A Smart Manufacturing Public-Private Partnership Program
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What is Smart Manufacturing? Smart Manufacturing is the dramatically intensified application of manufacturing intelligence using advanced data analytics, modeling and simulation throughout the manufacturing and supply chain enterprise. In the short term, smart manufacturing addresses efficiency, environment, product quality, and productivity improvements. Longer term, smart manufacturing is targeting a dramatic and fundamental shift in manufacturing processes toward demand-dynamic economics, flexible service-oriented factories and demand-driven supply chain service enterprises. Smart manufacturing encompasses the (1) technology, (2) interoperability, (3) operational practice and (4) shared business infrastructure on which manufacturing intelligence can be generated and applied to multiple meaningful use areas that include economic, energy, EH&S and sustainability performance.

What are the Potential Impacts? The Smart Manufacturing Leadership Coalition [SMLC] (25 companies, five manufacturing consortia, six universities, one government lab) has built on the earlier NSF funded work of 20 companies and 20 universities to develop a roadmap for smart manufacturing. The SMLC has estimated meaningful impacts:

Demand-driven use of resources & highly optimized plants and supply networks - 80% reduction in cost of implementing modeling and simulation; 25% reduction in safety incidents; 25% improvement in energy efficiency; 10% improvement in overall operating efficiency; 40% reduction in cycle times; 40% reduction in water usage

Product safety- Product tracking and traceability throughout the supply chain; pinpoint product recalls managed dynamically; product trustworthiness

Sustainable production processes for current and future critical industries- 10x improvement in time to market in target industries; 25% reduction in consumer packaging

Maintain and expand existing U.S. industrial innovation base- 25% revenue in adjacent industries; 25% revenue in new products and services; 2x current small and medium enterprises (SMEs) addressing total market; more highly skilled sustainable jobs created

What is the Market Failure The current market creates a cycle of smart manufacturing investment disincentives and slow, incremental adoption. Most U.S. manufacturers currently manage production with "homegrown" customized software or manual paper-intensive processes. Without the scalability of industry standard approaches, no single vendor has been able to profitably develop viable business volume at current growth rates. At the company and factory level, vertically segmented investments in (1) compartmentalized infrastructure, (2) uncoordinated applications on replicated infrastructure, and (3) operational assimilation of non standards based modeling and simulation remain more easily justified over risky, expensive, incremental and slow return smart manufacturing infrastructure investments. Despite major industry projected impacts of smart manufacturing, it is unprofitable to replace the still serviceable $50 - $60 billion in 20 - 40 year old mainframe distributed control systems in U.S. manufacturing plants today even though these systems embody the production technologies adapted to the old regime of pre-digital age manufacturing.

Large companies that are applying enterprise smart manufacturing within their boundaries see benefit but are not able to reap the more significant rewards of a demand-dynamic economy without the broader infrastructure investment across the supply chain. Simultaneously, the market creates a prohibitive cost of entry into smart manufacturing for small and medium size companies, resulting in slow adoption within

the supply chain and impacting the investment return for both the large and small companies that do invest. U.S. smart manufacturing infrastructure remains balkanized with limited factory and supply chain effectiveness along with significant replicated but uncoordinated investment. This is aggravated by the fact that retrofit application of smart manufacturing in U.S. brownfield plants is a more difficult investment than for new, greenfield plants which are mostly deployed in other countries. Without a basic industrial infrastructure for smart manufacturing, new modeling and simulation industries are not economically viable at a time when the U.S. industry needs to move aggressively into smart manufacturing.

What is needed? Manufacturing data is the essence of *manufacturing intelligence* and the key to new demand-dynamic manufacturing. New industry-supported organization, business, interoperability and technology models and infrastructure across multiple industry segments are needed to significantly lower the entry of entry to pervasive application of data analytics, modeling and simulation and to demonstrate service-oriented factory enterprise models. Data needs to be more easily obtained via low cost sensors, more easily collected, consistently defined, managed as an operating asset, shared within companies, and selectively shared among companies. Core capabilities with modeling and simulation must be developed and become broadly accessible to small, medium and large enterprises. The cost of operational implementation needs to be cut in half by sharing pre-competitive costs.

These goals are facilitated by an industry-directed, community source data analytics, modeling and simulation *platform* that functions as a *clearinghouse and gateway* for core, pre-competitive tools, infrastructure, practices and workforce needs. A community source platform would provision:

(1) A test bed environment, fully available to small, medium and large companies, to accelerate testing and assimilation of existing modeling and simulation approaches, the development and testing of new products, and demand dynamic manufacturing innovations.

(2) Standardized, interoperable and sustainable business decision modeling and simulation tools and facilities (e.g. risk management, energy management, emissions compliance statistics) in a library of plug and play functions. These tools would be developed for enterprise real-time, data-driven dashboards for industry wide key performance indicators (KPIs) that are developed in combination with a shared data access program.

(3) Shared supply chain models with end-to-end visibility aimed at dramatically reduced inventories (demand-driven production), dynamic involvement of small and medium enterprises in the supply chain, improved product availability, faster production of customized products, and instant tracking/traceability throughout the supply chain.

Why a Public-Private Partnership Model? The U.S. needs investment in the (1) pre-competitive technology, (2) interoperability, (3) operational practice and (4) shared business INFRASTRUCTURE on which manufacturing intelligence can be generated and applied to multiple meaningful use areas across entire factory and supply chain enterprises. Government investment through a public-private partnership intervention will quickly lower the cost of assimilating modeling and simulation into enterprise operations by an estimated 80% and will provide the demonstration models and test beds to help lower risk. These two foundational goals of the partnership will accelerate development and demonstration, reduce investment uncertainty, provide the vehicle to share risk and produce commonly used, non-competitive approaches and technologies that can show the way to raise the median for U.S. industry. The partnership will overcome the market tendency to do numerous lower risk incremental changes versus larger, higher risk (currently) step-changes. It provides the capacity for demonstration model and test beds to show how to work within enterprise multi-plant, multi-company, multi-supply chain connectedness and to focus on new workforce skills. Stimulating more private investment in building and accelerating the application of tools and building workforce skills for competitive advantages by lowering the burden on infrastructure investment is key to breaking through the existing market barriers.