ADVANCED MANUFACTURING RESEARCH AND INNOVATION AT NSF

Pramod P. Khargonekar
Assistant Director
National Science Foundation
"To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..."
NSF Role in Advanced Manufacturing

• Support basic research in engineering and science to enable future manufacturing technologies

• Prepare the next generation workforce for manufacturing research, innovations, and industry practices
NSF Laid the Foundations of 3D Printing in the 80’s
3D Printing will be $550B Industry by 2025 - McKinsey

• 3-D printers can handle materials ranging from titanium to human cartilage
• Produce wide variety of components and products
• Example: In 2016, GE Aviation will introduce the first 3D-printed parts in an aircraft engine.
NSF FREEDM Engineering Research Center leads to Manufacturing Institute

NSF ERC

DoE - EERE

PowerAmerica
NSF Role in Manufacturing Innovation Institutes (MIIs)

• Connecting NSF research communities to MIIs

• Education programs to address workforce development at MIIs; Ex: ATE program

• MIIs as “teaching factories” for university students

• Partnership with other agencies
Response to AMP 2.0

- Alliance for Manufacturing Foresight (MForesight)
  - co-funded by NSF and NIST
  - channels rapid input from industrial, academic and nonprofits
  - helps align advanced manufacturing research with national priorities and challenges to ensure efficient use of funding for the greatest possible return on investment

- I/UCRC Clusters for Grand Challenges
  - Partnership of three I/UCRCs with one ERC
  - Processing of advanced structural composites using embedded sensing, measurement and control systems with scalable IT platforms
Where is NSF Investing today for Tomorrow’s Revolutions?

• Cyber-Manufacturing

• Cellular Biomanufacturing

• Nanomanufacturing
“The Internet of Things has already set in motion the idea of a fourth industrial revolution—a new wave of technological changes that will decentralize production control and trigger a paradigm shift in manufacturing.”

-Markus Löffler, McKinsey
Advanced Manufacturing Cybermanufacturing

- FY 2015: $6.5M for 30 research projects to explore manufacturing research in the internet age
- Key themes:
  - production-as-a-service
  - manufacturing apps and operating systems
  - manufacturing exchanges, security
  - predictive analytics

Design of an Agile and Smart Manufacturing Exchange, ECCS-1543872, Chakrabarty, Maggs and Zavlanos, Duke University
Predictive Manufacturing – The IMS Center

Watchdog Agent®

- Signal Processing/Prediction Extraction
- Time Series Analysis
- Frequency Domain Analysis
- Time Frequency Analysis
- Principal Component Analysis
- Fault Diagnosis
- Performance Prediction
- Health Assessment
- Statistical Pattern Recognition
- Feature-Map Feature-Reduction
- Self-Organizing Maps
- Recurrent Neural Networks
- Graph Neural Networks
- Hidden Markov Models
- Gaussian Process

Analytics

Platform

Cloud

Provisional Site

BIG DATA

Vibration

Acoustic Emission

Rotational Speed

Torque

Quality Inspection

Production Systems

U. Cincinnati

Illustrated by Behrad Bagheri

CRM

PLM

SCM

OEE

MES

ERP

JIT

2/12/16
Goal: Establish new manufacturing paradigms that integrate an array of new nanomanufacturing technologies for manufacturing at scale.

Plasmon wave imaging- 1000:1 reduction
Optical frequencies, but with X-ray wavelengths!
Goal: Develop reliable and robust nanomanufacturing systems to make nanostructures from multiple materials
Advanced Cellular Biomanufacturing

Significance: Cell-based therapies and diagnostics have the potential to revolutionize human healthcare

Goals of the Program: Fundamental research on biomanufacturing of cellular therapies

Potential Impact:
- Enabling implementation of new therapies
- Economic impact through a new type of industry
- Education of the new generation of bioengineers
Advanced Manufacturing

Cellular Biomanufacturing

• FY 2015: $3.7M for 13 high-risk, high-impact research projects on the manufacturing of cells and cell-based products for future healthcare.
Conclusions

• NSF is planting the seeds for new manufacturing industries of the future by investments in basic research
• NSF is collaborating with federal agencies, the academic and private sectors
• NSF is enabling the future workforce in manufacturing
Thank you!