SMART MANUFACTURING/SMART GRID BIG DATA/ANALYTICS MODULES/EXERCISES
PLANNING ROUNDTABLE
January 25, 2013

BACKGROUND NOTES
Goals of planned modules and exercises

US industry is facing changed operating conditions which offer new potential and new threats that challenge strategic, technology and innovation decisions as well as the preparation of business and engineering students. Specific goals:

• Stimulate recognition of evolving smart systems (manufacturing, grid, related supply chain), underlying drivers, issues, their highly complex interactions with varying organizational and environmental contexts; in particular, capture and convey issues and potential of Big Data, and Analytics implicit in the systems – all in a way that non-IT oriented students and managers (and faculty) can understand
• Support instruction with module, materials and exercises enabling ready and seamless integration into current business and engineering courses and use by current faculty
• Apply (fully or with emphasis on problem definition and use of output) optimization and analytic methodologies and tools used by organizations to anticipate and assess potential future demand, requirements and support decision making at strategic planning and operational levels
• Enhance critical/analytic thinking and systems thinking; challenging of assumptions, and visioning skills necessary to effectively address complex problems.

Key Dimensions of Big Data (from IBM)

Big data (as an enabling and constraining phenomena) spans four dimensions:
• Volume
• Velocity
• Variety (many forms of data, structured and unstructured such as text, video)
And
• Veracity (highly uncertain data requiring looking at multiple data sources and assessing co)

Examples of applications within first 3 dimensions
(see: http://www-01.ibm.com/software/data/bigdata/)

Volume:
• Turn 12 terabytes of Tweets created daily into improved product sentiment analysis
• Build on 350 billion meter readings per year to better predict power consumption (supporting Smart Grid)

Velocity:
• Assess 5 million trade events per day to promptly identify potential fraud
• Analyze 500 million call detail records per day in real-time to predict customer churn faster

Variety:
• Take advantage of the 80% data growth in images, video and documents to improve customer satisfaction
Analytics and smart systems imply systems are **instrumented** (enabling data collection), **interconnected** (context sensitive pattern recognition across divers data sources), and **intelligent** (producing actionable insight.)

### Characteristics of “smart” systems

#### A. Smart manufacturing (SM)

**Benefits:**
- Plant and enterprise-wide data sharing bridges current silos with the intent to support rapid/agile decision-making and communication. Integration is enabled across not only machines and manufacturing cells but also across the globally distributed supply/value chain.
- With increasing self-aware, self-diagnosing and optimizing machines, SM is expected to reduce costly downtime and maintenance, improved energy efficiency (particularly when coupled with smart grid) and to enable more accurate planning as well as innovation. Potentially, technologies from other disciplines could be drawn on to enhance manufacturing.

**Challenges:**
- SM is highly complex and dynamic and must be continually reconfigured as new technology is developed and incorporated.
- Full implementation of SM is currently limited by the inability of manufacturers to adapt legacy production and make optimal use of real-time actionable data.
- Systems must enable use of competing vendors and globally distributed activity while ensuring consistent knowledge, data gathering and understanding across value chains.
- Implementation is hampered by differences in culture between manufacturing and IT developers.
- per SMLC (Jim Davis, UCLA), companies investing in SM are not able to reap the full benefit of the investment until their partners, suppliers, and customers also invest.

#### B. Smart grid (SG)

**Benefits:**
- enhanced grid reliability, improved precision of monitoring and control, greater flexibility in energy sources and allocation and overall reduction in energy cost.

**Challenges:**
- optimization across industries and companies may force behavior changes and reduce efficiency, performance and competitiveness of individual firms, particularly manufacturers.
- As with SM, but even more intense, there are numerous stakeholders with varying perspectives and demands

an aside (focus of a different program):

**Standards** will be critical related to SM, SG and also cloud computing among many other areas) offering:
• essential common data formats, controls and performance measures across devices, systems, sensors and organizations (including multiple vendors)
• vehicles for companies to balance individual strategic and operational requirements with implied cross organization/cross-sector, even cross-national environmental and efficiency initiatives
• support for innovation by giving confidence that new products, technologies and processes will be compatible with legacy systems, infrastructure and vendor capabilities, and will be accepted in the market
• support required to local reporting requirements while recognizing varying levels of understanding, contexts and proprietary concerns

Example module resources

• IBM Smart Grids for a Smarter Planet (Jerry Willsmore, IBM Global Energy and Utilities Industry at http://wn.com/Smart_Grid_IBM_Smart_Grids_for_a_Smarter_Planet
• Schiller, Christian and Fassman, Stefan, IBM. The Smart Micro Grid: IT Challenges for Energy Distribution Grid Operators at http://www.generatinginsights.com/
• whitepaper/the-smart-micro-grid-it-challenges-for-energy-distribution-grid-operators.html (Generating Insights will be an ongoing source of input)
• IBM Corporation, 2010. Business Analytics for Manufacturing
• IBM (and related) tools such as Cognos
• smart grid and smart manufacturing materials such as National Electrical Manufacturers Association papers, “Vids For Grids” training videos and business and technical transformation sections of the Smart Manufacturing Leadership Coalition roadmap as well as planned platforms to support SME learning and resource sharing from SMLC and National Center for Manufacturing Sciences (NCMS)
• CTIM tool slides and exercises

Example module outline with energy focus
(4-5 extended sessions, teaching notes offer options for condensed usage)

Understanding complex, dynamic and interactive contexts for energy demand, usage, innovation
• Big data challenge and potential value
• IBM Smarter Planet initiative
• Global warming as illustration of complexity and uncertainty; strategy, risk implications
• Alternative energy types and trade-offs; emerging technologies
• Added dimension of social, political and sustainability pressures; innovation drivers and constraints
• The role of standards and the challenge of anticipatory standards
• Smart grid and micro-grid cell potential, evolution paths and obstacles, IT challenges.

Assessing underlying drivers, factors and futures (2 sessions)
• Stakeholder analysis
• Tools
  • Analytics and optimization – beyond intuition
• Other tools (basic level – help explicate problem, surface needs, assumptions, context and factors that may not be quantifiable or readily expressed by users/customers)
  o Mindmapping and causal mapping to bring out important interconnections; allow focus on solution space without losing sight of broader contexts and interrelated systems
  o Scenario planning (tactical and strategic) to help assess implications of a range of changes and potential futures
  o Roadmapping to help students plan transitions from legacy systems and from one development to another and to identify gaps in resources and skills and cascading impacts of change
  o Input sub-tools to assist in identifying underlying, root cause factors.
• Integration of tools with each other and with organizational processes

Application to smart systems (example: smart manufacturing)
• Domain specific characteristics, requirements; integration, intelligence, and innovation
• Evolution paths
• Tool application; cases, exercises, potentially, simulations/serious games)