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MRP SYSTEMS RESEARCH

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ABSTRACT

Paper will give the analysis of theoretical MRP base and "Monitor" and "Scala" software efficiency analysis in the solution of "resource planning management" problems. The aim is to find out what are the original features of every solution on the way to profit maximisation at manufacturing enterprise. Paper will show what are the results of software implementation at the manufacturing enterprise compared to the period of work without software. Estimation of the efficiency of the "Scala" and "Monitor" software starts from the preparation of manufacturing process stage, and stretched up to financial results achieved. In this paper results achieved throw planning activities will be compared with real results. Analyses of manufacturing problems solutions throw software installed: using of work centre loading simulation possibilities for the optimisation of present and future manufacturing capacity; pre-calculation for future products; rating of subcontractors; EOQ calculation; delivery performance analysis; optimisation of inventory; supply chain management.

Theoretical MRP base analysis gives the estimation of final profit sensitivity to different input data. This work will be practically approved on the manufacturing enterprises, under the pressure of real limits of enterprise, with analyses of results achieved. The aim is to find the most optimal solution, which enables to increase profitability

Estimation of existing solutions and proposals for the possible improvements in the "Monitor" and "Scala" software will be included in this paper.

Key words: MRP, ERP, integrated software.

1. INTRODUCTION

In this paper are given analyses of two MRP software vendors; the "Scala Business solutions" and "Monitor Industriutveckling AB". Analysis includes comparison of MRP theoretical knowledge base and software realization, comparison of MRP software with world trends for such programs and the analysis of feature situation in this sector.

1.1 Features of MRP systems in general.

Before MRP (material requirements planning) most production control systems was dealing with some variant of statistical reorder points. Originators of MRP understood that such approach is more suitable for final products, than the components. The demand for final products originates outside the system and therefore subject to uncertainty. Components are used to produce final products, and they are known for given final assembly schedule. Treating with both types of demand in the same way, as is done in a statistical reorder point system, ignores the dependence of component demand on final product demand, and as a reason leads to inefficiencies in scheduling production. Any demand that originates outside the system is called independent demand. This includes all demand for final products and some demand for components, sold as replacement parts. Dependent demand is demand for components used for producing of independent demand products. Production to meet dependent demand should be scheduled so as to explicitly recognize its linkage to production to meet independent demand. MRP adds the link between independent and dependent demand that is missing in statistical reorder point systems. MRP is called a push system, because it computes schedules of what should be started into the line based on demand.

1.2 Function of MRP.

The basic function of MRP – plan material requirements. MRP used to coordinate orders within the plant and from outside. Outside orders is called purchase orders, and within orders called jobs. MRP focuses on scheduling purchase orders and jobs to satisfy material requirements generated by external demand. MRP dealing with two basic dimensions of production control: quantities and timing. The system determines suitable production quantities of all types of items, from final products that are sold to inputs purchased as raw materials. Production timing must also be determined, to ensure meeting order due dates.

MRP works with end items and lower-level items. Bill of material (BOM) describes relationship between end items and lower level items. Demand for end items generates dependent demand for lower-level items. To facilitate the MRP processing, every item in the BOM is given a low-level code or LLC. By this code indicated the lowest level in the bill of materials. Low-level codes have the property that the lower a part is in the bill of material; the higher is its low-level code. Most commercial MRP packages include a BOM processor in order to automatically assign low-level codes.

Also MRP requires information concerning independent demand, which comes from the master production schedule (MPS). The MPS contains gross requirements and scheduled receipts (status of outstanding orders).

The basic MRP procedure is simple. MRP does next procedures for each part:

- Netting: Determines net requirements by subtracting on-hand inventory and any scheduled receipts from gross requirements.
- Lot Sizing: Divides the netted demand into suitable lot sizes to form jobs.
- Time Phasing: Determines start times through the offsetting the due dates of the jobs with the lead times.
- BOM Explosion: Generates the requirement of any required components at the next level.

Iterate: Repeats previous steps until all level are processed.

1.3 Manufacturing resources planning – MRP II.

Over time, additional procedures have been developed, in order to eliminate such problems in Material Requirements systems as: capacity infeasibility, long planned lead times, system nervousness.

Belong simply addressing deficiencies of MRP, MRP II also brings together other functions to make a truly integrated manufacturing management system. The additional features of MRP II are: demand management, forecasting, capacity planning, master production scheduling, rough-cut capacity planning, capacity requirements planning, dispatching and input/output control.

1.4 The Instance of MRP II hierarchy.

The world instance is used because there are probably as many different hierarchies for MRP II as there are MRP II software vendors. In general the MRP II system could be divided: long-range planning, intermediate planning and short-term control.

1.4.1 Long-Range Planning.

Long-Range Planning is the top of the MRP II hierarchy. It involves three functions: forecasting, resource planning and aggregate planning.

- The forecasting function seeks to predict demands in future. Long range forecasting is important to determine what are the capacity, tooling and personnel requirements. Short-term forecasting converts a long-range forecast of part families into shorter-term forecasts of individual end items.
- Resource planning is the process of determining capacity requirements over the long term. An important output of resource planning is projected available capacity over the long-term planning horizon.
- Aggregate planning is used for determining levels of production, staffing, inventory, overtime, and so on over the long term. To assist the aggregate-planning process optimisation techniques are often used.

1.4.2 Intermediate Planning.

Intermediate Planning is at the intermediate level. It has the bulk of the production-planning functions: demand management, rough-cut capacity planning, master production scheduling, material requirements planning, capacity requirements planning and job release.

- Function of demand management is the process of converting the long-term aggregate forecast into a detailed forecast while tracking individual customer orders.
- Rough-cut capacity planning (RCCP) is used to provide a quick capacity check of a few critical resources to ensure the feasibility of the master production schedule.
- The material requirements planning module of MRP II is identical to the MRP procedure described earlier.
- Capacity requirements planning (CRP) provides a more detailed capacity check on MRP-generated production plans than RCCP.

1.4.3 Short-Term Control

Short-Term Control is at the low level. Once a job or purchase order is released, control must be maid to ensure it is completed on time with the correct quantity and specification. If the job is for purchased components, the purchase order must be tracked. This is a straight-forward practice of monitoring when orders arrive and tracking outstanding orders. Job for internal manufacture falls under the function known as shop floor control. Within SFC are two main functions: job dispatching and input/output control.

- Basic idea of job dispatching is to develop a rule for arranging the queue in front of each workstation that will maintain due date integrity while keeping machine utilization high and manufacturing times low.
- I/O control provides an easy way to check releases against available capacity and works in the following way.

a. Monitor the work in process (WIP) level in each process centre.
b. If the WIP goes above a certain level, then the current release rate is to high, reduce it.
c. If it is goes below a specified lower level, then the current release rate is too low, so increase it.
d. If it stays between these control levels, the release rate is correct for the current conditions.

2. Comparison of "Monitor" and "Scala" software with theoretical know-how.

MRP basic inputs are: forecast of demand for end items, the associated bills of material, current inventory status and any data needed to specify production policies. Data came from three sources: the master production schedule (MPS), the item master file and inventory status data.

2.1 The master production schedule.

Master production schedule (MPS) is the source of demand for the MRP system. It gives the quantity and due dates for all parts with independent demand. It includes demand for all end items, and also external demand for spare parts. Minimum information contained in the master production schedule is a set of records containing a part number, a need quantity, and a due date for each purchase order. MRP use this information in order to obtain the gross requirements. Usually MRP uses the part number to link to the item master file where other processing information is located.

In "Scala" we have special MPS module. A Master Planning Schedule shows all expected events for a stock item on the top level, and re works them for production. Examples of expected events are Sales Orders, current Work Orders, Forecasts, stock balance, etc. This routine is used for creation of proposed work orders. Forecasts are the basis for proposals generation. Also the purchase Schedule could be created, based on Master Schedule. The Purchase Schedule creates Purchase Order Proposals for all shortages that occur in the Master Schedule. Master Planning Schedule could be used as a basis for the Net Requirement Calculation.

In order to perform requirements planning based on manufacturing forecast the "Monitor" has special procedure "Register manufacturing forecast". Manufacturing forecasts are then used for requirement planning in the "Run netting manufacturing forecast" procedure, where requirement calculations are performed.

In "Monitor" we have special feature Manufacturing order suggestion. A customer order, registered for the manufactured parts will create stock reservations for those parts. If the sold parts are structure parts, the system will create also material requirement for the incorporated manufactured parts, stocked parts, fictitious parts and purchased parts. When the available stock balance for the affected parts falls below the safety stock level, system automatically places manufacturing order suggestions for these parts. In this procedure order suggestions are loaded and generated into actual manufacturing orders. Also the Quantity and Finish period of each order suggestion could be changed manually. The order suggestions that have generated into orders are deleted automatically.

2.2 The Item master file.

The item master file contains: a description of the part, bill of material information, lot-sizing information, and planning lead times. The BOM (bill of material) list the components and quantities

directly required to make only that part. This information used by BOM processor for displaying complete bill of materials for any item. MRP accumulates total demand of a part before it processes that part, by using low-level codes.

The others two pieces of information necessary for performing of MRP processing are the lot-sizing rule (LSR) and the planning lead time (PLT). The LSR determines how the jobs will be sized in order to balance the competing requirements of reducing the inventory and increasing capacity. Within EOQ and Wagner are possible lot sizing rules. To determine job start times PLT used. In MRP this procedure is simple: the start time is equal to the due date minus the PLT.

In "Scala" we have special tool "BOM manager" which enables inserting and editing BOM structure and contains information about items, accessories, open items, routing and costing. Also there is convenient possibility for graphical representation of BOM tree.

"Scala" has different LSR for recalculating net requirements for planned work orders: Lot for Lot (Each requirement (work order, sales order, and so on) creates a planned work order.), EOQ (Economic Order Quantity - When the requirement reaches the EOQ value, a planned work order is created.), FOQ (Fixed Order Quantity- When a requirement arises, the same number of planned work orders are created to cover the requirement as the number in the Order Quantity field. This method means a temporary over production.), Fixed Period Time (All requirements during the time period specified in the Stock Planning file create a planned work order.).

In "Scala" the lead time in days is automatically calculated for manufactured stock items using operation data. The lead-time for purchased items is the time from order until delivery (7 * Number of delivery weeks). There are two tipes of lead times in "Scala": Cumulative Lead Time Excluding Purchased items(Contains the total cumulative production time in days, excluding the lead time for purchased items..), Cumulative Lead Time including Purchased items (contains the total cumulative production time in days, including the lead time for purchased items

The calculation uses the Lead Time Calculation routine. The routine calculates the time required to manufacture a stock item accordingly to formula (Queue Time) + (Set up Time) + (Run Time) + (Move Time). "Scala" uses this information for calculating the load of work centres and capacity.

In "Monitor" in addition to BOM we have special tool for Structure List presentation. Procedure allows you to see all the incorporated parts and operations that relate to the part viewed. The structure list displays a complete breakdown of the part in as many levels as necessary. The right part of the window consists of a graphic structure map.

In "Monitor" LSR is used for order suggestions during requirement calculation or as part information. The lot sizing rule determines the quantity the order suggestion should have, when a requirement arisen. Lot sizing rules available are: Lot for Lot, Fixed Quantity(EOQ must be filled in), Bucket Part(earlier known as Reorder point), Period Requirement(provides an order suggestion that will be sufficient for a period of the same length each time).

In "Monitor" lead times are only used for purchased parts. Lead time describe the "replacement time" for the purchased parts. During order suggestions system uses lead times to calculate a reorder period based on a requested delivery period. During pre-calculations, the system calculates the throughput time including material procurement.

2.3 Inventory Status Data.

It is important to no know the status of inventory during the determining net requirements. The procedure is frequently named coverage analysis – it determines how much demand is covered by current inventory. Current inventory consists of on-hand inventory and scheduled receipts (SR). Scheduled receipts are jobs released during prior runs of MRP and are currently in process, or purchase orders that have not yet arrived from the vendor. If internal jobs are not yet arrived at an inventory are named as work in process (WIP). Scheduled receipt data is organized by job number and contains the information: part number, the current quantity, the desired quantity and the due date.

"Scala" has special module Material Requirement Planning, which includes the procedure for net requirements calculation. Also "Scala" contains possibility for testing the availability of the material.

In "Monitor" we have special routine Material Clearance, which enables to estimate the availability of materials for the work order specified.

2.4 MRP Outputs.

The output of an MRP system includes planned order releases, change notices, and exception reports. Planned order releases eventually become the jobs that are processed in the plant.

In "Scala" there are different possibilities for order release. The manufacturing and purchase order proposals could be released at the base of customer order. Release order proposal could be made from net requirement calculation. Work order could be released from the batch file.

"Monitor" creates stock reservations for registered customer order for manufactured parts. And at the base or material requirement the purchase order proposal could be made.

2.5 Analysis of the possibilities of MRP II systems.

Here are given average medium Estonian enterprise requirements to MRP II systems, and analysis of how "Scala" and "Monitor" software covers them.

Table 1. Analysis of how "Scala" and "Monitor" software cover average Estonian enterprise requirements.(x-included, ¤partly included, - not included)

Requirements to software possibilities	Scala	Monitor
Supporting of main processes connected with production.	x	x
Own price calculation	x	x
Material requirements planning and scrap management	¤	x
Planning of production resources	x	x
Material resource planning	x	x
Cost calculation	x	x
Salary and working time management	x	¤
Accounting support	x	x
Estonian language support	x	-

3. HOW "SCALA" AND "MONITOR" SOFTWARE REACT TO THE WORLS TREND FOR ERP SYSTEMS.

3.1 World trend for ERP systems.

ERP (Enterprise resource planning) systems have been around since the mid-1970s when they first ran on mainframe computers. Enterprises that invested huge sums in these big and complex systems now have elaborate legacy setups that they are absolutely dependent upon to run their companies. Because there's so much at stake, ERP

providers and customers introduce changes to technology and deployments gradually to avoid costly mistakes.

Nonetheless, ERP systems *do* change--albeit slowly. For example, people started talking about adapting ERP software to client/server technology at the beginning of the 1980s, but it wasn't until the late 1990s that more client/server versions shipped than mainframe versions.

Today, ERP is still evolving--adapting to developments in technology and the demands of the market. Today the ERP systems became collaborative. Four important trends are shaping ERP's continuing evolution: improvements in integration and flexibility, extensions to e-business applications, a broader reaches to new users, and the adoption of Internet technologies.

- Improving integration, flexibility
- Embracing e-business
- Reaching out to new users
- Adapting to the Internet

Improved ERP software helps customers:

- Reduce cost and time of business processes
- Improve end user productivity
- Provide better information on time for decision making
- Provide new business opportunities

3.2 How "Scala" and "Monitor" software react to the world trends.

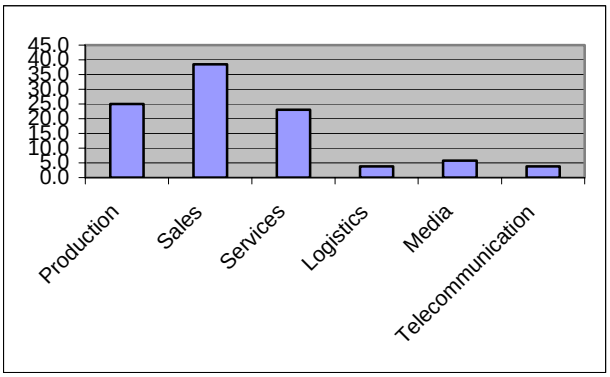
"Scala Business Solutions" started moving in the ERP world trend direction with new product "iScala". This process was started 3 years ago, and feature trend is producing one new version of product every year. Deployed Connectivity Solutions are: CRM (Customer Relationship Management) Integration, SCM Integration, E-commerce site integration, XML-EDI solutions, Warehouse integration, Bar-Code for distribution, SAP integration. "iScala" is planned to be ready for Web Services in 2 years. Today the program could be accessed throw the Interned throw the XML to predefined functions.

The source code in "Monitor" and window designs was developed in Sybase PowerBuilder together with Microsoft Visual C/C++. The database design is made using Platinum ERwin/ERX. This makes the program very accessible to other databases and operating systems.
"Monitor Industriutveckling AB" have supplementing eCommerce solution for Monitor Enterprise Resource Planning System. The eCommerce supplement is mainly intended for business between companies, the so-called "B2B" (Business to Business), but can also be adjusted for business between companies and consumers, called "B2C" (Business to Consumer).
At the moment "Monitor" has no trends to work throw Internet without code preinstalled.

4. PRESENT SITUATION IN ESTONIA .

At the moment "Scala" software is used in 85 Estonian companies, and the "Monitor" software is used in 5 Estonian companies. The difference is that "Scala" software are used by different sector enterprises. "Monitor" is used only at "Manufacturing" enterprises. Percentage of total implemented "Scala" solutions by sector could be seen at the graph.

Fig.1. Graph of total implemented "Scala" solution by sector.



5. CONCLUSING REMARKS

Estonia has one of the smallest IT markets in Central and Eastern Europe. In recent years the country has seen a surge in demand for software and related IT services, and as a result the number of international vendors present on the Estonian market has increased substantially. At the beginning in the early 1990s the demand was initially limited to the basic accounting functionality. As the IT, integration, and connectivity needs of Estonian businesses have become more complex; the country has embarked on a second wave of investment into ERP solutions. IDC believes. Next few years will be critical in establishing the place of many of these vendors in the ERP arena. With joining the European Union the level of government and corporate investment in infrastructure is expected to intensify.
Estimation of situation in the world showed that future belongs to the APS (Advanced Planning and Scheduling) systems. Advanced Planning & Scheduling enhances existing manufacturing capabilities by effectively closing the loop between ERP business functions and the shop floor, while giving managers useful, real-time information on the current shop floor activities with advanced scheduling and quality control functionality.
In Estonia however for present period will growth the trend of growth for the integrated ERP software for small and medium size enterprises, but bigger companies began to look over for the advanced solutions and after some period the APS software will be in use at the Estonian market.

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