Challenges to Educating Engineers about Sustainable Manufacturing

Fazleena Badurdeen
Associate Professor of Mechanical Engineering
Director of Graduate Studies for Manufacturing Systems Engineering
Institute for Sustainable Manufacturing Core Faculty,
University of Kentucky,
Lexington KY USA
Introduction: Sustainable Manufacturing

Sustainable manufacturing at *product, process and systems* levels must:

- demonstrate reduced *negative environmental impact*,
- offer improved *energy and resource efficiency*,
- generate *minimum quantity of wastes*,
- provide *operational safety*, and
- offer improved *personnel health*;

- All while maintaining and/or improving the *product and process quality* with overall *lifecycle cost benefits*

(Jawahir, et al., 2014)
Introduction: 6R Approach for Sustainable Manufacturing

- Use
- Sales, Marketing, and Distribution
- Remanufacture
- Redesign
- Recover
- Reuse
- Post-Use
- Pre-Manufacturing
- Product/Process Design
- Extraction
- Recycling

(Jawahir and Bradley, 2015)
Introduction: Sustainable Manufacturing (Contd.)

- Product-Process-System Integration for Sustainable Manufacturing

**Product Innovation**
- Sustainable materials for products
- Advanced product design
- Effective product disassembly/recovery
- Design for reuse & remanufacturing
- Modular and reconfigurable design
- Design for improved performance

**Process Innovation**
- Sustainable processes
- Advanced process technologies
- Integrated processes
- Improved process performance

**System Innovation**
- Sustainable systems
- Enterprise level system integration
- Supply chain integration

(Jawahir, Rouch and Badurdeen, 2013) (Badurdeen et al., 2011)
Engineering Education & Workforce Development

• Realizing sustainable manufacturing innovations require developing an educated and skilled workforce
  -- United Nations SDG 4: Quality Education

• A ‘Lifecycle’ approach to recruit, reeducate and retrain at all levels for building workforce pipeline

• A multi-disciplinary approach to address sustainable manufacturing challenges
  – ‘Convergent’ research AND education

• Collaboration between key stakeholders: universities, industry, state/federal agencies

‘Education’ Lifecycle to Promote Sustainable Manufacturing

( Badurdeen and Jawahir, 2016)
Programs/Opportunities

• NSF Education & Human Resources Directorate
  – Divisions: DUE, DGE, HRD, DRL

• Manufacturing USA institutes
  – Mission for engineering education and workforce development
  – LIFT w/APLU and NCMS ➔ Expert Educator Team

• ONR Manufacturing Engineering Education Program (MEEP)
  – Established through the National Defense Authorization Act (NDAA), 2017

• NIST Manufacturing Extension Partnership (MEP) program – SMEs and technical workforce development