Sustainable Manufacturing Advances in Research and Technology (SMART):
Multidisciplinary Collaboration Network and Roadmap Development

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US NSF Sponsored SMART Coordination Network

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SMART CN - Project Objective

• To bridge the gap between the academic knowledge discovery and industrial technology innovation for sustainable manufacturing.

• To foster interactions that create new research directions or advance manufacturing sustainability.
SMART CN – Collaboration Organizations

- AIChE - Institute for Sustainability (IfS)
- CACHE Corporation
- Center for Advanced Process Decision-Making (CAPD), Carnegie Mellon U.
- Center for Industrial Sustainability, Wayne State U.
- Center for Sustainable Engineering, Syracuse U.
- Institute for Sustainable Manufacturing (ISM), U. of Kentucky
- National Alliance for Advanced Biofuels and Bioproducts (NAABB)
- National Center for Manufacturing Sciences (NCMS)
- National Council for Advanced Manufacturing (NACFAM)
- NSF ISRC Engineering Center for Environmentally Benign Semiconductor Manufacturing, U. of Arizona
- Smart Manufacturing Leadership Coalition (SMLC)
- Texas-Wisconsin-California Control Consortium (TWCC), Austin, TX
SMART CN – Main International Collaborators

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Project Tasks

1. To conduct comprehensive and in-depth review of the frontier research and technological development for sustainable manufacturing.

2. To define the roadmap towards manufacturing sustainability and identify the bottlenecks in a number of focused research areas via several workshops.

3. To coordinate the research through sharing knowledge, resources, software, and results.

4. To establish partnerships with industrial groups to expedite technology introduction.

5. To conduct education and outreach to a wide range of stakeholders.
Coordinated Research and Education on Sustainable Manufacturing

Academic Research
- Process-product Systems Studies
  - Modeling
  - Process control
  - Product quality
  - Safety & security
  - Energy efficiency
- Design
- Optimization
- Education & workforce training
- Supply chain
- Waste reduction
- Material efficiency

Sustainability Studies
-Metrics
- LCA
- Industrial ecology
- Policy & regulations
- Sustainability assessment
- Uncertainty
- Complex systems
- Multiscale systems
- Environ./health
- Sustainability decision making

Manufacturing Technology Innovations
- Material/alternative feedstock
- Energy/alternative energy
- Product & performance
- Process development
- Pollution prevention
- Supply chain
- Water conservation
- Business management

Industrial Innovation
- Chemical
- Petrochemical
- Specialty chemical
- Pharmaceutical
- Automotive
- Electronics
- Iron & steel
- Energy/biofuels
- Construction
- Food

Manufacturing Industries
Sustainability and Process/Product Systems Research and Education Coordination

Core Areas

I – Fundamental study on manufacturing sustainability

II – Sustainable design and integration

III – Sustainable operation, system management, and cyber-infrastructure

IV – Energy and alternative energy

V – SMART education
Sustainable Manufacturing Roadmap Development Workshop
Cincinnati, OH, Aug. 15-16, 2013

• Workshop Goal
  • To explore the topics of sustainable manufacturing
  • To capture the key needs and solutions that point to an R&D agenda
  • To flesh out some key ideas into project slates
  • To facilitate a meaningful dialogue
  • To develop a roadmap

• Participants (53)
  • Academic (25)
  • Industrial, National Labs, and Government (28)
Workshop Objective

• The workshop seeks to bring together the manufacturing community to develop a comprehensive “roadmap” – a coordinated research and development agenda – for sustainable manufacturing.

• To develop consensus for a national agenda that will define key challenges, establish a common vision, capture goals for realizing the vision, and give direction to research and development investment by industries, academia, and government.
Functional Model for the Workshop

Sustainable Manufacturing

1.0 Technology Development
   - 1.1 New Product Development
   - 1.2 Alternative Feedstocks and Materials
   - 1.3 New Pathways and Processes

2.0 Process and Systems Management
   - 2.1 Process Design
   - 2.2 Plant Operations
   - 2.3 Materials and Energy Management

3.0 Enterprise Management
   - 3.1 Supply Chain Modeling
   - 3.2 Information Management
   - 3.3 Logistics Optimization

4.1 Workforce Education and Management
4.2 Water Management and Air Quality
4.3 Life Cycle Analysis and Design for Sustainability
10 Key Themes

1) Comprehensive Characterization and Quantification of Manufacturing Processes
2) Data and Model Access for Sustainability
3) Model-Based Assessment and Control for Sustainability
4) Optimized Design for Sustainability
5) Comprehensive Life-Cycle Assessment
6) Standards and Platforms for Information Exchange
7) Clear Definition and Semantic Understanding
8) Pervasive Adoption of Sustainability Practices
9) Systematic Sustainability Achievement
10) Sustainable Manufacturing Education
### Key Finding Example: Standards and Platforms for Information Exchange

**Timeline (Years from start)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
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<tbody>
<tr>
<td>1</td>
<td>Conduct a standards assessment and void identification, documenting the results and defining critical voids. Develop a standards roadmap for sustainability. Specifically address performance standards.</td>
</tr>
<tr>
<td>2</td>
<td>For defined needs, develop/adopt defacto standards. Work through NIST and with standards organizations to move to official standards (association approved standards are an attractive alternative).</td>
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<tr>
<td>3</td>
<td>Develop an architecture for information management for sustainable manufacturing. Leverage existing architectures and activities as a first priority.</td>
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<tr>
<td>4</td>
<td>Develop/adopt a framework for data models, and create a systematic method for capturing the data models for sustainable manufacturing.</td>
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<tr>
<td>5</td>
<td>Leverage existing activities to develop and implement a secure collaboration network across the supply chain.</td>
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1. **Standards and Platforms for Information Exchange** - Define, extend, and develop needed standards for supporting commonality in sustainable manufacturing mandates and activities. Create standard platforms to support the functionalities needed for establishing and maintaining a sustainable manufacturing environment.

1.1 Conduct a standards assessment and void identification, documenting the results and defining critical voids. Develop a standards roadmap for sustainability. Specifically address performance standards.

1.2 For defined needs, develop/adopt defacto standards. Work through NIST and with standards organizations to move to official standards (association approved standards are an attractive alternative).

1.3 Develop an architecture for information management for sustainable manufacturing. Leverage existing architectures and activities as a first priority.

1.4 Develop/adopt a framework for data models, and create a systematic method for capturing the data models for sustainable manufacturing.

1.5 Leverage existing activities to develop and implement a secure collaboration network across the supply chain.
Sustainable Manufacturing

We Are Seeking Broader Collaboration.