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This issue contains two blog posts.

Renault SA Proves Simulation Accuracy for Press-Hardening Processes

The automotive industry is currently facing various challenges in terms of design concepts. Legal regulations in a highly competitive market force automotive OEMs and suppliers to change their design paradigms to reduce CO_2-emission. In order to make them capable to meet future requirements –concerning also fuel efficiency and dynamics – the introduction of new material classes, such as manganese boron ultra-high strength steels, was actively promoted. Together with new materials, new production technologies like press hardening emerged and affected the production process planning and process design at the OEMs.

At Renault SA the strategic decision to open up in-house press hardening facilities was taken in 2010. The Douai-plant in France and the Valladolid-unit in Spain were chosen as suitable locations for the installation of press hardening lines. Not long after appeared a need for a state-of-the-art process design tool that would be quick, easy-to-use and therefore cost-effective: evaluation and validation of numerical FEA-tools were done, taking into account the wide variety of parts to be produced in the new press hardening lines. Renault already has sound experience in conducting planning and design tasks for their parts, tools and processes with FEA-tools. Since 2001 AutoForm products have been constantly in use for various purposes. Main fields of activities are drawing operations and process engineering as well as validation, tryout support and press shop support. Therefore, expanding their interest in AutoForm products towards its embedded hotforming solution – AutoForm-ThermoSolver^{plus} – became the logical consequence. Furthermore, the intensified control of quality during production, like temperature measurements - operational since 2014 - for parts, tools and cooling water in the production line, and the already existing measurements of thickness, roughness, mechanical properties, hardness and metallography enabled Renault to comprehensively check the capabilities of the AutoForm solution.

For this purpose, a direct press hardening process for a particular part geometry has been investigated. In this process, the tailor welded blank, made of 22MnB5, is heated up to a temperature of 930 °C and kept at this temperature for a time in a furnace. This ensures the full transformation of the microstructure phase from the initial ferritic-perlitic to an austenitic state. A decrease of flow stresses occurs during the increase of temperature. Plastic deformation is eased and elastic springback effects are diminished in the subsequent forming stage. After the forming stage, the blank is kept under pressure for a defined period of time in the closed and cooled tools for quenching. The microstructure of the part then becomes martensitic, which defines the properties of the final part. High hardness values and tensile strengths values in a range above 1,200 N/mm^2 can be reached depending on the applied steel quality.

In an initial test stage, the capability of AutoForm-ThermoSolver^{plus} to predict the martensite fraction in the part geometry was proven. The laser-tailored blank has two thickness values of 1.6 mm and 1.3 mm: simulations were run for constant blanks corresponding to these thickness values, all other process parameters (including a drawing gap of 1.6mm) being kept constant. Since each thickness has a specific thermal inertia, the cooling path for the part and the phase transformation behavior are affected. For both thicknesses, the corresponding martensite fractions were determined in this rather rough approach and the intended position of the welding seam could be confirmed as technologically feasible (fig. 1). Expectedly, it was pointed out that the overall part becomes “harder”, “stronger” when the thickness is increased.

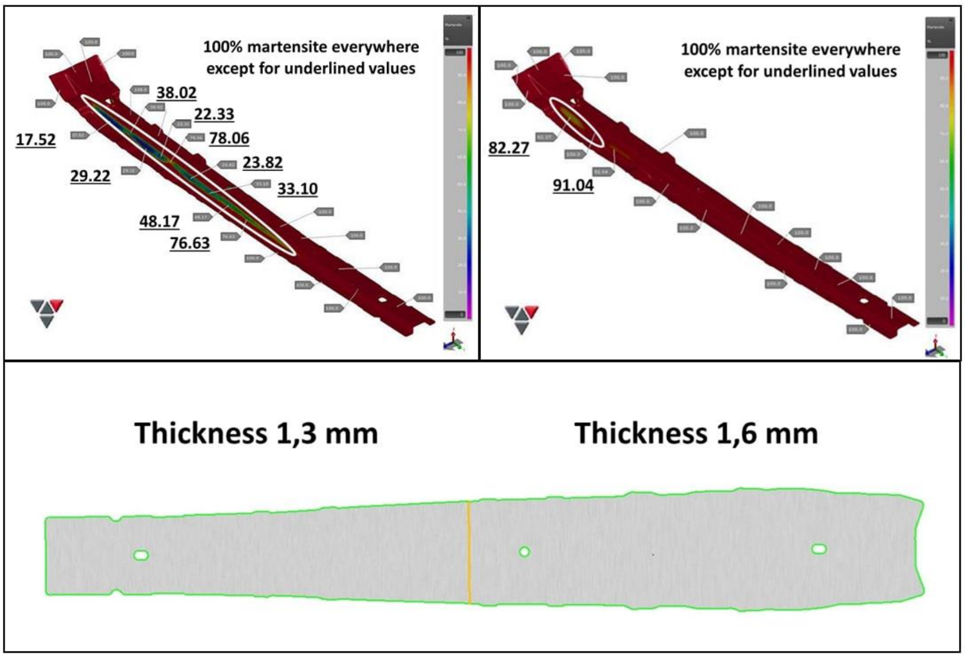

Figure 1: Martensite fractions after direct press hardening of a side member of a thickness of 1.3 mm (upper left), 1.6 mm (upper right) and validated position of the welding seam for the Tailor Rolled Blank (bottom).

In a subsequent test stage, the maturity of the software in terms of mechanical calculations was tested. Therefore, thickness measurements taken from AutoForm-ThermoSolver^{plus} results were compared to real measurements obtained from physically existing parts in the production line after hotforming. The objective was to validate the accuracy of the code in predicting thickness values, considering the tight tolerances needed for the part. It could be shown that there is a good accordance between the computed and the real results (fig. 2). Expanding the interest to the hardness values (HRC) results of similar quality have been obtained. The deviation between the numerically computed hardness values and the real measured results taken from the real part oscillates in a range between +2 and +5 HRC.

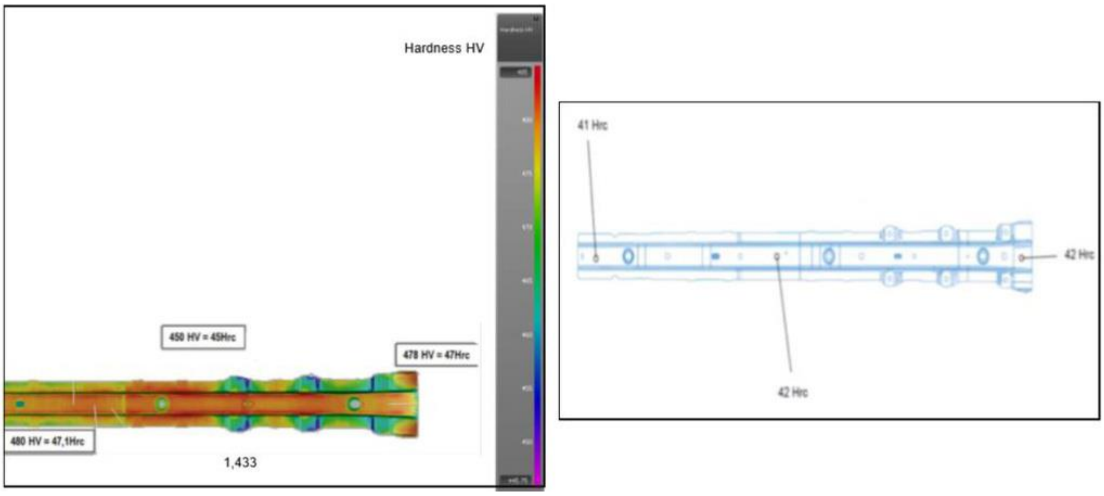

Figure 2: Computed (left) vs. real (right) hardness distribution after direct press hardening of the side member

Another interesting topic was the evaluation of the embedded heat transfer model between the part and the tools, the interaction between the part and the environment through convection and radiation, and the heat conduction within the part. In order to be on the safe side during parameter planning and process design, a thermographic analysis has been carried out. Data obtained by means of the AutoForm solution were compared with real measurement results. For the measurement procedure, a moment in time after drawing in the direct press hardening process has been chosen. First temperature measures were taken 7 seconds after drawing and quenching; another data set refers to a time of 14 seconds after the process, during cooling at room temperature. The entire thermal history through all stages of the direct press hardening process is accumulated in these moments; the implemented models were all validated. The maximum deviation between the computed values and the real results is about 25-30 °C. In all cases the tendency is very well reproduced.

After these encouraging results an entire part and his corresponding process have been simulated. The idea was to optimize the set of input parameters for the real process and the real production equipment, so several simulations had to be performed. In addition to the already described items, the challenging topic was to predict thermally induced distortions and to control them to respect the intended final shape of the geometry. For the previously described laser-tailored blank, a minimal quenching time of 4 seconds was determined in the process. An overall martensitic fraction of 95% for the proposed geometry could be ensured. These results also translate into promising values for the hardness and the corresponding strength. Concerning the thermal distortions an optimum quenching time of 5 seconds has been obtained (fig. 3). For the entire parameter optimization 7 simulations were necessary, each of them took 1 hour.

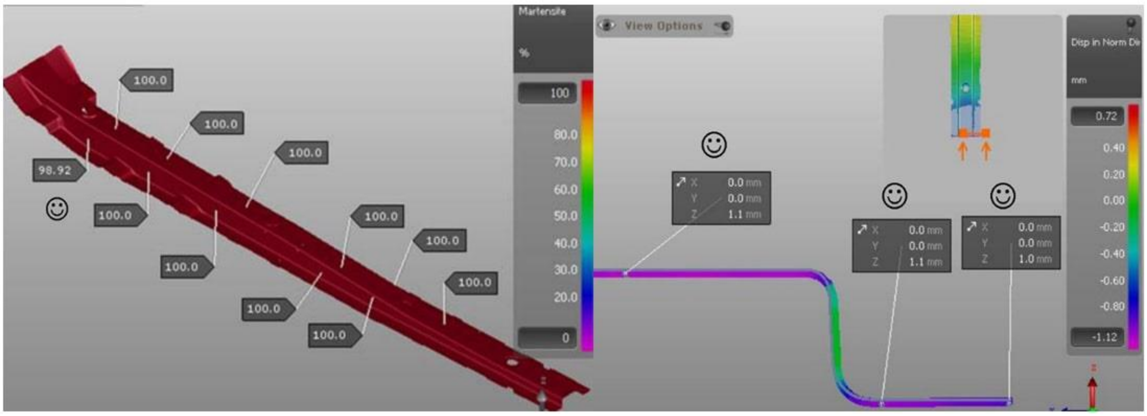

Figure 3: Martensitic phase 95% after 4 sec. (left)
and minimal thermal distortion after 5 sec. quenching time

By comparing numerical results with real data coming from an existing production line, Renault SA has successfully proven the capabilities of AutoForm-ThermoSolver^{plus}. A strong correlation between virtual and experimental results has been validated in detail. The press hardening process determined through simulation is feasible. Since then Renault SA uses this numerical tool for the investigation of feasibility of press hardened products and the corresponding process validation. The most beneficial outcome of such an approach is to ensure fully martensitic phase fractions, controlled thermal distortions, minimal quenching and process cycle times respectively. The virtual approach enables Renault SA to quickly validate feasibility and define optimized set of parameters. Thus the productivity is remarkably enhanced and Renault SA has strengthened its competitiveness.

By Vincent Ferragu, General Manager, AutoForm France

Gestamp Chassis Increases Productivity with FEA Tool Engineering

Gestamp Chassis began developing its processes with the support of AutoForm's incremental simulation software solutions more than a decade ago. It now applies a new AutoForm solution for the design of tool surfaces in the Catia environment: AutoForm-ProcessDesigner^{forCATIA}.

The Gestamp Chassis unit is responsible for analyzing, developing and optimizing all the parts that make up vehicle chassis. The aforementioned unit has production plants, offices and R&D centers across the world. In Spain, it has two centers in Abrera (Barcelona) and Boroa (Biscay).

The Forming Team of the Gestamp Chassis office in Boroa, is faced with demands related to quality, delivery times, costs and functionality, decided to test AutoForm-ProcessDesigner^{forCATIA}.

After almost a year of assessment during which AutoForm was actively put to the test the Gestamp Chassis Boroa team concluded that their newly implemented software had indeed contributed to the streamlining of day-to-day work and affirmed they have obtained the design of deep drawing and formed tools in a simple and swift way, notably increasing their productivity.

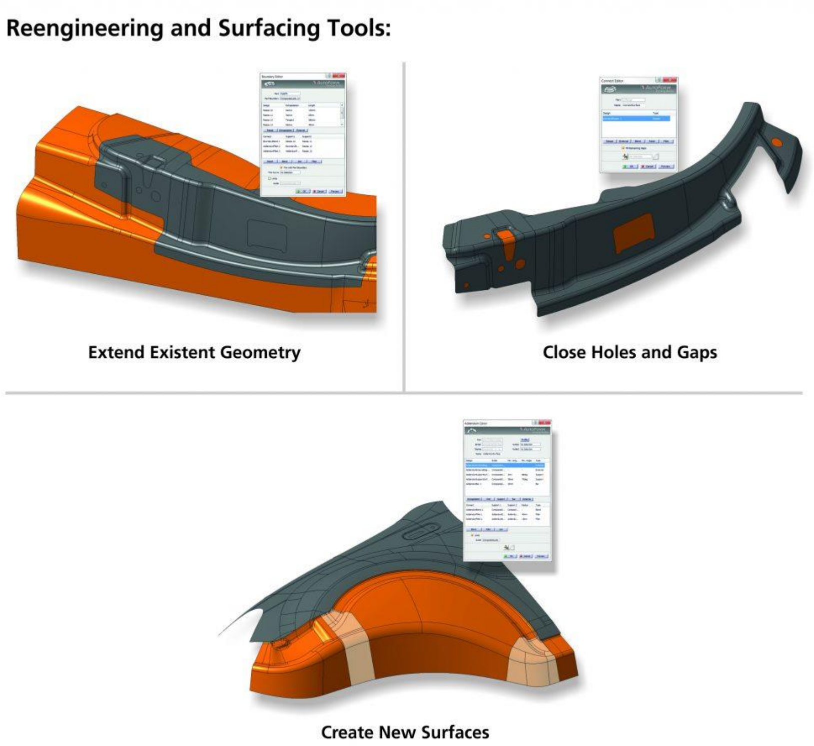

Figure 1 – Re-engineering Surfacing Tools

"Due to the short time frames and excess work, we tried to find a solution that allowed us to work in a swift and effective way. We started to use this AutoForm solution and we were able to affirm that it is a tool that has allowed us to reduce time spent in constructing tools for simulation, and helped enable us to work in a simpler manner," said Beflat Sedano, from Gestamp Spain.

Largely, different products (used either singularly or in combination) are available on the market to support users in accomplishing tool design tasks, but as AutoForm's founder, Dr. Waldemar Kubli, points out "The initial problem engineers used to face before AutoForm-ProcessDesigner^{forCATIA} was launched was due to the lack of dedicated functionalities. Despite the widespread use of different CAD systems in engineering, none of them is fully and efficiently suited to support all necessary phases of the sheet metal forming engineering process. This is particularly evident during the tool design phase when the die layout for the complete forming process must be defined and validated. AutoForm-ProcessDesigner^{forCATIA} represents the strategic missing link that allows users around the world not only to complete designs for drawing dies but also for all secondary operations tools without leaving CATIA environment; and this is really something new."

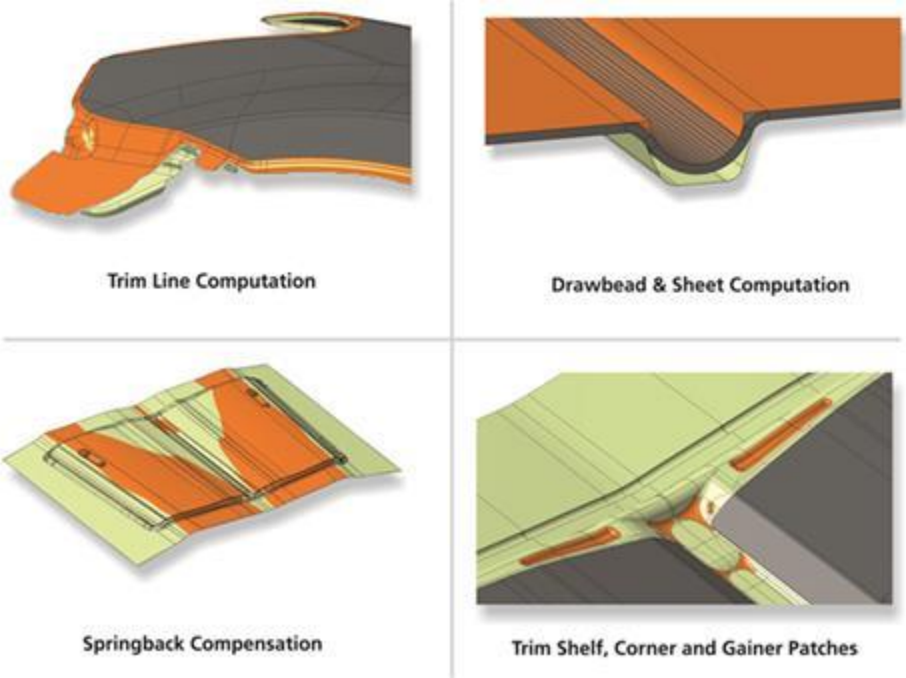

Figure 2 – Some example unique features

“What really makes the difference for them is the fact that our software is developed specifically for tool makers of automotive part designs. Where they save a lot of time is at the point of extrapolating surface. Other software has tools that extrapolate individual tasks, but AutoForm has a specific tool which is able to combine all of them in the easiest and simplest way in one environment. This makes their life easier but not only in terms of speed, also in quality, as it is a must for them.”

The evaluation and subsequent implementation of this solution in the work flow of Gestamp Chassis has been so successful that they decided to quadruple their number of user licenses.

AutoForm is a software integrated into the Catia V5/V6 environment, tailor made for process designers, supporting the customizable workflow standardization of all the parts involved. It combines the experience of AutoForm in sheet metal forming processes with powerful tools for the creation of surfaces designed according to the requirements of the manufacturer. Users can quickly create a die face layout, including all the operations necessary for deep drawing, cutting or secondary operations with various types of cutting or deep drawing tools.

"It is a very intuitive tool for creating processes and the commands that are used are very versatile. Since it is a program designed specifically for the metal Stamping sector. It allows us to save time at the same time as optimizing the design.”

“With just two AutoForm editors we are able to extend facets creating most of the draw die,” Confirms Benat Sedano. The aforementioned editors are the Boundary Editor and the Connect Editor (see video below). “With the former we extend the surface through segments and with the latter we are able to join them.”

Based on the geometry of the desired part, users benefit from the standardized process of the Catia tree. This guides users with methodology based on the steps followed in AutoForm, adjusted to the Catia environment and customized according to the way each client works. The tools and commands are intuitive and boast analytical functionalities for verifying results are consistent and feasible at any moment. Ultimately customers are provided with a predefined standard methodology applicable to any process. This sequence of previously applied and interrelated commands allows for an automatic update of the complete process and prevents errors. Surfaces can also be compensated with the same environment according to the elastic return of the metal sheet.

"So far AutoForm has become a huge tool which the user can benefit from standardized tool design to unique features as Compensator, Clearance or Drawbeads Editor. It is therefore worthwhile using unique features or surface extrapolation as they mainly highlight. In this new R8 version we can design drawbeads with exactly the same geometry as AutoForm Forming or compensate tools not only for inner parts but also for outer parts."

The geometric results that are obtained meet Class A requirements can be used for machining. This solution is the result of an innovative approach that is unique and oriented towards the quality of the design process, which improves and facilitates everyday work in tool design departments.

"For us the most important benefit is the speed of construction as part of the required quality. In addition, the solution provides a standard methodology facilitating the exchange of designs between the team," said Benat Sedano.

AutoForm-ProcessDesigner^{forCATIA} is a solution that is relatively new on the market for AutoForm, compared to its solutions for the incremental simulation of sheet metal forming processes. The technology requires an implementation period within any company Structure and, at the end of the period, provides a customizable standard approach to the design of the process, a consistent methodology and, as Gestamp Chassis has seen, a significant increase in productivity.

Use this link to watch a demo of the software: formingworld.com/demo

By Xavier Serra, Senior Application Engineer, AutoForm Spain

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