial Center.* Students are guided to visit the Industrial Center to observe all the manufacturing process for the two products and the facilities available in the Industrial Center with special emphasizes in the flexible manufacturing system (FMS). The FMS (see Fig. 5) is the major metal-cutting installation for the two products and hence is the critical manufacturing resource for MRP II.
- *Data collection.* In the Industrial Center, the students are requested to record the manufacturing process data such as the machine setup time, running time for component cutting, material usage rate, etc. These data together with the quality data from SPC and standard time from work measurement are consolidated and applied in the MRP II workshop.

*The mrp II workshop*

In the workshop, the students are explained and guided through a closed loop MRP II process (see Fig. 6) with particular reference to the manufacturing of the photo frame and the chess set. The

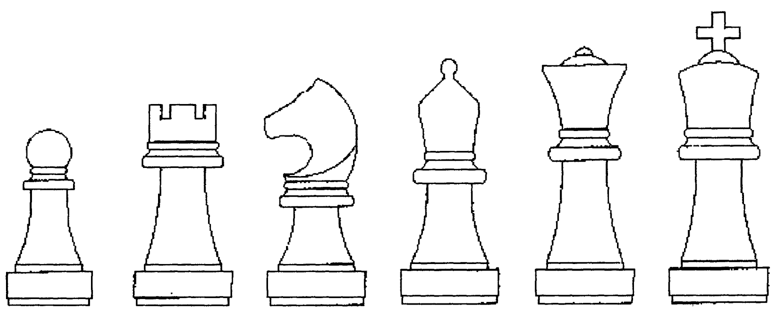

Fig. 4. The chess set.

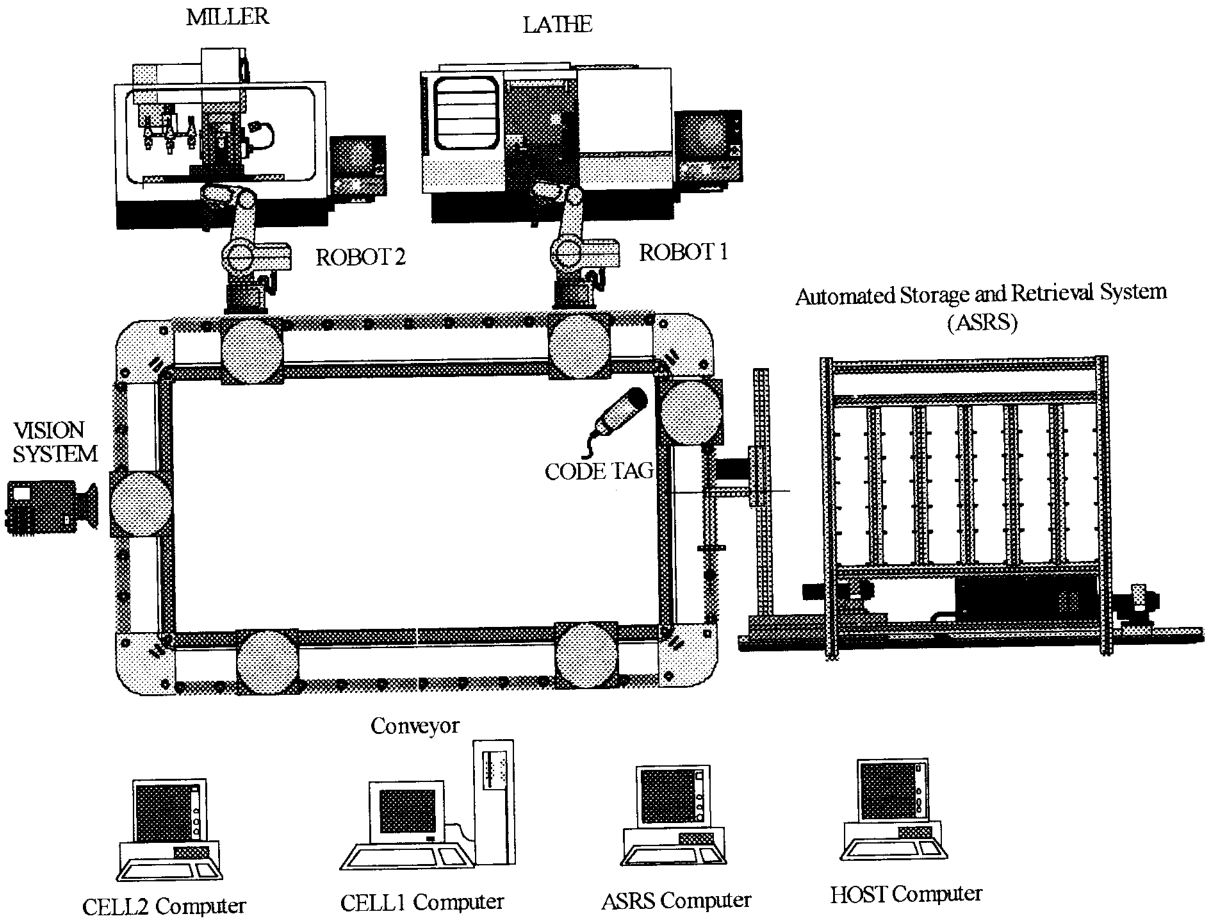


Fig 5. The flexible manufacturing system.

objective is to enable the students to appreciate the operation principle of a closed loop MRP II system through the recognition of the relationship among the sub-systems and the information flow for operational control.

The core of the MRP II training model consists of three elements, they are:

- generic education
- application training
- problem solving.

Hence, the workshop is conducted in three sessions; generic education, application training and constructive problem solving, with the duration of one day, two day, and one day respectively. Study groups of five students are formed in the workshop. Each group is equipped with a slave printer for report printing and requested to submit a group report to stipulate the findings and problems encountered during the walk through the closed loop MRP II system with comment on the results. The details of these three training sessions are further elaborated in the following.

- *Generic education.* The operation principle of closed loop MRP II is reviewed with the students. With reference to customer demand and sales forecast, the master production schedule (MPS) is prepared to initiate the production planning system. The material requirement planning (MRP) system generates a material plan required to accomplished the production orders by exploiting the bill of material (BOM) and in-hand inventory. The capacity requirements planning (CRP) system is confirmed if the capacity (including labor and machine resources) are available to accomplish the tasks of production. Then purchasing order will be generated for 'buy' parts whereas the manufacturing order will be issued to the shop floor for the 'make' parts. Finally, the shop floor control (SFC) system takes care of the production scheduling on the shop floor. Furthermore, the mechanics of the critical modules in the closed loop MRP II system, such as the principle of BOM, calculation of planned order release, calculation of net material requirement etc., are reviewed with the students. A commercial computer software is also introduced to the students which provides the 'hands on' practice. The hardware configuration of the computer system is shown in Fig. 7.
- *Application training.* Performance forms are provided to the students to list down the manufacturing data for the two products collected in

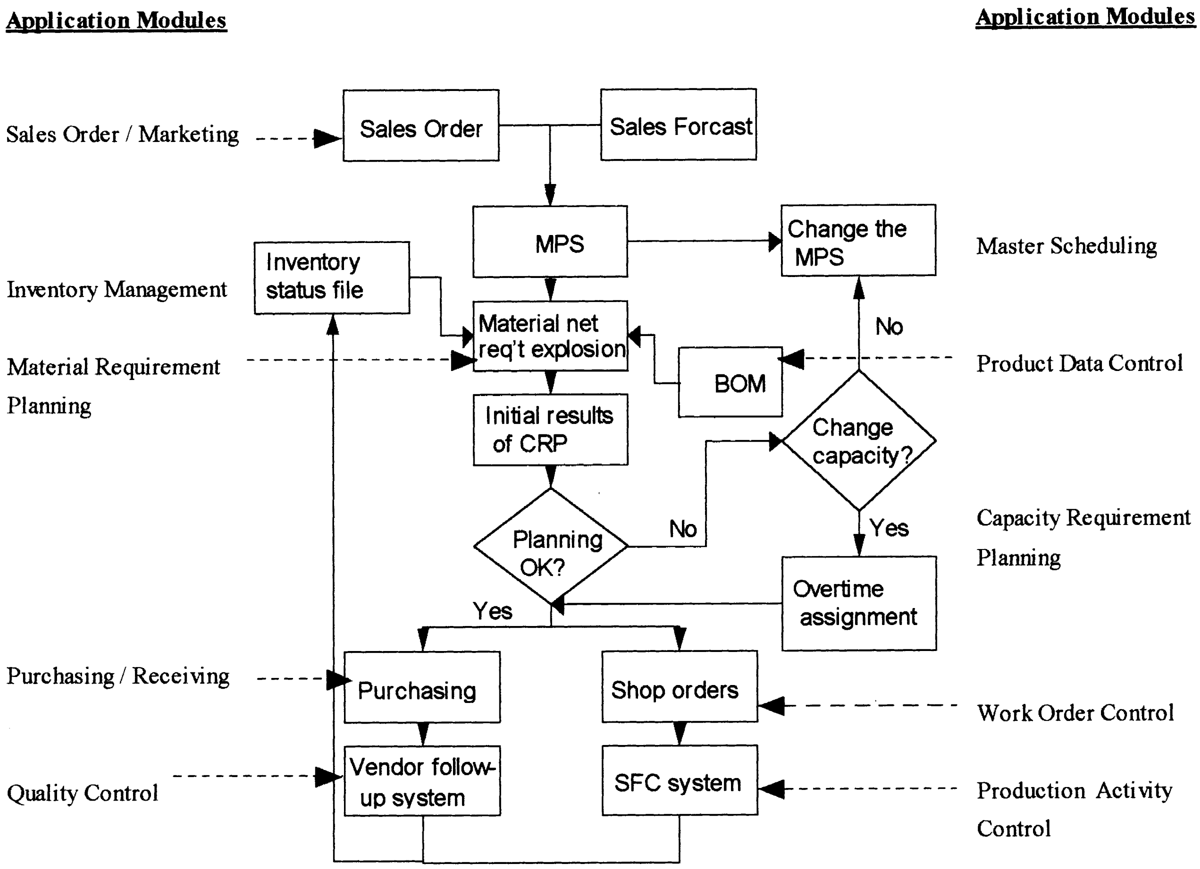


Fig. 6. Closed loop MRP II system.

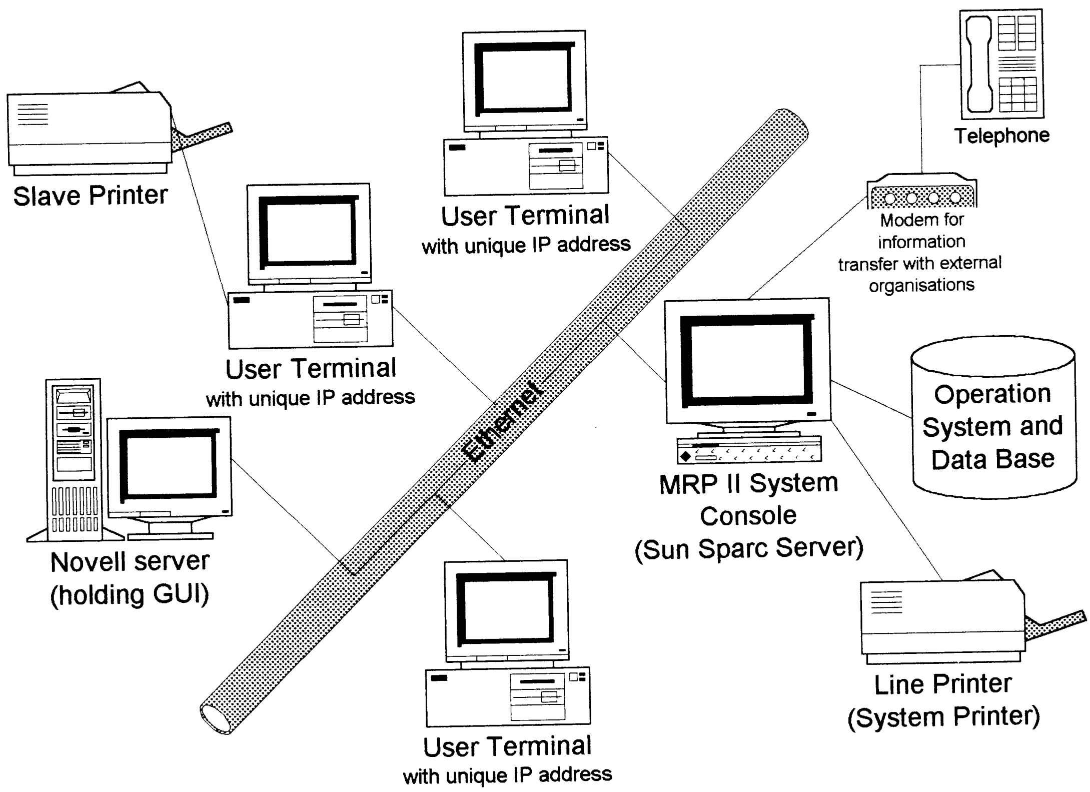


Fig 7. The hardware configuration of the computer system.

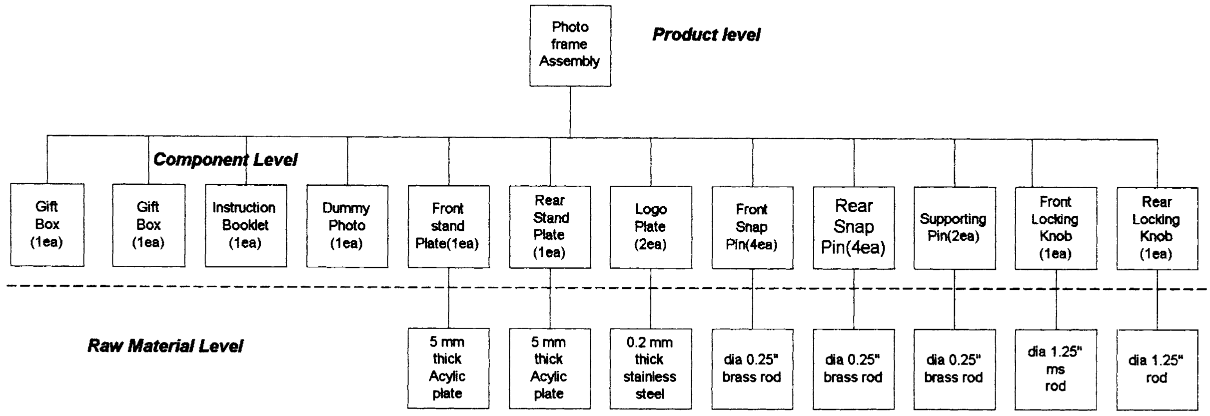


Fig 8. Product structure of the photo frame.

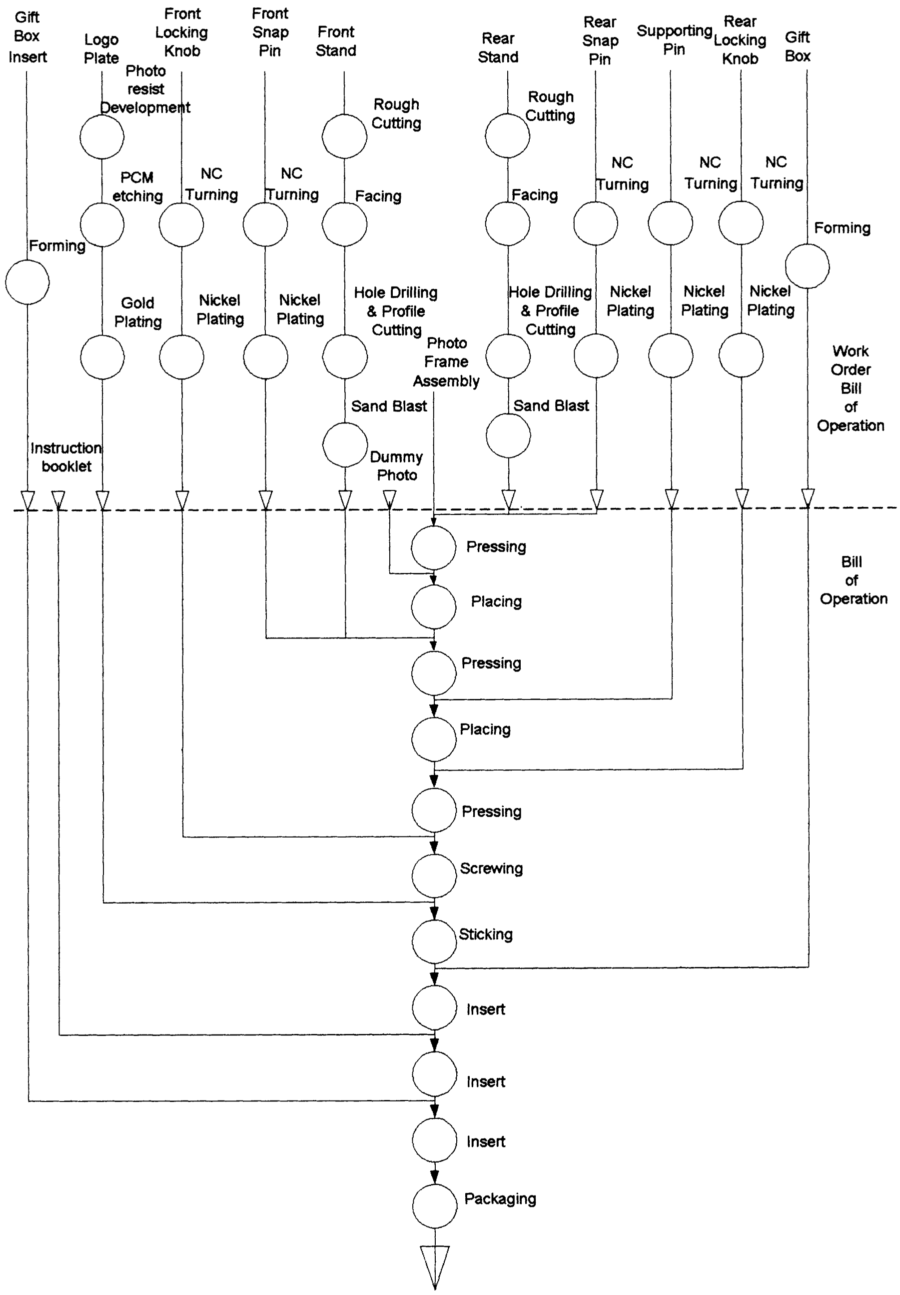


Fig 9. Process chart for the photo frame.

the pre-MRP II workshop. Together with the addition information such as the product structure (Fig. 8 shows the product structure of the photo frame), the manufacturing process chart (Fig. 9 shows the manufacturing process of the photo frame), the sales order quantity, stock inventory data, shop load capacity, etc., the study groups are guided to prepare the part master, BOM, costing BOM, master production schedule, material plan, workshop capacity plan, and the shop-floor schedule for the two products. The students then follow the step-by-step guidebook and the demonstrations, and manipulate the computer system to verify their findings.

- *Constructive problem solving.* With the completion of the application training, the students are instructed about the changes in available capacity, sales order quantity, component lead time, etc. The study groups are required to refine their plans to accommodate the changes. They are asked to carry out re-planning either manually or with the help of the computer system. However, they are recommended to allow the computer to perform the calculation and then exercise their judgments and decision to cope with changes such as delay in production, material shortage and special sales orders.

## CONCLUSION

In this paper, the authors describe a MRP II training model, its design and development that aims to overcome the major obstacle to successful implementation of MRP II system in industry [19]. The review after the training program indicated that the approach is very satisfactory and the objectives of the training are met. This model also eliminates the inadequacy of MRP II training in a classroom-type approach pointed out by DiBello and Glick [21]. Most students appreciated and enjoyed the constructive problem-solving approach because it stimulated their interest to tackle the problems using knowledge gained. Furthermore, the problems were found to be exciting and fun. However, some students commented that they were not able to complete all the problems during the training period and that they need to finish constructive problem solving at home.

The pre-MRP II workshop was welcomed by the students, particular by those who are non-engineering students. It provides a valuable introduction to the manufacturing environment surrounding the MRP II system. It was found that both the engineering and management students did not have much problem in understanding the fundamentals of a MRP II system, for example, the conversion of product structures into the BOM and the process charts into bills of routing. Nevertheless, the computer system with many modules and functions might require more time for the student to familiarize.

Action learning is much more interesting and provides an effective way of learning. The interactive study groups played an important role in the MRP II training model. The groups were worked in harmony to achieve the common goal. The supportive atmosphere established in the group encouraged the interaction, problem-solving, and decision-making activities, and hence promoted motivation, communication, creativity, flexibility and adaptability that are required for the success of MRP II system.

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