MRP-3 CONCURRENT INTEGRATION OF PLANNING AND SCHEDULING IN OKP.

Prof. Dr. Javier Borda Elejabarrieta.

Managing Director of SISTEPLANT, S.A.,
Professor of Production and Engineering Management,

University of Deusto-Bilbao. Member of IFIP WG 5.7

ABSTRACT

The current market practices for most capital equipment manufacturers provide them with some special difficulties in production management tasks. These are, mainly:

1. Design changes during the necessary overlapping of the production process.

2. Some degree of uncertainty with supplier's due dates and quality specifications accomplishments.

3. Sensibility of changes and other incidences in the current schedules that operates at the shop floor level.

4. Warnings of a chaotic behaviour in both due-dates and productivity originated by a delay between the coupling of the re-scheduling of operations at the shop-floor level and the planning process at the office level.

Advanced technology for facilitating integration, lay the concept of the MRP-3, a new production management system specially indicated for the "minibusiness" model of a factory, and which is probably going to give a leap in the next future to the organisational procedures in discrete manufacturing, and in particular in OKP.

Keywords

OKP, MRP-3, integration, scheduling, planning, distributed production.

1. OBJECTIVES

Regarding all that issues, the objectives of the paper are:

1. To establish a reference-model for the utilisation of the MRP-3 system for one to twelve months of lead-time (intermediate lead-times) OKP facility.

2. To make a functional design approach of the MRP-3 in OKP.

The reference model is used as an organizational issue leading the way in wich a particular OKP company must interact with the MRP-3 software. Key issues for that are:

- The planning integration as a part of the Engineering department.

- The "coordination technology" engineer who is going to set and facilitate information structure along the project.

- Prompt definitions of the FAS (final-assembly-schedule) and BOP (bill of processes), with assignation of critical materials to each BOP's gantt bar.

2. INTRODUCTION

MRP has been largely used in OKP eventually in conjunction with the PERT-CPM. When done, a common practice is performing the first order BOM calculation based on the critical path nodes of the PERT, and the second order BOM is coupled using due date tolerances around the first order calculated ones.This is mostly a tuned and relatively advanced practice, requiring one way (from PERT to MRP) software integration. But the inconvenients are the following ones:

. The PERT (or GANTT-BAR correspondent deployment) is lost as a major way of communication along the company due to the breaking from "phases" into "bills of materials".

  The phases planning is the most natural way of communication at the shop floor level and with the planning-engineering department.

. Plant capacity scheduling and rescheduling are not feedbacked to the different PERT-GANTT's even manually because this amounts a lot of work. Obviously they become rapidly obsolete and uneven for planning purposes

Could be the MPS's (Master Production Schedule) critical resources analysis of help?. The Master Production Schedule practical application in OKP is concerned with the product parts that have some possibility of reliable enough resource consumption data forecasting, and that are also in the critical path of the PERT.

Depending upon the particular product concerned though, these are, normally, pre-engineered adaptable semi-standard items sometimes produced in anticipation by some kind of forecast.

Unfortunalety, the FAS (final assembly schedule) is let out of the critical resources analysis, and there we have one inconvenient, because it is an intensive time-consuming activity.

The other inconvenient is that critical resources analysis is not an scheduling tool, having no finite capacity and interactive bottle-necks sequenciying optimisation capabilities.

Then you use it as a planning tool for relative long-term resources allocation, and this is the correct way to do in a MRP-2 environment; do not ask for more.

3. MRP-3; A NEW PARADIGM

A new coming generation of production planning and control systems for OKP (and also in general) is claimed to contend with four contradictory facts: efficient (and low) inventory, high productivity of direct and indirect labour, great customer service and design and production continuously dropping changes (see FIG. 1).

What gaps to fulfill? Basically we have three:

a) A simple-integrated and interactive model with the PERT-GANTT, the MPS (master production schedule), the FAS (final assembly schedule), the MRP and the SFC (shop-floor-control).

b) A practical-comprehensive scheduling optimization and simulation system as part of the SFC subsystem. The goals to achieve with it are speed of calculations, weighted multicriteria optimization and global resources optimization (lead-times, machines and labour).

c) A "full-duplex" filtered interactive communication feedback as the integration key of the above elements.

Consequently, MRP-2 smartest use in OKP is given in FIG.2. The shop floor feedback adjustments is an important missed issue.

Given that these changes are increasing in frequency and influence, some kind of link is necessary between the SFC (shop floor control) level and the PERT-GANTT level, otherwise arising lots of communications, poor inventory management, confused traceability of materials and a considerable amount of innecesary coberture in both safety stocks and safety lead-times.

Obviously, this link will be a filtered feedback, not allowing inconvenient changes at the PERT-GANTT level to put innecesary "nervousness" inside the system.

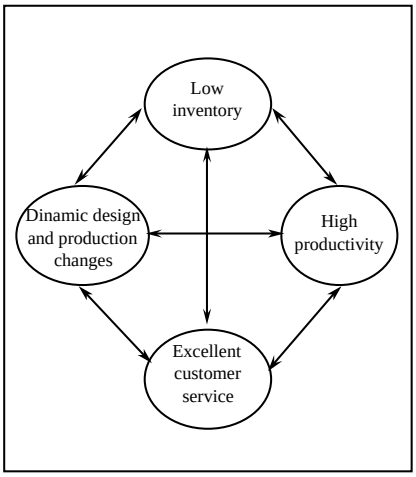

Figure 1. The contenders

We will see as follows that the key for that is a system in wich the MRP is a hidden process, the BOM (bill of materials) being replaced by the BOP (bill of processes) and the leading actors are a single and reliable PERT-GANTT system (PROJECT[1]) at the planning level, and an adequated SOS (scheduler-optimization-simulation) called SIMPLAN[2] at the SFC level.

[1] Project is a trademark of Microsoft Group.
[2] SIMPLAN is a trademark of DATALDE, S.A.

4. THE REFERENCE MODEL

FIG. 3 represents the reference model for OKP. The gantt-chart is the well known PROJECT which has embebbed CPM (critical-path-method) computation. A hierarchy of GANTTS is given by the system, thus laying off progressive detailed bars (phases/tasks) schedule as the core of the interdepartmental communication and as the basic planning tool. The gantt-chart incorporates the role assigned to the MPS system in FIG. 2.

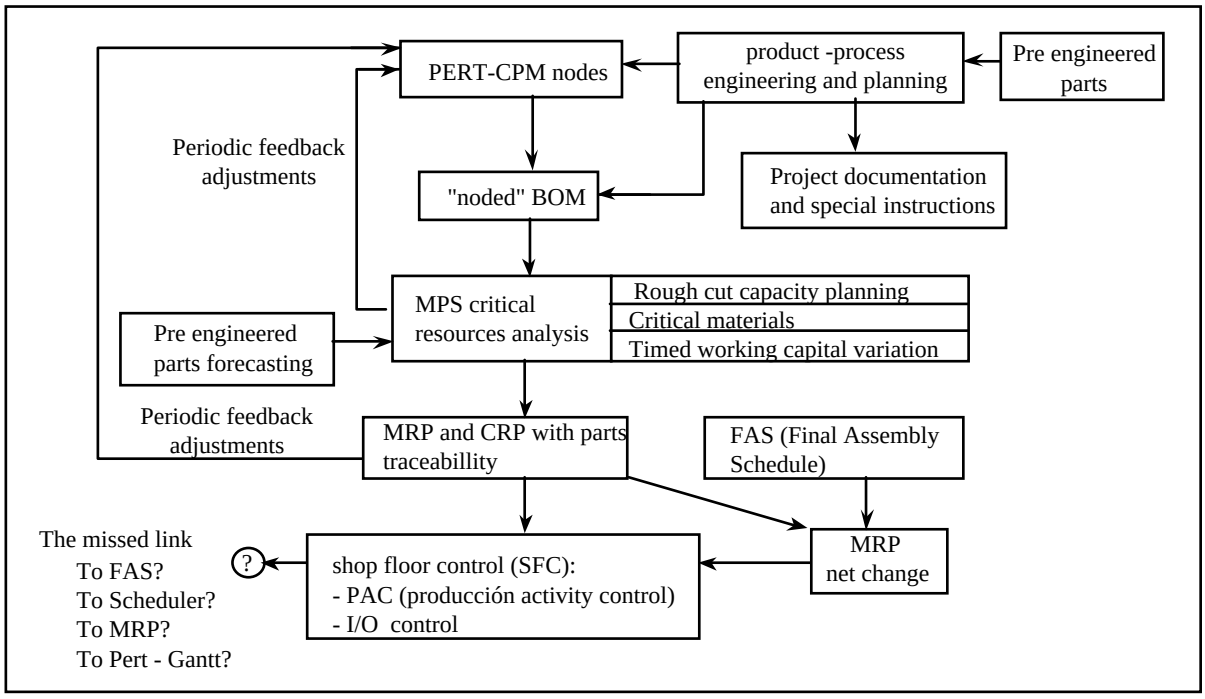

Figure 2. MRP-2 smart use in OKP: key issues and the "missed link".

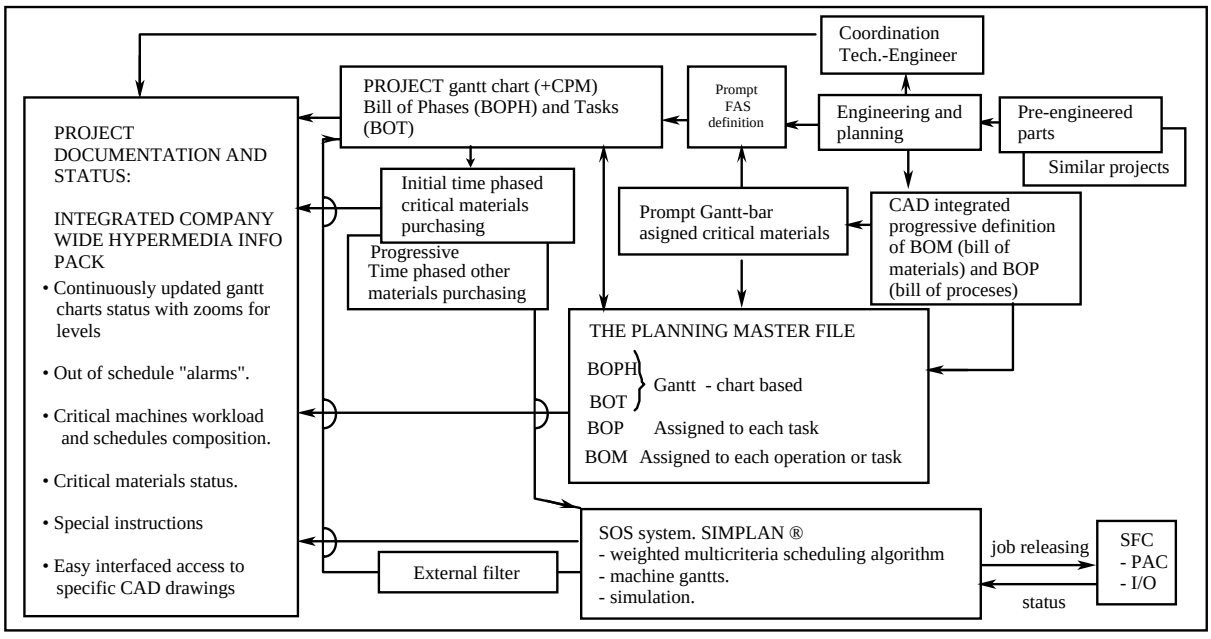

Figure3. MRP-3 simplified reference model in OKP.

A "coordination technology engineer" from the engineering and planning department is in charge of organising estructured project documentation in the networked database. This is a new organizational role trying to make use of "information technology" as "coordination technology". Set and audit the project's structured information along the design and manufacturing process is his main commitment.

Observe the early definition of the final assembly schedule (FAS), thus permitting the gantt-charts to be more detailed, precise and time-phased, synchronising as much as possible the assembly, engineering, fabrication and purchasing.

This is one of the three keys for putting the gantt-chart as the core of manufacturing coordination info system, another one being the planning master file which is the interface between the planning and the scheduling levels. Here, the information is arranged as follows:

a) Maintaining the hierarchy of the gantt-chart, with the bill of phases (BOPH) and the subordinated bill of tasks (BOT).

b) Defining the bill of operations (BOP) for each task.

c) Defining the List of materials (BOM) for each task or operation, depending on lead-times and sometimes in convenience.

The third one is the continiuously interactive loop that integrates in real time the planning (GANTT) and scheduling (SOS) levels.

The SOS is based on the product SIMPLAN[2], an ORACLE[3]-based multistage (from FAS to fabrication) weighted multicriteria very fast heuristic scheduling algorithm, developed for an user's consortium and evaluated by Dr. Browne. The system has input restrictions and gives detailed operation to operation machine GANTTS. The weighted criteria are the following:

. Minimise lead-times (a%)

. Minimise machine changeovers (b%)

. Maximise machine occupation (c%)

. Minimise direct labour occupation (d%).

. FIFO/priority (e%)

Being a + b + c + d + e = 100%, and as told, the output of the model is a typically coloured gantt-chart per operation-machine, ready to do simulation with it just moving the bars. Eventual deoptimization figures are given in each simulation trial.

[2] SIMPLAN is a trademark of DATALDE, S.A.
[3] ORACLE is a trademark of Oracle Corp.

An external filter is necessary to link the real-time feedback from SIMPLAN[2] to PROJECT. Scheduling and planning are integrated in a team composed by the senior planning staff and minifactories leaders in a two-level structured organization, using the hypermedia as a real-time information system which highlights alarms and exceptions. This blows an interactive planning-scheduling simulation session helped by the MRP-3 system.

The mentioned external filter uses the planning master file to detect which changes at the SOS level are significative enough to altere the Gantt-bars at the planning level.

This is done in a very simple way by comparison of the bar-due dates significative changes. Not any more sofisticated tool is needed, given that the SOS performs a finite capacity optimization model taking into account detailed operations schedules with their correspondent queue compression factors, overlapping and so on.

5. OTHER FUNCTIONAL ASPECTS

Software integration of the reference model is always a quite difficult issue. Let us examine the different aspects separately.

- FAS definition in the Gantt-chart. This is a simple issue and is easily introduced in the PROJECT in terms of bill of phases and tasks. The capabilities of the system to calculate resources consumption and to put them in terms of graphical information are of great value, helping in the simulation process at this stage of planning the different final products.

- Materials assignement on gantt-bars. Requires an external file. This is the above mentioned "planning master file". An SQL[4] program updates simultaneously the gantt-chart and the master-file.

- BOP and associated BOM from the CAD. The smartest way to do that is a common file BOP-BOM for both the CAD and the MRP-3. This is not a major inconvenient just switching and complementing the procedure of creating BOM in the CAD side with the BOP, and laying them in the planning master-file.

- Updating the gantt-chart from the SOS system

A very simple interface program is necessary to send the finally filtered reschedules to the gantt-chart. It is done in terms of changing:

- starting and due dates in the gantt-bars (normal conditions).

- prelations and dependencies among phases/tasks (abnormal conditions).

[2] SIMPLAN is a trademark of DATALDE, S.A.
[4] SQL Standard Query Lenguaje

Initial plans can be maintained in the gantt-chart, and displayed in conjunction with the current ones.

- The hypermedia info pack

  An external interface SQL program automatically activated by filtered changes in the gantt-chart, the planning master file, the SFC status, the purchasing status and a special "engineering and planning comments section", updates continuously the proprietary files of an hypermedia e-mail, thus giving a compact permanently updated "info-pack", which can be specially content-based (e.g. alarms from the mentional filtered changes) mail-adressed.

6. MAIN RESULTS AND STATUS

The expecting results with the consistent organisational changes derived from the use of the MRP-3 are the following:

* Better due-dates accomplishment and faster reaction upon schedule unexpected changes, both given by 20-30% lead-times reduction.

* Preventive actions with customers, suppliers, and the dynamic allocation of internal resources.

* Significative raising in direct labour productivity and machine utilisation. Expecting figures are 10% and 20% respectively.

* Significative decay of unexpected and no convenient subcontracting.

* 12-24 man-hours/day saved in administrative production and engineering tasks for an SME ranging from 100-250 people.

Finally, and looking at the status, a MRP-3 prototype is being built by the R+D department of Datalde, S.A. based on their own product called SIMPLAN, an advanced multistage multicriteria shop floor scheduler simulator, in conjunction with PROJECT. The SIMPLAN has been sold in seven capital-equipment companies along half year, as an SFC help in an MRP-2 environment. Next step is to try the MRP-3 model in these seven companies.

7. CONCLUSIONS

MRP-2 application in OKP is not appropriated given the poor use of both the Gantt-charts and the BOP. In the other hand, finite capacity scheduling is eventually performed as a complement for adjusting MRP calculations with the shop-floor reality, and thus the MPS has not always a clearly defined role.

This way, the organization is privated of a very intuitive and potentially precise procedure of planning and scheduling communication in OKP; the gantt-chart. Two sense feedback, linked by agile software, of the levels of planning (by gantt-charts) and scheduling (by a SOS system) in conjunction with an hypermedia info-pack user interface, is promising to become the OKP production and planning system of the future, given that this software model can be a single-comprehensive one when dealing with the convenient BOP instead the currently used BOM.

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9. BIOGRAPHY

Prof. Dr. Javier Borda Elejabarrieta has been working as plant Engineer and Production Manager staff for 7 years, and from 1984 he is the managing director and C.E.O. of DATALDE, S.A., a spanish 35 people industrial engineering company, sited in the Basque Country. He read in 1989 the Doctoral Mechanical Engineering dissertation on "CIM for plastic injection workshops". He is also Professor of Production and Engineering Management in the University of Deusto, Bilbao, and the author of several international papers and a book titled: "Advanced Maintenance Techniques" (1990). He has become recently an IFIP WG 5.7 member.