Advanced Manufacturing for Texas

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Advanced Manufacturing

The use of new technology to improve how products are made. This can be the technology to improve existing manufacturing process or the development of new manufacturing processes.
A National Strategic Plan for Advanced Manufacturing*

Manufacturing provides many of the jobs and drives many of the businesses of today. Yet its role in providing jobs and providing the businesses of tomorrow is even more important. The manufacturing sector accounts for about 72% of all private sector R&D spending and employs 60% of U.S. industry’s R&D workforce. As a result, the manufacturing sector develops and produces many of the technologies that advance the competitiveness and growth of the entire economy, including much of the service sector.

*Executive Office of the President, National Science and Technology Council, A National Strategic Plan for Advanced Manufacturing, Feb., 2012.
Design (Innovation) Gravitates to Where Things Are Made
Manufacturing in Texas

• In 2009, the average salary in Texas manufacturing was $73,319 compared to $43,146 for other non-farm sectors
• Manufactured goods account for 93% of all Texas exports
• Second only to California in Manufacturing jobs
High Value – Low Volume as a Texas Opportunity

From: Anderson, C., Wired Magazine
High Value – Low Volume Texas Market Segments

• Manufacturing for Unique & Extreme Environments
  – Personalized Products
  – Medical
  – Oil and Gas Equipment
  – Aerospace
  – Defense
SFF Markets

Accuracy

Patterns

3D Printing – Concept Models

Prototypes

Strength

Manufacturing

Machining Forms
Additive Manufacturing Started in Texas in 1985
Direct Manufacture

(A) Conventional Duct fabricated from Vac Formed plastic  
Part Count = 16 (plus glue)

(B) Component modified and consolidated for fabrication via Additive Rapid Direct Manufacture  
Part Count = 1

Made in Texas
Incredible Complexity Delivered Fast: Fine Art and Fashion

Ervinck

Harker
UT Historical AM Contributions

- 1987: UT Develops 1st SLS Machine (Deckard & Beaman)
- 1988: UT Commercializes to DTM
- 1989: First SLS Parts Sold
- 1991: Ti, SuperAlloy SLS Parts
- 1992: First SLS Direct Metal Parts & First SLS machine sold to Sandia
- 1998: 1992
- 2002: SiC Laser Sintered Parts (indirect)
- 2007: Custom Nylon Ankle-Foot Orthotics
- 2010: Flame Retardant Nanocomposites SLS Characterization
- 2011: Silicon Infiltrated Silicon Carbide Fuel Reformer
- 2014: Next Generation High Temperature Polymer SLS Testbed

Department of Mechanical Engineering
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First SLS Machine
Laser Additive Manufacturing Pilot System - LAMPS

- Laboratory Scale System
- High Temperature Polymer System ~ 350°C
- In-Situ Measurement
- Open Architecture Software
- Materials & Process Control Testbed
LAMPS Design External
Digital Manufacturing and Design

What is Digital manufacturing and Design?

By capturing data at every stage of the production process—and by deploying specially-designed software and other digital tools—manufacturers can efficiently share and revise their digital designs.

Example

![Moving Manufacturing Upstream Diagram]

System Architecture & Integration → Design → Manufacturing Processes

Prediction with Quantified Uncertainty

Gives

Models - Multiphysics, Cost/time, Uncertainty
Metrology - As built

Affordable On Time Products
Cyber-Enabled Manufacturing Systems

ESTIMATED BEHAVIOR  FAULTY BEHAVIOR

SUBTLE CHANGES CAN BE USED TO ACCURATELY DETECT AN UPSET

REAL-TIME MONITOR AND CONTROLLER

MONTE CARLO METHODS FOR NONLINEAR NON-GAUSSIAN ESTIMATION

DIRECT METAL SLS MACHINE

HIGH-FIDELITY COMPUTATIONAL MODEL

IR TEMPERATURE SENSORS

MAIN IDEA
optimal combination of information coming from sensors and that coming from a high-fidelity physics-based model running online

Accurate nonlinear non-Gaussian estimation. Cyber-physical systems (CPS) enable real-time operation. Bayesian framework can be used for uncertainty quantification. Development of the monitoring system can be automated.
National Network for Manufacturing Institutes

- Fraunhofer Model
- NNMI not-Fraunhofer more like RFP houses
- Texas should do this correctly at the State level
Complex Engineered System
3D-Fax - Demonstrated in 1992

Selective Laser Sintering
University of Texas

X-Ray Tomography
Scientific Measurement Systems

Part Recreated Here

Part Scanned Here

Telecommunication

3D-Fax

Demonstrated in 1992
We have seen this before

Willy Wonka and the Chocolate Factory
1971