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Information exchange within the area of tool design and sheet-metal-forming simulations

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Today, shortened lead-times in the automotive industry have raised requirements on rapid information exchange. The increased use and access to the Internet have created possibilities to transfer information to people independent of location. This development, together with the increased speed in the portable computer technology, has opened possibilities for bringing results from sheet-metal-forming simulations directly to the customer. Previously, the results were presented with pictures; now it is possible to use animations. The only requirement is to have access to a post-processor or a viewer that is powerful enough to handle the results. The advantage with animated results is the improved possibilities to follow the sheet-metal-forming process.

In this project, the methodology for reporting results from sheet-metal-forming simulations at Volvo Cars Body Components is studied. A potential for improvement would be possible if the reporting procedure is changed from paper copies to a database structure. In the database the results should be stored as files with animated results that the user is able to rotate and zoom. This methodology will contribute to faster and more accurate decisions because it will be based on current information and the user could easily analyse the results without access to special programs.

1. Introduction

Sheet-metal-forming simulations have become more common in the automotive industry during the past decade and are efficient tools for many applications. The most significant advantages compared with try-out methods are the time and cost reductions. The use of sheet-metal-forming simulations in the automotive industry has been described by Makinouchi (1996) and Makinouchi et al. (1998).

The use of sheet-metal-forming simulations enables the possibility to visualize the forming process. With the simulation technique, it is possible to animate the process and thereby analyse it during the punch stroke. If the same analysis is performed in a real tool, the punch stroke would be stopped at different heights and both material and time would be wasted. The simulation technique, on the other hand, can achieve results without these drawbacks. It can also be much easier to bring the results to the customer or analyse them without being tied to the access to a press-shop.

However, paper copies traditionally present the results from a sheet-metal-forming simulation since the simulation software requires specific programs to visualize the results. This is a drawback since a complete set of animations of different parameters requires a lot of paper copies and makes it hard to follow the forming process.

It would be an advantage to store the results in a database where animated results from the sheet-metal-forming simulations were stored. Then the results would be easy to access and analyse. The requirement is to have access to a post processor or a viewer that is

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powerful enough to handle the results. It is also necessary to have a database, which could store the results and is easy to search. The database must have possibilities to be accessed via the Internet and have effective security handling for sensitive information.

This paper describes a method for handling and distributing results from sheet-metal-forming simulations within a company.

2. Methodology

The project was limited to the procedure for information exchange of results from sheet-metal-forming simulations at Volvo Cars Body Components (VCBC).

To establish which information is important to exchange and who is using it, an investigation was made regarding the need for information. The next issue was to find a suitable exchange procedure that would be easy to access and handle for both the customer and the producer. Since there are several ways to distribute information within VCBC it was also an aim to use the internal information channels. This makes it easier for all parties to use the exchange channels since they were already familiar with them. After having established both the needs and channels for the information exchange, a tool for creation of the results in a suitable format was investigated.

3. Work flow for tool manufacturing

During the development of a new car model, the tool manufacturing process is a very time- consuming and cost-consuming part. To establish the role for sheet-metal-forming simulations in the automotive industry, a short background description of the tool development procedure is needed.

The development of the tool manufacturing work-flow has changed over the last decade. Previously, a normal work-flow could be described as shown in figure 1.

Since the tool production has a large influence on the lead time for the development of a new car model, a critical issue has been to reduce the tool development time as much as possible. One way of doing this has been to introduce sheet-metal-forming simulation. The technique of sheet-metal-forming simulation has contributed to reductions in the lead time mainly by:

- reduction of the number of try-out tools to a minimum;
- analysing many different design proposals at an early stage;
- analysing the process in detail in every stage of the forming process.

At VCBC, sheet-metal-forming simulations have been a part of the production procedure for the last half-decade. The workflow of designing a tool can be seen in figure 2. Compared to the old method (figure 1) the simulation technique interacts with the different activities early in the process which contributes to faster and less costly development process.

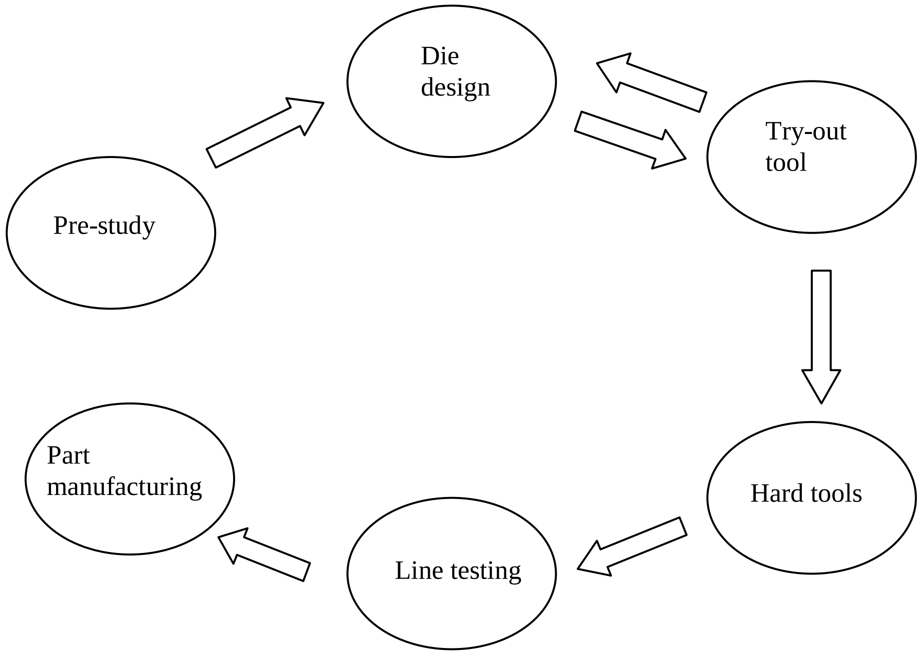

Figure 1. Traditional work-flow in tool design.

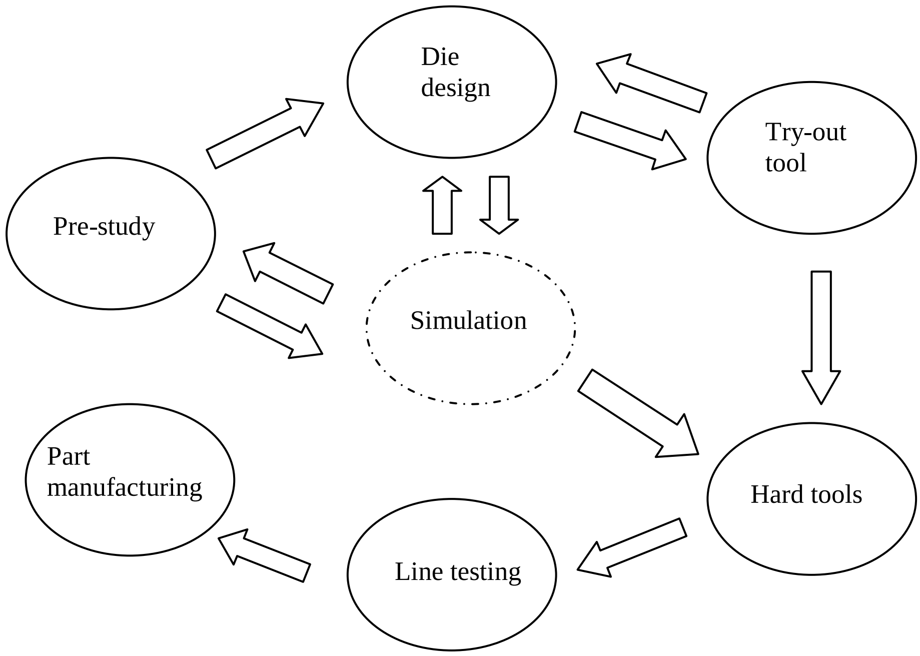

Figure 2. Work-flow in tool design with access to sheet-metal forming simulations.

4. Information exchange

Information exchange has always been an important issue to succeed with complex projects such as producing a tool. In the past decade the information exchange has changed both in terms of methods and channels. Information methods could be defined as ways of achieving accurate information about an issue, and information channel is how the information is distributed. The increased pressure on shortened lead-time has raised demands on better and faster information exchange.

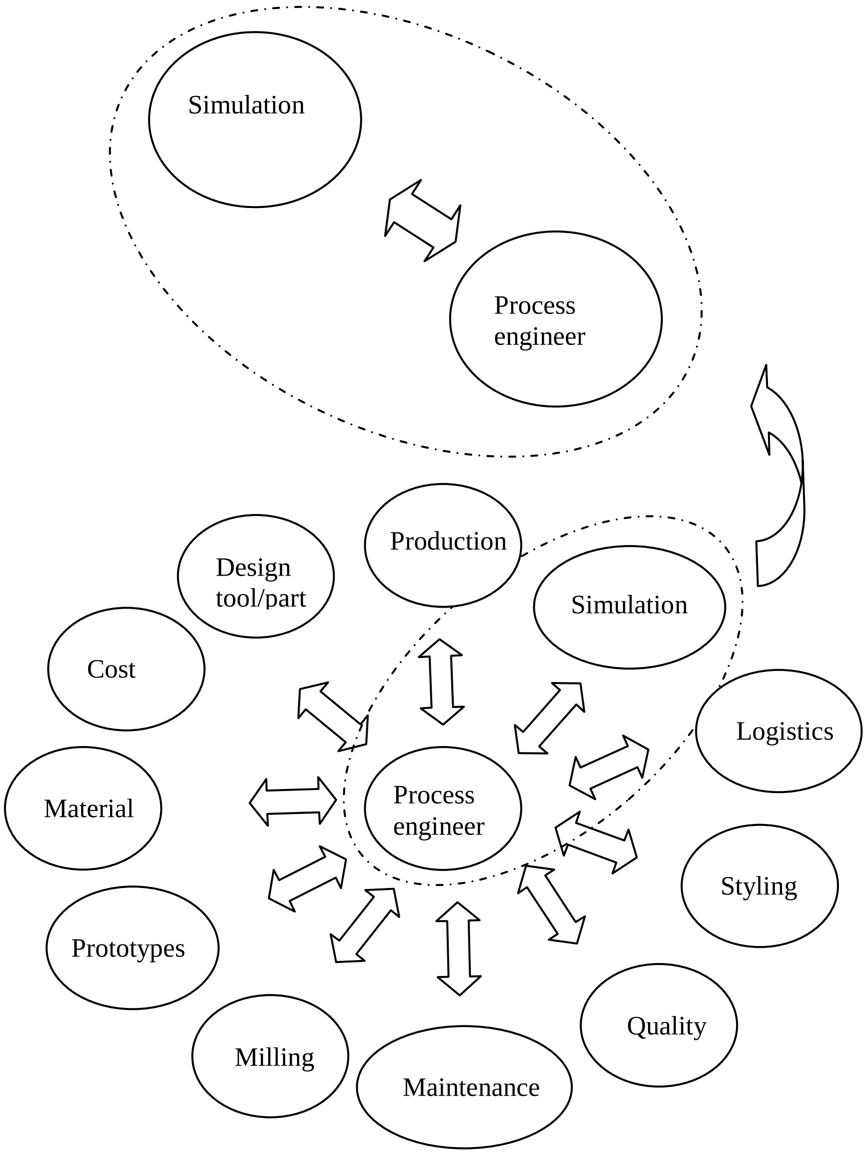

Figure 3. Information exchange in a tool manufacturing process at VCBC. The information exchange between the process engineer and simulation was investigated in this project.

In figure 3 an example of the information exchange is seen for a tool development process. The figure is simplified so only the main information channels are visible. An ordinary process for development of a tool is much more complex. In order to achieve better understanding of the need for information structure we hereafter concentrate on the interaction between the process engineer and simulation (see figure 3).

There is intense information exchange between the people working with sheet-metal-forming simulation, Finite Element (FE) specialists, and the people working with the die design (process engineer). Traditionally, at VCBC, the results are analysed at the department of virtual verification. The form of analysis is that the FE specialists show animations of the results on a workstation and these results are analysed by an experienced die designer and the FE specialist together. After discussion of the results, the FE specialist writes a report where the most important results are presented.

This form of information exchange restricts the customer to a paper copy of the results of the sheet-metal-forming simulation. If the customer needs additional information it is necessary for him to have access to a post-processor or another visualization tool.

Figure 4-6 show examples of the information that is exchanged between the FE specialist and the process engineer. The results are from a sheet-metal-forming simulation of the hood outer of Volvo V70.

5. Use of new information exchange technology

Today many companies have an internal communication system, an Intranet. At VCBC this is accessible via Internet, which makes it possible to access the information stored in this system by means of portable computers. To access information, the only requirement is to have a connection to the Internet via for example, a mobile phone. Figure 7 shows a proposal for an effective information exchange using tools which are available today.

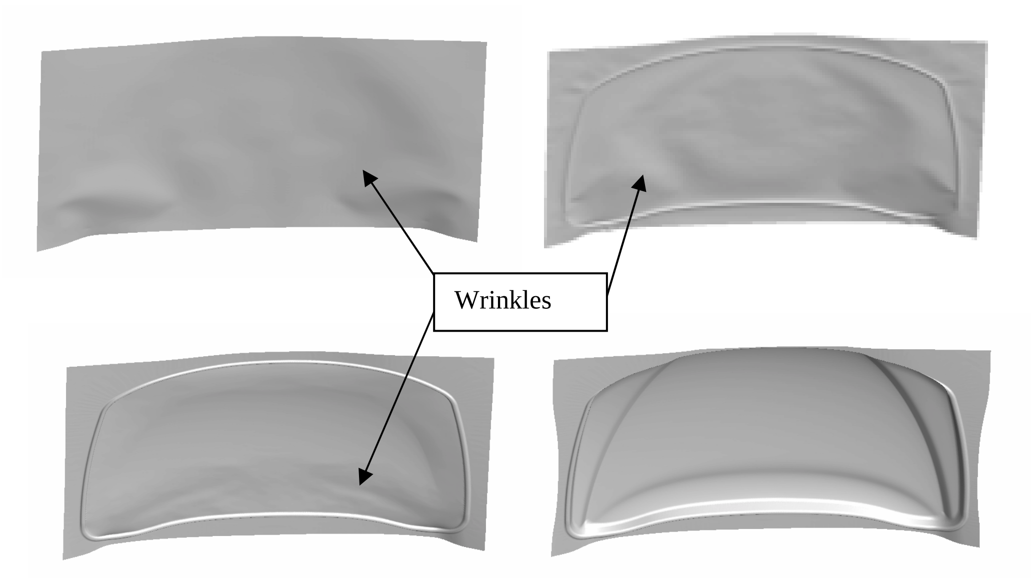

Figure 4. Development of wrinkles during the forming procedure.

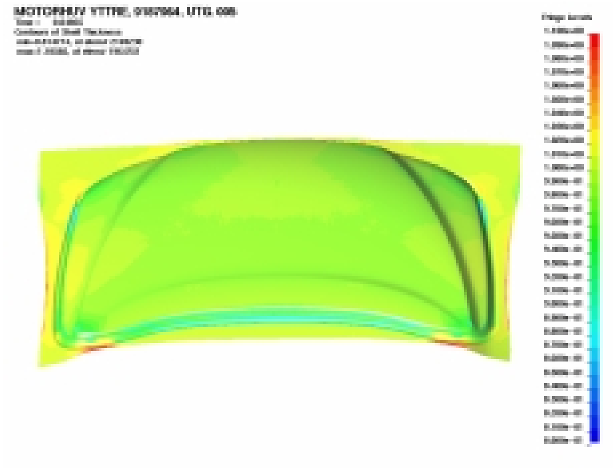

Figure 5. Thickness distribution.

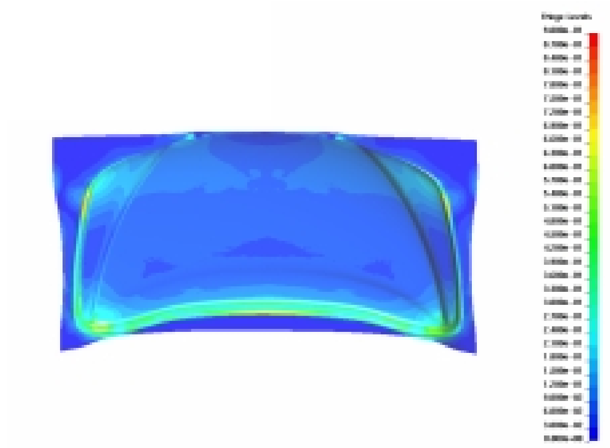

Figure 6. Risk for failure (FLD). Areas with risk for failure are in red. The principal strains are for all elements plotted in a diagram and those which are located above a limiting curve (FLC) are considered as failure. This is described in Pearce, 1991. FLC can be achieved from experiments.

5.1. Database

The information, e.g. reports, can preferably be stored in a database where it is easy to search for the required information. One proposal is to use Lotus Notes which allows storage of large datafiles. In this database the information is stored in different reports which are produced by the FE specialist as mentioned in section 3. In the reports, animation files with specific results such as thickness distribution and strain distribution are stored and can be viewed by a customer.

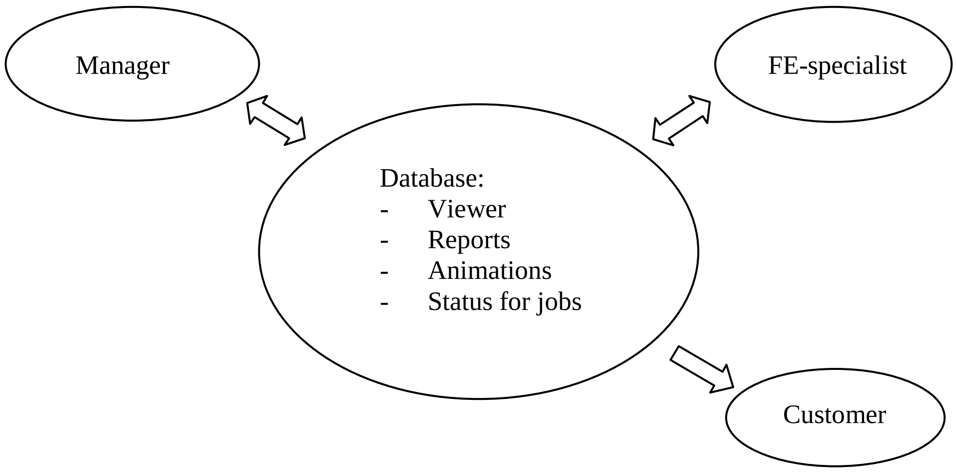

Figure 7. Information exchange.

5.2. Result files/reports

The result files/reports must be stored in a form at which can be read by a viewer. The viewer should be able to handle the animations in the reports, which are generated by the FE code, and visualize them for the user. Today there are many viewers available as free-wares (free of charge) on the market. Most of them, however, are limited in that the animations do not permit moving or zooming of the model.

Ceetron (2000) provides a post processor where animations can be exported as files on a format called "vtf". Ceetron also provides a viewer called GLview Express, which is a free-ware that can read the vtf format. In the viewer it is possible to rotate and zoom the model so it can be analysed by the user without the need for an expensive post-processor.

If a software with these capabilities is installed in the database, it gives the user the possibility to install it on an ordinary PC and view/analyse the animations independent of location

5.3. Economical aspects

The economical aspects of improved information exchange can e.g. be:

- shorter report time;
- decreased education costs;
- decreased lead time for decision;
- decreased licence costs.

5.3.1. Shorter report time. Today a report contains a number of pictures to describe the forming operation. With a technique like that described in this article, where the pictures are replaced by animation, one could cut the time for report writing by half. A small calculation example is as follows.

An engineer simulates 30 parts per year. For each part, the technique saves 2 hours. This gives 60 saved working hours per engineer per year. If the engineers’ time costs 100 Euro per hour, this gives a saving of 6000 Euro a year per engineer in increased efficiency in report writing.

5.3.2 Decreased education costs. With a viewer, it is easy to have access to a variety of different parts and analyse them in detail. This educational tool does not require the help from an experienced engineer, who should run the post-processor or viewer. This contributes to a more efficient use of the forming knowledge within a company since more persons could be used for information exchange.

5.3.3 Decreased lead time for decision. In the automobile industry of today, the tool design are often carried out by subsuppliers. These subsuppliers have regular and dense contacts with the car manufacturer. This demands a lot of time and travel. With access to a good tool for information exchange the meeting would be more efficient. It is easier to explain problems in the process when there is a possibility to analyse the part from different views during the meeting. Another advantage is that the participants do not need to interrupt the meeting due to lack of analysing causes.

5.3.4. Decreased license costs. The license cost could be minimised since the customers do not need any special post-processor to view the results. Since the methodology proposed in this article is based on that the viewer is a freeware, the need of post-processors will be minimised.

5.4. Advantages

The accessibility of the information contributes to faster and more accurate decisions because these will be based on current information. This technique would also decrease the amount of paper copies since all information will be accessible on computer.

Presentations of the results would be easier since the only thing that is required is a PC. Compared to the techniques of today, a presentation would not require a FE specialist to handle the software and post-processors that are licensed for a suitable special computer software. The economic saving is hard to estimate but, according to the calculation example in section 5.3.1, only the savings in reporting is enough for the license cost. If the other cost savings are accumulated, it is obvious the cost-saving potential is large.

6. Results

A suitable solution for VCBC was to use the software from Ceetron (2001) that was mentioned in section 5.2. After some modification, it was possible to generate animations of the most important results from a sheet-metal-forming simulation i.e. wrinkles, strain distribution, thickness distribution and risk for failure. These results are then stored in Lotus Notes, together with a viewer. This database is going to be connected to VCBC´s Intranet. Then the results would also be accessible from a portable computer.

The size of the result files requires that the viewer and the PC, which is used for analysing the results, have enough speed and memory to handle the models. During the project, problems occurred due to limitations in memory allocation. This problem must still be solved before VCBC can use this proposal for information exchange in full scale.

It is important to have a clear strategy for the database so it is easy to find the material searched for. It is preferable to have fixed headings or categories where the reports are stored so the database will be searchable.

Since the tool manufacturing process is a long process it is important to treat reports regarding modifications that appear during the development of the tool in a structured way so it is easy to follow the development in the database.

7. Summary

This study has focused on the results from the FE group at VCBC. One of their software packages is LS-DYNA (2001), which is treated in this work. Since other software is also used by the FE group, a limitation is that GLview only handles results from LS-DYNA. Since a report consists of results from different programs e.g. Autoform (2001) and LS-DYNA, it would be preferable to be able to handle all the results in the same viewer. However, it is the final and most important results, the verifying simulation, that is performed in LS-DYNA. Therefore it is an advantage to have a viewer that handles these results.

To achieve a successful information exchange the main concerns are:

- easy access to results;
- the possibility to analyse results without requirements of stationary software or expert personnel;
- the possibility to access the results from any location;
- a viewer that can be installed on a PC free of charge; if not, the cost for the software would be unnecessarily large.

Acknowledgement

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