

## Advancing quality and accelerating analysis for large welded assemblies

LOHR Industrie leverages NX and Teamcenter to ensure product quality, enhance durability and accelerate CAE model preparation

### Business challenges

Deliver reliable, long-lasting products

Master product complexity

Reduce analysis model build time

Enable multiple departments to view design content earlier

### Key to success

Integrated NX environment for design and simulation

Full 3D mathematical modeling and wider use of CAE to ensure product integrity

Partially automated weld model preparation using NX Open

Collaborative Teamcenter environment for sharing data between departments

### Results

Successfully entered new target market

Realized 60 percent time savings in model preparation

Accelerated workflows through real-time design and approval

Improved quality in terms of both process and product

## LOHR INDUSTRIE

### Translohr – an innovative “people mover”

LOHR Industrie is a privately-owned French group that specializes in designing and manufacturing transportation systems for moving both goods and people. Historically, LOHR has been a leader in the car-carrier business. However, during the past 10 years, LOHR has invested in developing people movers and railroad transport systems. One of the company's most innovative developments is the Translohr, a new generation of light-rail urban tramway. Currently, Translohr systems are in service in Clermont-Ferrand, France, as well as in Padua and Venice, Italy and in Tianjin and Shanghai, China.

Francois Weill, manager of computer-aided design (CAD), computer-aided manufacturing (CAM) and product lifecycle management (PLM) at LOHR, explains the company's innovation culture: “Our motto is One Idea Ahead. The people mover is a good example because it uses tires, not rails.”

The Translohr is a dedicated people mover, which uses a single rail for steering the vehicle while traction is delivered through tires instead of rail. As a result, the Translohr requires less infrastructure than other railway systems. The car body is fairly narrow and the vehicle has a tight turning radius, which allows it to navigate narrower streets in older cities. The Translohr has a low floor that allows people to get easily on or off the vehicle.



# PLM Software

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Francois Weill  
Manager  
CAD, CAM and PLM  
LOHR

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Didier Turlier  
Manager  
Mechanical Simulation and  
Structural Analysis  
LOHR

In addition, Didier Turlier, LOHR’s manager of mechanical simulation and structural analysis, notes that the Translohr structure is made of welded aluminum, which is ideally suited to LOHR’s highly proven capabilities. LOHR has a long history in using welding technologies for assembly and even has its own training school for welders.

Just as importantly with regard to the transport system’s quality and performance: “When you build systems like people movers, you have to be sure they will last for 20 to 30 years,” says Weill. Weld fatigue is a critical issue that must be thoroughly addressed by LOHR engineers to facilitate confidence in the final product. The Translohr is designed to withstand approximately 10 million cycles in fatigue related to traction braking and centrifugal acceleration forces over a 30-year lifecycle.



### **NX delivers comprehensive high-value 3D modeler**

As you might expect, LOHR products have thousands of components. As a result, managing complex assemblies is a critical requirement. Weill strongly believes that 3D modeling is essential to tackle this level of product complexity. “It’s always been the aim of our company to do full mathematical models,” he says.

With this in mind, LOHR chose Siemens PLM Software’s NX™ software years ago for the quality of its solid modeler; today, NX is the only CAD system that LOHR uses. “NX has all of the functionality needed for building extremely complex 3D models,” explains Weill. “When you have an exhaustive 3D model of your product, you can anticipate every problem that you will encounter – collisions, managing the weight and so on. This is the only way to allow all of our departments to proceed with their work.”

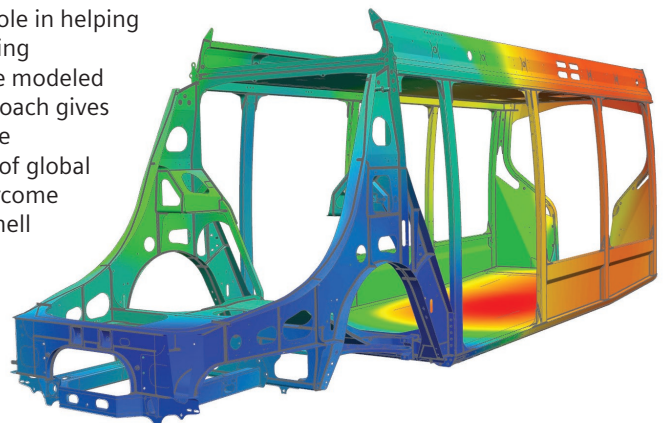
Weill values what he calls the top-down and bottom-up technology of NX – the ability to either add components to an existing assembly or create the 3D data in the assembly and then create the components.

Since the early days, the use of NX has expanded beyond the design department. Turlier explains, “Our philosophy is that all of our information and data have to be defined using the CAD tool. In addition, we [the structural analysis department] share the same tools so we can extract all the information – and most importantly, the right information – to make the finite element (FE) model.” In this regard, LOHR uses NX to perform linear static, modal, dynamic response, thermal, flow and buckling analyses.

### **Ensuring product quality and integrity**

For products that are primarily assembled using welding technology, welds play a critical role in ensuring structural integrity and product quality. At LOHR, seam welds are an important part of the manufacturing process. Numerous factors affect the cost of the assembly process, including the number of welds, seam weld lengths, use of intermittent welds and weld throat sizes. However, these factors also impact how the structure behaves dynamically and its affect on fatigue life.

As a result, simulation plays an important role in helping balance these requirements while maximizing performance. Traditionally, companies have modeled welds using solid elements. While this approach gives accurate results, the model size can become prohibitively large for performing any type of global analysis on large vehicle structures. To overcome this issue, LOHR investigated the use of a shell element model to represent the welds.



***“We spend about 75 percent of the simulation time in model preparation. Using the automated process enabled by NX, we cut about 60 percent of the model preparation time.”***

Patrice Klein  
Simulation Manager  
CAE Analysis Group  
LOHR

### **Innovative approach for seam weld analysis**

LOHR’s vehicle structures are mainly made of sheets and extruded members and therefore lend themselves to the use of shell elements. The first step in the model preparation consists of generating the mid-surface. LOHR uses the NX mid-surfacing capability for this process.

LOHR has developed another innovative approach by using shell elements to represent the weld itself. The method is applicable for both static and fatigue analyses. For static strength assessment of fillet welds, an equivalent stress is computed at the mid-point of the weld throat. For fatigue, analyses are performed at weld toe and through the throat locations. Finally, the weld shell element and the sheet mid-surfaces are connected using glue connections.



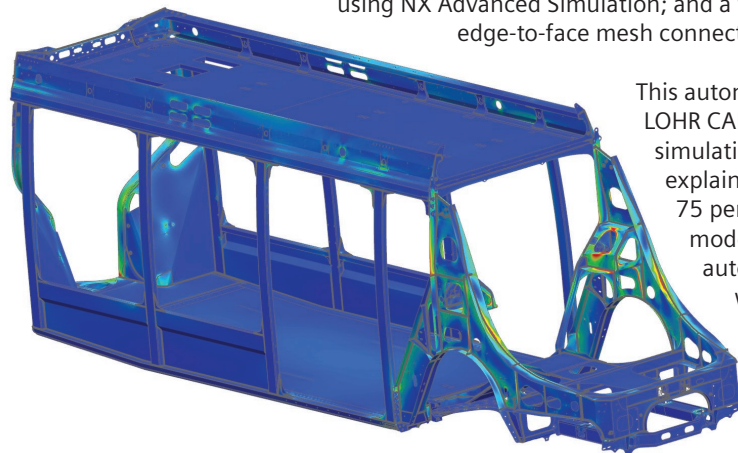
LOHR validated this new approach using tensile load specimens and comparisons against a fine solid mesh. In one test case, the LOHR model was composed of only 1025 degrees of freedom as compared to over 500,000 degrees of freedom for the solid model. The coarse model results compared favorably with the fine solid mesh results, giving the team the confidence to move forward. The modeling method can be extended to partially penetrated fillet welds, overlap joints and groove joints.

While there are significant advantages to having a smaller FE model, this method does require several manual steps to make the weld imprints on the sheet bodies, sub-divide the faces and make the connections between weld and sheet elements. This would normally require a very time-consuming model preparation process.

### **Automating weld model preparation using NX Open**

To reduce FE model preparation time, LOHR embarked on an innovative project to automate the weld modeling process. As a first step, LOHR decided to use the NX Weld Assistant tool to define the weld geometry. Eric Franchet, design engineer at LOHR, says that by using the Weld Assistant, his team saves a lot of time in the modeling process. The user simply provides the weld locations and cross section size and the tool creates the weld as a solid body. Franchet notes, “Another distinct advantage of NX Weld Assistant is that if you move the components, then the weld will be kept associated and move accordingly.”

Next, LOHR developed a suite of C++ programs that leverage the NX Open application programming interface (API) to automate various steps through a customized user interface in the NX environment. The interface guides the user through various steps in the automated process. These include a CAD body connection to make the imprints and assign attributes to the imprint faces (imprints can be quite complicated, especially when welds are located on both sides of a sheet body); an idealization step to create mid-surfaces; transferring CAD connections to the mid-surface; meshing using NX Advanced Simulation; and a final program to create the 1D edge-to-face mesh connections.



This automated process is now used by all LOHR CAE analysts. Patrice Klein, simulation manager, CAE Analysis Group, explains the benefits: “We spend about 75 percent of the simulation time in model preparation. Using the automated process enabled by NX, we cut about 60 percent of the model preparation time.”



## Solutions/Services

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## Client's primary business

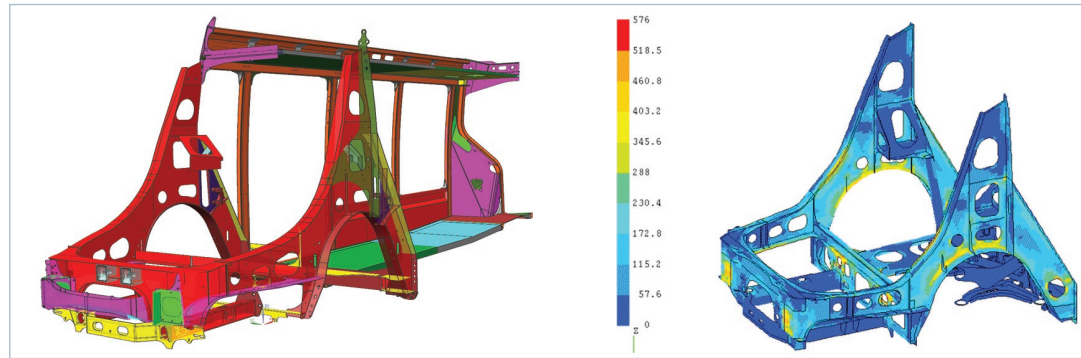
LOHR Industrie designs and produces transportation systems, including car-carrier road transports, rail transports, defense-related logistical transports and public urban transports, such as trams on tires and light-rail people movers.  
www.lohr.fr

## Client location

Duppigheim, Alsace  
France

***"The advantage we get from Teamcenter is that first everybody sees the same information at the same time; and then, by avoiding the use of paper, we dramatically accelerate the process."***

Francois Weill  
Manager  
CAD, CAM and PLM  
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Since LOHR uses NX for both CAD and CAE modeling, the company reaps additional benefits because associativity is maintained throughout the process. Klein notes that when they make CAD model changes, such as modifying weld parameters or moving objects or faces, the FE model is automatically updated.

### Teamcenter provides concurrent and collaborative engineering

For LOHR, sharing the design information with everyone on the team is crucial. Weill explains, "The computation aspects, the process aspects take a long time. And so, it is important to see the results of the design as soon as they are available."

Analysis teams need to review weld locations and evaluate the impact on overall strength and durability. At the same time, LOHR process engineers may wish to review the weld locations to determine if a robot can reach the weld area easily. In addition, process engineers might work with the CAE analysts to discuss post-weld treatment to improve joint quality.

To enable this collaboration, LOHR relies on Siemens PLM Software's Teamcenter® software to share its 3D models and data. Weill describes the benefits: "Now that we are using Teamcenter and taking the integration of NX into Teamcenter into account, everybody is able to see the geometric model being built in real time. This is concurrent engineering."

LOHR uses Teamcenter workflows to orchestrate design reviews. This enables multiple departments to review and approve or reject the design. Weill calls this "real-time design and approval."

Turlier adds, "In the future we will probably use Teamcenter to share stress analysis results with the designers and the people who are working in manufacturing."

### Impact of NX and Teamcenter on LOHR's business

"Without NX, building such a complex structure as a people mover – with all the equipment – would be a real challenge and would have taken substantially more time than we took to be successful," says Weill. "The advantage we get from Teamcenter is that first everybody sees the same information at the same time; and then, by avoiding the use of paper, we dramatically accelerate the process. Using Siemens' technology, we've speeded up workflows through real-time design and approval. We have realized a 60 percent time savings in model preparation. And our quality has measurably improved both in terms of process and product. Most notably from a business perspective, the use of NX and Teamcenter has enabled us to successfully enter a new target market."

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