Sales and Operations Planning Practices at Semiconductor Companies

Venkatesh Dwaraknath , Christina Chen
Technology & Manufacturing, SPS, Motorola, Austin, Texas.

Metin Çakanyıldırım* and Bora İşbulan
School of Management, University of Texas at Dallas, Richardson, Texas.

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Abstract

We have recently surveyed 9 semiconductor companies about their sales and operations planning (SOP) practices. Operations planning is the process of setting the production volumes typically for 18 months into the future. Sometimes this process may include capital investment decisions. Since this process is driven by demand forecasts, a portion of our survey deals with forecasting. The primary aim of the survey is to reveal effective planning practices of participants to facilitate benchmarking of SOP activities. This report includes a critical discussion of survey results. We conclude that there are three SOP related problems that bother most manufacturers: Efficiency/Responsiveness of the SOP process, Forecast Accuracy and Integration of Finances into the SOP process. We make suggestions to deal with these problems.

*www.utdallas.edu/∼metin

1 Introduction

With this report, we reveal and discuss effective Sales and Operations Planning (SOP) practices in the semiconductor industry. We have gathered these practices by surveying 9 semiconductor companies. Our survey [4] has two main parts: forecasting and operations planning. Although operations planning is of primary interest, forecasting practices are also included because they are the main driving force behind operations planning.

The SOP process carries a lot of importance for many semiconductor companies. It is one of the processes that bring several business groups together and push them to plan in harmony to achieve the company goals. SOP plans generally cover a planning horizon of 18 months and deal with decisions such as fab loading, transfers (of products and equipment among fabs) and capital investment. These decisions together determine how successful a company is in utilizing its supplies and equipment in serving the customer demand. This supply and demand matching is critical for the financial performance and market share of the semiconductor companies.

Having emphasized the importance of SOP process, we alphabetically list and clarify some of the terms used in our SOP survey and discussions:

- Business Group: A division or segment of an organization generally treated as a separate profit and loss center.
- Demand: Need for a particular product or component. Demands may come from several sources, e.g., customer order or forecast, an interplant requirement, or a request from a branch warehouse for a service part or for manufacturing another product. At the finished goods level, demand data are usually different from sales data because demand does not necessarily result in sales. For example, when there is no finished goods on hand, there can be no sale.
- Forecast: An estimate of the future demand. A forecast can be created by mathematical means using historical data and/or by using estimates from informal sources.
- Highest level SOP meeting: SOP meetings where senior management, usually in the ranks of President, Vice-President and/or General Manager, participate and make decisions on capital investment, product transfers etc.
- Master Production Schedule (MPS): Representation of what a company plans to produce in specific configurations, quantities, and by certain dates. The MPS is **not** a sales forecast representing merely the customer demand. The MPS must take into account the forecast, the production plan, and other important considerations such as backlog, availability of raw materials and fab capacity, and management policies. The master scheduler maintains the schedule, and in turn, it becomes a set of planning numbers that drives the material requirements planning.
- Performance Measure (Performance criterion, Metric): The characteristic to be measured for an operation, item, good, service, business etc.
- Product (Finished Good, Finished product, Device): Any good or service produced for sale, barter or internal use.

- Product Family: A group of products with similar characteristics.
- Product Technology: The concepts, terms and philosophies used in the design and manufacture of a product.
- Production Plan: The agreed upon plan that comes from the SOP process, specifically the overall level of output planned for production. Various units of measure can be used to express the plan: units, hours, wafers, etc. The production plan is converted to a more detailed plan (MPS) with the management's authorization issued to the master scheduler.
- Sales and Operations Planning (SOP): A process that integrates customer-focused marketing plans for new and existing products with the operational management of supply chains. The process brings together all the plans for the business (sales, marketing, development, manufacturing, sourcing, and financial) into one integrated set of plans. The process must reconcile all supply, demand and new-product plans at both the detailed and aggregate level, and tie to the business plan. It is the definitive statement of the company's plans covering a horizon sufficient to plan for resources and to support annual business planning process. Executed properly, SOP links the strategic plans for business with its execution and reviews performance measures for continuous improvement.
- Sales Plan: A time-phased statement of expected customer orders anticipated to be received for each major product family or item. It represents sales and marketing's commitment to take all reasonable steps necessary to achieve this level of actual customer orders. The sales plan is a necessary input to the SOP process. It is expressed in units identical to those used for the production plan.
- Supply Demand Match (SDM): A process of matching available raw material and capacity supply to actual demand and forecasts. If there are any disconnects, they need to be resolved or carried over to the future, for example as inventory or stockouts.

Next we discuss the responses to survey questions one by one. Survey questions are in italics whereas responses and discussion are in the standard font. A "x" in a table indicates that the company in the corresponding column engages in the activity or has the item in the corresponding row. In our tables, we use "H" for high, "M" for medium and "L" for low. In our tables, company names are disguised by using code names such as AA, BB, etc.

2 Survey Results

2.1 General Background

1. Does your company utilize a Sales and Operations Planning (SOP) process to develop an integrated set of mid-to-long term plans?

All companies use a SOP process but the details of these processes may vary significantly.

2. Check all the functions that directly participate in the SOP process.

See Table 1. At all companies, Marketing, Operations and Finance functions directly participate in the SOP process.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Sales	x		x	x	x	x		x	x
Marketing	x	x	x	x	x	x	x	x	x
Operations	x	x	x	x	x	x	x	x	x
Finance	x	x	x	x	x	x	x	x	x
Product development			x	x	x	x		x	
Service / logistics	x		x	x	x	x			x
IT			x						
HR			x						
Legal			x						

Table 1: Functions that directly participated in the SOP process

3. Please list the number of Business Groups (BG) or divisions within the company.

With the exception of one company which reported 26 BGs, all companies reported from 3 to 10 BGs: specifically 3, 4, 4, 5, 5, 6, 9 and 10. However, one company answered questions below considering only one of the BGs.

4. At what level of interaction does your company exercise its SOP process?

In 6 out of 9 companies, SOP is exercised both individually by BGs and then together by all BGs to produce roll up summaries. One of the remaining companies rolls-up the summary of all BGs together without working separately at the BG level. Another company exercises SOP only at combinations of BGs that are related perhaps operationally or financially. Yet another company treats BGs entirely separately.

We do not have information on BGs of each company. Roughly speaking it would make sense to treat each BG separately only if BGs are totally independent operationally and financially. When BGs are dependent, more efficiencies can be achieved by studying roll up summaries together. For example, when two BGs' demands have different up-down cycles, capacity transfers between these two can alleviate SDM problems.

5. At which geographical levels are SOP activities conducted? (select all that apply)

See Table 2. All companies conduct SOP at global levels, this should not be surprising given that all companies are global semiconductor manufacturers.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Country	x			x	x				
Regions	x	x		x	x				x
Global/worldwide	x	x	x	x	x	x	x	x	x

Table 2: Geographical levels at which SOP activities are conducted.

6. Is there a concise documented SOP policy that covers the purpose, process and participants in the process?

On this question, companies are split almost equally, 4 saying "yes", 5 saying "no".

7. Which department(s) within the organization or the BG mainly drive the SOP Process? Please explain the organizational structure of the department(s) within the organization or BG. If necessary please attach a separate sheet.

See Table 3. In summary, Sales/Marketing and Manufacturing/Operations are the main drivers of the SOP process.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Capacity planning	x					x			
Manufacturing/operations		x	x	x			x		x
Sales/marketing			x	x	x	x	x		x
Accounting/finance			x				x		x
Business line				x					x
Service/logistics						x			
Production Planning							x		
Supply Chain Management								x	

Table 3: Departments driving SOP.

8. Please list the number of employees, in this department(s), that directly participate in the SOP process. Please list the number of managers in this department(s).

See Table 4. There is one company where less than 10 employees and only 2 managers are involved in SOP process. This company is smaller than others in size. At the rest of the companies, generally 50 or more employees and 10 or more managers are involved in the SOP process.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Number of employees	>50	26 - 50	10 - 25	>50	<10	>50	>50	>50	10-25
Number of managers	20	30	22	50	2	20	>20	10	N/A

Table 4: People participating in SOP.

2.2 Forecating

9. There is clear accountability for developing the forecast. Accountability means there is one or more departments within the company that takes responsibility for forecast errors, excess inventory or lost sales.

Except for one company which does not assign responsibility for excess inventory, all companies surveyed have accountability mechanisms for forecast errors, excess inventory and lost sales. In general, excess inventory is not perceived as undesirable as backlog or lost sales.

10. Please rank the relative importance of the following factors in the process of demand forecast generation: (Select one rating for each topic)

See Table 5. Sales / Field calls and Consensus estimates are the most important inputs used in forecasting. On the other hand, statistical techniques and computer software are not considered to be important although they are used by many companies.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Sales / Field Calls	H	M	H	M	H	H		H	H
Consensus Estimates	M	H	H	H	H	H		H	H
Statistical Techniques	L	M	L	L	M	M	M		L
Software Tools	H	L	M	H	M	M	L		H

Table 5: Importance of techniques/sources used in forecasting.

11. How frequently is the forecast/ demand plan generated?

Out of 9 companies, one company generates forecasts weekly and another generates them quarterly, yet another company generates them both weekly and monthly. All others forecast monthly.

One company converts forecasts into a detailed MPS bimonthly although it generates forecasts monthly. Another company said it summarized sales calls weekly or biweekly for forecasting purposes.

Quarterly forecasting can lead to DFM problems because actual demands may be quite different than forecasts in this case. We suggest monthly forecasting which should be easily implementable as it is already the practice at most of the companies.

12. What is the primary time horizon used for forecasting?

3 companies use 1-24 months of forecasting horizon. One of these companies says it pays more attention to the first 1-18 months. One company prepares monthly forecasts for 5 quarters and weeekly forecasts the current quarter. for Three other companies use 1-18 months. Two companies uses 1-12 month horizon. Although 1-12 month horizon is long enough for production planning, it is too short to plan for activities that have long lead times, tool acquisition being a primary example. We suggest a forecasting horizon of at least 18 months.

13. What levels of product aggregation are used for forecasting?

2 companies forecast only at product family level, 2 others only at product level. One company has another category between product and product family, and forecasts at this category level. One company forecasts at a very detailed level (segment code). Two companies forecast at product family and product level together. Another company forecasts at product technology and product family level. The detail at which forecasts are made varies greatly among the surveyed companies.

14. In continuation to questions 12 and 13 above, do you use different levels of product aggregation for different time horizons - for e.g., device level forecasts for 1 to 12 mo., product family level forecasts for 1 to 24 mo. etc?

4 companies use uniform product aggregation levels over their forecast horizons. Remaining 4 companies aggregate products for the further portions of the forecast horizons and forecast for these aggregated products. 1 company uses weekly time buckets for the current quarter as opposed to monthly buckets for other quarters. Those companies which have short forecasting horizons may want to extend the horizon but forecast for aggregated units towards the end of the extended horizon. Doing so, they would not spend much effort on forecasting when extending the forecast horizon.

15. What risk profile is reflected in the forecast plan at the following time horizons?

See Table 6. Conservative plans have 75% probability of achieving, the same numbers are 50% for Most likely plans and 25% for Aggressive plans. Generally speaking forecasts for 1-3 months into the future hold with 75% probability and those for 4-24 months into the future hold with 50% probability. Four companies consider 4-12 month plans as most likely, i.e. they materialize only 50% of the time. This level of accuracy in forecasts is unacceptable. Those companies need to pay more attention to improving forecast accuracy.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Conservative plan	1-3	1-3	1-3	1-3	13-24	1-3	4-12	1-3	1-3
Most likely plan	4-12	13-24	4-12	4-12	13-24	4-12	13-24	13-24	4-12
Aggressive plan	13-24	>24	13-24			>24		13-24	

Table 6: Forecast uncertainties over different horizons (measured in months).

16. Is the forecast/demand plan integrated to the organization's/BG's Long Range Plan?

6 companies say "yes", the other 3 say "no". These 3 companies are actually relatively larger ones among the eight companies surveyed. It seems integration of forecasts into long range plans is overlooked at larger companies.

17. How would you rate your organization's ability to react to a sudden change and develop a revised forecast/ demand plan? (for scenario planning).

7 companies can react to sudden changes fairly quickly and accurately, the other 2 are rather slow in reacting. One company which say "yes" to Question 16 cannot react fairly quickly to sudden changes. All the other companies which say "yes" to Question 16 can act fairly quickly. Thus, incorporation of forecasts into long range plans seems to be helping to reduce the time to react to changes. However, by itself such an incorporation does not necessarily guarantee faster reaction to changes.

18. a) What software and statistical tools does your company use or implement for forecasting purposes?
b) How satisfied is your company with the results of the tool? (Select one rating for each chosen software above.)
c) If you selected Other in a), please explain.
d) Please explain what statistical methods are used.

For a) and b), see Tables 7 and 8.

	AA	BB	CC	DD	EE	FF	GG	HH	II
I2	x		x		x		x		
Oracle							x		
SAP America	x	x		x		x	x		x
Spreadsheets	x	x		x	x	x	x		x
Software developed by your company	x	x	x	x		x	x		
Other	x						x	x	
Statistical Tools				x	x	x			

Table 7: Forecasting software and statistical tools.

c) One company uses Essbase, another uses Merlin. We are not given more information on how these software are actually used and what they involve.

d) Two companies use regression methods and another one does trend analysis (possibly using regression methods) .

19. Are there metrics in place to measure the effectiveness (or quality) of the forecast plans?

All companies say "yes" except one. We believe that measuring accuracy of forecasts must be an integral part of fore-

	AA	BB	CC	DD	EE	FF	GG	HH	II
I2	M				L				
Oracle							H		
SAP America	L	M							M
Spreadsheets	M	L		M		L	M		L
Software developed by your company	M	L	L		L	L	M		
Other	M						M		
Statistical Tools					M	M			

Table 8: Level of satisfaction with forecasting software.

casting. Accuracy of past forecasts will give feedback to forecasters and allow then to improve the forecasting procedures.

20. How frequently do you measure and review forecast plan accuracy?

5 companies measure and review forecast accuracy monthly, 1 bimonthly and 2 quarterly. The company which generates forecasts quarterly reviews them on an ongoing basis. We interpret this to mean that minor updates are made to quarterly forecasts as more information becomes available.

Five of the six companies which generate forecasts monthly in Question 11 measure accuracy monthly as well. The company which generates forecasts weekly measures the accuracy quarterly. Relative to forecasting, this company assesses accuracy quite infrequently. The reason could be lack of established and streamlined methodologies for measuring accuracy.

2.3 Operations Planning

21. The total planning horizon for the SOP process - how many months into the future are you planning?

Except for three companies which use a planning horizon of 12 months, all use 18 months.

All but one of the companies which use 18 months or longer forecasting horizon (see Question 12) use 18 months of planning horizon. Companies which uses 12 month forecasting horizon also uses 12 month planning horizon. Thus, planning and forecasting horizon lengths closely match.

22. Within the past 5 years, has your planning horizon remained constant, decreased in span or increased in span?

5 companies did not alter their planning horizon length. 3 companies increased it whereas 1 decreased it.

Ideally longer horizons are desirable if data pertaining to longer horizons reflect reality well. Thus, we expect that planning horizons expand as data collection, storage and decision modelling becomes more sophisticated. On the other hand, an explanation for decreasing planning horizon could be improvements in processes that puts a lower bound on the length of

planning horizons. Decreasing tool purchase and qualification lead times are a good example for this phenomenon.

23. What are the primary objective of your SOP process?

3 companies primarily use the SOP process to align plans with demand/sales. The other 6 use it to align plans with both demand/sales and business strategy.

In our opinion, first 3 companies also pay attention to strategic plans but they perhaps are more customer oriented to make demand/sales plans their priority.

24. What is the length of time to complete one cycle of the SOP process?

3 companies spend a month for one cycle of SOP process. 3 companies complete the cycle in two weeks and 1 completes in three weeks. Two companies take more than a month.

Generally speaking companies which streamline their SOP processes by automating information flow should have shorter cycle times. One may argue that bigger companies may take longer times. If we use the number of BGs (of Question 3) to measure the size of a company, we find no clear relationship between the size and the cycle time.

25. Frequency of SOP process:

One company prepares SOP bimonthly, another does it quarterly and all the remaining companies prepare SOP on a monthly basis. The company which prepares SOP bimonthly is the one which prepares MPS bimonthly in Question 11. Similarly the company that forecasts quarterly prepares SOP on a quarterly basis.

The company which generates forecasts weekly (Question 11) prepares monthly SOPs although it can complete a SOP cycle in two weeks (Question 24). It appears this company is more prepared than others to increase the frequency of its SOP process. At the other extreme, the company that prepares SOP quarterly should investigate ways of either updating SOP between quarters or switching to a monthly cycle. A quarter is too long to adequately respond to the changes in the market.

26. a) What software and statistical tools does your company use for planning purposes (for e.g. Supply Demand match)? b) How satisfied is your company with the results of the tool?

See Table 9. Companies generally use spreadsheets and software developed in-house. Strikingly, no company is satisfied fully with any software whether it is a spreadsheet, is developed in-house or is purchased.

27. What are the key items covered in the SOP process: (select all that apply)

See Table 10. Sales, Production issues and Demand/Production gap closure plans are named to be the key items by most companies. New product schedules, customer service and inventory are also considered as key factors. On the other hand, Financial forecasts and Capital planning are perceived as key items only by a few companies.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Software developed by your company		x/M	x/L	x/M		x/M	x/M		
Spreadsheets	x/M	x/M				x/L	x/M	x/L	x/M
Software developed by another company customized to your process	x/M	x/M					x/M	x/L	
Other	x/M				x/L				

Table 9: SOP software/Satisfaction level with them.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Current sales		x		x	x	x		x	x
Sales (orders)	x	x	x	x	x	x		x	x
Sales Plans/promotions	x	x			x	x			x
Sales forecast accuracy		x	x		x	x		x	x
Production Issues	x	x	x	x	x	x		x	x
New Product Schedules	x	x			x	x	x	x	x
Financial Forecasts	x				x			x	x
Customer Service	x			x	x	x		x	x
Inventory	x	x		x	x	x		x	x
Contingency Plans/Risks Assessments	x	x	x	x	x	x		x	x
Gap Closure Plans/Actions	x		x	x	x	x	x	x	
Capital Planning	x						x	x	
Technology Roadmaps	x					x	x	x	
Other									

Table 10: Key items of the SOP Process.

28. How do you prioritize the orders for fulfillment?

See Table 11. Most companies prioritize customer orders by customer rank or manufacturing capability. These priorities come before revenue/profit/volume considerations.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Primarily first come first serve basis	L	H	M	H		L	M	M	H
Priority basis by customer rank	H	L	H			H	M	H	M
Priority basis by revenue/ profit/ volume	M	L	L		M	L	H	M	M
Manufacturing Capability	M	M	H			H	H	L	H

Table 11: Priorities for order fulfillment.

29. What levels of product aggregation are used for Supply/Demand match?

Four companies aggregate at the product level, one at family level, one at product technology level and one at a level between product and family. One company aggregates at both product family and product level. One company says "at packaging level", this company might have interpreted question for a very short term.

We compare these answers to those for the level aggregation for forecasting purposes (Question 13). 4 companies (two at the product level, one at the a level between product and family and one both at product and product family level) use the same level of aggregation for forecasting and Supply/Demand match. Two companies forecast at family level but match Demand and Supply at product level. This practice agrees with the general principle of "looking at details in the present and using aggregation for the future".

30. Referring to questions 21 and 29 above, do you use different levels of product aggregation for different time horizons - for e.g., device level planning for 1 - 12 mo., product family level planning for 12 - 18 etc?

Four companies say "yes", five say "no". These three companies focus on the details in the present.

A company that uses different levels of aggregation details it as: product level for 1-4 months, a hybrid level between product and family for 5-18 months and technology or applications level beyond 18 months. Along the same lines, another comments: "the farther out the period [in the planning horizon], the more focus [is] on technology rather than specific product".

31. Is there a process in place to ensure the alignment of the forecast/demand plans and production plans (commonly, the output from the SOP process) to the strategic/ business plans of the organization?

Five companies say "yes", four say "no".

Three companies which say "yes" mention a "Higher level" review process to check the alignment of SOP to strategic/business plans. Our guess is that upper management examines SOP numbers against overall (financial, strategic, mar-

keting) plans, perhaps on a monthly or quarterly basis.

Three companies which say "no" say one of the primary objectives of SOP is to align plans with strategic/business plans (Question 23). We feel that these companies want to use SOP to steer plans towards business strategy but they have not yet institutionalized a process for doing so.

32. Are there metrics in place to measure the effectiveness (or quality) of the production plans, commonly the output of the SOP process?

All companies say "yes" except for two. For metrics see Table 12. We sum up metrics in three categories: Responsiveness, Inventory, Utilization. Examples of Responsiveness metrics are the fulfillment of the production plan, flexibility, on time delivery, customer request versus committed order size. Examples of Inventory metrics are availability, shortage, excess inventory. Examples of Utilization metrics are capacity and inventory utilization. A company mentioned 'desirability index" which is a metric to measure accuracy and consistency of production plans with respect to implemented plans. It is defined as the geometric mean of the accuracy and consistency. We classify this metric as a Responsiveness metric in Table 12.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Responsiveness	x	x		x		x	x		
Inventory		x		x			x		
Utilization				x					

Table 12: SOP effectiveness metrics

33. How frequently do you measure and review production plan accuracy?

Except for one company which measures accuracy bimonthly and two which measure quarterly, all companies measure accuracy monthly.

In comparison with the frequency of measuring the accuracy of forecasts, all companies measure SOP accuracy at the same frequency or higher. SOP plans are more closely monitored than forecasts. This is probably because forecasts do not directly impact the bottomline. Their effect is felt through the SOP process. However, it may be a viable idea to check forecast accuracy more often to see if and how SOP plans improve their responsiveness to market demand.

34. Are financial estimates integrated within the SOP process, are they only related or are they totally separate?

At one company financial estimates are fully integrated into SOP process. At two companies, they are separate. Remaining six companies adjust financial numbers according to the outcomes of SOP process.

35. Are financial (mathematical or other) models actively used to aid decision-making?

Eight companies say "no". One mentioned Hyperion models which we assume to be a specific and customized model/software.

36. a) How do data developed in the SOP process (sales, production, inventory, financial plans etc.) reside?

Two companies say in "fully integrated database", but neither is the same company responding positively to Question 35. All others have partially integrated database.

b) Are inventory plans generated as part of the SOP process?

All companies say "yes" except for three. We believe that by planning production for certain demand figures inventory plans are implicitly generated. Those companies which say "no" may not have the practice of reporting/storing those inventory plans.

37. What meetings are held as part of the SOP process? (select all that apply)

See Table 13. Note that all companies hold marketing/sales and manufacturing/operations meetings as a part of SOP.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Marketing/sales meeting	x	x	x	x	x	x	x	x	x
Manufacturing/operations	x	x	x	x	x	x	x	x	x
Pre - SOP (regional/country)	x			x	x			x	x
Pre - SOP (worldwide)				x					
SOP (regional/country)	x	x		x	x				
SOP (worldwide)	x	x	x	x	x				x
Post SOP (regional/country)				x					x
Post SOP (worldwide)				x					x
Executive committee meeting	x	x	x	x		x		x	
Other					x				

Table 13: SOP meetings.

38. Are all required departments represented in all SOP meetings?

Two say "no", seven say "yes".

One of the companies which say "no" later reveals that it wants to see representation from finance and upper management in the SOP meetings.

39, 40, 41, 42, 43, 44, 45. These questions are all about **the highest level of SOP meeting**. *What is the average number of participants and the relative importance of issues? What types of decisions are made? Who is the primary owner of the meeting? What is the effectiveness level of communicating decisions made to all parties? Who are communicated about the decisions? Is there a SOP Knowledge Management System in use for managing all the information, decisions, action items*

and issues made in the meetings including the highest level meeting? If NO, how do you manage and retain information?

See Table 14. In general, the highest level SOP meetings are owned by president/vice president/general manager and involves about 15 participants. In these meetings short to midterm issues are discussed and factory loading and capital investment decisions are made. Most companies have knowledge management systems to communicate these decisions to employees within 48 hours.

One may expect that answers to Question 36 and 45 are correlated. But one of the companies which keeps the data of SOP process in a fully integrated database (Question 36) accepts that it does not have a knowledge management system but several non-integrated databases (Question 45). Many of the companies which have partially integrated database (Question 36) claim to have a knowledge management system (Question 45). As a result answers to Questions 36 and 45 are not related.

46. Is the Master Production Schedule driven by the output from the SOP process, commonly the production plan? If you selected Partial, please specify a % figure.

One company says "yes". Eight companies say "partial". Among those eight, one does not specify a % figure. The other seven say 60, 75, 75, 80, 80, 80 and 95%. Thus, at most companies SOP drives the MPS schedule to a great extent.

47. Is a self-audit or some internal assessment process used to routinely assess improvement opportunities for the SOP process? If Yes, how often per year?

4 say "no", 5 say "yes". Frequency of audits range from 1 to 4 per year. One company specifically mentioned that self assessments are done quarterly and corporate assessment is done annually.

48. Rate each aspect of the company's SOP process:

See Table 15. In the overall, companies highly rate two aspects of SOP: Senior management commitment and Effective decision making. Interestingly, companies seem to be unsatisfied with their SOP process: there are only 5 High ratings as opposed 13 Low and 22 Medium ratings.

49, 50. Please explain what you would consider as the strengths and weaknesses of your SOP process.

See Table 16 for strengths and weaknesses. According to many companies, the biggest strength of SOP is in bringing together several departments and forcing them to make integrated decisions. SOP process seems to suffer most from the inaccurate forecasts. Companies also complain that SOP cycle is long and there problems with data integrity/validity.

51. On which basis do you assess the efficiency (success) of your SOP process/cycle: (select all that apply)

See table 17. All companies that replied to this question concur that "time and response to changes in demand" is the most important aspect of SOP in determining its success. Companies basically look for a SOP process that can respond to demand changes quickly.

	AA	BB	CC	DD	EE	FF	GG	HH	II
39. Average # of participants	11-15	5-10	16-20	<5	11-15	16-20	16-20	11-15	5-10
40. Ownership	P	BM	P	P	P	P	P	P	P
41. Relative importance of issues									
Short term items/issues	M	M	L	H	L	H	H	H	M
Midterm items/issues	H	H	M	M	M	H	H	M	H
Longer term items/issues	M	L	H	L	H	M	M	L	M
42. Decisions									
Capital Investment	x	x		x		x	x		
Factory Loading	x	x		x		x	x	x	
Transfers	x			x		x			
Other			F/M		SDM				
43. Communicating decisions in †	<48 hrs	<48 hrs	<48 hrs	<24 hrs	<24 hrs	Poor*	<24 hrs	Poor*	
44. Who are communicated									
Senior Management			x						x
Senior and Middle Management	x					x			
Senior Management, Middle Management and Analysts+		x		x	x		x	x	
45. Knowledge management system	○∼○, ⊠, @	x	x	x	@ www	○∼○, www	x		

Table 14: Highest level of SOP meetings. P: President / Vice President / General Manager, BM : Business Manager / Division Manager. F/M: Finance and Marketing focusing on top 20 customers. † : Effectiveness of communicating decisions is measured in hours it takes for all parties to hear them. * : Poor implies that the decisions are not communicated to all parties. + : These analysts participate in the meeting. ○∼○, ⊠, @: No single system, several non-integrated databases are in place, decisions are communicated via mail and e-mail. ○∼○, www: No single system, several non-integrated databases and web pages are used for storing/communicating decisions.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Forecasts are trusted	M	L	M	M	L	L	L	L	M
The SOP process is documented	M	M	M	M	M	H	L	L	M
Senior management commitment to SOP	M	M	H	M	M	L	M	M	M
SOP process is effective for profitability	M	M	H	L	M	L	M	L	L
Effective decisions made routinely	M	M	H	H	M	L	M	L	

Table 15: Aspects of the SOP process.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Strengths:									
Integration between departments	x	x		x	x				
Perspective in setting company direction		x			x				
Efficiency-Responsiveness				x	x				
Rigorous calendar and meeting schedule						x			
Technology roadmaps						x	x		
Yielding an accurate plan	x					x			
Top management involvement					x				
Worldwide Indicators/Trends							x		
Revenue Targets								x	
Weaknesses:									
SOP cycle too long	x					x			
Forecast accuracy	x			x			x	x	
Financial and volume forecast mismatch	x								
Data integrity / validity				x		x			
Inadequacy with Site Sourcing Decisions							x		
SOP is too complex	x								
Weak communication among regions and departments		x							
No management and finance involvement						x			
Execution							x		

Table 16: Strengths and weaknesses of SOP process. Efficiency is the time it takes do a single SOP cycle.

	AA	BB	CC	DD	EE	FF	GG	HH	II
Resources consumed to develop plans	x						x		
Number of iterations within the cycle	x			x			x		
Management of risk				x			x		
Time and response to changes in demand	x		x	x	x		x	x	
Capital efficiency			x				x		
Other				SDM	SDM				

Table 17: Basis for the success of SOP process.

3 Conclusion

We have surveyed 8 global semiconductor manufacturers about their sales and operations planning practices and discussed our findings. Since there are about 10-15 global manufacturers, our survey covers at least half. Consequently, we believe that our data reflects the realities of semiconductor manufacturing and our conclusions are relevant to a great extent to all manufacturers.

We briefly list the issues that stand out:

- **Efficient and Responsive SOP process**. Many companies complain about the length of their SOP cycle, its complexity, input data validity/integrity, these complaints can be avoided by building integrated databases and automating SOP process. Automation can be achieved in two ways: Expediting communication and Streamlining decision making. Databases, intranet, information systems all help in expediting communication. Streamlining decision making is more challenging because in many instances it involves using (and sometimes building) nonstandard decision making tools. Such tools usually come as software. The use of software, however with low satisfaction level, confirms that companies are aware of the need for decision tools but have not found satisfactory solutions. For a similar survey that led to the same conclusion, see [1]. That survey is based on interviews that took place at manufacturer sites, it deals with managerial issues of forecasting and capacity planning.

  Automating SOP process will also cut down the SOP cycle time and allow for more cycles per month, i.e. frequent forecasting and planning. Consequently, SOP plans will be able to quickly respond to demand changes.

- **Forecast Accuracy**. Somewhat related to forecasting frequency is forecast accuracy: The more frequent the forecasts are, the more accurate they are. Thus, shorter SOP cycles would improve forecast accuracy. Independent of forecasting frequency, there seems to be a need for better forecasting practices/techniques. Semiconductor business is volatile but we have found that some companies think they have more forecast accuracy than others. It could be worthwhile to investigate what kind of products/process technologies/forecasting techniques etc. are likely to lead to more forecast accuracy.

  The first step of improving forecast accuracy is measuring it. Such a measurement can be used to provide feedback to forecasters as well. A model that measures accuracy is discussed in [2]. For a survey that deals only with the forecasting practices of semiconductor manufacturers, see [3].

- **Integration of Finances into SOP process**. All companies agree that SOP's strength lies in the integration of decision making by bringing several departments together. However, there is a tendency of keeping SOP only as an operational planning tool. In order to fully benefit from the SOP process, we believe that financial planning must also be integrated to it. After all, finances represent the bottomline profit and many companies die or survive by these numbers.

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References

[1] M. Çakanyıldırım and R.O. Roundy (1999). *Demand forecasting and capacity planning in the semiconductor industry.* Technical Report 1229, SORIE, Cornell University, NY.
This report can be obtained by ftp://ftp.orie.cornell.edu/pub/techreps/TR1229.pdf.

[2] M. Çakanyıldırım and R.O. Roundy (2002). *SeDFAM: Semiconductor demand forecast accuracy model.* IIE Transactions, Vol.34, No.5: 449-465.

[3] R.O. Roundy (2001). *Report on practices related to demand forecasting for semiconductor products.* Technical Report 1229, SORIE, Cornell University, NY.
This report can be obtained by ftp://ftp.orie.cornell.edu/pub/techreps/TR1294.pdf.

[4] Sales and Operations Planning Survey. Conducted by University of Texas at Dallas/Cornell University.
This survey is available at www.utdallas.edu/∼metin/Research/SOPsurvey.html.