exaSIM™

Accelerating PRODUCTION

3DSIM™

What is it?

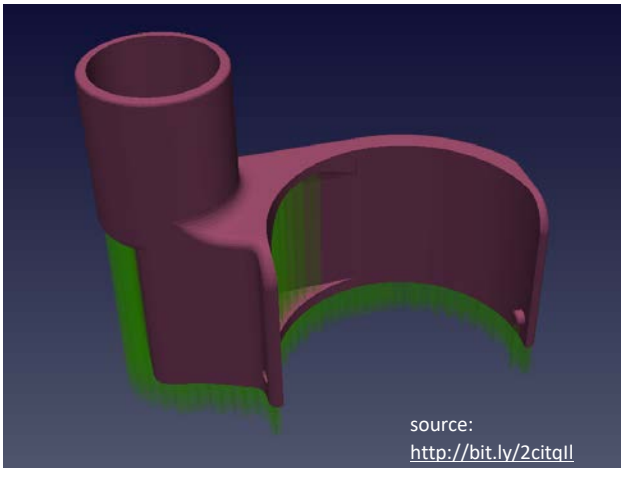
exaSIM™ is a suite of metal Additive Manufacturing (AM) simulation tools that provide critical insight into the complex physics-based phenomena associated with laser powder bed fusion. exaSIM generates practical solutions to residual stress, distortion and build failure, enabling users to achieve part tolerances and avoid build failures without trial and error experimentation. STL files can be automatically distortion compensated to counteract the distortion that occurs during part production. Two types of support structures are automatically generated based upon residual stress predictions, enabling exaSIM users to avoid wasting time and material when placing supports. Build failure can be avoided by utilizing the automatically generated supports and the Blade Crash detection feature. For ease of use, greater speed, data storage, and rapid feature implementation, exaSIM runs in a secure cloud environment. exaSIM is available in **GovCloud** for our customers who want access within an ITAR, FedRAMP and DOD SRG compliant and ISO 9001 / 27001 / 27017 / 27018 certified environment.

How does it work?

exaSIM™ utilizes patent-pending computational solvers to predict residual stress and distortion in a layer-by-layer fashion. A user supplied STL file or machine build file is automatically meshed for analysis. A strain pattern is calculated using either: ***1) Uniform Assumed Strain***, ***2) Scan Pattern Strain,*** *or* ***3) Thermal Strain***. Uniform Assumed Strain provides the fastest approximation by utilizing a uniform isotropic strain assumption. Scan Pattern Based Strain offers a higher fidelity solution by considering local scan pattern orientation to predict anisotropic shrinkage. Thermal strain, a simulation mode unique to 3DSIM, provides the highest degree of accuracy. Thermal strain is based upon a full-part thermal analysis, scan vector-by-scan vector. Local strain magnitude is calculated based upon the number of times a location goes through elevated thermal cycling without re-melting. Scan orientation is utilized within thermal strain to correctly predict anisotropic effects. All exaSIM modes can be used to output supports, create visualizations, conduct trend analyses, predict build failure mechanisms and provide distortion compensated STL files. exaSIM offers both linear elasticity and non-linear plasticity assumptions.

Support Generation:

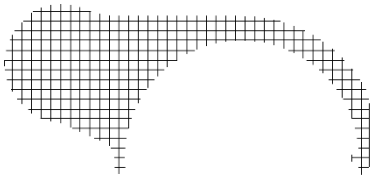
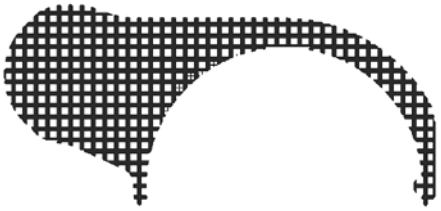
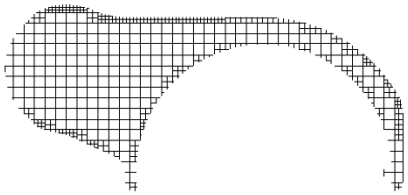
The maximum residual stresses that supports must withstand are predicted using 3DSIM's Mechanics Solver and passed to the support generation module**.** Support structures are automatically generated based upon an algorithm which varies the support density to carry these maximum residual stresses. The resulting support structure is provided to the user, in an STL file format. A sample support structure is shown to the right *(green lines)*, where supporting walls for both internal holes and bottom surfaces were generated.



source: http://bit.ly/2citqll

exaSIM provides three types of support structures. Thin wall supports are single-scan-width walls that are distributed beneath each downward-facing surface below a user-specified angle. Uniform supports are placed based upon geometric considerations only. Stress-based thin wall supports are distributed such that more walls are placed in regions of higher residual stress and fewer walls in regions of lower residual stress. Thick wall supports are uniformly spaced supports where the thickness of walls increase in regions of higher residual stress. Each of these support types can be output as STL files for any exaSIM simulation.

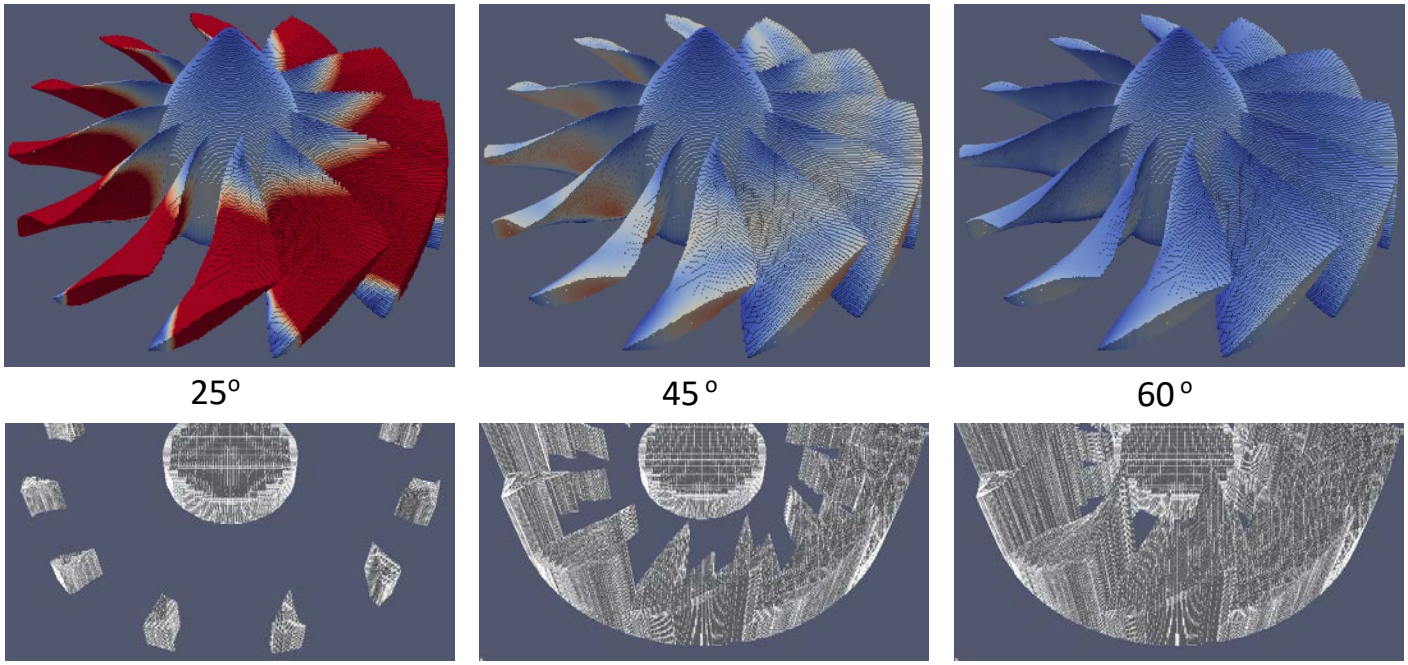
Example Support Structure Cross-Sections for the Part Shown Above:

Uniform thin wall support	Residual stress-based thick wall	Residual stress-based thin wall
		

Trend Analysis:

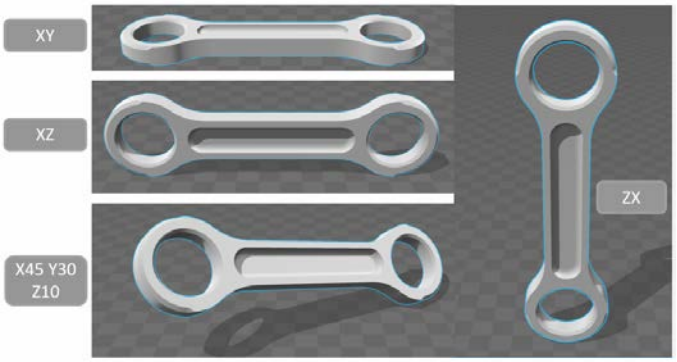
exaSIM users can select successful part orientations and support strategies by visualizing the effects of their assumptions on distortion and residual stress for as-built parts. Stress, distortion, blade crash potential and high strain regions are output in the VTK file format. These files ***(including layer-by-layer VTK files)*** can be viewed in many 3rd party visualization tools, including Paraview, a free viewer. VTK files enable users to see the differences between the original un-deformed geometry and the final deformed geometry before and after removal from supports. Color maps can also be used for viewing distortion trends, final residual stress, maximum stress components throughout the build, high strain regions and potential blade crash location. These visualizations enable users to select the orientation and strategy which best meets their part design intent. By reducing maximum part stresses and distortion, users can reduce their likelihood for build failures.

1) Comparative distortion analysis and support generation for different support angles



25° 45° 60°

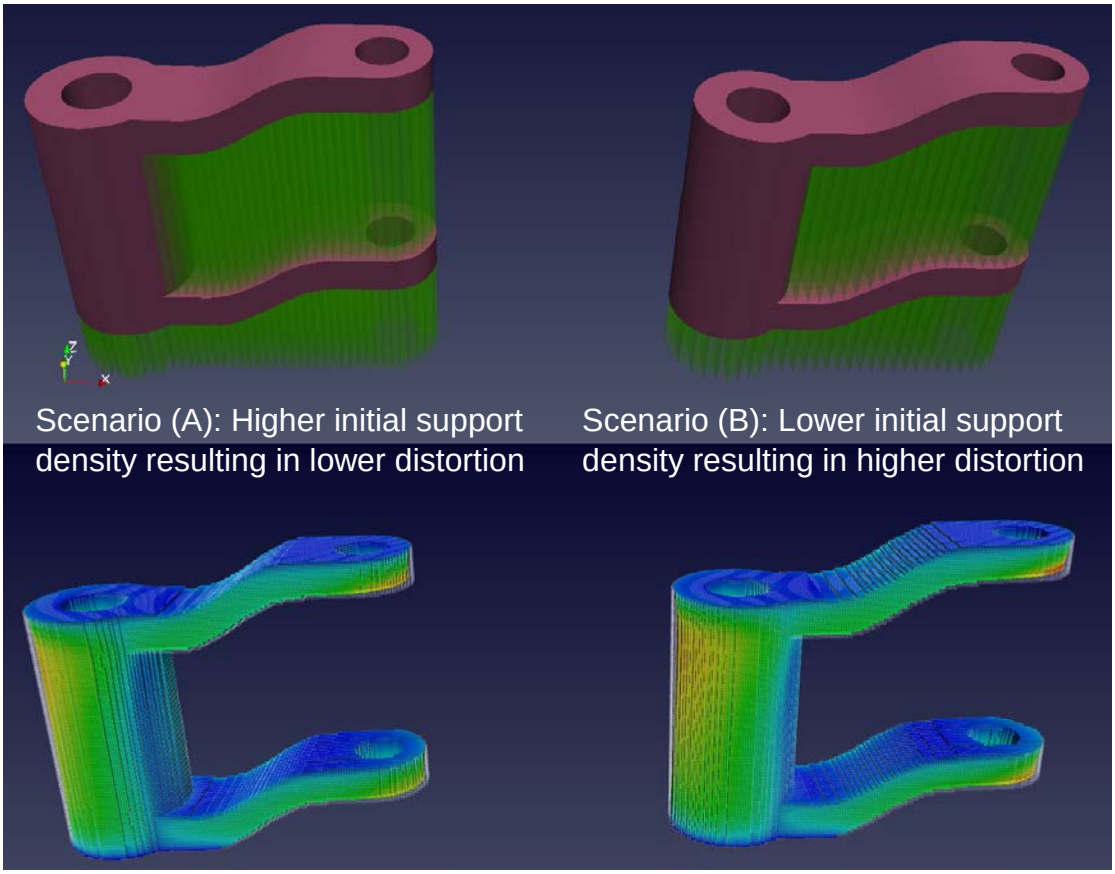
2) Comparison of stress and distortion trends based on part orientation



a) Various part orientations

b) σyy Stress Distribution

3) Comparison of distortion for varying support densities



Why Buy exaSIM?

exaSIM provides users unparalleled insight into AM-specific physics and includes features and simulation options that are not available through any other simulation provider, including predictions driven by **reading metal AM machine build files** and performing a **full-scale thermal analysis utilizing the exact scan vectors used to build a part**. Built-in features include ***Distortion and Stress Predictions, Support Generation, Blade Crash Detection, Distortion Compensation,*** and identification of ***High Strain*** locations in parts and supports.

Pricing

FEATURE LIST	exaSIM BASIC $1,000/Mo $10,000/Yr	exaSIM ADVANCED $1,500/Mo $15,000/Yr	exaSIM ULTIMATE $2,000/Mo $20,000/Yr	exaSIM HOURLY $50*/Mo $20/Hour	exaSIM ENTERPRISE (contact us for a quote)
UNIFORM ASSUMED ISOTROPIC STRAIN	✓	✓	✓	✓	✓
SCAN PATTERN ANISOTROPIC STRAIN	x	✓	✓	✓	✓
THERMAL ANISOTROPIC STRAIN	x	x	✓	✓	✓
Stress-Based Automatically Generated Supports	✓	✓	✓	✓	✓
On-Plate, As-Built Part Distortion & Residual Stress	✓	✓	✓	✓	✓
Part Distortion after Removal from Supports	✓	✓	✓	✓	✓
Distortion Compensation	✓	✓	✓	✓	✓
Blade Crash Detection	✓	✓	✓	✓	✓
Identification of High Strain Locations	✓	✓	✓	✓	✓
Layer by Layer Stress, Distortion & Blade Crash Visualizations	✓	✓	✓	✓	✓
Build File Readers for Multiple AM Machines	✓	✓	✓	✓	✓
Concurrent Simulations**	*1*	*1*	*1*	*customizable*	*customizable*
User Logins	*Unlimited*	*Unlimited*	*Unlimited*	*Unlimited*	*Unlimited*
Community Forum and Help Page Access	✓	✓	✓	✓	✓
Email and In-App Technical Support	✓	✓	✓	✓	✓
User Group Participation	✓	✓	✓	✓	✓
Real-Time Simulation Progress	✓	✓	✓	✓	✓
Worldwide AWS Cloud Access	✓	✓	✓	✓	✓
Dedicated Storage**	*3 TB*	*3 TB*	*3 TB*	*3 TB*	*customizable*
User-Customized Material Assumptions	✓	✓	✓	✓	✓
Priority Support	x	x	x	x	✓
Onsite training	x	x	x	x	*available*
Single-Point-of-Contact Technical Success Manager	x	x	x	x	*available*
AWS GovCloud***	*available*	*available*	*available*	*available*	*available*

** Includes 5 hours/month of simulation time – after which customers are billed $20/hour for simulations*

*** Concurrent simulation limit can be increased for $1,000/month or $10,000/year per instance. 1TB additional storage included per instance.*

****AWS GovCloud upgrade available for $5,000/year*

Looking for a *Custom Configuration*? We will work with you to create a plan.