ISMR SAYS: **Simulated sheet metal forming operations have improved product quality, reduced body component lead time and married a more distinct, attractive design with improved manufacturability at Volvo Cars Body Components' plant in Olofström, Sweden.**

Form and fu

Volvo Cars' designers and engineers have allied form and function with speed and precision in the development, production and delivery of car body components – using simulation techniques to achieve their goal

In Sweden, roughly one in every five cars sold is a Volvo. In 2005, the Swedish manufacturer sold a total of 443,947 cars to over one hundred countries.

Volvo Cars head office, product development, marketing and administration are all based in Göteborg, Sweden. Its final assembly facilities are in Göteborg, Ghent (Belgium) and Pininfarina in Uddevalla. Most of the car body components are stamped at Volvo Cars Body Components in Olofström and Göteborg. Volvo Cars is currently to start local automotive production in China – the new Volvo S40 will be built at Volvo Cars' partner Changan Ford's production plant in Chongqing.

Volvo Cars has been a wholly owned subsidiary of Ford Motor Company since 1999 and is part of the Premier Automotive Group (PAG) with Jaguar, Land Rover and Aston Martin. Volvo Cars is also a Centre of Excellence for Safety for Ford Motor Company and a Centre of Excellence for Telematics for PAG.

ISMR was invited to its 291,314 m^2 plant at Olofström, 150km north east of Malmö, which produces approximately fifty million car body components per year. In 2005, Olofström consumed 400,000 tonnes of sheet metal, delivering car body components by train and container to various plants and customers.

Volvo Cars Body Components' plant in Olofström, Sweden

New launches and requirements

With a vision to be recognised as the most competitive stamping operation delivering high quality car body components through a robust, lean and environmentally-friendly production process, Volvo Cars Body Components at Olofström has, with the smart use of metal forming simulation techniques, improved the manufacturability of Volvo Cars' distinctive design and reduced costs and part lead-times.

Volvo Cars Body Components uses mainly mechanical presses and has twenty press lines, two transfer presses, one power press and five coil-fed presses. It is also in the process of constructing a new hydraulic press line which should stand ready in the end of 2007.

Volvo Cars Body Components has twenty press lines

The Olofström plant delivers body components mainly to Volvo Cars' final assembly facilities in Göteborg, Ghent and Uddevalla. It also delivers components to Ford of Europe and PAG.

"We produce panels and subassemblies for two body-in-whites per minute," said Anders Skogsgårdh, manager, Engineering Stamping CAE, at Volvo Cars Body Components. "Ten car models are currently in production and there are approximately two new car projects per year. It is unique to have so many models in the same press shop at the same time and we make extensive use of forming simulation to early secure manufacturability, reduce lead times and costs."

Sheet metal forming simulation

Core processes for Volvo Cars Body Components include manufacturing engineering, tooling and

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Above (l-r): Kristoffer Trana, senior forming analysis engineer; Anders Skogsgårdh, manager of Engineering Stamping CAE and Dr. Mats Sigvant, technology area leader, FE-simulation at Volvo Cars Body Components

the production of body components (stamping, sub assembly and material planning/logistics). The Stamping Engineering encompasses Stamping CAE, Die Process Engineering and it liaises with Strategy and Concept, Assembly Engineering, Geometry and the R&D/Design in Göteborg for new product development.

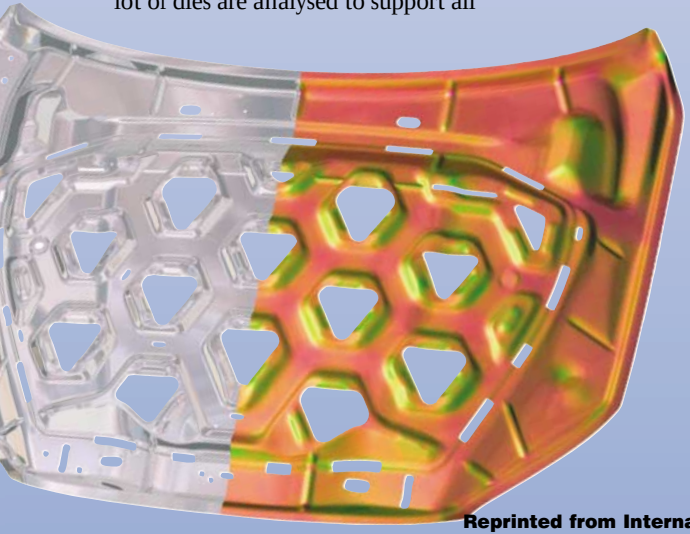
"There are forty people in Stamping Engineering," Anders Skogsgårdh told ISMR, "and seven of us work in sheet metal forming simulation."

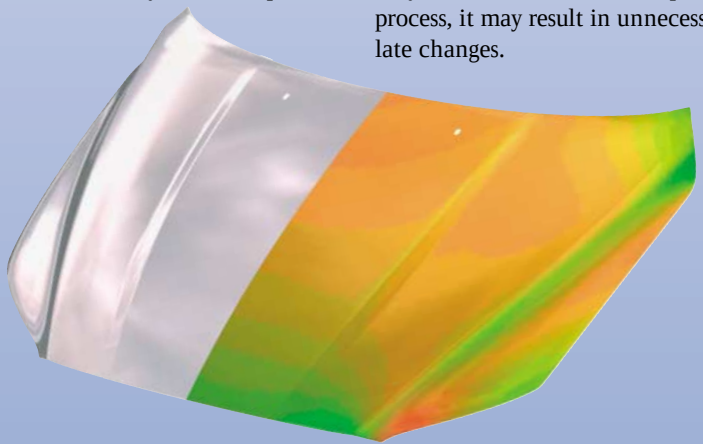
Volvo Cars Body Components uses AutoForm CAE software for draw-die development/optimisation, layout of trimming and flanging tools, detection of surface defects, calculation and compensation of springback, optimisation of material usage etc. Pre-production work includes die development, simulated forming, analysis and the manufacture of the formed dies. A lot of dies are analysed to support all the new car models in production.

Above right and below: AutoForm software has enabled Volvo Cars Body Components to perform more accurate simulations

"From 2000, with big changes in our workload and multiple projects on hand, we made the decision to just use AutoForm software for sheet metal forming," said Anders Skogsgårdh. AutoForm's Incremental, DieDesigner and Sigma modules have allowed Volvo Cars Body Components to perform more accurate simulations, analyse more parameters and ensure many more loops and robustness evaluations.

"Some car manufacturers distinguish between simulation and final validation and they like to have two or three different software codes for final validation but we only use AutoForm," commented Kristoffer Trana, senior forming analysis engineer, Volvo Car Body Components. "We found that a multi-code approach was not good enough because if we encounter problems very late in the development process, it may result in unnecessary late changes.



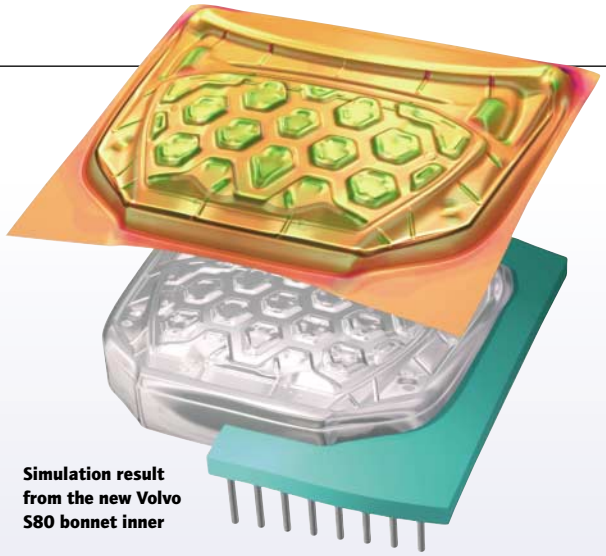


"AutoForm's tooling/tryout solution allows us to simulate more processes," added Trana. "We need high precision and we are constantly trying different processes and simulations to find a optimum between product attributes and manufacturability. One indicator from using sheet metal forming simulation is that the quality of the try-out and the body of the first series production car is so much better than it was five years ago. Surface finish is also much improved. With increased volumes and focus on material utilisation the nesting-module has become more important."

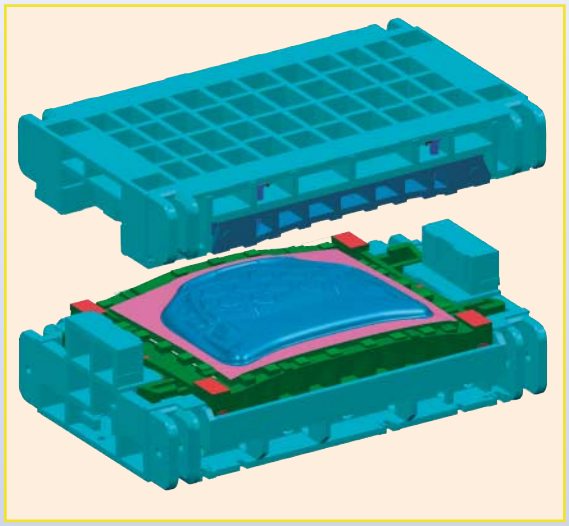
Trana also points out the importance of having core stamping experience and sheet metal knowledge when performing simulations.

"The same engineer who does the sheet metal forming simulation is also present at the tryout floor – this is crucial because we can learn from actual production, get vital feedback and strive for improvement," he told ISMR. "This means that there is real liaison between all the departments."

Skogsgårdh agrees. "Simulation is a key enabler to shorten tooling lead-time and secure manufacturing robustness. We can be assured of reliable, lean stamping production due to stable forming processes, quality assured dies before die manufacturing and better/faster tryout," he told ISMR. "We increase our knowledge with each simulation and, in the process, gather correct CAD data for part and die, which is invaluable for future projects."



Simulation result from the new Volvo S80 bonnet inner



Above: Die Design for die manufacturing

Streamlining processes

Volvo Cars Body Components has recorded a huge increase in output since 2000, incorporating the production of the new S40/V50 (the old S/V40 was stamped at another plant) within its current press shop.

"We have made large steps in accuracy with our simulation processes," commented Dr. Mats Sigvant, technology area leader, FE-simulation, Volvo Cars Body Components. "To be able to increase production, we needed to be better in the pre-production and simulation phase to remove as many problems as possible before the cars

Left: Tooling and high speed milling at Volvo Cars Body Components

Below: Forming sequence of the new Volvo S80 bonnet outer

come to production. We have streamlined the process and lowered tryout times. We now have very few problems with forming dies since the simulation is working well, we are saving money and the results are respected. The bottom line is that people like simulations, they see the benefit. It saves time and cost."

In the pre-study stage, Volvo Cars Body Components simulates almost everything – all line dies, transfer dies and a lot of progressive dies. Die design for simulation is done in AutoForm-DieDesigner or Catia. Volvo Cars Body Components also specifies that contracted toolmakers must use AutoForm software.

"Toolmakers send us their simulation files and we check and approve them," commented Dr. Sigvant. "We would have previously supplied our simulation model and material database to the supplier. We then discuss the best way of producing the tool. Suppliers must produce tools within safety margins for production. One of the benefits from using simulation is to get better tools from third parties. We also support R&D/Design in Göteborg with feasibility studies for new car concepts - different areas may have to be modified using simulation."

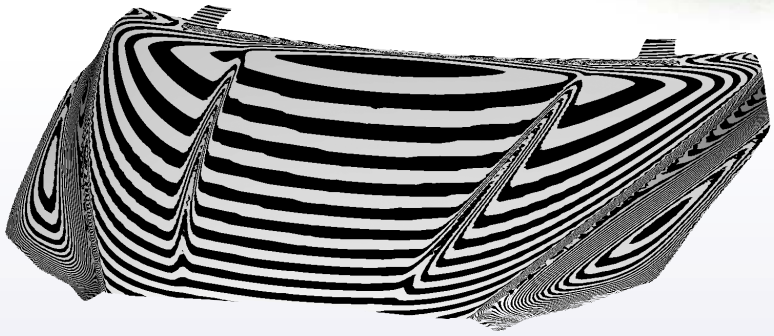
Material issues and challenges

Volvo Cars Body Components has a long history of using high strength steel and aluminium – it was one of the first carmakers to use dual phase materials in volume production and has been steadily increasing its usage of this material over the last ten years. It also uses a lot of tailored blanks but has reached a mature level of consumption for these.

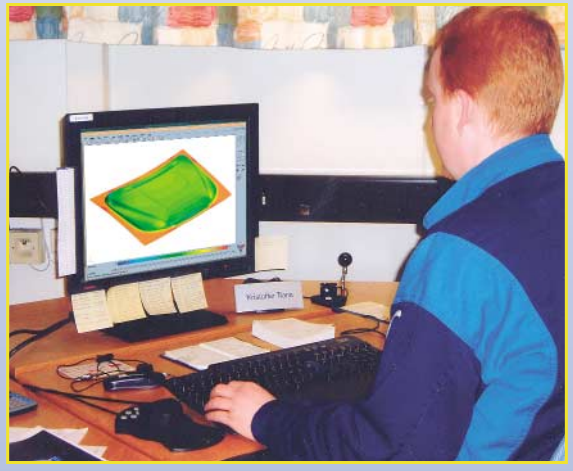
"Today, we have tougher materials but also quite tough requirements," commented Kristoffer Trana. "We need to be aware of issues like springback. This means getting a pressed panel from the draw die quickly while putting the other dies on hold. In this way, we can make corrections to the draw die before we start spend time and money on the following dies. This is also an area where CAE simulation is crucial."

Anders Skogsgårdh agrees.

"Simulation allows us more time to spend on other processes and procedures. We don't have the time to waste – we go from one model to another and there are limited timeframes, which is where good simulation tools are vital."



Right and below: Analysis of surface defects in simulation and at tool tryout/presshop



Above: Kristoffer Trana shows ISMR a simulation of a Volvo car body component

"With some high strength steels, we can find springback problems," commented Dr. Mats Sigvant. "Springback is a challenge and can give different results. In tryout, the physical material results can be different so it is equally hard to handle in the virtual world." Therefore, the springback problem goes hand in hand with, and is very much related to, process robustness and material properties.

AutoForm is tackling the springback problem with a die compensation package in a new version of its software, and with its Sigma module, which was launched one and a half years ago.

"We also determine the material data for forming simulation in corporation with a research company based in Olofström so that we have control over the material data which is input to our simulation processes," added Sigvant. "This means that our database is constantly being updated with new material data."

Another key issue, such as material utilisation, can also be controlled using simulation software, which is particularly crucial in a climate of high steel prices.

Volvo Cars has already adopted a working method with upfront simulation in its car programmes but future demands on lead-time reductions will reinforce this need even further.

"We need to work even harder and be more dedicated with our forming expertise and simulations in the concept, pre-study and die design phase onwards," Skogsgårdh told ISMR. "We need closer collaboration with our suppliers and we need to continuously develop with a focus on four main areas – enhanced materials models (improved material data, failure criteria etc.), springback, surface defects and robustness."

"Car bodies are becoming stronger and lighter," he concluded. "We aim to develop processes with excellent manufacturability that can meet Volvo Cars' distinctive and attractive exterior requirements, demands and core values." ISMR