

Modern Methodologies and Approaches to Enterprise Resource Planning

Irina Shafranskaya,

Post – Graduate Student of the Perm Affiliation of the Institute of Economy of the Ural Branch of Russian Academy of Sciences

Table of Content

| | |
|---|----|
| Introduction..... | 2 |
| Section One. Current Planning Methodologies..... | 3 |
| The Pre - systems | 3 |
| MRP (Material Requirements Planning) Methodology | 4 |
| MRP II (Manufacturing Resource Planning) Methodology..... | 5 |
| ERP (Enterprise Resource Planning) Methodology | 6 |
| Summary on the Existing Systems..... | 7 |
| Section 2. New Paradigms to Manufacturing Resource Planning. | 9 |
| APS (Advanced Planning and Scheduling) Methodology | 9 |
| SRP (Supply – Chain Resource Planning) Methodology | 10 |
| Simulation Methodology | 12 |
| Conclusion | 14 |
| References..... | 15 |



Introduction

Enterprises today are increasingly challenged to improve revenues, while cutting costs and maintaining customer's liability. On the industrial enterprise level this transfers into several spheres of improvement according to the organisational chart of the enterprise. Delivery and sales departments' aim is to attain 100% on-time delivery. Operational departments are to decrease work-in-process. On the shop level the task is to increase the capacity with no extra capital acquisition. Marketing service should possibly improve customer's satisfaction. And planning department is to optimize the usage of existing resources, reducing or eliminating the costs.

These improvement need to be done in the light of rush jobs, increasing customer demands and limits on overtime, in the real-time environment that can flex to meet constantly changing needs.

Many enterprises are finding a way to increase the visibility of business processes in order to:

- Identify short and long-term impact of adding, removing or reassigning resources such as people, machines and tooling;
- Gather sufficient information about short, medium and long – term capacity requirements and capabilities to make effective capital expenditure decisions;
- Realise acceptable return on investment;
- Understand the impact of additional or rush jobs on the current facility load and current customer commitments;
- Predict or eliminate bottlenecks before they occur and create the plans and schedules which meet or exceed customer requirements, while optimizing capacity and eliminating costs according to the accepted inventory control policy.

The most common planning methodologies, which have been spread world-wide in recent years, are the systems of resource planning based on the informational system of the enterprise. In manufacturing, the key systems are Material Requirement Planning (MRP), Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning (ERP) systems which are to handle production, supply and



capacity planning and inventory control under the uncertain market demand circumstances.

The aim of this research is to describe the key principles of manufacturing planning systems and the trends of their further development and evolution.

In section one the most common systems (mentioned before) are briefly described and their advantages and drawbacks are highlighted according to the current critics.

In section two the trends of the above mentioned systems' development are observed and new paradigms to the manufacturing planning are presented.

Section 1.

Current Planning Methodologies.

The Pre - systems

The development of the methods of enterprise management and control in the beginning of the XXth century is connected first of all with the names of Frederick Taylor and Henry Gantt. Frederick Taylor was “the father” of the idea of business specialization; he argued planning as the basic element of production management. He also considered that planning should be done by professionals. Henry Gantt, who was his colleague, studied the quantitative methods of operational management. He considered time as the basic resource of planning, thus the base for decision making was the comparison between planned and current duration of any manufacturing operation.

Taylor and Gantt's works became the foundation of such disciplines as Industrial Engineering and Operational Research.

In the beginning of 60's it were the USA who started to focus on Inventory Control. It was obvious that in conditions of growing demand and mass production the usage of mathematical modelling of demand and inventory could lead to the least costs. It was stated that the right choice of the optimal batch should be the most important to improve the efficiency of any enterprise. The first automotive inventory control systems were based on the calculation of Bill of Materials. According to the



production plan the Master Production Schedule (MPS) was formed and the volume of raw material in need was calculated.

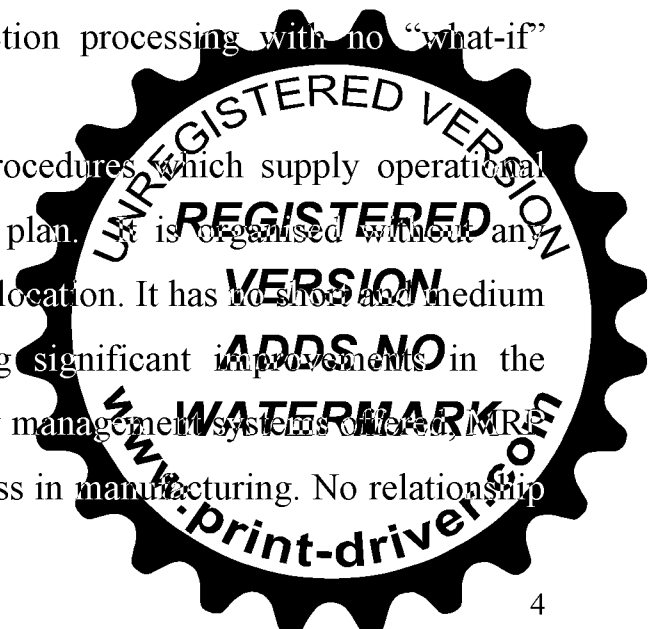
MRP (Material Requirements Planning) Methodology

MRP is a standard production planning approach. MRP essentially creates time-phased plans for components and materials required for production. According to Orlicky's definition, MRP consists of a set of logically related procedures, decisions rules, and records (alternatively, records may be viewed as input to the system) designed to translate a master production schedule (MPS) into time phased net requirements, and the planned coverage of each requirement, for each component inventory item needed to implement this schedule (Chung, 2000). In the task characteristics, MRP has been introduced as a scheduling, priority, and capacity management system for the use of plant managers and their supervisory staff.

While MRP systems offer the ability to calculate a production schedule for manufacturing floor, they present a number of limitations that have challenged manufactures:

- MRP is based on infinite capacity planning, which assumes unlimited stocks of materials and resources;
- Plans and schedules are calculated using simple lead time assumption;
- Planning is a sequential lengthy and inflexible process, using the linear algorithms;
- The process may take hours to complete;
- The focus is on calculation and transaction processing with no "what-if" simulation and no decision support.

Thus, MRP methodology is a number of procedures which supply operational planning of resources for a certain production plan. It is organised without any feedback and abilities to re-plan the resources' allocation. It has no short and medium – term planning possibilities. While providing significant improvements in the customer service compared to what old inventory management systems offered, MRP is simply built around bill – of – materials process in manufacturing. No relationship



between the firm's marketing strategy and manufacturing method could be found (Vollman et al., 1997). Also MRP system lacks technical capabilities in integration with the tasks of different enterprise departments.

MRP II (Manufacturing Resource Planning) Methodology

Since 1975, the MRP system has been expanded from MRP to the standard MRP II. The standard combines planning and scheduling with assumption of infinite capacity. The link to the other activities such as purchasing, inventory control and sales is performed in isolated planning and scheduling solutions by simply retrieving, storing of interchanging data in the system only when needed. One of the most common reasons for MRP II adoption failure is that the firm is unable to develop a realistic MPS, which is likely a compromise between the demand of the customers and the supply of production. MPS is the top level plan that sets out which products the company will make and when the company is planning to make them. MRPII does not have the ability to establish mechanisms for managing the realistic MPS plan without overloading available capacity requirements plan and disrupting the existing workload. It is suggested that MRP II does not provide functionality and integration to reflect the contemporary manufacturing reality (Yusuf and Little, 1998). It is now considered an inadequate tool as a capacity planner. The above mentioned authors recommend that MRP II be enhanced in three ways. The first is the improvement in the existing MRPII functions by means of better software capable of resolving problems that could otherwise be resolved only by travelling back and forth between several systems. The second is the hybrid use of MRP II and other manufacturing control systems to gain the combined advantages of more than one system. The third is integrating other functions with MRPII modules to bridge the island of automation existing in the finance and management (Yusuf and Little, 1998). However, as long as all the function areas are not integrated the organization with technology, MRPII cannot be considered an enterprise-wide system. It would be more efficient to work in a fully integrated system for the firm.



ERP (Enterprise Resource Planning) Methodology

ERP is an industry term for a broad set of activities that helps the enterprise manage its businesses, including product planning, inventory maintenance, supplier relationships, customer service, order fulfilment, finance, and human resources and so on.

ERP systems are organized according to the module structure. Thus they offer the visibility across the enterprise. Different departments are able to view enterprise wide information and, if allowed, can input or change data. This helps to run the enterprise much more effectively as a single cohesive unit, rather than a number of disconnected departments. The functionality of the system consists of steering corporation, manufacturing applications, supporting applications and specialized configurations. ERP manufacturing applications are similar to the functionality of MRPII. In addition, ERP compasses human resources, decision support applications, distribution, maintenance support, quality and regulatory control, and health and safety compliance.

ERP is considered to be a broad company – wide solution that integrates multiple business operations. ERP focuses on the long – range view of resources needed to meet anticipated production requirement.

The main drawback of ERP methodology is that it generally cannot drill down to the shop floor to manage individual orders or individual work stations in real time. While using lead times, manufacturers have often found out that lead times at each work centre might be much higher than needed, resulting in high work – in – process and inaccurate delivery dates.

Most ERP vendors still use the same basic model as MRPII for the manufacturing planning portion of their systems. ERP has been selected world-wide for its integration capability, reputation, standard software, three-tier client/server architecture, business engineering and migration tool from the mainframe.

But since manufacturing planning models and data are integrated within the certain firm all the potential problems such as data reliability and the quality of MPS

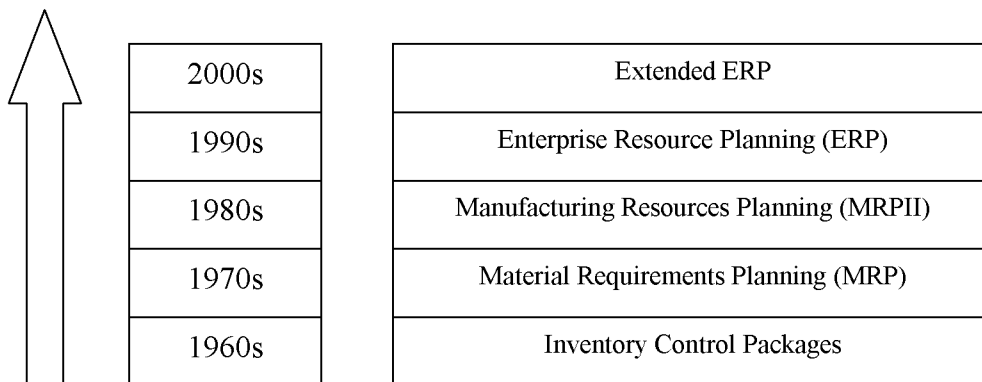


still exist. ERP methodology is not concentrated and does not use the optimization algorithms on the shop floor level planning.

Summary on the Existing Systems

All the above – described systems may be organized in a level scheme. According to Figure 1 the levels are situated in the methodological extend and any pre-standing level occurs the basis of the further one.

Figure 1. Methodological Evolution.



Not taking to the consideration the Inventory Control systems the low level is Material Requirements Planning (MRP). At the low level the methodology of planning is simply used as a tool of transporting data about products and customer orders between different modules. The medium level is presented by the extended standard MRPII. At the medium level a set of data files is used to perform the same task with the same data file during manufacturing processes within the firm. The ERP could be considered the high level of planning At the high level the methodology is more complicated just to perform the same task in the firm while using the same data but in wider context. As far as the most important task is to integrate the information flows of the enterprise and to improve the level of decision making, Table 1 shows the levels of integration within different standards.



Table 1.

Degree of Potential Integration of Planning Tasks in MRP, MRPII and ERP

| Planning tasks | Degree of potential integration | | |
|---------------------------------|---------------------------------|--------|------|
| | MRP | MRPII | ERP |
| Bill of materials | Low | High | High |
| Master Schedule Planning | Low | Medium | High |
| Capacity resource planning | Low | Medium | High |
| Product development methodology | Low | Low | High |
| Data management | Low | Medium | High |
| Marketing activity | Low | Medium | High |

Source: Sock Hwa Chung and Charles A. Snyder (2000)

Thus concluding this section the main drawbacks of the existing methodologies of planning can be summarized:

- 1) The main disadvantage of all methodologies is connected with the levels of decision – making process. Thus all of them are mostly devoted to the operational level of planning instead of the fact that most important decisions are made on the strategic and tactical levels. Consequently, this disconnection of these levels turns into the disconnection of decisions made and the aims which are to be gained at the different levels of the industrial enterprise. Developing this idea we can suppose that this causes the gaps in operational, tactical and strategic levels of enterprise planning.
- 2) Also all the methodologies lack data integration and data analysis module, which is very important one for decision making at the strategic and tactical levels.
- 3) At the operational level some options also lack control especially the shop floor level scheduling and rescheduling of the MPS.

So the exploration and development of new methodologies is very important because all the mentioned drawbacks make the current methodologies hardly be considered universal.



Section 2.

New Paradigms to Manufacturing Resource Planning.

APS (Advanced Planning and Scheduling) Methodology

Schedule is a plan that state when certain controllable activities should take place. In dynamic stochastic manufacturing environment production planners must not only generate high – quality schedules but also react quickly to unexpected events and revise schedules in a cost – effective manner. There are many types of disturbance that can upset the plan, including machine failures, processing time delays, rush orders, quality problems and unavailable materials.

A great deal of effort has been spent developing methods to generate optimal production schedules. Scheduling is a process of creating a production schedule for a given set of jobs and resources. A number of authors (Herrmann at al., 2000, Wu at al., 1999) have proposed rescheduling approach to the manufacturing resource planning. Rescheduling provides a perspective that can put into proper context the need to solve production scheduling problems of the manufacturing system. Robust schedules can increase the productivity and improve the system performance.

APS methodology is proposed to give organisation the ability to identify accurate delivery dates based on the true loaded capacity of a facility at the time, the job is needed, not based on simple standard lead times. APS systems use advanced mathematical algorithms to accurately model shop resources and job routings, which also allow the creation of “what – if” scenarios to create the best schedules based on customer requirements and current resource constraints.

APS is a specialized application which extends the ERP system and is focused on one specific element of the company’s business – the planning, scheduling and controlling of shop operations to control current orders. APS methodology provides the ability to view and manipulate shop operations in real time, reacting by shifting priorities on a customer order or workstation basis in order to avoid bottlenecks and meet delivery promises.



One of the major strengths of APS system is their ability to apply multiple constraints to a schedule, in order to create a one that considers not only delivery timeframes but also resource utilization. APS methodology implemented in the ERP system is able to recognize constraint resources, support job prioritization, allow personnel skill to be used as constraints. APS can be applied as a model for extremely complex manufacturing systems. APS module in the planning system provides the granularity necessary to efficiently manage the production environment.

SRP (Supply – Chain Resource Planning) Methodology

Most of the undertaken researches focus on methodologies for more effective implementation of existing production planning and control systems or upon improved scheduling and modelling algorithms. D.F Kehoe and N.J Boughton (2003) propose the alternative paradigm of planning and control in manufacturing systems. According to their researches, “more important is to synchronize the activity from product development and supply chain management, to marketing /sales and customer service”. This means aggressively adopting practices such as cross – functional and product designs and manufacturing processes, visibility and real-time data from other areas that can impact the profit cycle; and adopting technologies to enable the profit.

As globalisation of manufacturing and innovation continue to accelerate, it will no longer be an option but rather a requirement for survival and success. Table 2 shows the basic principles of this new paradigm, which we will call, quoting D.F Kehoe and N.J Boughton (2003), supply – chain resource planning (SRP).

Table 2.

Alternative Approaches to Manufacturing Planning and Control

| | | |
|-------------------------------|----------------------------------|---------------------------------------|
| Characteristic | Traditional planning and control | Internet based interactive partnering |
| Planning approach/methodology | ERP | SRP |
| Data management | Data warehouse | Data retailer |



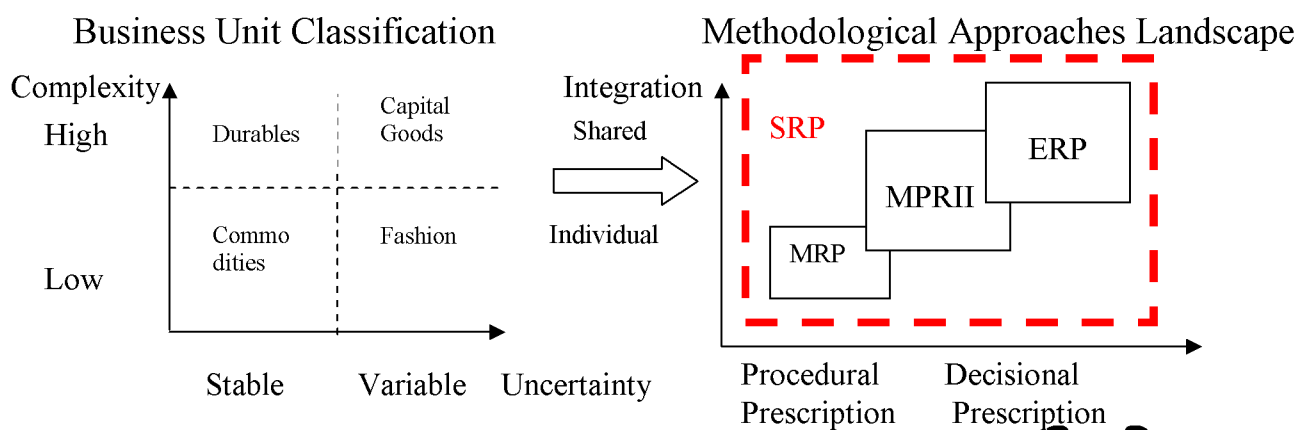
| | | |
|----------------------|------------------|----------------------|
| Organizational basis | Enterprise based | Supply – chain based |
| Business focus | Multi – site | Multi – business |
| Technological base | SQL technology | HTTP technology |

Recognition of the importance of the supply – chain and effective supply – chain management has grown over recent years. Companies have reduced their core manufacturing capabilities and placed a greater reliance on both new and existing suppliers. In the continually existing global economy, organizations need to be able to respond to the demands of their customers and, as consequence, the effective management of the supply – chain is a critical factor differentiating successful organizations from the rest.

There are some reasons for implementation of SRP. Figure 2 shows how the methodological approach depends on the type of business unit.

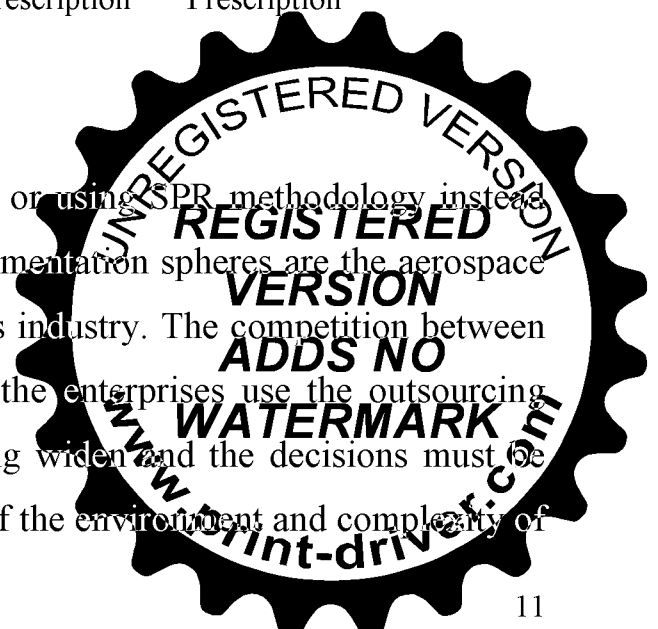
Figure 2.

The Relationship between the Business Unit Type and Planning Methodology Approach.



Source: D.F Kehoe and N.J Boughton (1998)

The reasons of improving ERP methodology or using SRP methodology instead of ERP are rather clear. The most obvious implementation spheres are the aerospace and machine - building industry and the logistics industry. The competition between the manufacturers all around the world makes the enterprises use the outsourcing manufacturing units. So the horizons of planning widen and the decisions must be made in real – time conditions. The uncertainty of the environment and complexity of



manufacturing both grow. This requires the improvement not only of the planning system within a certain enterprise but through all the supply – chain.

Simulation Methodology

Instead of the advanced accurate scheduling and transparent supply – chain management tools and methodologies are needed to facilitate the planning process and the implementation of these plans. Manufacturing organisations are characterized by real – time dynamism and by being data intensive. Not only is a top – down approach needed but a bottom – up voice is required so that the current constraints of a manufacturing organisation can be used to shape strategy formulation. Any planning methodology must produce statistics that are or can be readily converted into new performance measures.

As Table 3 shows, much depends on manufacturing planning linkages, which are closely connected to each other in the context of organisational development.

Table 2.
Manufacturing Decisions Linkages

| Type of Decision | Type of information used for decision | Duration of decision |
|------------------|---------------------------------------|------------------------------|
| Strategic | Qualitative | Long – term (years) |
| ↓ | ↓ | ↓ |
| Tactical | | |
| ↓ | ↓ | ↓ |
| Operational | Quantitative | Real time (minutes, seconds) |

Source: Frank Dewhurst et al. (2001).

The proposed by Frank Dewhurst et al. planning methodology is the development of existing MRPII or ERP system which the enterprise have implemented before. The methodology bases on two principles. First is the usage of manufacturing data base

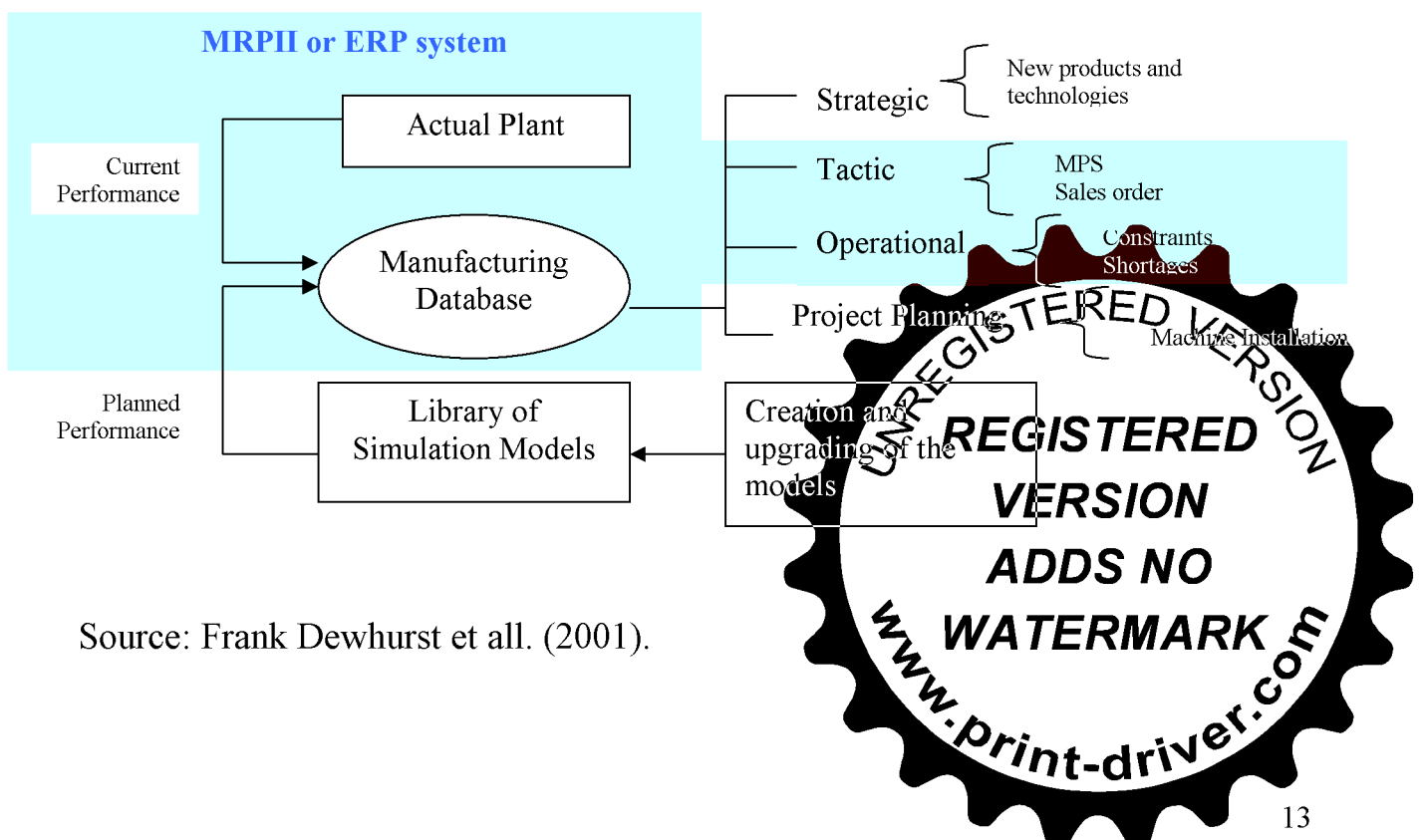


(MDB). It assumes to contain all data required to run a manufacturing plant. It is the result from a successful implementation of MRPII or ERP system. The second basis is the simulation models library. The performance of the plant will be emulated through this linked library of simulation models, created when a new manufacturing facility is designed or modified. This could be constructed using data from MDB. Over a period of time these models would be tuned to accurately simulate the performance of the enterprise.

The planning methodology is designed to provide strategic, tactical, operational and project planning capabilities using the same tool and data sets. Hence, the strategy formulation cascades down to the operational levels but operational level concerns cascades up to the strategy formulation. Consequently, the strategic planning function is not allowed to divorce itself from the realities of the shop floor thus preventing the adoption of a costly strategy that is ultimately unworkable. The principle linkage scheme of levels of planning and the methodology is shown at Figure 3.

Picture 1.

The Principle Scheme of the Connection between Levels of Planning and Simulation Methodology.



Source: Frank Dewhurst et al. (2001).

A library of linked simulation models could be tested by running the simulation with the shop schedule and comparing stock movements and the average queue length to those observed on the shop floor.

According to the methodology simulation can be extended, from its traditional use by academics for analysing manufacturing systems, to form the basis of methodology for manufacturing planning. By employing an IDEF – system analysis and incorporating the manufacturing database of a company with a discrete event simulation all aspects of planning from strategic, tactical, operational and project planning and be catered for using common set of tools and data. However, to implement the methodology a manufacturing plant must be capable to being modelled. Once a model of plant has been constructed and validated then a non-simulation specialist can create and rapidly run and reconfigure a model of manufacturing facility to experiment with different planning scenarios.

Conclusion

Enterprises today are increasingly challenged to improve revenues, while cutting costs and maintaining customer's liability. Plenty much of the enterprises exist recently under the conditions of tense competition. The possibilities of growth through outsourcing and cost – cutting are exhausted. Now most enterprises have to search for the increasing of productivity and efficiency through the implementation of modern planning methodologies which had been developing since the middle of the XXth century. Thanks to the rapid computer sphere development more and more standard planning tool based on the well-known methodologies of MRP, MRP II and ERP are available. But they also lack some important modules and options.

The main drawback are listed below:

- All existing methodologies are short of visibility and ability to predict the performance of MPS on the shop floor level:
- All the existing methodologies have gaps in operational, tactical and strategic levels of decision – making process:



- All the existing methodologies lack the supply – chain management and control algorithms under the conditions of global economy.

Basic trends of the development of planning systems concerns both internal and external spheres of enterprise environment.

Inside the enterprise the trends are:

- ✓ The usage of the advanced algorithms of scheduling and rescheduling; for capacity planning;
- ✓ The integration of the information system with the shop floor level ;
- ✓ The predictability of constraint and bottlenecks in manufacturing and accurate planning of delivery dates;
- ✓ The opportunity to perform “what – if” scenarios.

Outside the enterprise the trends are:

- ✓ The implementation of supply – chain based planning;
- ✓ The growth of the information flows;
- ✓ The usage of Internet – based manufacturing control systems;
- ✓ The expansion of the planning horizons.

Overcoming the gaps in operational, tactical and strategic levels of decision – making process is possible through the use of simulation methodology which provides the forecasting of the top – management decisions and their influence on the profit cycle.

Thus, the development of planning is driven by these trends and new methodologies are recently to be worked out and implemented.

References

1. Chung, S.H., Snyder, C.A. (2000), ‘ERP Adoption: a Technological Evolution Approach’, *International Journal of Agile Management Systems*, Vol. 2, No.1, pp. 24 – 32.
2. Hermann, J.W. (2000) ‘Order Release’, in ‘*Encyclopedia of Production and Manufacturing Management*’, Norwell, Massachusetts.



3. Vollman, T., Berry, W., Whybark, D.C. (1997), '*Manufacturing Planning and Control Systems*', McGraw Hill, [New York, NY.
4. Wu, S.D., Storer, R.H. (1999) '*A Graph-theoretic Decomposition of the Job Shop Scheduling Problem to Achieve Scheduling Robustness*', *Operations Research*, Vol. 47, No. 1, pp. 113 – 124.
5. Yusuf, Y., Little, D. (1998), '*An Empirical Investigation if Enterprise-Wide Integration of MRPII*', *International Journal of Operations and Production Management*, Vol. 18, No. 1, pp. 66 – 68.

