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Challenges to Educating Engineers about Sustainable Manufacturing

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ASME MSEC
Manufacturing Science and Engineering Conference

namrc46
North American Manufacturing Research Conference

ISM
Institute for Sustainable Manufacturing

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)

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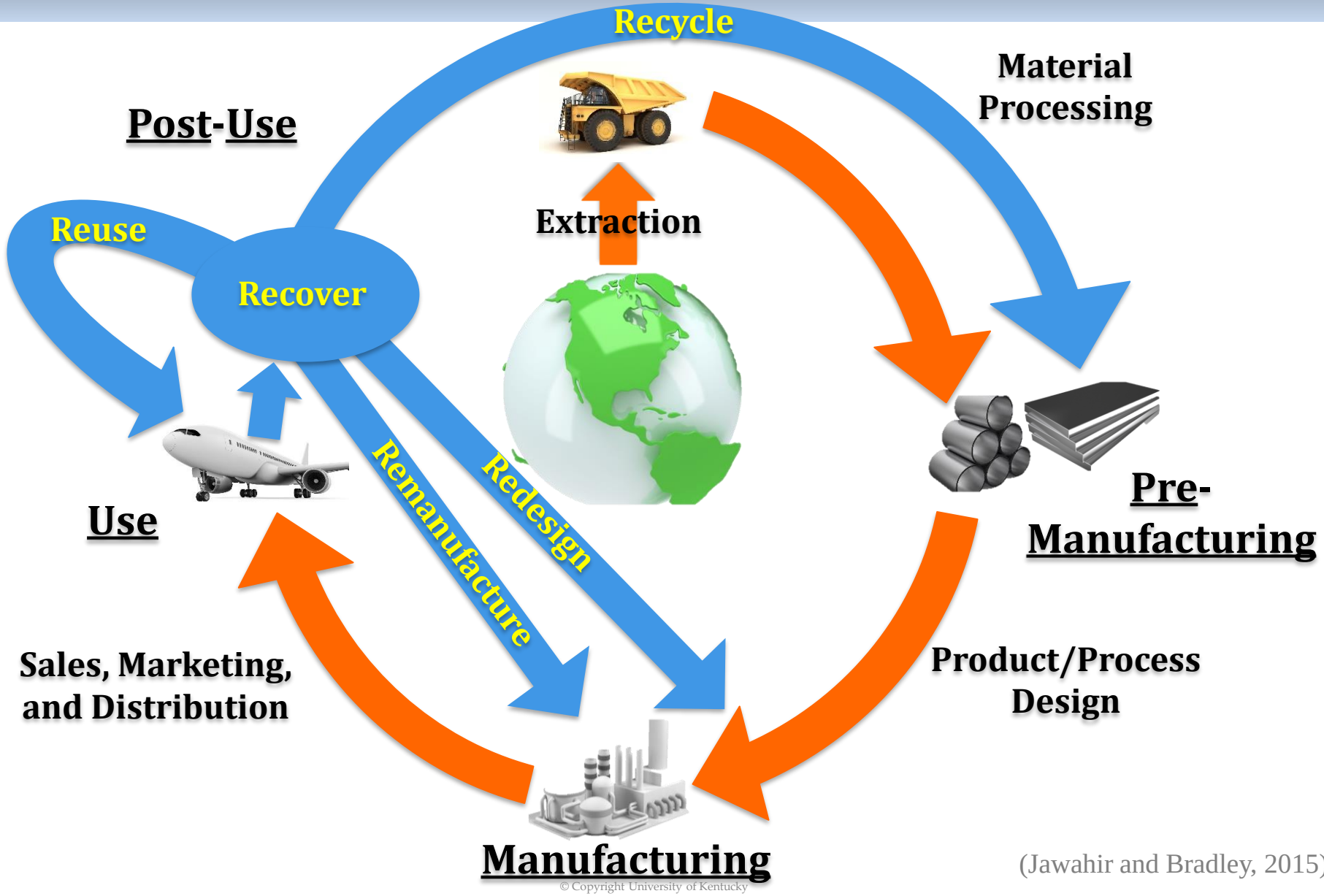
Introduction: 6R Approach for Sustainable Manufacturing



(Jawahir and Bradley, 2015)

Introduction: Sustainable Manufacturing (Contd.)

- Product-Process-System Integration for Sustainable Manufacturing

Product Innovation

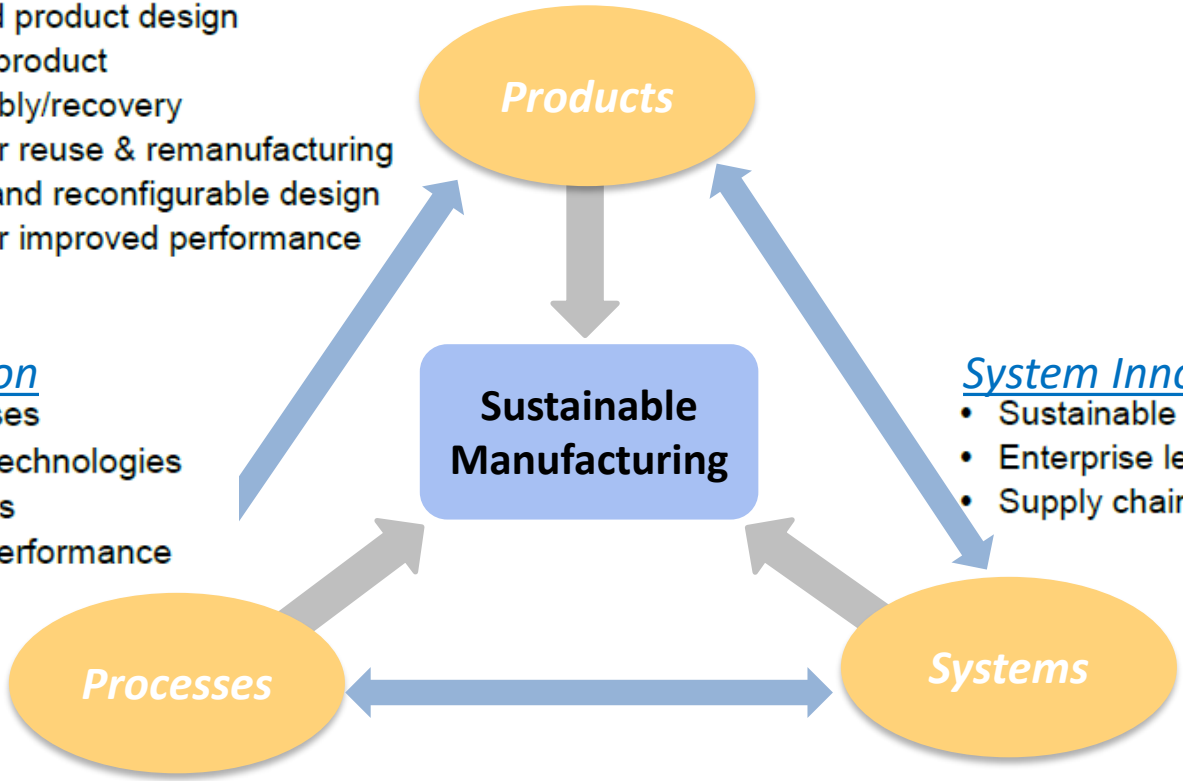
- Sustainable materials for products
- Advanced product design
- Effective product disassembly/recovery
- Design for reuse & remanufacturing
- Modular and reconfigurable design
- Design for improved performance

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)

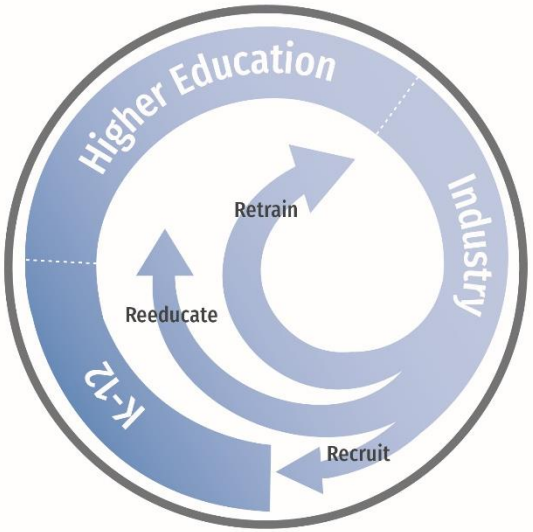
Engineering Education & Workforce Development

- 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)

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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

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