2012 EL Project Title and Number: Production Network Supplier Characterization

Program Title: Sustainable Manufacturing Program

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Summary: Production network resiliency is a measure of the network's ability to reduce consequences of, and recover from, various types of man-made or natural disruptions. Resiliency is impacted by decisions to increase sustainability performance of both the supplier and the production network. Presently, the manufacturing industry's ability to assess impact of suppliers' sustainability decisions is restricted by the lack of reliable sustainability and resiliency analysis approaches. The fundamental barrier is the absence of standard supplier characterization and analysis methods that may be widely adopted for such effective performance analysis. The new technical idea is a standard, model-based supplier sustainability characterization and method to analyze impact of supplier choices on the production network resilience. If successful, the standard characterizations will lead to new approaches for effective assessment of supplier sustainability while optimizing production network resilience.

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Objective: To assist U.S. manufacturing industry in optimizing production networks' resilience with respect to sustainability decisions by developing and validating standard model-based supplier characterization and production network resilience analysis methods, by 2014.

What is the new technical idea? Production network resiliency is a measure of the network's ability to reduce consequences of, and recover from, various types of disruptions. Resiliency is impacted by decisions to increase sustainability performance of both the supplier and the production network.

Presently, the manufacturing industry's ability to assess impact of suppliers' sustainability decisions is restricted by the lack of reliable sustainability and resiliency analysis approaches. The fundamental barrier is the absence of standard supplier characterization and analysis methods that may be widely adopted for such effective performance analysis. The new technical idea is a standard, model-based supplier sustainability characterization and method to analyze impact of supplier choices on the production network resilience.

The standard model-based characterization of suppliers will be developed using a collection of precise, formal models of supplier production processes, resources, and sustainability performance metrics for selected manufacturing sectors. The method to analyze impact of supplier choices on the production network resilience will be developed by analyzing and extending state of art methods for production network resilience and risk assessment.

The research challenge is to develop supplier characterization and production network resilience analysis methods for situations where sustainability of the network is assessed for a single as well as for multiple products. In both situations, method for production network configuration and disruption definitions will be needed to support production network resilience analysis. In addition, factors that account for measures of probability of disruption (of either natural or man-made kind), reduction of consequences of disruption, and cost of recovery to normal performance of production networks will need to be defined[1]. Also, the aggregated measures of production network resilience will need to be defined for multiple product production scenarios.

Our previous experience with developing and evaluating formal languages such as MSDL[2] demonstrated that such formal representations can support capture of precise specifications about supplier resources and process information. Our previous experience in production network modeling and uncertainty modeling and analysis presents a basis on which we will build production network resilience analysis methods.

What is the research plan? The project will build on the manufacturing and assembly processes characterizations, provided by the respective program's projects, to provide additional required supplier information. The required supplier information will follow from the sustainability and resiliency assessment models created in collaboration with the Sustainability

[1] Falasca, M. et al. A Decision Support Framework to Assess Supply Chain Resilience. In proceedings of the 5th ISCRAM Conference, 2008.

[2] Manufacturing Service Description Language (MSDL) ontology in collaborative development with Prof. Farhad Ameri of Texas State University.

Modeling and Optimization project. The Integrated Production Processes project will provide process plan information as a reference point for supplier information gathering.

We anticipate two types of users of the project's results: software application developers and the application users who are manufacturing sustainability experts. These experts use the software applications to help plan, analyze, and optimize supplier performances with respect to sustainability and resilience metrics. Support of these users informs planning of the two research tasks – (1) Development of precise, formal models of supplier characterization, and (2) Development of the production network resilience analysis method – which will be performed iteratively in the following four phases, each year.

First, during the Identification of Requirements for Model-Based Supplier Characterization phase, we will work with stakeholders (e.g., software vendors and sustainability experts) that have interest in advancing the manufacturing sustainability as well as the production network resilience analysis and optimization processes. We will analyze representative use cases for which the customers (e.g., OEMs) require assessment and identify supplier characterization requirements for given manufacturing processes.

Second, during the Definition of Models of Supplier Characterization phase, we will devise a necessary collection of models, including resource, material, and process models, that meet the identified sustainability assessment requirements. For example, we will analyze and extend the MSDL model to include additional model attributes required by the supplier characterization such as energy consumption of resources, age of equipment, material efficiency, etc.

Third, during the Definition of Production Network Resilience Analysis Method phase, we will (1) devise a method for production network configuration and disruption definitions; (2) analyze and extend factors that account for measures of probability of disruption, reduction of consequences of disruption, and cost of recovery to normal performance of production networks, such as density, complexity, and node criticality; (3) devise metrics that combine these factors in useful manner and introduce the metrics in analysis models; (4) devise aggregated measures of production network resilience for the multiple product production scenarios; and (5) update the supplier characterizations to accommodate resiliency assessment requirements.

Fourth, during the Validation of the for Supplier Characterization phase, we will validate the resulting manufacturing supplier characterization models on selected sustainability and resiliency scenarios. Both single and multiple product scenarios will be utilized to validate the characterization for selected industrial data sets.

As an outcome of developing the standard models, a precise supplier characterization will be possible for use by software vendors to implement standard interfaces and methods in manufacturing applications that analyze and optimize production networks for sustainability and resiliency. Ultimately, the precise supplier characterization will be adopted as a standard to provide reliable computation of a supplier sustainability and resilience performance. To increase the likelihood of the outcome, and alignment of the project and the user requirements, the software vendors and users of their applications will be engaged in planning and delivery of the project through regular workshops.

Major Accomplishments:

Recent Results: This is a new project.

Standards and Codes:
Standards activities are planned with ASTM E60 to develop necessary key terminology, definitions, technical specification, and representations for describing sustainable manufacturing resources, processes, and their performances. Standards activities are also planned with ISO 50001 to address standard methods to compute and compare energy and material efficiency across supply chain. No standard activities are presently identified for production network resilience methods development, which will be a new goal for this project.