dynamic replenishment at HP: increasing supply-chain transparency via a standard and scalable collaboration solution.

HP employed best-of-breed program management and IT resources to create a collaborative planning and procurement solution with one of its largest suppliers. The resulting system and processes saved over four million dollars in its first year of implementation.
Introduction

Situation

In the summer of 2000, HP’s rapidly growing Inkjet Supplies Operations (ISO) finished up a cost-savings audit on their internal processes for ordering inkjet cartridge components. High on the list of potential measures was inventory management of a custom, fairly expensive integrated circuit (IC) manufactured by ST Microelectronics (abbreviated “ST” in this document).

Figure 1 illustrates the continuum inventory collaboration from discrete orders (very little collaboration) to automated and integrated replenishment (high level of automated collaboration). As can be seen, the decision to implement an e-SMI/DR system may often be based on parts cost and volume.

In the case of ISO, the components (semiconductor wafers from which the ICs are cut) are high cost (a high cost of material as well as a high cost of manufacturing). With an expectation of rapidly growing volumes, implementing a dynamic replacement strategy for these wafers was a natural.

Figure 1. The inventory collaboration continuum

HP recognized that the supply chain between themselves and ST had to be opened up and that inventory responsibilities needed to be shared between the two companies. The key was a dynamic replenishment system implemented within a supplier-managed inventory (SMI) model. The resulting system—e-SMI/DR—has reduced a three-month forecasting window down to one day. Today, the right parts are shipped at the right time, and to where they are needed.

This paper describes the successful implementation of an e-SMI model by one of HP’s largest operations, including the steps it took to make it successful. By illustrating these successes, it encourages other organizations faced with similar issues to employ some or all of the solutions presented here.

Challenges/Opportunities

From the outset, the primary goal of the project was inventory reduction. The process for resolving a wafer production schedule was hit-or-miss, and relied on HP predicting
consumption up to three months in advance, freezing the forecast, and then negotiating the forecast with ST Micro. Misses in the forecast were extremely costly (and not uncommon), leaving either HP holding an excess of inventory (or attempting to shuffle parts between worldwide manufacturing facilities) or ST Micro scrambling to catch up with an underestimated demand. Either way, the partnership suffered and costs increased. All of this was compounded by the fact that HP was anticipating significant volume growth as the printer business grew.

One of the factors that HP had going for it was that the wafers being ordered from ST Microelectronics were unique—designed and ordered solely by HP. Even with that, the thought of exposing the entire supply chain to each other was an extreme change in the business relationship. Ultimately, both companies realized that operating in a collaborative way is much better than operating in an adversarial way (as one team member put it “let your adversarial conversations be at the cost table.”)

An additional challenge was the notion of having ST manage the inventory. After all, this seemed to put the entire inventory cost burden on them and none on HP. (However, as we will see, the system actually has an ingenious system of checks and balances that results in a shared responsibility for success).

ST stood to gain from the SMI system as well. Wafer fabrication facilities are notoriously expensive—technicians have to be trained for months to prepare them to run the equipment and process the material correctly. For example, overbuilding such a facility has enormous financial repercussions—there had been occasions where ST Microelectronics had built and put in extra capacity, only to have it sit idle because of an over-forecast in demand.

**Overview of results**

The e-SMI project has become an overwhelming success. Foremost, HP is saving millions of dollars each year because of reduced inventory in the supply chain. ST has benefited from the ability to optimize their manufacturing capacity, lowering their costs and reducing response times.

Further, both companies benefit from a near-elimination of part obsolescence; having excess out-of-revision components that are lower in yield, or lower in performance, is extremely expensive.

**The ISO e-SMI/DR system**

**Description of e-SMI/DR**

At the highest level, the e-SMI/DR system is a e-procurement mechanism using internet applications, services, and technologies to automate and streamline current purchasing processes and enable new procurement processes and business models. Specifically, the system uses an internet-based B2B model to automate procurement and planning information, allowing ST Microelectronics to use HP-provided data to develop inventory and replenishment plans. ST Microelectronics is then able to ship to HP based on these plans.

Aside from the technical issues, probably the most radical change that e-SMI/DR introduces is the notion of the supplier managing the inventory—all he way from the manufacturing facilities to the supplier’s stocking locations (inventory consignment). Turning over and consolidating the responsibilities of the management of the supply-chain linkage presents multiple benefits to HP.
To balance this responsibility across both companies, a key metric was created called service level. Instead of being measured just on timeliness of orders, the service level metric represents availability of material and planned consumption. The result is a feedback loop; if HP orders too much material (but the orders are met), the service level shows ST managed inventory well, but HP’s planning was poor. Conversely, if the consumption matches the planning well, but the inventory isn’t there, then the service level shows ST’s inventory management needs improvement. This provides both companies with the ability to reduce plan-to-actual variability and to quantify variability and its effect on system inventory levels.

In summary, the dynamic replenishment process permits proactively placing material into the manufacturing process that will be consumed by HP. It allows for quick, pre-emptive resolution of supply/demand imbalances across all of the HP manufacturing sites.

**Collaborative Planning and Forecasting**

The forecasting process begins with a consumption plan that is created with the aid of HP’s back-end Supply Chain Planning software. With collaborative planning, the plan is sent via the Internet from ISO’s supply chain management systems directly to the ST systems, which automatically replies with the capacity information. Manual intervention will be required only if ST’s capacity doesn’t meet HP’s need.

ST then ships the materials based on the ISO manufacturing sites' daily consumption plans. This information is transmitted via the Internet and available through a global reporting portal. The entire process is automated, including payment processing—without the use of purchase orders. The result is a huge reduction in overhead—human intervention to manage due dates, orders, change orders and approvals are eliminated.

The closed-loop nature of the system provides almost instantaneous “what if..?” information (Figure 1). For example, when ST ships an order, an “advance shipment notification” transaction is issued. Similarly, when HP receives the order, a “goods receipt notification” transaction flows back to ST. Between those two transactions, the amount of in-transit material is always available. This information is also available to the collaborative forecasting software (“DR calculator”) as well as for reporting (the collaborative reporting portal).
Figure 1. e-SMI/DR transaction flows

Technical Implementation
The core of the e-SMI/DR system is the collaborative forecasting and reporting applications. These applications are integrated into an HP corporate trading exchange called “hp des a standard B2B communications linkage, as well as integrated applications (of which SMI is one). Its objective is to synchronize the supply chain to reduce cycle times and improve profits. KeyChain is based on several standard Internet technologies (such as RosettaNet®) to widen the prospective base of suppliers and ease integration into HP’s systems.
KeyChain accomplishes back-end interfaces to both companies’ legacy systems through semi-custom B2B and enterprise system integration capabilities provided.

Implementing the e-SMI/DR System
Implementing the system involved engaging the global IT and manufacturing management organizations for both companies. The work was split between the two IT organizations; ST created the DR calculator and HP provided the reporting portal and most of the IT effort for database and messaging design and implementation. The distributed organization designed and brought the project to pilot testing in a little over seven months.

What Worked
From the project kick-off, HP certainly leveraged their strengths — including a strong IT team and best-practice program management capabilities.
A key aspect to the success of the project was having sponsorship in place from the beginning, and at all levels of the project. Further, these sponsors were actively involved throughout the project, and were instilled with a clear focus and understanding of the impact the system would have on their respective organizations.
As the project progressed, management of change (MOC) processes were used extensively (e.g., organizational business process mapping, in-depth communications plan, and training plans). Communicating all of this information was a challenge—especially with an eye towards reducing travel expenses; to that end multiple mediums and creative presentation mechanisms were employed to keep participants’ interest.

Lastly, extensive education was employed to communicate the benefits of the new tools and processes. This served to create interest as well as pre-train the eventual end-users of the system. Much of this education was hands-on training on prototype software as the system development progressed.

**What Didn’t Work (What We’d Do Differently..)**

There were two main challenges during the implementation of the e-SMI/DR—neither of which was particularly destructive but involved engaging extra resources to surmount.

First, both companies are global, and resources were globally distributed. To compound that, there are different cultures within each company, so extra resources were dedicated to involving sponsors and keeping communications lines open. Nonetheless, the notion of collaboration at such a deep level within the companies was difficult to impart upon the participants (especially those involved in the day-to-day manufacturing and scheduling functions).

Second, in hindsight, HP would have widened the scope of the project to include other ST-provided parts in the project from the beginning. While the IC wafers represents the bulk of the product received from ST, not including all parts causes dual systems (one automated and one manual) to have to be employed.

**The Future**

**What Will Further Be Improved**

The biggest improvement to the system—being worked on now—is widening the number of suppliers and including all parts from each supplier. Suppliers are brought on-line one at a time to minimize impacts on production. As HP gains more experience with the e-SMI/DR system, they will be able to provide suppliers with a “canned” approach to interfacing with the system.

**Summary**

The HP/ST e-SMI implementation has had a far broader impact than just the empirical benefits on supply chain transactions. While planning and replenishment cycle times have been reduced, and variability has been greatly mitigated, it is the changes in processes and responsibilities that have had the biggest impact.

With e-SMI/DR, the supplier is empowered to manage inventory. Metrics are monitored which measure availability and actual vs. target inventory levels for both ST and HP. As one participant said “it makes the conversation [between ST and HP] more sharp. Instead of relying on innuendo and rumor—‘it seems to be costing us a lot’, now we can get a number that says ‘it’s going to cost us this much to do that.’”

The following tables illustrate the benefits that have been realized by both the supplier (ST) and the consumer (HP).
### Figure 3. Supplier (ST Microelectronics) Before and After Comparison

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrete Order Management (many orders and associated info)</td>
<td>Blanket Purchase Order (Soft pegging of supply and demand)</td>
</tr>
<tr>
<td>Full visibility of HP inventory updated manually</td>
<td>Full visibility of HP inventory automatically updated daily from HP’s ERP system</td>
</tr>
<tr>
<td>Full visibility of HP demand updated manually</td>
<td>Full visibility of HP demand automatically updated daily given latest information</td>
</tr>
<tr>
<td>Manual changes from HP and/or supplying factories</td>
<td>Changes flow automatically when backend systems are updated</td>
</tr>
<tr>
<td>Shipping to discrete order</td>
<td>Dynamic shipment recommendation given today’s conditions</td>
</tr>
<tr>
<td>Supplier measured on earliness or lateness</td>
<td>Supplier measured on availability &amp; plan-to-actual variability</td>
</tr>
<tr>
<td>Frequent interventions</td>
<td>Alert-based exception intervention</td>
</tr>
</tbody>
</table>

### Figure 4. Consumer (HP) Before and After Comparison

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrete Order Management (many orders + associated information)</td>
<td>Blanket Purchase Order (Soft pegging of supply and demand)</td>
</tr>
<tr>
<td>Limited visibility of Supplier information.</td>
<td>Full visibility of supplier finished goods inventory (FGI)</td>
</tr>
<tr>
<td>Full visibility of WW HP demand updated manually.</td>
<td>Full visibility of WW HP demand automatically updated daily given latest information</td>
</tr>
<tr>
<td>Manual changes from HP and/or at supplying factories.</td>
<td>Changes flow automatically when backend systems are updated</td>
</tr>
<tr>
<td>Limited shipment visibility.</td>
<td>Dynamic shipment/WW time-phased demand availability plan given today’s conditions.</td>
</tr>
<tr>
<td>Consumer not measured</td>
<td>Consumer measured on % plan-to-actual variability (enables root cause supply chain troubleshooting)</td>
</tr>
<tr>
<td>Frequent interventions</td>
<td>Alert-based exception intervention</td>
</tr>
</tbody>
</table>
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