



GE Additive

For the ready.

Collaborate with the AddWorks™* team at GE Additive to find a faster path to full-scale metal additive production.



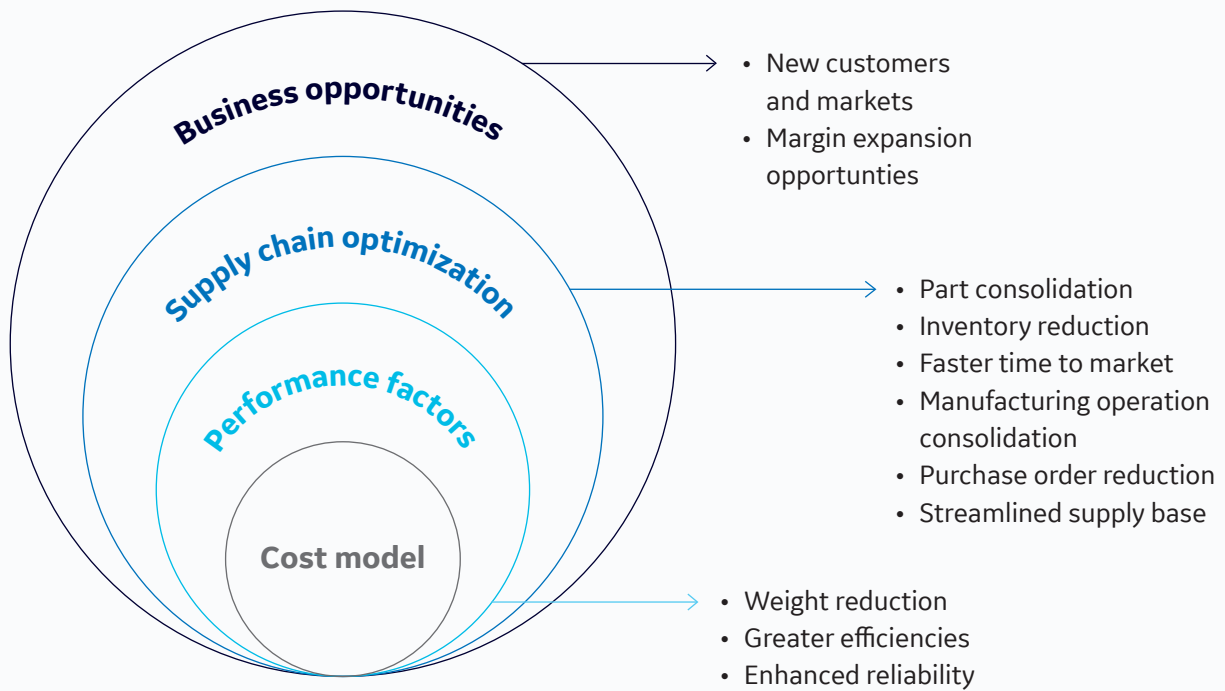
*Trademark of General Electric Company

AddWorks from GE Additive

Realize ROI beyond the cost to make a part.

No one knows your parts and your industry like you.
No one knows metal additive like we do.
Together, we can transform the way your business is done.

Thinking through the bigger business case



Look beyond the limits of a cost-per-part model. Turn metal additive into your competitive advantage. As a power user of metal additive technology, GE's AddWorks team is your trusted partner.

Achieve your additive advantage.

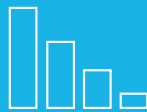
Whether you're looking to additively manufacture critical parts in highly regulated industries like aerospace and medical or non-critical parts for which certifications are not required, **the AddWorks team at GE Additive applies best practices and a proven methodology to solve your biggest technical and business challenges.**

Collaborate alongside the global leaders in metal additive to:



Accelerate innovation

Identify new opportunities for growth and bring innovative parts to market faster when you brainstorm and problem-solve alongside our additive experts.



Reduce risk

Tap into our advanced technical capabilities to qualify your metal additive parts faster and increase your success rate with additive parts.



Lower costs

Shorten your time to market and find cost savings wherever you are in the additive process with tailored solutions designed for your team.



Improve part performance and processes

Leverage our team of additive designers, engineers and material scientists to optimize your parts and processes with a systematic approach that goes beyond the part.

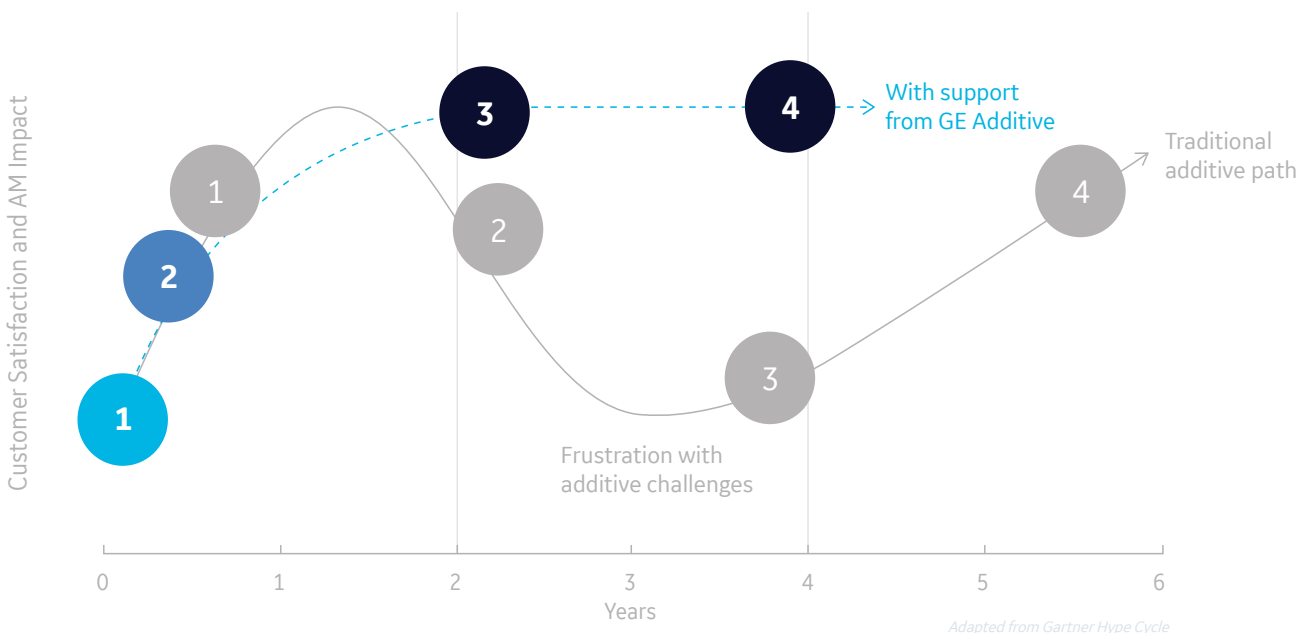


Transform your business

Rewrite the rules of manufacturing, optimize your supply chain and open new market opportunities with our unparalleled expertise and proven methodology.

Move to full production of critical parts—faster with proven solutions from GE's AddWorks team.

Path to Production for Critical Parts



Key process steps:

Concept Sprint	Development Sprint	Production Sprint
1. Build a business case and identify a part.	2. Design the part for metal additive.	3. Qualify the part and enable full production. 4. Help you certify the part with a third party.



Comprehensive support—workshops and training, hands-on consulting and print services—to accelerate time to market



Extra expertise where you need it, whether in concept, development, qualification or full production

CASE STUDY: GE9X HEAT EXCHANGER

From design to production in 5 years

When it comes to flying, every ounce counts. That's why the teams at GE Aviation looked to additive to reduce weight—and related costs—of the GE9X engine.

The first metal additive heat exchanger certified for aerospace:

Solutions from GE Additive:

Duration: 5 years from design to production



AddWorks
Engineering Services



Concept Laser
M2 machine



Aluminum (F357)
powder

How much further did additive take the GE9X heat exchanger?

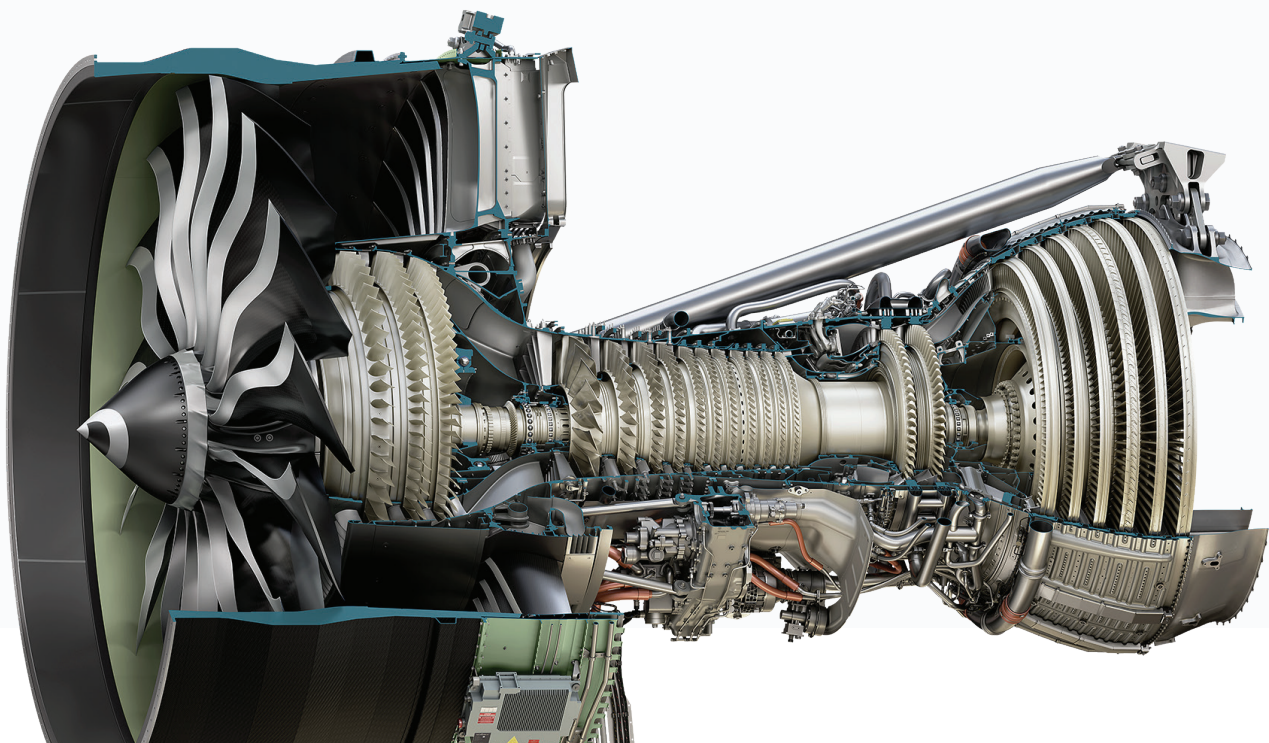
Results:¹

163 traditionally
manufactured parts

1 additively
manufactured part

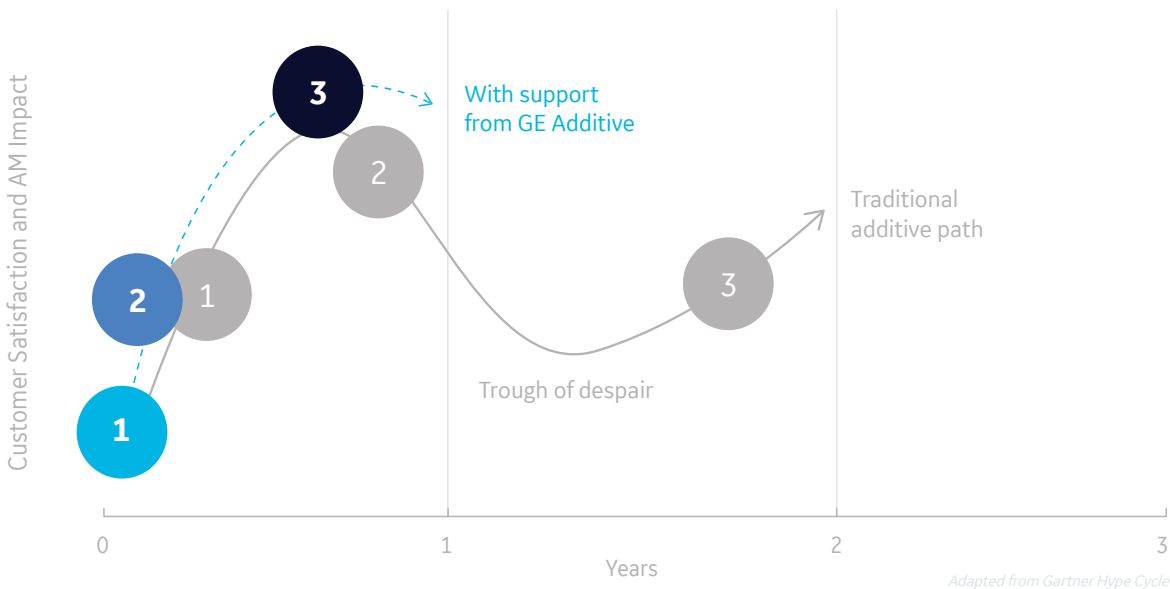
 **40%**
lighter

 **25%**
cost reduction



Move toward full production of non-critical parts—faster with proven solutions from GE's AddWorks team.

Path to Production for Non-Critical Parts



Key process steps:



Get there faster with a trusted partner.

Whether manufacturing critical or non-critical parts with metal additive, you can get to scaled production faster when working alongside someone who's done it before.

With support from GE's AddWorks

- Work side by side with metal additive experts.
- Avoid missteps in building a business case.
- Incorporate proven methodologies and best practices for additive design.
- Get access to GE's established material parameters and production tools.

Without support

- Undergo a steep, long learning curve for technical team.
- Risk your business case and part decision failing during development.
- Experience unanticipated expenses and obstacles.
- Get started without existing best practices, templates or material parameters.

CASE STUDY: GENERAL ATOMICS

Accelerating the adoption of metal additive

General Atomics Aeronautical Systems Inc. (GA-ASI) shot for the moon—and stuck the landing. After six months of close collaboration with GE's AddWorks, the GA-ASI team launched a test flight of its MQ-9B SkyGuardian, the first remotely piloted aircraft (RPA) with a metal printed part, its NACA inlet.

Solutions from GE Additive:

Duration: 6 months* from business case to qualification



AddWorks
Application
Sprints



AddWorks
Engineering
Services



Concept Laser
M2 machines



Titanium Ti6Al4V
AP&C powder

How much further did additive take General Atomics' SkyGuardian?

Results:²

3

traditionally
manufactured parts

1

additively
manufactured part



33%
lighter



85%
tooling
reduction



92%
cost reduction
per part



Courtesy of General Atomics Aeronautical Systems, Inc. All Rights Reserved.

*Results not typical

For the ready.

A person wearing a white lab coat and a blue wristband is working with small metal parts on a table. The person's hands are visible, and they are pointing at a small metal part. The background is a blurred industrial setting.

How to leverage GE's AddWorks team for your success.

Wherever you are on the path to full metal additive production, our team can help get you there faster.

Engineering Services

Let our experts tackle the challenges for you. We can take your part requirements and develop the application-specific design, material or manufacturing process to meet your needs so you can explore additive without adding infrastructure to adopt the technology.

With your input, our AddWorks team can:

- Characterize and qualify a material
- Design your application for metal additive
- Validate the application design
- Establish and qualify the manufacturing process for your application

Consulting Services

Leverage our experts to work beside your team, teaching additive skills and strategies to overcome challenges in additive design, materials, manufacturing and overall production. For instance, you may need assistance as you develop your material or process specification. Or, you may have reached a roadblock in qualifying your hardware for production. AddWorks engineers will be there to help.



Achieving Qualification

Scaling additive production requires qualification. In regulated industries, such as orthopedics and aerospace, rigor is even more important. Our additive experts have experience qualifying hardware in highly regulated markets and can help you reduce the learning curve so you can get your product to market faster. In the end, you will qualify the machine, the material, and the process. We follow industry-wide processes to establish robust and repeatable production outcomes.

Installation Qualification (IQ)

The purpose of the IQ protocol is to provide documented evidence that the machine is installed according to documented and pre-approved specifications.

Operational Qualification (OQ)

The purpose of OQ is to demonstrate that a system operates according to written pre-approved specifications throughout a specified operating range.

Performance Qualification (PQ)

The purpose of PQ is to demonstrate that the additive process, under anticipated manufacturing conditions, consistently produces product(s) that meet all engineering requirements.



Ready to get started? Let's tackle your top challenges.

Our global team of engineers and manufacturing specialists is ready to help you realize your additive advantage. Minimize the learning curve for additive and get to full production faster than your competitors when you work with GE's AddWorks experts.

Challenge 1

Proving ROI and Building a Business Case

Sometimes manufacturers won't see a positive ROI with additive if they look only at the cost to make a part. A part-focused business case fails to capture the larger impact additive can have on your business, which limits your ability to innovate.

Fast track: Our experts help you assess how additive impacts the whole process, from part performance to efficiency to supply chain, when designing your business plan. You'll uncover all the opportunities for ROI that go beyond part cost and consolidation.

Challenge 2

Issues with Production

Initially, achieving printing repeatability of high-quality parts can prove challenging.

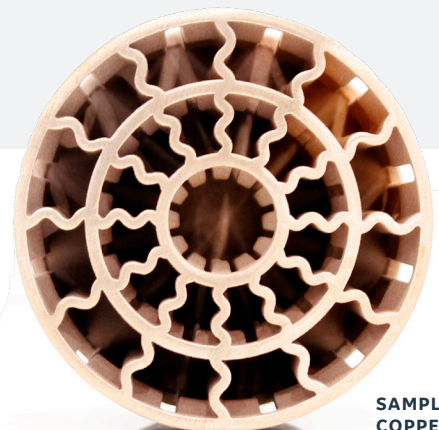
Fast track: Engage GE's AddWorks team to use our pre-established process parameters for several key parts, materials and machines to shorten your development time. As you work toward qualifying and certifying parts, we'll help you create a locked-down process to prove repeatability and meet industry certification requirements.

Challenge 3

Achieving Qualification

Scaling additive production requires qualification. In regulated industries, such as orthopedics and aerospace, rigor is even more important.

Fast track: Our additive experts have experience qualifying hardware in highly regulated markets and can help you reduce the learning curve so you can get your product to market faster. In the end, you will qualify the machine, the material, and the process. We follow industry-wide processes to establish robust and repeatable production outcomes.



SAMPLE
COPPER PART

Together, we'll accelerate your path to AM industrialization.

GE Additive's machines are built to address your specific business challenges. That's why we start with meeting with your team to define your production roadmap—one that helps drive your goals and gain the competitive advantage you need.

As we work together, we can:

- Plot your production roadmap to achieve your business goals
- Identify and document your “critical Xs” and quality-control measures to enable the entire production of your application
- Leverage GE Additive's facilities, resources and intellectual property to offset some initial capital investments to decrease overall investment and adoption timeline risks
- Scale operations safely by minimizing operator contact with machines and materials

Checklist: Prepare for our first meetingw.

- ✓ **Part and product use case identification**
- ✓ **Business case or ROI plan**
This must include the buy in from engineering, top-level management, supply chain, product leaders and finance
- ✓ **Long-term plan for additive impact on supply chain**
- ✓ **Facility layout or initial scaling plan (three- to five-year outlook)**
- ✓ **Corporate financial planning around additive strategy**
This requires a minimum \$5M investment toward people, facility, technology and future-state development to begin.
- ✓ **Desired outcome of full-scale production**

Tip: GE's AddWorks team can work with you to refine any any of these elements.



GE Additive

Are you ready?

To collaborate with the metal additive experts.
To reach full-scale production at the speed of today.
To reimagine and redefine the rules of manufacturing.
And hit the production floor running.

Get to full production faster than ever before when you realize your metal additive advantage. Our experts are ready to walk the path to production with you.

Let's go. Talk to GE's AddWorks experts today.

ge.com/additive/addworks

¹GE Additive Storyboard (accessed April 23, 2020).

²NACA Inlet case summary. Photo via GA-ASI.

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