

AEROSPACE

AeroFEM GmbH

Bringing the iconic Junkers Ju 52 aircraft back to life digitally

Products

NX, Simcenter

Business challenges

Reduce aircraft take-off weight to meet modern certification standards

Reconstruct the aircraft, whose production data was destroyed in WWII, using new scans and existing models

Substitute original materials for modern ones that match specifications, are commercially available and pass certification

Keys to success

Use NX for reverse engineering

Leverage Simcenter tools to conduct aerodynamic and structural analysis

Integrate modern aluminum alloy, matching the original materials' properties and meeting modern requirements

Results

Recreated the Ju 52 digitally

Highlighted the original Ju 52's advanced engineering

Leveraged the digital model as a historical record

Reduced take-off weight from 10.5 to 8.6 tons

AeroFEM uses Simcenter and NX to reverse engineer an aircraft, integrate modern materials and meet aviation standards

Demonstrating the airworthiness of the Junkers Ju 52

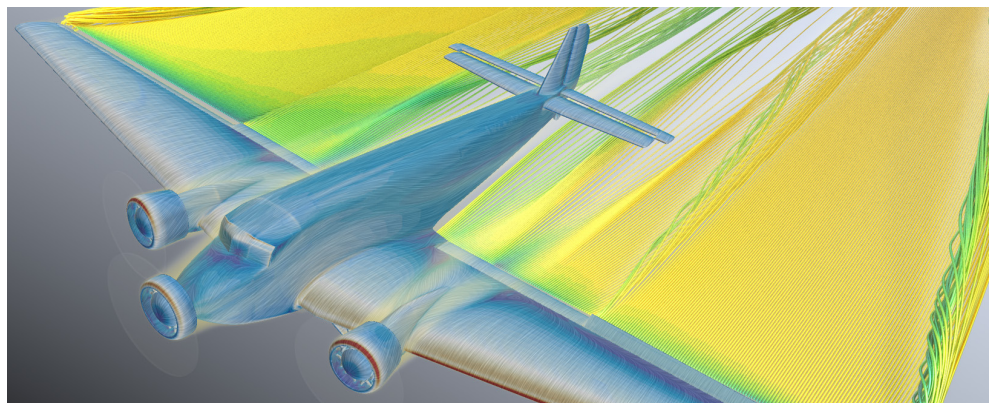
In the world of aviation, few aircraft are as iconic as the Junkers Ju 52, fondly known as "Tante Ju" (Auntie Ju). First taking to the skies in 1932, the Ju 52 quickly became a symbol of reliability. Originally intended as a civilian airliner by the German company Junkers, its most distinctive feature was the corrugated metal skin, which not only gave it a unique, rippled appearance but also added stability without significantly increasing weight.

The Ju 52/3m, the most famous variant, was a trimotor aircraft with three engines that significantly improved its performance. This made it a favorite for airlines and cargo operators. In its early days, the Ju 52 was used by Deutsche Luft Hansa, the German

national airline, to connect cities across Europe. Its ability to land on shorter, rougher airstrips where other aircraft struggled made it particularly useful in remote or developing regions.

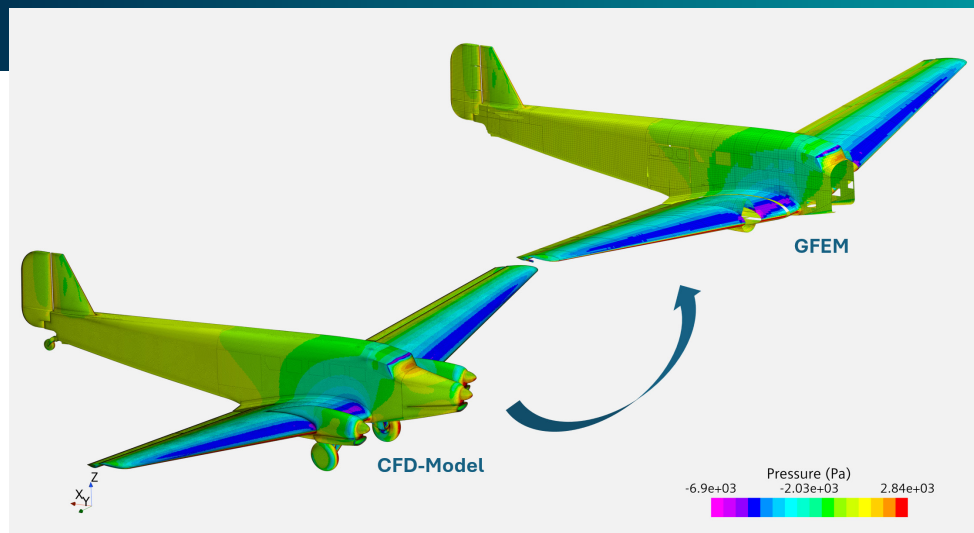
Beyond Europe, the Ju 52 played a significant role in opening air travel and transport in areas where infrastructure was minimal. For example, in South America, it became a vital link across the Andes, and in Africa, it was a common sight, delivering goods and passengers to otherwise isolated places. The aircraft's versatility was another hallmark, with configurations ranging from passenger seating to cargo holds and, in some cases, as a floatplane.

Even after newer and faster aircraft were developed, the Ju 52 continued to be used worldwide, valued for its durability and straightforward mechanics. Today, the Ju 52 remains a beloved icon of early aviation, with several preserved in museums, offering a nostalgic glimpse into a bygone era of aviation.



“Using Simcenter STAR-CCM+, we put the geometry we obtained from reverse engineering into a CFD analysis. We then used the results from the CFD analysis to provide the boundary conditions in Simcenter Femap for FEA analysis. This gave us the internal loads on every truss of the aircraft.”

Danny Wadewitz
Analysis Engineer and
Executive Board Member
AeroFEM



Facing the challenges of modernizing the Ju 52

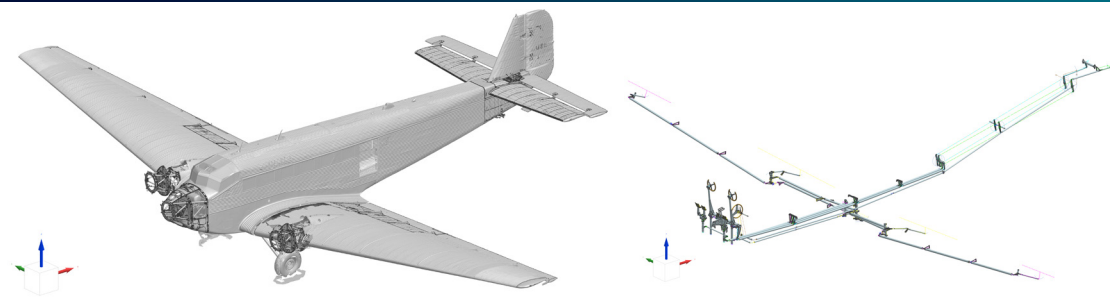
Despite its success and beloved status, the Junkers Ju 52 faced modern challenges that were detrimental. By 2018, the remaining operational models in Europe had been grounded following a tragic accident that highlighted the necessity for modern airworthiness standards. In response, AeroFEM, a Swiss engineering firm specializing in aviation projects, embarked on a mission to demonstrate the airworthiness of a modern-day replica of the Ju 52 using cutting-edge technology from Siemens Digital Industries Software. For this, they used Simcenter™ software and NX™ software, which are part of the Siemens Xcelerator business platform of software, hardware and services.

The project to revive the Junkers Ju 52 was no small feat. The original aircraft had been developed without the aid of modern design tools, relying on “paper, pencils and slide rules,” notes Danny Wadewitz, analysis engineer and executive board member at AeroFEM. The goal was to create a new version of the Ju 52 that met current airworthiness regulations, particularly the stringent weight limits imposed by modern standards.



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Highlighting the importance of reverse engineering

As industries strive to integrate legacy technology into modern frameworks, reverse engineering plays a crucial role in ensuring older designs remain relevant and operational in a digital age. This process involves deconstructing existing products to understand their components, structure and functionality, allowing engineers to recreate or enhance them using current technologies.

For AeroFEM, reverse engineering was the key to breathing new life into the Junkers Ju 52. By digitally capturing every aspect of the aircraft, they created a detailed 3D model, preserving the original design while adapting it for modern applications. This approach not only honors the engineering accomplishments of the past but also bridges the gap between historical designs and contemporary standards.

Since technology evolves rapidly, reverse engineering offers a way to maintain continuity between the past and the present. It allows engineers to study and replicate successful designs, ensuring valuable insights and innovations are not lost over time. This practice is particularly important in industries like aviation, where engineers must often integrate legacy systems with cutting-edge technology to meet modern safety and performance requirements.

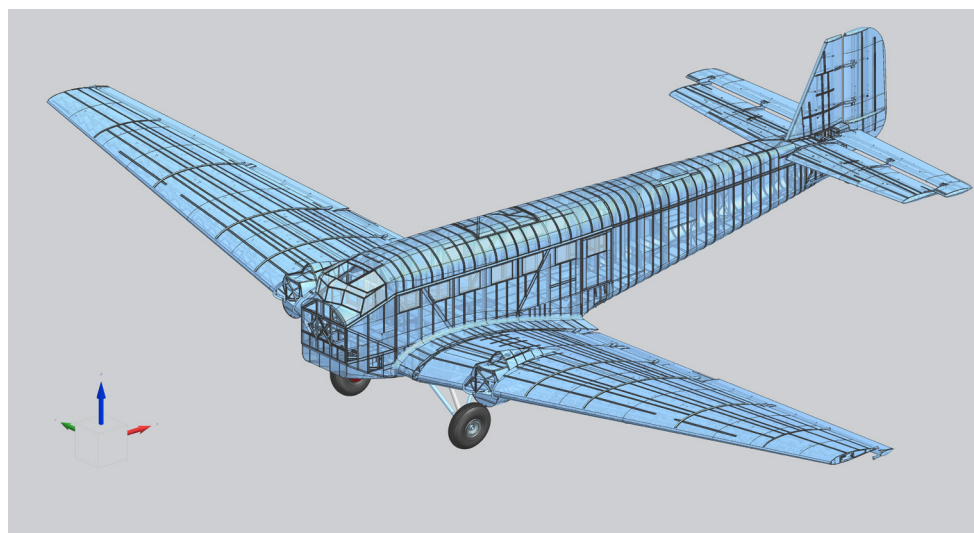
Leveraging Simcenter and modern engineering tools

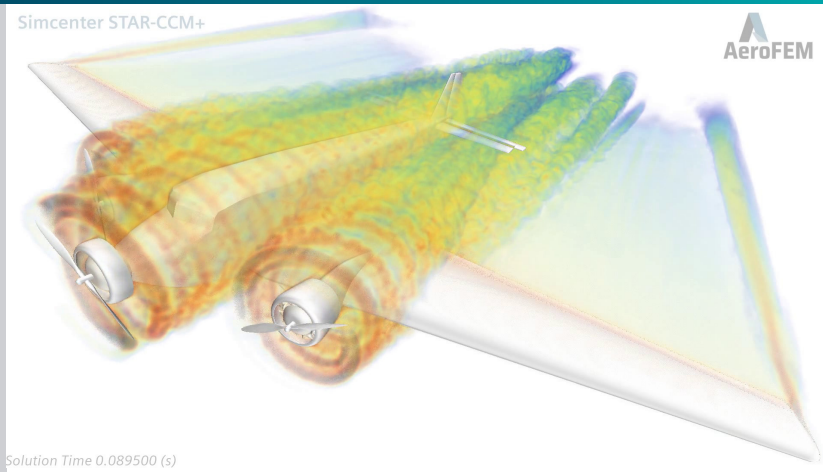
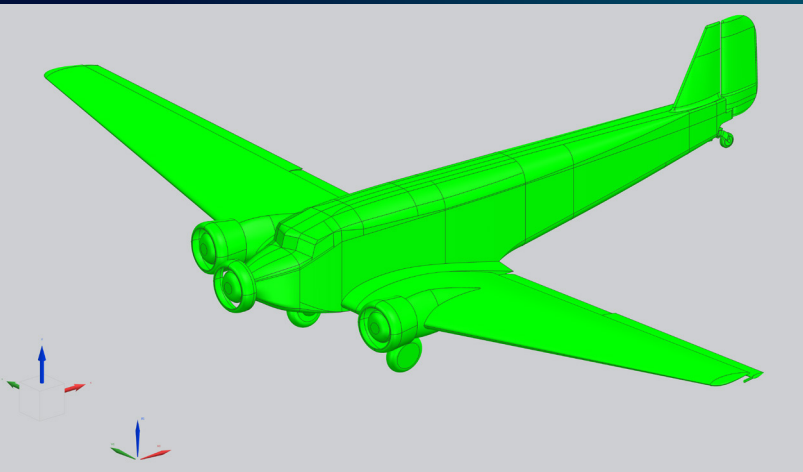
AeroFEM’s approach to tackling these challenges was to leverage Simcenter tools, which provided a comprehensive suite for simulation and analysis. This allowed the team to recreate and analyze the aircraft with unprecedented precision.

The process began with extensive reverse engineering, which started with two existing Ju 52 aircraft to gather initial data. “We basically had to redo everything from scratch,” says Wadewitz. “The idea we had was to 3D-scan the aircraft, which we essentially did twice. We did it once from the outside and then again from the inside and also in different stages of disassembling the aircraft.”

The scanning process generated a vast cloud of points, which served as the foundation for creating detailed digital models. Using NX as an advanced reverse engineering toolkit, AeroFEM transformed these points into surfaces, parts and a complete assembly of the aircraft.

“Fortunately, Siemens has advanced NX reverse engineering tools, which are very intuitive and easy to use,” says Wadewitz. “Our engineers working on this, who have never done so before, picked up on using NX quickly and almost perfected the process.”





With the digital model in place, the team moved on to aerodynamic and structural analysis using Simcenter STAR-CCM+™ software for computational fluid dynamics (CFD) and Simcenter Femap™ with Simcenter™ Nastran software for finite element analysis (FEA). Leveraging these solutions, AeroFEM engineers performed comprehensive simulations to understand the aircraft's performance and structural integrity under various conditions.

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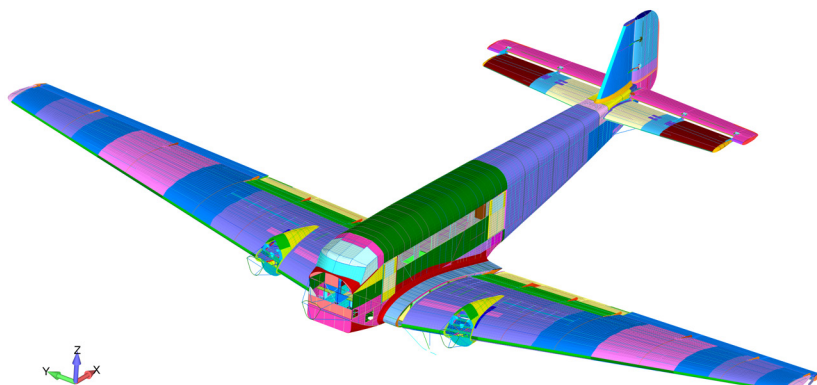
This analysis revealed the remarkable engineering of the original Ju 52, which left little room for weight optimization. "One of the surprises was that there was little room for optimization," says Wadewitz. "The engineers at the time knew what they were doing, so there wasn't much room for weight savings on the structural side." Since they could not lower the take-off weight from 10.5 to 8.6 tons to meet modern certification standards structurally, they could do so by reducing the amount of fuel and the number of passengers. This solution had little impact on the aircraft's range since modern engines use considerably less fuel than the original engines.

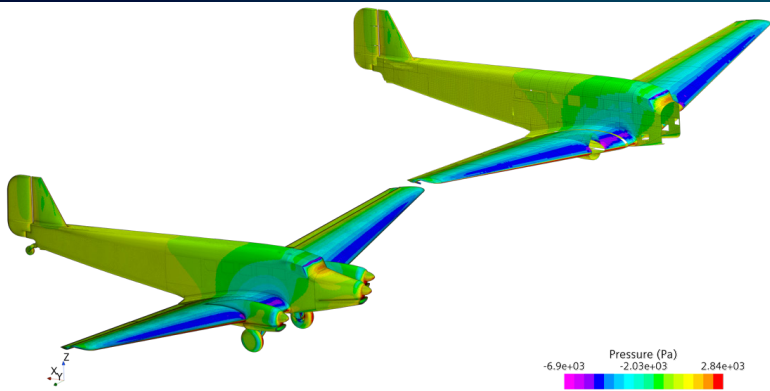
However, a critical aspect of the project was selecting materials for the replica aircraft. The original Ju 52 was made using a copper-aluminum alloy, which had to be replaced with modern materials due to availability and certification constraints.

"You have to use what's commercially available now," says Wadewitz. "We had to choose a material that is similar in strength and durability but is commercially available."

The team opted for modern aluminum alloys that closely matched the original materials' properties, ensuring the aircraft retained its historical integrity while meeting contemporary standards.

AeroFEM expected challenges given the age of the aircraft, asymmetry and material deformations. Over time, wear and tear had impacted the aircraft's structural integrity, requiring careful consideration in the simulation process.





"It's definitely not symmetric anymore," says Wadewitz. "The aircraft had a lot of incidents and repairs and was subjected to the type of material deformations that come with time and creep."

These factors had to be considered when translating the reverse-engineered shape into the form intended by the designers.

Understanding the outcomes and lessons learned

Although the project ultimately did not proceed to flight testing due to a premature end to funding, it remains a significant achievement in the field of engineering. AeroFEM successfully demonstrated the capability to apply modern tools to historical designs, proving the engineering prowess of the past could stand alongside modern advanced technologies.

"With the authorities, in our case EASA, we didn't get very far," says Wadewitz. "We got to the point where we applied for a type certificate; if the funding hadn't ended, we would have ultimately gotten the replica aircraft flying."

Despite this setback, AeroFEM's work provided invaluable insights into the structural integrity and potential for modern enhancements to the Ju 52. The digital model they created during the project serves as a historical record, preserving the aircraft's legacy for future generations. "This is now the definitive record of the aircraft's design," says Wadewitz. "It's probably one of the oldest aircraft now in a PLM like Teamcenter."



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Solutions/Services

NX
siemens.com/nx
Simcenter STAR-CCM+
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Customer's primary business

AeroFEM develops your ideas from concept to serial production, including design and verification by simulation or tests for certification.
aerofem.com

Customer location

Ennetbürgen
Switzerland



The Junkers Ju 52 project offered numerous lessons for AeroFEM and the wider engineering community. It highlighted the importance of meticulous data collection, the power of modern simulation tools and the enduring legacy of historical engineering.

One key takeaway was the need to respect and understand the original engineering decisions made nearly a century ago. "The requirements are more stringent now than they were at the time, and the engineers back then knew what they were doing," says Wadewitz.

The project also underscored the value of collaboration between historical research and modern technology, paving the way for similar initiatives in the future.

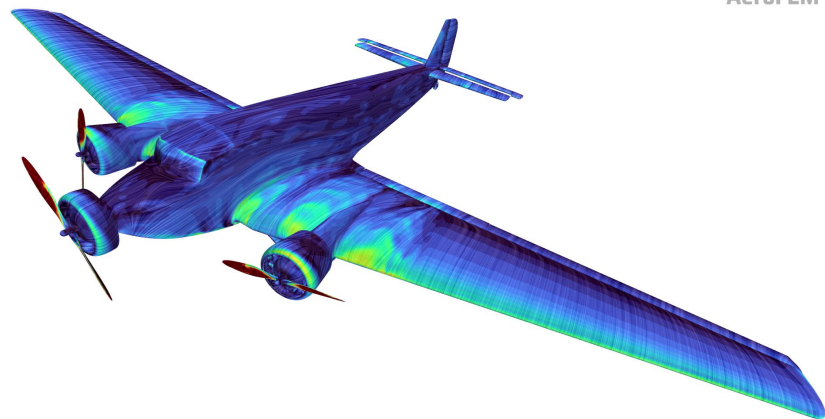
Preserving and learning from our engineering heritage

AeroFEM's attempt to bring the Junkers Ju 52 back to the skies stands as a remarkable example of engineering innovation and dedication. By leveraging Simcenter and NX and applying modern engineering principles, they demonstrated the feasibility of bridging historical designs with contemporary standards. While the Ju 52 may not have taken flight again, its legacy endures via the efforts of AeroFEM and the valuable insights gained from this ambitious endeavor.

Looking to the future of aviation, projects like this remind us of the importance of preserving and learning from our engineering heritage, ensuring the lessons of the past continue to inspire innovation and excellence in the future.

Simcenter STAR-CCM+

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