For the ready.

Optimize your processes with proven metal additive solutions for automotive manufacturers.
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 prototyping castings
- Product differentiation with new IP

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

Business opportunities

Supply chain optimization

Performance factors

Cost model

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%, 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.

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

Cost reduction strategies that accelerate mold tool production, require less tool maintenance, facilitate faster cycle times and allow for smaller tool diameters.

Conformal cooling channels

Conformal cooling channels in mold 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) enables 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 aluminate (TiAl), aluminium (AlSi10Mg), cobalt chrome molybdenum (CoCrMo), nickel alloys like 718 (Ni 718), stainless and alloy steels (17-4, 316, and others), and copper.

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.

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

Improve fuel efficiency with lighter, consolidated components.

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 applications 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:**

- 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
MAKING PARTS WITH NEW POWDERS

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:**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Outcomes</th>
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</thead>
<tbody>
<tr>
<td>Parts maintain electrical conductivity and material homogeneity.</td>
<td>Achieve complex geometries at a competitive cost.</td>
</tr>
<tr>
<td>Pure copper provides excellent thermal conductivity and freedom of design.</td>
<td>Design complex shapes and thin cooling ducts with minimum distortion.</td>
</tr>
<tr>
<td>Pure copper delivers the highest electrical performance and longer life and reliability.</td>
<td>Increase part lifetime by combining parts into one build.</td>
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</tbody>
</table>

For the ready.
Additive parts at scale? We’re ready. Our proven process helps you adopt additive—faster.

Path to Production for Non-Critical Parts

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:

<table>
<thead>
<tr>
<th>Concept Application Sprint</th>
<th>Development Application Sprint</th>
<th>Production Application Sprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Build a business case and identify a part.</td>
<td>2. Design the part for metal additive.</td>
<td>3. Qualify the part and enable full production.</td>
</tr>
</tbody>
</table>

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

### Binder Jet Technology for Mass Production in Automotive:

- Provides the flexibility to scale without sacrificing quality
- 99.9% material density achievable
- No supports required
- Nest parts in full build volume for maximum productivity
- Superior green strength allows for automated production solution

### Design Freedom
- Allows for complex internal passages, thinner walled structures, and undercuts
- Create highly detailed and fine-feature parts directly from a CAD file

### 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)

### Surface Quality
- Achieve exceptional surface characteristics and minimal porosity
- Deliver best-in-class repeatability, productivity, and usability

### Productivity and Safety
- Suitability for highly regulated industries by providing superior part yield
- Closed powder handling for less waste and operator exposure

### 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.

### Key Advantages

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### Materials Available for EBM Machines

- Arcam EBM Ti6Al4V Grade 5, P-Material
- Arcam EBM Ti6Al4V Grade 23, P-Material
- Arcam EBM Nickel alloy 718, D-Material
- Arcam EBM Highly Alloys Tool Steel, D-Material
- Stainless Steel 316L
- Stainless Steel 17-4PH
- Maraging Steel M300
- Aluminum AISi10Mg
- Aluminum AISi7Mg
- Nickel 718
- Nickel 625
- Titanium Ti6Al4V ELI Grade 23
- Cobalt CoCrMo

### DMLM Machines

- Laser beams 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.

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### Materials Available for DMLM Machines

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- Arcam EBM Ti6Al4V Grade 23, P-Material
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- Aluminum AISi10Mg
- Aluminum AISi7Mg
- Nickel 718
- Nickel 625
- Titanium Ti6Al4V ELI Grade 23
- Cobalt CoCrMo
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