Summary

The research is situated within the production facility in Zwolle. The problem to be investigated takes place after the assembly line for the production of the frame, which is separated from the subsequent processes. A continuous flow of assembled frames to the internal customers cannot always be guaranteed. The unreliability of the delivery of frames causes disturbances within subsequent processes.

After the frame assembly the final assembly lines are twofold in Zwolle, one final assembly line for the easier work in large volumes and one final assembly line for the heavier and more complicated work in smaller volumes (respectively the Castor- and Polluxline). Both lines have a possibility to store assembled frames. In between the assembly process of the frames and the two final assembly lines, a paintshop is set up that enables the customer to state his colour preferences. The paintshop and the two final assembly lines are all internal customers of the frame assembly, all to be supplied by only one frame line.

As was previously stated, this manner of production has caused a problem in the continuous flow of frames to the final assembly lines, both from the frame assembly line as well as from the paintshop, resulting in downtime on the final assembly lines. The occurrence of downtime on the final assembly lines leads to additional costs, caused by overtime. For the Castorline this comes down to an additional cost of €225 per minute of downtime, while for the Polluxline this comes down to €75 per minute. In the period between January 2007 and September 2008, the production losses on the throughput of frames to the Castorline have resulted in a net loss of €537.000, while the net loss on the Polluxline was €127.000.

Given the complexity of the problem, a clear overview of the entire situation is needed. Therefore, the following question needs to be answered:

Which problems surround the supply of frames?

Moreover, within the present-day situation the lack of controller functions on the product flow is another problem to be dealt with. The following question will look into whether an adjustment within the production control can contribute to an improvement of the production process.

To what extent is it possible to design a controller function which is able to resolve the present-day problems?

In the final months of this research, Scania Zwolle has decided to reduce the production volume of trucks due to diminishing market demand, resulting in the temporary shut down of the Polluxline. In line with this recent development, this research will be supplemented by an overview of the expected production situation for the upcoming period.

In order to map the production situation, qualitative models have been designed. Within these models, the following aspects have been taken into account: the processing of orders, the assembly process, and the information supply between the processing of orders and the assembly process. The processing of orders aspect takes into account the entire process from the initial customer order up until the finalized order. Similar, the assembly process aspect takes into account the entire process from the import of parts up until the assembled truck. Within the production process the following disturbances have been taken into account.

1. The handled production sequence on the frame line
2. The presence of postponed frames and chassis
3. The presence of colour frames
4. Disturbances on the frame assembly line
5. Disturbances on the final assembly lines

Next, the qualitative models and the disturbances are quantified. Firstly, this information is used in order to create an explanatory model for the analysis of individual production days. Within this model, the production is simulated through the use of the real data on production sequences and disturbances. This analysis did not only show that the explanatory model operates according to the created qualitative model, but moreover also showed that the qualitative model is a simplified but nevertheless correct reflection of reality.

Secondly, the quantitative data is used for the analysis of longer production periods. In order to do so, statistical distributions have been made for the previously mentioned disturbances. Resulting in a general production model, in which the disturbances are varied in order to determine the influence of these independent variables on the dependent buffer content. The influence of disturbances on the final assembly lines is taken into account within the model, however it is not investigated any further. Stagnation on the final assembly lines increases the delivery reliability of the frame line, however it is of course not the ambition.

Linear regression is used to determine the significance of the linkages. The results of this research are summarized in table S.2

tabel S.2: Disturbances

		Castorline	**Polluxline**	**Potential Savings Castor**	**Potential Savings Pollux**
Production sequence	Total amount of Work in Progress	No significant correlation	No significant correlation	-	-
	Proportion Pollux:Total WIP	Significant correlation	Very significant correlation	€120 p.m. per % more Pollux frames within the total WIP	
Postponed chassis	Inter Arrival Rate	No significant correlation	No significant correlation	-	-
	Type of delay (types 4 & 5)	Significant correlation	Significant correlation	€28 p.m. per % improvement of types 4 & 5	€10 p.m. per % improvement of types 4 & 5
	Duration of the delay	No significant correlation	No significant correlation	-	-

		Castorline	Polluxline	Potential Savings Castor	Potential Savings Pollux
Colour frames	Throughput time paintshop	Significant correlation	Very significant correlation	€130 p.m. per chassis	€140 p.m. per chassis
	Spreading over time	No significant correlation	No significant correlation	-	-
Disturbances frame line	Time To Repair (TTR)	Very significant correlation	Very significant correlation	€360 p.m. per % improvement	€34 p.m. per % improvement
	Time Between Failure (TBF)	Very significant correlation	Significant correlation	€340 p.m. per % improvement	€35 p.m. per % improvement

This table gives an answer to the first research question: Which problems surround the supply of frames. In addition to the reduction of the above-stated disturbances, the throughput of frames onto the final assembly lines can also be improved by adjustments in the production system:

- The increase of the buffer capacity at the start of the Castorline has a positive influence on the throughput onto the Castor-and Polluxline.
- The implementation of another mechanism for production control can contribute to a better throughput, which answers the second research question.

For the upcoming period, the Polluxline will be closed, resulting in a downfall of one of the internal customers. The assumption is that this will improve the delivery reliability of the frame line. Nevertheless, the simulation model still indicates a high likeliness of problems surrounding the throughput of frames.

The analysis of the problems in the previous production situation showed/indicated that the downtime on the frame line largely contributes to the delivery reliability onto the Castorline. When the disturbances for the frame line and for the Castorline will not change in the future, the present-day organisation will continue to encounter problems. In that case, a decrease of the cycletime on the frame line or an increase of the buffer capacity is strongly recommended.