Additive Manufacturing to Automotive Manufacturing: The Challenges of Volume Production

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ROADMAP

- **Why AM?** Efficiency, agility, performance
- **History of AM at Ford:** Over 30 years of use and exploration
- **Use cases today:** Prototyping, Manufacturing, Production
- **Case study:** Validation of production AM applications
  - Materials
  - Function
  - Manufacturing
- **Automotive industry requirements**
- **Bridging the Gaps**
WHY ADDITIVE DESIGN AND MANUFACTURING?

**Business Efficiencies**

- Design, Engineering & Validation
- Manufacturing Efficiencies
- Distributed Sourcing
- New Market Share / Revenue / Performance

**Customer Attributes**

- prototyping
- MRO inventory

Can AM Change the Automotive Manufacturing Landscape?
HISTORY OF ADDITIVE MANUFACTURING AT FORD

1988
Ford purchased SLA machine serial #3

AM Training and Development Center opens

Local centers develop

Sand printing

Manufacturing Aids

Prototypes and Visual Aids

Functional Parts

Metal printing

30+ YEAR JOURNEY

2020

Early access evaluations for emerging technologies
ADDITIVE MANUFACTURING AT FORD TODAY

• Advanced Manufacturing
  • Co-location of research, manufacturing, product development
  • Industry 4.0 and the digital factory

• Research
  • Materials development
  • Process development
  • Validation

• Product Development
  • Design for AM
  • Implementation
TODAY: MANUFACTURING FLOOR

Weight Reduction

90%

80+ kg
10 kg
1.9 kg
TODAY: PERSONALIZATION AND CUSTOMIZATION
TODAY: NICHE MARKETS

- F-150 Raptor Auxiliary Plug
- Special requirement for **niche market** — China
- 14 design **iterations** in 19 days
- **Customized** aesthetic with logo and texture
- Appearance **requirements** met without secondary coating
TODAY: SPARE PARTS

- Focus HVAC lever arm service parts
- Eliminated inventory and warehouse requirements
- Reduced lead time by 50%
- Reduced minimum order quantities
TODAY: SERIES PRODUCTION
CASE STUDY: SERIES PRODUCTION

- Mustang GT500 Electric Parking Brake Bracket
- Convert from metal to plastic
  >60% weight reduction
- Cost savings compared to tooled part
- Reduced complexity
  RH/LH to mono design
- Quick iterations/validation to improve design and performance
CASE STUDY: MATERIAL VALIDATION

- **Interior Weathering:**
  - Short-term heat exposure: tensile, impact, appearance
  - Long-term heat exposure
  - UV stability
- **Fogging:** SAEJ1756
- **Odor:** Ford standard
- **Flammability:** ISO 3795
- **Fluid & Chemical Resistance:** USCAR2
- **Retains Properties After:**
  - Heat aging @ 125C
  - Temp/humidity cycling
  - Thermal shock (-40°C to 125°C)
CASE STUDY: FUNCTIONAL VALIDATION

- Component-level testing:
  - Benchtop vibrational test
- Vehicle-level testing:
  - Track car testing
- Assembly-level testing:
  - Ergonomic testing
  - Torque testing
- Quickly modified designs to address opportunities to improve

AM Parts Require Same DV Testing as Conventional
CASE STUDY: MANUFACTURING VALIDATION

- Designed for AM and optimized function
- Ford validated **minimal variation** from print to print
- Created **DFMEA** for each part based on engineering requirements
- Created new **PFMEA**
- Followed **standard automotive PPAP** process

Generalized AM Process That Meets Ford Quality Standards
BRIDGING THE GAPS FOR TOMORROW

- Speed / cycle time
  - Hours/minutes versus minutes/seconds per part
  - Limited build envelopes
- Materials
  - Lack of automotive grade materials
  - Locked or closed systems
  - Cost
- Design
  - CAE tools for simulation and design
  - Mindset shift in design for AM guidelines
BRIDGING THE GAPS FOR TOMORROW

• Security throughout digital thread and cloud based software
  • Protecting ideas, design, counterfeit parts
• Data and computing power
  • Volumes of data, process control, data analytics
  • Data formats / file types and compatibility
• Education and training
  • Develop the pipeline
  • Engineering workforce
  • Manufacturing workforce
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<th>New Sources of Value</th>
<th>New Capabilities</th>
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<td>Service parts / low-volume production</td>
<td>Emerging AM technologies</td>
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<td>Automotive grade materials</td>
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<td>Mass customization</td>
<td>Software: design and simulation tools</td>
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<td>Distributed manufacturing</td>
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BRIDGING THE GAPS FOR TOMORROW
ACKNOWLEDGMENTS

- Research & Advanced Engineering
- Materials Engineering
- Product Development
- Ford Performance

- FCSD (Ford Customer Service Division)
- Advanced Manufacturing
- Supplier Technical Assistance
Questions?

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