ELECTRONIC CIRCUITS WORLD CONVENTION 8

A STANDARDS-BASED APPROACH TO INTEGRATING INFORMATION ACROSS THE ELECTRONICS MANUFACTURING SUPPLY NETWORK

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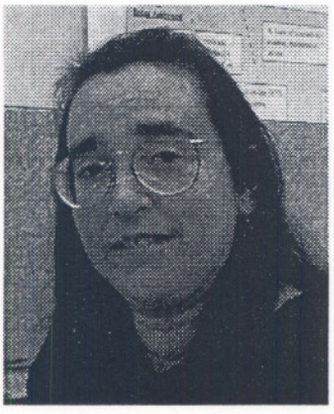

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Barbara Maia Goldstein serves as leader of the Infrastructure for Integrated Electronics Manufacturing (IIEM) Project at NIST and co-chairs the Factory Information Systems Technology Implementation Group of the National Electronics Manufacturing Initiative. Ms. Goldstein previously served as U.S. Delegate to IEC TC93, member of ISO 10303 IPO Electrical Applications Committee, and Chair of the Tools & Technology Council of ANSI Harmonization of Product Data Standards (HPS) Committee. She initiated the STEP Process Plant Application Protocol Planning Project as a consultant to the Process Data eXchange Institute (PDXI).

Short Abstract (Synopsis):

This paper summarizes industry needs for the integration of information systems across the electronics manufacturing supply chain. Various standards development and demonstration projects, and their impact on the supply chain integration, are discussed. While standards cannot address all the complexities introduced by outsourcing, several are under development which promise to reduce the burden of multi-organizational information exchange and management.

Introduction

Electronics manufacturers (OEMs) are contracting an increasing breadth of production processes to their network of suppliers - a trend which is global, but highly pronounced in North America. By relying on a broadly distributed supply network, OEMs achieve enormous flexibility. They can rapidly modify their manufacturing capacity by adding or subtracting new suppliers for any element of the production process with little or no impact to their investments because they own a shrinking percentage of the manufacturing capability. With this model, OEMs that previously were required to predict the exact acceptance of any particular product or product version can now dynamically respond to market conditions as they change.

At the same time, however, the outsourcing model raises a number of challenges in terms of technical capabilities and business processes. In some cases, outsourcing exacerbates existing problems; in others, it creates new concerns of its own. The issues are complex, and threaten the competitive stature of major manufacturers:

- **Product demand.** Product life cycles are being measured in weeks instead of months or years, driving fast-paced evolution in assembly technology and creating the need for ever tighter control of the manufacturing process.

- **Integration issues.** High technology products are often built in factories without integrated software systems. Highly sophisticated assembly equipment lines still operate as classic islands of automation, with little ability to communicate and coordinate.

- **Interface issues.** Even the most advanced manufacturers have aging, homegrown systems, presenting serious integration issues. Those issues are compounded by the rapid growth of an Electronics Manufacturing Services (EMS) industry that introduces another component - first-tier suppliers - with which a manufacturer's homegrown system must interface.

While greater reliance on a supply network provides flexibility in response to unpredictable market conditions, a serious lack of standards for information integration across cross-company and inter-company systems threatens to limit any potential efficiency gains.

Traditionally, supply chain integration has not addressed such issues as collaborative design, quality, yield, and component traceability. As the electronics industry migrates to a model of close integration among OEMs and their supply chains, it becomes more necessary to share accurate and timely information across the entire supply chain. In many instances, the development and adoption of industry standards could allow companies to share a richer scope of information with less in-house effort. Table 1 lists business processes, the data that supports them, and some of the related standards development efforts currently underway.

Table 1

Business Process	*Information Exchanged*	*Related Standards/Efforts*
Business Process Definition	Common terminology, process model	Supply Chain Council SCOR model, NEMI Virtual Factory Information Exchange Project (VFIIP)
Vendor Evaluation; Make/Buy Decision	Vendor scorecards, cost-benefit analysis	
Procurement	Purchase requisitions, purchase orders, invoicing, payment	EDI, ANSI X.12
Planning/Scheduling	Enterprise resource planning	Open Applications Group, RosettaNet
Bid/Quote Management		Open Applications Group, NEMI VFIIP in collaboration w/IPC
Order Fulfillment	Demand, schedule, projection to stock, inventory, WIP, finished goods, in-transit, raw/consigned materials flow	RosettaNet, Open Applications Group
Engineering to Manufacturing Hand-off	BOM, netlist, CAD, approved materials list, engineering change orders	IPC GenCAM, EDIF NEMI VFIIP in collaboration w/IPC
Test	Inspection, in-circuit, functional, stress, SPC, imaging, system test reports	SMEMA Standard Recipe File Format (SRFF), NEMI Plug & Play Factory Project, NEMI VFIIP
Production Control	Machine recipes	SMEMA SRFF, NEMI Plug & Play Factory Project
Component Traceability	Component genealogy, traceability, machine parameters	Silicon Integration Initiative standards, NEMI VFIIP
Packing/Shipping	Incoming: pallets, cartons, contents, acknowledgement Outgoing: pallets, cartons, contents, receiver Bi-directional information reporting	NEMI VFIIP
Production Status	Factory floor information reporting, alarms & alerts, cycle time, yield	NEMI Plug & Play Factory Project NEMI VFIIP in collaboration w/IPC
Final Assembly		NEMI VFIIP
Inter-Company Workflow		Object Management Group, IIOP NEMI VFIIP
Infrastructure	Security	W3C

The remainder of this paper will highlight some of these collaborative research and standards development efforts.

National Electronics Manufacturing Initiative (www.nemi.org)

The National Electronics Manufacturing Initiative (NEMI) is an industry-led consortium made up of more than 50 North American electronic equipment manufacturers, suppliers, associations, government agencies and universities. This organization roadmaps the needs of the North American electronics industry and identifies critical gaps in the region's electronics infrastructure. Based on this information, NEMI then stimulates R&D projects to close the longer term gaps, and establishes implementation projects to eliminate the nearer term gaps. Another important area of activity is the consortium's support and encouragement of standards activities to speed and broaden the introduction of new technology.

The NEMI Factory Information Systems Technical Implementation Group has initiated two projects to define standards that support information exchange partnerships across the manufacturing supply web: the Plug & Play Factory Project and the Virtual Factory Information Interchange Project (VFIIP). The Plug & Play Factory Project will result in three draft IPC standards by the end of 1999 which will facilitate interoperability among hardware and software components used in the manufacturing process. Based on XML (eXtensible Mark-up Language) and Hypertext Transfer Protocol (HTTP), these proposed standards provide a common interface among all the hardware components on a PCB manufacturing line. The standards allow data to be collected from all machines – regardless of vendor or geographic location – and displayed inside a web browser.

The NEMI Virtual Factory Information Interchange Project extends the reach of interoperability from within an enterprise (the focus of the Plug & Play Factory Project) to information systems distributed across business partners. VFIIP will spur the development of standards not previously needed when manufacturers performed most functions in-house, and will validate and recommend standards and processes which promise efficiency gains for the electronics industry. This endeavor is being spear-headed by Intel and Celestica.

One of the initial efforts undertaken by the project is collaboration with IPC on a new standard for bills of material (BOM) and engineering change orders (ECOs). In addition, the project will prototype the technology identified and developed in an industrial setting.

GenCAM Standard (www.gencam.org)

The IPC estimates that over $100 million each year is spent on non-value added translation of design data for the production of circuit board assemblies. Consequently, IPC is in the process of developing the Generic Computer Aided Manufacturing (GenCAM) standard to reduce these costs. GenCAM is a method of representing data associated with an electronic assembly in a standards-based manner. Some of the data contained in a GenCAM file includes: the board layout, location of components, electrical traces, definition of test fixtures, artwork, and administration data. In addition to the original design data, changes to the data are included directly in the file so that revision history can easily be ascertained.

Combining GenCAM with the Standard Recipe File Format (SRFF), electronic manufacturers have a standards-based way to represent information from idea to manufacture. It is anticipated that an idea would be first formalized through a CAD package, the output of which would be a GenCAM file. A CAM program would use this GenCAM as input, combine it with knowledge about the manufacturing process, and produce SRFF files. By using GenCAM and SRFF to transfer information through the enterprise, only two file formats are required to move an idea to manufacture. This is sharp contrast to the dozens of potential methods to transmit information in the present climate.

SRFF Standard (www.smema.org)

The Surface Mount Equipment Manufacturers Association (SMEMA) recently released the Standard Recipe File Format (SRFF) Specification, which outlines a generic method for producing process control files. Process control files, often referred to as "recipes," provide the instructions to electronic manufacturing equipment.

Prior to SRFF, vendors made use of a proprietary method for describing manufacturing information within their recipes. Hence, recipes could not be shared among equipment developed by different vendors, which greatly reduced the flexibility of electronic manufacturers. If a product were to be moved to a manufacturing line that contained different equipment from the first, new process control files would have to be written, costing both time and money.

SRFF was developed to reduce the costs and time associated with moving production from dissimilar

manufacturing scenarios. It was also developed to increase quality and flexibility. SRFF attempts to accomplish these goals by describing specific attributes about a product in a generic manner. Manufacturing data is combined with the attributes to provide instructions to equipment. The main advantage is that manufacturing instructions are "decoupled" from the equipment used to produce the products.

Lack of flexibility is especially salient in today's environment of increased outsourcing. EMS providers (contract manufacturers) are continuing to expand, often by purchasing current manufacturing facilities. Since the equipment contained in these newly acquired manufacturing facilities are seldom identical, the need to communicate with the equipment in a standardized method becomes increasingly important.

NIST Internet Commerce for Manufacturing (www.mel.nist.gov/namt/projects/icm/icm1.htm)

The Internet Commerce for Manufacturing (ICM) project, part of NIST's National Advanced Manufacturing Testbed, is working with industry to develop, validate and demonstrate the use of open systems and standards for efficient sharing of printed circuit assembly data between electronics manufacturers and their supply chain partners.

To date, the ICM project has established a distributed testbed, linking together commercial applications and prototype software to demonstrate potential supply chain efficiency gains through more efficient use of the Internet and information exchange standards. Software and specifications showcased in the testbed include the NEMI Plug & Play Factory testbed at the Georgia Institute of Technology; Agile Software's product change collaboration tools; Automata Design Inc.'s manufacturability analysis software; IPC's GenCAM standard, and emerging XML-based standards for bills of material, quoting and change collaboration.

The project has also developed a web-based standards roadmap to help navigate industry through over 700 information technology related standards. Other activities include release of a Conformance Test Module for the IPC GenCAM standard, and procurement of two actual boards via an electronic bid site with web-accessible design information.

Other Activities

A number of other groups are working on complimentary projects with mandates to create standards to ease supply chain integration across the OEM-EMS-Supply web. Through its charter and by virtue of its membership, each has outlined which part of the problem they are choosing to address:

- The RosettaNet consortium has set the goal of creating the "lingua franca for eBusiness" in the areas of product introduction and order management.
- CommerceNet launched the eCo Working Group to define cross-industry electronic commerce standards.
- The Silicon Integration Initiative's (Si^2) Electronic Component Information Exchange (ECIX) project is dedicated to designing standards for creation, exchange and use of electronic component information.

Conclusion

As the above efforts mature, industry will soon have the ability to go from design through assembly, test and distribution via a suite of standards, and to see this approach validated in academic and industry testbeds. Such a standards-based approach to integrating information across the electronics manufacturing supply chain will become increasingly integral to success as manufacturers outsource an ever-widening scope of their production processes to their supplier networks.