

Opening Up to Standardization

By Barbara Goldstein and John Cartwright

Traditional factory information systems are not meeting the new demands of supply chain integration. Two industry projects are doing something about it.

Today's electronics manufacturers are expected to reduce their time-to-market cycles and lower total costs simultaneously. Product development cycles and volume ramp-up times are rapid, and corresponding end-of-life production is dramatic. This environment is harshly unforgiving when market introductions are missed or product demand is not correctly estimated.

In such a highly competitive market, outsourcing has become a key strategy for survival for original equipment manufacturers (OEMs). While the electronics industry's compound annual growth rate (CAGR) has been reported around 8 percent, the North American electronics manufacturing services (EMS) segment is expected to grow at a compounded rate of 25 percent through 2001 (Figure 1).

Outsourcing to a network of EMS providers offers OEMs several advantages, including: greater flexibility through access to factories and best-of-breed software applications; reduced costs through better factory utilization; global support for a global customer base; shortened development schedules; and reduced time to market.

Relying on a broadly distributed supply network gives OEMs enormous flexibility. They can rapidly modify their manufacturing capacity by adding or subtracting new suppliers throughout production. This flexibility has little or no impact to OEMs' 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 a product can now dynamically respond to market conditions as they change.

While OEMs retain responsibility for defining high-level product specifications/architecture, electronics manufacturing leader-

ship is shifting from OEMs to the EMS industry. The outsourcing trend currently consists primarily of board assembly. However, other manufacturing activities are increasingly fueling it, including final product manufacturing, product distribution, field support, even detailed product design.

Business and Technical Changes

In the 1970s and early 1980s, the principal business model for large electronics companies was a vertically integrated enterprise. Components, subsystems and systems were manufactured under enterprise. Several of the larger firms even developed their own materials and assembly/test equipment to support the manufacturing process. These vertically integrated OEMs were organized to efficiently handle all aspects of product development internally.

Now that an increasing number of tasks are being done outside the OEM's walls, many of the technical and business processes that worked well for in-house production are no longer efficient. Instead, these processes may actually be trapping inefficiencies in the supply chain. Subsequently, OEMs must learn to use their supply chains as efficiently as they did when they were monolithic contained entities (Figure 2).

Data interchange is key.

Factory information systems (FIS) form the nervous system of an enterprise, analyzing data and delivering information to machines and people who need to make information-based decisions. These systems provide a bidirectional flow of information.

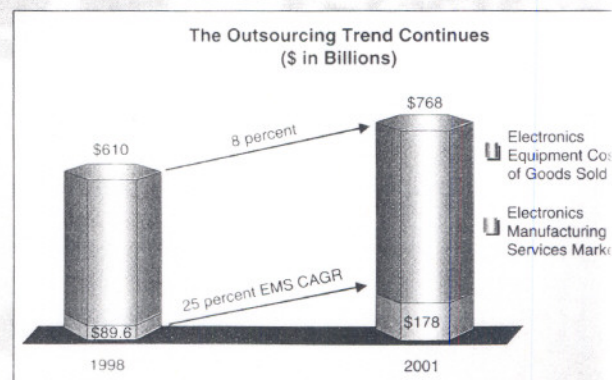


FIGURE 1: EMS industry growth is about three times growth of the overall electronics industry.

Background artwork provided by Mark Teague Photography, Smyrna, GA.

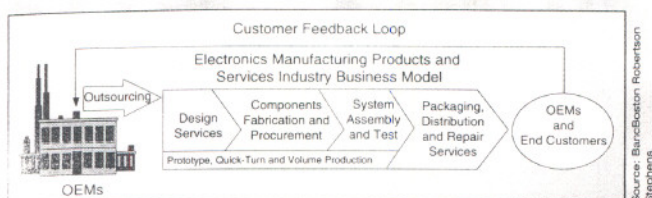


FIGURE 2: Vertical integration gives way to virtual integration as OEMs outsource an increasing breadth of production processes to their network of suppliers.

between the factory floor and the rest of the enterprise. Increasingly, a company's internal systems are expected to interface with systems external to the organization.

Particularly, outsourcing requires the two-way transfer of manufacturing data between the OEM and the EMS provider. While large manufacturers may currently be able to replicate their in-house FIS applications at their contractor's site, replication is often not possible or practical for the entire industry or even in isolated cases.

While greater reliance on a supply network provides some flexibility in response to unpredictable market conditions, the lack of integration among cross-company information systems may limit potential efficiency gains. Most companies have found that integrating design and production functions is a difficult task, even when manufacturing is a captive activity. Such problems are amplified for the EMS provider, who must be able to accept designs produced by a variety of systems and return both product and formatted information to its OEM customers. Even when multiple OEMs share a common tool, each customizes its use, resulting in output that is nonstandard across implementations.

Greater reliance on outsourcing demands open systems and emphasizes the need for industry-wide standards for machine interfacing, supply chain communication, and data exchange between factory information systems and between enterprise resource planning (ERP) systems and the factory floor.

Business processes must evolve.

The question of *what* information should be shared is as important as the question of *how*. Regarding *what* data, OEMs and EMS providers are struggling to define their respective roles, responsibilities and contributions. What is the value to be added by each? Intel, for example, has maintained a philosophy of "Copy Exactly! (CE!)" regarding its information systems, but how does the concept of CE! work when each EMS provider is attempting a proprietary value-add? Which party holds the intellectual property? What should be proprietary and what should be shared across the supply web?

OEMs want their EMS providers to learn from and improve their processes based on experiences with other customers. However, OEMs do not want these other customers—the OEMs' competitors—to benefit from *them*. OEMs also want their EMS providers to manage a production process that often looks chaotic due to short product lifecycles. However, EMS facilities fear that, if they provide a real time data feed to their OEM customers, they will be downgraded for the chaos they are being paid to manage.

OEMs turn to EMS providers in part for the cost savings achieved by not maintaining in-house expertise across the production cycle. EMS providers fear that, as OEMs selectively trim their production expertise, their designs may fail to be optimized for manufacturability. For this reason, among others, many EMS facilities encourage their customers to allow them to participate in both product design and assembly.

Industry Response

Two current industry projects are addressing some of these critical questions. The National Electronics Manufacturing Initiative's (NEMI) Plug & Play Factory project has been underway since late 1997 and is scheduled for completion this year. The second project, NEMI's Virtual Factory Information Interchange, is currently being organized.

Plug & Play Factory

The Plug & Play Factory focuses on the development of standards necessary to achieve interoperability—or, plug-and-play capability—among hardware components used by North American electronics manufacturers. Project activities are comprised of three areas:

- Definition of standards for a software framework that will allow interoperability among software and equipment produced by different vendors.
- Development of process-specific, machine communication interface standards for surface-mount equipment. These standards will leverage the Generic Equipment Model (GEM) specification developed for semiconductor equipment and web-based standards for data transmission.
- Establishment of a test bed manufacturing line at the Georgia Institute of Technology (Georgia Tech, Atlanta, GA) to prove the concepts developed by the project.

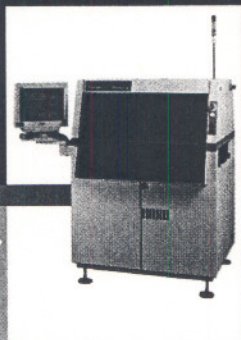
The project periodically demonstrates the capabilities of the evolving plug-and-play framework. The current iteration of the demo involves data collection over the Internet from a diverse set of electronics manufacturing equipment, produced by different vendors. At the core of the demonstration is a software framework, based on eXtensible Mark-up Language (XML). This framework provides a common interface among all the hardware components on a PCB manufacturing line, which, in this case, is the Georgia Tech test bed. It allows data to be collected from all the machines on the line and displayed inside a web browser.

In the past, manufacturing systems have typically been proprietary. A screen printer, for example, could not interface with a solder paste inspection machine unless both pieces of equipment were from the same vendor or were the product of an expensive tailor-made solution. With plug and play, the component placement equipment from one company would be able to interface with a piece of functional test equipment from a second company, with no additional programming required.

Virtual Factory Information Interchange

The Virtual Factory Information Interchange project will leverage the work done by the Plug & Play Factory across the supply chain. In its 1998 roadmap, the NEMI FIS Technology Working

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Data Interchange

Group identified several gaps in the manufacturing process, including supply chain integration of both product data and processes.

Factory information systems should produce accurate, timely data to be shared throughout the supply chain, providing real-time information to engineers and managers. The communications problems posed by company firewalls and interapplication communications issues must be resolved for FIS to become a low-cost, off-the-shelf reality.

Traditionally, supply chain integration has not addressed such issues as collaborative design, quality, yield and component traceability. The electronics industry is migrating to a model of close integration of the OEMs with the rest of the supply chain, dictating the need to share ERP and FIS information in real time.

Virtual Factory Information Interchange will address the problems of supply chain integration and related issues. Project activities will focus on the development of:

- a business process model describing OEM/EMS interactions
- product information standards to pass data between business partners
- information technology (IT) infrastructure needed to guarantee security and efficiency
- a prototype implementation in a production environment.

Conclusion

Outsourcing continues to gain momentum among electronics manufacturers as a competitive strategy for shortening time to market and reducing overall costs. However, a lack of integration among cross-company information systems and the failure of business processes to accommodate this new paradigm may easily negate potential efficiency gains. Factory information systems are struggling to adjust to new demands for communication across inter-company firewalls and among the various ERP components used to connect the OEM and its EMS providers. The traditional FIS solution that made functional and economic sense for the OEMs' relatively long and stable production runs does not meet the new demands of supply chain integration.

The need for open systems, operating frameworks and standard interfaces has never been greater. Beyond the technical issues, however, are the business process issues. Members of the supply chain must redefine their roles and reset boundaries to support this new approach to manufacturing. Broader supply chain integration is needed, through the development of web-based standards to connect factory equipment and software applications.

Barbara Goldstein and John Cartwright chair the Factory Information Systems Technology Working Group as part of the 1998 NEMI Roadmap and the Factory Information Systems Technical Implementation Group that coordinates collaborative research. Goldstein is project leader for the Infrastructure for Integrated Electronics Manufacturing Project at NIST; (301) 975-2304; e-mail: bgoldstein@nist.gov. Cartwright is manager of the Manufacturing Execution System for Systems Manufacturing—Intel Corp.; (503) 696-2867; e-mail: john.m.cartwright@intel.com.