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 (TWCCC), Austin, TX**

SMART CN – Main International Collaborators

R. Gani
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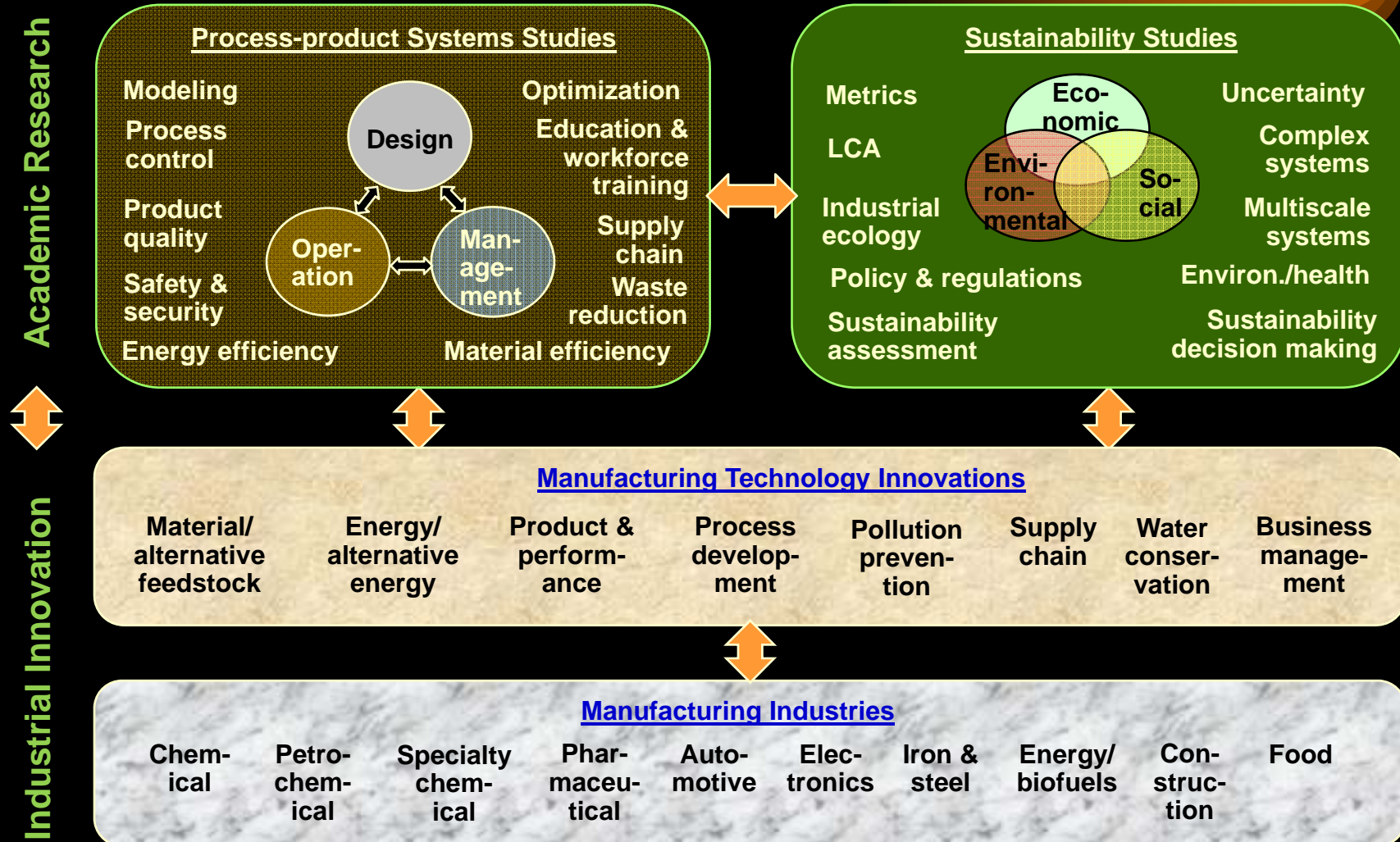**BUT**
Germany

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

Oper-ation

Man-age-ment

Optimization

Education & workforce training

Supply chain

Waste reduction

Material efficiency

Sustainability Studies

Metrics

LCA

Industrial ecology

Policy & regulations

Sustainability assessment

Eco-nomic

Envi-ron-mental

So-cial

Uncertainty

Complex systems

Multiscale systems

Environ./health

Sustainability decision making

Industrial Innovation

Manufacturing Technology Innovations

| Material/ alternative feedstock | Energy/ alternative energy | Product & perform-ance | Process develop-ment | Pollution preven-tion | Supply chain | Water conser-vation | Business manage-ment |

Manufacturing Industries

| Chem-ical | Petro-chem-ical | Specialty chem-ical | Phar-maceu-tical | Auto-motive | Elec-tronics | Iron & steel | Energy/ biofuels | Con-struc-tion | Food |

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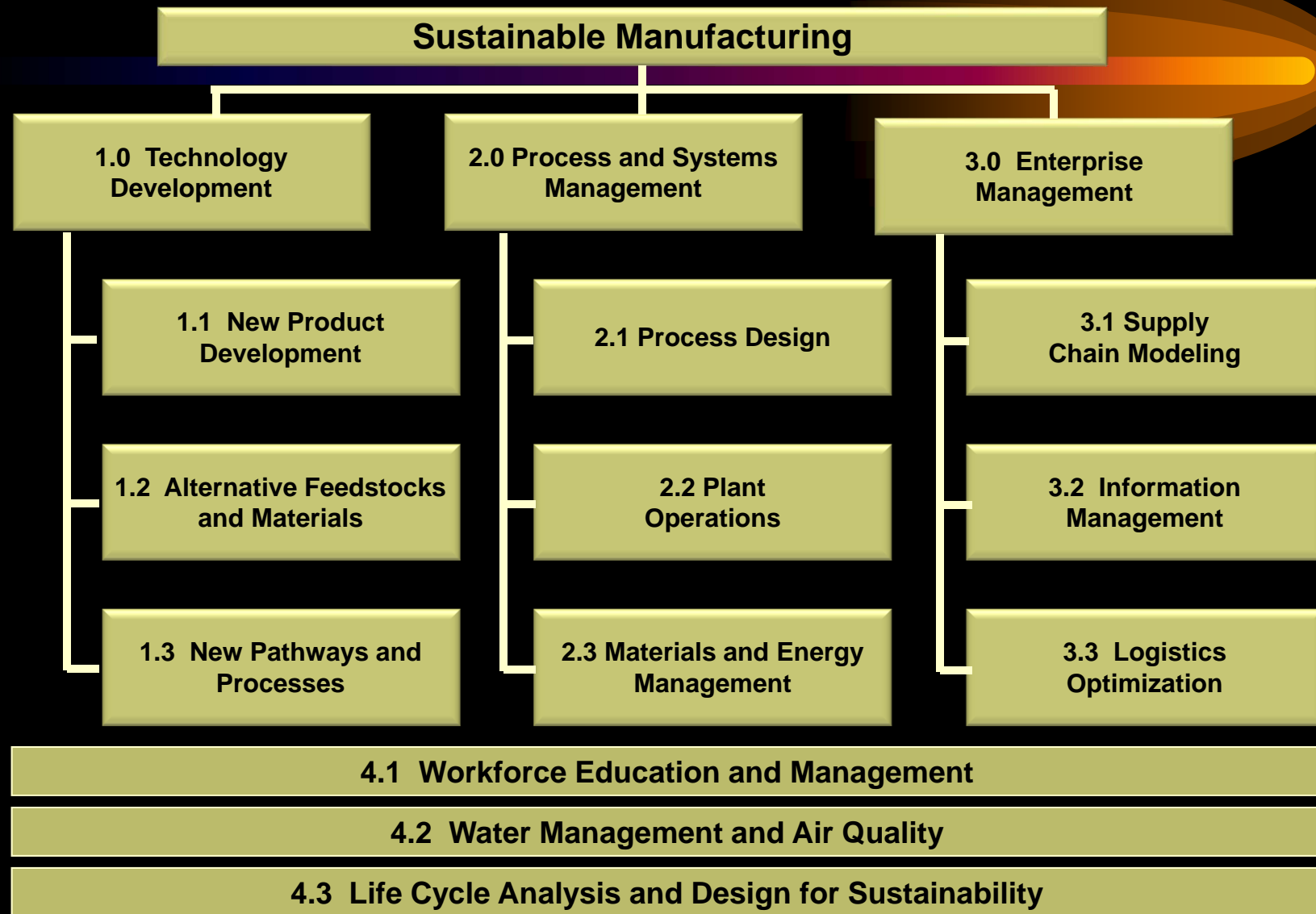
- **Workshop Goal**
    - **To explore the topics of sustainable manufacturing**
    - **To capture the key needs and solutions that point to an R&D agenda**
    - **To flesh out some key ideas into project slates**
    - **To facilitate a meaningful dialogue**
    - **To develop a roadmap**
- **Participants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

2.0 Process and Systems Management

3.0 Enterprise Management

1.1 New Product Development

2.1 Process Design

3.1 Supply Chain Modeling

1.2 Alternative Feedstocks and Materials

2.2 Plant Operations

3.2 Information Management

1.3 New Pathways and Processes

2.3 Materials and Energy 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)	1	2	3	4	5	6

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
- Conduct assessment and identify voids. Develop association partnership/champion
- Develop a sustainability standards roadmap. Define and prioritize critical standards set

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).
- Develop defacto standards – initial set
- Develop and implement additional standards
- Transfer responsibility to partner organization and support deployment

1.3 Develop an architecture for information management for sustainable manufacturing. Leverage existing architectures and activities as a first priority
- Define requirements for communications and interoperability across a supply chain
- Define existing programs for leverage/partnership
- Develop a sustainable manufacturing platform for supply chain management and optimization

1.4 Develop/adopt a framework for data models, and create a systematic method for capturing the data models for sustainable manufacturing
- Define the attributes of sustainable manufacturing to be captured in data models
- Define a set of products/sectors/processes for initial population
- Populate and manage

1.5 Levarage existing activities to develop and implement a secure collaboration network across the supply chain
- Define requirements and benchmark existing activities e.g. NNMI Institutes
- Adopt/adapt/leverage a secure collaboration environment for application in sustainable manufacturing
- Deploy and manage a secure collaborative environment

Sustainable Manufacturing

Social

Bearable   Equitable

Sustainable

Environment   Viable   Economic
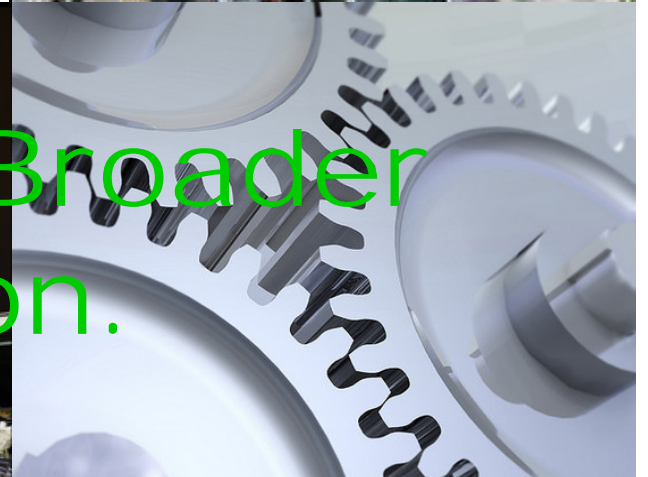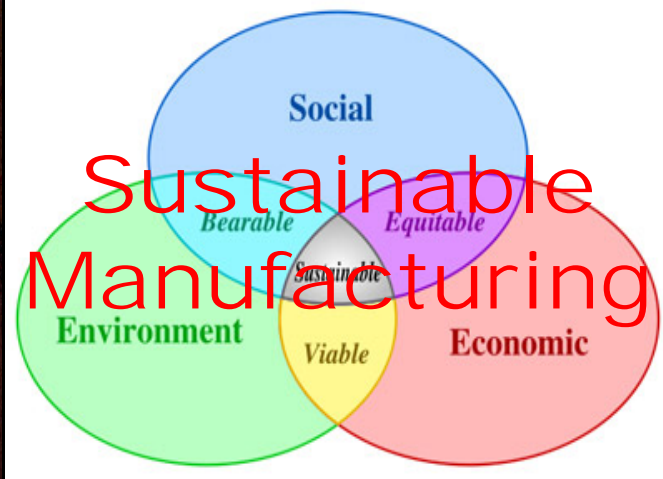
We Are Seeking Broader Collaboration.