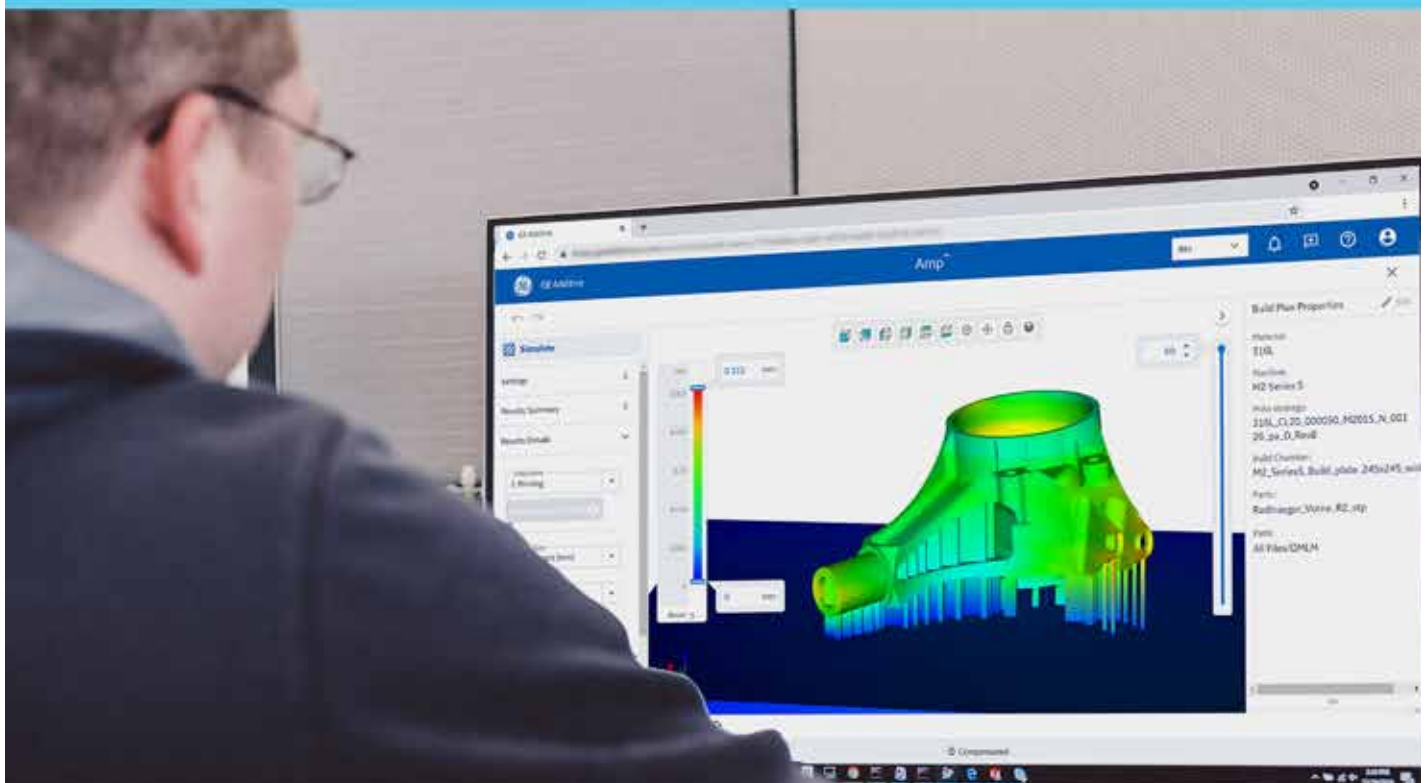GE Additive

GE Additive's Amp™ software platform gets you to industrialization faster

Reduce trial and error and pave a smoother, more cost-effective
path to full metal additive production

Enable speed and scale with software built for metal additive.

With additive manufacturing (AM), you can improve the design and manufacturing of complex parts, reduce costs and transform the supply chain.

But to move from design to print with ease is no small task. While the metal additive industry has focused heavily on hardware and powder, you need more than best practices and a well-tuned machine to fully realize an industrialized additive factory floor. You need software designed for additive that enables teams to move quickly throughout the design and development process.

Today, software for metal additive is fragmented. The software tools available are as numerous as the problems you could encounter. However, with an integrated software solution developed by additive experts, manufacturers can more easily overcome their challenges, take products to market at scale and achieve a true competitive advantage through the industrialization of metal additive.

With an integrated software solution you can improve your additive workflow in four key areas:

DECREASE time and cost of part development

INCREASE candidate parts for AM

IMPROVE part yield

ENHANCE accessibility and collaboration

More additive products in production. Greater competitive advantage.

With an integrated metal additive software solution, you can significantly reduce typical development time while saving costs and consolidating your software assets.

time reduction from improved trial and error process

cost reduction from fewer development builds and material waste

From **multiple** software tools **to 1** integrated platform

Innovation made for users, by users.

GE Additive understands the challenges manufacturers face when adopting metal additive. When we couldn't find a software solution that met our needs and was easy to use, we created it.

GE Additive's Amp software platform leverages the knowledge of our AddWorks™* experts by taking their best practices and know-how and incorporating it directly into Amp. Now, you can move toward industrialization with a repeatable, consistent and streamlined process—and transform your business.

*Trademark of General Electric Company

A better way to work:
Introducing Amp, GE Additive's AM software platform.

Developed exclusively for GE machines, Amp integrates the tools engineers need to manage, process and manufacture metal additive parts on one integrated platform—built on GE's expertise and experience.

From development to print production, Amp offers a flexible, streamlined workflow so manufacturers can improve part production and significantly reduce trial and error needed to develop print-ready parts.

Amp breaks down the silos between CAD, build prep, simulation, compensation and inspection data to help improve part production. With centralized data, you can access tools that simulate how the manufacturing process unfolds in real time and see the estimates for cost and time for a part throughout the process.

See how Amp transforms the additive design and development process.

Before Amp

*Open-loop, time-consuming linear process*

- Cumbersome STL files
- Linear process
- Limited team access
- Multiple, non-integrated tools
- Seemingly endless trial and error
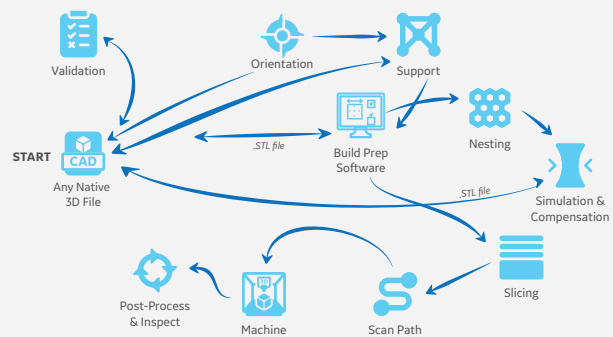
With Amp

One integrated, data-centric solution

- Uses native 3D files rather than STLs
- Enables more tasks and people to work simultaneously through a flexible work process
- Provides built-in estimates of cost and time
- Significantly reduces trial and error
- Creates a complete digital thread
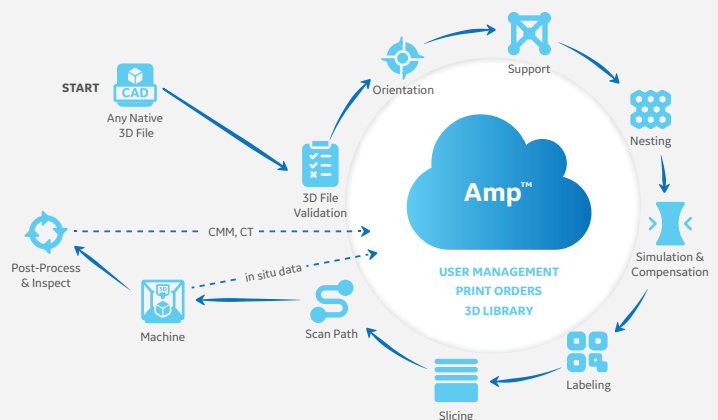
Streamline the additive process with GE's Amp.
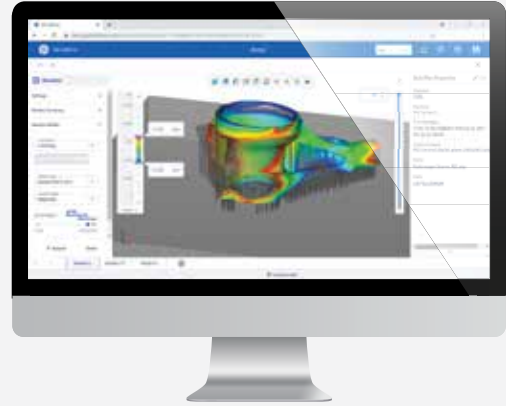
Additive manufacturing is due for a better solution to simulate and compensate for developing complex additive parts. The typical 1:1 compensation method used lacks precision and results in too much trial and error. Traditional simulation tools require many input variables that additive engineers might not have access to and make the process more complex than it needs to be.

With Amp, companies no longer must choose between trial and error or complex tools that only a few can readily understand. Using lessons learned after years of additive part development, GE streamlined the experience to help move companies toward industrialization faster and support experienced and new users with recommendations based on best practices.

See how software designed for metal additive can improve your workflow.

#1 DECREASE time and cost of part development

Current additive build-prep resources demand too much expertise and manual inputs from the user, which can create issues due to the interpretation or inconsistent use of the software tools.

Amp provides an intuitively designed menu of tools to help decrease time of part development by providing layout insights, orientation recommendations, automated overhang detection, multiple types of support generation and arrangement and labeling.

Amp's Simulation and Compensation tool is iterative, adaptive and convergent. This solution lets you successfully produce parts more quickly—without the need for extensive trial and error that most additive users face today—and reduce costs associated with material and manpower.

- Simulate and identify where the heat stresses will occur during the build.
- Eliminate the need to input a myriad of variables or print test coupons and avoid expensive materials testing characterization with pre-calculated and validated material models tied to GE Additive's machines, materials and parameters.
- Leverage machine-relevant parameters for simplified setup with calculations backed by many years of material expertise and experimentation results.
- Minimize time switching between software tools with an integrated platform and data-centric workflow.
- Compensate for distortions using the intelligent morphing algorithm that blends local and uniform part geometry while detecting and avoiding self-intersection.

#2 MAXIMIZE number of possible applications to print

Additive engineers typically use a trial-and-error method by compensating with an equal amount to the distortion. As part complexity increases, it becomes impossible for someone to compensate for all possible distortions, and the team concludes that this part is not a good candidate for additive.

However, when Amp's Simulation and Compensation takes on the burden of simulating the stresses incurred and then iteratively compensates toward a result, the range of candidate applications expands. What one person could never do alone, the power of the Amp Simulation and Compensation tool can.

- Increase the number of possible parts and boost machine capacity with more successful additive parts faster, drawing more value out of your machines.
- Experiment with different and complex designs that optimize part quality and reach the desired outcome faster.
- Freedom to design your part for functionality without the restraints of traditional manufacturing.

#3 IMPROVE part yield

Complex metal additive parts are rarely produced and designed on the first attempt. Problems can produce local flaws in part geometry or surface finish or even cause a build to fail before completion. These issues could stem from dimensional errors in as-built part geometries to re-coater interference that may interrupt the build.

Amp's Simulation and Compensation enables engineers to generate simulation-based calculations of distortion before the print process. This means engineers can reduce the number of prints to get to the first good part and consequently industrialize more candidate parts.

- Integrate materials, parameters, build plate and other necessary information to run a simulation, eliminating the need for manual part adjustments.
- Discover potential fail points by simulating the build process before printing.
- See highly visual reports that use tools such as x-ray plots of part temperature, distortions and high-stress regions, and 2D and 3D plots of re-coater crash risks, layer by layer.
- Predict re-coater crashes based on clearance, as well as provide useful insights to fix potential issues.

#4 ENHANCE accessibility and collaboration

To industrialize metal additive, you need scalability in your process. Consolidating software tools into one data-centric workflow allows multiple users to collaborate in a flexible way as they develop the print process.

- Load reports that include relevant, actionable information to help you make informed decisions.
- Eliminate unnecessary files with a data-centric workflow that consolidates tools and file-sharing into one workflow.
- Leverage GPU computing resources on the cloud that reduces the burden of extensive computer resources and lets you scale as needed.

Witness the power of Amp.

Amp offers two modules: Print Model, and Simulation & Compensation, to help you optimize your additive process.

Print Model

Automate manual tasks
- Based on real-world best practices
- Simplified process to print parts

Track pedigree
- Relationships captured between various inputs
- Audit history of printed parts

Leverage CAD model
- Clean data, no need for STL, no healing

Experience a single data-centric process
- No saving out to other software tools
- No learning separate interfaces
- Everything in one place

Conduct quality checks
- Fail points flagged before print

Simulation & Compensation

Add Simulation to your additive process
- Easy-to-use tools for design/manufacturing engineers
- Reduced barrier for non-simulation experts

A unified user experience
- Seamless flow from build preparation to sim/comp
- All interactions saved for future needs

Save time
- Digital iterations until your design intent is achieved
- Reduce manual processes and wasted resources from trial builds

Save money
- Reduce costs associated with material and manpower
- More opportunities to use additive on new parts
- Get more parts through development and into production
- Maximize number of possible applications to print

One integrated platform. A myriad of ways to optimize your process.

See how GE Additive's Amp software platform enables you to save time, money and resources throughout the additive process.

Configuration Management
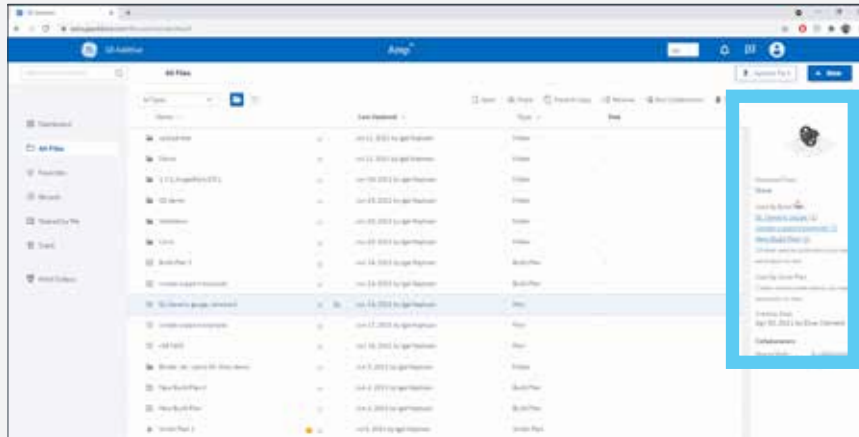
Preview of part geometry

Build plans for the part

Full digital thread of additive data

Number of collaborators

Without Amp
Large STL files are created and moved between different tools in a non-secure, open-loop environment, without traceability or the ability to learn.
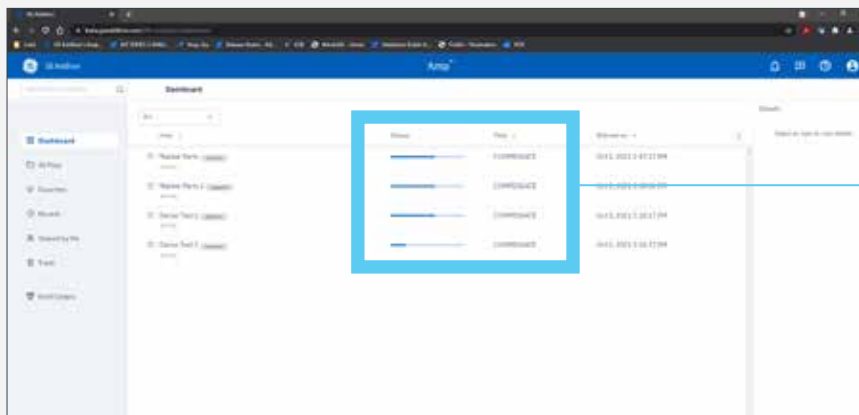
With Amp
Amp can extract data from native 3D files and manage everything in a data-centric dashboard.
Key benefits:
• Integrate multiple processes
• Enable collaboration by sharing any file in the platform
• Maintain audit trail of print order

Jobs Dashboard

Check status of jobs

Without Amp
Users are limited in their ability to get real-time insights into the status of their production. Leveraging different software tools often leads to disconnected information and manual re-entering of data.
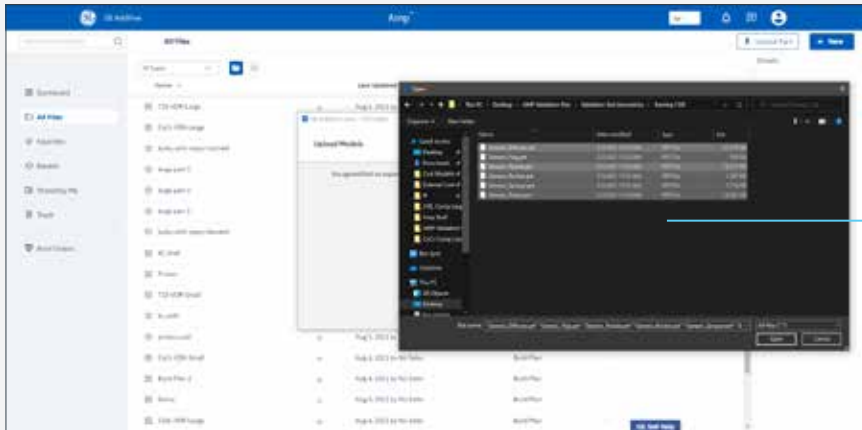
With Amp
Users can queue tasks, check the status and receive notifications when tasks are completed.
Key benefits:
• Efficiently manage and run multiple projects at the same time
• Streamline workflow among users

CAD Import

Drag and drop as many files as you want to upload

Without Amp
Customers are forced to save out to STL files, losing important manufacturing information to create their build plans.
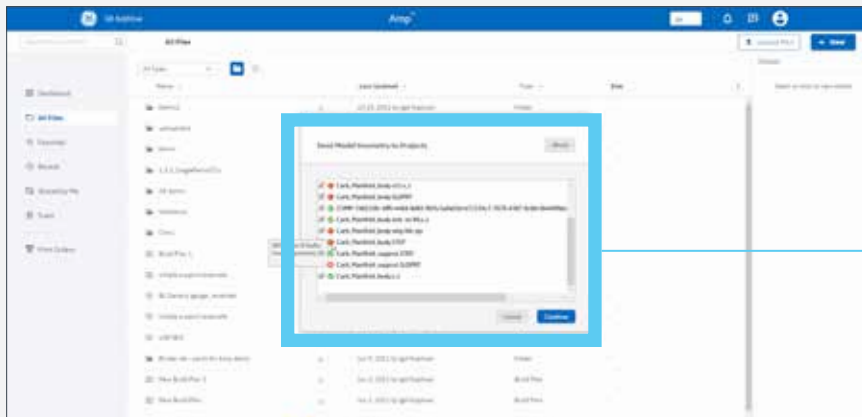
With Amp
Upload part files and extract data from native 3D files, not just STLs, so all parts have clean data and require no healing.
Key benefits:
- Retain original geometric information
- Create a single source of truth for part data

Validation

Number of faults and what type of faults found within the native files

Without Amp
Customers learn about faults and potential issues with their 3D data during the trial and error stage, causing the user to start the process all over.
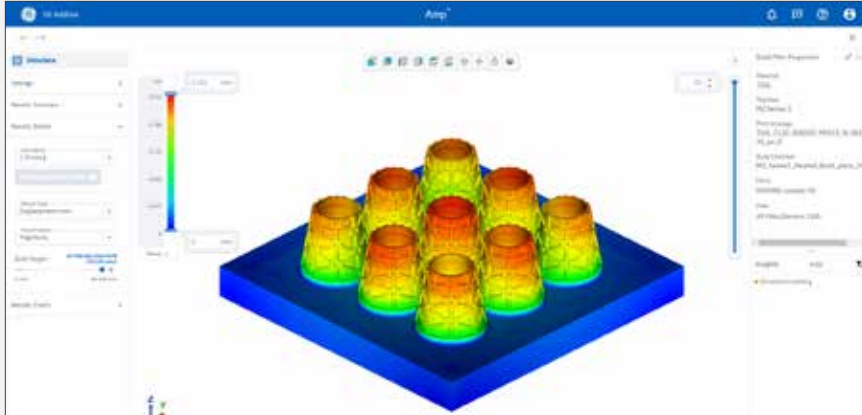
With Amp
Customers are alerted during the file upload stage of any faults with the geometry of the parts making it not valid for 3D printing.
Key benefits:
- During data upload, the validation tool reviews files and alerts the user of any potential errors with the 3D data
- Error message tell the user what the faults are

Simulation

Without Amp

Typically, engineers go through a lengthy trial-and-error period testing different printing parameters to work out the right combination that delivers a suitable build plan for production.
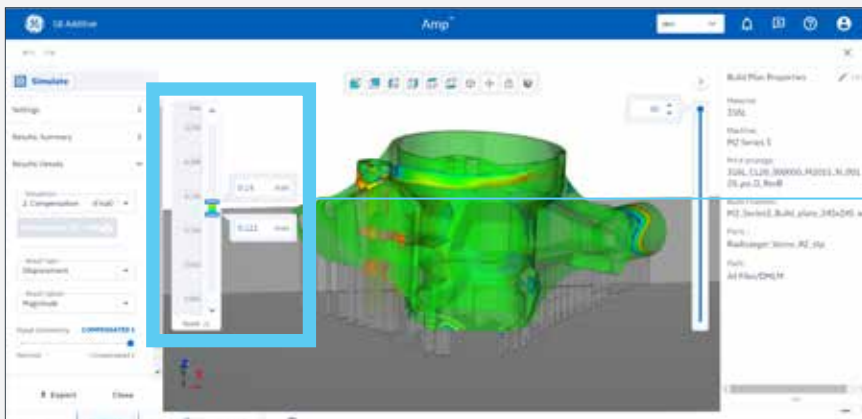
With Amp

Users can model the behavior of a part under a range of conditions before the printing process begins. The software predicts thermal, mechanical stresses, enabling engineers to arrange parts and compensate for distortions.

Key benefits:

• Reduce or eliminate trial and error
• Reduce the time and cost from design to print

Compensation

Compensate to nominal geometry

Without Amp

Engineers manually manipulate the geometry to compensate for distortions seen in the printing process, contributing to the tiresome trial-and-error process that leads to printing a successful part.
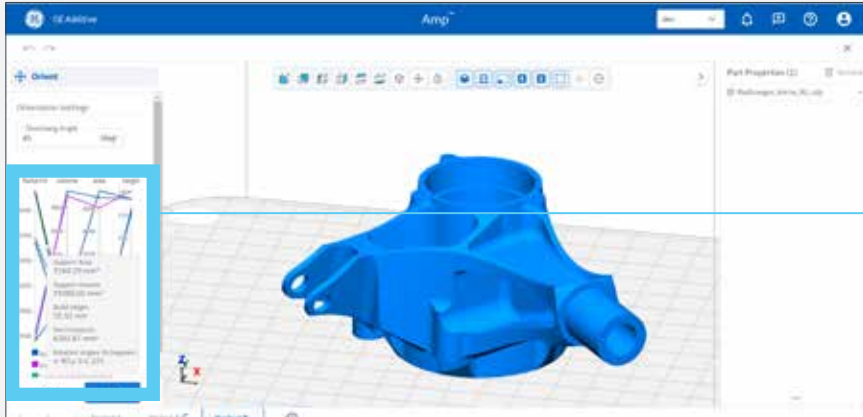
With Amp

Amp iteratively compensates until it finds a solution that produces a successful print.

Key benefits:

• Eliminate manual intervention
• Converge on a solution

Orientation

Optimized orientations based on predefined objectives

Without Amp

Part orientation is reliant on tribal knowledge and individual opinions.

With Amp

The software provides recommended part orientations that lead to successful prints based on successful prints based on GE's collective experience and knowledge.
Key benefits:
- Select from multiple options to optimize part orientation according to your specific criteria
- Ensure designs follow best practices that lead to the best chance of success during printing

Auto-generated supports
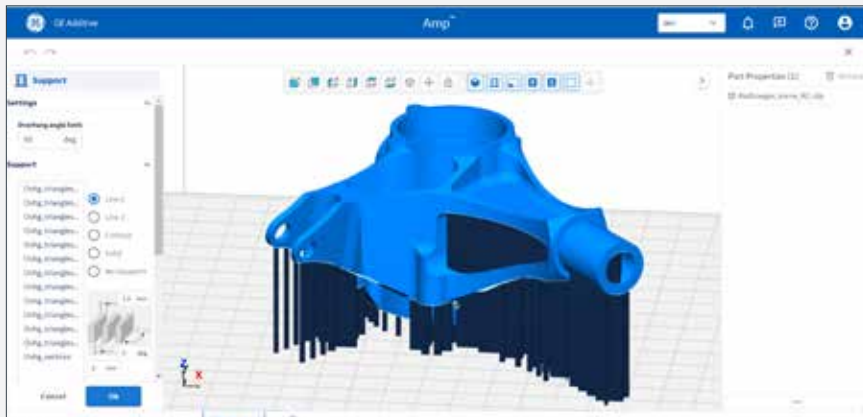
Without Amp

Users must create, adjust and fix the supports for parts manually.
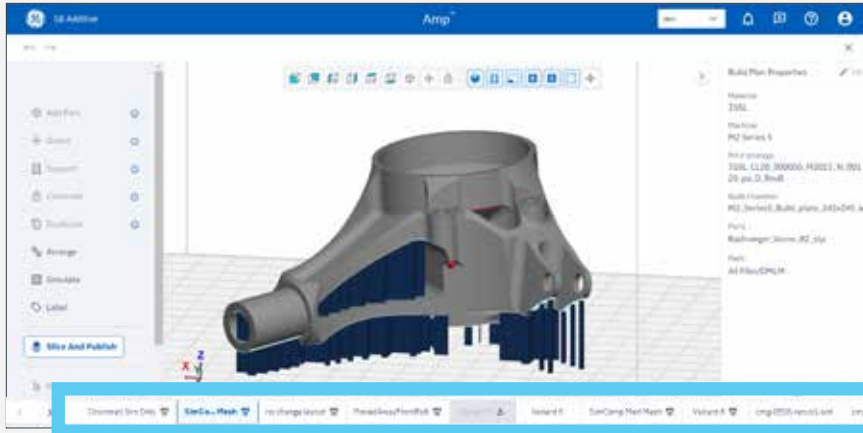
With Amp

The software recommends the best approach to print parts based on additive best practices.
Key benefits:
- Accelerate development time
- Increase efficiency post-processing

Build Plan Variants

Quickly test different scenarios (orientations, supports, simulation, etc.)

Without Amp
Testing different build plan scenarios is disconnected from the final build plan. Finding and discovering historical knowledge is difficult.

With Amp
Users can create several alternative build plan configurations to test different printing scenarios.
Key benefits:
- Easily create new variants
- Quickly test different scenarios (orientations, support, simulation, etc.)
- Save and access multiple alternatives in one build plan

Reports

Clear, useful, easy to interpret, showing what is actually important

Without Amp
Companies need a highly technical and simulation-focused engineer to read and translate reports.

With Amp
Users can run reports that are easy to use and understand to evaluate the designed part.
Key benefits:
- Provide meaningful feedback on simulation results
- Give direction to design and manufacturing engineers on the build strategy

![GE logo] **GE Additive**

Are you ready?

To leverage the tools and techniques leaders use in metal additive industrialization.
To go to market with a successful additive part—faster and at scale.
To cement a lasting competitive advantage.

With GE Additive's Amp software platform, your company can achieve a true competitive advantage by industrializing metal additive parts while reducing total process time and final part cost.

See how Amp works for you:

- **Scale software usage to meet your business needs**, with GE-hosted, private-cloud or on-premise deployment
- **Automate manual tasks based on best practices**, saving time and money
- **Facilitate business case development** with built-in cost and time estimates
- **Manage additive digital assets centrally**, ensuring state-of-the-art security
- **On-board team members to be productive faster** with simplified, cost-effective training

When you're ready to optimize and industrialize your path to metal additive success, the pioneers in full metal additive industrialization are here to help.

Let's fast-track your path to additive industrialization.
Contact us today: Amp.Software@ge.com

Amp™ Software Platform