MONITORING THE OPERATIONS MANAGEMENT PERFORMANCE IN AUTOMOTIVE INDUSTRY

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ABSTRACT
In the case that has been the basis for the project, the global manufacturer has a problem in fulfilling the due-to-order deliveries of final product in required by clients time horizon. In the paper the issue related to monitoring of production plans execution will be analyzed. Authors will also present briefly the theoretical background of research and will discuss main problems that has appeared by analyses of manufacturing system performance. The operational management performance measures elaborated by authors will be presented.

KEYWORDS: production planning, production control, MPS, performance measures, production sequence

1. INTRODUCTION
The manufacturing can be described as subsystem of company responsible for management of materials, people and processes to reach required quality of products in desirable time and by stated cost level. The system is composed of elements machines and tooling, people and processes.

The manufacturing system is treated as a complex entity combining technological-, social-, economics subsystems and being influenced by business environment. Production planning in dynamic changing business environment must be capable of dealing with uncertainty and support the ability to fulfill customer expectation for shorter delivery times, higher quality and cost effectiveness determines the company competitive position. Production planning based on the Planned Order Release schedule and MRP concept seems to help to meet mentioned above requirements. These researches examined a variety of buffering or dampening techniques to minimize the effect of uncertainty. Comprehensive literature review can be found in Guide and Shiverasta [2]. The underlying causes of uncertainty and effects it has to manufacturing planning system with MRP has been described in Koh and Saad [5,6], who evaluated model for diagnosis of manufacturing planning activities in order to identified why problems with late deliveries of finished product appeared.

Most of the mentioned above techniques assume the modification of Master Production Schedule when a variation of manufacturing system has appeared. The high replanning frequency in order to overcome the uncertainty induce the system nervousness. Changes in MPS result in due-date changes in open orders, quantity and timing for planned order of end products. Mentioned above changes are being translated into gross requirements changes for components and timing of their delivery. Additionally deviations between the Planned Release Schedule and the actual release schedule might appear. Unexpected changes in MPS effects in situation that materials needed for a particular order may not be available particularly when there is an increased in ordered quantity and shorten due date.

In case of automotive industry where Just-in-Time deliveries are common business practice changes that appear in MPS results in problems with on-time customer fulfillment. Number of researches that has been conducted in automotive industry regarding the improvement of
the performance concentrate mainly on material flow management within supply chain and integration of planning activities[1,7,8,9]. There is a research gap for evaluation of the influence that the disturbances in execution of MPS might have on operations management performance.

2. OPERATIONS MANAGEMENT SYSTEM IN AUTOMOTIVE INDUSTRY

In European automobile forecast customer demand regarding volume and item specification many months in advance in order to figure out an attractive product mix for assembly plant balancing. Actual customer orders that are received are either fitted into the plan laid out by the production programmed months ahead, or the forecast orders in the system are amended to customer requirements – to the extent the production flexibility allows.

2.1. Sequencing in automotive industry

The analyzed production system is typical for nowadays European automotive industry and is a mixture of traditional mass production features in department responsible for pre-treatment and lean production concept in area of final assembly [11]. The production system is characterized by high stability understand as:

- steady production plans
- high similarity of production routines
- high similarity of product structure (BOM)

The manufacturer to protect the stability of production system and achieve the gains of economy of scale combine two policies by production planning, as followed:

- build-to-order
- build-to-forecast.

The production sequencing process is typical for automotive industry [3]:

- Order entry, which is a check whether the orders are feasible to be built, and if they are, transfers them into the order bank.
- Order bank, which holds all unsold orders until they are scheduled for production. The order bank does not fulfill any real purpose apart from providing a comfort buffer for the manufacturer to achieve efficient production.
- Order scheduling, which picks the orders from the order bank and assigns them to build periods (generally weeks) at the different plants. The scheduling tool takes parts availability, market and dealer fair share allocations and mix constraints into account, most of which are decided in the production programming meeting.
- Order sequencing, where the scheduled orders for a build week are re-shuffled into a sequence of build orders for the assembly plants. The sequencing tool needs to take build constraints into account. In any case, only after the orders are sequenced, do suppliers actually receive their final call-off of what is required, as only then it is actually defined what parts will be needed. This is another reason why holding scheduled orders is of very limited use, and explains why the schedules issued by the manufacturers show such a high degree of fluctuation.
- Manufacturing. Once sequenced, the orders are sent to the body shop, where the order is generally identified with the physical floorpan, which then becomes a complete body. After the body shop, the body enters the body-in-white storage, the only purpose of which is to achieve efficiency in the paint shop by accumulating bodies that are meant to be sprayed in the same color. The downturn of batching is that the initial production sequence is distorted, hence it becomes unpredictable for all subsequent operations as to what cars are coming down the process. After paint, the cars are generally re-shuffled again before they are sent on the assembly track, to ensure the mix of cars is aligned with the constraints opposed by the line balancing activities.
Due the fact that all deliveries of raw materials and components are based on just-in-time basis, any changes in order sequence results in problems with on-time deliveries of components, what seriously disturbs the overall operations management performance.

2.2. Performance measures

The performance measure apply in automotive industry can be divided into 2 categories:
- Financial
- Non-financial

Financial measures indicate mainly sales performance like sales probability, market share, sales volume.

Most non-financial metrics used by automobile manufacturer regards the logistics performance like lead time, fill rate, on-time performance, damage or responsiveness and enhance mainly 1st tier suppliers ability to fulfill OEM requirements. It is hard to establish benefits with measuring non-financial performance, due the fact that links between non-financial measures and the expected results are not self-evident and need careful verification; also many non-financial measures are worryingly vague and thus easier to manipulate than financials. Often companies are overloaded with increasing number of indicators to avoid missing anything important.

The following research project has show that there is a need to elaborate a set of simply defined indicators for operations management performance measurement in order to easily to evaluate the effective of sequencing activities in automotive industry. The metrics should capture how well the overall planning activities has performed and identify where opportunities exist to increase competitiveness.

The methodology guidelines for indicators definition (mentioned in section 3) has been based on assumption that from a managerial perspective, the best measures accomplish four things:
- validity
- usefulness,
- robustness
- integration.

The validity of indicator can be understand as a ability of indicator to describe the performance in three dimension: what, where, how.

The usefulness of the indicators has been defined as a simplicity of its definition and calculation process not generating additional operational cost.

In following paper the robustness has been defined as a the applicability of the metrics for different elements (nodes and links) of manufacturing system.

Integration of measures understand as a ability to enhance performance at whole manufacturing system and allow to conduct comprehensive field research for primary

Unfortunately these criteria cannot be satisfied simultaneously. At the operational level, where measures can both capture specific aspects of the activity and provide actionable guidance, validity and usefulness are most applicable. As measures are consolidated into higher and more strategic levels of reporting, their value diminishes. The reverse is true for the criteria of robustness and integration whose value is greatest at the consolidated or strategic level and lowest at the operational level [4]

3. MONITORING THE OPERATIONS MANAGEMENT PERFORMANCE IN AUTOMOTIVE INDUSTRY

3.1. Problem domain

In the analyzed manufacturing system by the execution of elaborated Master Production Schedule a number of variations appears regarding both time of particular order completion and the orders sequence. The MPS is elaborated on the basis on predefined criteria which are known. The excising system for operations management monitoring register the production sequence at a number of Production Control Point (PCP) that are located within assembly plant (fig1).
Within manufacturing system problems appear due to the fact that a number of disturbing events has occurred between the time the observation is made and the MPS was prepared. The history of events which appears between MPS elaboration and its execution are known. All deliveries of raw materials and components are based on just-in-time basis. Suppliers are being informed few days in advance about production plans (production sequence). 1st-tier Suppliers are being informed about qualitative and quantitative orders requirements at three time-points. The first roughly information on required components and materials is given to suppliers when Master Production Schedule is agreed a few weeks before production starts. The more detailed orders are defined at first PCP order-point (few days before production starts) when the production orders sequence is planned. The last call for supplies of components takes place when pre-treated products leave dep. 2. The main value adding process is generated by final assembly (Dep. 3). All supplies of components are supposed to arrive at final assembly department in the required sequence due to the fact that there are no buffers. Any significant changes that appear in a planned sequence within production process results from the problems with in-time supplies of components in final assembly. Due to the production process logic (Fig.1) the adequate sequencing of production orders is of crucial importance for company performance.

The aim of the research was to improve the production planning and control activates in order to achieve higher reliability of planned production sequence.

The operations management performance is measured as a relation between production plans and the executed real production of finished goods in a defined production cycle. The effectiveness of production system at operational level is measured regarding the reliability of production sequence.

In following paper the sequence will be defined as a set of following production orders identification number (POIN) observed at entry to the production system which are consistent and might have common attributes like for example color etc. Due the disturbances in production plans observed at following production control...
points (PCP) the set of following POIN becomes inconsistent so it will be perceived not as a sequence but as a block of productions orders.

3.3. Problem solution

In ideal system the sequence of production orders at manufacturing system entry should be the same as this one observed at production ending control point. In real manufacturing system the differences are significant. The sequence at the end of production system comparing to the manufacturing system entry is both mixed within defined block of orders and also inconsistent. The inconsistency is perceived as a fragmentation of original block of items into smaller block and its mixture with others block.

Consequently it is impossible to forecast precisely both the time when defined block of order will be manufactured and the order following POIN within block will appear. This situation influence on-time supplies of components for final assembly and finally seriously affects the ability to provide clients required goods on-time.

For purposes of measuring of the difference between ideal and real system state the following two indicators has been proposed:

- Sequence dispersion range (SDR)- measured for block of POIN as a difference between maximum order identification number in defined block and minimum identification number observed at chosen production control point.
- Sequence order displacement (SOD)- measured for block of POIN as number of pairs of orders identification number that appear at final production control point in the same order as observed at the initial production control point. However is it also possible to measure the partial SOD at defined scope of PCP within manufacturing system for example at production department 1 entry and production department 1 exit.

On the basis of mentioned above indicators the evaluation of operations management might be made. The overall production sequence quality (OPSQ) will be calculated as follows:

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\text{OPSQ} = n / \text{SDR}, \quad \text{where } n \text{ is the number of POIN in analyzed block}
\]

The overall production sequence quality presents the rate quantity of POIN in analyzed block to SDR at observed production control point for example if there was “n” POIN and the SDR equals to “n” the quality of operations management regarding sequencing will be 100%.

The OPSR evaluation will be supported with detailed SOD analyses in order to point the critical production control point, where the highest disturbances appear.

The proposed approach will help to improved the production planning and control activities in order to provide customers on-time deliveries of final goods.

4. CONCLUSIONS

The paper presents the preliminary results of case study conducted in automotive industry. The aim of the studies is to optimize the quality production planning and control activities. On the basis of conceptual framework presented in the paper an IT solution called Prograph 0.99 has been elaborated. The software is at present evaluated at automobile assembly plant. The preliminary results show that the indicators proposed by the authors are suitable for appropriate evaluation of performance management. The software due the wide range of analyzing abilities is suitable for application at massive production databases for identification of problematic areas within manufacturing system and allows to undertake actions to improve the quality and reliability of sequencing. The presented research is strongly case-based however due the fact that european manufacturing systems are quiet similar the proposal might be applied for another companies in the sector.
5. REFERENCES


