ENTERPRISE RESOURCE PLANNING
AN INTRODUCTION

S Dharmavasan
Kingslake Engineering Systems (Pvt) Limited

The increasing globalisation of trade combined with rapid advances in computing and reduction in costs of the technology is leading to companies investing in integrated software systems for managing the entire enterprise. Without appropriate information technology systems in place, most companies can no longer function effectively. In addition, IT is being used increasingly to differentiate the company from their competitors by being more customer oriented. This paper will outline the history of resource planning starting with basic MRP and move on to the evolution of this technology to the current trends in Enterprise Resource Planning (ERP) which are leading to more customer focused business management. In addition, future strategies and some of the current research areas which will appear in products in the next few years will also be highlighted. The practical implementation of the theories in software will be illustrated with a state-of-the-art ERP package targeted at midsize manufacturers ($5-$350 million) - SYMIX. Symix is a fully integrated ERP software system which handles customer service, order entry/estimation, manufacturing, inventory control, financial, human resources etc.

Introduction

In "Re-engineering of the Corporation" by Michael Hammer, the driving forces behind re-engineering were characterised as the three C's: customers, competition and change. These same issues affect manufacturing companies worldwide.

Customers have become more demanding and are also more sophisticated. They know that they can move from one manufacturer to another in different countries with ease. They are also more knowledgeable about their needs and will exert the same pressure they are under to their suppliers.

What was once the "free" market, Soviet bloc and other Communist countries, closed markets (such as India) have all opened up and are competing with each other. As a result, what was once local and gentle competition has given rise to more cut-throat and global competition.

Change has come in the form of geo-political changes such as the fall of the Soviet Union, changes in philosophy in countries such as China which have led dramatic altering of international competition. In addition, technology, in particular-computing and telecommunications, have altered the way companies work and do business. The more recent advances with the wider acceptance of the Internet too will give rise to major changes in the way businesses compete and survive.

What does this mean for manufacturers? They need to be able to make quality products, at lower costs and must be ever more agile and efficient. However, will this alone be enough as manufacturers everywhere become more efficient, cut down on cost and produce quality products? The answer to this question must be that unless the customer can see some strategic or competitive advantage in working with a particular manufacturer they would move. Therefore, the key is to differentiate from the competition. For example, Symix, a leading vendor of Enterprise Resource Planning (ERP) software for mid-sized companies sees the answer in being the customer's competitive advantage and have introduced a series of products and services which go beyond traditional ERP software. This set of products and services is called Customer Synchronised Resource Planning or CSRP.

In reviewing the manufacturing scene in Sri Lanka, it was found that very few manufacturers are actually using ERP systems. In fact, the use of MRPII which has been in use since the 1970's too has not been adopted. This has partly been due to the cost of such systems and partly due to failure in implementations. In this paper, we review the background to ERP and explore the issues relevant to implementation. We also list some of the common reasons why projects fail and steps which could be taken to ensure successful implementations.

Material Requirements Planning

Material Requirements Planning (MRP) started life in the 1960's in the USA as a computerised approach for the planning of materials acquisition and production (Orlicky, 1975). Orlicky realised that by implementing MRP on a computer the technique would become effective in managing manufacturing inventories.

Essentially, materials requirements planning tries to answer the following questions:

1. What are we going to make?
2. What does it take to make it?
3. What do we have?
4. What do we have to get?

This was called the universal manufacturing equation by Ollie Wight, a pioneer in MRP. He pointed out the above logic applies wherever things are produced.

The early computer applications of MRP were built around a Bill of Material Processor (BOMP) which converted a discrete plan of production for a parent item into a discrete plan of production or purchasing for component items. The computer program used a Bill of Material (BOM) which contained a listing of all the materials to be used in the manufacture of the item in the form of components or raw material. The BOM was used to generate component demand to produce the required final product. This projected gross demand for components could be then compared to the available inventory as well as those outstanding orders within the planning time horizon. By systematically going through each level of the BOM it would be possible to generate a list of required materials and when they should be purchased. Typically, these computer programs were implemented on large mainframe computers and run in centralised material purchasing departments of large companies.

As time went on, additional operational functions were added to the basic MRP system to provide more planning capability. Some of these are listed below:

- Master Production Scheduling (MPS): This is essentially a production schedule based on the business plan or sales forecast of the company. In other words, it is the anticipated manufacturing schedule for selected items by quantity per planning period. The MPS provides the basis for making customer delivery promises, utilising the capacity of the plant effectively, attaining the strategic objectives of the business as reflected in the production plan, and resolving conflicts between marketing and manufacturing. Therefore, MPS should be seen as the main linking pin between marketing and sales, engineering and manufacturing.
- Rough Cut Capacity Planning (RCCP): This function checks certain key resources such as people or machinery that may be required to produce certain items. Clearly, if these resources are used up there would not be much point in planning for the other non-critical resources. For example, if the RCCP shows that the MPS cannot be achieved then the MPS must be modified or more resources added.
- Capacity Requirements Planning (CRP): The MRP system in planning orders for both manufactured and purchased items to meet the requirements of the MPS ignores the capacity constraints in the manufacturing facility. CRP, uses the routing information (the operations to be carried out on the materials) to estimate the capacity required at each work centre. Then, a forward or backward scheduling algorithm is used to calculate when the various work centres should be loaded. As the CRP is only done after each MRP calculation it is used as a check rather than as an interactive planning tool.
- Production Activity Control (PAC): This is the module which is used to collect data from the various work centres on what actually happened and to compare this information with the planned costs, activities etc.

It was soon realised that by combining these various planning functions with the execution functions of PAC and Purchasing it was possible to have a feedback loop. This was then known as closed loop MRP. This is shown schematically in Figure 1.

Manufacturing Resource Planning MRPII

The 1970's saw the development of material requirements planning functions being combined with financial modules. In addition, the master production scheduling was extended to deal with the full range of tasks in master planning and the support of business planning in financial terms. This extended and integrated approach was known as manufacturing resource planning or MRPII. Since 1980, the number of MRP installations has steadily grown as applications became available on lower cost mini and micro-computers.

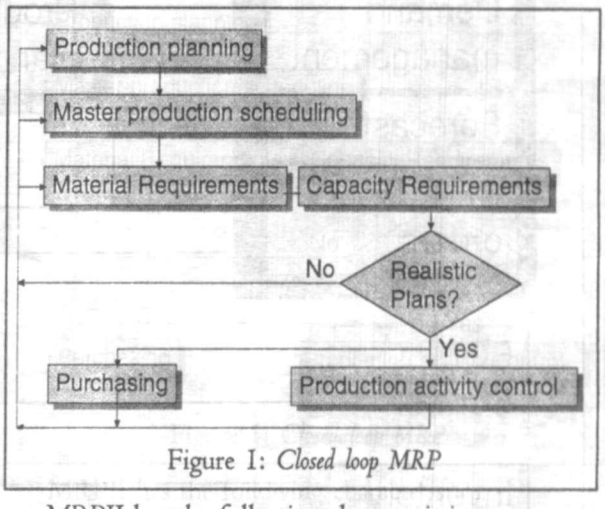


Figure 1: *Closed loop MRP*

MRPII has the following characteristics:

- A series of functions which go beyond material requirements planning.
- A set of tools to address both priority and capacity, and to support both planning and execution.
- It has provisions for feedback from the execution functions back to the planning functions. Plans can then be altered when necessary, thereby keeping priorities valid as conditions change.
- Finance - The ability to translate the operating plan (in pieces, kilos or litres) into financial terms (dollars).
- Simulation - The ability to ask what-if questions and to obtain comprehensive, detailed, actionable answers - in both units and dollars.

A schematic overview of MRPII is shown in Figure 2.

The success of MRP was partly due to the crusade launched by the American Production and Inventory Control Society (APICS) in the early 1970's. More importantly, MRPII made use of the computer's ability to store centrally and provide access to a large body of information required to run a manufacturing company. It helped to coordinate the activities of various functions in the manufacturing firm such as engineering, production and materials.

Just in Time

At the same time as MRPII was being implemented in manufacturing organisations in the West, the Just in Time (JIT) production also attracted interest. Western industrial managers, aware of the success of their Japanese counterparts, realised that achieving just in time in manufacturing was essential in order to compete in worldwide markets.

JIT is a manufacturing philosophy with a very simple goal, i.e., produce the required items, at the required quality, and in the required quantities, at the precise time they are required. It was developed in the 1960's in Toyota's automotive plants in Japan. It is currently used in a variety of industries including automotive, aerospace, machine tools etc.

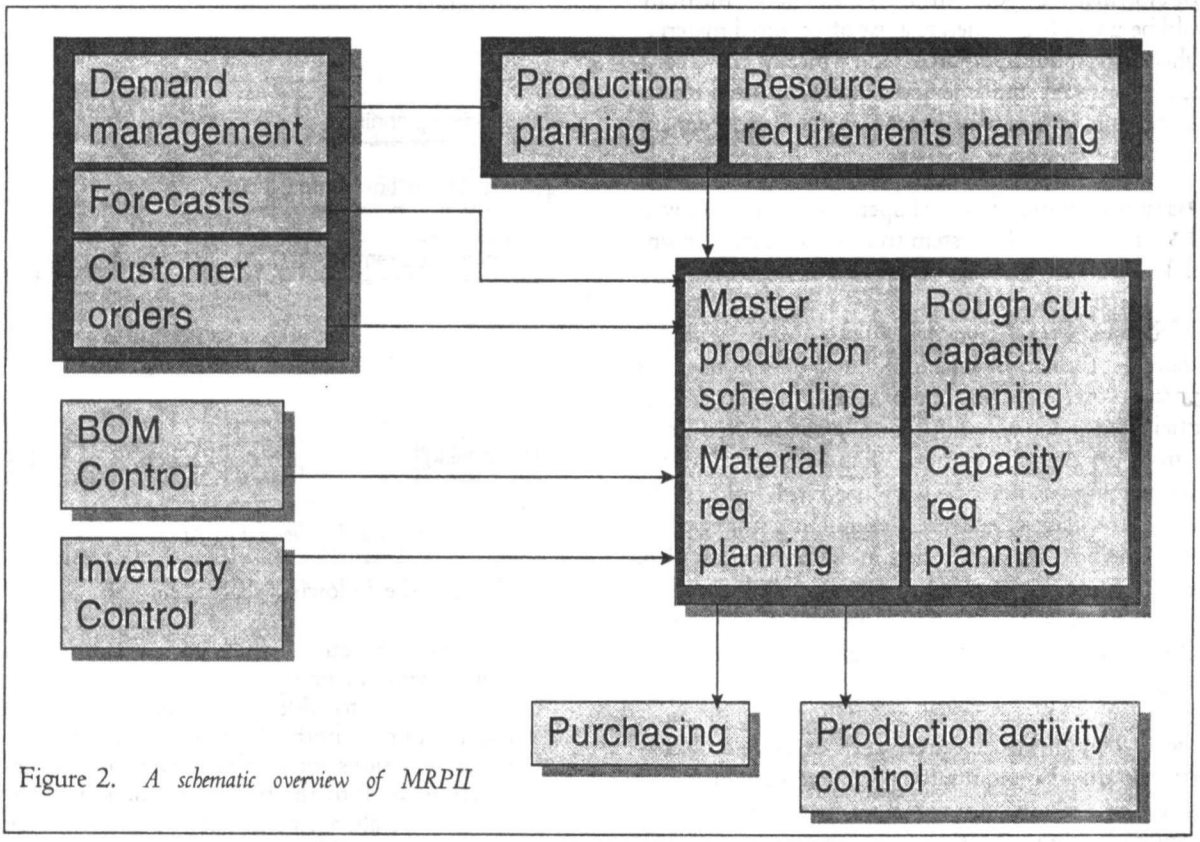


Figure 2. *A schematic overview of MRPII*

The JIT approach involves a continuous commitment to the pursuit of excellence in all phases of manufacturing systems design and operation. The goals of JIT are:

- Zero defects
- Zero set-up time
- Zero inventories
- Zero handling
- Zero breakdowns
- Zero lead time
- Lot size of one

Based on the above goals the key elements of the JIT philosophy are:

⊙ An intelligent match of market demand with product demand with product design with due and early consideration given for manufacturing problems at the product design stage.

⊙ The definition of product families based on a number of important manufacturing goals and the design of manufacturing systems to facilitate flow based production of these families where possible.

⊙ The establishment of relationships with suppliers to achieve just in time deliveries of raw materials and purchased components.

The main importance of this approach is that the emphasis is not purely on the manufacturing function but the total environment - customer, supplier and the factory.

The system that executes JIT delivery on the shop floor level is known as Kanban. Its aim is to improve the system productivity and to secure operator involvement and participation in achieving high productivity by providing a highly visible means to observe the flow of products. It must be noted that the Kanban system is only applicable to plants which are termed repetitive manufacturers.

JIT on the other hand can be applied to discrete and repetitive manufacturing.

The significant difference between Western and Japanese companies is that Western companies generally implement improvements as a step change and by the application of technology. The Japanese approach on the other hand introduce change incrementally and continually, and they generally involve people.

Enterprise Resource Planning

As discussed above, MRPII was internally focused within a manufacturing organisation whereas the JIT philosophy relied on the pull of the customer to create a

demand for the manufacturer which extends through each operation right back to the suppliers. Soon companies relying on MRPII alone realised that it was essential to integrate the customer demand into the system and to use this demand to drive the rest of production.

This increasing focus on the customer has led to the integration of the Customer service functionality into MRPII. Figure 3 shows an overview of a typical Enterprise Resource Planning system. In this, in addition to the MRPII functionality, various other modules such as Customer Service, Human Resources, alternative methods of shop floor control are integrated.

Enterprise Resource Planning Systems permit organisations to manage resources across the enterprise and enable the integration of sales management, component procurement, inventory management, manufacturing control, project management, distribution, transportation, finance and other functions.

The main advantages of ERP systems are:

- Closed loop order fulfilment.
- Reduced Manufacturing cost by reducing wastage.
- Additional cost reductions through operational efficiencies.
- Decreased time-to-market
- Increased product quality

ERP Software - SYMIX

Symix is a state-of-the-art software system which implements the features necessary to provide enterprise resource planning capabilities. The system is targeted at mid-size manufacturers defined as those with a site or sales less than $350 million. Mid-size manufacturers tend to be those who supply the major companies, also known as Tier I companies. Recently, the mid-sized manufacturers have come under increasing pressure from world-wide competition and also from their customers who have been requesting cost reductions (eg., General Motors).

The Symix software has been developed over several years and started life as an MRPII package in the late 1970's. Having been developed for micro-computers initially, the kernel of the system is relatively efficient. In addition, the system has been implemented using a relational database management system and fourth generation language (PROGRESS). This allows customisation to take place relatively easily and for the software to be run on a wide variety of platforms including Windows PC, UNIX and AS/400.

Symix comprises a suite of products which go beyond the traditional ERP software. The various products are:

* SyteLine - a robust and proven state-of-the-art ERP system
* SyteSelect - A software system which allows full customer service, order and product configuration including rule based definition of products. The software is designed to be operated on mobile computers.
* SytePower - A business intelligence system which allows senior and operational managers to analyse the underlying data in various ways to determine key business drivers.
* SyteService - A field service management system to carry out warranty and other field service work.
* SyteGuide - A process modelling and implementation tool with several business templates (including ISO9000, TQM etc) to help companies use best practices.

The Symix SyteLine's client base includes a large proportion of Japanese and Asian companies. As a result the software includes a combination of features of best practices from the US and Japan including MRPII and JIT. The additional shop floor data collection features also make it eminently suited to carry out high quality Production Activity Control (PAC) and Computer Integrated Manufacturing (CIM).

Implementation

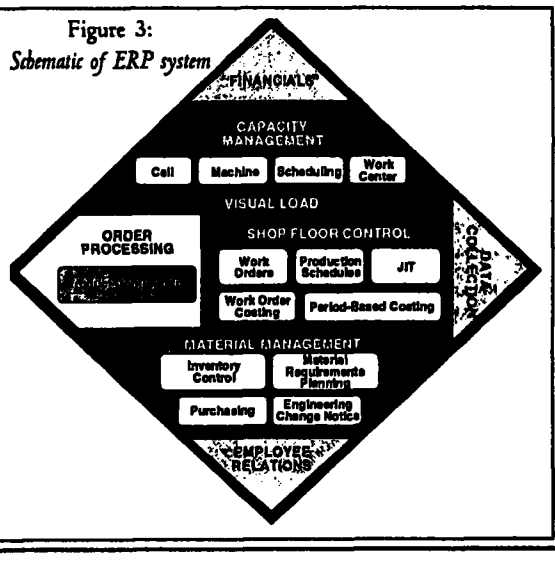
The implementation of ERP systems can cause difficulty due to their integrated nature. Many researchers have tried to understand the background to ERP success and, indeed, failure. It seems to be generally agreed that failure of an ERP installation can be traced to the following key reasons:

♦ Lack of top management commitment to the project: Most manufacturers have a formal and informal system in place. The implementation of ERP results in a need for formal and rigorous procedures. This may require culture changes in the organisation. Therefore, a favourable environment for the change cannot be created without a full and enthusiastic involvement of top management.

♦ Lack of education in ERP for all those who will have to use the system: There has to be an understanding of how ERP works and the inter-relationship between the various players. It does not mean that everyone needs to be an expert in ERP but certainly there should be adequate understanding of the functioning of ERP and what is expected.

♦ Unrealistic master production schedules: The ERP system is seen to be unable to provide the required resource planning.

Figure 3:
Schematic of ERP system



♦ Inaccurate data, in particular BOM and inventory data: Although the ERP principle is deceptively simple, without accurate data the system will never work.

♦ IT focused implementation: Frequently, the implementation is delegated to the IT department which leads to an IT emphasis rather than a business emphasis for the project.

Although many companies have implemented ERP, the reaction ranges from "It hasn't helped us at all" to "It's terrific; we couldn't run the business without it". To help focus on this issue the Oliver Wight organisation has developed an ABCD classification as follows:

A. Effectively used company-wide; generating significant improvements in customer service, productivity, inventory, and costs.

B. Supported by top management; used by middle management to achieve measurable company improvements.

C. Operated primarily as better methods for ordering materials; contributing to better inventory management.

D. Information inaccurate and poorly understood by users; providing little help in running the business.

Assuming that a Class A implementation is required, many practitioners recommend the following stages:

□ Audit/Assessment I: An analysis of the company's current situation, problems, opportunities, strategies etc. It addresses questions such as: "Is ERP the best step to take now to make us more competitive? If so, what is the best way to implement?"

□ First cut education: Senior management and operating managers must learn how ERP works; what it consists of; how it operates; and what is required to implement and use it properly.

□ Vision statement: A written document defining the desired operational environment to be achieved with the implementation of ERP. It should answer the question "What do we want this company to look like after the implementation?"

□ Cost/Benefit analysis: A process to generate a written document that spells out the costs of implementation and the benefits of operating ERP successfully and should result in a formal decision whether or not to proceed with ERP.

□ Project Organisation: Creation of an Executive Steering Committee; an operational level project team; full-time project leader and project team. By now the software, consultants should also be chosen.

□ Initial education: All the people who need to be involved in the ERP system as users must have training on ERP and the software system.

□ Conference Room Pilot: Review and improve processes. Map the software to actual processes and data. Define reports necessary, operational procedures etc.

□ Install software and hardware.

□ Data conversion and customisation of software.

□ Parallel run or pilot runs of specific systems.

□ End-User training on how to use the software system.

□ Go live

□ Post-implementation review: A focused evaluation of the company's situation, problems, opportunities and strategies following the implementation. It is the driver via which the company moves into its next improvement initiative (JIT, TQM, etc).

□ On-going education

Current ERP Research

The main thrust of current development of ERP is the continued application of software engineering techniques to improve the ERP system in terms of its user interface, its interconnectivity with other systems, data management etc. None of these have changed the underlying basic MRPII procedure.

As seen in the Symix product line, there is more emphasis on the business intelligence and customer service aspects. Also, most modern ERP systems have a layering of decision support tools such as fourth generation languages on top of the database. In addition, more use is being made of relational database management systems as opposed to earlier file based systems.

The area of constraint based scheduling is also attracting interest. This is quite a difficult problem to solve in a generalised way and as a result more problem or domain specific approaches are being developed. However, these have not been accepted by industry due to a certain lack of transparency in the way the scheduling takes place. Better user interfaces combined with these highly numerically intensive algorithms may provide suitable solutions.

Another area attracting substantial research is that of product data modelling and integration of design and real-time data collection.

Conclusions

This paper has explored the background to enterprise resource planning and current state-of-the-art. Based on these we conclude that:

* ERP provides manufacturing companies with a competitive advantage
* Success depends on implementation.
* Total commitment of senior management is required.

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