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Siemens Digital Industries Software

Simcenter 3D for additive manufacturing simulation

Print right the first time

Solution benefits

- Print right the first time
- Simulate the build process for metal powder bed fusion additive manufacturing applications
- Predict potential geometry distortions during the build
- Investigate efficiently different build positions and support scenarios
- Mesh the specimen geometry exactly using powerful Simcenter 3D algorithms
- Generate compensated geometry (BREP) based on the simulated distortion fields

Additive manufacturing (AM) is changing the way products are made. New revolutionary machines and processes are rapidly pushing AM from the prototype environment onto the production floor. The additive manufacturing capabilities in Simcenter™ 3D software are used to predict distortions and defects before parts are printed, thereby reducing the number of test prints and improving the quality of the final print.

High-quality simulation environment

The high-quality simulation capabilities of Simcenter 3D are paramount to industrializing AM. During the AM process simulation, the parts are meshed accurately with tetrahedron meshes and sliced afterward, which gives better results than voxel meshes.

Enhanced inherent strain approach

A new approach was developed that was brought to the market with Simcenter 3D. The layer-by-layer build process during the powder bed fusion printing leads to layer shrinkage during the cool down of the layer. The stiffness of the printed structure has a strong influence on part distortion.

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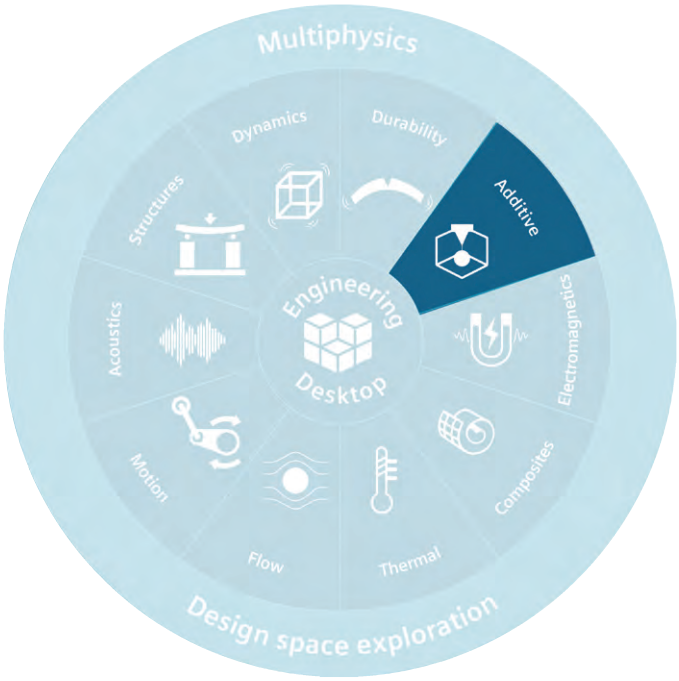
Calculated distortions can be used to compensate for the part prior to the printing process. The initial geometry can be automatically morphed into the precompensated shape and replaced in the built tray for further analysis, or it can be sent directly to the printer to be printed correctly the first time.

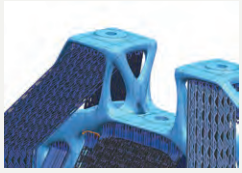
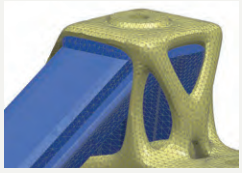
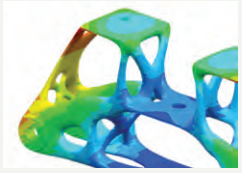
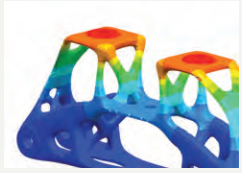
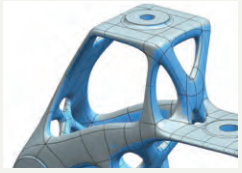
Fully integrated with NX end-to-end workflow

Simcenter 3D for AM is seamlessly integrated into the end-to-end Siemens' digital enterprise software AM workflow. The process is streamlined to be used by nonexpert computer-aided engineering (CAE) users as well.

Providing a platform for multidiscipline simulation

The Simcenter 3D AM solution is part of a larger, integrated multidiscipline simulation environment with Simcenter 3D Engineering Desktop at the core for centralized pre-/postprocessing for all Simcenter 3D solutions. This integrated environment helps you to achieve faster CAE processes and streamline multidisciplinary simulations that integrate additive manufacturing with any of the Simcenter 3D solutions, such as thermal mechanical, vibro-acoustic, or other more complex analyses.



Build preparation	Model setup	Simulation	Postprocessing	Compensation
Build preparation in NX Additive Manufacturing and transfer to Simcenter 3D	Automatic generation of thermal and mechanical input files using exact meshing of the specimen.	Calculation of distortions based on thermomechanical analysis using enhanced inherent strain method.	Visualization of thermal history, distortions, probability of overheating, recoater collisions and more...	Compute predistorted geometry (BREP) based on the simulated distortion.
				

Validation, feedback to application engineers

Industry applications

Today, AM is still mainly a research and development (R&D) activity as this process remains expensive and slow, preventing its use for large projects such as in the automotive industry. However, some industrial applications are already linked to the printing of complex parts, which are difficult to produce by traditional methods. The primary goal is to create parts that are lightweight and have good mechanical properties. Repairing parts previously produced by traditional processes can also be a valuable application of AM due to the unique nature of each component.

Aerospace and defense

The space industry already produces structural parts for launchers. The goal is to produce parts that are lightweight and have good mechanical properties.

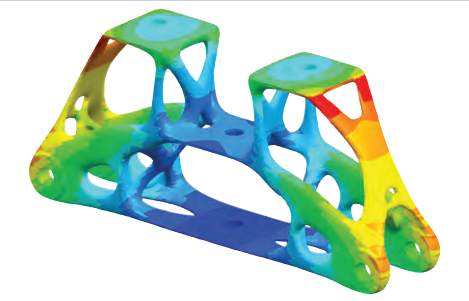
The airplane industry is also developing this technology, but is in more of an exploratory phase with the goal of producing components with complex geometry.

Industrial machinery

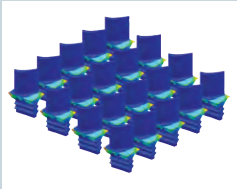
Power generation appears to be an industry that is exploring AM to produce turbine blades and other combustion chamber components. AM can also be applied to repairing existing turbines.

Automotive industry

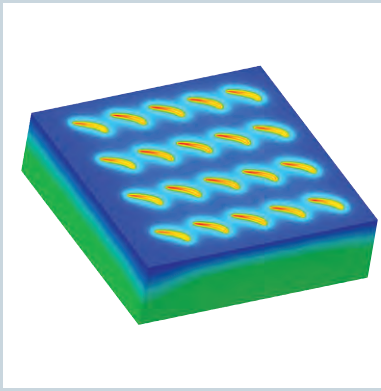
Lightweight structures for racing cars and completely new bionic designs can be manufactured with additive manufacturing technology. Generative design can be used to find new proposals that can be manufactured with additive manufacturing technology.

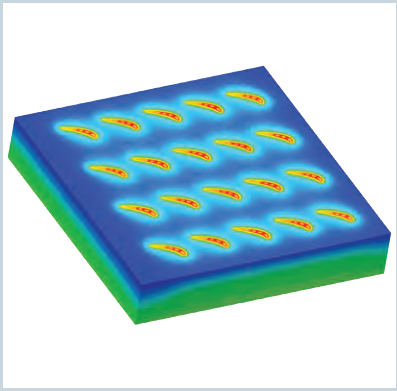


NX AM integrated solution



Simcenter 3D





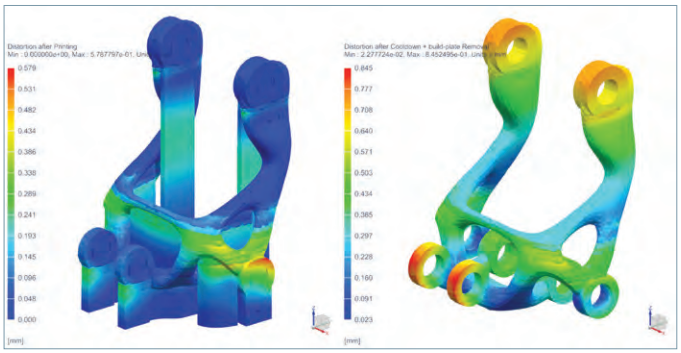
Simulate printing process

Predict thermal distortion

Allow compensation and print right first time

Simcenter 3D Additive Manufacturing

Simcenter 3D Additive Manufacturing simulates the AM process for selective laser melting (SLM). The setup from a part in the built tray, including support structures, is used as a basis. The user selects the parts to simulate and define printing process parameters (material, number of parts, layer slicing, laser parameters, etc.) and run the simulation. The result is the temperature distribution and distortion of the part.



Module benefits

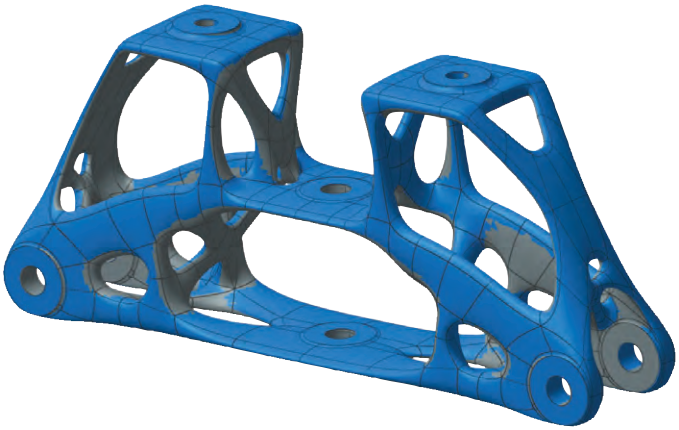
- Simulation of the build process for powder bed fusion metal prints
- Fully integrated into the NX™ software additive manufacturing framework
- Unique model setup and solving methodology

Key features

- Solving the coupled thermomechanical solution
- Material and process parameters for AM
- Consideration of support structures from fixed plane modules
- Analyze thermal distribution
- Analyze distortion before and after support removal
- Detect recoater collision
- Predict probability of overheating
- Efficiently compute stiffness curves
- Compute pre-distorted geometry for compensation

Omnimesh for Simcenter 3D

Simcenter 3D Additive Manufacturing is used to compute the distortion of parts during the AM process. The part distortions can be transferred to the initial geometry to pre-deform it using powerful geometry modification techniques based on the boundary representation (BREP) model. A new compensated part file is generated that can be used to replace the original part on the build tray. The compensated geometry is then used for validation and can be directly sent to the printer.



Module benefits

- Pre-deformation of BREP geometry
- Generation of NX part files of compensated geometry

Key features

- Compute pre-distorted geometry for compensation
- Read distortion field from Simcenter 3D Additive Manufacturing
- Fully integrated into the additive manufacturing workflow

Capabilities chart

General capabilities	Specific capabilities	Simcenter 3D Additive Manufacturing	OmniMesh for Simcenter 3D
Simulation capability			
Distortion analysis	Layer-by-layer simulation	•	
Thermal history	Simulate the thermal history of single or multiple parts on the build tray	•	
Support failure	Prediction of support failure	•	
Recoater collision	Identify layers with large deformation in z-direction	•	
Probability of overheating	Identify areas with high overheating probability	•	
Prediction of shrinklines	Stiffness analysis of the part to identify shrinklines	•	
Thermomechanical analysis	Coupled thermomechanical analysis	•	
Heat treatment	Stress relief load case for nickel-based alloys	•	
Cool down	Cool down to ambient temperature	•	
Support removal	One step support removal and cutoff from the build tray	•	
Material			
Metal	Application for metal powder bed fusion	•	
Model setup			
Powder mesh	Meshing the powder for thermal analysis	•	
Detailed meshing (tetrahedrons)	Detailed meshing of the specimen	•	
Mesh slicing	Layer setup is realized by mesh slicing	•	
Manual change of meshing setup	Flexibility to manually modify the mesh and simulation setup	•	
Homogenized material for support structures	Use solid meshes for supports and apply homogenized material (properties can be determined in the application)	•	
Compensation			
Compensate geometry based on BREP body	Compensation of part in additive manufacturing build tray		•

Note: One fixed plane product is a minimum prerequisite for Simcenter 3D AM. The Simcenter 3D AM Product is a prerequisite for Omnimesh for Simcenter 3D. Other dependencies or prerequisites may apply for individual products.

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