Production efficiency through Process Orientation

A study in process orientation and production systems at Trelleborg Wheel System spring 2004.

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This article is based on a Master Thesis in Engineering Logistics at Lund Institute of Technology. The study was conducted at Trelleborg Wheel System in Trelleborg, Sweden. The production site in Trelleborg manufactures tires mainly intended for the worldwide forest and agriculture industry and has recently begun to adopt a process orientated view of their organisation. In this study a process map over the production site in Trelleborg is developed and the process is analysed from various aspects. In order to gain greater focus on the existing bottleneck in the production flow, the production control method had partly been changed at the production site, before this study was initiated. The thesis analyzes the existing production control system and investigates how the production flow and the manufacturing system are affected. The study also analyzes how a measurement system may be developed in order to better support the process orientated organization.

Keywords: Process orientation, bottleneck, production control method, pull/push-system, process measurement.

Introduction

Purpose
The purpose of this report is to map the current manufacturing process from a process orientated point of view. The concern is also to define the production control method that is used. The production flow is currently characterized by an apparent bottleneck, the curing stations, which is constraining the whole system. Additionally, the purpose is to propose suggestions in order to improve and develop the manufacturing process, even though investments in the bottleneck are not an issue. The aim is also to investigate and suggest adjustments of the measurement system in order to facilitate control in the production flow. The problem formulation was summarized into three research questions which are aimed to be answered in this study:

- How can the production organisation be identified and described in a process map?
- What production control method is used to control and coordinate the different activities in the production flow, what strengths and weaknesses can be identified and how can the production control system be improved?
- Could new measurement parameters be found that in a better way aligns with the demands in a process orientated organisation and at the same time facilitate and support control of the current production system?

Methodology
This study has adopted the system approach in order to illustrate the significance of how the different parts are connected. An abductive approach has allowed the authors to move back and forth between theoretical studies and empirical data collection. During the study both qualitative and quantitative data have been collected and discussed. The qualitative data consist of observations and interviews with employees at the Trelleborg factory. The interviews have mainly been of informal nature and have been conducted during the spring 2004 as the authors spent a significant amount of time at the factory location. The quantitative data originate from the business systems, Movex and Qlickview, which are used at Trelleborg Wheel Systems.

The method used for analysing the process is based on the theory of constraints. This method suggests that the process should be analysed from a holistic point of view and conducted with basis in the constraining part of the process.[1] From this starting point, further areas for penetration and comprehensive study were identified; the production control method used, reduction of change-over time, elimination of disturbances in the process and development of new measurement parameters.

Literature review
The core idea of process orientation is to achieve a horizontal view of the organization, gain greater holistic understanding and to get more focus on the customer. A process is commonly defined as “a chain of activities that deliver customer value”[2]. Ljungberg slightly
extends the definition as “a process is a repetitively used network of orderly-linked activities using information and resources for transforming inputs into outputs, extending from the point of identification to that of the satisfaction of the customer’s needs”[3].

In order to achieve process orientation and gradually move away from a function based organisation, a first step is to identify and map the processes. The process map can be illustrated in different ways, and the method used in this study originates from the research done by Anders Ljungberg and Everth Larsson [4]. The process map should illustrate the relationship between the activities, the objects that initiate each activity and the resources that each activity needs to perform the transformation. The process map is aimed to cover the whole process, which implies that the starting point is located where the customer demand arises and the end point is the fulfilment of the customer’s need.

It is advisable that the development of a process based measurement system is conducted through a structured procedure. This should be done by first mapping the processes, secondly identifying the customer demands and finally identifying parameters that align with these demands. The framework of demands could be described as in figure 1, where three sources of demands affect the specific activity or subprocess.

The Process mapping

The study started with a comprehensive mapping of the production organisation and the information was presented in a process map. The whole process is initiated by a production demand of a specific article and runs until the finished tires are produced. It was found that in order to follow the whole process it was necessary that “external” activities - activities that take place in external units to the factory - must be incorporated in the process map. Hence, the process map includes both “internal” and “external” activities. Internal activities take place within the factory. The process map that has been developed within this study is illustrated in figure 2.

Information and control systems

The company is currently utilizing an ERP/ MRP-system that supports the majority of the material and production planning. The system, called Movex, generates a production order containing information concerning articles, operations and quantities. Based on this information, the system generates a list describing in which order the operations in each activity will take place. This list is called the “steer plan”. The “steer plan” is used differently in the activities, depending on the characteristics of the specific activity. In a number of activities the steer plan is used as a production trigger that initiates the production. Other activities are triggered by what is called an “overview list”. The information in these overview lists are based on the steer plan in the next coming upstream activity and what already has been produced in the specific activity. Hence, the overview list facilitates for the operators to make the right decisions concerning which order that is the most urgent to produce, regarding to the need of other activities.
Analysis

Pull and push hybrid as control method

The analysis of the production control method in the manufacturing process showed that both pull- and push based features are present. The activities that are triggered directly by the steer plan from Movex should be classified as push based control. In addition, the activities that are triggered by the overview list should be classified as pull based control, since the initiation is based on the status in the system. This implies that the overall control method should be classified as a hybrid method, and that a number of interfaces between pull and push are present. The product mix and time-consuming change-over implies that this method is appropriate in the current situation. The possibility to adopt a pure pull or push control method is impeded by the product design and the design of the manufacturing process in each activity. Nevertheless, it was stated that a couple of weaknesses existed and hence there is a potential to develop the manufacturing process in order to gain better performance.

Reduction of change-over time

It is possible to reduce the change-over time in the activities, which implies that the capacity could be enhanced and that it will be possible to gain greater flexibility in the production flow. The change-over time may be reduced by improved production planning routines, more flexibility among the operators and changed working routines. The changed working routines imply identification of change-over tasks that could be transformed from internal to external tasks. Internal tasks, means tasks that are not feasible to conduct while the machines are still running. External tasks, means tasks that have the nature to possibly be conducted at the same time as the machines are still running. It is important to first consider the change-over time in the bottleneck activity in order to achieve substantial improvements of the whole process.

Disturbances in the process

During the study a number of various disturbances in the process were identified. The most crucial disturbance concerns late delivery of materials within the production flow. Significant effort is currently used in order to eliminate this kind of disturbance. We are suggesting that more effort should be put into preventing the disturbance in advance. One method to achieve this is to develop a real-time visualisation tool that presents the current status of the system. This tool should incorporate information concerning the need of material in each of the bottleneck machines, planned machine change-over and the position of needed materials downstream in the production flow. One example of how such a tool may be designed, is presented in figure 2. This visualisation tool may be used in order to observe and control the material buffers in front of the crucial activity, the bottleneck activity, and hence facilitate for both the production managers and the operators to overview the production flow. The information gathered in this tool could be collected from the current MRP-system, Movex.

Measuring parameters in the processes

During the study, it was learned that there is a need to develop new measurement parameters in the process. The suggested parameters have been developed by first creating a framework of the demands that exists on each activity. In this study, the framework of demands for each activity is based upon the overall demands of the whole process and the analysis of the manufacturing process. If the diverse parameters could be related to what is beneficial for the whole process, sub-optimization may be avoided and incentives for incremental improvement in each activity will be created. In order to develop measurement parameters, three activities that are crucial for the overall production system were identified; the curing-, the strip-winding- and the building activity. The demands and suggested parameters of these three activities are illustrated in figure 4.

The suggested parameters in the curing activity are based upon demands related to the fact that this is the bottleneck activity. The parameters are aimed to gain greater focus on higher utilization by reducing the change-over time in this activity. Higher utilization implies the possibility of greater production volume in the whole system.
This strip-winding activity is the one just in front of the bottleneck activity, the curing activity. The most important task for this activity is to support the curing activity with the needed material at the right time, to make sure that this activity achieves a high utilization. Hence the suggested measurement parameters are based on how accurately the curing activity is supported and therefore running.

The building activity, is according to the hybrid control method, initiated by a push based feature. This implies that the production volume should be partly individually optimized. Nevertheless, there is no point in keeping a higher production level than the capacity of the bottleneck. The measurement parameter is therefore proposed to indicate how well the building rate corresponds to the production rate in the curing activity. By measuring the number of “curing-hours”, this could facilitate in order to ensure that the overall flow of materials is adjusted to the bottleneck capacity. The parameter, “curing-hours”, corresponds to the standardized operation time of the specific tire in the curing activity.

Figure 4. Suggested demands and measurement parameters

<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curing</td>
<td>High utilization</td>
<td>Average time for change-over</td>
</tr>
<tr>
<td>Strip-winding</td>
<td>High delivery precision</td>
<td>Number of hours the curing activity is idle</td>
</tr>
<tr>
<td>Building</td>
<td>Even production rate compared to the bottleneck</td>
<td>Number of &quot;curing-hours&quot;</td>
</tr>
</tbody>
</table>

Conclusions

The study states that the process map should be further developed and integrated into the organisation in order to gain pervasive understanding of the whole process.

The study states that a number of present indicators at the company align with process orientation which implies that the production site has begun a transformation away from a function based organisation. Foremost, the production supervisor has a holistic responsibility of the internal process and this implies that he or she may be able to eliminate sub-optimization. If appropriate tools, such as the suggested tool aimed for visualisation of the bottleneck buffer, are developed, this implies that the holistic responsibility could be further utilized.

The proposed measurement parameters are in this study regarded as examples of how a measurement system could be developed. Foremost, is it advisable that also the demands from the end customer are incorporated in the framework of demands, when the proposed parameters are modified, in order to achieve a process based measurement system.

Nevertheless, the most significant potential of process based development is present in the interfaces between external units and the production site in Trelleborg, where the functional boundaries are assumed to be very sharp. Even though such development extends the constraints of this study, we have pointed out areas that may be of interest in order to achieve beneficial process based improvement. Achieving better understanding of the end customer involves integration with functions such as sales functions. Coordination with the suppliers and adjustment of both the process of the suppliers and the internal process according to common needs, may also improve the overall performance. One way to achieve this may be to install management functions of both the “internal” and the “external” process more adjacent to the daily tasks.

References