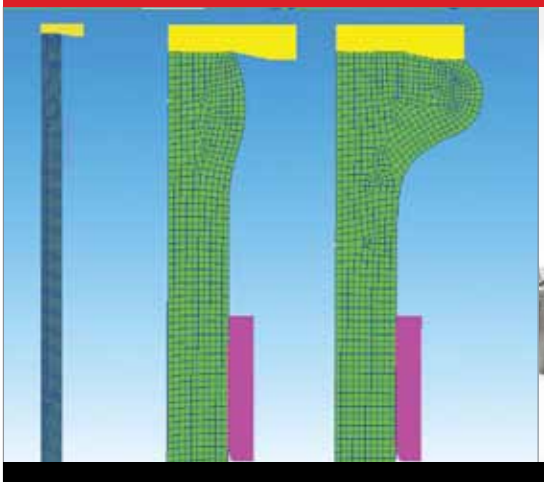
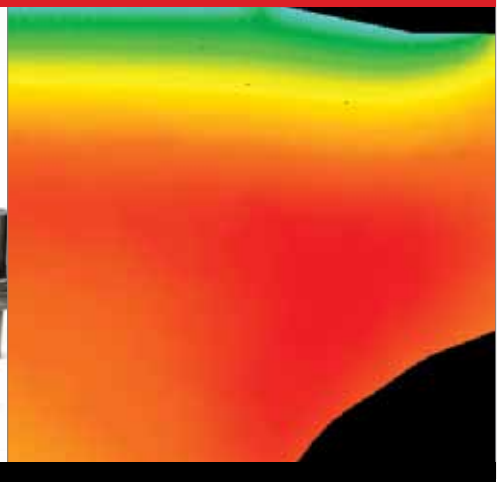
MSC Software

CASE STUDY

MSC Software: Case Study - Setforge

Simulating Manufacturing Processes





The Challenge

An acknowledged specialist in the manufacture of forged products, Farinia Group set up its Setforge Engineering unit to provide its other companies and their customers with leading-edge expertise in forging technologies. One of the major missions undertaken by the unit's engineers and project managers was to find a way of successfully simulating the electro-upsetting process, used to make very long sectional parts.

The Solution

To define an initial digital model and simulate the electro-upsetting process, the company used MSC Patran, a multidisciplinary pre- and post-processing environment, in combination with MSC Marc, advanced nonlinear analysis software, both components of the AFEA bundle from MSC Software.

The Know-How

French group Farinia acquired Setforge in March 2009. Farinia already owned a number of forges as well as foundry and machining facilities, and the acquisition of Setforge made it France's Number 1 forging specialist and one of the leading European groups in the sector.

Farinia adopted the name Setforge for its forging business, and with seven French plants, the division provides nationwide coverage for all hot and cold forging techniques including crank, screw and hydraulic presses, and hammers, while presenting a diversified services portfolio supporting:

- A range of metals including steel, stainless steel, titanium, brass and aluminum
- Industries including automotive (cars and trucks), aerospace (notably for high-value materials), civil engineering, energy, construction, and other sectors
- All production volumes: from one-off parts to multi-million unit runs.

Key Highlights:

Industry

Manufacturing

Setforge Engineering

Challenge

Simulate the electro-upsetting process used to make very long sectional parts

MSC Software Solutions

Patran to develop simulation model.

Marc to simulate the nonlinear multiphysics phenomena that characterize electro-upsetting technologies.

Benefits

- Achieve Best Cost/Performance Ratio
- Process Optimization

"We now know that we can also gain a lot from using the solutions from MSC Software, from their teams' know-how, and from their ability to listen to and collaborate with their customers."

Nicolas Behr, Chief Project Engineer, Setforge Engineering

Soon after reinforcing its forging business with the acquisition of Setforge, Farinia Group decided to set up an eighth entity, Setforge Engineering. From its base at the L'Horme plant in the Rhône-Alpes region of south-east France, the unit provides the group's forges with capabilities in joint development and R&D, while monitoring the state-of-the-art in forging technology.

Each plant answers customer inquiries at its own design office, but can also draw on a pool of human and material resources to address more specific demands, as well as offer appropriate, economically viable alternative processes. All forging technologies have their advantages and shortcomings, and all are subject to competition from other manufacturing processes.

Electro-Upsetting Technology

Long sectional parts like driving wheel shafts, axles, spindles and cylinder rods are among the mechanical parts for which all conventional forging techniques have their limits, notably the risk of buckling. This is why industrial customers do not always source this type of product from forges.

However, one forging technique is particularly good at this type of work. It consists of using the Joule effect by sending a strong electric current through a length of around 10 cm of the stock or "billet" to maintain one end at forge temperature, and then applying a hammer blow that shapes the stock against the anvil. This is the technique known as electro-upsetting. It delivers several advantages over other manufacturing processes such as machining. These include raw material savings and better fiber quality. The initial diameter can be multiplied by a factor of up to twenty.

In reality, the electro-upsetting is not the first stage in the manufacturing process, as induction is used to raise the temperature in the area concerned by the operation. Neither does it yield the finished shape. However, it does go a long way to producing the finished part, the last stage being conventional stamping.

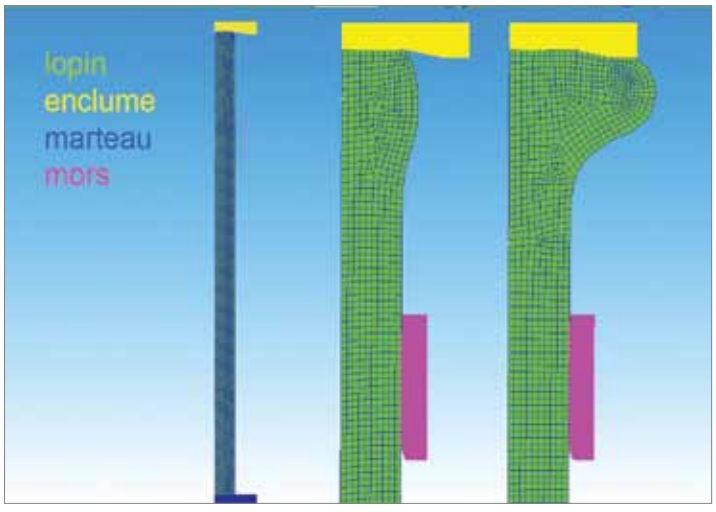
Within Farinia Group, the companies Barriol & Dallière Industries and Setforge Electroforge are experts in electro-upsetting and have their own production resources. Electro-upsetting is a proven technology, but the group felt that it was strategically important to gain more insights into the influence of a number of associated factors, and this is where the team at Setforge Engineering came in.

Simulation Resources

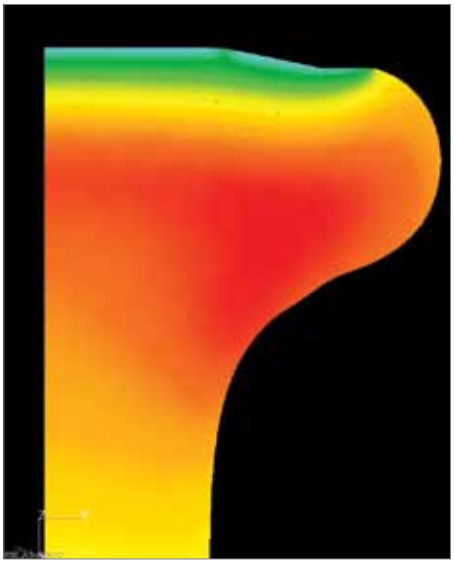
When Setforge joined the group, Farinia took the opportunity to review its simulation resources. Nicolas Behr, Chief Project Engineer at Setforge Engineering explains: "We realized the limits of the tools we were using and that their maintenance cost was too high relative to their capacities. What's more, because of some of the methods used by the group – especially electro-upsetting – we had to model and simulate the nonlinear multiphysics phenomena that characterize these technologies."

Setforge Engineering chose the Patran and Marc simulation solutions from MSC Software because they met these requirements, and then asked the MSC Software engineering services team in Lyons to conduct a mission. "We were

The part is shaped firstly by upsetting (in the background).



The billet (in green) is heated to the temperature of the forge between the jaws (in mauve) and the anvil (in yellow) and is crushed between the hammer (in blue) and the anvil



Temperature gradients upon completion of the deformation

still learning how to use these solutions, and this initial study looked complex. We thought it would be better to bring in the specialists", admits Nicolas Behr.

"Electro-upsetting is affected by electrical, thermal and mechanical phenomena involving complex sets of parameters. We asked MSC Software to develop a first model to see whether the results of the simulation matched our experience on the shop floor."

Alain Crozier, Senior Technical Consultant in the MSC Software team explains what is so special about the missions undertaken by the entity: "Our customers have experience and know-how in what they do and we have experience and know-how in simulation. Putting the two together delivers results.
Our methods of investigation and the way we present our results also enable our customers to develop their skills in using the software."

Parts shaped by upsetting are axisymmetric – though the finished part may not be – so a 2D representation is enough to work on. It is not the geometry that makes modeling these parts so complex; it is defining the parameters that will affect the calculation. These include:The electrical, thermal and mechanical properties of the material

- The laws governing the material flow
- The mechanical contacts and forces applied
- The power, electrical intensity and electrical process control
- The characteristics of the interaction with the environment (the temperature of the part can rise to 1,000°C at some points)

The First Model

Setforge Engineering asked to see a presentation of the model and the simulation 30 days after the start of the mission.

"Not only did the MSC Software team in Lyons do the job within the timeframe but the results proved that we had made the right choice", says Nicolas Behr. "We were able to compare a virtual video of the deformation generated by Patran with real video footage shot in one of our plants. The match was impressive."

The team at Setforge Engineering can now tweak the parameters in the first model to analyze more closely the influence they have on the process.

Other steps are now needed and Setforge Engineering, in agreement with the management of the Farinia Group, has decided to continue working with MSC Software to improve the digital model and fine-tune the simulation.

The first test showed that to reflect the reality of the process more accurately, the parameters would have to be enriched.

"Of course, our first iteration was a relatively simple digital model," explains Alain Crozier, "but the results were encouraging and enabled us to identify ways that we could improve it. For example, we think that we should consider the heat distribution in the tools during the material flow. We also worked on the assumption that the initial temperature in the deformed zone of the billet was homogeneous, while in reality the temperature is raised beforehand by induction. Because Marc also supports electromagnetic phenomena, it will be interesting to see whether this gradual and probably non-uniform rise in temperature has an impact on the result."

The simulation was carried out using standard versions of Marc and Patran software with no need for custom developments.

The deformations were on such a large scale that we had to automatically regenerate a mesh of the billet during the simulation. This is a standard function of Marc and Patran.The results are displayed in a range of different formats including:

- Time-dependent deformed shapes and real-time animations.
- Change of voltage and electrical intensity in the part
- Temperature gradient
- Mechanical deformations and constraints on the billet

Perspectives and Benefits

Even though this first simulation is only the first step towards a more comprehensive model, Setforge Engineering is already anticipating the potential gains.

"Right now, to prove feasibility and look for ways to optimize the upsetting process, we still have to use physical tests which are costly in terms of materials and tying up personnel and machines", explains Nicolas Behr. "We know that we can impact a very wide range of parameters and that is why we are optimistic about the gains that the MSC Software solutions can deliver. Through a better understanding of the technology, we also hope to offer this production method more often as an alternative to other competitive processes."

Setforge Engineering also uses Marc and Patran for other applications and provides technological guidance for the factories and their customers. The simulations and graphic results will be especially useful in illustrating the technical arguments used to support their recommendations.

"For all our projects, we aim to achieve the best cost/performance ratio by drawing on the forging skills that we have within the Group," concludes Nicolas Behr. "We now know that we can also gain a lot from using the solutions from MSC Software, from their teams' know-how, and from their ability to listen to and collaborate with their customers."

About MSC Software

MSC Software is one of the ten original software companies and the worldwide leader in multidiscipline simulation. As a trusted partner, MSC Software helps companies improve quality, save time and reduce costs associated with design and test of manufactured products. Academic institutions, researchers, and students employ MSC technology to expand individual knowledge as well as expand the horizon of simulation. MSC Software employs 1,000 professionals in 20 countries. For additional information about MSC Software's products and services, please visit www.mscsoftware.com.

Please visit www.mscsoftware.com for more case studies

About Patran

CAE Modeling and Pre/Post Processing

Patran is the world's most widely used pre/post-processing software for Finite Element Analysis (FEA), providing solid modeling, meshing, and analysis setup for MSC Nastran, Marc, Abaqus, LS-DYNA, ANSYS, and Pam-Crash.

Designers, engineers, and CAE analysts tasked with creating and analyzing virtual prototypes are faced with a number of tedious, time-wasting tasks. These include CAD geometry translation, geometry cleanup, manual meshing processes, assembly connection definition, and editing of input decks to setup jobs for analysis by various solvers. Pre-processing is still widely considered the most time consuming aspect of CAE, consuming up to 60% of users' time. Assembling results into reports that can be shared with colleagues and managers is also still a very labor intensive, tedious activity.

About MSC Marc

Accurate, Efficient & Affordable Finite Element Analysis

Marc and Mentat combine to deliver a complete solution (pre-processing, solution, and post-processing) for implicit nonlinear FEA. Marc provides the easiest to use and most robust capabilities for contact, large strain, and multiphysics analysis available today to solve static and quasi-static nonlinear problems.

Finite element analysis (FEA) has become a critical part of the product development process, but most FEA programs are limited to solving within the limits of linear material properties and displacements, small strains, and small rotations. Many software providers claim to have nonlinear capabilities, but few are able to consistently and reliably solve problems involving changing contact conditions between components and/or large strain (plasticity or elastomeric behavior, for example). When the going gets tough, even some of the most highly regarded nonlinear-focused FEA solvers turn to explicit dynamics and "tricks" (like mass scaling) that change the physics of problems and compromise solution accuracy. Because of these limitations, there are many aspects of product behavior that are not well understood until physical prototypes are available. This leads to late and expensive design changes, product failure in the field, and sometimes, safety issues.

Marc has no such limitations. Built from its first day to solve nonlinear problems, Marc and Mentat use advanced mathematics and FE technology to consistently obtain converged solutions for highly nonlinear problems involving nonlinear materials, large strain and displacement, and contact. Marc also incorporates serious multiphysics capabilities, enabling engineers to simulate situations involving coupling between structures, thermal, fluid, acoustics, electrical, and magnetics.

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