ABSTRACT
This paper is an abstract from a master thesis performed for Volvo Cars Uddevalla, VCU. This thesis maps processes at three different levels of detail. The process mapping that has been carried out on the first level of detail is about identifying the processes that entail the business of Volvo Cars Uddevalla. These processes are then categorized to provide an outline of the core of VCU’s business activities, and which components that support the business as well as the components that lead the business. As follows, the result of this process mapping is a main process map.

A second process mapping was made on activity level. The purpose of this mapping was part to reveal and make clear the composition and appearance of the processes, and part to analyze the processes in order to find possibilities of improvement. The main process, “provide premium cabriolets”, and the support process, “handle deviations”, were mapped and analyzed. The work resulted in process maps on activity level, which was designed to be integrated with the business system of VCU. Connected to the process mapping, a value analysis was carried out on the main process, and the support process, “handle deviations”, was subject to a problem analysis.

Finally, parts of the main process were mapped on a far higher level of detail where all operations and logistic flows were taken into consideration. Apart from being used as a connection to work descriptions in the business system, the results from this process mapping were used as a conceptual model in the bottleneck analysis of the process, which was carried out through the means of Discrete Event Simulation. The result of this analysis is an estimation of the capacity of a manufacturing system in the pre-implementation phase, sensitivity analysis of different factors such as quality disturbances and availability, optimization of buffer sizes and calculations of the optimum manning for different scenarios.

Background
VCU was during the study in the middle of a structural change. The ownership structure was changing with Pininfarina as a new majority owner. The work at VCU was carried through in the initial phase of a product switch to a new generation of cars with a ramp-up in production. The triggering factor for the work was a lack of adequate process maps for the organization of VCU.

Purpose
The report’s main purpose is to supply VCU with the main process map on activity level detail. Further purpose is to analyze the main process to find areas of improvements. This is conducted thorough a discrete events simulation of the main process with the goal to analyzing the capacity of the process.

Process view
A process is defined according to Ljungberg & Larsson [1] as a repetitive network of linked activities that uses information and resources to transform an “in-object” to a “out-object”. A
process can be categorized as a main process, support process or management process. A main process is a process that realizes the business idea.

The process can also be broken down into three levels of hierarchy. These are displayed in the figure below.

**The main process map**
The methodology for the creation of the main process map was mainly a “walkthrough” method, with interviews with area managers along the production line. The result of the study was a main process map which consisted of five sub processes:

- Plan short-term production.
- Manufacture Body
- Paint Body
- Final Assembly of Body
- Ascertain Quality

**Plan short-term production**
Plan short-term production is a process that has the purpose to coordinate and collect customer orders into a production sequence for the three different plants. The process is closely connected to the production and demands knowledge and presence in the production process. The process creates value because it allows the customer flexibility with order changes and adds to the VCU delivery precision.

**Manufacture body**
The purpose with the process is to manufacture a car body. The process encapsulates all activities that are performed to manufacture the car and the connection between these. A big proportion of the activities in this process are value adding.

**Paint body**
*Paint body* is the process that transforms the raw body into a painted body. As in many car factories the paint shop is the slowest producing unit in VCU and is because of this considered as the bottleneck. The main reason is the slow ovens which harden the paint.

**Final assembly of Body**
The process Final Assembly of Body transforms the painted body into a drivable
car. The activities in this process are mainly value adding and consist of working stations in different production lines.

**Ascertain Quality**

The purpose of this process is with the help of tests and controls to ascertain the cars’ quality before the car is delivered to the customer. Most of the activities in this process have no real value creation. But from the customer perspective these activities are essential because they identify and correct the product and due to this the whole process is value creating.

**Handle deviations**

Handle deviations were identified as a support process for the main process. While creating the main process map problems in this process were identified, and due to the high interaction with the main process the process was considered to have high impact on the performance of the main process, especially considering the product switch. Two main problem areas that were identified and analyzed were “containment of defect cars” and “the definition of a deviation”.

**Simulation**

The purpose of this analysis is to estimate the capacity of the VCU manufacturing system, which constitutes of a larger part of the main process. This was conducted through sensitivity analysis of different factors such as quality disturbances, production cycle time and availability. The methodology for the creation of the simulation model was adapted from Banks [2].

![Figure 4. Model creation Banks 1996 [2]](image)

**System definition**

The system that was defined for simulation in the study was the assembly shop. The main reason for this was that the assembly shop was undergoing the largest changes.

**Conceptual model**

During the production flow mapping of the defined system, the abstractions of the conceptual model emerged. The abstractions’ main focus was to reduce the complexity of the model without affecting the validity.

**Simulation model**

The system was simulated in the simulation program Extend. The conceptual model was divided into modules, whose individual behaviour was initially studied and validated to aid with the validation of the total model. The simulation itself was conducted as a full-scale trial with different scenarios where factors such as quality and availability were varied. The outcome of these scenarios was then used as a basis for sensitivity analyses of the factors.

**Simulation results**

The primary question which the simulation was supposed to answer was whether or not the assembly shop could meet the
capacity target for the new model. According to the simulation, the assembly shop will be able to meet that target. Furthermore, a study was made as to whether conveyor belts instead of the current AGVs (Automated Guided Vehicles) would make a significant impact on the production volume. The tests showed that conveyor belts would not lead to a significant increase in production. Despite lacking buffers, the assembly shop still had sufficient buffering capability to absorb most of the fluctuations caused by downtimes and quality problems. This was mostly due to certain “stations” such as turntables, which could house a car but which had a lower cycle time than the workstations. Additional results from the simulation were optimized staffing for certain tasks, and control rules for the body buffer.

References
