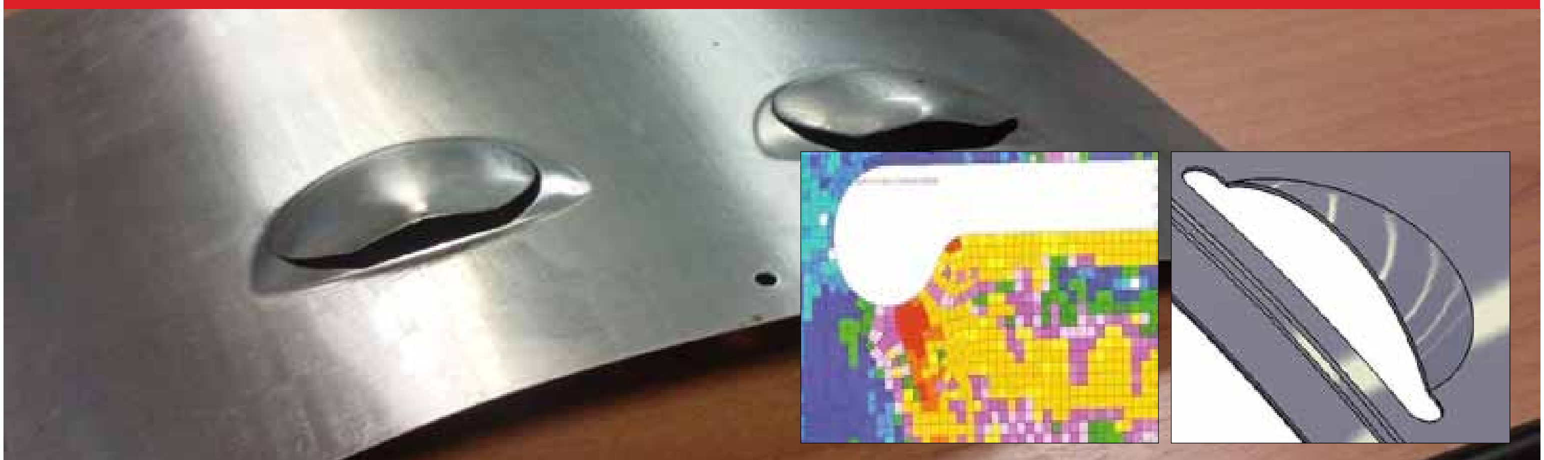
CASE STUDY

MSC Software: Case Study - DEMA

Stamping Out Waste

Aerospace Supplier, DEMA, uses Simulation to Save Time and Money



Design Manufacturing SpA (DEMA) is a major tier-one aerospace supplier to Bombardier, Alenia Aermacchi, AgustaWestland and other leading aerospace original equipment manufacturers. The company recently faced a challenge with an aluminum acoustic barrier which is part of a jet engine nacelle. DEMA performed finite element analysis (FEA) with the MSC Nastran implicit nonlinear solver which identified two problems in the initial design. These included a stress concentration around a radius and excess material beyond the dimensions of the finished part which would have required an expensive secondary operation.

Danilo Malacaria, Structural Engineering Manager for DEMA, addressed these problems by increasing several radii in the area of the stress concentration and changing the size and geometry of the initial blank to eliminate the excess material. He re-ran the FEA which showed that the changes solved the problem. “When we ran the operation with the new tool and flat panel, the resulting part matched the simulation results perfectly,” Malacaria said. “Finite element analysis saved us a considerable amount of money and time by helping to identify and correct this problem before we made a major investment in tooling.”

Based in Naples, Italy, DEMA also has a composite facility in Benevento, an helicopters assembly plant in Brinidis, a machining technology centre in Piacenza, Italy, an engineering and assembly operation in Montreal, Quebec and a composite processing and assembly facility in Tunisia. DEMA produces a wide range of aerostructures including aircraft fuselage sections, floor panels, cockpits, tailcones, fan cowls, ramps, cargo doors, slide boxes, horizontal stabilizers, helicopters fuselages and helicopter tail booms. DEMA’s customers include Alenia Aermacchi, Bombardier, Airbus Military and AgustaWestland for aircraft programs including the Boeing 787, Airbus 380 and A321, ATR 42-72, AW139, AW169, CSeries and Learjet.

Challenge of Producing Critical Aerospace Component

The acoustic barrier is produced in a stamping operation in which a female die applies pressure to a flat aluminum blank, forcing the blank

Key Highlights:

Industry

Metal stamping for the aerospace industry

Challenge

- Maintaining allowable stress concentrations during metal stamping procedure
- Reducing expensive secondary operations

MSC Software Solutions

MSC Nastran

Benefits

- Reduced prototyping and manufacturing costs
- Substantial reductions in design time

"Finite element analysis saved us a considerable amount of money and time by helping to identify and correct this problem before we made a major investment in tooling."

Danilo Malacaria, Structural Engineering Manager for DEMA

against a male die to form the finished part. The traditional approach would have been to develop the dies based on best judgment and send them to the press shop for tryout. Frequently the first stage of tooling would show problems such as cracking or excess trim. Changes would be made to the tooling and the new tooling would be tested again to see if the problem was fixed. In most cases, it was difficult to determine the cause of the problem so a considerable amount of trial and error would be required to solve it. It's not unusual for six iterations of modifications taking two weeks each to be required meet the customer's quality standards.

DEMA has pioneered the use of finite element analysis to simulate stamping operations with the goal of getting the die design right the first time. The company used the MSC Nastran implicit nonlinear solver. The solver allows users to perform advanced nonlinear structural analysis including contacts, large deflections, large rotation and large strain analysis capabilities.

The customer provided the part geometry in the form of a CATIA V5 computer aided design (CAD) file. DEMA engineers created an initial design for the male and female dies and the part and die geometry into the Patran pre-and post processor. They created a 2D mesh of the male and female tool and the flat sheet pattern. "2D shell elements provided a faster run with excellent accuracy when simulating sheet metal forming," Malacaria said. The 100 bar pressured applied by the press to the male and female dies was determined with physical measurements. The customer specified the use of 6000 series aluminum so DEMA engineers evaluated several different materials in an effort to determine which would work the best. DEMA engineers created a standard MSC Nastran input deck. The MSC Nastran nonlinear solver ran the analysis.

Simulation Highlights Potential Problems

The simulation results showed two potential problems. Figure 5 shows that the stress exerted on the material during the stamping operation is past its failure limits. The stress analysis results show that the peak is near the radius of a cutout in the component. Figure 6 shows that there is considerable excess material around the perimeter of the finished part. This extra material would need to be removed in a second trimming operation with a 4-axis computer numerical control (CNC) cutting machine which would add significantly to manufacturing costs. The simulation provided engineers with an understanding of these potential problems as well as diagnostic information that helped them determine their root causes.

DEMA engineers addressed the stress concentration problem by increasing the radius of the cutout in the component. They addressed the excess material by reducing the size of flat pattern geometry in the area of the excess. The engineers then re-ran the simulation to determine the impact of these changes. They saw that both of the problems they had addressed with the revisions were substantially improved but not completely fixed.

Engineers made several more iterations on the software prototype and re-ran the simulation to evaluate the impact of their changes until they found a design that eliminated both the excess stress and the need for a second trimming operation. In order to verify the results, DEMA engineers re-ran the simulation using the MSC Nastran implicit nonlinear finite element solver.

Figure 1: The nacelle houses a jet engine

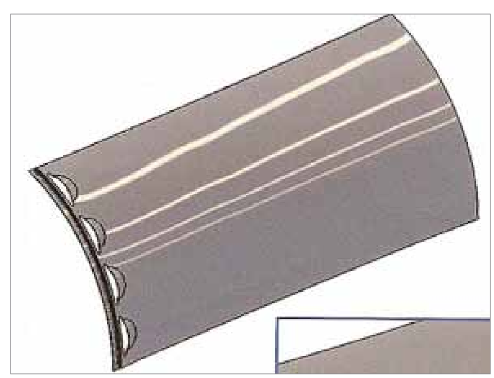


Figure 2: Component of the acoustic barrier assembly that is produced in stamping operation

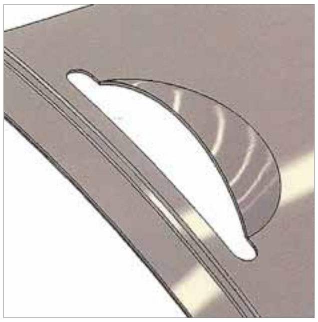


Figure 3: Close-up of critical section of stamped component21

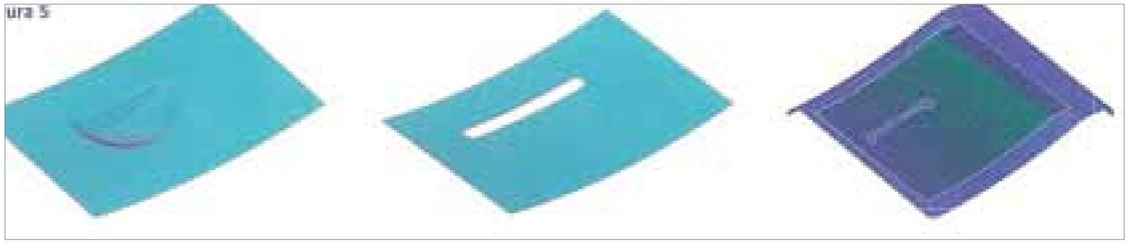


Figure 4: The image on the left shows a finite element model of the contact surface of the initial design of the stamping die. The center image shows the finite element model of the initial design of the flat panel geometry. The image on the right shows the models of the tool and material combined with the contact algorithm.

Getting the Die Design Right the First Time

Next, DEMA built a tool using the final design that was developed during the virtual prototyping process. The company installed the new tool in a stamping press and formed a few trial parts to evaluate the results. The simulation accurately predicted how the parts would be formed. In particular, the parts were free of flaws that would have indicated excess stresses and the finished part did not require trimming. Getting the die design right the first time reduced the time and cost involved in tool tryout since it is both faster and less expensive to try out possible solutions on the computer than in the press shop. Because of the demanding requirements for aerospace components, a certain amount of time to validate the die design is always required in the press shop.

"This application demonstrates how we can provide high quality and faster deliveries to our customers by utilizing the latest generation of computer simulation software," Malacaria concluded. "Rather than spending the large amount of time and money that would have been required to build and test the initial die design to see if it worked, we simulated a range of different designs and evaluated the results using the MSC Nastran FEA software. During the simulation process we eliminated a potential quality issue and also avoided the need for a secondary trimming operation. We determined the process, developed the initial blank and monitored stress concentrations before we even started building the die. The result was that the die worked perfectly the first time we hit it. There's no way to know for sure exactly how much money and time was saved by not having to re-cut and re-test the die but it's clear that the savings were substantial. Simulation has also helped us to create savings of the same magnitude on many other complex parts that presented similar challenges."

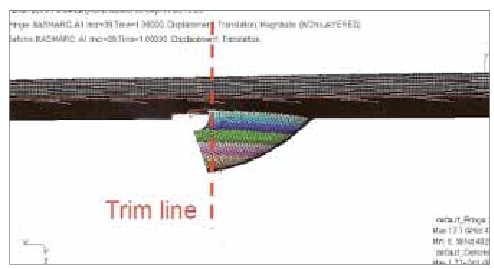


Figure 6: Simulation results for the initial die design show that excess material will have to be trimmed from one area of the part

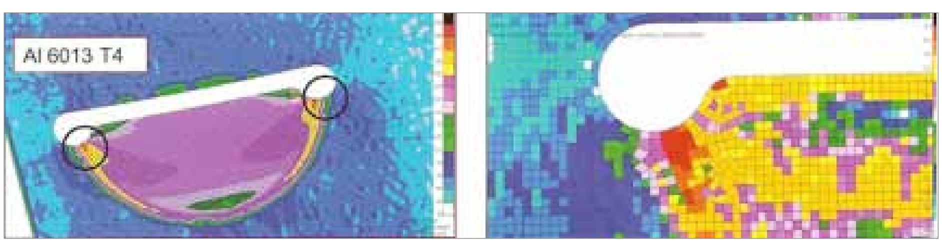


Figure 5: The image on the left shows the stress levels in the material in one area of the component during the stamping operation with the initial die design. The close-up view shown in the image on the right indicates that the material has exceeded its yield levels in the area shown in red just below the round cutout.

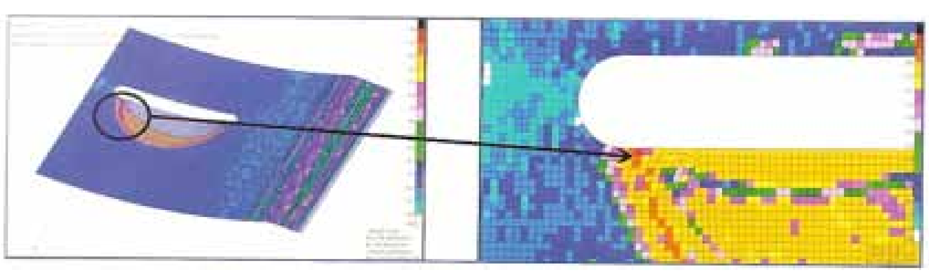


Figure 7: Simulation results show that modified design with a larger radius eliminates the excessive stresses

Figure 8: Component built in press shop shows that part does not require trimming

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.

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About MSC Nastran

Structural & Multidiscipline Finite Element Analysis

MSC Nastran is the world's most widely used Finite Element Analysis (FEA) solver that helped MSC Software become recognized in 2011 as one of the "10 Original Software Companies". When it comes to solving for stress/strain behavior, dynamic and vibration response and thermal gradients in real-world systems, MSC Nastran is recognized as the most trusted multidiscipline solver in the world.

MSC Nastran is built on work done by NASA scientists and researchers, and is trusted for the design of mission critical systems in every industry. Nearly every spacecraft, aircraft, and vehicle designed in the last 40 years has been analyzed using MSC Nastran.

In recent years, several extensions to its capabilities have resulted in a single multidisciplinary solver providing users with a trusted solution to simulate everything from a single component to complex assemblies under diverse conditions.

MSC Nastran offers a complete set of linear static and dynamic analysis capabilities along with unparalleled support for superelements enabling users to solve large, complex assemblies more efficiently. MSC Nastran also offers a complete set of implicit and explicit nonlinear analysis capabilities, thermal and interior/exterior acoustics, and coupling between various disciplines such as thermal, structural, and fluid interaction. New modular packaging that enables you to get only what you need makes it more affordable to own MSC Nastran than ever before.

As part of our commitment to quality, the MSC Nastran Software Quality Assurance Program complies with the applicable portions of Title 10, Code of Federal Regulations Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Title 10, Code of Federal Regulations, Part 21, Reporting of Safety Related Defects and Non-Compliances.

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