SUSTAINABLE MANUFACTURING WORKSHOP SUMMARY

SMART CN Project Executive Committee

November 25, 2012

The SMART CN Project Team successfully held its first workshop in Omni William Penn Hotel, Pittsburgh, on Oct. 31, 2012. The purpose of the workshop was to provide an overview of the project; to discuss and identify critical research and educational needs; to expand our network; and to learn more from AIChE, industries and foreign collaborators as well as US academic researchers about their views on manufacturing sustainability and experience in collaboration.

The workshop had 23 attendees, including two NSF program officers, 14 academic researchers from nine domestic universities and five foreign universities, and seven from industries, AIChE, and an EPA national lab. A complete attendee list can be found on the SMART CN project website: http://www.research.che.utexas.edu/susman/documents/aiche2012/RCM_SM_Pitt%20Workshop_Attandee%20List_103112.pdf.

The workshop was chaired by Prof. Yinlun Huang of Wayne State University. He represented the SMART CN project team to give an overview of the project. Then, Prof. Phil Westmoreland of NC State and 2013 President of AIChE gave a talk on AIChE's manufacturing activity. He indicated that ChE-style manufacturing is a theme of AIChE in 2013, and expressed AIChE's support of sustainable manufacturing efforts being made by our Sustainable Manufacturing Research Coordination Network, the Smart Manufacturing Leadership Coalition, and AIChE's Manufacturing Leaders Roundtable. Mr. Clayton Sadler, Manager of Process Design Development of UOP, focused on the impact of shale gas on petrochemical industry and sustainability, indicating its positive effects on the American economy, energy security, and environmental quality, as well as increased employment and social benefits. Prof. Rafiqul Gani of Denmark Technical University, an international collaborator of the SMART CN project, shared his experience in research and education collaboration at different levels, and highlighted his group's collaborative research on product and process sustainability. Prof. Jim Davis of UCLA, a leader of the Smart Manufacturing Leadership Coalition (SMLC), introduced the Coalition's various activities in industrial gas manufacturing, machine operations and line management, network-based manufacturing intelligence and collaborative manufacturing, multi-layer smart manufacturing, and the Coalition's commitment to a comprehensive approach.

The project team made two presentations. Prof. Thomas Edgar of UT-Austin presented the project team's plan to organize the First Sustainable Manufacturing Roadmap Workshop in Cincinnati, Ohio, in mid-Aug. 2013. Tom shared his experience in organizing smart process manufacturing workshops with Jim Davis of UCLA in the past few years. Prof. Cliff Davidson of Syracuse presented the project team's education and software coordination plan in sustainable manufacturing. These include development of case studies, integration of case studies and other modules into the electronic library of the Center for Sustainable Engineering, benchmarking the status of current education in sustainable manufacturing, and organizing workshops for faculty on sustainable manufacturing.

Note that the slides of all the presentations have been uploaded onto the project website: http://www.research.che.utexas.edu/susman/workshop.html.

The second part of the workshop consisted of a group discussion, co-chaired by Profs. Cliff Davidson and Mario Eden (Auburn University). The discussions covered various research and educational topics, listed below.

1. Sustainability assessment. The attendees discussed the need for sustainability metrics selection, which should reflect triple-bottom-line-based aspects. The structure of metrics should be studied, but data scarcity and uncertainty remains an issue. Sensitivity analysis may be a viable method in metrics selection.

2. Sustainability enhancement. Discussion participants recognized that sustainability problem definition and formulation are critical. Solution space and boundaries should be defined. Optimization techniques can be used in solution identification. Participants also suggested that multiple solutions should be presented for comparison. Again, data and information uncertainty is a challenge.

3. Design for Sustainability. This is a very important area in manufacturing sustainability study. Industrial leaders emphasized that methodological development is a high priority. Tools should include social factors.

4. Social sustainability. It was agreed that social factors should be included in studying manufacturing problems. Community sustainability should be an important area of study, but it has not yet received sufficient attention in engineering. The issues of manufacturing cost vs. social cost should be studied. There is a need to identify appropriate social indicators, but, again, data source and availability could be an issue.

5. Environmental and energy sustainability. It is important to study the impact of waste minimization in manufacturing. Energy consumption, supply chain, and alternative energy use vs. land use are important areas to study. In quantification, emergy and exergy analysis may be potentially useful methods.

6. Sustainable engineering education. The importance of enhancing sustainable engineering education was recognized. Educational models are available. Course availability should be identified. Sustainable manufacturing perspectives should be included in engineering education. AIChE IfS has developed credential courses for professionals.

In the Workshop, the SMART CN project team distributed a copy of the Request for Proposals on Educational Modules for Sustainable Manufacturing. The RFP can be accessed via http://www.research.che.utexas.edu/susman/documents/aiche2012/RCN%20SM_RFP%20on%20Ed_103112_Web.pdf. It was mailed to all the chemical engineering department chairs in the U.S. on September 25. The Project Executive Committee will announce the winners in December.

Notes from Discussion Session

David Fasenfest	• Community sustainability is a very important area when addressing manufacturing sustainability. • There should be a trade-off between maximum production and minimum negative social cost.
Heriberto Cabezas	• Waste minimization and environmental impact level should be considered. • Sustainability enhancement should be based on a long-term solution. • Energy sustainability factors: energy consumption, land use, and overall supply chain. • Emergy and exergy based quantification should be valuable.
Jay Lee	• Sustainability metrics are important in assessment. • Sensitivity analysis could be a good method for identifying important metrics.
William Hollar	• Sustainability metrics should be three-bottom-line-based.
Heriberto Cabezas	• Sustainability solution space should be defined with appropriate boundaries. • Human health indicators should be included in modeling.
Cliff Davidson	• Sustainability assessment and metrics selection is a critical research need. • Visiting student collaborations in the EU described by Professor Gani could be a model for our efforts in the US.
Subhas Sikdar	• To enhance sustainability engineering education, course availability should be identified. • Sustainable manufacturing perspectives should be included in engineering education.
Cliff Davidson	• Sustainable engineering/sustainable manufacturing education models should be studied.
Darlene Schuster	• AIChE IfS has been making efforts toward credential courses for professionals, M.S. level course development and offering.
David Fasenfest	• The normality of social consequences is questioned.
Jim Davis	• Structure of metrics should be studied. • Metric is an element of workflows. • Data selection in workflow analysis is important.
Yinlun Huang	• A recent survey among industrial leaders conducted by National Center for Manufacturing Sciences shows that LCA and sustainability metrics, sustainability enhancement methodology development, and sustainable engineering education and workforce are the top three important areas in sustainable manufacturing study.
Bruce Hamilton	• Energy sustainability is an important area of manufacturing

	sustainability, which should include energy storage and other types of renewable energy, such as solar energy.
Mario Eden	• Geothermal energy is also an area of study.
Bruce Hamilton	• Design for Sustainability (DfS) is an important area of study. • Social sustainability and community sustainability involving social scientists are also important in manufacturing sustainability.
David Fasenfest	• Sustainability improvement solutions may be sub-optimal. • Local content involving job hiring should be considered. • There is a lack of concern for the social component in engineering.
Darlene Schuster	• Integrating social components into sustainable manufacturing is a challenging task.
Bill Hollar	• Social sustainability metrics should be sufficiently included in assessment, although very challenging.
Subhas Sikdar	• It is important to develop sustainable technology. • Sociopolitical issues are sometimes more important than technical issues.
Rafiqul Gani	• There is a lack of reliable data for social sustainability quantification. • Industrial data are often not shareable due to proprietary issues.
Jay Lee	• Optimization techniques should be valuable for sustainable manufacturing studies. • Sustainability related constraints should be in optimization models.
Yinlun Huang	• In sustainability assessment and solution identification processes, data and information uncertainty is always a major challenge, especially when conducting predictive sustainability study.
Mario Eden	• Design for sustainability is an important area in sustainable manufacturing.
David Fasenfest	• There is a need to include social service cost, job and politics, and life cycle cost in modeling.
Mario Eden	• Social factors should be included in tools for manufacturing sustainability, but again data availability is an issue.
David Fasenfest	• Social sustainability should be included in curriculum development.
Mario Eden	• It is not clear what the data look like and where to obtain them.
Subhas Sikdar	• Multiple solutions should be provided for comparison and solution identification.
Darlene Schuster	• Engineers appreciate reasonable constraints in problem formulation.
Clayton Sadler	• It is important to include social factors in addressing manufacturing sustainability, but selection and quantification of metrics are challenging.