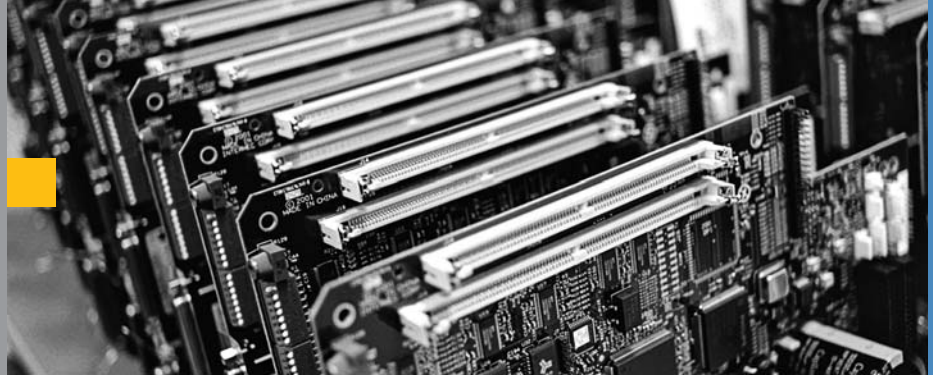
SAP Case Study



# mySAP™ SUPPLY CHAIN MANAGEMENT AT FREESCALE

## Reduced Order-Planning Cycle Times Bring Shareholder Value

freescale™ semiconductor

Freescale Semiconductor Inc., one of the world's largest semiconductor companies and formerly a division of Motorola, expects to grow profitably in coming years. However, the Austin, Texas-based company faced several challenges, including forecasting demand in a highly cyclical industry and managing its business as manufacturing costs increased rapidly. To address its requirements, the company implemented planning processes enabled by the mySAP™ Supply Chain Management solution. Freescale reduced its order-planning cycle time by one week and achieved an internal rate of return of 54.7% from its implementation.

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## AT A GLANCE

### Strategic Goals

- Achieve profitable growth
- Efficiently utilize manufacturing assets
- Lower order-planning cycle time
- Reduce inventory, staffing, and other costs

### Approach

Before implementing a new information system, Freescale Semiconductor Inc. standardized and simplified its processes and data, centralizing sales and production operations that had long been decentralized. Then, starting in 2000, the company implemented new supply chain planning processes enabled by the planning and execution functionalities in the mySAP™ Supply Chain Management solution. These included a shift from weekly to daily planning of order fulfillment, enhanced and centrally administered sales forecasting, and supply planning procedures that search broadly for alternative intermediate inventory. Freescale discontinued many legacy systems through this implementation, and pursued a change management approach that fostered increasing trust in the new planning processes.

### Results

Results achieved over the period from September 2002 to August 2005 include the following:

- **Enabling results**
  - **Reduced average order-planning cycle time** by one week
  - **Improved forecast accuracy** more than 10 percentage points at the product and logical customer level
- **Achieved an internal rate of return (IRR) of 54.7%** (The calculation incorporated costs incurred from September 2000 to August 2003.) The IRR computation incorporated the following:
  - **Reduced inventory carry costs** on a recurring basis by 11.6% of the value of a large one-time inventory reduction
  - **Achieved a one-time cost reduction** encompassing variable manufacturing and other costs
  - **Lowered recurring manufacturing costs**
  - **Improved productivity** with a dramatic increase in sales per planner
  - **Increased margin on top-line growth** by optimizing the product mix and selectively increasing wafer starts

## ABSTRACT

Freescale Semiconductor Inc., a global leader in embedded semiconductors, has demonstrated solid financial improvement since separating from Motorola in July 2004. However, the company wanted to utilize its wafer fabrication facilities more efficiently, to decrease its inventory, and to provide competitive order-planning cycle times for its customers. To address these issues, the company established improved supply chain planning processes, which involved shifting planning order fulfillment from weekly intervals to daily increments and improving forecast accuracy. The planning and execution functions of the mySAP™ Supply Chain Management solution enabled Freescale to improve these processes and meet cost reduction and customer service goals. The company expects a broadened deployment of SAP® solutions to improve operations further by enhancing order management, order commitment, and other processes.

# BUSINESS

Freescale (NYSE: FSL, FSL.B) designs and produces embedded semiconductors – known as computer chips – that provide the digital "brains" behind products that people use every day. Based in Austin, Texas, Freescale is one of the world's largest global semiconductor companies, reporting sales of US$5.7 billion in 2004 with a worldwide workforce of more than 22,000 employees.[1]

The company's technology powers cars, networking devices, wireless communications products, and refrigerators. One of Freescale's competitive advantages is its ability to offer families of processors with a range of characteristics that may be used in specific applications.

Freescale focuses on serving large and growing industries, with a goal of holding the first, second, or third position in its chosen markets. Freescale is a global market-share leader for semiconductors for automotive applications and the top provider of chips that process data over the Internet.

### Origins

Freescale traces its roots to 1953, when it began operations as the Semiconductor Products Sector of Motorola Inc. Since that time the company has pioneered global semiconductor developments, including key product categories such as cellular semiconductors and communications processors. The company has made innovations in areas such as advanced device packaging and led the evolution of process technology to raise chip performance while lowering overall system costs.

Radios with crystal receivers were among the world's first "semiconductor" applications, and in the 1960s, electronics with several transistors combined on a single wafer, or integrated circuit, made electronic devices smaller and more reliable. That technology moved into the consumer market in the 1970s, inside transistor radios and televisions. The evolution from analog to digital in devices such as personal computers and mobile phones has increased the market for wireless communications, electronic controls, sensors, and other applications.

### Independence from Motorola

After decades as a semicaptive manufacturing arm of Motorola, focusing in recent years on cellular phone and communications markets, Freescale Semiconductor became an independent company in 2004. "Before, we were just one part of Motorola," says Robert Benny, director of systems and process integration at Freescale. "Now we have our own corporate identity and have positioned ourselves to become a great company in our own right."

Freescale's customer base ranges across 100 of the world's most recognized original equipment manufacturers (OEMs) and extends to distributors, which in turn serve thousands of other companies. To produce its portfolio of over 14,000 products for more than 10,000 end customers, Freescale maintains design, research and development, sales, and manufacturing presence in more than 30 countries.

### Improving Financial Performance

Freescale has made progress on improving its financial performance since separating from Motorola. In the third quarter of 2005, the company tripled its earnings over the prior year and achieved its highest gross margin – a measure of manufacturing efficiency – in 10 years at 43.7%. Since 1998 alone, Freescale chips have gone into more than half a billion mobile devices. Company executives anticipate growing demand for products with more functions at lower cost and less power consumption for use in automobiles, wireless infrastructure devices, and industrial equipment. And in emerging markets, where primary demand for everything from consumer electronics to cars is increasing, the company looks forward to considerable opportunities.

1. All monetary amounts referenced herein are in U.S. dollars.

But Freescale must overcome several challenges. The semiconductor industry is highly cyclical – for example, it enjoyed a steep run-up from 1998 to 2000 and then underwent a severe decline during 2000 and 2001. It's subject to shortages and oversupplies that affect pricing, constant and rapid technological change, product obsolescence, and evolving standards. Competition is global. Freescale squares off with large, well-established competitors as well as smaller rivals in niche markets.

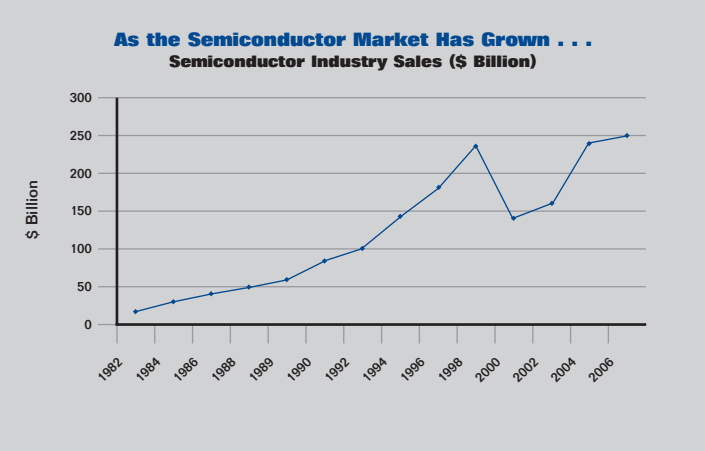


Figure 1a: Growth in the Semiconductor Market

Though there are many growth opportunities, the company must carefully manage its operations to sustain profitability. In particular, Freescale's success is highly influenced by utilization of its wafer fabrication facilities (known as "fabs"). And with each new generation of equipment, the capital costs have risen substantially (see Figures 1a and 1b). "The cost of one incremental capacity unit has become exponentially higher," says Mike Wolfe, director of IT infrastructure at Freescale. "Back in the 1980s, an entire wafer fab cost what one piece of equipment does today. When you have that kind of cost growth, you must focus carefully on how you use every bit of capacity."

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# CHALLENGES AND OBJECTIVES

Freescale's costs and customer order lead times were not as competitive as they could have been. And competition was raising the bar. Managing capacity to achieve target profit margins and service levels was imperative to business success.

### Product Line Complexity

Freescale's business is not a simple one. The products are diverse and have a variety of applications; many are customer-specific and the product mix is constantly changing. There are as many as 10,000 unique finished-good part numbers sold in any one year; 100,000 product and ship-to location combinations; and 30,000 shipments per month. Product life cycles range from less than one year for cell phone chips to 10 or more years for semiconductors for automobiles.

### Manufacturing Complexity

Semiconductor manufacturing can involve over 200 steps (see Figure 2 for a high-level overview), and manufacturing cycle times can stretch as long as 20 weeks. "Within that process, wafer fab operations are the most expensive and take the longest amount of time – about 75% of the total manufacturing cycle," says Benny. "Across the board, customers tend to be dissatisfied with semiconductor manufacturers' lead times. We strived to respond well to promised delivery dates, which meant we had to manage inventory carefully."

Compounding the inventory concerns was the fact that different planners handled the front end of the process (wafer fabrication), and the back end (final manufacturing, including assembly and test), as depicted in Figure 2. This situation created communication issues that required manual intervention to reconcile, and often generated suboptimal plans.

Freescale has customarily permitted customers to change their orders to some extent within an established four-week planning fence.[2] Consequently, the company had initiated manual expediting processes, which created further concerns with the stability of the manufacturing plan.

After commencing production with a set of wafers (referred to as "wafer starts"), there are often constraints, normally involving assembly and test operations. In final product testing, for example, Freescale may have to test various end products – so if the order mix continually churns, the company can run into shortages in testing capacity.

### Planning Issues

Since 1995 the company has used a formal sales and operations planning (S&OP) process to balance supply and demand, called a "consensus request for product," or CRFP. The company operates according to a strict calendar where demand signals are captured and used to drive sales operations, production planning, and long-term capital spending.

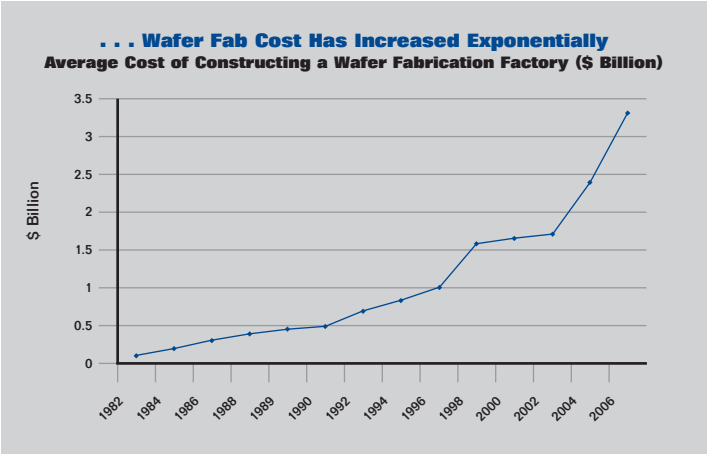


Figure 1b: Exponential Increases in Wafer Fabrication Cost

### Forecast Accuracy

The quality of the CRFP process is highly dependent on accurate demand forecasts. In the past, Freescale's operations relied on predictions for cell phone sales. These forecasts could create planning issues, and the complexity of Freescale's operations added to the difficulty of accurate forecasting.

2. A planning fence marks a period of time during which the production plan is normally not changed.

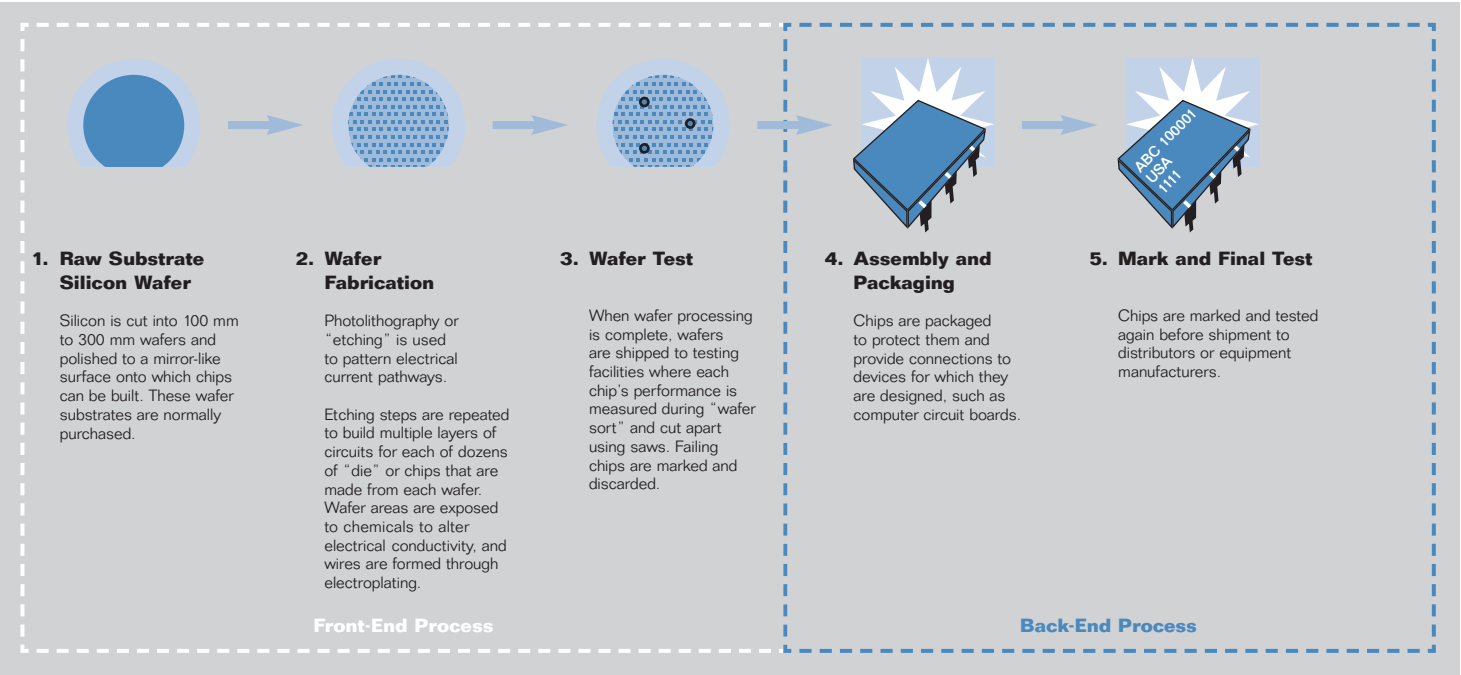


Figure 2: Semiconductor Chip Manufacturing – High-Level Steps

### Manufacturing Capacity and Inventory

Freescale's CRFP-related activities were not standardized. Individual planners, managers, and salespeople had great latitude. The resulting forecasts easily caused a variety of challenges for manufacturing. If assembly lines faltered, deliveries would be slowed and inventory would swell. What's more, individual segments of the semiconductor business were vertically integrated when Freescale was part of Motorola. Factories were therefore optimized for particular product lines, making it difficult to coordinate across the company. That in turn led to process diversity, shortages, and underutilization of manufacturing capacity.

### Order-Planning Cycle Time

Freescale's material requirements planning (MRP) system enabled planning in weekly intervals. The plan was simply derived from market demand and items in the bill of materials, without considering manufacturing constraints. "Our MRP system would produce a bill of materials explosion into the future," says Chuck Murphy, capacity planning and scheduling manager at Freescale. "The constraints weren't incorporated into the plan. So every day, factory staff would see a mountain of delinquencies in front of them."

Lack of visibility into inventory and orders compounded the challenges faced by manufacturing operations. "Our customers could get upset with us," says Wolfe. "It was not a good situation if we couldn't meet their requested delivery dates. We would be growing inventory at the same time we were shorting customers."

### Manual "Speed Binning"

The chips that Freescale produces from a single set of wafers are basically the same, but some run faster than others and thus command higher prices. Freescale tests the chips and assigns them into different "speed bins" depending on how fast they run. Freescale had handled "speed binning"– the planning and sorting of chips according to their clock speeds, expected yields, and market demand – by using ad hoc manual processes, adding task time and inventory.

### Responding to Business Cycles

Freescale faced challenges addressing the rapid fluctuations in semiconductor demand. "Business cycles definitely got in our way more than once," says Wolfe. "Since every part of the company planned its own capacity and demand, factories would get disjointed views of what to start producing. We were often lagging behind actual demand. When sales would begin to slump, it took awhile before we got our arms around the needed adjustments to the manufacturing plan.

"Likewise, we were forced to abandon opportunities because we weren't ready for the upturns. We needed to be more responsive, eliminate redundant and conflicting data sources, and get people out of the middle of the process."

### Legacy Information Systems

Freescale had information systems covering many processes, including demand planning, material requirements planning, and production route planning. The company also maintained systems for managing assembly capacity and handling back orders, and had early warning tools for late production and other issues. These systems didn't track essential information, such as detailed data covering work-in-process (WIP) inventory; they weren't well-trusted by planners; and they had many complex interfaces and redundant data. Multiple redundant order types for factories, for example, contributed to a long planning cycle time. To compound the problem, Benny says, "Our legacy systems were so old that no one knew how to maintain them."

> **"We eliminated the regional ownership of inventory. That was hard, but I can't overstate its value."**
>
> Robert Benny, Director of Systems and Process Integration, Freescale Semiconductor Inc.

### Need for Simpler Processes

Freescale executives knew that a measure of product and manufacturing complexity was intrinsic to its business. They were confident that the company could succeed – and better serve shareholders and customers – with improved data and simpler processes. They believed meeting these objectives would put Freescale in a better position for best-in-class performance, helping to secure its market position and long-term growth and counterbalancing some of the difficulties inherent in the semiconductor business.

# IMPLEMENTATION

Company management began to address business processes and data issues. Early efforts produced measurable value, put in place an essential foundation for further performance improvements, and positioned the company for the SAP implementation to follow. The timeline is summarized in Figure 3.

The project team chose the best of the company's existing tools, systems of record, and processes for any particular function. Then the team migrated everyone to those tools and shut down everything else.

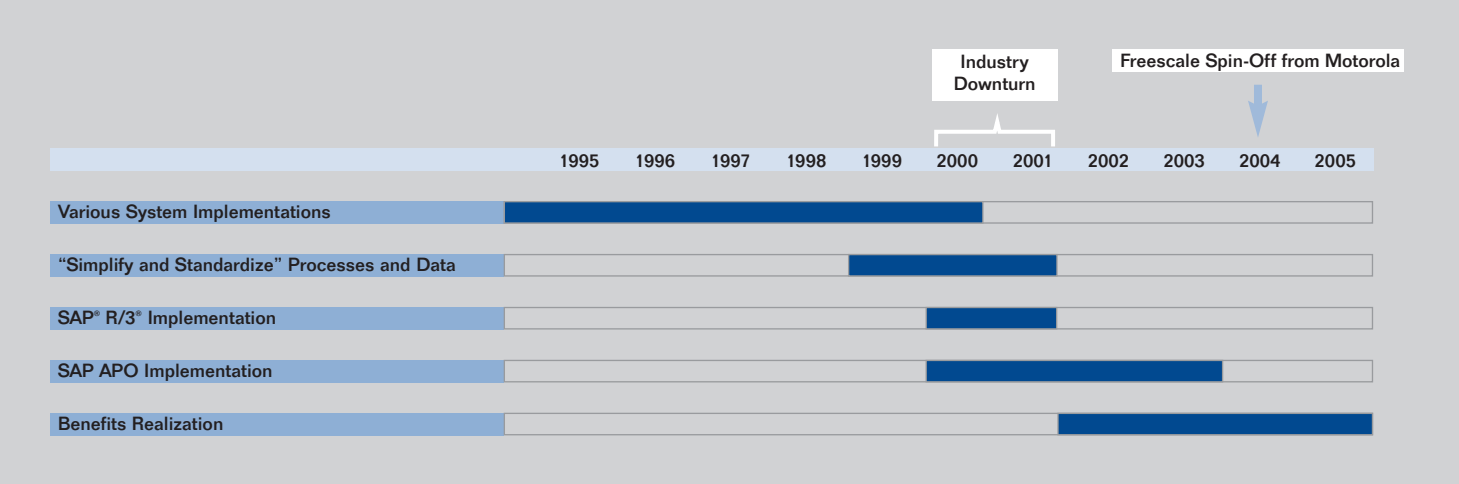


Figure 3: Timeline

### Initial "Standardize and Simplify" Phase

In 1999 Freescale's predecessor operations initiated a program to "standardize and simplify" processes and data. Sales and production had long been decentralized. To enable essential improvements, Freescale established a central order fulfillment organization, the sales organization began to focus on demand generation, and the manufacturing organization concentrated on supply. The company shifted away from decentralized order fulfillment activities to the use of centralized planning and manufacturing processes. Moreover, "We eliminated the regional ownership of inventory," adds Benny. "That was hard, but I can't overstate its value."

> **"The magic here was the centralization."**
>
> Neal Janke, Director of Master Planning, Freescale Semiconductor Inc.

In this phase, the company achieved important measurable results by working backwards. For example, staff members determined how much improvement in factory yield was required to reduce WIP inventory by a certain level and then initiated actions to achieve those targets. Through this transition, the focus was on improving underlying data quality, and Freescale thereby achieved more accurate forecasting, improved scheduling, reduced inventory, and improved on-time delivery. Customers noticed improvements in service. "The magic here was the centralization," says Neal Janke, director of master planning at Freescale.

While important improvements came about during this phase, much was left to do. Inventory still needed to be lower and service had to improve even more. Multiple poorly integrated systems hindered the necessary process improvements.

## Selection of SAP Solutions

In 2000 management had decided to fully standardize on SAP software to replace many of its legacy systems. The semiconductor business was confident that SAP was the right choice to support sales and manufacturing execution.

"SAP solutions enabled us to minimize the number of bolt-on applications by taking advantage of integration, which allows us to simplify our IT environment and lower our cost of operations and maintenance," says Wolfe. "And we were betting on the future. SAP has significant research dollars that we anticipate will benefit us down the road."

## Rollout of SAP Solutions

In early 2000 Freescale began implementation of SAP R/3® and quickly gained traction.[3] The first SAP implementation area covered financial functions, and human capital management and procurement processes followed.

Later that year the company rolled out the demand-planning functions of the SAP Advanced Planning & Optimization (SAP APO) component of the mySAP Supply Chain Management solution. Freescale was an early adopter of SAP APO beginning with version 2.0. The company phased in demand planning, first to forecast demand for its distribution customers, then for its OEM direct-buy customers. During the implementation Freescale retired its legacy forecasting application.

The project began with the supply network planning (SNP) features of SAP APO in August 2002 and relied largely on SNP's supply planning heuristic solvers and capable-to-match functionality.[4] The algorithm chosen in any specific case depended on the objective of the supply planning run.

SNP replaced several legacy systems (see Figure 4). The system generated plans covering complex and changing global production requirements, including about 2,000 orders per week to be scheduled at captive manufacturing plants and third-party factories. Following go-live, there were six superusers and 150 regular users of demand planning and SNP.

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## Investment

Freescale dedicated significant internal staff and consultants to the SAP APO implementation as well as a large outlay for the implementation. This cost was incurred from September 2000 to August 2003 and was used in the internal rate of return calculation.

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3. SAP® R/3® functionality is now available in the mySAP™ ERP solution.

4. The supply planning heuristic in SNP calculates requirements for product sources while taking quota arrangements, lead times, calendars, and lot-sizing rules into account. The algorithm assumes infinite capacity; the user can execute a capacity check after the requirements planning run is completed. This allows the user to determine how planned orders affect resources and whether or not the plan is feasible.

   The capable-to-match planning algorithm in SNP supports rule-based supply chain planning to propose a feasible solution for demand fulfillment in a multistage production environment. A search strategy, covering existing stocks and planned receipts, matches prioritized demand requirements (forecasts and orders) with available supply. Capable to match uses constraint-based heuristics to conduct multisite checks covering resource availability and priority. Freescale implemented these algorithms using lead-time constraints, but not capacity constraints, in the implementation covered in this case study.

## Implementation Characteristics

The implementation had the following characteristics.

**Visibility:** The planning and execution processes enabled by SAP APO and SAP R/3 provided visibility across the supply chain, including orders, forecasts, WIP, factory capacity, and raw materials. The front-end and back-end planning processes, which had formerly been planned separately and reconciled manually, were now tied together (see Figure 2).

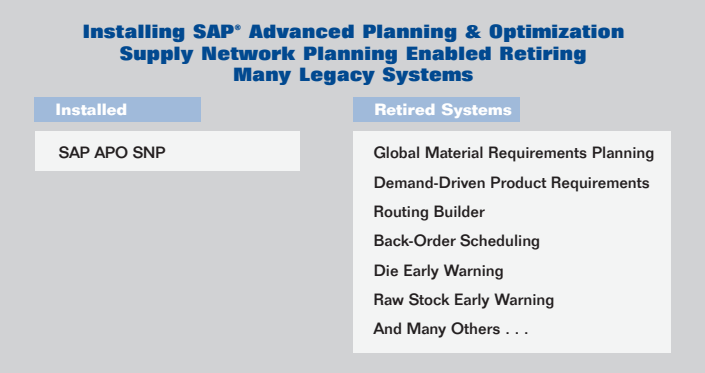


Figure 4: Legacy Systems Retired

**Interfaces:** Multiple interfaces provide data to and from SAP APO. These interfaces integrate with Freescale's customer relationship management system and billing history to support demand planning and with capacity management systems to support supply planning. Freescale chose to retain many of its legacy applications, which hinder fully synchronizing operational and financial data and require manual interfaces. For integration with SAP R/3, Freescale opted not to use the standard interface to SAP APO; instead, the company relied on custom programs. Ongoing use of legacy systems and interfaces represents issues involving maintenance costs and data deficiencies. Over time, Freescale expects to reduce these issues through a more complete implementation of SAP solutions.

**Use of spreadsheets:** Staff members use PC spreadsheets for analysis and manipulation, including some data covering forecasts by sales staff. Freescale built front-end software to support spreadsheet exchange but expects to be able to use existing SAP APO functions for this type of transfer in a subsequent release.

**Calendaring:** Freescale implemented the calendaring tool within SNP, which allows the plans to account for scheduled downtimes such as plant maintenance and holidays.

**Usability issues:** Staff members had some difficulty using the SAP APO graphical user interface, especially when tracking product availability across multiple time periods. Freescale has brought up these concerns with SAP and plans to take advantage of a later version of SAP APO, which addresses the issue.

## Change Management

The standardize-and-simplify phase leading up to the SAP implementation brought big changes that upended entrenched organizations and the status quo. To ease anxiety and educate staff members about their new roles, Freescale engaged in a training and communication campaign. Management also established a structure to ensure that business personnel and IT staff would collaborate to overcome any roadblocks. "We paired business and IT staff and asked them to take joint ownership of the outcome," says Wolfe. "This engendered 'creative tension,' which often generated a hybrid solution – practical from an IT point of view, while serving the complexities of the business."

> **"We've been able to keep our commitments to customers, even through periods of peak demand."**
>
> Robert Benny, Director of Systems and Process Integration, Freescale Semiconductor Inc.

Above all, Freescale had strong leadership throughout the project. The implementation team focused on educating managers on the value of trusting the system, working in a planned way, and relinquishing control. "The first passes at planning with MRP systems weren't really well received," says Wolfe. "We cranked through very large models, and if the answers weren't consistent with a manager's intuition, the conclusion was that the source data was wrong or the tool was wrong.

> **"Our old system always forced us to plan in seven-day increments, but we don't produce product in seven-day increments. Moving from seven-day to one-day increments gave us much more flexibility."**
>
> Robert Benny, Director of Systems and Process Integration, Freescale Semiconductor Inc.

"With SAP APO, we were able to build upon a rules-based engine and repeatable processes, which would allow us, for example, to preferentially serve certain customers. Thus we could overcome credibility issues, move away from rewarding firefighting, and secure the trust of senior management."

Since the first quarter of 2003, the company has seen an improvement in managers' and planners' confidence in the plans generated by SAP APO. As a result, Freescale is realizing increasing value from the new planning and execution processes.

# OUTCOMES

The new processes and enabling technology delivered by SAP APO were far superior to the legacy environment, with outcomes that are critical to Freescale's long-term viability. In short, Freescale became a better business partner for its customers and improved its operational performance and visibility across the supply chain.

Many results, such as inventory reduction, came about quickly without the significant dip in performance that often accompanies major IT projects. The undertaking was well worth the investment, with financial returns summarized as an internal rate of return of 54.7% for the overall project.

Specific outcomes achieved over the period from September 2002 to August 2005 include the following.

### Enabling Improvements

Freescale achieved favorable results, including planning cycle time reductions and improvements in forecast accuracy, which drove financial performance improvements.

### Reduced Order-Planning Cycle Times

Freescale was able to gain better insights into supply and demand, adjust to changing market conditions more readily, and reduce its weighted average planning cycle times by one week (see Figure 5). Several factors contributed to this reduction, including the following:

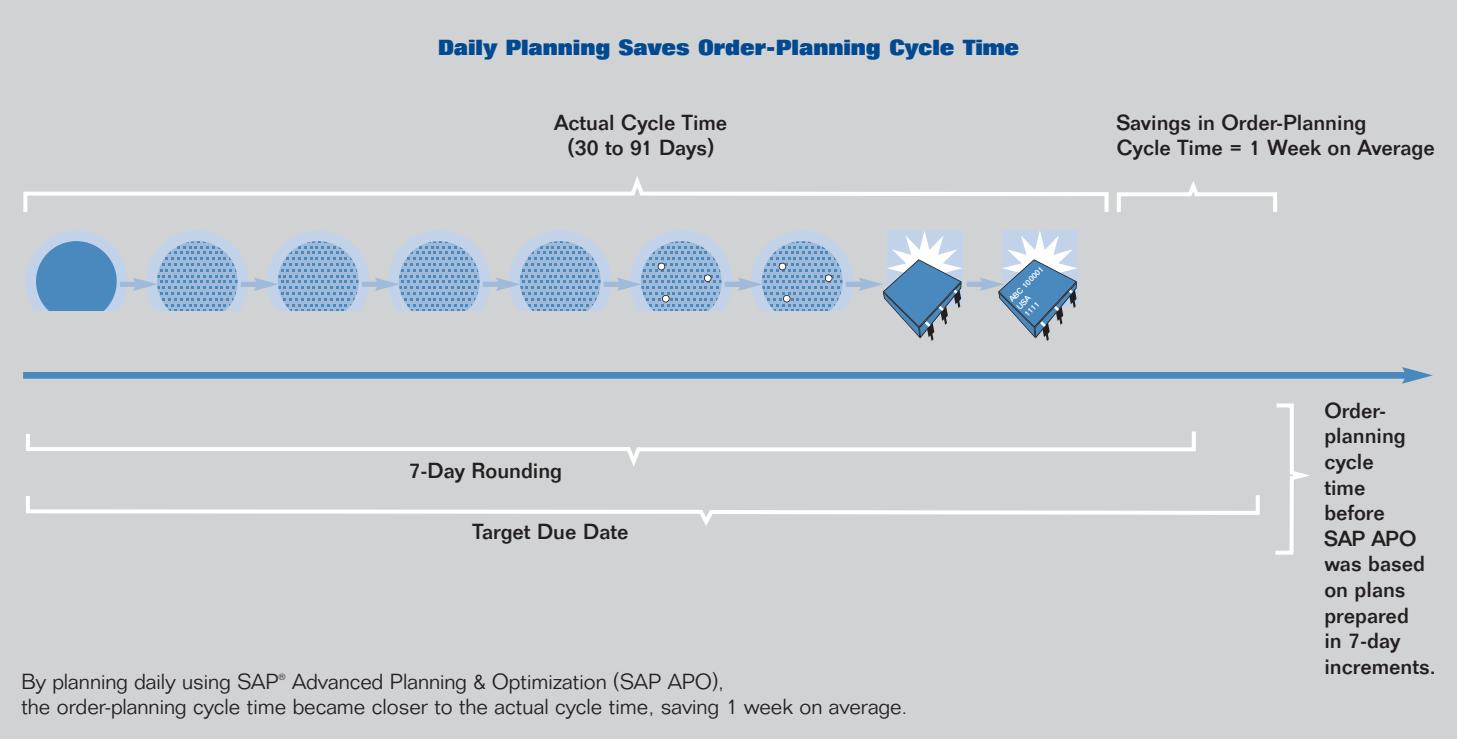


Figure 5: Improvements in Order-Planning Cycle Time

- Freescale used demand planning and SNP to enable a new planning process that shifted planning order fulfillment from weekly to daily increments. This eliminated the need to round plans in seven-day increments.
- The new systems provided better reporting of inventory levels, allowing planners to adjust stock levels.

Reduced planning cycle time unlocked many business benefits. By establishing a more direct link between customer and factory orders, Freescale could communicate lead times to customers, make delivery commitments more quickly, and honor delivery dates. Customers could reliably schedule deliveries from Freescale, which in turn allowed them to more dependably commit to their end-user customers. "We've been able to keep our commitments to customers, even through periods of peak demand," says Benny.

Better planning also helped cut inventory. "A long planning cycle time generates inventory," says Benny. "Our old system always forced us to plan in seven-day increments, but we don't produce product in seven-day increments. Moving from seven-day to one-day increments gave us much more flexibility."

### Improved Forecast Accuracy

Freescale has used the SAP Demand Planning application to develop more independent and objective forecasts. Freescale took a disciplined approach, developing a linear regression–based model using demand planning and incorporating historical sales data, unfilled orders, macroeconomic data, and other factors.

"One of the major process changes we made was shifting the forecast ownership away from sales for a large portion of our business," says David Waterston, who served as forecast process manager during the implementation at Freescale. "We shifted from a process that was based completely on sales input to a

process administered by forecasters, who had responsibility for the accuracy of specific large customer and distribution accounts. The forecasters could select the source of data – including sales input and model-generated data – that they thought would ensure the highest accuracy."

The forecast metric is based on a mean absolute percent error calculation for a rolling two-year horizon,[5] encompassing about 100,000 characteristic combinations and 2.4 million data points.[6] The metric is weighted by sales at the product level and averaged over a three-month period to reduce the impact of month-to-month sales spikes. Weighted aggregate forecast accuracy improved more than 10 percentage points at the product and "logical customer" level (a construct established to view sales to significant customers) for a four-month horizon.

Freescale devoted two years, instead of the one year originally anticipated, to achieve the improvements, largely because of difficulties forecasting in a changing business environment coupled with the early adoption of SAP APO. While its forecasts are more accurate and useful at the dollar-sales level, there is continued volatility in the accuracy of individual customer sales and in the product mix.

The automotive sector, for example, tends to have more accurate forecasts because many custom parts are involved and forecasts are based on direct sales input. But forecasts for consumer segments are much less accurate. These forecasts depend on a two-layer "program forecast" of end-use unit sales rates (such as for cell phones), as well as estimates of Freescale's market share in the segment. Though relatively low, this level of accuracy still provides value. "By preparing the program forecast, which SAP APO supports well, we demonstrate to management that we understand the big picture," says Waterston. "We then can use the bill of materials to create a detailed SKU-level demand forecast."

### Generated WIP-Feasible Schedules

The new system sends only WIP-feasible schedules and identifies where there are problems due to insufficient WIP to meet final manufacturing requirements for assembly and test locations.

Reports generated from SAP APO facilitate better management beyond a four-week window, identifying data problems and WIP shortages in enough time for corrective action. This approach has enabled management by exception, mitigated tendencies to bypass the system and build WIP in front of final manufacturing steps, and focused the factories on delivering the right product mix.

## Internal Rate of Return

As noted, Freescale achieved a 54.7% internal rate of return for the project. The calculation incorporated hardware, software, and other costs incurred from September 2000 to August 2003. The analysis was confirmed by the financial controller for the manufacturing organization and supported by operational managers of the wafer fabs. The benefit areas used in the calculation are as follows.

### Reduced Inventory Carrying Costs

Freescale wanted to improve management of its inventory, especially with investment analysts scrutinizing its inventory levels for hints about future performance. The company's efforts paid off. Inventory fell substantially during the period, and inventory carrying costs were reduced on a recurring basis by 11.6% of the value of the large one-time inventory reduction.

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5. The mean absolute percentage error (MAPE) provides a meaningful measure of the relationship between forecast and actual data. The absolute values of all the percentage errors are totaled, and the average is computed. Other measures, such as "mean error" (computed as the average error value), can be more heavily influenced by outliers and is harder to interpret.

6. "Characteristic combinations" is defined as the number of product and customer combinations.

Besides the factors noted, better forecasts contributed to inventory reductions by providing reassurance that customers would buy what Freescale produced. Waterston comments, "We believe that advance knowledge of product demand had a lot to do with the savings in inventory carrying costs."

Also, using the capable-to-match functionality of SNP produced the following benefits:

- **Automation of speed binning:** Targeting a specific speed distribution to meet demand contributed to a significant inventory reduction. "By putting in appropriate speed binning in SNP, we got a far more precise mix optimization," says Waterston. "We were able to allocate our wafers, capacity, and other resources very precisely, get more of the faster speeds out, and increase our average selling price."
- **Die inventory substitution:** Freescale developed a die coverage report to locate usable intermediate die inventory on a broader scale and redeveloped its bills of materials to allow substitution with alternate or preferred die. This enabled scheduling of shorter lead times and consumption of more die inventory before initiating additional wafer starts.
- **Product life-cycle management:** Through better management of product conversions, such as for model-year changes required by automotive customers, Freescale realized inventory reduction through streamlined product ramp-ups and ramp-downs.

"We were removing wafer starts, thereby avoiding millions of dollars of products put on the shelf early," says Waterston. "We still build inventory, but we build different inventory now, focusing on a selective approach."

### One-Time Cost Reduction

Freescale has high fixed costs, but its variable costs – largely associated with wafer manufacturing – represent about 25% of the total. Substitution was a key factor leading to reduced variable costs, allowing Freescale to make a significant one-time reduction in wafer starts of 1.9%. This in turn enabled a reduction in variable wafer manufacturing costs – coupled with an associated reduction of inventory carrying costs in 2002.

"When we threw the switch on SAP, the system said we didn't need to start anything for two weeks," says Waterston. "Some people thought there must be something wrong, but two weeks was right on target. We found that in our old system, people were putting in safety buffers, which had a cumulative effect. Since we have a fixed cost base to cover, we didn't want to empty any of the factories right away, so we took the reduction over a period of 12 weeks."

### Lowered Recurring Manufacturing Costs

Freescale achieved an ongoing reduction in variable manufacturing costs, resulting from a reduction of 8,000 wafers per year. This was a direct result of continuous improvements to substitution capabilities. "We had some follow-on efforts to improve the substitution rules to let us take advantage of our new capabilities," says Thomas Matthews, program management and quality systems manager at Freescale. "As soon as we'd improve a rule, we'd see a reduction in wafer starts the following week."

> **"We were removing wafer starts, thereby avoiding millions of dollars of products put on the shelf early. We still build inventory, but we build different inventory now."**
>
> David Waterston, Served as Forecast Process Manager for Freescale Semiconductor Inc. during the implementation

"For example, we might see that we had two alternate dies to make the same finished good – one for primary preference and one for second preference," says Benny. "We'd go back and look at the last six months and say, 'We're not consuming any of the second preference.' We'd change the substitution rules, the second preference would be consumed, and the wafer starts would go straight down."

### Improved Productivity

Freescale achieved a high level of productivity improvements, thanks to more efficient planning and scheduling, forecasting processes, and elimination of redundant systems. These factors

combined to lower manpower requirements. Even while sales increased, additional planning staff proved to be unnecessary and the annual sales per planner rose dramatically.

### Increased Margin on Top-Line Growth

Improving speed-bin planning and implementing substitution gave Freescale the flexibility to capture business in upside markets by optimizing the product mix and selectively increasing wafer starts.

## Other Benefits

Freescale identified other benefits, important though not quantified, including the following.

### Lowered Capital Equipment Requirements

Freescale was able to better manage capital equipment purchases. Improved forecasting and better visibility into actual orders enabled better anticipation of production equipment requirements.

### Flexibility in Managing the Supply Chain

With direct control over setting up supply chain parameters, Freescale's planning community enjoyed a more efficient means of defining products, setting up how orders are received and executed, and establishing how factory production is prioritized. Although the complexity of the bills of materials posed challenges, this level of control also created opportunities for optimizing supply chain configurations. "One of our planners dealt with some capacity limitations by splitting wafers coming out of one factory into two test sites and two assembly sites," says Benny. "Based on an analysis of yield data, she was able to streamline the process and perform all testing at one site and all assembly at another. This flexibility was not previously possible."

### Use of Quotas

Freescale used SNP to support manufacturing quotas for assembly locations, which allowed the company to achieve target utilization for individual plants. As long as WIP at a factory did not exceed the quantity necessary to make the quota, the automated process worked well, and it was no longer necessary to manually allocate WIP to factories.

"However, if WIP is too great at a given factory, the plan would direct that factory to make as much finished goods as possible, causing the other factories to underproduce," says Benny. "That was because we didn't turn on capacity constraining in SNP."

## Lack of Capacity Constraining

While Freescale achieved significant value, many anticipated benefits were unfulfilled because the company opted against enabling capacity constraining, which accounts for limits in manufacturing capability when generating plans. While Freescale

> **"We got a multisite quota capability, which we'd never had before."**
>
> Robert Benny, Director of Systems and Process Integration, Freescale Semiconductor Inc.

did activate the heuristics functionality of capable-to-match in SNP for constraining by lead time in the initial implementation, there were concerns that, if capacity constraints were enabled, planners would turn away orders without first trying to resolve potential conflicts.

Company executives expected to add capacity constraining within six to nine months after the initial implementation in 2000, but those plans changed with the industry downturn. The decision to postpone the necessary investment left Freescale with an incomplete set of tools.

"We got a multisite quota capability, which we'd never had before," says Benny. "But it doesn't work perfectly because we didn't turn on capacity constraining. In other words, we got daily granularity out of our SNP plans, and that helped us reduce quoted lead times to customers. We actually took out a week across the board. But we didn't make the plans capacity-feasible, which would have enabled a two-week reduction." Adds Murphy, "We built this fast sports car, but we're stuck in traffic in second gear."

# NEXT STEPS

By turning on capacity constraining in SNP, executing a road map covering implementation of additional SAP functions, and streamlining more processes, Freescale expects additional business benefits to accrue. Specific improvements include the following.

### Enabling Capacity Constraining

Freescale expects to enable capacity constraining, which will add further value to its already successful SAP APO implementation. Achieving benefits will depend on management supporting specific customer allocation rules and planners sustaining trust in the system. With constraining, Freescale will be able to achieve the benefits of a full implementation – including capacity-feasible schedules, improved factory utilization, better inventory management, improvements in speed binning (by reducing the planners' need for decision making), and a full two-week reduction in order lead time. Related process changes will allow more of a flexible shift of production from one fab to another and use of alternate routings in testing phases.

"Finally, we'll be able to see the impact of a decision made in final manufacturing on our wafer factories and vice versa," says Benny. "We will be more informed of these impacts and better able to react."

### Retiring Legacy Systems

Freescale continues to use legacy applications for various functions. The company aims to retire these systems and replace them with SAP solutions, thus providing for better data and even greater productivity. S&OP and production planning and scheduling are some of the legacy applications intended for replacement with SAP APO, while legacy systems for sales order management, inventory costing, and inventory management are targeted for replacement by the mySAP ERP solution.

### Enabling Available-to-Promise and Capable-to-Promise Functionality

Freescale expects to implement the rule-based global available-to-promise and capable-to-promise functionality of SAP APO, which will depend on a solid mySAP ERP foundation and accurate data maintenance. With these two functions, Freescale will be able to commit production capacity and available inventory to customers almost instantly, improve service, cut back orders, and answer "what-if" questions from customers and the factories.

### Allowing Expediting

Customer requirements and factory execution issues are among the occasional demands that require expediting, but the inflexibility of the current setup prevents use of SAP APO–enabled processes when expediting. (SAP APO is run three times per week to plan subsets of its resources; it only plans all resources once per week. Also, specific cycle times are loaded into SAP APO, and it's fed by a non-SAP inventory system.)

Global available-to-promise and capable-to-promise functionality will support expediting. "Our die coverage reports now tell us what WIP is available, and information about customer demand comes mostly from forecasts," says Benny. "By establishing a capable-to-promise process and an improved available-to-promise process, we'll know better about the specific dates that customers require product. We'll know what the customer really needs; regardless of what we determine is WIP- and cycle-time feasible.

"This will help with expediting when necessary. For example, we'll be able to say, 'Can you pull this die in by a couple of weeks to meet this need?' "

### Electronic Orders

Freescale uses electronic data interchange (EDI) to receive orders from customers. Its goal is 90% electronic order placement. Meeting this goal will help improve productivity, enhance communication with distributor and OEM channels, and provide more accurate data for supply chain planning.

### Enhanced Reporting

Implementing the Web-based functions of the SAP NetWeaver® Business Intelligence and SAP NetWeaver Portal components should advance reporting capabilities, addressing requirements for more real-time reporting from a very large planning database. The company foresees a more user-friendly and supportable online reporting platform relative to reporting in SAP APO and using standard SAP business warehouse functions.

# LESSONS LEARNED

Freescale found the following tenets to be key to success.

### Secure Buy-In Early

Involving planners, process owners, and multiple levels of management in early planning and implementation phases helped ensure broad support for the implementation. Change was managed well, customers experienced no service disruptions, and the organization was aligned to achieve targeted outcomes. The company also established continuous education programs that reinforced goals and new processes.

### Establish a Robust Transaction System Foundation

Freescale's management believes the company might have done better with a solid SAP R/3 backbone installed before the SAP APO planning systems – and with SAP APO installed all at once in a "big bang." Having in place systems of record for inventory, capacity, and so forth – with real-time feedback to factories – can help to secure the full benefits of SAP APO.

"It's not necessary to have these SAP components in place – we've proven we can get financially significant benefits and customer performance without all of them – but we've caused pain for our planners because we require that they work in multiple environments," says Benny. Freescale continues to address legacy interface issues. Deriving benefits from functions such as capable to promise and global available to promise will depend on completing the mySAP ERP foundation.

### Ensure Data Accuracy

Freescale found a direct correlation between data accuracy and benefits such as on-time delivery. "Your data discipline has to be impeccable. You have to be on top of every single element, because the system will base its recommendations on that data," says Benny. "If you neglect to track finished goods inventory, for example, it's just like being late with production."

### Manage Perceptions

Although Freescale did realize a favorable financial return, some people were not satisfied because they had trouble getting access to data from the systems. "We achieved real success," says Janke. "But perceived success depended on our ability to generate the reports people need. The data is good, so people expect to have it in custom formats." Freescale plans to focus on reporting in future implementations.

# CONCLUSION

In the semiconductor industry, engineering design and patent leadership – Freescale's strengths – remain keys to success. At the same time the market is increasingly demanding better service and lower costs.

Through planning processes enabled by SAP solutions, Freescale is satisfying those demands. Its performance has measurably improved, and the company continues to make strides. In 2004 Freescale was named a Supplier of the Year by a major automobile manufacturer for meeting high standards of quality and availability.

> **"Our customers come first. . . . Our SAP implementation is supporting this new management approach through improved supply chain planning."**
>
> Robert Benny, Director of Systems and Process Integration, Freescale Semiconductor Inc.

"Our customers come first," says Benny. "And our high-performance culture is reinforcing that. The new leadership of Freescale is focusing on the overall success of the business. Our SAP implementation is supporting this new management approach through improved supply chain planning. This enables us to streamline manufacturing, improve the speed of our decisions, and better serve our customers."

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