Public summary

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Improving the handling of special orders

Scania Production Meppel

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Introduction

In the context of my graduation project of the master Industrial Engineering & Management (IE&M), specialisation track Production & Logistics Management (IE&M-PLM), at the University of Twente, I conducted a research at Scania Production Meppel into the way of handling a special kind of orders. We define these orders in this summary as special orders. Due to complete confidentiality of my master thesis, this public summary describes the main issues of the research briefly, but as detailed and well explained as possible.

The summary below is divided into separate sections, starting with the company profile of Scania Production Meppel. Secondly, we give an introduction to the research, and we present the research question. After that, we formulate the sub questions that help to answer this research questions. We discuss each sub question in a separate section, and we conclude this summary with the discussion, conclusion and recommendations.

Company profile

In the early years of the twenty-first century, Scania decided to insource the painting of the plastic cabin components and the chassis components in the colour the customer wants. For that reason, a former Scania factory in Meppel was redesigned to make this process possible at that location. Then, in 2007 the factory became operational (Scania Production, 2016). From that moment on, the factory in Meppel delivers the painted parts to the European truck assembly factories, located in Zwolle, Angers (France), and Södertälje (Sweden). Currently, the location in Meppel has around 350 employees (SPS Office Meppel, 2016).

Research

Scania Production Meppel paints a wide range of different components. However, there are some customers ordering the truck components in such a way that their orders deviate from the regular ones. The factory in Meppel has difficulties to serve these customers efficiently. We refer to the orders of these customers as the special orders. This research is about these special orders, and gives an answer to the following research question:

How can Scania Production Meppel better organise the way of handling the special orders?

The answer to this research question is obtained with the help of six sub questions. These questions are listed below:

1. *What is the current situation at Scania Production Meppel concerning the way of handling the special orders?*
2. *Which problems arise due to the current way of handling the special orders, what are the causes and consequences of these problems, and which problems are selected for being part of the rest of this research?*
3. *What methods that can be applied to the identified problems at Scania Production Meppel can be found in the literature?*
4. *What conditions should be taken into account when developing alternatives?*
5. *What alternatives can be developed and which one must be selected based on a multi-criteria analysis?*
6. *Which recommendations follow from the observations?*

In the sequel of this summary we discuss the above formulated sub questions in distinct sections. Due to the involved confidential information, we are not able to give detailed answers to all questions, but we define the answers as complete as possible.

Current situation

In terms of the current situation, we describe the components painted at Scania Production Meppel, the production process of this factory, and the customisation level of Scania related to the existence of the special orders.

Components at Scania Production Meppel

Concerning the components involved at Scania Production Meppel, the truck can be divided into the cab and deflector on the one hand, and the chassis on the other hand. Every component of the truck belongs to one of these categories. Figure 1 (adapted from Olinga, 2012) shows all components being painted in Meppel. The grill set (divided into an upper grill, shielding plate, and lower grill), cab corners, sun visor, roof deflector, roof side deflectors, and side deflectors as indicated in the figure belong to the cab and deflector components. The chassis involves the bumper, boarding steps, fenders, side skirts, and mud guards.

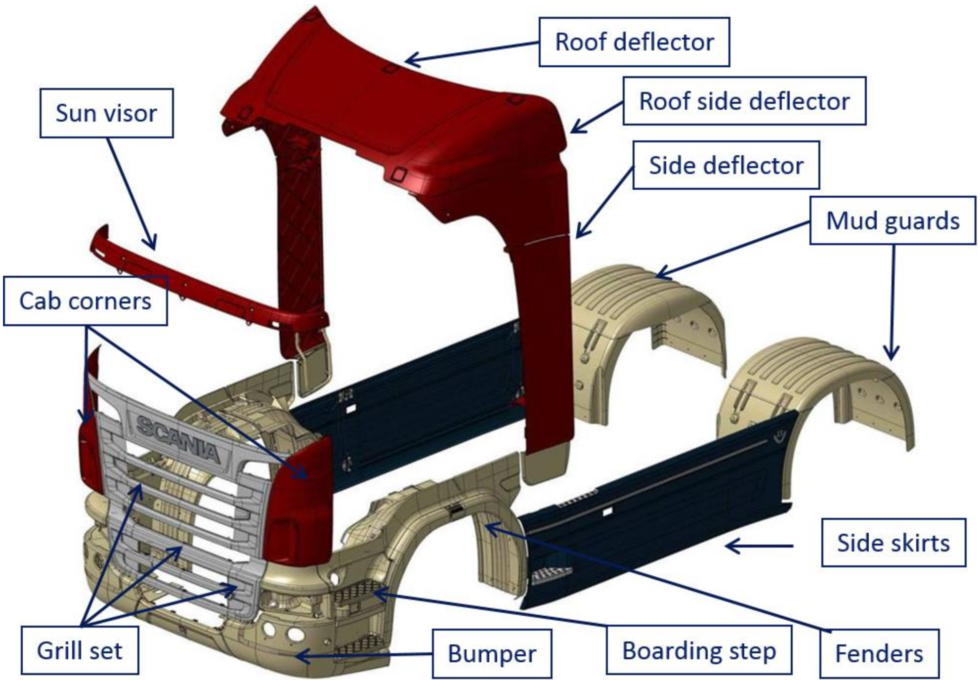

Figure 1 - Components of the cab and chassis (adapted from Olinga, 2012)

Production process Scania Production Meppel

The production process of Scania Production Meppel consists of multiple steps. Generally, these are the following:

- **Loading**: After receiving the materials from suppliers, those are placed in the warehouse. At the loading platform an empty skid arrives. Based on the sequence of skids as determined by the production planners, the system shows the upcoming order and the materials that must be picked. As a result, the empty skid matches with the available materials, and the components can be attached to the skid.
- **Painting**: Before the actual painting starts, the skids go through the power wash installation. This installation uses a cleaning spray to make the components fat free. After that, the skids with components go to an oven to increase the speed of drying. Thereafter, the skids proceed to a cooling area, where expansion due to the temperature increase must be eliminated. Subsequently, the skids proceed to either the T1 line or the T2/T3 line. The T1 line is the line designed for the chassis components, while the line of the cab and deflector components is the T2/T3 line.
- **Inspection and repair**: After being painted based on the customer specifications, the skids with components go to the Inspection & Repair (I&R) department. At the first station of I&R, the

components are checked on mistakes. If possible, the errors found are repaired at the next stations of the lines. However, in some cases the errors are too big to repair on the line. In that case, there are two possible options. The first one is to repair the damaged components offline, or at the Manual Paint Line (MPL), while the other option is to scrap the component. The MPL is used to paint components and colours that could not be painted at the regular line.
- **Assembly and packaging**: After unloading the components from the skids, different kinds of assembly steps are executed, like attaching non-plastic elements to the boarding steps and grills. Then, the assembled components are placed and stored in boxes. When the boxes are filled, these are packaged and so ready for sending to the truck assembly factories in Zwolle, Angers, and Södertälje. The storage of the boxes is in sequence, which means that the orders are sent to the truck assembly factories in the sequence as those are planned for truck assembly in Zwolle, Angers, and Södertälje.

Customisation at Scania

The customisation graph as developed by Boër, Sorlini, Bettoni, and Pedrazzoli (2013) demonstrates that Scania achieves a high customisation performance. The graph consists of three customisation dimensions, which are style, fit, and functionality, as already identified by Piller (2004). Firstly, the style is concerned with modifications related to sensual or optical senses, like selecting colours and applications. At Scania, customers have the possibility to select all desired colours. Further, the second dimension addresses the fit of a product with the dimensions of the customer, which is about tailoring a product and taking into account physical objects. In principle, a customer can select many different types for a certain component, but the options on this dimension are more static than for the style. Finally, the functionality is related to issues like speed, power, and technical attributes. A customer can select for example the preferred engine and can choose to add components like a fifth-wheel coupling. Thus, Scania performs well on all three dimensions, but the best on the style, as indicated in Figure 2. However, due to providing customisation possibilities to the customers, Scania and in particular the location in Meppel experience difficulties in the activities needed for these customised elements.

Figure 2 - Performance of Scania on the customisation graph

Problem analysis

The current way of handling the special orders leads in principle to three types of problems. These problem areas are the following:
- Capacity losses.
- Increased chance on mistakes.
- Decreased quality of components.

The identified problems are partly caused by having different handlings per truck assembly factory. However, the special orders resulting in these different handlings do not occur that often that further investigation only into this issue is desired. Changing the current production process in such a way that handling the special orders adequately is also no solution, because this involves a lot of effort and difficulties, that are presumably not worth it. Besides that, the special orders cannot be painted on the

MPL, because this production facility is overloaded and not meant for these orders. Therefore, we want to investigate the option to increase the overall capacity with a new paint line. Also maintaining the current situation or outsourcing parts from Meppel to an external painter can be a solution for the special orders. We expect though that the development of a new paint line is more profitable.

Literature study

As mentioned above, it is possible to outsource the parts of special orders to an external painter, but we prefer to paint these parts in Meppel. Slack et al. (2010) proposed a model containing the decision logic of outsourcing, as shown in Figure 3. This figure delineates when it should be explored to keep an activity in-house, and when to outsource it. The first question to answer is about whether the activity is of strategic importance. We determine the activity is for both Scania as a whole and the location in Meppel that the activity is strategically important, so this corresponds with our choice to insource the painting activity of the special parts. Thus, this model justifies researching the possible development of a new paint line.

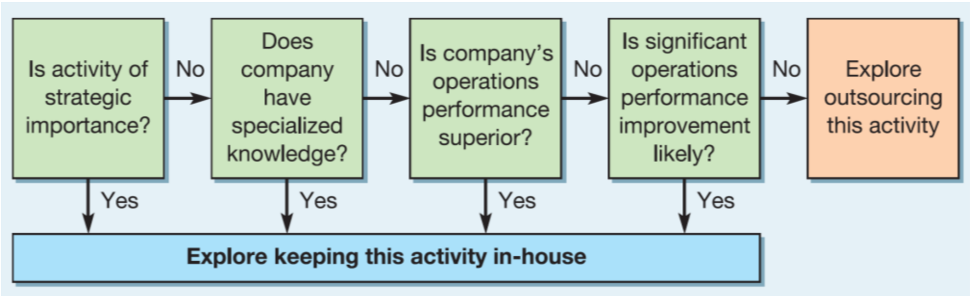

Figure 3 - The decision logic of outsourcing (Slack et al., 2010)

Further, we consider multiple production facility layouts and whether these are suitable for a new paint line in Meppel. In general, Irani (1999) mentioned the three traditional types of production facility layouts. These are the product layout, cellular layout, and functional layout. Figure 4 shows what these layouts look like, and how the products go through the process. Considering the painting process needed at the new line at Scania Production Meppel, each component follows a certain route with painting activities, which are always in the same sequence. According to Stützle (1998), these processes are referred to as flow shops. Inman (2007) stated that product layouts can be found in flow shops. This is in line with the findings of Slack et al. (2010), who identified that the production characteristics in Meppel comply with the product layout, where the transforming resources are located entirely for the convenience of the transformed resources.

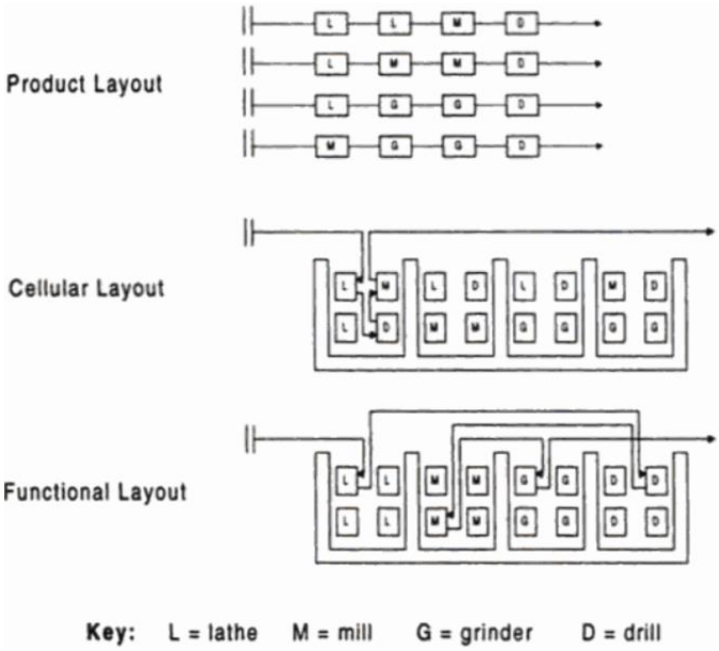

Figure 4 - Traditional types of manufacturing facility layouts (Irani, 1999)

Figure 5 as presented by McMullen and Frazier (1998) shows a basic variant of multiple parallel work stations in a row within a certain work centre. The tasks 3, 5, 6, and 9 in the squares are all performed in parallel. According to Dallery and Gershwin (1992), there are two reasons to choose for operations in parallel. These are either to realise a greater production rate or to accomplish a greater reliability. The first reason is argued when a certain operation is slower than the other operations. The second case is observed when a certain operation is less reliable than the other ones. Besides that, Ólafsson and Shi (2000) indicated that flexible resources match better with parallel cells. Since flexibility is to some extent required for the painting operations on the new paint line, this is something to take into account. In addition to pure serial or parallel lines, a combination of both is also possible.

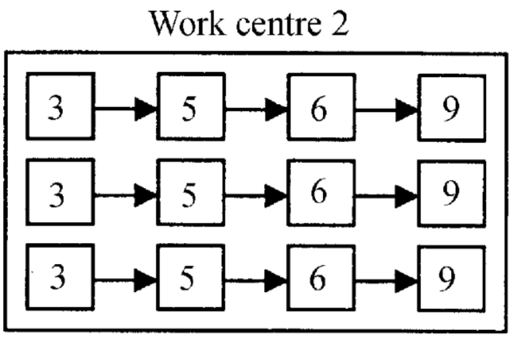

Figure 5 - Parallel work stations in a work centre (McMullen and Frazier, 1998)

The situations as discussed above belong to the category of open loop manufacturing systems. However, a manufacturing system can also be in the form of a closed loop, with for example pallets going round like in Figure 6, obtained from Yang, Riggs, and Hu (2013). In this figure, first, the pallet is loaded with the raw material. After that, the loaded pallet goes via a number of machines, where it undergoes several operations. Then, the pallet is full and ready for unloading. Instead of taking away the complete pallet, the processed materials are removed from the pallet. When all parts are unloaded, the pallet itself goes further and can be loaded with raw material again. Basically, the pallets are reused, resulting in a closed loop. The number of locations for empty, loaded, and full pallets can vary and can be determined as desired. Besides that, the introduction of buffers or storage in between is possible in such a closed loop manufacturing system (CLMS).

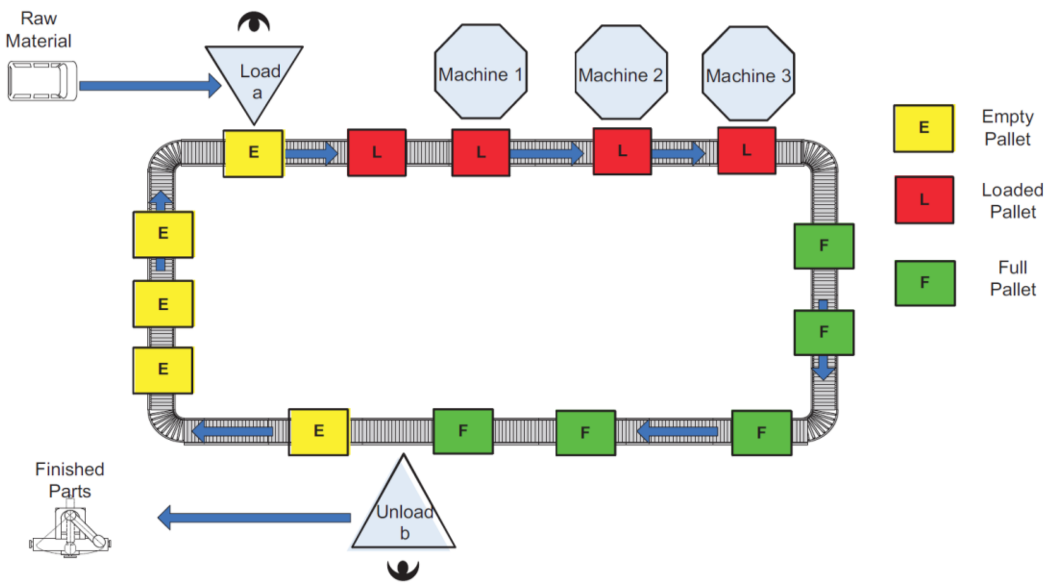

Figure 6 - A closed loop manufacturing system (Yang et al., 2013)

From the information presented in this section, it turns out that many different options exist to design a new paint line. However, not all described methods can be applied to the situation at Scania Production Meppel. The potential new paint line of Scania Production Meppel needs to be designed in a way similar to the MPL, where at least manual painting is concerned. The parts are loaded at the beginning of the MPL, undergo all needed operations, and are unloaded at the end. So, this corresponds with the CLMS as described above.

Conditions for the development of alternatives

A possible new paint line needs to comply with several conditions. Firstly, we have to identify which parts we want to paint with this paint line. Besides that, the paint line needs to meet certain requirements related to the design and dimensions of the work stations. Moreover, we establish criteria for the assessment of the alternatives later on.

Inclusion of parts
Developing a new paint line results in principle in creating more capacity than needed for only the special orders. Therefore, we look for more parts that we can include in the painting activities on the new paint line. We identify the parts from skids with a few parts on it as the most appropriate ones. Instead of attaching these on a skid and so painting on the regular line, those parts can be placed on a carrier of the new paint line, because this decreases the costs for painting these parts. We define the carrier as the equivalent variant of a skid, but then for the MPL or the new paint line.

Requirements
The work stations that need to be present at the new paint line must be the same as the work stations present at the current MPL. Furthermore, we can consider the dimensions of the work stations of the current MPL for the space requirements of the new paint line. Having this information, we are able to develop a new paint line. We have to make one important choice though, which concerns the design. This could be a serial concept, a parallel concept, or a combination of the serial and parallel concept.

Criteria
After the development of the alternatives, we have to assess those on criteria such that the total scores indicate the performance of a certain alternative. Therefore, we establish suitable criteria, that are listed in the left most column of Table 1. Each criterion has its own unit of measurement as shown in the second column of Table 1. In the end, we transform all scores to a Likert scale from 1 to 5 to make the assessment of the alternatives possible with a multi-criteria analysis (MCA). Further, we do not attach equal importance to all criteria. Therefore, we give weights to the criteria, resulting in the most important criteria having the most impact on the final score of the assessment. The fourth column of Table 1 contains the weights of all criteria, which are used in the assessment of alternatives. These weights indicate the investment costs (C1) and the running costs/benefits (C2) are the most important criteria in our assessment.

Criterion	Unit of measurement	Scoring method	Weight
C1: Investment costs	€	Likert scale (1-5)	0.2298
C2: Running costs/benefits	€ per year	Likert scale (1-5)	0.2298
C3: Risk	Likert scale (1-5)	Likert scale (1-5)	0.1723
C4: Implementation time	Likert scale (1-5)	Likert scale (1-5)	0.1245
C5: Surface area	m^2	Likert scale (1-5)	0.0372
C6: Capacity	Number of carriers per year	Likert scale (1-5)	0.1245
C7: Lead time	Likert scale (1-5)	Likert scale (1-5)	0.0220
C8: Consequences for the factory	Likert scale (1-5)	Likert scale (1-5)	0.0600

Table 1 - Overview of criteria

Development and assessment of alternatives

We introduce the following four alternatives, characterised by these elements:
- Alternative 1: close to the MPL, serial concept.
- Alternative 2: close to the MPL, parallel concept.
- Alternative 3: other location, serial concept.
- Alternative 4: other location, parallel concept.

Since the four alternatives have different capacities, we identify for each alternative which parts we can paint exactly with the designed paint line. We want to match the included parts as good as possible with the available capacity.

Subsequently, we perform an MCA and assess the four developed alternatives on the eight criteria as listed in Table 1. The used assessment method is in accordance with the Analytic Hierarchy Process (AHP), as described by Saaty (1988).

Assessment of all alternatives on the eight criteria (MCA)

Criterion	Weight	Alternative 1	Alternative 2	Alternative 3	Alternative 4
C1: Investment costs	0.2298	4	3	2	2
C2: Running costs/benefits	0.2298	3	4	3	4
C3: Risk	0.1723	4	4	2	2
C4: Implementation time	0.1245	4	4	3	3
C5: Surface area	0.0372	3	2	3	4
C6: Capacity	0.1245	2	4	2	4
C7: Lead time	0.0220	2	4	2	4
C8: Consequences for the factory	0.0600	4	4	2	2
Total	**1.0000**	**3.4401**	**3.6958**	**2.3914**	**2.9513**

Table 2 - MCA assessment overview

Table 2 shows in the bottom row the total scores of all alternatives. These are obtained by multiplying the weight of a criterion with the corresponding score on the Likert scale, and after that adding the numbers of all criteria. Based on this MCA, alternative 2 (3.6958) is preferred over alternative 1 (3.4401), alternative 4 (2.9513), and alternative 3 (2.3914). Moreover, we determined the NPV for all alternatives, with alternative 2 having the highest NPV. In addition, this NPV is much higher than the NPV of both maintaining the current situation and outsourcing the parts of the special orders from Meppel to an external painter. The corresponding payback period of alternative 2 is even less than a year. When considering both the MCA score and the financial consequences in terms of the NPV and the payback period, alternative 2 is the favoured one. Therefore, we prefer alternative 2 (close to the MPL, parallel concept) for painting both the special parts and the parts from skids with only a few parts.

Conclusion and recommendations

To conclude, we evaluate whether the implementation of a new paint line helps to solve the problems around the three identified problem areas. Thus, we consider the influence of the developed paint line on the capacity losses, the increased chance on mistakes, and the decreased quality of components. Following our solution, the capacity losses are not or at least less in place. Further, the increased chance on mistakes arises from additional handlings, but these do not exist anymore when a new paint line is developed. However, we have to admit that other manual handlings can emerge, but we assume these processes can be made more standardised and so less prone to errors than the current situation. Finally, keeping the painting activities at Scania Production Meppel ensures a better control on quality aspects, so the problem of the decreased quality of components is less in place then. Thus, since our solution helps to reduce the three identified main problems related to the special orders, we recommend to build a new paint line at Scania Production Meppel.

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