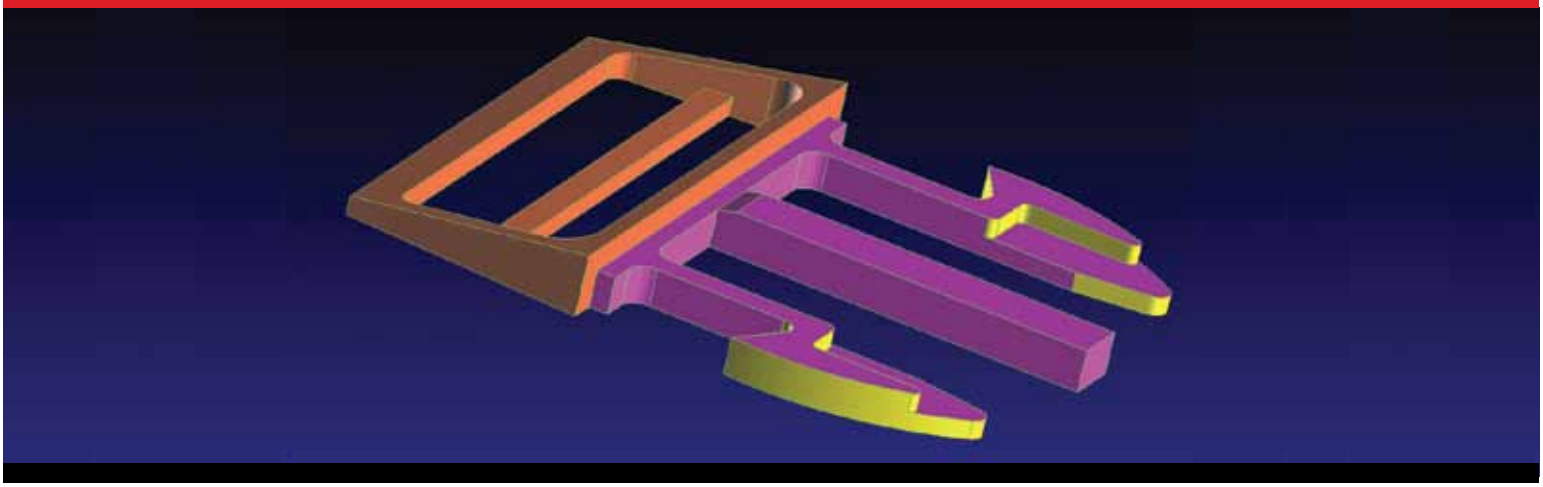
MSC Software

CASE STUDY

MSC Software: Case Study - ITW Delfast group

Engineers Get Design Right the First Time

ITW Delfast Improves Fastener Performance 30% by Using Simulation to Evaluate Design Alternatives



The ITW Delfast group designs and produces engineered plastic and metal fasteners for the automotive industry. The plastic fasteners typically are secured by a clip snapping into contact with a serrated shaft. These fasteners present a difficult design challenge because of the complexity involved in multiple contacting bodies undergoing large deformations with sliding contact. In the past, an experienced analyst performed finite element analysis, but this was expensive and time limitations meant that only the more difficult designs could be analyzed. In the cases where there wasn't time to analyze the design, it was often necessary to modify the tooling at an average cost of $1500.

To address these challenges, the company developed a method that enables design engineers with little or no computer aided engineering (CAE) background to perform the analysis and produce good results. Providing design engineers with analysis capabilities makes it possible to analyze nearly every new design. The engineers are typically able to improve the design by evaluating two or three alternatives to the original design. The new approach helps engineers get the design right the first time, eliminating the need to remake the tooling.

The ITW Delfast Group includes divisions in Brazil, China, France, Germany, Italy, Japan, Spain, Sweden and the United Kingdom. Its customer base includes all the major automotive original equipment manufacturers (OEMs) as well as Tier 1 and Tier 2 suppliers. The group's product line includes trim clips, hole plugs, hot melt plugs, brake and fuel line routing clips, watertight fasteners, sound seal screws and multi-blow products. The ITW Delfast Group is a unit of ITW which has 825 decentralized business units in 52 countries that employ approximately 60,000 people.

Key Highlights:

Industry

ITW Sverige

Plastic and metal fasteners for the automotive industry

Challenge

- Bringing non-linear finite element analysis to the designers
- Automation of CAE processes including model setup, analysis and report generation

MSC Software Solutions

SimXpert

Benefits

- Automated simulations and report generation make engineers more efficient
- Substantial reductions in analysis time
- Improved design performance
- Reduced prototyping and manufacturing costs

“The template has captured, implemented and a large extent automated our analysis best practices and put them into the hands of our design engineers”

Kristian Ostergren, Head of Design for ITW Sweden

Complex Analysis Challenge

Figure 1 shows a finite element analysis of a typical fastener produced by ITW Delfast. The company’s plastic fasteners nearly all require nonlinear analysis because components, particularly the clip which is shown in green with a fine mesh in Figure 1, undergo large deformations. Additional analysis challenges include the need to incorporate friction and plasticity into the analysis and address rapidly changing contact conditions as the clip snaps into contact with the shaft. In addition, complicated combinations of boundary conditions and load sequences are often needed to address the varying loads the fasteners will experience during assembly and in use.

The company has design teams in each of the countries where it operates and these teams work closely with customers to develop a large number of custom designs to address new applications. In the past, Kristian Ostergren, Head of Design for ITW Sweden, was the only person capable of performing these complex analyses. His time was occupied with other responsibilities so that he could only perform analysis on a few of the more difficult applications. “The result was that in the past most of our custom products were designed using the build and test method,” Ostergren said. “Sometimes, the performance of the initial design was unsatisfactory. In that case we had to change the design and remake the tooling.”

In the applications where the company was able to perform analysis, it was usually possible to improve the performance of the product and nearly always to meet the design requirements with the initial prototype, eliminating the need for retooling. Ostergren wanted to provide design engineers with a tool that would enable them to perform nonlinear analysis despite their limited analysis background. “I looked into CAD integrated solutions that are designed to provide non-CAE savvy users with the ability to perform analysis,” Ostergren said. “But I discovered that these tools do not provide the capabilities to perform the complex nonlinear analysis required for our products. In addition, our divisions use a number of different CAD systems, which would have made it difficult to implement a CAD integrated solution.”

Capturing Best Practices in a Template

Ostergren identified MSC Software’s SimXpert as a tool with the potential to capture the CAE process and analysis best practices into a simple tool for use by design engineers. SimXpert enables expert analysts to develop templates that cover all stages in the simulation process including modeling, job setup, solving and reporting within one integrated workspace environment. SimXpert templates are more than just a macro in that they provide full access to database objects and methods, support custom actions written in Python and offer high level loops and conditional branching. Templates can be designed by recording a sequence of operations or by dragging and dropping operations into the template workspace.

SimXpert templates can utilize linear and advanced non-linear, static and dynamic structural analysis based on the complete solution set provided by MSC Nastran. They can also predict loads and analyze system motion including flexible bodies based on MSC Software’s Adams capabilities. MSC

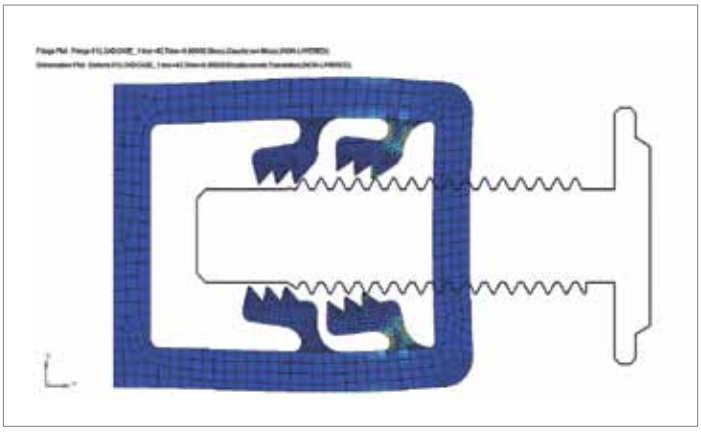


Figure 1: Analysis of typical ITW Delfast fastener

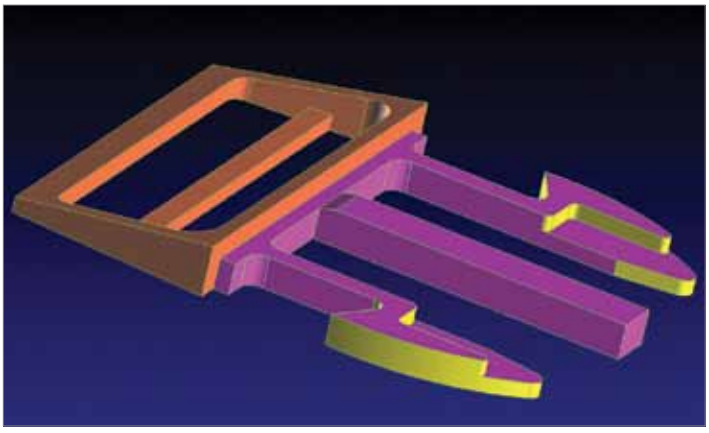


Figure 2: Color coded surfaces help users visualize current mesh settings

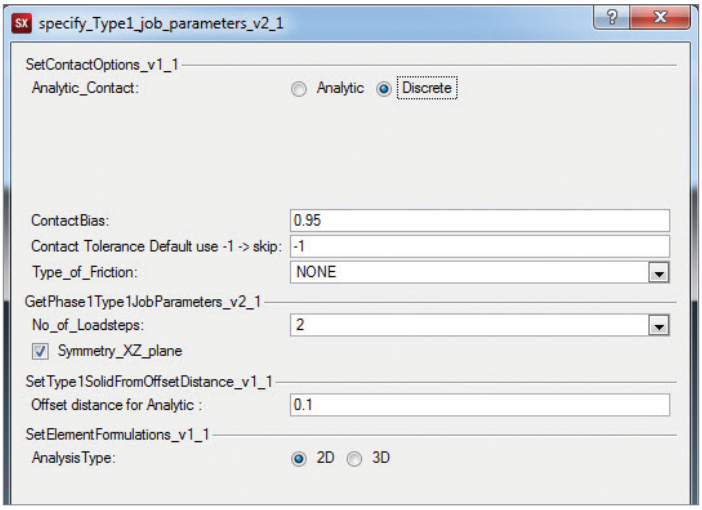


Figure 3: Setup parameters are contained in a single window

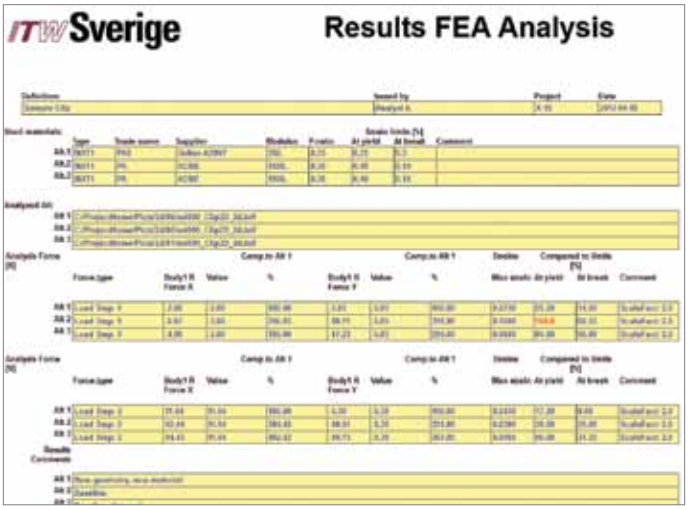


Figure 4: Report compares performance of selected cases

Nastran can also be used to perform large deformation, highly nonlinear, short duration transient analyses for structural impact and coupled fluid-structure interaction problems.

Ostergren and MSC worked together to develop a template that provides a high level of automation while enabling users to interact with the analysis in order to ensure that it accurately represents the current design. The template fully automates the process of defining and naming parts and properties, generating symmetry constraints, defining contact bodies, load set generation, analysis setup, job submission and report generation. The template can be run either step by step in interactive mode or in semi or full automatic mode.

Ensuring a High Quality Mesh

The template simplifies the generation of a good mesh which is the key to a robust analysis and accurate results. The template checks the dimensions of the part and suggests the element sizes to be used in the different regions. These regions are color coded as shown in Figure 2. The user can then fine tune the element size selections such as by refining the mesh in regions where contact or high stress concentrations occur.

The template then performs an automated process to adjust the locations of the nodes to improve element quality. Materials are added by entering the modulus, stiffness, strain limits at yield and break, and Poisson's ratio from the data sheets. The template offers an efficient way to manage and share material data between different users by making any new material automatically accessible. The entire reduced set of setup parameters is collected in a single window as shown in Figure 3. Robust defaults are provided for analysis and contact settings.

The template makes it fast and easy to change geometry, materials or boundary conditions and reanalyze the new design. The user checks off whether he or she would like to change the material, geometry, contacts and loads and boundary conditions and then the template is automatically re-run, stepping through the process of making the desired changes.

Iterating to an Optimal Design

The template also assists the user in maintaining the structure of the analysis directory tree. Each analysis for a particular application is stored in a directory with a unique filename. This approach simplifies the creation of a report comparing the different design alternatives shown in Figure 4. The report compares key analysis results for each of the selected cases. The deformed geometry of each design alternative is compared side by side. Graphs showing the load history overlay are provided for each design alternative.

Design engineers view color plots to see the strain concentrations. Typically they will redesign the fastener to spread the strain over a large area of the part in order to reduce strain values. Once they have reached a point where the analysis shows that strains are within acceptable limits, analysts often evaluate the possibility of using a less expensive material. "During this iteration process, our design engineers can typically make a 30% improvement in performance compared to their initial design concept," Ostergren said. "This helps to achieve a larger margin of failure which in turn avoids damage due to misuse and makes the product last longer."

Design engineers were provided with a training session that focused on the critical aspects of the analysis process. "The template makes it easy to generate results – the training was designed to ensure that design engineers can generate good results," Ostergren said. The training helped to build an understanding of the analysis setup and the solver. The importance of generating high quality elements during the meshing process was explained. Critical interrogation of the results was emphasized in order to identify potential errors.

"The template has captured, implemented and a large extent automated our analysis best practices and put them into the hands of our design engineers," Ostergren concluded. "The results have included substantial reductions in analysis time, improved design performance, and reduced prototyping and manufacturing costs. Furthermore, by using the template, our users are gaining confidence and competence to increase complexity and run new analyses beyond the template."

For more information, visit:

www.itwsverige.se/

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 SimXpert

Multidiscipline Simulation

SimXpert is a next generation CAE application that empowers engineers to perform an expansive range of multidisciplinary simulations by delivering new tools that accelerate learning curves and shorten model preparation and setup times all within a fully integrated user environment.

"Doing more with less" is a common theme in most companies today, but designers, engineers and CAE analysts spend most of their time and effort on manual, labor intensive tasks. Translating and fixing CAD data, meshing, reworking models, creating the same plots and charts over and over – all of these mean that engineers are spending more time developing expertise in using tools rather than on evaluating and understanding their products. SimXpert changes that by providing native access to CAD data and easy to use tools to automate their simulation jobs and get results fast.

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