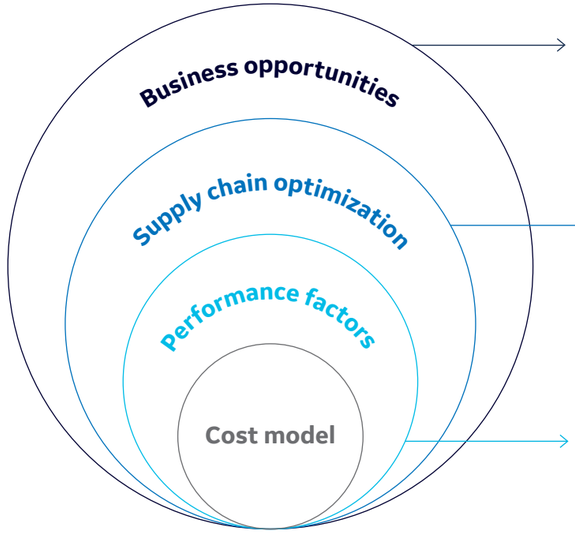
Automotive Solutions

Realize ROI
with metal additive.

From tooling/prototyping to mass production of engine, transmission, and chassis components, the ready are evaluating how additive can drive greater returns on investment.

Thinking through the bigger business case



- Increased productivity
- Improved part quality
- Accelerate time to market
- Rapid prototying castings
- Product differentiation with new IP

- Part consolidation
- Inventory reduction
- In-housing of tooling operations
- Reduced workflow
- Lead-time reduction

- Weight reduction
- Greater efficiencies
- Enhanced reliability
- Improved part performance
- Reduced distortion of the final product

OPPORTUNITIES FOR ADDITIVE

Conformal cooling

Strengthen your manufacturing processes with additive strategies that accelerate mold tool production, require less tool maintenance, facilitate faster cycle times and allow for smaller tool diameters.

Injection molding and die casting

AM allows for parallel and surface cooling channels to be designed and printed within the mold itself, which can reduce cooling time up to 30%,[1] thus reducing the overall cycle time. Balanced temperatures throughout the mold during the cool-down phase creates higher-quality parts due to less warpage and internal stress.

Tooling and cooling channels

Conformal cooling channels in tool production can lead to faster cycle times and improve the quality of the end-use part. For example, drills can leverage a mix of spiral and straight cooling channels to reduce tool maintenance and dead cavities and prevent boiling in the cooling channels.

Additive advantages of conformal cooling channels

Increase productivity

Cooling time in molding and casting averages 70% of the cycle time. Additive can reduce cooling time up to 30%, improving productivity and part quality.[9]

Build free-form cooling channels

Non-circular cooling channels (i.e., ellipticals, triangular and branches) enable rapid, uniform cooling process and minimize pressure loss.

Improve part quality

Minimize dead flow zones in cooling to prevent overheating of cooling water that can cause thermal shocks and heat cracks.

Reduce waste

Maintain a near and constant distance of the cooling channels from the mold insert to minimize defects from the heat transfer.

Take metal additive to full production.

Additive technology is truly becoming an important part of automotive supply chains, allowing automotive companies to customize car assembly tools, improve functionality and reduce weight at a lower cost than traditional manufactured tools.

Realize the potential for additive in automotive

Manufacture lighter, more durable parts with titanium (Ti6Al4V), titanium aluminide (TiAl), aluminum (AlSi10Mg), cobalt chrome molybdenum (CoCrMo), nickel alloys like 718 (Ni 718), stainless and alloy steels (17-4, 316, and others), and copper.

Design cooling channels and features unmatched by machining. Surface and parallel cooling allows for improved temperature management and unique designs.

Print oversized automotive parts on some of the world's largest 3D metal additive printers.

Streamline your supply chain and optimize manufacturing processes. Shorten lead times and reduce costs by additively manufacturing castings and custom parts on-demand.

Improve fuel efficiency with lighter, consolidated components.

OPPORTUNITIES FOR ADDITIVE

Supply chain robustness and resilience

Additive can help optimize manufacturing processes and streamline the larger supply chain. Shorten lead times and reduce costs by additively manufacturing hard-to-find and low-volume parts on-demand.

Additive advantages for supply chain efficiencies:

Reduce lead time
Manufacturers can print low-volume parts in-house, reducing the time to acquire replacement parts and streamlining the supply chain.

Lower expenditures
With parts printed on-demand, additive reduces production downtime and eliminates the expense of high-volume replacement parts.

Enable mass customization
Freedom of design with additive enables manufacturers to customize tooling for mass production of bespoke parts.

Extend product life span
With improved performance and less machining stress, additive extends the life span of outdated or damaged parts.

Streamline the supply chain
Additive enables more flexible inventory management, reducing inventory and the number of suppliers.

CASE STUDY

Cummins

When considering how additive could best impact its supply chain, Cummins looks at both high volume and low volume appliactions that can provide positive business impacts. For a customer in its New and ReCon Parts division for which the customer did not have a current supplier, Cummins found a great application in a low volume bracket. By printing its bracket in-house, Cummins could now make the part on-demand, with less tooling and material waste than conventional methods.

Results:[2]

Eliminated part inventory with on-demand printing capabilities

Decreased tooling by eliminating material cutting

Cut non-recurring costs

Reduced lead time for low-volume parts

Highly alloyed tool steel

Known for its hardness and resistance to deformation, tool steel encompasses a wide variety of carbon and alloy steels well suited for tooling but challenging for additive—until now.

Electron beam melting (EBM) processes high-crack-prone alloys at high-build temperatures in a vacuum environment to yield complex designs—something neither conventional nor other additive methods can achieve.

Additive advantages for highly alloyed tool steel:

Lower cost per part

Additive with EBM machines maintains tight stacking of parts, reducing post-processing costs and lead time, and increasing productivity.

Create high-quality parts with excellent properties

EBM's high-heat process enables excellent hardness, wear-resistance and ductility, increasing the quality and lifetime of parts.

Leverage freedom of design

Consolidate parts into one additive product with complex geometries; part built is free-floating in sintered powder.

Arcam EBM Spectra H system

As the only commercially available EBM technology for highly alloyed tool steel and other crack-prone materials, the Spectra H system is the perfect match for these alloys. Its large build volume enables manufacturers to stack several parts per build, increases productivity and minimizes process steps in both product development and production.

CASE STUDY

Gear hob

GE manufactured a highly alloyed tool steel gear hob with additive EBM technology to minimize post-processing, save costs and improve wear resistance and ductility.

- Achieved high hardness of 62-63 Hardness Rockwell C (HRC)
- Built free-floating in sintered powder
- Manufactured in near-net shape

Pure copper

EBM enables previously unattainable applications of pure copper. Now, manufacturers can leverage the freedom of design with pure copper that combines several parts into one without compromising the high electrical and thermal conductivity. Achieve higher part performance at lower costs per component while avoiding soldering and welding.

Additive advantages for pure copper:

Enhance part performance

Parts maintain greater electrical and thermal conductivity and high ductility with pure copper components.

Reduce costs

Every weld or solder increases the cost of production. Additive can print the entire part.

Build complex geometries

EBM technologies allow for shape repeatability and unique structures, such as coils, tiny cooling channels and free-floating beams.

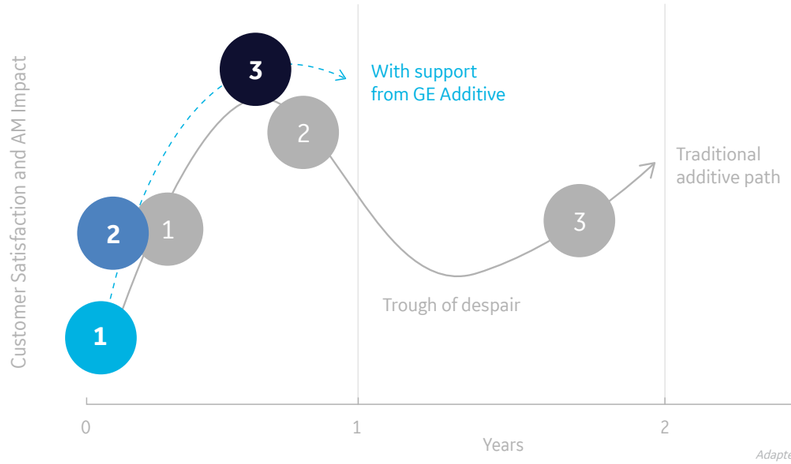
Applications for additive with pure copper:

	Benefits	Outcomes
Bus Bars **No more bending and welding.** EBM directly manufactures the whole product.	Parts maintain electrical conductivity and material homogeneity.	Achieve complex geometries at a competitive cost.
Heat Exchanger **New geometric capabilities** raise the component performance to a new level.	Pure copper provides excellent thermal conductivity and freedom of design.	Design complex shapes and thin cooling ducts with minimum distortion.
Inductor Coils **Reduce product costs associated with soldering several parts together.** EBM prints conductor coils as one part.	Pure copper delivers the highest electrical performance and longer life and reliability.	Increase part lifetime by combining parts into one build.

Additive parts at scale? We're ready.

Our proven process helps you adopt additive—faster.

Path to Production for Non-Critical Parts



Adapted from Gartner Hype Cycle

What are the Application Sprints?

Fast-track your path to full production of additive parts when you leverage the Application Sprints from GE's AddWorks™*.

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

Key process steps and GE's AddWorks Application Sprints:

Concept Application Sprint	Development Application Sprint	Production Application 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.

Get there faster with a trusted partner.

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

With support from GE Additive

- Work side by side with metal additive experts.
- Avoid missteps in creating a business case and selecting a part.
- 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 your technical team.
- Risk your business case and part decision failing during development.
- Experience unanticipated expenses and obstacles.
- Go without existing best practices, templates or material parameters.

*Trademark of General Electric Company

GE Additive's end-to-end solutions, ready when you are.

See where our experts and offerings can support your company—from MRO and process improvements to making parts or molds with new metals.

Machines

Our specialty machines offer low machine-to-machine variance to meet your industry requirements and scale production.

- Concept Laser, direct metal laser melting
- Arcam EBM, electron beam melting
- Binder Jet, powder-bed fusion with binding agents

Powders

We create certified, high-performing powders for every metal additive need, taking into account a variety of mechanical behavior design data and material science.

- Titanium alloys
- Nickel alloys
- Aluminum alloys
- Cobalt chromium
- Stainless steels

Print Services

Ensure quality and speed to market when you send your part to GE for printing, no matter how complex or large the part. We serve you a printed part in one hand and a product roadmap in the other.

- Large-format printing
- Design to print (AddWorks)
- Production printing

AddWorks from GE Additive

Our global team of 200-plus engineers and manufacturing specialists can support your team and accelerate additive adoption.

- Workshops and training
- Application Sprints
- Consulting services
- Engineering Services

Customer Experience Centers

GE experts are ready to collaborate in person when you visit one of our two on-site locations, designed to help you from initial design to full production.

- Cincinnati, Ohio (USA)
- Munich, Germany (Europe)
- Mitsubishi Corporation Technos Co., Ltd.* (Japan)

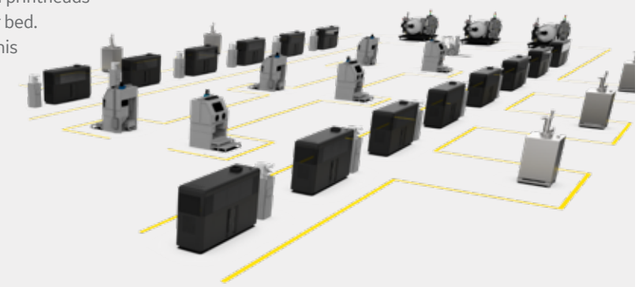
*Sales partner in Japan

BINDER JET, EBM, AND LASER

Which 3D printing technology is best for you?

Binder Jet Technology gearing up for mass production in automotive:

The binder jet process spreads a thin layer of powder, with printheads strategically depositing droplets of binder into the powder bed. GE is actively partnering with select companies to bring this disruptive technology to volume production in factory installations.



Design Freedom
- Provides the flexibility to scale without sacrificing quality
- 99.9+% material density achievable

High Productivity
- No supports required
- Nest parts in full build volume for maximum productivity
- Superior green strength allows for automated production solution

Cost-Effectiveness
- Lower cost powder
- Powder reuse greatly reduces raw material cost
- Extremely fast process creates tremendous throughput
- Factory solution

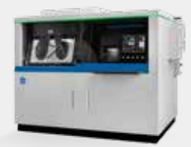
- Stainless Steels (Ex: 316L, 17-4, 304)
- Copper
- Nickel based alloys
- Others under development (partner application driven)

Our experts will help you find the machine type fit for your application.

Key advantages

Electron Beam Melting (EBM) machines	Direct Metal Laser Melting (DMLM) machines
EBM machines create dimensionally accurate parts quickly and efficiently by utilizing a high-power electron beam. The process takes place in vacuum and at high temperatures, resulting in stress-relieved components with material properties better than cast and comparable to wrought material.	DMLM machines use lasers to melt layers of fine metal powder and create complex geometries with incredible precision directly from a CAD file. Several different machine envelope sizes — including the largest powder-bed metal additive system in the world — are available to meet the needs of any industry.
Design Freedom • Allow for dense nesting of entire build tank and large, bulky parts without swelling • Easily create little to no supports on parts at low costs **High Productivity** • Achieve high productivity for large volumes • High process temperatures produce parts with no residual stress **Cost-Effectiveness** • Enable use of reactive and crack-prone materials (e.g., TiAl) at low costs • Reuse powder extracted from the Powder Recovery Station (PRS)	**Design Freedom** • Allow for complex internal passages, thinner walled structures and undercuts • Create highly detailed and fine-feature parts directly from a CAD file **Surface Quality** • Achieve exceptional surface characteristics and minimal porosity • Deliver best-in-class repeatability, productivity and usability **Productivity and Safety** • Suited for highly regulated industries by providing superior part yield • Closed powder handling for less waste and operator exposure

Materials available for machines

			
Q20plus Build volume 350 x 380 mm (Ø/H)	**Spectra H** Build volume 250 x 430 mm (Ø/H)	**M2 Series 5** Build volume 250 x 250 x 350 mm (x,y,z)	**X Line 2000R** Build volume 800 x 400 x 500 mm (x,y,z)
• Arcam EBM Ti6Al4V Grade 5, P-Material • Arcam EBM Ti6Al4V Grade 23, P-Material	• Arcam EBM Ti6Al4V Grade 5, P-Material • Arcam EBM TiAl, D-Material • Arcam EBM Nickel alloy 718, D-Material • Arcam EBM Highly Alloyed Tool Steel, D-Material	• Stainless Steel 316L • Stainless Steel 17-4PH • Maraging Steel M300 • Aluminum AlSi10Mg • Aluminum AlSi7Mg • Nickel 718 • Nickel 625 • Titanium Ti6Al4V ELI Grade 23 • Cobalt CoCrMo	• Aluminum AlSi10Mg - Balanced • Aluminum AlSi10Mg - Productivity • Titanium Ti6AL4V Grade 23 • Nickel 718

GE Additive

Are you ready?

To rethink mold making and die casting.

To accelerate production and shorten lead times.

To improve performance and reduce costs.

To look forward, not back.

When you're ready to optimize your business with metal additive, the people who pioneered its full production are ready to help.

Let's go. Talk to GE today.
ge.com/additive/industry/automotive

[1] Tooling and Molding Precision Targeting EXTERNAL (accessed August 13, 2020).

[2] Blair Clafin, "Cummins Takes Next Step in 3D Printing and the Future of Manufacturing," Cummins, March 7, 2019, https://www.cummins.com/news/2019/03/07/cummins-takes-next-step-3d-printing-and-future-manufacturing (accessed June 11, 2020).