A Systems Approach to Supply Chain Vendor Integration

Personal Insights from Two Industry Veterans

by Bob Scarborough & Ron Jones

If we look back 50 years, we are still manufacturing integrated circuits today the same basic way we did then. We begin with wafers and photomasks and go through a number of spin, expose, develop, etch and deposit steps. We have gone from 1" to 12" wafers, several to 40+ mask layers. Ion implant and RTP have replaced many of the furnaces of old, but it's still the same basic process. In assembly, we still attach the chip to some substrate, make connection to the bond pads and seal up the package to protect it from moisture and contamination. Sometimes we attach the die and make connections at the same time with flip chip, but even this technology was used back in the 60's. With minor changes, we still build the venerable PDIP the same way we did in 1964. Probe and test also haven't changed much.

One thing that has changed over time is the disintegration of the supply chain. Decades ago, it was typical for a semiconductor company to perform all of their own manufacturing as well as make many of their own supplies (e.g. wafers, masks, photoresist and lead frames). Over time, cost factors drove companies to move to lower-cost geographical regions and outsource the manufacture of supplies. No longer could you walk the floors of a single factory and look at "mouse bites" at metal etch, talk to the probe operator about probe tip planarity, look at a bond lift problem in assembly and talk to the test engineer about a load board -- all without moving more than a few hundred feet from your desk.

This geographic dispersion started the communication environment we have today. In the early days, IDM's typically had rudimentary internal systems for sharing data with their distant factories. Next came the advent of the subcontract assembler with locations all over Asia. In the mid-1970's, fax machines became affordable and volumes of data flowed across the Pacific via this medium. The obvious problem is that the data was not electronic and had to be punched into computers to be useful electronically. With the advent of e-mail, data was initially typed into messages (same problem as above) or attached in an electronically usable form. This form evolved with ftp so that data could be pushed or fetched by either party and read electronically.

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foundry and OSAT company had their own data field names and ways of formatting data in an electronic WIP report, for instance. Because the data from the semiconductor supply chain is significantly different in structure than data from a classical discrete manufacturing operation (which starts with many parts and end with one finished product), our industry was never able to leverage many other standards efforts.

If you look at standards that are in wide usage, there is typically a major driving force (usually financial), with significant benefits throughout the value chain and monumental downsides when standards are not in place. Take UPC codes in the retail industry, for instance. Imagine a Safeway, Walgreens or Costco without UPC codes for POS support and inventory management. There are tacit penalties for companies that don't support the standard, namely, their products and services don't get selected for inclusion. The champion to get things started with a new standard may be an industry association or a government entity.

For the semiconductor industry, there has never been a significant level of pain or financial driving force to make an industry standard imperative. Volumes, both in products and transactions, are small enough that they can be executed with brute force without major financial or operational implications. Attempts at semi industry-specific standards such as SMDX and RosettaNet semiconductor WIP never caught on for the reasons stated elsewhere in this article. Data translators are currently used today to morph data from various suppliers into each company's own "data standard." Even if a standard is in place, data integrity can be a major issue if there is any significant level of human involvement or intervention in the overall data flow.

SUPPLY CHAIN INTEGRATION – A REVIEW

Beyond the standards issue, the manufacturing modules of all major ERP systems are configured for discrete (many to one BOM) manufacturing, rather than the one-to-many BOM of the semiconductor industry. This makes it difficult to store the semiconductor data in the ERP so that it can be readily used for production planning, yield and failure analysis, lot genealogy, etc. Some semiconductor IBOM (inverted bill of material) functionality must be used in conjunction with standard ERP offerings to support semiconductor supply chain management requirements.

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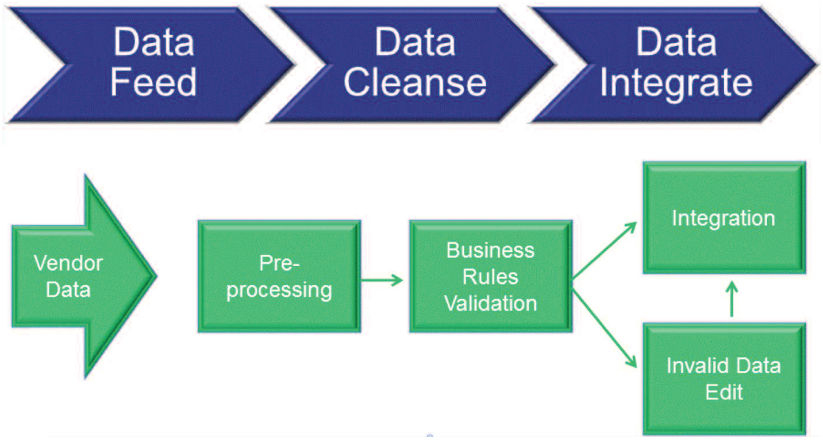
While the business goals of supply chain integration are improved productivity and visibility, the integration itself is a standard systems engineering design requirement. To simplify this discussion, it is helpful to cover the mechanics of supply chain integration at a basic level. Our outline for the transaction flow follows:

The main stages in supply chain integration are (a) Data Feed - capturing the data from the supplier; (b) Data Cleanse - readying the data for processing in the supply chain solution; and (c) Data Integrate - incorporating the data into a supply chain management solution (SCM).



Ideally, data capture is a straightforward process. The vendor provides a data repository (via web service or data repository) and the information is retrieved as it is published by the vendor. Most commonly, vendors publish data files for automated retrieval, but there are vendors that have limited options because they aren't big enough to have the needed level of IT support or because their standard policies do not support this. For most SCM integrations, data capture is the easiest part of the process.

Data Cleansing is where the magic occurs. The information transitions from the vendor delivery format to the required SCM system format. The major stages here are pre-processing (or data manipulation) and business rules validation.

Pre-processing includes several basic steps such as:

1) mapping the field names the vendor uses to the field names the SCM system uses;

2) transition steps where one might find and replace document numbers during a system transition; or

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3) more complex rules needed to identify required information if it is not readily available.

An example of a more complex rule could include a vendor that executes assembly and test processes and bills for these as separate paypoints, but does not distinguish between these separate events in their manufacturing execution data. The pre-processor would be needed to separate the transaction points so that the SCM system can use predictive information for yield and cycle time by step, and manage the vendor procurement and material acceptance process.

Business rules validation is addressed after data pre-processing. The focus here is to ensure that the information pushed into the SCM system is valid information – valid purchase orders, valid parts, valid vendors. The data not only needs to be properly arranged but also actionable and structured so it is useful in the system.

After the data cleansing the mechanics of pushing the data into the SCM system for planning, production control, vendor performance monitoring, etc. is complete. If the data fails the business rules validation test, ideally it is available in a grid for review and final processing so that no information is lost. It is also good to have standard system tracking for integration, following standard traceability and history protocols.

SYSTEMIC ISSUES IN VENDOR SUPPLY CHAIN INTEGRATION...THE BIG QUESTION

Given the time, standards and industry discussions, as well as individual company efforts that have been dedicated to SCM integration, one big question remains. Why isn't this process easier by now? This is an excellent question. We believe the answer is found in our experience of what works and what doesn't work on a company-by-company basis.

There are three parties to every completed integration: the company, the vendor, and the IT practitioners or SCM implementers. Most of the time, the onus is on the IT team to make this happen -- quite often with less-than-desirable results. Experience shows all three players have important roles in deploying and maintaining quality integration.

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The SMDX Standard Initiative Personal Insights

"The Semiconductor Manufacturing Data eXchange (SMDX) Standard initiative started in mid-1996. I was doing an ERP and Advanced Planning/ Scheduling selection project at Macronix in Taiwan, shortly after founding N-Able Group. The client was using seven assembly providers, seven test providers and an offsite wafer foundry, in addition to their own manufacturing facility. Getting data from 16 different manufacturing locations into a common format to feed the planning engine was a nightmare. This brought into focus a problem we had suffered with for years in the outsourced semi manufacturing space: lack of a data standard. I understood the problem well, as I had spent the previous 12 years running subcontract assembly/ test operations and trying to supply data to a wide variety of customers.

"I decided to undertake the task of developing a communication standard for the myriad data in the semiconductor supply chain. I approached the Fabless Semiconductor Association (FSA), whose membership outsources all their manufacturing. The FSA

INTEGRATION PROJECTS

The process of project integration has a fairly standard flow: (a) a kick-off meeting for all three parties; (b) deployment by the IT and vendor teams; (c) data review and sign-off by the company; and (d) roll-out of the integration to live operations. This is often a "noisy" process that hinders straightforward action, for instance:

(a) Kicking off a project often needs to go through vendor review committees, confidentiality and partnering agreements, and scheduling challenges across multiple time zones. We've found that there is not significant repeatability in most vendor processes – they cannot repeat the same steps time after time. Even though we have integrated one of the major foundry players 30 times, the company continues to go through all of the overhead steps every time -- including revalidation of code and committee review.

(b) Deployment by the IT and vendor teams is usually not technically challenging for experienced personnel. The main challenge is maintaining focus and commitment from all of the parties involved. The company plays a vital role in ensuring that the integration remains a high priority in the vendor relationship.

(c) Data review and company sign-off requires time commitment by supply chain personnel which is challenging during heavy operations requirement schedules. However the biggest challenge in supply chain integration remains the quality of the data provided; not the mechanics of retrieving and formatting the information. We'll discuss this in more detail later.

(d) Transitioning the data to live operations once it is signed off may require some planning, but is fairly straightforward. Maintaining the bridge and data quality once it is operational also merits additional discussion.

WHY ISN'T DATA INTEGRATION SIMPLE?

Standards have been proposed many times over the last twenty years -- standard data formats, standard data transfer protocols, and standard data exchanges (vendor-provided solutions). Yet today many of the same issues remain. There is no doubt that there is value in standardization, but why

Board formed a committee, which I chaired. The charter was to provide input and critique the development of a communication standard. There were representatives from throughout the supply chain and from all the major software segments supporting the semiconductor industry. Monthly meetings were held with attendees from fabless and IDM semiconductor companies; foundry and OSAT suppliers; equipment vendors and material suppliers; as well as ERP, MES, Planning/Schedule and Yield Management software vendors.

"A data dictionary was built, covering a wide range of data elements with unambiguous definitions. Messages were constructed from the data elements to communicate WIP status, yield scrap, direct material attributes, and a wide range of other information that typically flows among members of the manufacturing supply chain and their customers. A hardware architecture was developed for an SMDX Gateway that would map data from local systems to the SMDX standard and back again. This was crucial to avoid the barrier of companies having to change the actual data elements in their internal systems. Working proto-type gateways were developed for

hasn't data integration been streamlined and simplified? Our experience, as discussed in this document, points to the nature of the issues and to their ultimate resolution.

The main reasons data standards have not worked include:

(a) vendor desire to customize or extend the standards to provide more value;

(b) process, product, and corporate cultural challenges in defining standards interpretation;

(c) lack of best practices and repeatable processes in the vendor-side data deployments;

(d) lack of a single large player who can dictate industry standards;

(e) inconsistent data quality -- even when it is provided in a "standard data format."

Data and protocol standards delivered by vendors would require a degree of conformity and communication that is not realistic over such a broad heterogeneous set of suppliers. While Vendors have significant scope to improve the repeatability of their integration support -- especially the main supply chain vendors for the industry, the other issues are more challenging.

THE DATA QUALITY CHALLENGE

Major supply chain vendors have two significant sets of software functionality. MES (manufacturing execution systems) are used to manage shop floor operations at a detailed level. ERP (enterprise resource planning) solutions are used for purchase order and billing management. A supply chain vendor has an internal task to integrate these two solutions – something that often requires extensive compromise and simplification of the transferred data. This process can make the comparability of the data generated by the two systems challenging (for example, matching invoices from the vendor to the WIP (work in process) status information). At the same time, supply chain data integration looks for paypoint information (major inventory steps where there is a transfer of owned inventory value and a purchasing requirement to pay) as well as WIP on the floor information at a minimum.

How the vendor extracts the information from their own system for use by the company (either for reporting, website updates, or data transfer) also

proof of concept. Data was picked up from an MES system at a foundry, converted to SMDX standard format and transmitted to a fabless company in the U.S. There, the data was converted from SMDX format to the native format of the company ERP system and uploaded.

The test was replicated with data from another foundry and another fabless company, with data going from both foundries to both fabless companies. A trial was also done in reverse with data going from the fabless company to the foundry. The trials clearly proved that data could be communicated using the SMDX Standard and inexpensive hardware. As XML markup language came into usage in the late 90's, the standard was updated with XML tags as field identifiers.

"Though SMDX was shown to be an effective tool for standards-based communication in the semiconductor industry, it never moved into popular usage. Several contributing factors were cited by various companies in various ways:

1) Companies seem to resist paying money to use a data standard. In some cases, standards are developed by groups that have income from

impacts the quality of the information. It is common for vendors to insert manual processes between core data collection and the information provided – introducing another opportunity for error. Inconsistent or unfocused efforts can also result in poor data structuring and formatting. We've already discussed several potential problem areas, and we haven't even discussed the challenges of maintaining quality data in the original vendor systems-of-record!

Our experience has shown that it is best to use the standard formats for each individual vendor. Ideally, each supply chain vendor has standard data outputs that are derived directly from their core systems with no manual intervention. This should be the best quality data available, since it is the same information the vendor uses to manage internally. Taking the standard data formats – even when unique to each vendor – and running it through the data pre-processing stage is actually quite straightforward. A mapping utility in the pre-processing stage supports a standard way to take a vendor field name and to map it to a supply chain field name. Data quality and integration into standard vendor processes is undeniably the path of highest return and least resistance.

WHAT CURRENTLY WORKS?

The best solution to vendor supply chain integration requires visibility and prioritization. By visibility and prioritization, we mean all three parties to the integration – especially the company itself – must continually emphasize the importance and priority of the integration. A specific example will be helpful here.

Our example company has ten supplier integrations. When they approach a new supplier, they include the requirement for quality data in their initial negotiations with the vendor. During their quarterly performance meetings with the vendor, they always have an agenda item for data integration quality. They tell the vendor (and commit internally) that they are running their business on this data and that if it is not accurate, they cannot move forward. If there is a supply chain data quality issue, it is escalated to an internal executive level and from that leverage point is made visible at the highest contact levels in the supplier available. The company maintains a commitment internally as well. All personnel need to use the SCM solutions and the data in them – and if the data provided by the vendor is incorrect, they need to engage the appropriate vendor personnel to get

other sources to pay for the development and support of the standard. SMDX had the involvement of many people in providing input, but most of the actual work was performed and paid for by the N-Able Group. As the time approached to start rolling out the standard, expenditures began to rise and we could not find another viable way to fund this activity.

2) There seemed to be an issue as to whether a private company could be trusted to manage an industry data standard. We worked with several standards organizations, but could never find the right synergy. We offered use of the SMDX Data Dictionary to RosettaNet for use in their semiconductor WIP PIPs, but the dot.com bust killed that activity.

3) It was suggested that several larger companies that had done work in communicating with their customers did not want to lose this advantage by moving to a standards-based approach that would level the playing field.

"Though SMDX never became an industry standard, it did get N-Able Group heavily involved in the system space of the semiconductor industry, which now comprises one of the company's major practices."

~ Ron Jones

this fixed quickly. No workarounds to the system are acceptable. Doing so would decrease the perceived importance of the data quality.

Our example company is very successful with their supplier data integrations. All of the desired benefits have been realized – from information velocity and collation across the supply chain to vendor performance monitoring, to stream-lined procurement and inventory valuation, to early warning indicators if delivery is not as expected. They have achieved the results everyone wants and yet few achieve. It didn't come through data standards or repeatability of vendor processes. It came through a commitment to visibility and firm application of procedural guidelines.

PROPOSAL ON HOW TO MOVE THE INDUSTRY FORWARD

How do we leverage what has proven to be successful for individual companies to the broader industry as a whole? How do we make this "easy" for all? We believe the answer for the industry is the same as what works for successful supply chain integrations today – visibility. Supply chain data integration quality suffers from a lack of visibility at the industry level. When it is visible and important on an individual company level, the desired results are achieved.

We firmly believe this challenge would be resolved by creating and publishing industry supply chain performance standards. One way to achieve this would be a report card for every industry supplier. The report card would include the published results from their customers on the quality, robustness, stability, and speed of their integrations. Visibility of SCM data integration success by vendor at a broad public level would equate to a vendor evaluation standard. Competition between vendors, and a desire to be publicly successful in this area, would increase the pressure to improve the quality and availability of supply chain data.

Without the pressing industry drivers to move the semiconductor industry to data standards, this is our best hope to improve the current state of the industry. If vendors were publicly rated by an independent standards body every quarter or every year, the resulting report card is something that companies could use when choosing a vendor. Under such a system, suppliers would compete on a level playing field for the highest ratings. Poor visibility and perceived importance that drives many of the challenges that exist today would truly be a thing of the past.

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