esi get it right®

Superform USA relies on PAM-STAMP 2G to iteratively design complex tools and prove feasibility virtually

Superform USA
http:// www.superformusa.com

THE PROCESS

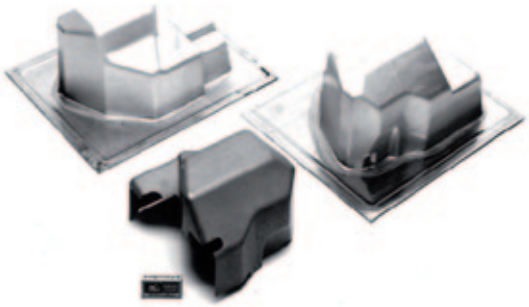
Superplastic forming (SPF) is a non conventional sheet metal forming method that involves shaping sheets of superplastic material into complex shapes at elevated temperature and controlled pressure. Typical elongations exceed several hundred percent and the process offers excellent parts integration and elegant 'one piece' solutions compared with other processes. At Superform, PAM-STAMP 2G is used extensively during the tool design stage to fine tune and 'virtually' test the tool design in order to get it right the first time.

THE STORY

PAM-STAMP 2G and custom SPF modules enabled Superform to offer a highly competitive one-piece alternative to a 23-piece welded Air-stair.

THE BENEFITS

"The unique ability to 'see inside the press' by modeling the forming process enabled a solution to this problem to be virtually tested before committing to hardware changes... Modeling, when executed correctly, can capture subtle details occurring during forming and can be used to solve problems requiring equally subtle solutions."



Part of the Luxfer Group, Superform USA and its sister company Superform Aluminium are the world's leading suppliers of aluminium, magnesium and titanium superformed components, supplying parts to various industries including Aerospace, Automotive, Truck, Rail, Medical Systems and Architecture. Today, Superform has two manufacturing sites, in the UK and the USA, and offer forming solutions for a range of aluminum, magnesium and titanium alloys for a variety of applications.

At Superform, making complicated shapes is nothing new, so the introduction of finite element modeling cannot be completely credited with the ability to take on challenging geometries and successfully 'Superforming' them. What it does allow, is a high level of confidence when the time comes to create the actual form tool and is invaluable in predicting local thickness variations to support the customer's design requirements.

As there is no software solution yet, to automatically create the form tool for Superforming, tools are designed intuitively based on years of experience and backed by sound engineering principles. The designs are then improved iteratively based on the results from modeling.

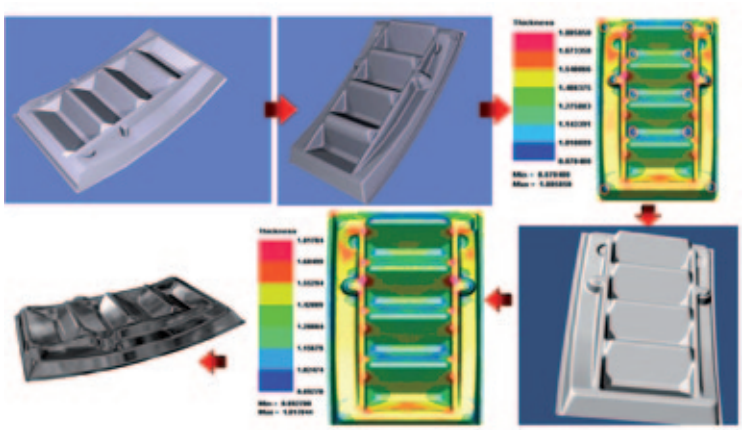
The FE code of choice at Superform is PAM-STAMP 2G. The version used for superplastic forming has unique modules tailor-made for the process. The software is capable of automatically meshing the tool geometry, adaptive meshing of blank elements, scaling sheet velocity and mass predicting a pressure cycle for a part through a dedicated algorithm. The code has been put to use to refine tool designs for complex parts, optimizing thickness and forming time.

The example presented here uses finite element modeling to iteratively optimize the design of a part and make it suitable for Superforming.

The Air-stair is a stairway of four steps integrated to the door of a small aircraft. Superform proposed a one-piece design to replace a twenty-three piece welded aluminum assembly, thereby offering a lighter, stiffer and cost effective solution.

Original 23 piece welded design (top) and one-piece design optimized for SPF (bottom)

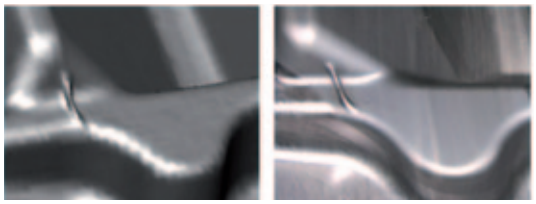
The new design's smooth radii and truncated corners minimized localized thinning and optimized the thickness distribution in the final part. Several iterations were performed before arriving at final design.



Different stages in the design iteration process

To optimize the thickness distribution, a novel two-stage forming process was used. The heated flat sheet was superplastically pre-stretched in certain regions before being draped over the tool surface to create the final shape; all in a single pressure cycle. Pre-stretching was critical; if over-stretched, simulation predicted a wrinkle. The following illustration reveals the remarkable correlation between the simulated wrinkle and the actual wrinkle created when the pre-stretching was overdone.

Remarkable correlation between simulated (left) and actual (right) wrinkle.



The finished part presents a striking example of the synergistic capability of Superforming combined with modeling.

"PAM-STAMP 2G has transformed the speed with which we can develop thickness predictions and forming cycles. While we deploy our intuition, experience and creativity to design the tools, PAM-STAMP 2G lets us test the feasibility of our ideas without cutting metal."

A.J. Barnes,
Technical Vice President of Superform USA.

"PAM-STAMP 2G's user friendly interface makes FE modeling much faster compared to other codes. It is now an integral part of our technical armory and used almost every day."

Hari Raman,
Process Engineer at Superform USA

To find out more on ESI's Sheet Metal Forming Simulation Suite, visit www.esi-group.com/products/metal-forming

ABOUT ESI GROUP

ESI is a world-leading supplier and pioneer of digital simulation software for prototyping and manufacturing processes that take into account the physics of materials. ESI has developed an extensive suite of coherent, industry-oriented applications to realistically simulate a product's behavior during testing, to fine-tune manufacturing processes in accordance with desired product performance, and to evaluate the environment's impact on product performance. ESI's products represent a unique collaborative and open environment for Simulation-Based Design, enabling virtual prototypes to be improved in a continuous and collaborative manner while eliminating the need for physical prototypes during product development. The company employs over 750 high-level specialists worldwide covering more than 30 countries. ESI Group is listed in compartment C of NYSE Euronext Paris. For further information, visit www.esi-group.com.

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