

Enabling Technology: Product Data Standards and Model Based Enterprise **Innovative Manufacturing Institute (IMI)**

Overview. This paper proposes that the National Network of Manufacturing Institutes include an Innovative Manufacturing Institute that has the mission of accelerating the development and acceptance of the standards and product models required to achieve broad industry and market use of new manufacturing processes and products. This paper also proposes that the same IMI develop the application protocols that enable the product digital thread. The digital thread is a concept for how product data that conforms to standards, can be exchanged, stored and used throughout the lifecycle of the product. It is an extension of the product data standard concept.

Product Data Standards enable wide acceptance and use of new technologies. New technologies usually do not lead to major economic advances until new standards for their applications and interoperability are developed and gain wide acceptance. Standards enable interoperability. Interoperability creates great advances in the use/value of products. In 2005, NIST published a study that estimated that the lack of interoperability accounted for \$1B/yr of cost in the US automotive industry. Current practices result in new standards lagging the new technologies by 10-20 years. Standards are usually developed by the users of a new technology, not the developers. The users identify the interoperability issues and eventually look for partners to help develop the standards that they need. The IMI, proposed in the paper, will reduce the lag in new standards development and use in industry, by as much as half. The impact on the applicable industries, and the nation's economy, will be huge. If the US can develop and implement new standards faster than competing regions, our industries gain a big competitive edge.

An example. Computer aided design products entered the market place prior to 1980 and were immediately purchased by product designers. But, no serious effort, to build a standard for exchanging the CAD data occurred until 1988 (PDES, Inc.). The first standard (ISO 10303,STEP) application protocols were published beginning in 1993 (AP203 configuration controlled design), and continue to the present. Industry investment in design and manufacturing systems that used the standard finally reached \$200M/yr in 2005, more than 25 years after the CAD product technology first entered the marketplace .

Role of IMI. The IMI's mission is the acceleration of the development and use of the standards needed to achieve wide investment in, and use of, new technologies. The IMI will achieve acceleration by identifying disruptive new technologies, and quickly organizing collaborative teams of engineers and technologists to work on the appropriate interoperability standards. The IMI will recruit broad stakeholder support and involvement from the product technology developers, component manufacturers, OEMs and ultimate customers/end users by offering them a "faster lane" to larger markets and sales. PDES, Inc. filled this role in the example described above. It did so with mostly voluntary industry investment and minimal federal (NIST, NASA, DOE, DOD) participation. The pace of the development and adoption was determined by the level of voluntary contributions of industry members of PDES, Inc. In the US, nearly all standards are developed through voluntary contributions of

industry technical labor and funds. The creation of an IMI that focuses on standards development can change standards development from a reactive to a proactive process. The IMI can identify the need for new standards, much earlier, and actively recruit the appropriate industry contributors.

The Product Data Standards and Model Based Enterprise IMI should not be regional. It should be national. There is no one region of the country where standards development is or should be located. There is no one industry or engineering discipline that would or should own the task of accelerating the development of new product standards. The Product Data Standards and Model Based Enterprise IMI should also be inclusive of all of the US stakeholders (government, industry, academia, end users, standards development organizations). The IMI does not need a large dedicated facility. Most of the work can be done best if the engineers work from their desk at their employers' location and communicate with one another by internet. PDES, Inc. uses the virtual model combined with semi-annual face-to-face workshops lasting about one week.

Model Based Enterprise. A model used in the manufacturing domain may be a geometric representation (CAD), an analysis (geometry + performance, e.g., stress, strain, thermal), cost associated with the product data description, requirements model, manufacturing process model, maintenance model, etc. The standards for these models are intended to allow the flow of information across domains and disciplines, by having an agreed to syntax and using the STEP specifications. When a new material or manufacturing technology, especially disruptive technologies, leaves the lab and enters an industry, one or more of the models in use to design, manufacture, analyze, assemble or sustain the product will need to be created or amended. Frequently, the new technology will impact the interoperability in the supply chain of the industry. If the interoperability is impacted, new standards that enable the interoperability will be required. PDES, Inc. recognized the connection between the development of standards and the models and expanded their work to embrace the Model Based Enterprise.

Example. In order to develop a standard such as STEP, the engineers must develop use cases. Use cases lead to models of how a product is designed, manufactured, used in the marketplace, and repaired/sustained. The aerospace companies were the initial members of PDES, Inc. They built a portfolio of use cases for product data that was created and used in their industry. In other words, they built models to describe how the aerospace industry designs, manufactures, assembles and uses product data. The test case and first adoption of STEP was the design of the engine interface of the Boeing 777 and the three engine models that were planned. Boeing and the engine manufacturers (GE, P&W, Rolls Royce) built STEP models of the engines and the engine housing and used them in the design and assembly of the aircraft. PDES, Inc. member companies realized that they had to address the standards development task from the perspective of "Model Based Enterprises".

Model Based Enterprise Role For IMI.

The modeling of products, and how they are manufactured and used in an industry is essential and extremely valuable for the growth and success of the industry. The marketplace has discovered this. A good example is the evolution that has occurred from computer aided design(C AD) to manufacturing

execution systems(MES) to product life cycle management(PLM) products. As new manufacturing, and materials technologies come out of the NNMI network , the Product Data and Model Based Enterprise IMI will proactively and aggressively build new or amended models to accommodate the technologies. The new or amended models will be used to create new standards for interoperability in the IMI. The key value of the IMI will derive from reducing the time required to get the new technologies widely used in US industry.

Digital Thread

The digital thread is a concept for how product data that conforms to standards, can be exchanged, stored and used throughout the lifecycle of the product. It is an extension of the product data standard concept. Digital thread activities include: Generating, capturing, organizing, and utilizing relevant data & information. The priorities of the digital thread are:

- Interoperability: standards-based data exchange, long-term archival/retrieval
- Integrity: verification & validation of data & models
- Trust: security, intellectual property protection, traceability
- Culture Change: data management planning, legal risk perception, shift from databases to decision-making.

Applying the digital thread involves continuously integrating empirical data with models and simulations to understand, predict, and optimize manufacturing outcomes. The digital thread concept includes integrated manufacturing system and weapon system representations. It extends the focus of model based enterprise to turning data into information, and integrating it across the fleet, factory and life cycle.

National Economic Impact

The digital thread is most valuable for complex products or those that have long life. It enables the products to be maintained, and upgraded, more efficiently. The digital thread is only valuable if the digital data is created and archived in formats that comply with standards. The goal of the NNMI is to grow and sustain US manufacturing industries. The NNMI network of IMIs won't have nearly the impact that the President envisions if there is no acceleration in the pace of creating and amending the standards, and the related models and digital threads. An IMI that accomplishes the acceleration is an ideal public-private partnership. Such an IMI is both politically and economically desirable. The IMI doesn't pick technology "winners or losers" it does provide the facility to accelerate the economic benefits when the "winners" are crowned in the marketplace. It is the role of NIST to create and be involved in such a partnership.

Long Term Sustainment

PDES, Inc. will celebrate its 25th anniversary in 2013. It is owned, operated and funded by industry. Federal agencies, such as NIST, DOE, DOD and NASA, have provided some funding and in kind support on a periodic or project basis. The pace of standards development in PDES, Inc. is determined by the willingness of the industry members to contribute funds and technical staff. The specific standards and

application protocols that are selected are, therefore, those with the most near term value to the member companies making the contributions. PDES, Inc. has an existing governance structure that is very compatible with partnering with the other IMIs in the NNMI network. PDES, Inc. will submit a proposal to stand up the Product Data and Model Based Enterprise IMI if an RFP inviting proposals is issued by NIST.

For more information contact:

Dr. Gerry Graves

843-760-3793

gerry.graves@scra.org