SMART MANUFACTURING: AN ENGINEERING VIRTUAL ORGANIZATION TO DEVELOP A TECHNOLOGY ROADMAP

FY 2008 Progress Report

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In the first year of this award, the primary accomplishments are:

(1) The initialization of an industry-academic Engineering Virtual Organization (EVO) that is uniquely balanced with approximately half industry and half academic participation,
(2) An established EVO organization and processes for conducting business and moving technical goals and objectives forward,
(3) A technology roadmap and draft report articulating priority transformations to achieve Smart Process Manufacturing based on a workshop held in April, 2008
(4) Two papers, six presentations and a website that have been used to disseminate the results of a workshop, generate broader national discussion, gather additional input and further build the EVO.

We are reporting the 2008 activities associated with this award along three dimensions: (1) constitution, organizational approach and activity of the EVO, (2) progress on a Smart Manufacturing Technology (SPM) technology roadmap, and (3) dissemination of initial workproduct and facilitation of broad discussion and input.

Constitution and Activity of the Smart Process Manufacturing Engineering Virtual Organization

The formation of the academic-industry Smart Process Manufacturing (SPM) Engineering Virtual Organization (EVO) kicked off with a workshop at NSF on April 21-22, 2008 entitled, "NSF Roadmap Development Workshop: Zero-Incident, Zero-Emission Smart Manufacturing." The planning for the workshop drew upon a start-up organizational approach comprised of a Steering Committee and a Technical Workgroup. Both the Steering Committee and the Technical Workgroup are composed of approximately half academic and half industrial participation ensuring merged business and research perspectives. Conceptual planning, framing of the workshop, agreement on scope and objectives and specification of the facilitation were addressed by the Steering Committee. The initial content and material organization for the workshop were developed by the Technical Workgroup, which conducted an accelerated initial run of the expected workshop approach to form and organize content. This content was used to both structure the workshop and to provide an effective material initialization point for a much more detailed development of content.   The workshop itself was composed of 18 industrial participants from fourteen companies and 15 academic participants all from different universities. Each

person was invited because of experience on emerging smart plant concepts and involvement in broad perspective planning efforts. The use of professional facilitators ensured the involvement and voice of all participants and enabled the building of important interrelationships needed to start-up the SPM EVO. This Steering Committee/Technical Workgroup/Full EVO organizational structure and approach has been established as an operating structure for the SPM EVO. Raw data for the Technology Roadmap from the workshop was distributed to the full EVO for comment, the Steering Committee reviewed the report areas the needed further work and development, the Technical Workgroup is working through the specific content. Version 1 of the Technology Roadmap is in draft now and expected to be ready for distribution first quarter 09.

Smart Technology Roadmap

The objective of the April 2008 Smart Process Manufacturing workshop was to provide the vehicle for collaborative work and facilitated assessment to generate foundational information for the technology roadmap. The road mapping methodology was provided by IMTI, Inc. (Integrated Manufacturing Technology Initiative), a professional facilitation company, to generate, capture, and provide content for the roadmap. The data and information produced during the April workshop includes:

1. A current state assessment for the three pillars (Technology Management, Systems and Facilities Management, and Enterprise Management) shown in Figure 1, identifying technical and intellectual barriers and deficiencies, state of practice, and best practices and emerging research.

2. A future state vision for each pillar, articulating high-level goals and objectives for research and development (R&D) focus.

3. A framework of identified and prioritized issues and solutions within each pillar.

4. A review and prioritization by workshop participants of key solutions to be pursued across the scope of Smart Process Manufacturing.

The workshop produced the functional framework shown in Figure 1, a great deal of data about of the functional areas, and 31 priority solutions. The initial report is published and can found at http://www.oit.ucla.edu/nsf%2Devo%2D2008/ . The results are also summarized in Edgar, T.F. and J.F. Davis, "Smart Process Manufacturing: A Vision of the Future," Industrial & Engineering and Chemistry Research, 100th Anniversary Commemorative Issue (2008).
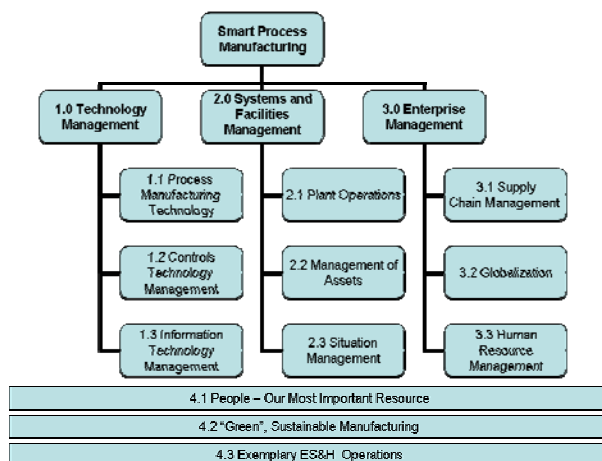
Figure 1. The Smart Process Manufacturing functional model provides a hierarchical, logical framework for analysis of technology research and development requirements.

Since the April meeting, the EVO processes have been applied to consolidate the workshop results into an initial version of a technology roadmap. The full EVO has reviewed and provided input on the initial report and the Steering Committee members have reviewed it in detail, agreeing to frame the roadmap as a progression of transformations:

1. Data to Knowledge
2. Knowledge to Operating Models
3. Operating Models to Key Plant Assets
4. Key Plant Models to Global Application
5. People, Knowledge and Models to a Key Performance Indicator

We have further developed the vision, motivation and business case for SPM based on the workshop results and we have begun to conceptualize some of the technical transformations. This work and the collective thinking about the April workshop results are summarized in a recent presentation at the 2008 AICHE meeting in Philadelphia. In parallel, we have contracted with the IMTI group to help us develop the workshop results into this the roadmap format that now reflects these transformation concepts. This report is in draft and our steering/technical workgroup is convening in mid December 2008 to review it and to develop the next level of detail. This Level 2 Roadmap is in draft and is expected to be distributed first quarter 09 for full EVO review.

Dissemination of results and facilitation of broad discussion and input

In this first year, the following presentations on the Smart Process Manufacturing EVO and its work have been made:

1. Davis, J.F. and T.F. Edgar, "Smart Process Manufacturing: The Results of an NSF Workshop," AICHE Annual Meeting, Philadelphia, PANovember (2008).

2. Edgar, T.F. and J.F. Davis, Smart Process Manufacturing – Results from An NSF-Sponsored Workshop, CACHE Corporation – Retrospective and Future Outlook, AICHE Annual Meeting, Philadelphia, PA November (2008).

3. Davis, J.F. "Smart Process Manufacturing," Abnormal Situation Management Workshop, city?,South Africa, October (2008).

4. Davis, J.F. "An Engineering Virtual Organization," Academy of Management Conference, Anaheim, CA, August (2008)

5. Edgar, T.F. "Smart Process Manufacturing, ", Panel Discussion, Foundations of Computer Aided Process Operations, Boston, MA July (2008).

6. Davis, J.F. " Smart Process Manufacturing Technology Road Map, " Abnormal Situation Management Consortium Quarterly Review Meeting, Arlington, VA June, (2008).

7. Edgar, T.F. "Smart Process Manufacturing", Integrated Environmental Management

Consortium, Houston, TX June (2008).

8. Edgar, T.F., "Smart Process Manufacturing in the Semiconductor Industry," Integrated Measurement Association, Snowbird, UT, October(2008)

The following papers and reports have been published:

1. Davis, J.F, and T.F. Edgar, "NSF Roadmap Development Workshop: Zero-Incident, Zero-Emission Smart Manufacturing", April 21-22, 2008, Report May (2008)

2. Edgar, T.F. and J.F. Davis, "Smart Process Manufacturing: A Vision of the Future," Industrial & Engineering and Chemistry Research, 100th Anniversary Commemorative Issue (2008).

3. Davis, J.F. and Edgar, T.F. "Smart Process Manufacturing – A Vision of the Future", accepted, Foundations on Computer-Aided Design 2009, Breckenridge, June 2009

As an initial gateway for the Smart Process Manufacturing EVO, the following website has been established and is currently being used as a repository for smart process publications and representations.

http://www.oit.ucla.edu/nsf-evo-2008/

We would like to note that in a Google search, "Smart Process Manufacturing" brings up the EVO SPM report, the SPM website and an overview article about the April workshop at the top of the list.