ADDITIVE MANUFACTURING: AN EXPOSÉ ON THE DIVERSITY OF INDUSTRIAL USE

National Academy of Engineering
German-American Frontiers of Engineering
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AMT
THE ASSOCIATION FOR MANUFACTURING TECHNOLOGY

Agenda

- Introduction
- Requirements
- Applications
- Challenges & Opportunities
- Summary & Conclusion

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- Introduction
- **Requirements**
  - **How AM Answers the Call**
  - **Technology Alignments**
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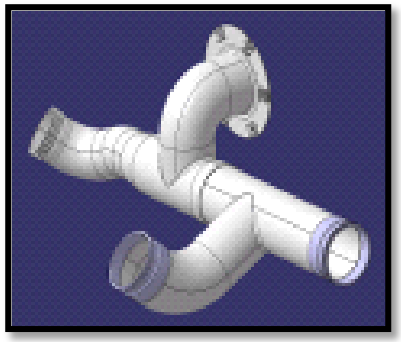
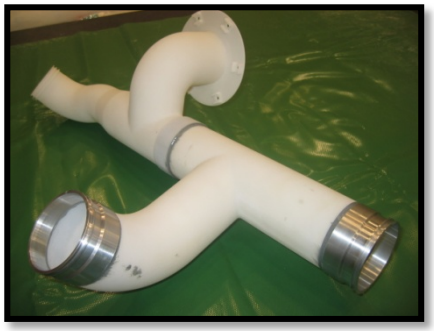
Requirements: *How Additive Answers the Call*

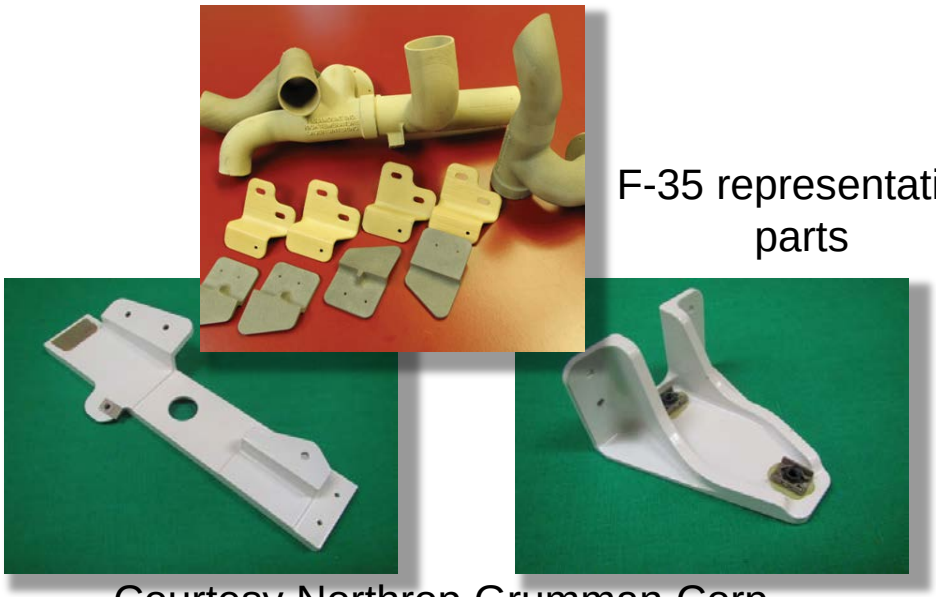
- **1st: Affordability**
  - Reduce tooling, waste
  - Complexity = Simplicity
- **2nd: Smart(er) Manufacturing**
  - Integrate processes
  - Support RP & production
- **3rd: Optimize Product Design**
  - Reduce weight, Support modularity
  - Multi-functional parts



Traditionally: 9 piece welded duct assembly



AM: 2-piece bonded assembly

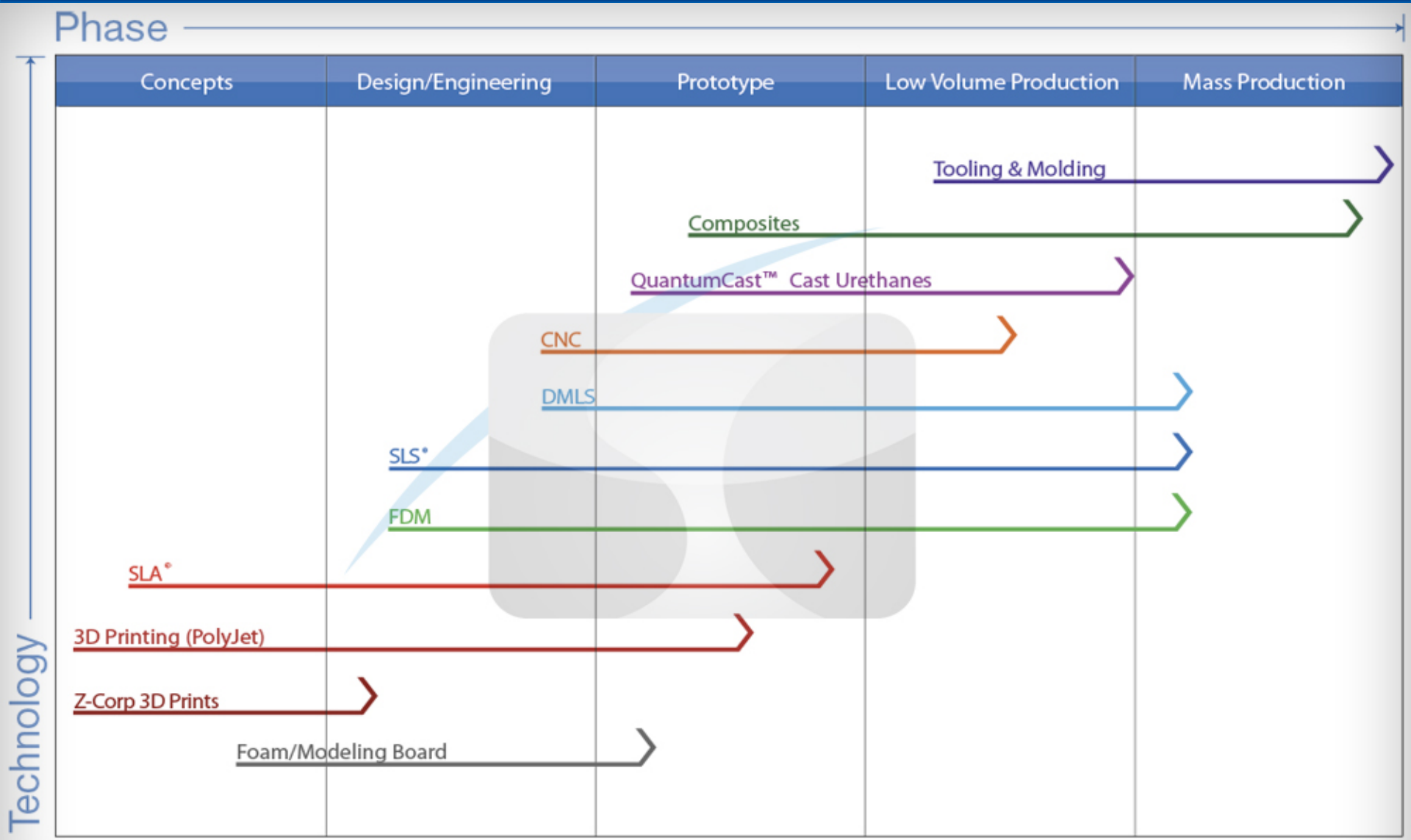


F-35 representative parts

Courtesy Northrop Grumman Corp

With Additive You Can Design for **Functionality**

Requirements: *Technology Alignments*



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- **Applications**
  - **Snap Shot**
  - **Industrial Use**
  - **Diversity**
- Challenges & Opportunities
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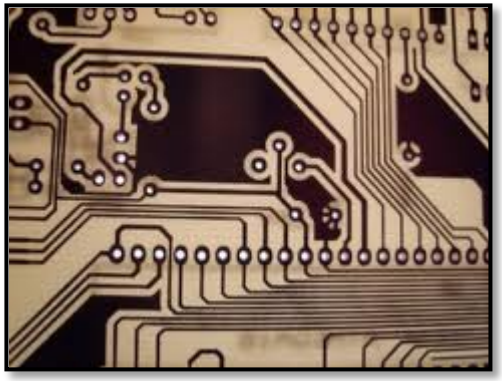
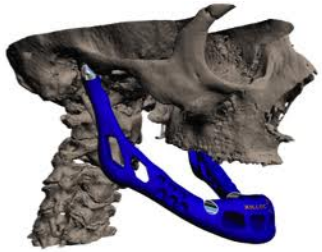
Applications: *Snap Shot*

- Polymeric Components
  - **Laser Sintering (LS)**
    - Low-temp, non-structural (Aero, Auto)
    - FDA 510(k)-approved (implants)
  - **Hybrid Applications**
    - Embedded sensors / continuous fiber
- Metallic Components
  - **Laser and Electron Beam Melting**
    - Implants, replacements
    - Aerospace components

Creates Difficult to Machine Shapes



Enables Hybrid Materials



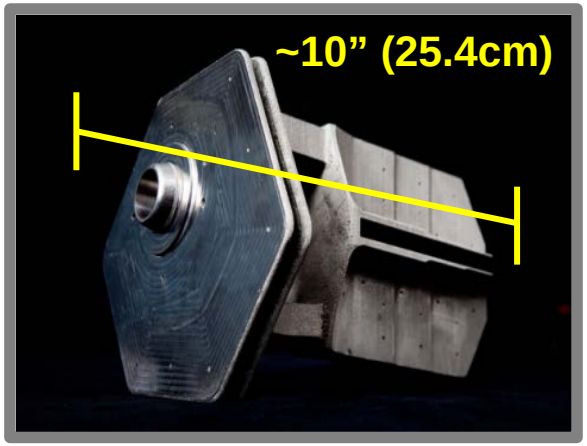
Courtesy Materialise

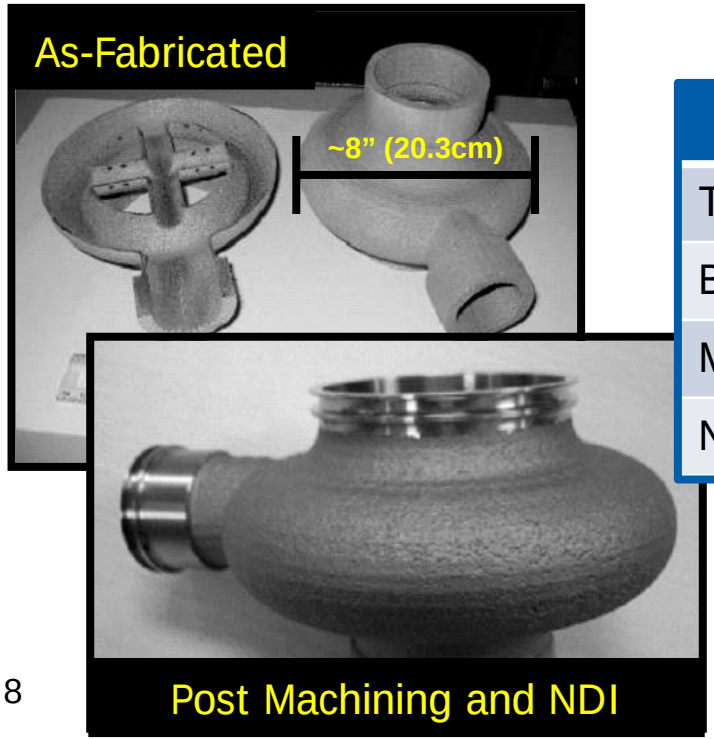
Improves Performance

Provides Similar Mechanical Properties (NGC)

Applications: *Industrial Use*

Composite Interface Fitting (JWST)	
Traditional Manufacturing	Additive Manufacturing
~500 CNC machining hours	32 build hours
~16 – 26 week lead time	~4 day lead time
Nominal	60% - 70% cost savings





Hot Air Mixer (UCAS-D)	
Traditional Manufacturing	Additive Manufacturing
Buy-to-Fly ratio 10 – 20:1	Buy-to-Fly ratio ~2:1
Min. 4-pieces w/ 2 welds	1 piece w/ no welding
Nominal	35% - 45% cost savings

Courtesy of Northrop Grumman Corp. and CalRam Inc.

SLS Gimbal

Aeryon Labs Inc. | Aeryon Scout UAV | Ontario, Canada

Courtesy of Solid Concepts Inc.

Air Duct – Orbis Flying Hospital

Structural Integrity Engineering | California
FDM (Fused Deposition Modeling)

Meet all FAA (8130-3) requirements for flame, smoke, toxicity and airworthiness while remaining lightweight. (Courtesy of Solid Concepts, Inc.

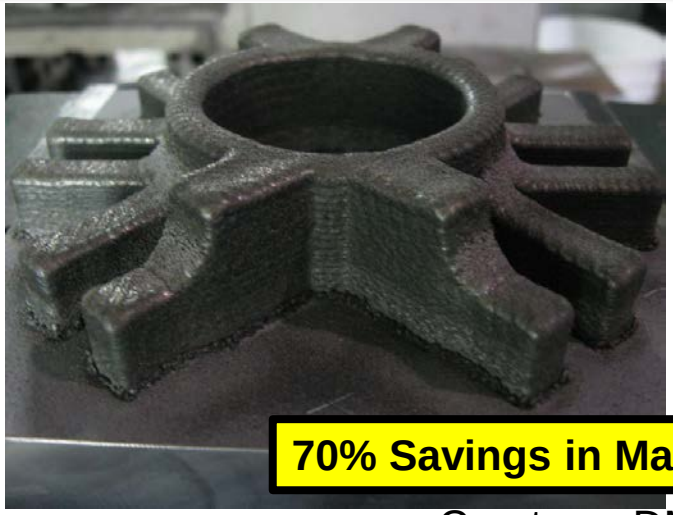
SLS Fuel Tanks

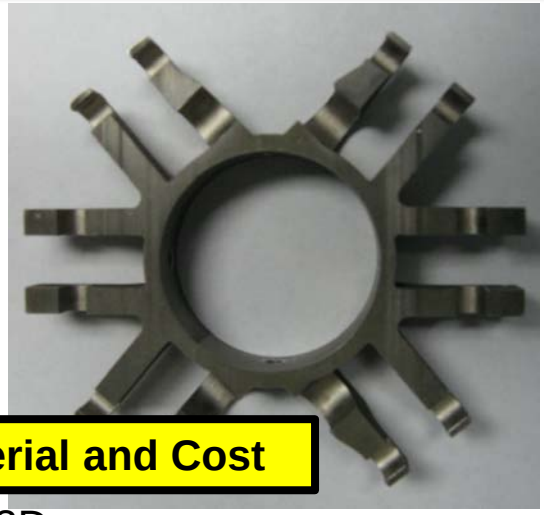
Area-I | Georgia

SLS of fuel tank, ailerons, control surfaces, mounting plates, more...

Courtesy of Solid Concepts Inc.

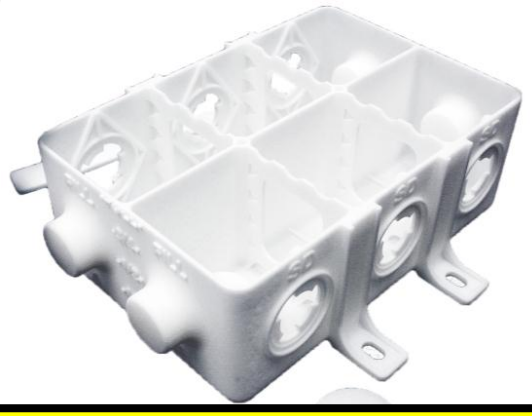
Applications: *Oil & Gas / Automotive*



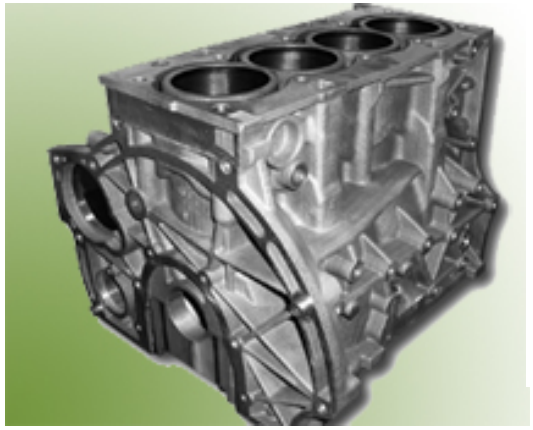


70% Savings in Material and Cost

Courtesy: DM3D



Fuel Tanks (Solid Concepts):
Internal Baffles (above)
Automotive Racing (below)



Courtesy: ExOne

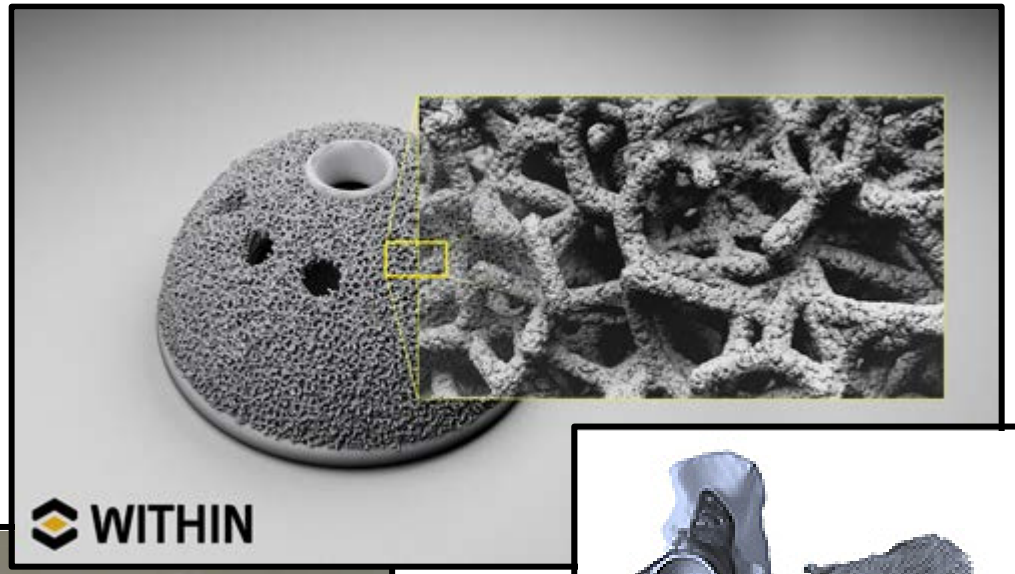
35% Weight Savings
20% Greater Rigidity

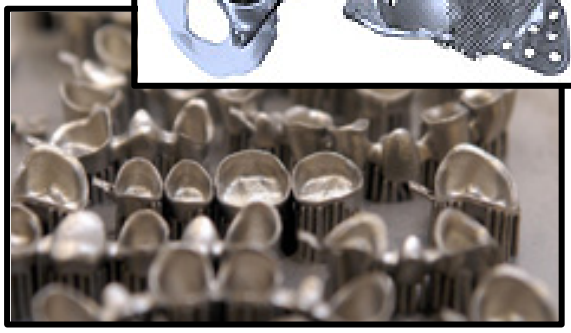
Courtesy: Rennteam Uni Stuttgart

Trending From Prototyping-Only To Now ***Include Production***

Applications: *Medical & Dental*

Courtesy: Society of Mfg. Engr.



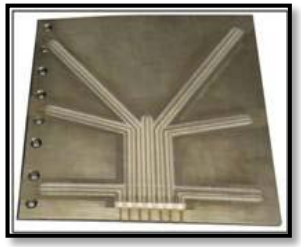


Courtesy: OPM

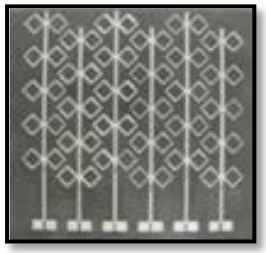
Polymeric (PEKK) & Metallic (Ti-Al6-V4) Applications FDA-Approved

Applications: *Diversity*

Large Structures



Sensors



Antennae

Functional Apparel

Weight Reductions

Functional Furniture

Multi-Functional Parts

Toys & Model Hobbyists

Complex Parts

Additive Manufacturing: An Enabler for Next-Gen Production

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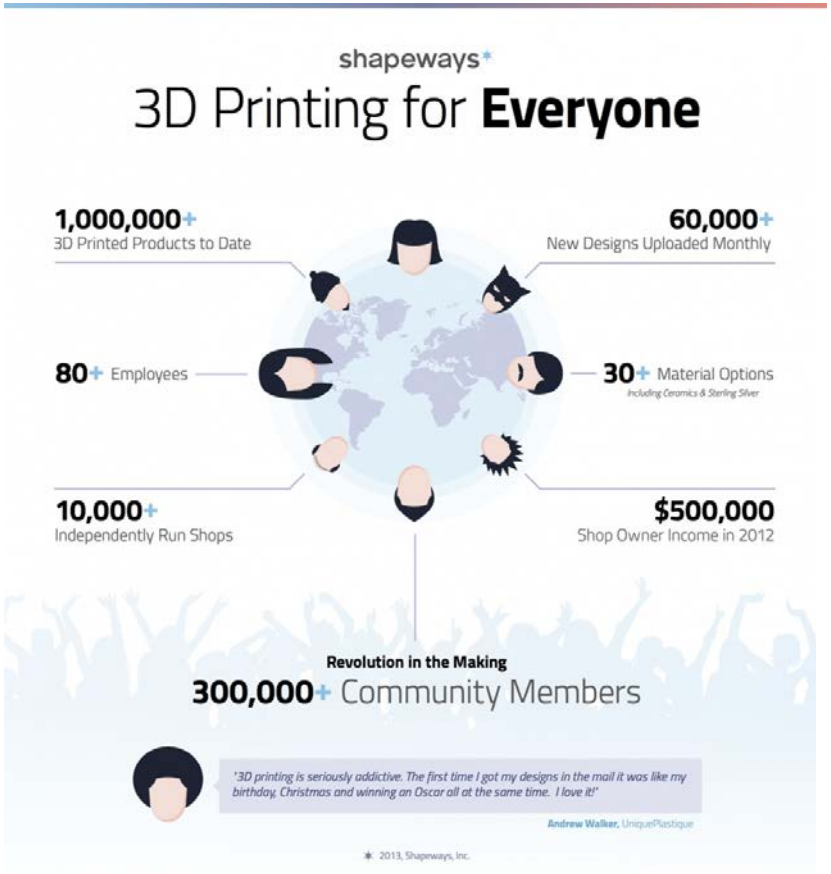
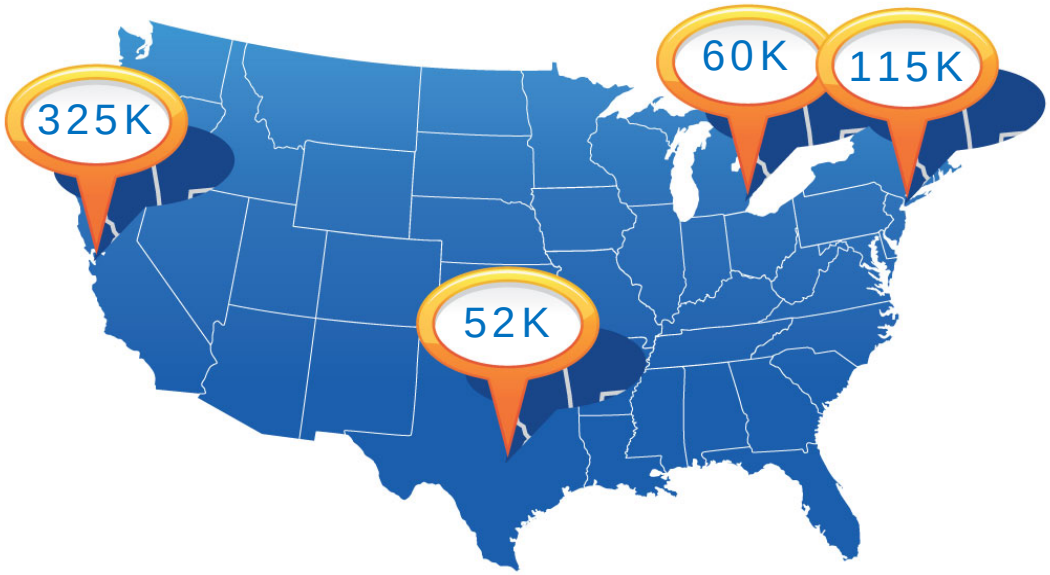
  - **Industrial Base& Maker Movement**
  - **Roadmap Summaries**
  - **NAMII**
- Summary & Conclusion

Challenges: Industrial Base & Maker Movement

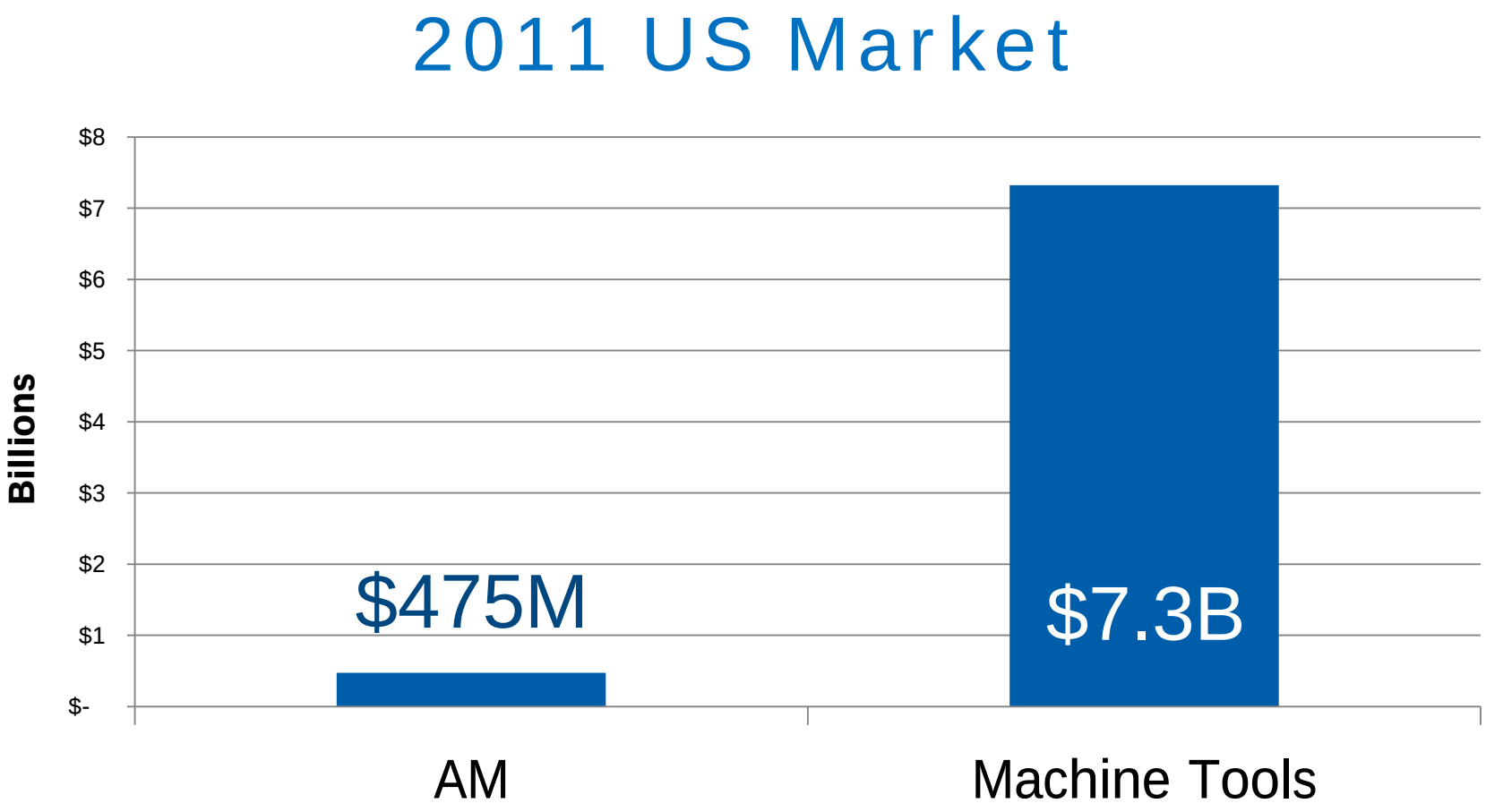


Maker Faire®



Need: Harness Maker Momentum to Influence Industrial Sector

Challenges: Industrial Base & Maker Movement

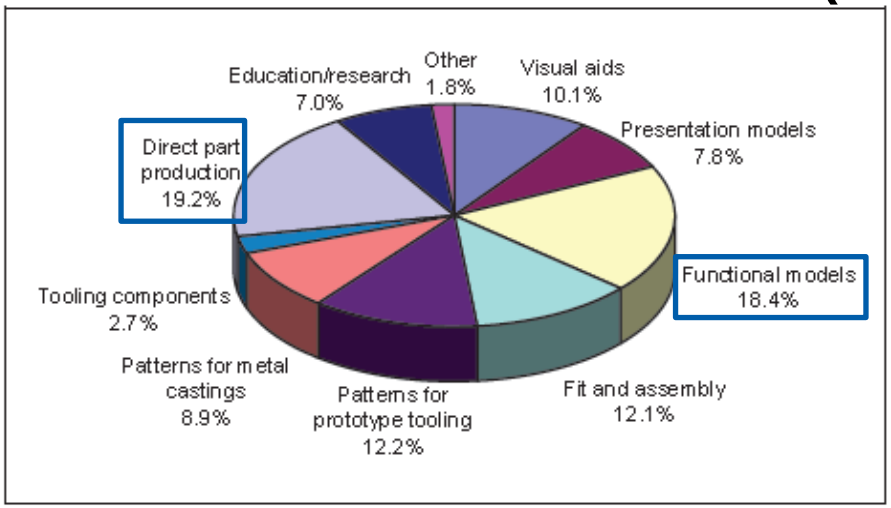


AM Source: Wohlers Associates 2012 Report
Machine Tool Source: AMT

Opportunities: *Industry Metrics*

Source – http://wohlersassociates.com

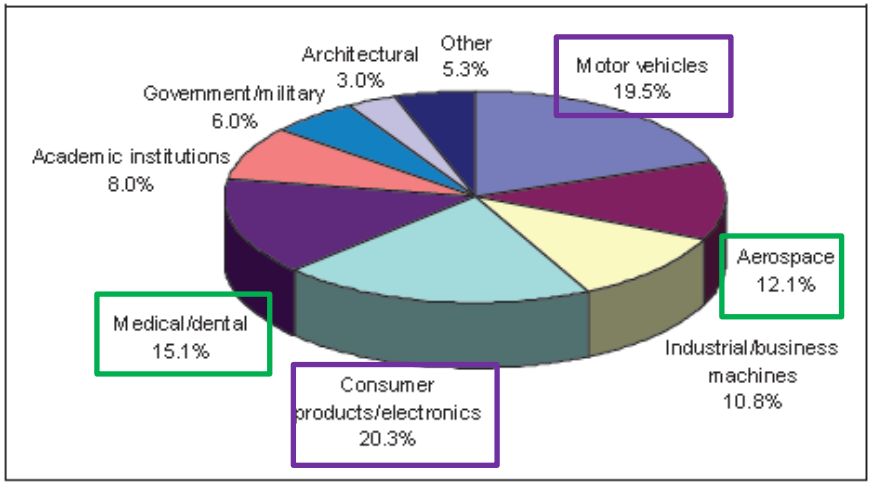
PRODUCTS: Direct Part Manufacturing (19.2%)
Functional Models (18.4%)



Source: Wohlers Associates, Inc.

Wohler's Associates site to order "Wohlers Report"

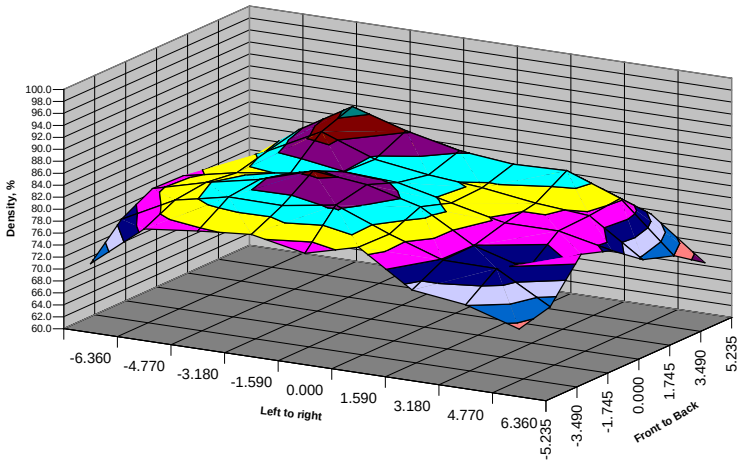
MARKETS: Consumer & Auto ~40%
Aero & Medical / Dental Accelerating

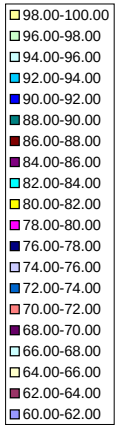


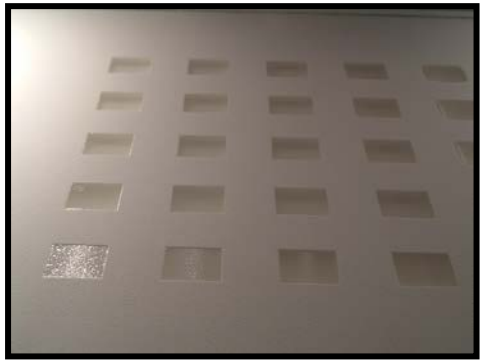
Source: Wohlers Associates, Inc.

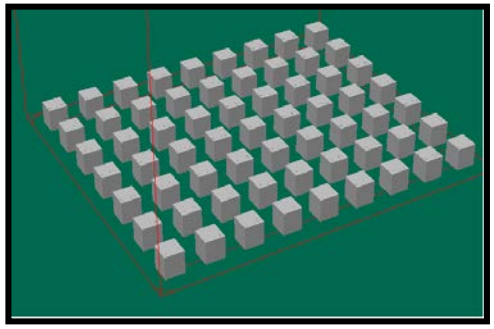
Trending From Prototyping-Only To Now ***Include Production***

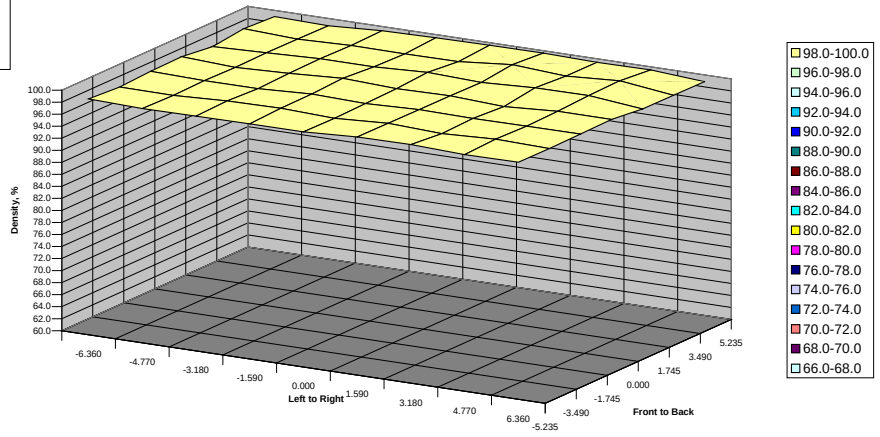
Challenges: Technical Summaries











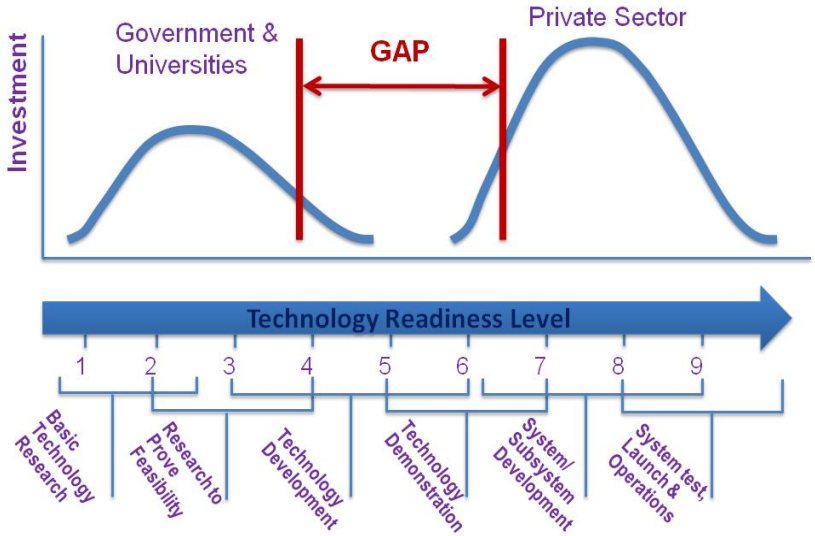
Taguchi DOE for Optimized Density (>98% with bed consistency)

Need: Increased Understanding of Processes & Accelerated Metallic Maturation (Materials & Processes)

NATIONAL NAMII ADDITIVE MANUFACTURING INNOVATION INSTITUTE

driven by NCDMM

- **Industrial Commons**
- **Technology Transition & Commercialization**
- **Workforce & Education**



Opportunity: Collaborative Innovation Focused on Advancing AM Industry

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Summary & Conclusion

- The Technology
  - No longer just “emerging”
  - Design for **functionality**
  - AM Is an **enabler, compliment**
- The Business
  - **Increase education to non-AM communities**
  - Prototyping to functional models to end-use production
  - AM discriminator: **Knowing** how to use AM

Additive Is A Compliment to Current Manufacturing

Contact Information

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Questions?