# USING VIRTUAL REALITY IN DESIGNING THE ASSEMBLY PROCESS OF A CAR

**Ilse Becker[1], Ville Toivonen[2] and Simo-Pekka Leino[3]**
(1) Valmet Automotive and Tampere University of Technology, Finland (2) Tampere University of Technology, Finland (3) VTT Technical Research Center of Finland and Tampere University of Technology, Finland

## ABSTRACT
This paper presents a study of a company that is testing virtual reality (VR) tools in designing the assembly process of a new car model. This is the first time in the company's 40-year history that virtual reality is used in the designing process. The company designed its production processes simultaneously with the product development which was done by a newly founded company located on another continent. A benchmark research was made in the case company to find out, which virtual tool features are needed when designing an assembly process. Collaboration usage of the virtual reality tool was tested with the product development (PD) over internet. A review of the existing literature showed that the focus of the research in VR has been mainly in product development or in single subassemblies. Different kinds of systems were found with various features. Regarding the assembly, some system features were essential for virtual prototyping. No literature about similar cases was found where the target was to design the whole assembly process sequence of a brand new vehicle designed by a brand new company collaborating for the first time in a tight schedule.

*Keywords: Immersive Virtual Build and Prototyping, Simultaneous Engineering, Design of Assembly Process, Benchmarking*

## 1 INTRODUCTION
There have been many research papers published about using immersive virtual reality in product development in the automotive industry. A few of them have been written from the virtual assembly perspective, e.g. Jayram et al. [1] have been doing research in Washington State University together with the Virtual Assembly Technology Consortium (VATC) where also industry has been involved in. In the research they used a tool called VADE (Virtual Assembly Design Environment) which was developed in the University. In their case study of assembling the fifth wheel to a truck chassis, the downstream value to ergonomics was evaluated. However, their study focused on individual subassemblies. Bullinger et al. [2] have been studying virtual assembly together with concurrent engineering developing "right first time" -methods like virtual assembly planning and ergonomic prototyping. In their method also VirtualANTHROPOS – a virtual model of a person – was applied. Also assembly sequencing was part of their research. Volkswagen has been using virtual reality in their company quite a long time, since 1994 [3]. The software and hardware possibilities were much more limited at that time. The term VRAD (Virtual Reality Aided Design) is used in Volkswagen. The scope in virtual product design differs from the scope in designing a virtual assembly production process. In order to produce cars of top quality, the production process needs to be designed simultaneously with the product so that the product engineering design receives feedback from the production engineers and their requirements, thus resulting into an optimal process designed and implemented. The case company is talking about simultaneous engineering but in the literature also the term concurrent engineering is used. Krause & al. [4] explain the difference of the two terms: their finding is that concurrent engineering is most often used in the American language area, while simultaneous engineering is more common in Europe. Both terms describe the parallel development work with all the partners who are integrated in the product design and engineering process. Simultaneous engineering and virtual assembly process have been developed and tested with good results for instance in a rock crusher manufacturing company [5]. Even though engineering design and production departments involved in simultaneous engineering were from the same company, the virtual assembly sessions were facilitated by a sub-contractor. Utilization of VR improves

communication and collaboration between engineering design and production. It also enables better human requirements management, better safety and ergonomics, cost effective verification and documentation process, and increased productivity. The process included data conversions from CAD to VR, but the biggest bottleneck was the lack of a common PDM. Especially feedback, like deviations and such, from reviews should be attached within the model and somehow transferred back to PDM. In the traditional automotive industry simultaneous engineering and collaborative design is not a new phenomenon. E.g. Toyota is one of the most famous companies who have made use of this practice to a great extent [6]. Also many other traditional automotive companies are using simultaneous engineering in this manner. But when it comes to automotive companies who are cooperating for the first time, with no previous common history, the situation is more complicated. In the case study, the design comes from a brand new OEM (Original Equipment Manufacturer) who is designing a car of the new era. The manufacturing partner shares over 40 years of history with traditional OEM's. The time to market is essential because of the competitive situation in the car market. These circumstances make a challenging starting point for the whole cooperation and design task. Huhtala et al. [7] have described how the time pressure in product development and time to market has grown in the past years (Figure 1). The starting point and hypothesis in this study was that VR as a tool is a necessity in the projects of the new era. The aim was to find out, what kinds of features the commercial systems have, and which of them are needed in the virtual assembly design at the case company.

## 2 THE CASE COMPANY'S HISTORY AND STATUS TODAY

The case company is located in the southwestern part of Finland. It has been manufacturing cars for over 40 years for traditional OEMs. In its manufacturing role the company has also been using more or less simultaneous engineering by designing the production process at the same time as the product is being designed in collaboration with the OEM. In the beginning of the 21st century the company's strategy was expanded from contract manufacturing to service providing. Traditionally, very soon after the concept phase, physical prototypes are built to get an impression of the product and its manufacturability. In 2008 the company made an agreement with its first customer of the new era. The partners agreed that the car should be developed simultaneously with the production. Time to market pressure existed and led to a situation in which the production process has to be designed by virtual prototyping. That is why the case company decided to test its first immersive virtual build system to design the assembly process. In addition, they decided to conduct a pre-study to find out, what are the advantages of virtual build for them, and what properties are needed in the system in this context. By using the immersive virtual reality system in the production process design, the cooperation partners wanted to get as near the DfM (Design for Manufacture) and DfA (Design for Assembly) targets as possible. This kind of early design can be compared to making movies, as illustrated by the filmmaker Howard Hawks's comment in the Chicago Tribune interview: "The one thing I've learned about making movies is that you can't fix a film once the shooting begins. If it's not right in the script, the problems are only bigger as the images move from paper to the big screen." [8]

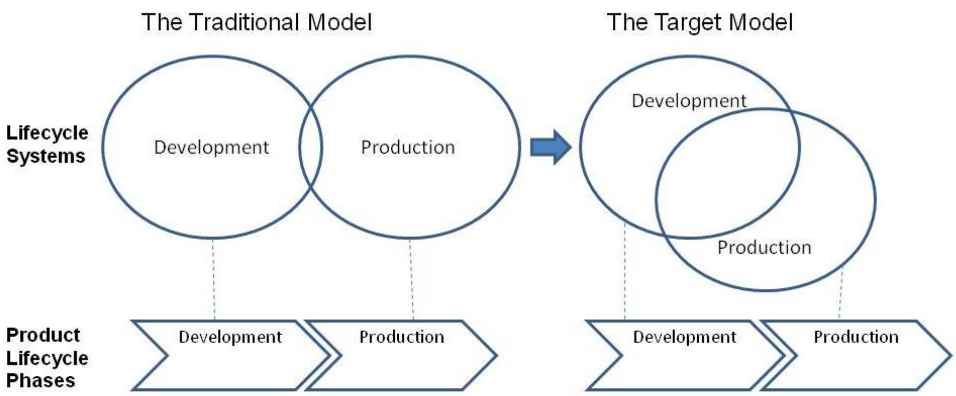


*Figure 1. The incidence of lifecycle system at the change of the product lifecycle change; the traditional and target model. [6]*

### 2.1 Virtual prototyping and virtual build

In the case company the method is called virtual build. It can be compared with virtual prototyping (VP) and virtual assembly (VA) which are more familiar terms. Wang [9] claims that there is still much confusion with the terminology in this area, for example with the terms virtual reality (VR) and virtual environment (VE). Mäkiranta et al. [10] define the differences between CAD and VR, and say that VR is an interactive system where the user is acting in immersive virtual environment set up with help of several hardware and software tools. Wang [9] made a comparison of VP and digital mock-up and found them very similar. For VP Wang proposes the following definition: "Virtual prototype, or digital mock-up, is a computer simulation of a physical product that can be presented, analyzed, and tested from concerned product life-cycle aspects such as design/engineering, manufacturing, service, and recycling as if on a real physical model. The construction and testing of a virtual prototype is called virtual prototyping." Furthermore, he included three essential types of models in virtual prototyping, as shown in Figure 2:

- a 3D solid model
- a human-product interaction model
- Perspective test related models.

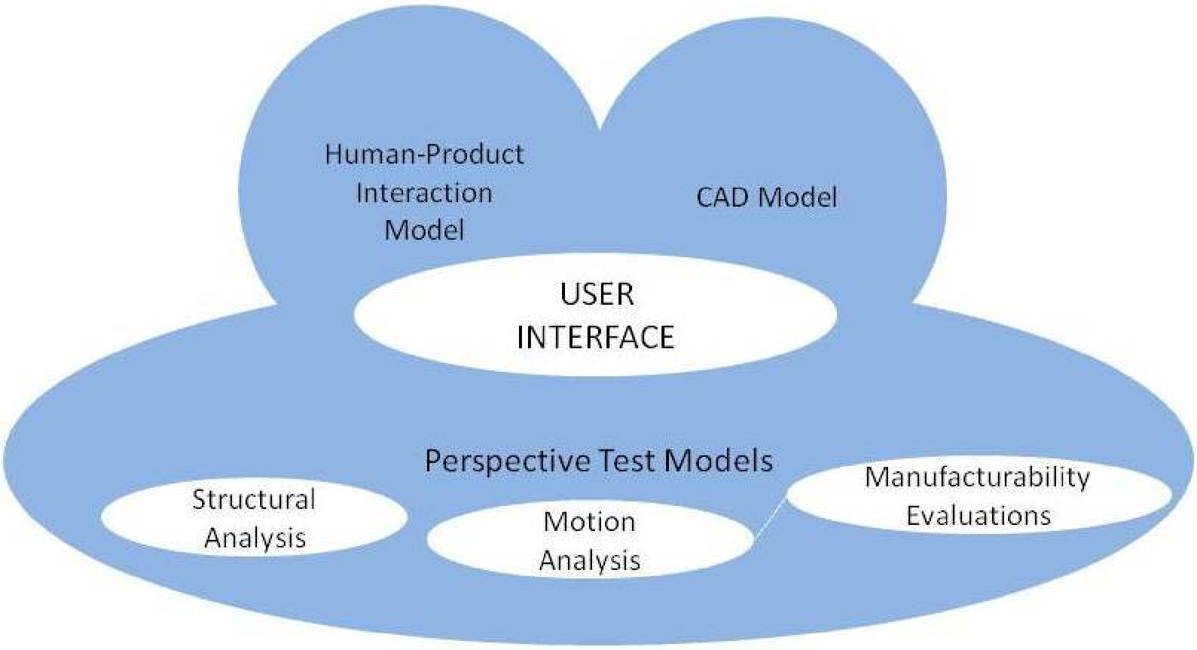


*Figure 2. Components of a Virtual Prototype, 3D solid model, Human-product interaction model and perspective test related models [9].*

Virtual build in the case company utilises the CAD model in a virtual environment. A human manikin can be included for ergonomics analysis. Often modelling the motion tracks of the assembly worker is considered more time consuming than beneficial, so detailed analysis is only applied to the most problematic assembly sequences. Kinematic and structural analysis can be included in the virtual prototype, but they are not considered important from the virtual build point of view. The manufacturability evaluation is based mostly on the expertise of the SE (Simultaneous Engineering) teams, i.e. no quantified analysis tool is used for giving an index score.

## 3 METHODS

The case company wanted to gain understanding of immersive virtual reality through virtual prototyping of the designed vehicle regarding the assembly production process design. In this design the company focused in the manual assembly process with an immersive VR tool. Body shop and paint shop processes with robots were designed with other tools. In the assembly shop the SE teams needed to get understanding of the new vehicle and figure out how and in which sequence it should be built up in the assembly shop process. The SE teams used all of the three models included, but what was most important for them in the Perspective Test Models category was the evaluation of manufacturability. When they noticed something difficult to assemble they made a change proposal for the design engineering. This simultaneous engineering was used as a collaborative tool with product design engineering at the OEM. Simultaneous engineering work between the product development and the case company's production process design is very important because it gives the engineers the possibility to design for assembly and manufacturing. To evaluate the manufacturability of the vehicle design, the SE teams needed the help of the immersive virtual prototyping. In the previous traditional vehicle projects, this work was done with a physical prototype by pulling the vehicle down and building it up again. In the new case project there was no physical prototype and the evaluation had to be done through virtual modeling. At the same time they also wanted to conduct a pre-study with different kind of systems to find out, which would be the most suitable for the future projects. Figure 3 shows the context of the production process planning, where a VR system was applied to assembly sequencing. The change of focus also derives different needs for the system compared to a traditional user experience or product functionality focus of the product design.

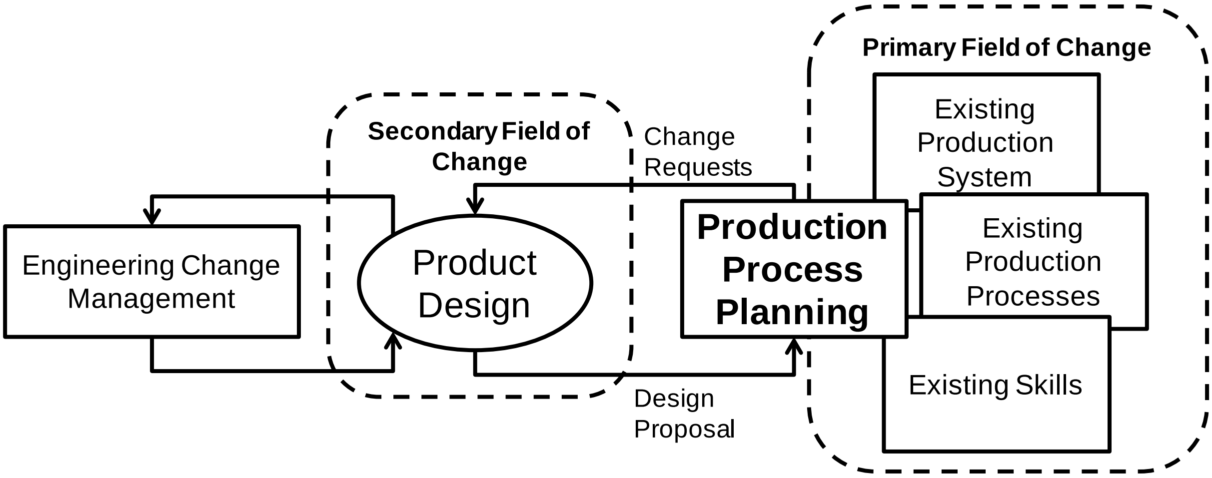


*Figure 3. The SE teams propose their ideas to the product design when planning the assembly sequence within the line stations. This is an ongoing discussion until the final design is ready.*

The purpose of production process planning is to verify that the designed product can be manufactured or assembled in economically viable way as well as in an ergonomic way. Process planning often has limited possibilities to affect the design, so the primary field of change is in the current production system. Any change requests need to go through a change management process of the product design before they can be applied, which also causes time lag and additional costs. The problem is that in the early PD phases the change management process is not ordinary and that may cause time delay in processing. A large portion of the production expertise is tacit knowledge of the workers or otherwise described in a way that makes a direct computational analysis difficult. A Virtual Reality system can be used in process planning for facilitating the communication between assembly personnel when there are no physical prototypes of the product design.

## 3.1 The benchmarked system tools

Close to a dozen different VR software were considered and evaluated based on their listed features. Three of the prominent systems were tested in actual use. The system names are left out as the authors do not want to advertise nor recommend certain commercial software or to involve themselves. The systems were tested from the assembly point of view, not from product development point of view.

***System A***

Test system A was in use for six months altogether. It was a whole package of hardware and software including a mobile screen with a 64 bit PC cluster, two cameras for tracking, two 3D projectors with good resolution and over twenty passive glasses. During the first three months there was a consultant from the system supplier running and preparing the sessions according to the information he got from the team leaders. The next three months the case company's team leaders did the preparations by themselves and also moderated the sessions. This was possible after the group of team leaders had been educated to use the system.

***System B***

System B was the next system tested. The system was simpler. The rented hardware consisted of one 3D projector and three active 3D glasses. There was one 64 bit PC. The test conditions were not exactly the same but this system did not need to be analyzed in exactly the same way as the first one. The case company rented this system only for two months, because they already had the first experience of immersive Virtual Build and its possibilities. They had also planned the assembly sequence with system A, and system B was benchmarked against system A and the experiences with it.

***System C***

System C was the third system tested and the last one in this case study. It was an integrated part of the CAD system in use. It had also a shorter test period for similar reasons as system B.

## 3.2 Collaboration testing

Also collaboration sessions with product design engineering were tested with system A. The OEM had implemented system A as well, and in the collaboration session both partners could see in their own VE e.g. the same fitting parallel. The data which were transferred were only the position coordinates of the subassembly. The assembly itself was exactly the same revision of a CAD model at both sides' servers.

## 3.3 Virtual tools usage test

In the first phase the company tested system A. It was mainly used in the general assembly and also to some extent in the paint shop, where the sealing operations were tested from the ergonomic aspect. In these assemblies the team sees how well the part fits its position, if there is enough free space for the assembly tool, and if the assembly is ergonomic for the person who is doing the assembly.

Before the virtual build session is started, a process engineer has made a proposal, in which order the parts are fitted in the car body. The new car model was planned to be assembled on the same line than the previous one which had been in the production already for some years, and this had to be taken into account. Especially as the previous model was produced by another OEM and differed extensively in design. The test proceeded by starting to assemble the parts in the body at general assembly station 1 line 1. When having assembled all the station 1 parts the team starts to do the same on station 2 etc. The assembly stations layout is shown in the figure 4. There were also several subassemblies which needed virtual build before fitting them into the car body, e.g. the instrument panel and the front and rear sub frames of the chassis. This was also done by the teams responsible in a similar manner. During these assembly sessions the proposed sequence was discussed and changed if the team came to that conclusion.

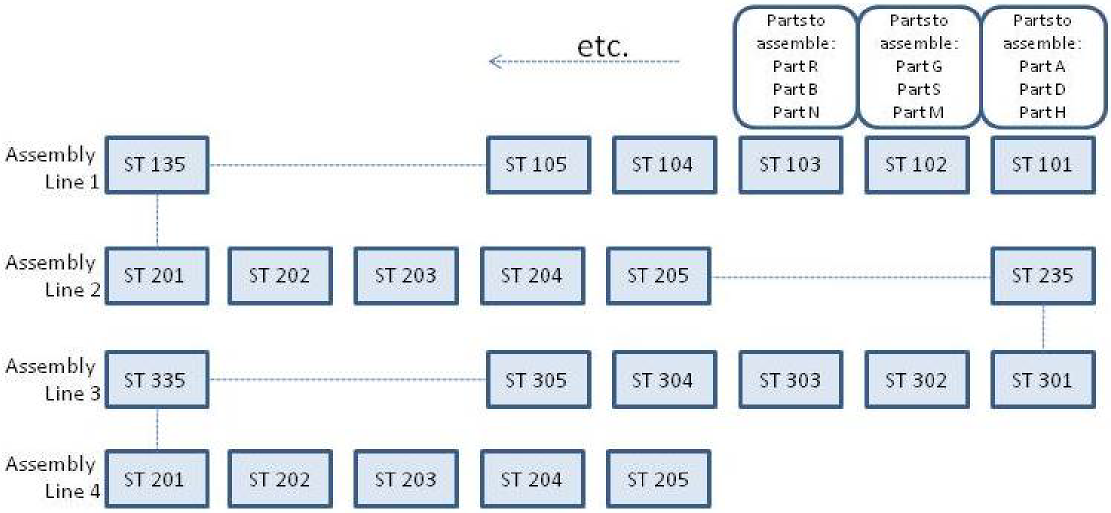


*Figure 4. The assembly station layout and lines in the process*

### 3.4 SE teams in virtual build, participant interviews

Figure 4 shows a session going on with SE team and a moderator from the system vendor.
After having tested all the three systems, nine participants were interviewed by using a questionnaire. The participants were mostly team leaders from the manufacturing department. During the new project they had learned to use CAD in analyzing the product subassemblies. Previously they worked mainly with the physical parts. They were asked the following questions for example:

- what was their opinion of analysing assembly issues with the VR tool compared to a normal screen review
- what was their opinion about the effectiveness of VR on solving assembly problems
- did they notice any benefits in learning the new product with VR
- was there enough space for everybody participating in the VR sessions

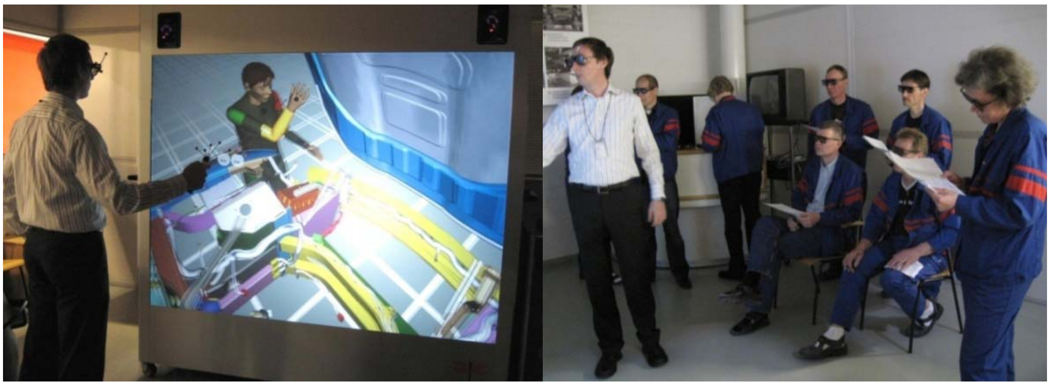

*Figure 5. SE Team with moderating consultant in planning the assembly sequence virtually*

## 4 RESULTS AND LESSONS LEARNED

### 4.1 Comparison of the tested systems

The main criteria in comparing the tested systems were:

- the inbound data flow, where the data preparation and conversion efforts were relevant
- the working process itself during the sessions, operating the system and the ways of use.
- the outbound data flow: how the analysis results could be shared and utilized

The main target of the sessions was to find out the possible assembly sequence for the new vehicle. The assembly sequence used on the current production line had to be taken into account. To be able to define the sequence, the teams had to know how much space there was for the assembling tool to operate and if it was ergonomic to use. To find out these facts, a possibility to measure between different parts and clearances was needed. Also cutting sections possibility in the assemblies was sometimes necessary to find out the exact state of all assemblies involved. The tracking feature, where the car body moves when the system operator moves, was found not necessary in the virtual build case. The most suitable environment in the virtual assembly was one power wall, which also was tested. CAVE (Cave Automatic Virtual Environment) equipment was also tested a bit and found that it was more for the PD. This was also the conclusion in Volkswagen Company [3].

The test results of the three systems are collected in Table 1. System A had good visuality and also operating with it in the session was good. The negative experience with the system was that the preparing work was laborious and time consuming with all the CAD data conversions. Since there were also uncertainties with the accuracy of the CAD data versions, this resulted at its worst to a session break, requiring new preparations and postponement to the next day. The benchmarking group visited during this project another car factory which was also using system A. They did not have problems with the conversions because their management of the CAD data was well-run with help of a PDM system. They had a converter integrated to the system which converted all updates that engineers had made during the day automatically in the night.

With the systems B and C no conversions of the CAD data were needed. Actually any CAD data didn't need preparation in system B, because the software was designed to project any Open GL data to VE on the fly. The case company was using only single CAD software with the product models, so the multi-software support was not so necessary in their case.
System C was a part of the CAD system that was already in use in the case company, which was an advantage in this case. No data conversions were needed and the user interface had the most important features for virtual build process, e.g. it was possible to take measures of the clearances and cut out sections from the assemblies. With system C there was no time to test tracking or ergonomics with a human model but according to the manuals those should also be possible.

### 4.2 Results of the collaboration test

The efficiency and results of the simultaneous sessions were not remarkable. Repetition was often needed as the bad quality of the audio hindered mutual understanding. Also because of different native languages understanding was not the best possible. The SE team leaders spoke fluent English but the manufacturing team leaders did not. The manufacturing personnel's opinion was that taking a snapshot of the issue and emailing it to the partner with comments was a much more useful way to communicate, especially considering the ten hour time difference.

*Table 1.*

*The table describes the performance of the tested systems in those features which were meaningful for the case company.*

| | A | B | C |
|---|---|---|---|
| Inbound data flow | Not good | Excellent | Excellent |
| Working process | Excellent | Not good | Good |
| Outbound data flow | Good | Not good | Excellent |

### 4.3 Results of the interviews

Almost everyone (eight out of nine) said that VR increased clarity compared to a regular screen projection very much or greatly (four or five on a scale from one to five). It also helped in learning a new process. Also as many (eight), said the system speeded up problem solving very much or greatly. The results of the sufficiency of space varied depending of the respondent. The lack of space was considered a problem when session had over twenty participants, and most respondents preferred a group size of five to ten people. The screen was not wide enough for big groups and those on the side were not able to see the VE anymore. Also the session operator standing in front the screen and using the wand to move the parts disturbed often if there were many people participating. In most sessions the operator sat with a PC in the back corner and used space mouse, which worked better for visibility. The interviewees experienced a need for file conversions very negative. The main reasons for this were occasional mistakes with the session preparation and the following need for arrangement of a new meeting.

### 4.4 Management of the CAD data and engineering changes

A PLM system is absolutely necessary in managing the CAD data. The system should be properly integrated with the product design. This was not the situation in the case company at the beginning of the project, because the product design was in another company. Managing engineering changes during the product development process and especially in its early phases is a big challenge. There are numerous changes and the process is typically quite fuzzy in this phase. Later, as the parts have been released, the case company starts an engineering change managing process with change requests and change orders, including the system managing the changes. But before that, the problem spreads to the whole engineering network, e.g. subcontractors and suppliers who design their tooling based on the 3D models.

### 4.5 Transferring the CAD data

Another problem related to the PDM is the communication line between the partners. It is challenging to get an efficient and secure communication line up and running between the partners in order to transfer the 3D data. This is hard to believe, considering the Internet era and broadband connections, which almost everyone has at home. But in the product development cases it is not so easy. The difficulties experienced here are:

- the big companies have their own internal networks secured with firewalls etc. against attacks from outside
- the 3D data in the product development is top secret and is to be protected from third parties
- if using the Internet, the transfer security of the files is essential
- the file sizes are often very big and transferring over the Internet takes a lot of time
- when establishing a leased line between the simultaneous partners the costs are considerable; furthermore the establishing requires at least two service providers unless the partners are located in the same country

Many researchers have recognized the PDM integration problem. At the beginning of this paper we already mentioned the study by Leino [4] introducing a crush rock company who lacked a common PDM although they operated in the same company. The technical university in Dortmund is doing research in a project called ADiFa [11] (Anwendungsprotokoll zur Prozessharmonisierung in der Digitalen Fabrik; User Protocol for Harmonizing the Processes in the Digital Factory), where they are defining the potential improvement areas in digital factory. The aim is that the whole product development network is properly integrated and that the data management is accurate. The potentials of the digital factory can be utilized fully when the isolated digital methods, tools and models are integrated into a common engineering system, in technical as well as in organizational aspects.

### 4.6 Heaviness of the cad models

The virtual build of a car using the CAD models causes the model to become so heavy at some point of the process that lightening the model by erasing unnecessary items inside the subassemblies would be helpful.

## 5 CONCLUSIONS AND DISCUSSION

The case company was constrained to implement immersive virtual reality system in the assembly production process design due to the time to market timetable in the case project schedule. This is more or less presumed to be the situation also in the future. In order to survive in the new strategic situation, the company wanted to find the most suitable system for their virtual prototyping. Three systems were tested from the case company's point of view. The main criteria which governed the decision of the selected system were:

- The assembly parts can be moved with a space mouse or a wand so that the team gets an impression of assembling the part like in real world
- Collision detection is essential because the quarters of the car body are close and there is often too little clearance to get the part assembled
- From the previous reason also measuring of the distance and clearances in the assembly have to be checked in some situations
- The possibility to use a human manikin in some special assembly cases was also one criterion. The assemblies should be so ergonomic that the installer will not get stress injury
- CAD model conversions were unwanted in the case project. In another kind of project where the CAD data versions are managed and organised properly with a PDM system and which also does the converting automatically during the night, conversion could also be conceivable
- The tracking feature was not necessary in the virtual build case. But if the case company plans to do product development in virtual reality the tracking should be disposable then

Immersive virtual environments are widely implemented in the automotive industry. In the domain of assembly simulations they are used for different aspects: testing and optimization of the assembly processes as well as defining the assembly sequence. The assessment of the ergonomics of the assembly sequence is also important. In both situations, the display of a full scale model and the involvement of multiple people are crucial for the validity and significance of these evaluations. This study has been made by Salzmann et al. [12] inside the Volkswagen Group. The case company made the same conclusion in their new car project, even more so as the only possibility to do the prototyping in the beginning was virtual. To make it look as real as possible, using immersions with the help of a third dimension was essential. Blach et al. [13] have been studying the phenomenon and claim that the major difference between VR systems and other 3D systems like CAD is the response time and update rate, which should be so high that the boundary between the user and the virtual environment vanishes. This has been noticed also in a study made at Volkswagen [3]. A common PDM system was also found as an essential precondition needed to have efficient sessions in virtual build. In addition to the researches mentioned earlier in this paper, also Rouibah [14] has made research about existing PDM systems and their support when exchanging data across company borders. He encouraged in his research into the development of new generation of PDM, called Collaborative Product Data Management, cPDM. Also Kuvaja [15] has stressed this feature in a case where there are separate companies doing the development and manufacturing and where the OEM usually is responsible for total project. In that case an active reporting system is needed in order to have a successful project. The reporting is needed additionally to support the CAD model management in the PDM system; because the engineering change process is not yet ordinary in the early PD phases. Kotinurmi et al. [16] has also been studying the integration between separate development and manufacturing companies as well as component suppliers. The degree of difficulty increases if the companies have different CAD systems. In that case the product structure data integration is usually not easy to transfer.

The case company is still in the middle of the project to productize the new car model. When the serial production has started, a follow-up research could be made in the case company of how good the virtual build succeeded in the assembly planning and what were the main problems in that case. Further study could also be made in the case company to find out the possibilities how to create preparedness for a collaborative PDM system. The already much studied research object of engineering change management could also still be examined in the case company and from the early PD phases point of view by reviewing the literature carefully and extensively to find out, what results there are in that area.

## REFERENCES


[1] Jayaram, S., Jayaram, U., Young, J.K., DeChenne, C., Lyons, K.W., Palmer, C. Mitsui, T. *Industry case studies in the use of immersive virtual assembly.* Virtual Reality (2007), 11:217-228.

[2] Bullinger, H.J., Richter, M. Seidel, K.-A. *Virtual Assembly Planning.* Human Factors and Ergonomics in Manufacturing. Vol. 10 (3), 331-341. 2000

[3] Zimmermann, P. *Virtual Reality Aided Design: A Survey of the Use of VR in Automotive Industry.* Advanced Summer Institute on "Product Engineering: Tools and Methods based on Virtual Reality", 30th May-6th June 2007

[4] Krause, F-L., Franke, H-J., Gausemeier, J., *Innovationspotenziale in der Produktentwicklung.* 2007. Carl Hanser Verlag München Wien

[5] Leino, S.-P., Kiviranta, S., Rantanen, P., Heikkilä, J., Martikainen, T., Vehviläinen, M., Mäkiranta, A., Nuutinen, P., Hokkanen, I., Multanen, P. (2010) *"Collaboration between Design and Production by exploiting VR/AR and PLM - Case Metso Minerals"* 3rd International Conference on Applied Human Factors and Ergonomics - AHFE2010. 17- 20 July 2010. Miami Florida USA

[6] Morgan, J.M., Liker, J.K., *The Toyota Product Development System: Integrating People, Process And Technology.* 2006. Productivity Press.

[7] Huhtala, P., Pulkkinen, A., (toim.). *Tuotettavuuden kehittäminen – Parempi tuotteisto useasta näkökulmasta.* 2009. Teknologiateollisuus ry.

[8] Campbell, R.G., Roth, E.S. *Integrated Product Design and Manufacturing using Geometric Dimensioning and Tolerancing.* 2003. Marcel Dekker, Inc.

[9] Wang, G., G., *Definition and Review of Virtual Prototyping.* Journal of Computing Information Science in Engineering. September 2002. Volume 2, Issue 3, 232 (5 pages)

[10] Mäkiranta, A V., Multanen, P., Leino, S-P S. & Lind, S M. 2009. *Method and tools for machine maintainability design in VE.* The Sixth International Conference on Condition Monitoring and Machinery Failure Prevention Technologies, Dublin, Ireland, 23-25 June 2009 pp. 877-888.

[11] ADiFa; *Anwendungsprotokoll zur Prozessharmonisierung in der Digitalen Fabrik.* Projektlaufzeit: Juli 2008 bis Juni 2011. Technische Universität Dortmund. http://www.aps.mb.tu-dortmund.de/cms/de/Forschung/Aktuelle_Forschungsprojekte/ADiFa/index.html

[12] Salzmann, H., Jacobs, J., Fröhlich, B., *Collaborative Interaction in Co-Located Two-User Scenarios.* Joint Virtual Reality Conference of EGVE – ICAT – EuroVR (2009)

[13] Blach, R., Landauer, J., Rösch, A., Simon, A. *A highly flexible virtual reality system.* Future Generation Computer Systems 14 (1998) 167-178.

[14] Rouibah, K. , *Managing Concurrent Engineering Across Company Borders: A Case Study.* 2002. IEEE, Proceedings of the 36th Hawaii International Conference on System Scienses (HICSS'03).

[15] Kuvaja, K., *Autojen sopimusvamistajien asema Simultaneous Engineering –toiminnassa ja integroituminen tuotekehitysprosessiin.* JOKO 32/2008

[16] Kotinurmi, P., Becker, I., *Towards Seamless Product Structure Information Integration.* 2008 eBRF Conference in Tampere.

Contact: Ilse Becker
Tampere University of Technology
Department of Production Technology
Valmet Automotive Inc.
23500 Uusikaupunki
Finland
Tel. +358405422210
Fax +358204848009
Email: ilse.becker@valmet-automotive.com

Ilse is a PhD student at Tampere University of Technology. She has started these studies in autumn 2009. She has been working several years in the case company which is manufacturing cars for different OEM's. In the past five years she has been acting in simultaneous engineering teams cooperating with the OEM's in product design. She is interested in many aspects of simultaneous engineering and, in particular, how to adapt oneself to the new era projects and manage project work that differs completely from the traditional ways.