Semiconductor User Information Service Newsletters 1990

+ 1991

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Research *Bulletin*

MARCH PROCUREMENT PULSE: BUSINESS OUTLOOK MIXED, INVENTORIES RISE

The *Procurement Pulse* is a monthly update of critical issues and market trends based on surveys of semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

Figure 1
Averaged Monthly Semiconductor Orders

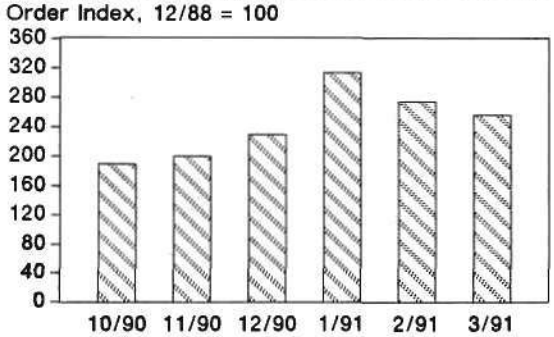


Figure 2
Averaged Semiconductor Lead Times

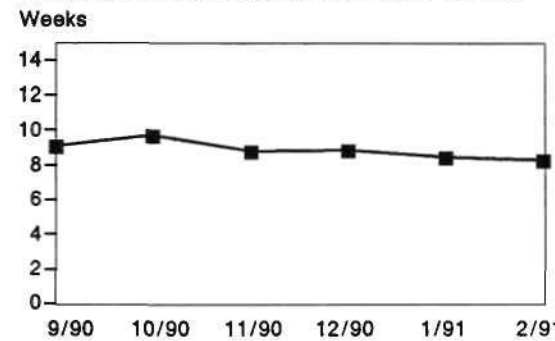


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

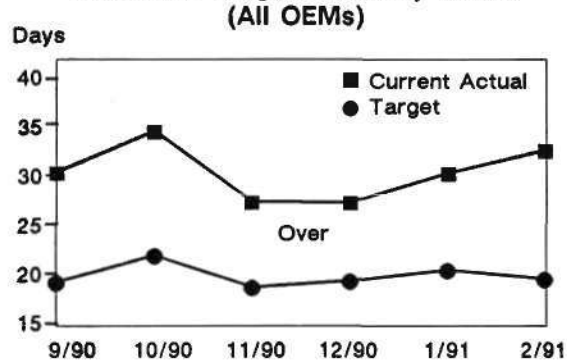
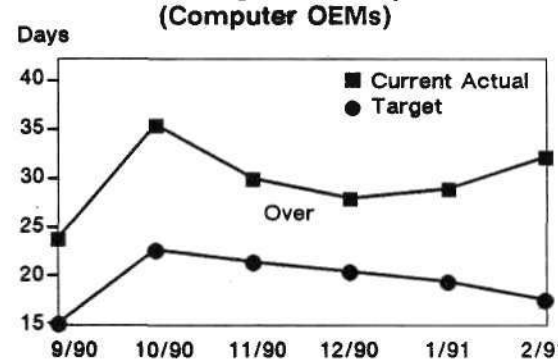


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (March 1991)

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SEMICONDUCTOR ORDER LEVELS DOWN, SYSTEM BUSINESS OUTLOOK UP

Figure 1 shows that this month's respondents expect to slightly reduce (by 6.5 percent) their semiconductor order levels in March relative to February. This small reduction in anticipated order activity does not signal a lowering of general demand but rather inventory correction measures being made for specific components. For the past two months, the six-month system sales outlook has ebbed and flowed with the status of the situation in the Persian Gulf. The current procurement managers' six-month outlook for system sales improved from last month's 3.7 percent to 5.2 percent. The computer sample raised its six-month systems outlook even higher, from 5.9 to 8.4 percent. It appears that the prewar slow-growth trend in system sales has resumed now that the Gulf War is successfully concluded. Dataquest continues to expect slow growth in the systems market and related semiconductor arena due to the lack of any high-volume new product that could pull growth higher.

LEAD TIMES REMAIN BORING AND STABLE

Figure 2 illustrates, with actual data points, a semiconductor market at a textbook supply-demand equilibrium. February's lead time average of 8.4 weeks is slightly down from last month's 8.6 weeks and 2 days less than December's 9 weeks. The semiconductor market has been balanced in this manner for the last nine months (six months shown) to the extent that some memory suppliers shifted production levels to change demand to the next-generation (and higher-profit) devices. With the exception of 1Mb DRAMs, lead times have remained stable as demand and supply have weathered both peace and wartime economic uncertainties with little variance in delivery schedule. Overall prices continue to remain flat or slowly declining (except for the 1Mb DRAM) as buyers continue to seek cost-based price reductions where applicable. Dataquest sees the possibility that as early as May 1991 some DRAM suppliers could take advantage of the current firming of 1Mb DRAM contract prices and relatively longer (10+ weeks) lead times by increasing production now and later undercutting the ASP. If enough incremental 1Mb shipments are made (beginning late in Q2 1991), the pre-Q1 1991 average price erosion could resume. Except for the 1Mb-4Mb DRAM supply situation, Dataquest does not foresee any supply or price volatility over the next six months.

SEMICONDUCTOR INVENTORIES UP, CORRECTIONS UNDER WAY

Semiconductor inventory levels rose for the second consecutive month, while targeted levels were lowered to force adjustments. The overall targeted and actual levels went from last month's respective 20.7 and 30.6 days to this month's reported 19.8 and 32.9 days. The computer segment of the survey again this month reported a diverging of targeted and actual inventory levels, going from last month's respective 19.5 and 29.0 days to this month's reported 17.6 and 32.2 days. The overall incremental increase in semiconductor inventory since December (19 percent in days) is being addressed and corrected with a lowering of order levels (negative 18 percent in dollars since January's high) combined with anticipated increased demand-driven usage. Because availability is not a problem, Dataquest continues to observe inventories being a very closely watched and manageable cost-control index and expects actual levels soon to come into line with the historical actual average of 30 days.

DATAQUEST PERSPECTIVE

Historically, the Gulf War will be seen as having little effect on real-time electronics business, other than compounding the overall market's uncertainty level. The cessation of hostilities and coincidental increased market optimism may not be the beginning of a trend, but they highlight the volatility of the market in the absence of large, identifiable demand-generating products. The average slow-growth pattern seen in the second half of 1990 appears for now to be picking up momentum. None of this month's respondents noted any problem products, and a minority noted quality as a current concern. In the continued absence of supply problems, demand issues are being addressed with forecast improvements and increased supplier-user planning updates. One of this year's Semiconductor Supplier-of-Year Award winners mentioned that "the trust involved with sharing long-range plans with your customer takes a big step, almost like a marriage...." In any relationship, good communication is key to preventing and solving problems. This supplier won the award because his company listened and responded to customers' needs. World-class suppliers and customers communicate.

Mark Giudici

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Research Newsletter

1991 SEMICONDUCTOR SUPPLIER-OF-THE-YEAR AWARDS TO MOTOROLA, ANALOG DEVICES, AND MAXIM

SUMMARY

The third annual Dataquest Semiconductor Supplier-of-the-Year Awards were presented at the Forecast '91 Conference on March 5, 1991, at Dataquest headquarters in San Jose, California, to an audience of over 250 people. For the first time, this year's awards were categorized by supplier size. For the third consecutive year, *Motorola* earned the Major Supplier Award, representing the category of larger companies. The two new categories created this year are for the midsize and niche market segments. The Midsize Supplier Award was given to *Analog Devices,* and the Niche Market Supplier Award went to *Maxim Integrated Products*. To a worldwide semiconductor user sample, these three companies epitomized excellence in supporting their customers' requirements based on quality, price, delivery, technical support, and customer service.

METHODOLOGY

The Semiconductor Supplier-of-the-Year Award is based on data collected from electronics companies that purchase semiconductors worldwide. Via telephone survey, Dataquest collected data from companies listed in the *Electronic Business* (EB) magazine's Top 200 Electronics Companies for U.S. companies, and the respective EB Top 50 Electronics Companies for Japan and Europe. Dataquest reviewed this list and deleted those that manufactured or distributed semiconductors and those that were software companies in order to ensure that our sample was made up of semiconductor users.

We identified the main semiconductor purchasing location for each company and sent a letter explaining the survey and a list of eligible semiconductor suppliers from our worldwide supplier database.

The survey asked the respondents for their choice of Semiconductor Supplier of the Year in three size categories, as follows:

- Major suppliers (annual revenue over $500 million)
- Midsize suppliers (annual revenue between $50 million and $499 million)
- Niche market suppliers (annual revenue under $50 million)

For each size category, the respondent was asked which semiconductor supplier ranked highest in each of the following areas:

- On-time delivery
- Quality
- Price
- Technical support
- Customer service

In the event that an electronics company named its own captive semiconductor source as the preferred supplier, the respondent was asked to exclude that choice and vote again.

There was one respondent per company. If the first respondent contacted at a company did not care to participate, a second respondent was chosen at random from our procurement site database. If the second did not participate, a third respondent was chosen; and if the third respondent did not respond, the company was dropped from the survey. Scores were calculated for each of the five performance areas in each size category. For each

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TABLE 1
1991 Semiconductor Supplier-of-the-Year Rankings

Rank	Major	Vote (%)	Midsize	Vote (%)	Niche Market	Vote (%)
1	Motorola	35	Analog Devices	17	Maxim	16
2	Texas Inst.	19	Hewlett-Packard	14	Silicon General	10
3	Intel	10	Cypress	13	Lattice	10
4	National	8	Linear Tech.	5	Xilinx	9
5	AMD	7	Burr-Brown	5	TRW	7
	Others	21	Others	46	Others	48
	Total	100	Total	100	Total	100

Source: Dataquest (March 1991)

size category, the five performance scores then were aggregated into one score to determine the Supplier of the Year for that size category.

PROCUREMENT RANKINGS

Table 1 summarizes rankings of each size category's top five suppliers as voted on by the worldwide *Electronic Business* sample.

The relatively high percentage of votes received by the top five major suppliers compared with the other two categories reflects the large number of these smaller suppliers and their fragmented markets. It is still impressive that the top three major suppliers gained 64 percent of the vote and that, despite a worldwide sampling, the highest-ranked Japanese supplier gained only 3 percent of the total major supplier votes.

DATAQUEST PERSPECTIVE

The winners of this year's award met or exceeded their customers' expectations and requirements summarized in the listing of key issues from our annual procurement survey. The focus of providing excellence in the majority of areas of price, product, quality, delivery, and service requires listening to the needs of customers and delivering on commitments. Programs such as Motorola's "Six-Sigma" plan have gained momentum and are raising the overall level of performance throughout the industry. Dataquest expects to see a continual raising of this overall performance as companies strive to reduce total costs and improve efficiencies in the face of increasing domestic and foreign competition. A good start to begin improving performance is to refer to the top 10 procurement issues noted in SUIS newsletter number 1991-11, entitled "1991 Semiconductor Procurement Survey: Basics Are Back." Good luck to those aspiring for next year's award!

Mark Giudici

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Research Newsletter

1991 SEMICONDUCTOR PROCUREMENT SURVEY: BASICS ARE BACK

SUMMARY

This newsletter highlights the results of the Sixth Annual Dataquest Semiconductor Procurement Survey that was taken in the November-December 1990 time frame. The three key findings of the survey were as follows:

- Respondents expect to increase their 1991 semiconductor purchases by 10 percent.
- The majority (88 percent) of respondents expect equipment sales to grow or stay at 1990 levels.
- The three top issues are price, availability, and cost control.

METHODOLOGY

As in past procurement surveys, Dataquest used the *Electronic Business* Top 200 company listings as a basis for the survey. We removed from the sample all companies that made or distributed semiconductors or software in an attempt to ensure that we dealt with potential semiconductor users only. This reduction brought our sample down to 170 companies. From this base, we surveyed by telephone 760 procurement sites of these companies and received 193 responses (25 percent response rate). As seen in Figure 1, the majority (52.8 percent) of the respondents were from the Pacific (29.5 percent) and Northeast (23.3 percent) regions because of the larger concentration of technology manufacturing in those areas.

Figure 2 shows the total respondent breakdown by application segment in 1990 purchasing dollars. The survey's total respondent 1990 purchasing power totaled $2.74 billion, or 15.6 percent of the North American semiconductor market.

SEMICONDUCTOR USER OUTLOOK

User Expectations

A strong showing of over three-fourths (82.5 percent) of this year's respondents expect to either increase or stabilize their system sales in 1991 relative to 1990 levels, as shown in Figure 3. The level of optimism is slightly less than last year, with a few more respondents expecting to see lower sales (10.9 percent in 1991 versus 6.5 percent in 1990). Despite the lower system sales outlook, buyers still expect to purchase 10 percent more semiconductors in 1991 than in 1990. Relative to the past five annual forecasts, this level of increase falls slightly below the forecast mean of 12.4 percent.

The survey was taken in the midst of a foreboding economic environment for 1991, and the electronic sales outlook has wavered a bit more now in response to the Gulf War. Our monthly survey data on system sales and semiconductor purchases reflect a slight lessening of optimism due primarily to the overall economic situation, which is being exacerbated by the psychological impact of the war. In comparison with recent semiconductor supplier forecasts that we have seen, the 10 percent forecast appears to be a formidable, yet realistic, growth target.

The overall response in terms of 1991 equipment sales expectations was split evenly between increased sales (44 percent) and sales remaining at 1990 levels (44 percent). As seen in Figure 3, all respondents (except military/aerospace) expect their respective applications to increase in equipment sales. The application with the highest expectation to maintain flat business levels (after the small transportation sample) is the military/aerospace segment. Figure 4 illustrates that the level of growth for more than 90 percent

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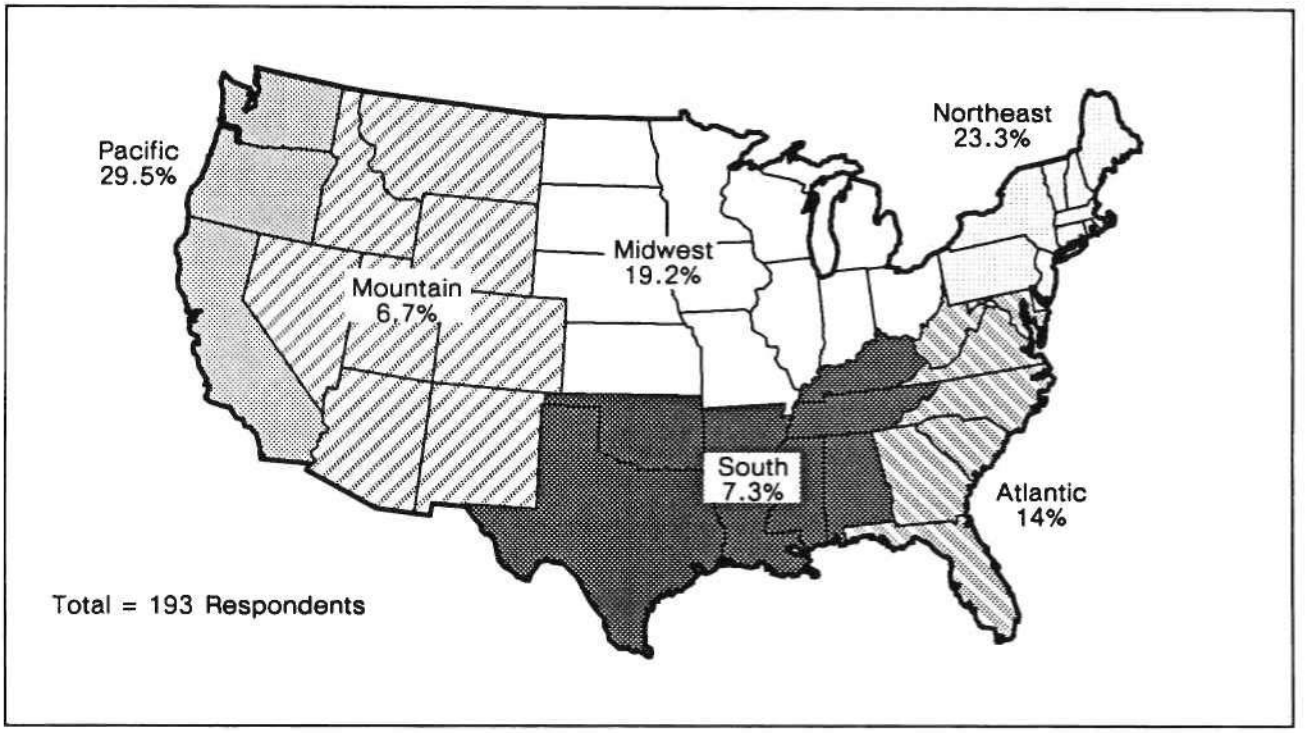
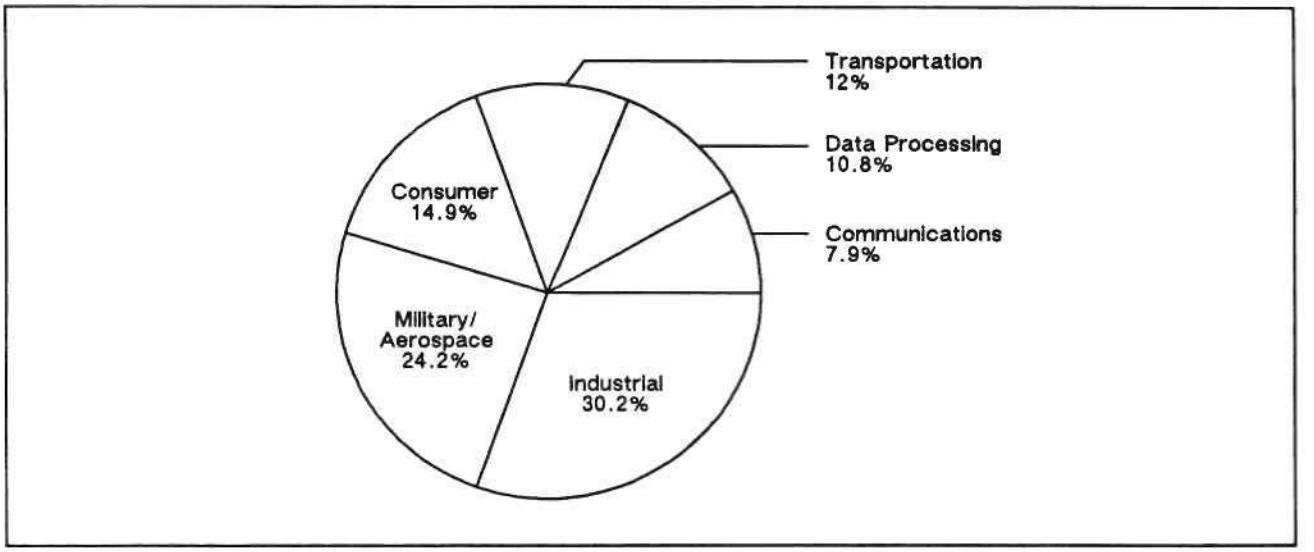
FIGURE 1
Procurement Survey Audience



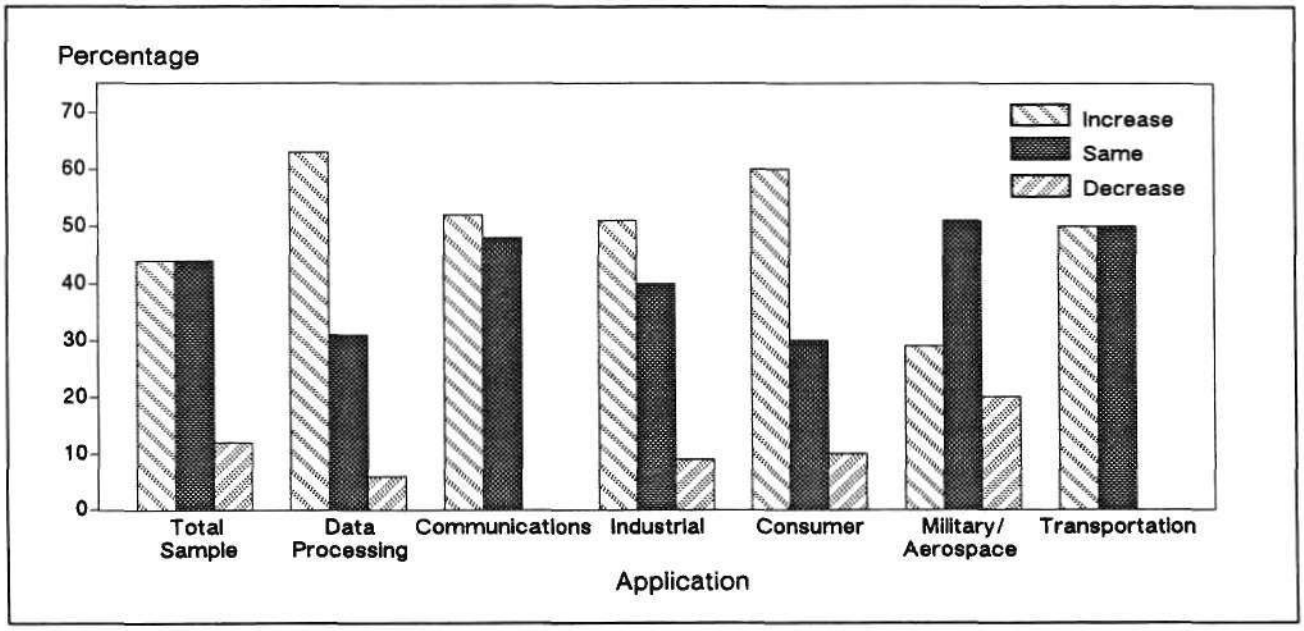
Source: Dataquest (March 1991)

FIGURE 2
1990 Survey Respondents' Purchasing Dollars



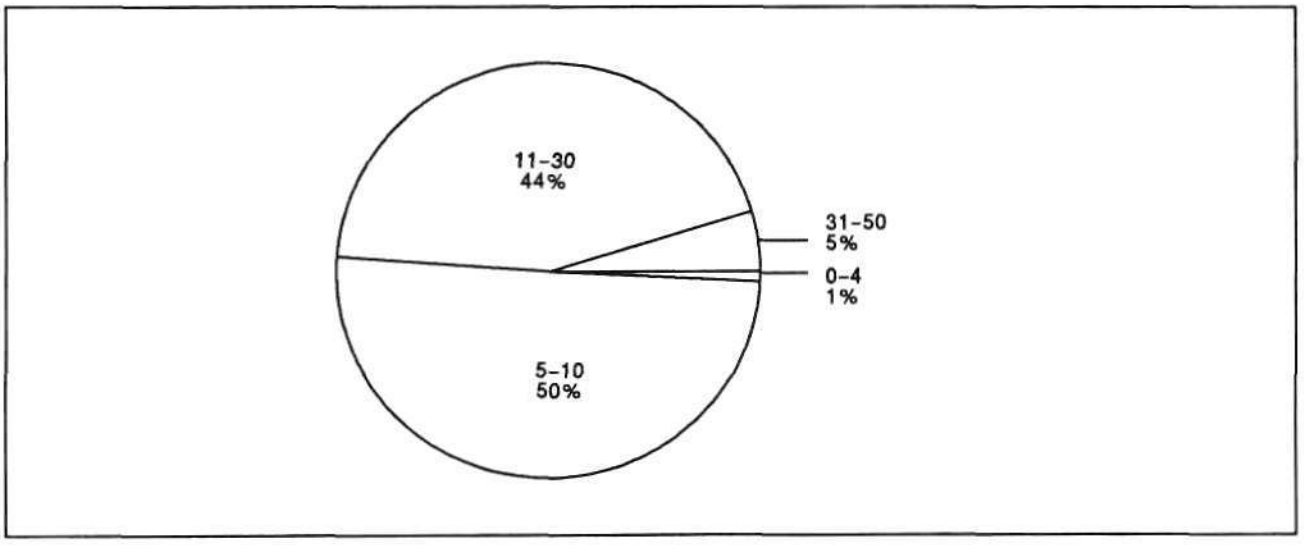
Source: Dataquest (March 1991)

FIGURE 3
1991 Equipment Sales Expectations



Source: Dataquest (March 1991)

FIGURE 4
Growth Expectations of Respondents Forecasting Growth



Source: Dataquest (March 1991)

(94.7 percent) of the overall sample expecting growth ranges from 5 to 30 percent, while Figure 5 shows that respondents in the industrial application expect to have the highest mean growth.

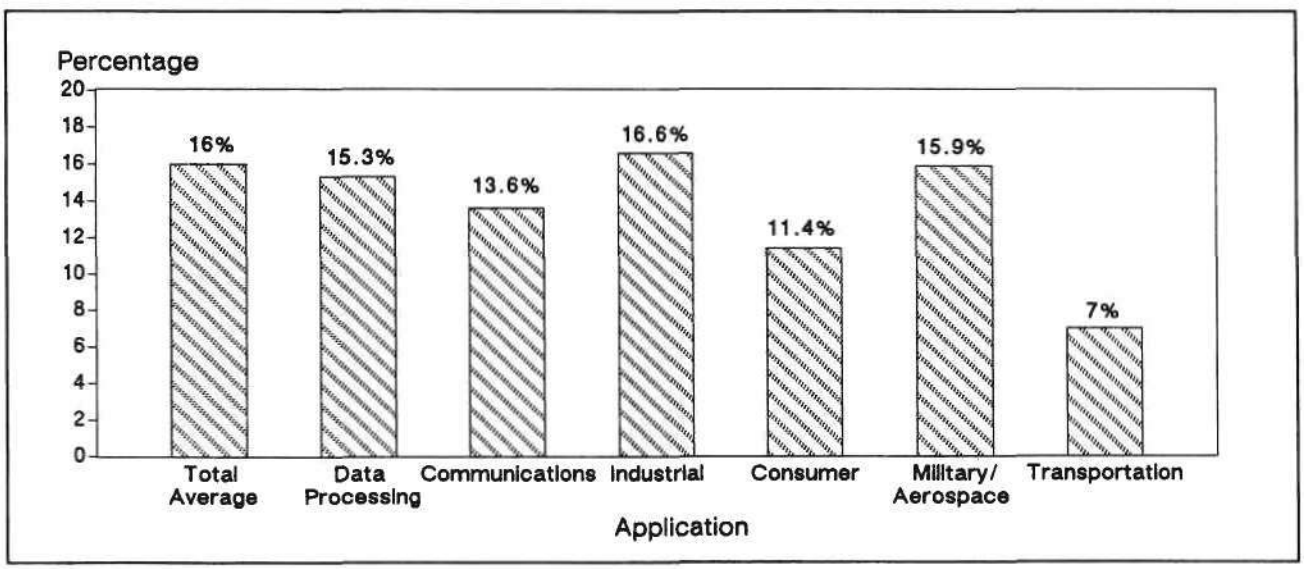
User Inventory Plans

The targeted semiconductor level has dropped to 40 days, down 15 percent from last year's average target of 47 days. As shown in Figure 6, close to half (47 percent) of this year's respondents maintained average inventory levels at targeted levels of 40 days. Less than one-third (31 percent) of the sample were above target last year, averaging 46 days, and over one-fifth (22 percent) of respondents were below target, averaging 33 days of semiconductor inventory. This reduction in average inventory target levels, including a representative military response, reiterates the message that the preaching and practice of cost/inventory control is being acted upon. Another reinforcing message for future inventory control is illustrated by Figure 7, where 86 percent of the responding sample will either retain or reduce their 1990 semiconductor inventory target levels in 1991. This trend of lowered inventory targets is currently being reflected in Dataquest's monthly sample of procurement managers, where there now is an average 20-day inventory target.

FIGURE 6
Respondents' Inventory Levels

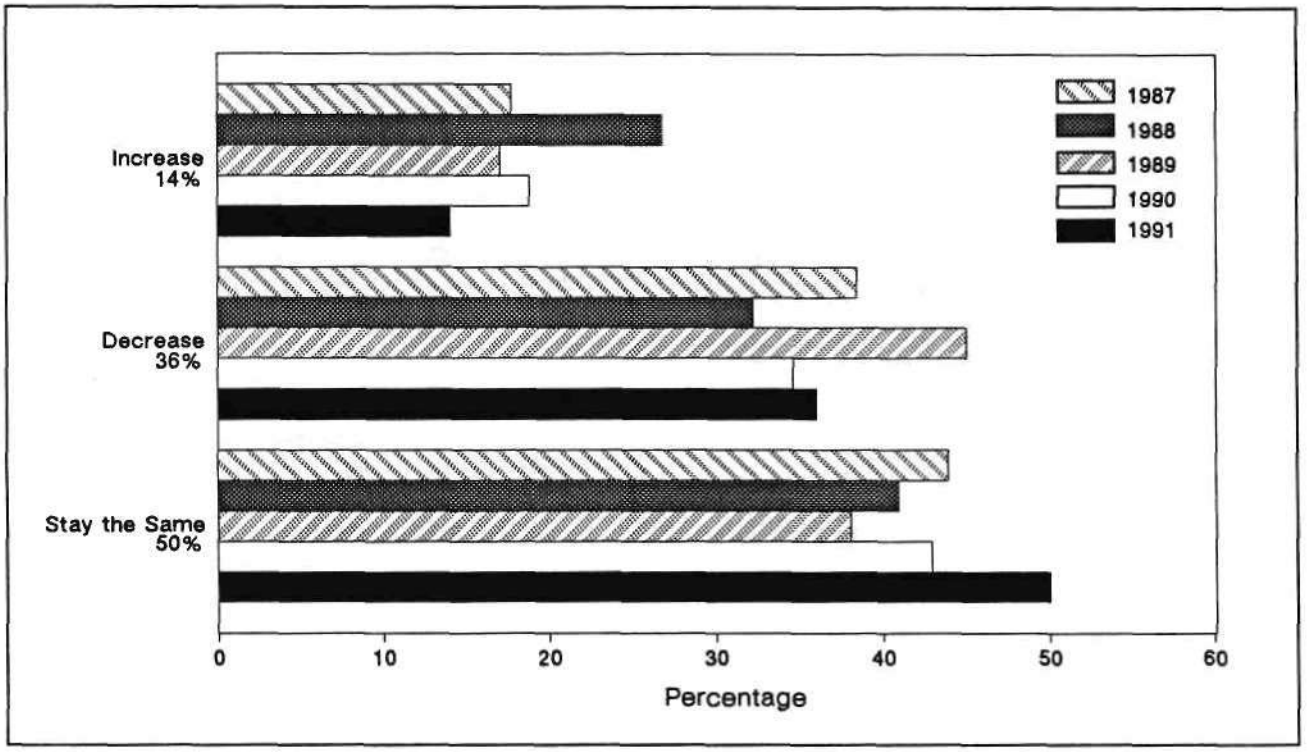
Source: Dataquest (March 1991)

FIGURE 5
Growth Expectations by Semiconductor Application



Source: Dataquest (March 1991)

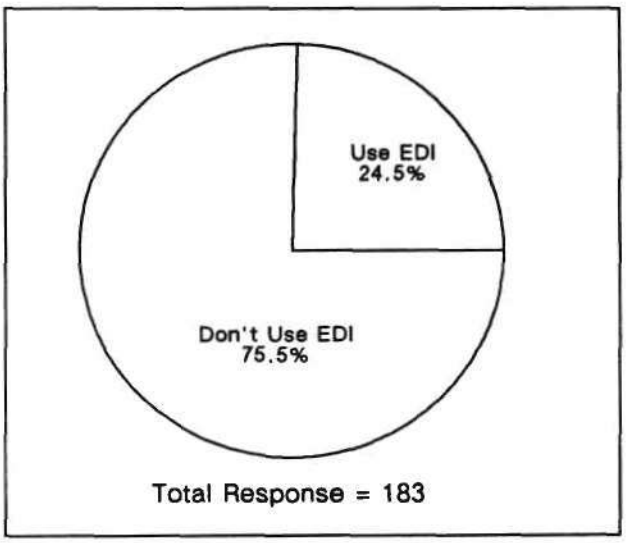
FIGURE 7
Expected Change in Target Inventory Levels



Source: Dataquest (March 1991)

This year, we included a question regarding the use of electronic data interchange (EDI) to check the status of this mode of order and inventory control. As Figure 8 shows, less than one-fourth of the respondents (24.5 percent) currently use EDI; of those that use it, close to half (48.9 percent) use it for only 10 percent or less of their semiconductor orders. The low utilization of EDI apparently is due to the real or perceived costs involved in setting up the equipment and to the relationships necessary for it to work. We will continue to track this area of procurement in the future.

FIGURE 8
Electronic Data Interchange Usage



Source: Dataquest (March 1991)

Top User Issues Focus on Cost Control

After being the number two issue for the past four years, this year's respondents listed semiconductor price as the number one issue facing them in 1991, as shown by Table 1. Last year's number one issue—on-time delivery—dropped to number six in priority, primarily because of improvements in forecasting and delivery commitments achieved in 1990. Tied in closely with price (and rising from last year's number four), the new number two issue is availability, followed closely by an unchanged number-three ranked cost control.

Rounding out the top four issues that focus on cost control is just-in-time delivery/inventory control. Quality/reliability has risen to number five among issues for procurement managers in 1991. The shift from supplier performance seen in 1990 to a focus on overt cost control in 1991 reflects the way that most companies are coping with the current economic environment. Performance to commitments is being de-emphasized in part because many companies are satisfied with the level of support of their suppliers. A new entrant to the top 10 issues in 1991 (number nine) is "petroleum-based pricing issues," again reflecting cost concerns mixed over uncertainty with developments in the Middle East. As mentioned in our newsletter highlighting the annual Semiconductor Supplier-of-the-Year Award presentation (number 1991-12, entitled "Semiconductor Supplier of the Year—Awards to Motorola, Analog Devices, and Maxim") the following three companies exhibited to buyers their commitment to meet last year's top issues:

- Major supplier—Motorola
- Midsize supplier—Analog Devices
- Niche market supplier—Maxim Integrated Products

Companies wishing to win an award next year should take this year's list of top issues to heart to best meet their customers' needs.

DATAQUEST PERSPECTIVE

This year's survey confirms many of the trends that Dataquest has previously reported; in addition, it also highlights new issues on which semiconductor users are focusing. The user community's relatively positive outlook for system sales and semiconductor procurement in the face of an uncertain economic environment is still being reflected in Dataquest's monthly *Procurement Pulse* survey. The perceived or real impediments to EDI use were reflected in the relatively low level of use by this year's respondents. As ease of use improves, EDI implementation should increase for future sampled companies. The overall "back to basics" theme of this year's responses reflects the concern of many companies that cost-cutting measures come first in uncertain times. Suppliers that provide users with both the nuts and bolts of low overall prices and superior delivery and service (totaling low overall costs) will be meeting most of this year's users' needs.

Mark Giudici

TABLE 1
User Issues

1991 Rank		1990 Ranking	1989 Ranking	1988 Ranking
1	Pricing	2	2	2
2	Availability	4	1	1
3	Cost control	3	7	4
4	JIT/inventory control	5	6	9
5	Quality/reliability	6	4	6
6	On-time delivery	1	3	3
7	New products/obsolescence	7	8	8
8	Government regulation	10	-	-
9	Petroleum-based pricing issues	-	-	-
10	Reducing vendor base	8	-	7

Source: Dataquest (March 1991)

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Research *Bulletin*

FEBRUARY MARKET WATCH: FLAT EQUIPMENT DEMAND AND MANAGED SEMICONDUCTOR SUPPLIES REFLECTED IN STABLE AND LOWER BUSINESS LEVELS

The *Market Watch* is a monthly Dataquest bulletin that is released after the SIA book-to-bill Flash Report. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

ANOTHER SLIGHT RISE IN THE BOOK-TO-BILL RATIO, BUT THE NUMBERS TELL OTHERWISE

January's book-to-bill ratio rose slightly to 0.96, up from December's 0.95 level, as seen in Figure 1. Although the ratio is up, the actual

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

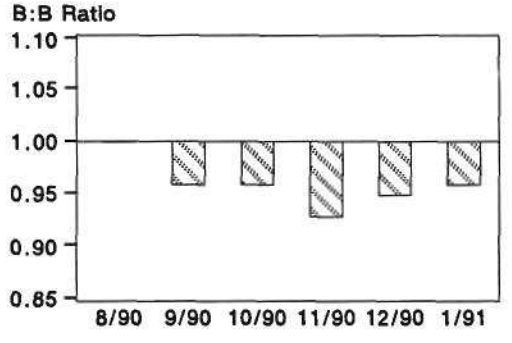


Figure 2
DOC Computer Demand

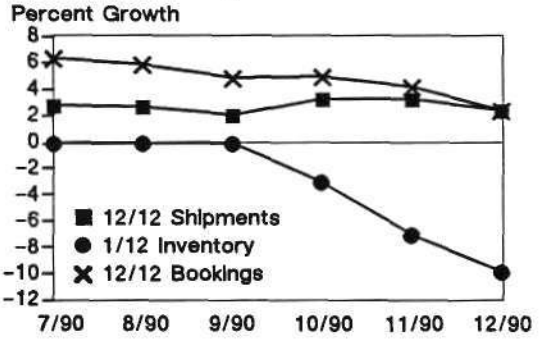


Figure 3
Semiconductor Inventory Level

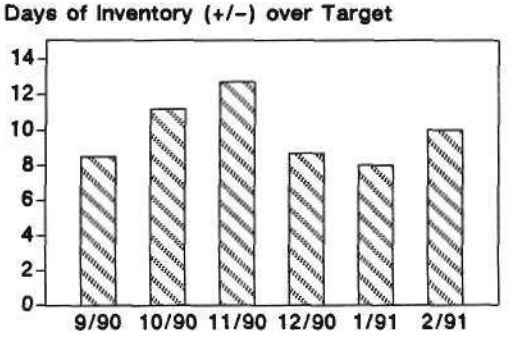
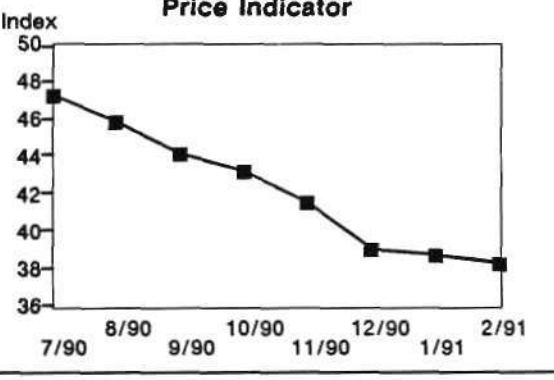


Figure 4
U.S. Weighted Semiconductor Price Indicator



Source: WSTS, U.S. Department of Commerce, Dataquest (February 1991)

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average booking and billing dollars show a *steady decline* for the last three months. The only bright spot in the billing numbers is that last month's semiconductor shipments were a meager 4.3 percent higher than January 1990's billing equivalent. The expected increase in semiconductor purchases noted in the January *Procurement Pulse* did not materialize, partly because of the uncertainty surrounding the economy and the Iraq war. The six-month business outlook for systems buyers is still positive (3.7 percent) but down from the last month's prewar optimism of 6.9 percent. This lowering of expectations will not severely impact semiconductor order rates, because user semiconductor inventories on average remain at the 30-day level.

COMPUTER BOOKINGS AND SHIPMENT RATES MERGE, INVENTORY RATES CONTINUE TO DIVE

Figure 2 illustrates the slippage of the December bookings and shipment rates of computers and business machines to an equal rate of 2.45 percent from 4.2 percent and 3.3 percent, respectively, reported in November. The decline in inventory rates seen in the Department of Commerce's December numbers reflects efforts to improve year-end financials in view of slow sales and confidence in the ready availability of raw materials to replenish shelves in balance with future needs. The Iraq war appears to be adding another layer of psychological uncertainty to an existing soft economy, which is resulting in some delays to system orders. Dataquest still expects the year to reflect a steady growth pattern in semiconductor business (9 percent worldwide), although the near term may result in lower-than-average growth because of the war.

SEMICONDUCTOR INVENTORIES RISE TO AVERAGE LEVELS

The levels of respondent users' semiconductor inventories rose slightly (by 3 days to 31 days) this month; targeted levels also increased (by 1 day to 21 days). The resulting 10-day difference is 3 days more than last month's difference and generally reflects lower system sales that most likely will be adjusted for next month. The outlook for system sales during the next six months still is positive at 3.7 percent but is not as rosy as last month's prewar 6.9 percent forecast. The continued positive business outlook is expected to be maintained regardless of the war and could be negatively affected only by a dramatic financial mishap. Dataquest expects semiconductor users to continue to hold semiconductor inventories at about a 30-day average and will balance this padding with their system sales levels.

OVERALL PRICES FLATTEN, AVAILABILITY REMAINS GOOD

Largely because of the recent flattening of DRAM prices, the overall price level as per the most recent *DQ Monday Report* has remained unchanged since last month's review. Because of selected fourth-quarter 1990 production reductions by some Japanese memory suppliers, the overall 1Mb DRAM market price has flattened, and non-Japanese suppliers continue to follow the Japanese lead in firm pricing for this device. Lead times for memory and most other semiconductor products remain consistent and predictable. Dataquest does not expect the current level of price stability to be maintained because of the steady/slow growth demand pattern now in motion. Memory price declines may resume if non-Japanese suppliers in aggregate try to take advantage of stable prices by increasing shipments. This scenario, if enacted, will not be felt in the market for six to eight weeks because of the fabrication time needed for the additional parts.

DATAQUEST CONCLUSIONS

System sales expectations remain in a low growth mode, and procurement plans closely mirror this outlook as semiconductor inventories are maintained at a constant level. The overall availability of semiconductors remains very good despite some memory production cutbacks. Forecasting continues to improve, keeping inventories of both suppliers and users controllable. In the near term, Dataquest expects to see steady semiconductor demand levels and stable supplies equaling flat prices and lead times. Looking beyond the next three months involves considering the directions of the economy and the war. Low growth being the status quo, a resumption in economic growth and/or a resolution to the war could perk up a reluctant electronics market.

Mark Giudici

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Research Newsletter

NORTH AMERICAN MEGABIT-DENSITY DRAM PRICE OUTLOOK: TODAY (1991), TOMORROW (1993), AND THE DISTANT FUTURE (1995)

EXECUTIVE SUMMARY

While the Gulf War wages, IC procurement teams grapple with plans for long-term megabit-density DRAM price trends. Meanwhile, a recent abrupt shift in global DRAM market conditions has altered the 1991 DRAM/VRAM pricing outlook to the joy of suppliers and the consternation of most users. As shown in Table 1, this newsletter provides a strategic perspective on Dataquest's Semiconductor User Information Service (SUIS) forecast of North American bookings prices for megabit-density DRAMs through the year 1995 and also sheds instant light on the altered 1991 price scenario. This newsletter states the critical assumptions behind the forecast regarding DRAM supply and demand, cost models, trade issues, and suppliers' strategies so that users and suppliers can respond to volatile DRAM market shifts.

OVERVIEW: AN ALTERED 1991 OUTLOOK PLUS THE LONG-RANGE VIEW

This newsletter focuses on four DRAM price estimates: the range of North American bookings

TABLE 1
Semiconductor Price and Lead Time Trends
(North American Bookings[1], Volume Orders)

Part	Original Price Range Expected for First Quarter 1991[2]	Long-Range Price Trend (Dollars) Preliminary Result of Actual Price Range for First Quarter 1991[3]	1993 Price Forecast[2]	1995 Price Forecast[2]
1Mbx1 80ns DRAM, SOJ	4.00 to 4.90	4.25 and 4.90	3.40	3.20
4Mbx1 80ns DRAM, SOJ (300 mil)	17.00 to 28.10	18.00 to 29.00	11.30	8.50
256Kx4 120ns VRAM, ZIP	10.05 to 10.55	10.05 to 10.55	7.67	6.85
4Mbx9 80ns SIMM	NA	NA	111.87[4]	86.05[4]

1 This SUIS forecast is for North American bookings pricing. *Worldwide* bookings pricing is somewhat higher.
2 These prices correlate with the SUIS forecast dated December 1990.
3 This price range is a *preliminary* estimate that correlates with the SUIS forecast that will be published during March 1991. Japan-based suppliers cut production during late 1990, which enabled DRAM pricing to increase during early 1991, as shown in this column.
4 Estimated but not by survey.
NA = Not available
Source: Dataquest (February 1991)

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prices, *originally* expected for the first quarter of 1991, as garnered through the SUIS year-end 1990 survey of users and suppliers; the preliminary results of the actual prices for the first quarter of 1991; the 1993 price forecast; and the 1995 price forecast. An emphasis is placed on highlighting the assumptions on which Dataquest bases the forecast in order to provide deeper insight into Dataquest's SUIS pricing outlook for 1991 and beyond. Because global DRAM market conditions have shifted so sharply since the quarterly price survey was conducted during November and December 1990, emphasis will also be made on the altered 1991 DRAM market/price outlook.

The price analysis presented here correlates with the quarterly and long-range price tables mailed to SUIS clients on December 20, 1990. For SUIS clients that use the SUIS on-line service, the quarterly pricing presented here correlates with the quarterly and long-range price tables dated December 1990 in the SUIS on-line service. The price analysis in this newsletter also correlates with the *Source Dataquest* report entitled "Semiconductor Price Outlook: First Quarter 1991," dated January 1991. For additional product coverage and more detailed product specifications, please refer to those sources.

DRAM MARKET CONDITIONS

The 1991 market for 1Mbx1 DRAMs recently changed sharply—and so have Dataquest's assumptions on the 1991 price outlook. The 4Mbx1 DRAM scenario remains in line with original assumptions, although it is somewhat modified. Although the 1991 price forecast for 1Mb DRAMs has changed, the assumptions for the long-range DRAM price forecast have *not* changed dramatically since December 1990:

1Mb DRAM: Japanese Suppliers Raise Prices and Other Suppliers Tag Along

Table 1 reveals that the participants in Dataquest's year-end 1990 price survey originally expected the North American bookings price for 1Mbx1 80ns DRAM SOJ in volume contract orders to range from $4.00 to $4.90 during the first quarter of 1991. From now on, the SUIS price forecast on DRAMs will refer to volume orders instead of the former specification, which was 100,000-piece orders. On this basis, in December 1990 SUIS forecast a price of $4.29 for the first quarter of 1991.

A Short-Term Assumption Proves Wrong

Under Ministry of International Trade and Industry (MITI) guidance, some Japanese suppliers have begun to withdraw from this market and have either raised the price for the 1Mb DRAM during early 1991 or held pricing stable at high levels. SUIS anticipated this trend by Japan-based suppliers but assumed that 1Mb DRAM suppliers from other regions would not join Japanese companies in raising prices. This assumption proved wrong. In fact, non-Japanese suppliers *for the time being* have joined Japan-based suppliers in raising the price for 1Mb DRAMs.

An Early Look at the Updated SUIS 1991 Price Forecast for 1Mbx1 DRAM

The SUIS first-quarter 1991 price survey is being conducted during February 1991, and the updated forecast will be published in March 1991. The early results of this survey indicate, in conjunction with other market information, that the actual first-quarter North American bookings price for the 1Mbx1 DRAM as specified will be between $4.25 and $4.90 versus the December 1990 forecast of $4.29.

Dataquest assumes that current market conditions—which are marked by Japan-based price "leadership" in terms of upward pressure on 1Mb DRAM prices, with other suppliers opportunistically following—will hold true for the first half of 1991. Under this assumption, North American bookings prices for 1Mbx1 DRAMs could edge *upward* during the second quarter of 1991. The early results of the current price survey signal such a price trend, followed by a flat or slowly declining price profile for the second half of 1991. For the fourth quarter of 1991, the North American bookings price forecast for 1Mbx1 DRAMs will likely be increased to $4.25 versus the original December 1990 forecast of $3.79 for year-end 1991.

4Mbx1 DRAM: Demand to Pick Up and Prices to Decline during 1991

Table 1 shows that participants in the fourth-quarter 1990 price survey originally expected the North American bookings price for 4Mbx1 80ns DRAM SOJ in volume contract orders to range from $17 to $28 during the first quarter of 1991. On this basis, SUIS forecast a price of $19.80 for the first quarter of 1991.

No Major Change in the SUIS 1991 Price Forecast for 4Mbx1 DRAM

The early results of the current (February 1991) price survey indicate that the actual first-quarter North American bookings price for 4Mbx1 DRAMs will be quite close to $19.80, which was forecast in December 1990.

Dataquest's operating assumption for 4Mb DRAM is that first-tier Japanese suppliers, along with other worldwide suppliers, will ramp up production during 1991 and cut prices in order to win business in line with historical crossover experience. This assumption has proved sound. Current market conditions are marked by a strong move by Japan-based suppliers from the 1Mb DRAM to the 4Mb device with consequent downward pressure on 4Mb DRAM prices. Although upward pressure on 1Mb DRAM prices reduces the incentive for sharp 4Mb DRAM price declines, Dataquest still foresees a 4Mb DRAM crossover (4:1 unit/price ratio) for the second quarter of 1991.

In fact, Dataquest believes that capacity for 4Mb DRAM is likely to *exceed* demand for 1991; however, suppliers will avoid bringing all of the capacity on-line this year in order to avoid a 4Mb DRAM market glut. The early results of the survey also indicate that the SUIS forecast on the North American bookings price for 4Mbx1 DRAMs for the fourth quarter of 1991 will likely be increased in nondramatic fashion to a price in the $14.50 to $15.00 range versus the original December 1990 forecast of $14.00.

MEGABIT-DENSITY DRAM: THE LONG-RANGE ASSUMPTIONS

As noted, most of the assumptions for the long-range DRAM price forecast have *not* changed dramatically since December 1990. Clearly, one assumption—that non-Japanese suppliers will continue to lower prices while Japan-based suppliers depart any given DRAM market segment—has been controverted for the short term.

The following key assumptions guide the SUIS long-range megabit-density DRAM price forecast for North America. First, global DRAM capacity will exceed market DRAM demand during the first half of this decade. A second assumption is that the foreign market value (FMV) system of pricing either will terminate during mid-1991 or will be replaced by a pricing system that assures low-priced DRAMs for North American users. Third, cost-based price reductions will assure lower pricing for 4Mb DRAMs and competitive pricing for 1Mb devices. A fourth assumption—which Dataquest still believes will hold true after 1991—is that non-Japanese suppliers will again continue to lower megabit-density DRAM prices to take market share as leading-edge Japan-based suppliers migrate to next-generation products.

During February and March 1991, Dataquest Semiconductor Industry Service (SIS) and SUIS analysts in San Jose, California, will work closely with SIS DRAM analysts in Tokyo and London to reassess these assumptions and the concomitant SUIS DRAM price forecast.

1Mbx1 80ns DRAM: The Critical Assumptions

Under these assumptions and as shown in Table 1, Dataquest anticipates that the North American bookings price for 1Mbx1 80ns DRAM SOJ in volume orders will be $3.40 for 1993 and reach bottom at a price of $3.20 for 1995.

In terms of the four assumptions, these points should be stressed. First, analysts in Dataquest's Semiconductor Equipment, Manufacturing, and Materials Service (SEMMS) and SIS Memory recently analyzed the combined worldwide demand for 1Mb DRAMs and 4Mb DRAMs against the megabit-density DRAM fab capacity outlook for the 1990 to 1994 time frame. This analysis *conservatively* estimates that megabit-density DRAM capacity utilization should reach its highest level, 77 percent, during 1991 and decline to 74 percent for 1994. Succinctly, megabit-density DRAM capacity should exceed demand over the long term, barring a major and unexpected supplier reduction of production capability.

Second, a 1Mb DRAM cost model developed by SUIS and SEMMS analysts reveals that suppliers will be able to profitably manufacture this device at the prices specified in the SUIS forecast (i.e., $3.40 for 1993 and $3.20 for 1995). Next, Dataquest anticipates the demise of the FMV system—but the remaining 1Mb DRAM suppliers will be non-Japanese and thus will be unaffected even if FMVs do survive in some form.

An Early Look at the Updated Long-Range Forecast for 1Mbx1 DRAM

Because non-Japanese suppliers opportunistically raised 1Mbx1 80ns DRAM prices early in 1991, Dataquest realizes that the anticipated

long-term decline in 1Mb DRAM pricing is likely to start at a higher 1991 level than the original 1991 forecast price of $4.02. Suppliers may aim for continued *upward* pressure on pricing, but long-term market forces should dictate otherwise. During March 1991, the North American bookings price forecast likely will be increased for 1993 to a price of about $3.80 and for 1995 to a price range of $3.40 to $3.60.

4Mbx1 80ns DRAM: The Forecast Remains Consistent

In line with the previously mentioned four assumptions and supporting analysis, as shown in Table 1, Dataquest anticipates that the North American bookings price for the 4Mbx1 80ns DRAM SOJ in volume orders will be $11.30 for 1993 and $8.50 for 1995.

In terms of the four assumptions, the following points are stressed. First, as noted, megabit-density DRAM capacity should exceed demand over the long term, barring an unanticipated cutback in capacity. Next, Dataquest's 4Mb DRAM cost model conservatively shows that suppliers will be able to profitably manufacture this device at the price levels indicated in the long-range SUIS forecast. Third, the anticipated termination of the FMV system—or its replacement by a less onerous pricing scheme—would permit pricing to decline at an even more rapid rate than projected by the SUIS forecast.

A volatile element of risk always lurks in the DRAM marketplace. Regarding the long-range 4Mb DRAM market/price outlook, one such risk would be a jump by several suppliers to the 16Mb DRAM, in effect bypassing the 4Mb generation. As of early 1991, suppliers speak of such a move, but none has done so.

Changes in the Rules of the Game: 1Mb VRAMs and 4Mb SIMMs

In the DRAM business, many of the prior rules of the game (e.g., process technology, fab funding) will change with the move from 1Mb DRAM to 4Mb densities and above. A major change derives from system needs in terms of video applications, meaning more rapid growth in demand for video RAMs (VRAMs) and system size constraints, which translates into increased demand for single in-line memory modules (SIMMs). In response to client inquiries, this newsletter now shifts attention to two less familiar DRAM devices—the 256Kx4 VRAM and the 4Mbx9 SIMM—which will command more market attention over the long term.

256Kx4 VRAM: The 1991 Price Forecast Remains Consistent

Table 1 shows that participants in the fourth-quarter 1990 price survey originally expected the North American bookings price for 256Kx4 120ns VRAM ZIP in volume orders to range from $10.05 to $10.55 during the first quarter of 1991. Partly on this basis, SUIS forecast a price of $10.10 for the first quarter of 1991. The early results of the current price survey indicate that the actual first-quarter North American bookings price for this 1Mb VRAM will be on target with a price of $10.10 as forecast in December 1990.

Conservative Assumptions for 1Mb VRAM Price Forecasts

SUIS assumptions for 1Mb VRAM prices have been *conservative*. First, as of late 1990 and early 1991, the supplier base for devices such as 256Kx4 VRAM and 128Kx8 VRAM has been narrow. Dataquest expects the supplier base for VRAMs to widen over time. Until the supplier base does *in fact* widen, SUIS conservatively assumes moderate, not aggressive, short- and long-term rates of price decline. A second and related assumption is that some suppliers remain uncertain regarding their strategy for this market. The VRAM market to date seems more similar to the fast SRAM micromarkets than to the mainstream 1Mb DRAM and 4Mb DRAM markets. For example, not all suppliers will offer a full range of 1Mb VRAMs. Instead, depending on market demand patterns—some of which are being set during 1991—some suppliers will focus on 256Kx4 VRAM, some on 128Kx8 VRAM, some on both configurations, and others on wider configurations. Still other prospective suppliers could choose either to not enter the VRAM market or to enter but then depart.

The early results of the current survey indicate that the SUIS forecast on the North American bookings price for 256Kx4 VRAMs for the fourth quarter of 1991 will *decrease* to somewhat below—but still near—the $9.20 that was forecast in December 1990.

256Kx4 VRAM: A More Aggressive Long-Term Price Forecast

Table 1 also shows that Dataquest anticipates that the North American bookings price for the

256Kx4 VRAM as specified will decline to the $7.67 level for 1993 and to $6.85 for 1995. *Some* survey participants consistently project a price for the VRAM that is below the SUIS forecast. If the supplier base for this IC continues to expand, the price for the 256Kx4 VRAM is likely to decline at a more rapid pace and could reach just under $6 for 1995. The early results of the current price survey indicate that the long-range SUIS forecast on the North American bookings price for 256Kx4 VRAMs will likely be decreased, although the precise changes are not yet known.

Another Change in the Rules of the DRAM Game: More SIMMs

Dataquest sees continued growth in demand and supply of SIMMs. For system design engineers, SIMMs can help reduce system size. For procurement teams, SIMMs can serve as an effective tool for hedging against volatile price swings of different density DRAMs (e.g., 1Mb DRAMs versus 4Mb devices). For purposes of this newsletter, SUIS makes its preliminary projection of long-term pricing for 4Mbx9 80ns SIMMs.

4Mbx9 80ns SIMM: Conservative Assumptions

Table 1 shows that SUIS expects the North American bookings price for 4Mbx9 80ns SIMMs in volume orders to be $111.87 for 1993, decreasing to $86.05 for 1995. This product is not yet covered in the quarterly price survey, so no current price range is available.

The following assumptions guide this forecast. First, Dataquest firmly expects the SIMM supplier base to steadily expand over the long term. The number of suppliers is likely to increase. Also, *some* DRAM suppliers anticipate that SIMMs will represent a much larger share of their total DRAM revenue vis-à-vis past or current levels. Second, Dataquest makes a conservative cost model assumption in formulating the long-range forecast for 4Mb SIMM pricing. The 4Mbx9 SIMM cost model correlates directly with the conservative assumption on which the 4Mb DRAM price outlook is based. Should 4Mb DRAM prices decrease more rapidly than is now forecast, 4Mbx9 SIMM prices are also likely to fall at a faster rate than now expected.

DATAQUEST CONCLUSIONS AND RECOMMENDATIONS

This newsletter provides strategic insight into Dataquest's SUIS forecast of North American bookings prices of 1Mbx1 DRAMs, 4Mbx1 DRAMs, 256Kx4 VRAMs, and 4Mbx9 SIMMs for today (1991), tomorrow (1993), and the distant future (1995). It spells out the critical assumptions on supply/demand, cost models, FMVs, and suppliers' strategies on which SUIS bases the forecast. Under the current volatile market conditions, Dataquest makes the following recommendations.

Users should adjust to a new reality: Suppliers of 1Mb DRAMs will hold pricing power over the first half of 1991. Supply/demand patterns do not fully explain the current market shortage, which means that 1Mb DRAM prices should decrease over the second half of this year, perhaps abruptly.

The market should still plan for the 4Mb DRAM crossover during the second quarter of 1991. Early survey results indicate that prices for 4Mb DRAMs will continue to erode in line with prior expectations and that the current 1Mb DRAM shortage should *not* be a stabilizing factor on 4Mb DRAM pricing.

Users must coordinate closely with suppliers of devices such as 4Mb DRAMs, 1Mb VRAMs, and 4Mbx9 SIMMs over the long term in order to avoid scenarios such as today's spot shortage of 1Mb DRAMs. The rules of the DRAM games are changing, and users and suppliers must work together to adapt to the new market forces.

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Research *Bulletin*

FEBRUARY PROCUREMENT PULSE: BUSINESS LEVELS FLATTEN, INVENTORY LEVELS STABILIZE

. The *Procurement Pulse* is a monthly update of critical issues and market trends based on surveys of semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

Figure 1
Averaged Monthly Semiconductor Orders

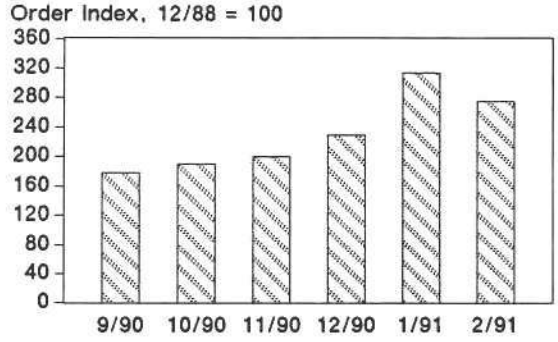


Figure 2
Averaged Semiconductor Lead Times

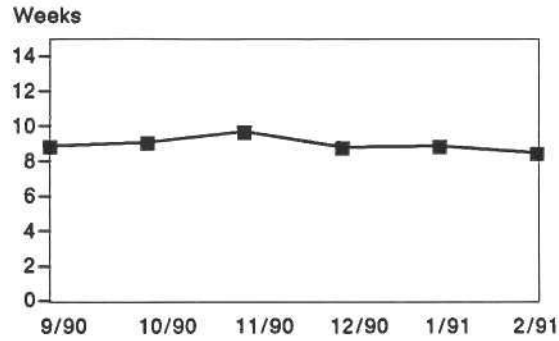


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

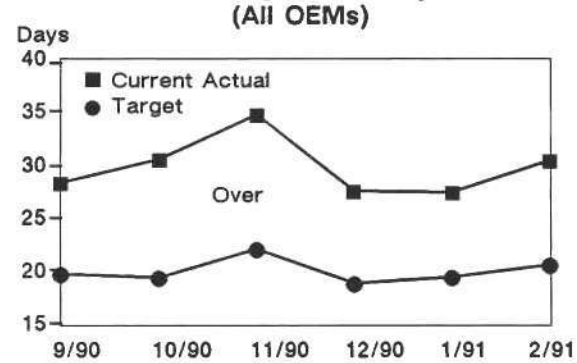
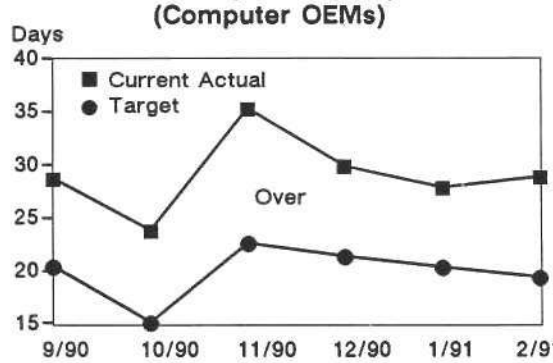


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (February 1991)

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WARTIME WORRIES COMPOUND BUSINESS UNCERTAINTY

As seen in Figure 1, the expected order levels for semiconductors in February should decline slightly—12 percent—from last month's increased expectations. The events that occurred between this and last month's survey (i.e., the Iraq war, recessionary fears) have added an additional level of uncertainty to the fragile order-inventory balance that was adroitly being maintained during the past six months. Although the purchasing expectations were lower than expected in January, the overall trend in order-level activity continues to be positive, in line with a lower but positive system sales forecast. This month's six-month system sales outlook averaged 3.7 percent compared with last month's 6.9 percent figure. Prewar optimism that the Iraq crisis could be resolved peacefully may have biased some of last month's responses that were recorded in the January 1 through 10 time frame. Dataquest continues to expect slow growth in system sales because of replacement and isolated new product introductions that will directly correlate with slow semiconductor sales for the next two quarters.

HO-HUM, LEAD TIMES REMAIN EFFECTIVELY UNCHANGED

Figure 2 shows how little lead times have deviated from their 9-week average of the past six months. The current level of 8.6 weeks is two days less than last month's average of 9 weeks. Overall semiconductor availability remains excellent, with all of this month's respondents noting no problem devices. Lead times for 1Mb and 4Mb DRAMs are being watched closely. Because of production reductions by major Japanese suppliers, prices have firmed for these products. Lead times remain stable, but there are isolated increases for the 4Mb density as crossover pressure continues to raise demand levels for this part. Non-Japanese DRAM suppliers are currently taking advantage of the firming of 1Mb DRAM prices but may resume downward pricing once fab adjustments now being made reach the market in two to three months. Suppliers capable of producing the 4Mb DRAM are focusing all efforts to maximize shipments in order to meet pent-up crossover demand and garner attractive profits and market share. Dataquest does not foresee extension in the overall lead time for semiconductors, but isolated DRAM increases may occur in the next few months.

INVENTORIES RISE SLIGHTLY, YET REMAIN VERY MANAGEABLE

Overall reported targeted and actual inventory levels rose from a respective 19.7 and 27.6 days to 20.7 and 30.6 days. The computer segment's inventory levels moved in opposite directions this month. For computer manufacturers, the respective targeted and actual levels changed from 20.5 and 28 days to the current 19.5- and 29-day average. Both Figures 3 and 4 illustrate how, amid business uncertainty, procurement operations have controlled inventory at about a 30-day actual level while striving for an ideal average 20-day target. As mentioned in last month's *Procurement Pulse*, average inventory levels rose in response to last month's anticipated increase in orders. The expected drop in orders this month is also being tempered by this small blip in inventories. Dataquest foresees no long-term shortage of semiconductors (including DRAMs) that would require inventory increases.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

The war with Iraq has not directly impacted the overall direction of system demand, but it has blunted the traditional quick rise in order activity in the first quarter. Orders for both systems and semiconductors on average appear to be on a slow growth curve, with both industries experiencing pockets of above- and below-normal sales. Although non-Japanese DRAM suppliers are following the upward price trend, availability remains very good for the 1Mb device. The shift to the 4Mb DRAM in the next few months may increase some suppliers' lead times, but this situation will be corrected by the end of the second quarter as the number of suppliers increase and production yields improve. Dataquest forecasts the low growth in demand for electronics experienced before the war to continue for the next six months, and this growth trend may increase when hostilities end.

Mark Giudici

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Research Newsletter

USERS' LONG-RANGE PRICE OUTLOOK—80X86s VERSUS AMX86s VERSUS 680X0s VERSUS RISC PROCESSORS

EXECUTIVE SUMMARY

In the midst of war, system houses continue to plan for long-term IC price trends. As shown in Table 1, this newsletter provides semiconductor users with a strategic perspective on Dataquest's Semiconductor User Industry Service (SUIS) microprocessor (MPU) price forecast through 1995. The long-range forecast is based in part on the results of Dataquest's most recent price survey. This newsletter assesses the critical "whys" behind the forecast—Dataquest's assumptions on suppliers' strategies, marketing trends, and legal issues—so users can adapt to the shifting market.

TABLE 1
Semiconductor Price and Lead Time Trends
(North American Bookings, Volume Orders)

	Long-Range Price Trend (Dollars)			
Part	1991 Price Forecast	Q4 1992 Price Forecast	1995 Price Forecast	Key Assumptions behind Long-Term Forecast
80286-12 PDIP	8.47	7.82	7.15	Supplier base will remain competitive.
80386SX-20 CPGA	89.85	79.82	77.10	Intel's war to kill the 80286 will shift to ICs such as the 80386SL.
80386-25 CPGA	155.93	146.00	143.00	Users must coordinate system life cycles with Intel's MPU product path—or else suffer negative consequences.
80486-25 CPGA	530.75	416.00	394.00	Intel will change the rules of the MPU game.
68020-25 CPGA	94.00	85.00	80.60	The ceramic package makes the difference.
68030-25 CPGA	161.00	140.00	130.00	As users move to the 68040, Motorola has less incentive to lower 25-MHz 68030 prices.
68040-25 CPGA	538.85	400.90	365.00	The 68040 will have a long and healthy life cycle.
SPARC-25	88.74	66.55	53.66	Suppliers of RISC processors will battle on price.

Source: Dataquest (February 1991)

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As reflected in Table 1 and by the title of this newsletter, users can plan for competitive MPU pricing over the long term.

Overview

This newsletter focuses on three price estimates—the 1991 price, the fourth quarter 1992 price, and the 1995 price—for select micromponent devices in order to assess long-term price trends. Emphasis is placed on highlighting the assumptions on which Dataquest bases the long-range forecast to provide users with deeper insight into Dataquest's SUIS pricing outlook for 1993 and beyond.

The pricing analysis presented here correlates with the quarterly and long-range price tables mailed to SUIS clients on December 20, 1990. For SUIS clients that use the SUIS on-line service, the quarterly pricing information presented here correlates with the quarterly and long-range price tables dated December 1990 in the SUIS on-line service. The price analysis in this newsletter also correlates with the *Source Dataquest* report entitled "Semiconductor Price Outlook: First Quarter 1991" dated January 1991. For additional product coverage and more detailed product specifications, please refer to those sources.

MICROPROCESSOR PRICING ISSUES

Table 1 shows that users of high-speed 16- and 32-bit MPUs can expect continued price competition over the long term among major suppliers of CISC and RISC ICs. The following issues should heavily influence these price trends from now until 1995: the evolution of Intel's 80X86 and Motorola's 680X0 families of CISC products; the possible wild-card role of AMD's 80386-type device (AMX86s); and the impact of RISC devices on the CISC market.

Will the 80286-80386SX Battle Ever End?

Table 1 shows that the North American bookings price for the 12-MHz 80286 device (PDIP) in 15,000-piece orders should be $8.47 for 1991. Dataquest forecasts a price of $7.15 for the fourth quarter of 1992.

A key assumption behind this forecast is that the supplier base will remain competitive over the long term. Two suppliers—AMD and Siemens—have been and are expected to be strongly supportive of users of the 80286. Both suppliers experienced a surge in new orders from Eastern Europe during 1990, which should extend the product's life cycle well into the 1990s, especially in that world region.

To answer the question of will the 80286-80386SX battle ever end, AMD and Siemens will continue the battle, although one of the companies may eventually be forced from this market. For example, Dataquest projects a price of $7.15 for this device for 1995. Pricing at this low level means a narrow profit margin and signals a future contraction of the supplier base.

Intel's 80386SX: Flat—or Rising—Prices after 1992

Table 1 shows that the North American bookings price for 20-MHz 80386SX devices in a ceramic pin-grid array (CPGA) package in orders of 1,000 to 5,000 pieces should be $89.85 for 1991. Dataquest forecasts a price of $79.82 for the fourth quarter of 1992. Users should anticipate stable prices thereafter.

A key assumption behind the price forecast for both 20-MHz 80386 IC and 12-MHz 80286 devices is that Intel will continue its campaign to kill the 80286 but will shift the fight from the 80386SX to other products such as the 80386SL. For example, Dataquest expects Intel to attack the portable and laptop PC markets—key applications for suppliers of the 80286—with innovative and ultimately price-competitive newer ICs such as the 80386SL. While maintaining pricing pressure on the 80286, Intel will halt pricing declines for 80386SX products over the long term.

Table 1 shows that Dataquest expects a price of $77.10 for the 20-MHz 80386SX during 1995. Dataquest forecasts a flat price profile for this device ($77.10) during the 1993 through 1995 period.

Why? Because of a second assumption behind the 20-MHz 80386SX forecast: Intel will strongly and favorably support users that coordinate system life cycles with Intel's MPU production migration schedules. In essence, users that migrate to higher-speed and higher-priced devices (or to entirely new replacement devices) in line with Intel's migration path can expect to experience fewer spot shortages and fewer rising price scenarios. The forecast says, in effect, that Intel wants users to migrate from the 20-MHz 80386SX during the second half of 1992,

if not sooner. Users that do not can expect stable prices at best and run the risk of long-term price increases, which occurred to *some* users of the 16-MHz 80386 IC during 1990.

The 25-MHz 80386: Users Should Migrate as Price Stabilizes

Table 1 reveals that the North American bookings price for the 25-MHz 80386 IC (CPGA) in orders of 1,000 to 5,000 pieces should be $155.93 for 1991. Users can expect relatively stable prices after 1991. For example, during the fourth quarter of 1992, Dataquest forecasts a price of $146 and a price of $143 for 1995.

The critical assumption behind the 25-MHz 80386 price forecast was stated in regard to the 20-MHz 80386SX forecast: Intel will most favorably support users that coordinate system life cycles with Intel's product migration schedules. Intel's commitment to the 25-MHz 80386 has started to decrease. During the second half of 1991 and over the long term, users that shift from the 25-MHz 80386 MPU to higher-performance devices such as the 33-MHz 80386 or the 80486 can expect sharper declines in price for these higher-priced ICs—and also reduce the risk of untimely spot shortages or extended lead times.

The 25-MHz 80486: A Change in Intel's Rules of the Game?

In the DRAM business, many of the prior rules of the game regarding such things as process technology and fab funding changed with the move from 1Mb DRAMs to the 4Mb density. Likewise, a basic assumption behind the price forecast for the 80486 is that Intel will set new rules as users move to the 80486 and later to its likely successor, the 80586.

Why? A new element has been added to the equation—these MPUs (unlike in prior generations) incorporate on-board microperipheral functions such as floating-point and memory management, which can be maintained or dropped from the MPU depending on individual customers' needs. Over the long term, Intel's product/pricing strategy will no longer be based on a simple and straightforward premium charge for a higher-speed version of a device (e.g., the 25-MHz 80386 versus the 33-MHz 80386). Instead, by varying the MPU's architectural mix or other features such as power management, Intel will be able, in effect, to tailor future microcomponents to users' micromarket needs regarding product price/performance trade-offs. For example, during 1991 Intel might introduce a lower-performance version of the 80486 (e.g., with no floating-point capability) in order to accelerate the move by users away from the 25-MHz 80386.

A second and related assumption is behind the 80486 long-range price forecast. Intel plans to become more impervious to external pricing pressure than had been the case with the 80286 and 80386SX devices and, to a lesser extent, the 80386. Users of Intel devices will be able to sacrifice (or gain) product performance in exchange for a somewhat lower (or higher) price, but Intel will ignore, to the best of its ability, *competitors'* pricing for similar-type products. This strategy dovetails with Intel's aim of obscuring clear and simple speed-based price structures for a family of devices.

As shown in Table 1, Dataquest forecasts that the North American bookings price for the 25-MHz 80486 IC (CPGA) in orders of 1,000 to 5,000 pieces will be $530.75 for 1991. Learning-curve cost savings should bring the price for the fourth quarter of 1992 to the $416 level. Under the assumptions outlined above, pricing will grudgingly move down to $394 for 1995. After 1992, users of the 80486 are likely to migrate to the 80586 device, a RISC product, or special versions of the 80486.

A Wild-Card Role for AMD's 80386-Type Device?

Many clients have asked Dataquest what long-term effect will AMD's entry into the 80386-type product segment have on Intel product pricing *if* such entry results in market acceptance. To date, Dataquest assumes that there will be little market effect from AMD's 386-type offering on Intel's 80386—and even less on the 80486 and successors. This assumption, in turn, is tied to two other assumptions.

First, Dataquest fully expects Intel to use, with some success, every legal and marketing attack possible to delay or disconcert users from using this IC in systems. Dataquest foresees no impact from AMD's 80386-type part on the market until the middle of 1991 at the very earliest. More likely, Intel will be able to use the courts of law in conjunction with an aggressive marketing campaign to stifle the initial effect, if any, of the new AMD chip until the end of 1991. Second, as already indicated, Dataquest assumes that Intel will

fiercely and successfully resist being drawn into any more pricing battles with AMD. *If* AMD's 80386-type device survives the anticipated legal and marketing onslaught and proves a winner in the marketplace, Intel would accelerate the shift of users from the 80386 family to the 80486 family or to RISC processors.

SUIS analysts recognize that other members of the industry—including some Dataquest analysts—believe that AMD's device will have a sharper market impact. That difference, in perspective, is a major rationale for this newsletter—to explain the assumptions behind the forecast so users can better understand and use the pricing information.

Motorola Microprocessors

As of early 1991, the major news concerns the ramp up by Motorola—or the reduction in users' backlogged demand—for the 68040 IC. The 68020 and the 68030 devices remain Motorola's workhorse products.

25-MHz 68020 Devices: The Ceramic Package Makes the Difference

Table 1 shows that the North American bookings price for 25-MHz 68020 devices (CPGA) in 1,000- to 5,000-piece orders should be $94 for 1991. Dataquest expects a price of $85 throughout 1992. Users can expect a relatively flat price profile for the 1992-through-1995 period.

The key assumption behind the forecast is that Motorola will continue to target high-end PC and workstation applications with the 25-MHz 68020 processor, which uses a CPGA, and will target lower-performance PC applications with the 16-MHz 68020 IC, which uses a plastic quad flat pack (PQFP) package. Under this assumption, after 1991, Motorola will be limited by the ceramic package cost constraint from making sharp reductions in the manufacturing cost and market price for the 25-MHz 68020 device (CPGA). Dataquest expects the price of $85 for 1992 to edge down slowly to just under $81 for 1995.

25-MHz 68030: A Steady—If Not Spectacular—Decline in Pricing

Table 1 shows that the North American bookings price for the 25-MHz 68030 device (CPGA) in 1,000- to 5,000-piece orders should be $161 for 1991. Dataquest expects a price of $140 for the fourth quarter of 1992. Pricing should continue to steadily but not dramatically decline over the long term. Dataquest expects pricing to decline to $130 for 1995.

Two assumptions exist behind this outlook. First, during 1991 and 1992 Motorola must migrate users to the 68040 device, which reduces Motorola's incentive for cutting the price of the 25-MHz 68030 IC for the next two years.

By contrast, Motorola will be able to lower pricing more sharply for the higher-priced 33-MHz 68030 MPU during 1991 and 1992; this 33-MHz part generates a lower sales volume and a wider profit margin than does the 25-MHz 68030, which means more room for price decreases. Motorola has used this device to satisfy *some* users that endured a delay in delivery of the 68040, and an ease in pricing for this MPU may appease long-term customers.

The second assumption behind the 25-MHz 68030 forecast signals a steady if not spectacular decline in pricing after 1992. Although the ceramic package remains an important cost element of the 25-MHz 68030 MPU (CPGA), the forecast assumes that Motorola will be *less constrained* from lowering the manufacturing cost and market price of this part over the long term than will be the case with the lower-priced 25-MHz 68020 IC (CPGA).

The 25-MHz 68040: Competitive Long-Term Pricing

Table 1 shows that the North American bookings price for 25-MHz 68040 devices (CPGA) in 1,000- to 5,000-piece orders should be $539 for 1991. Dataquest expects a price of $401 for the fourth quarter of 1992. Prices should continue to decline steadily over the long term. Dataquest expects prices to decline to $365 for 1995.

The main assumption behind this outlook is that despite Motorola's inability to attain its original goal of a ramp during the second half of 1990, we do foresee a healthy long-term life cycle for the 68040. Many users are likely to migrate to the 68040 device, and over the long term, Motorola should be able to reduce manufacturing costs and market price as reflected in our long-term outlook. Once Motorola recovers the high cost of developing and bringing this product to market (which should occur at about the end of 1992), Motorola

could be even *more* aggressive on 68040 pricing—in response to market competition from RISC and other CISC chips—resulting in somewhat lower prices than currently projected.

The 25-MHz SPARC: A Multisourced RISC Processor

Table 1 shows that the North American bookings price for the 25-MHz SPARC device in 1,000- to 5,000-piece orders should be $88.74 for 1991. Users can anticipate a price of $66.55 for the fourth quarter of 1992. Prices should continue to decline steadily over the long term. Dataquest expects prices to decrease to $53.66 for 1995.

The key assumption behind this forecast is that suppliers of RISC processors will battle on price with each other *and* suppliers of CISC processors over the long term in order to win and keep system design-ins. The RISC arena will be more of a multisourced world than will the CISC 32-bit MPU segment. For example, as of early 1991, users can turn to about 10 suppliers for supply of the 25-MHz SPARC IC. This supplier base could narrow over time, but users will still enjoy multiple sources of supply.

The reality of multisourced RISC ICs will keep pricing pressure on all MPU suppliers during the next five years. Suppliers of CISC 32-bit processors may elect to avoid pricing battles, but the long-term threat of RISC IC alternatives should moderate sole-source suppliers' pricing power vis-à-vis the trend of the late 1980s.

DATAQUEST CONCLUSIONS AND RECOMMENDATIONS

Table 1 shows Dataquest's pricing outlook for critical MPUs and the assumptions on which the forecast is based. A key assumption is that Intel is changing the rules of the game for users of its processors. Another critical assumption is that the availability of RISC devices from multiple sources will lessen the pricing power of sole-source suppliers. A controversial assumption is that as of early 1991, the SUIS forecast does not foresee great market impact from AMD's 80386-type IC on Intel's product pricing strategy.

Under current conditions, Dataquest makes the following recommendations:

- Users of the 80286 IC can plan for a competitive, although more narrow, supplier base over the long term.
- Users of Intel's MPUs—the 80386, 80386SX, and 80486—must coordinate long-range system life cycles with the Intel MPU migration path or else face unfavorable prices and extended delivery schedules.
- As shown already through the 80386SL and 80486 devices, users must plan for a change in Intel's rules of the game: the IC price/performance trade-offs of the last decade will be replaced by the architectural/price/performance trade-offs of the next decade.
- RISC ICs translate into more favorable prices for many users.

Ron Bohn

Dataquest
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Research Newsletter

EUROPEAN DRAM PRICE HIKE

INTRODUCTION

Market prices for DRAMs in Europe have taken a sudden jump upward in the last few weeks. Dataquest believes this rise to be related to the new DRAM reference prices (RPs) released by the European Commission. These RPs set floor prices for Japanese-manufactured DRAMs and are revised each quarter. The reference price agreement has now been in operation for one year. Further details can be found in ESIS newsletters 1990-4 "European Commission DRAM Reference Price Agreement" and 1990-17 "European Commission DRAM Reference Prices Behind the Scenes."

IMMEDIATE IMPACT

A summary of the effects of the new RPs is provided below:

- Prices for Japanese DRAMs have increased at most densities.
- Many non-Japanese DRAM suppliers have also increased their prices.
- Europe is no longer the cheapest region for DRAMs.
- The ratio between 4M and 1M DRAM prices has dropped.

For the first quarter of 1991, DRAM RPs are believed to have increased over those of the fourth quarter of 1990 at all densities. The net effect has been an immediate increase in booking prices for all Japanese-sourced DRAMs, which at the 1M density have been about 15 percent. As it is estimated that Japanese companies supply approximately 50 percent of all DRAMs purchased in Europe, the effect on the market has been substantial. It is understood that non-Japanese DRAM suppliers have taken this opportunity to increase their DRAM prices too, although maintaining their prices just below RPs to remain competitive against Japanese companies. Figure 1 shows historical and projected European DRAM billing prices.

CAUSE AND EFFECT

European Commission DRAM RPs have increased because of cutbacks in Japanese production during the lull in demand in the third quarter of 1990. This led to higher unit costs and affected the projected cost of sales for the fourth quarter; these are used to calculate DRAM RPs for the first quarter of 1991. It is this delay in cause and effect that has taken DRAM buyers by surprise.

Japanese DRAM suppliers should not be so surprised and indeed are expected to take full advantage of the situation that has arisen. The reference price of the 4M DRAM has experienced a small rise as it has been increasing in production. This means that the ratio between 4M and 1M RPs is significantly less than in the last quarter and will certainly make the adoption of the 4M a more attractive proposition. The changeover from 1M to 4M is very important to Japanese DRAM suppliers as they urgently need to differentiate themselves from their competitors. The ratio is now believed to be under four.

BUYERS' VIEWPOINT

Throughout the second half of 1990, DRAM pricing in Europe was lower than in any other world region. This was believed to have been caused by the leakage of the DRAM RPs to buyers, which would then accept no other price than the absolute minimum price available, which was none other than the reference price. In this way, non-Japanese DRAM suppliers knew how they could go one better and sold at just below the reference price. This has worked in the buyers' favor as the market price for DRAMs came down.

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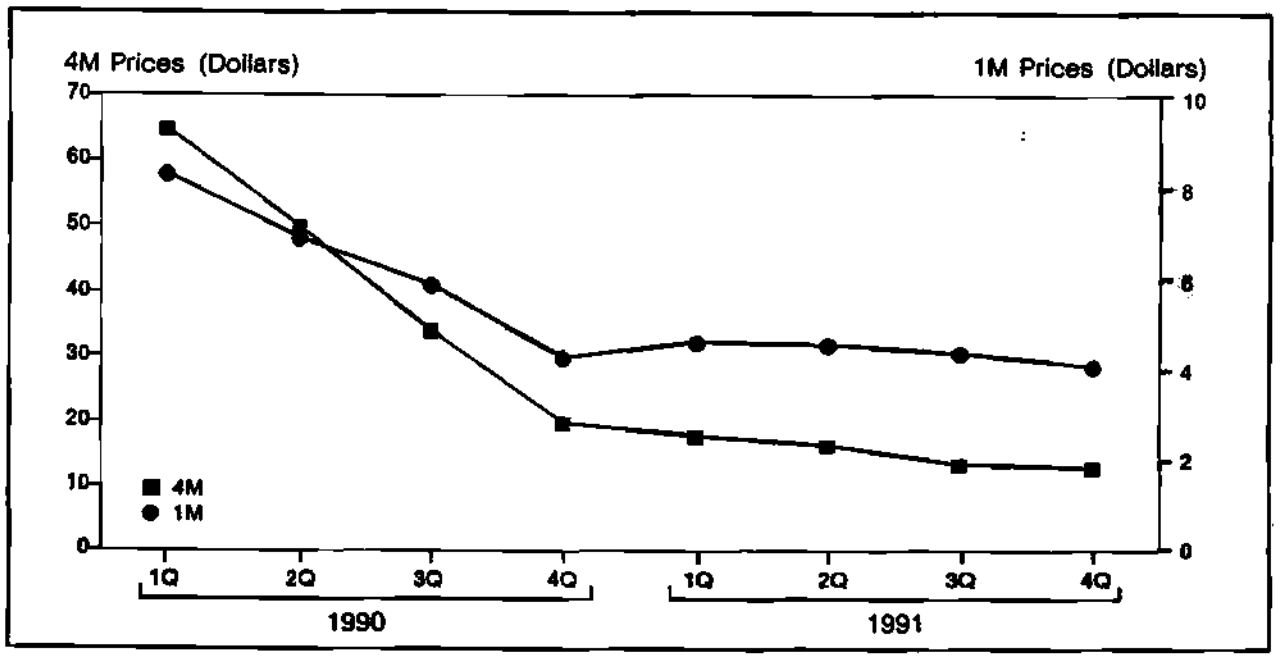
FIGURE 1
Estimated European DRAM Billings ASPs, 1M×1 80ns SOJ
(U.S. Dollars)



Source: Dataquest (January 1991)

TABLE 1
Contract Booking Prices for 1M DRAM (1M×1 80ns SOJ)

Market	Dec. 14, 1990 ($)	Jan. 14, 1991 ($)	Change
Europe	4.10	4.70	15% up
United States	4.58	4.50	2% down
Japan	5.07	4.92	3% down
South Korea	5.15	5.15	Flat
Taiwan	4.85	4.40	9% down
Hong Kong	4.60	4.60	Flat

Source: *DQ Monday Report*, Dataquest (January 1991)

However, reference prices can go up as well as down. It is no longer a buyers' market in Europe because it is now the vendor that sets the price. Non-Japanese suppliers are understood to have raised their prices in order to take advantage of the situation. This has driven the market price upward and has made Europe one of the most expensive markets in the world. The buyer has now to determine the benefits of procuring outside Europe. Table 1 shows last month's DRAM prices compared with this month's prices.

DATAQUEST ANALYSIS

Japanese DRAM vendors have taken a decisive step in ramping down 1M production. The increase in the 1M RP is a direct result of this action, and Japanese companies have accepted the risk of losing 1M sales to vendors not bound by this lower price limit. This is a terminal condition as any loss of 1M sales will result in higher costs and therefore an even higher reference price. In the second quarter of 1991 Dataquest expects to see an

increase in DRAM reference prices at every density except 4M.

DRAM buyers in Europe will need to determine whether or not now is the time to move up to 4M. Second-generation versions of the 4M are becoming available in volume. These have a 300-mil instead of 350-mil outline, which is the same footprint as the 1M device. With the cost per bit of the 4M now bordering on parity with that of the 1M, it would appear that the era of the 4M has come at last.

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Mark Giudici
Byron Harding

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Research Newsletter

USERS' LONG-RANGE PRICE OUTLOOK—SRAM AND NONVOLATILE MEMORY

EXECUTIVE SUMMARY

Even in the face of war, manufacturers of electronic systems must still plan for long-term trends, challenges, and opportunities. This newsletter provides semiconductors users with a practical look at the price forecast for SRAMs and nonvolatile memory through the year 1995 (see Table 1). The long-range forecast is based, in part, on the results of Dataquest's recent price survey of users and suppliers, which collected information as far in the future as the fourth quarter of 1992. Users can expect the sharpest price declines for higher-density devices—256K and above in SRAMs, 1Mb and above in EPROMs, and 2Mb and above in ROMs—but for different reasons.

OVERVIEW

This newsletter will focus on three price points—the 1991 price, the fourth-quarter 1992 price range (from the survey), and the 1995 price—for select SRAM and nonvolatile memory in order to assess long-term price trends. As will be shown, the information on the price range for the fourth quarter of 1992 can serve as a window of insight into the industry's pricing outlook for 1993 and beyond.

The price analysis presented here correlates with the quarterly and long-range price tables mailed to Dataquest's Semiconductor User Information Service (SUIS) clients on December 20, 1990. For SUIS clients that use the SUIS on-line

TABLE 1
Semiconductor Pricing and Lead Time Trends
(North American Bookings, Volume Orders)

	Long-Range Price Trend ($)		
Part	1991 Price Forecast	Price Range Forecast for Q4 1992	1995 Price Forecast
4Kx4 25ns SRAM (PDIP)	2.36	1.50 to 3.00	2.40
64Kx1 25ns SRAM (PDIP)	3.41	2.67 to 3.90	2.80
8Kx8 45ns SRAM (PDIP)	3.26	2.57 to 3.25	3.00
32Kx8 35ns SRAM (PDIP)	8.98	6.00 to 7.75	5.60
128Kx8 100ns SRAM (PDIP)	16.29	11.35 to 11.45	7.00
CMOS 128Kx8 150ns+ ROM (28-pin PDIP)	2.29	1.60 to 2.25	2.05
CMOS 512Kx8 200ns+ ROM (32-pin PDIP)	3.91	3.50 to 5.50	3.22

Source: Dataquest (January 1991)

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service, the quarterly prices presented here correlate with the quarterly and long-range price tables dated December 1990. The price analysis in this newsletter also correlates with the *Source: Dataquest* report entitled "Semiconductor Price Outlook: First Quarter 1991," dated January 1991. For additional product coverage and more detailed product specifications, refer to those sources.

SRAM TRENDS

The supplier bases for fast SRAMs and slow SRAMs differ, so users can expect different long-term pricing and market trends for these devices.

Fast SRAMs: A Shifting Supplier Base

The supplier base for 16K and 64K fast SRAMs will shift during the early 1990s. Japan's Ministry of International Trade and Industry (MITI) has advised Japanese suppliers to migrate to devices with densities of 256K and above. MITI also sets pricing guidelines, below which (as will be discussed) Japanese suppliers are not to price 16K or 64K products. Suppliers from North America, Europe, and Korea will move in to fill any supply void. For example, at the time this newsletter was written, Micron, Motorola, and Samsung were increasing their roles in the fast SRAM business. Non-Japanese suppliers can ignore MITI's pricing guidelines.

16K Fast SRAMs: As Low as $1.50?

Table 1 shows that Dataquest expects the North American bookings price for 4Kx4 25ns SRAMs (PDIP) in 20,000-piece orders to be $2.36 for the year 1991. The table also reveals that participants in Dataquest's year-end 1990 price survey expect the price for this device as specified to range widely—from $1.50 to $3.00—during the fourth quarter of 1992. MITI guidelines call for a price of at least $2.00 for 16K fast SRAMs—which means the departure of Japanese suppliers. With a few suppliers eyeing a price as low as $1.50 for this IC, under current market conditions, users can expect continuing price competition in this segment through 1993. After 1993, the supplier base should contract somewhat, with the price edging upward to the level of $2.40 by 1995.

64K Fast SRAMs: As Low as $2.57?

MITI advisories set $3.00 as the minimum benchmark for pricing by Japan-based suppliers of 64K fast SRAM. The price survey shows that some of the global network of suppliers plan to price below that level.

64Kx1 25ns SRAMs

Under present market conditions, the long-range outlook for 64K fast SRAM prices is similar to that for 16K fast devices but slightly different. For example, the information in Table 1 forecasts that the North American bookings price for 64Kx1 25ns SRAMs (PDIP) in 20,000-piece orders will be $3.41 for 1991. Users and suppliers expect the price for this part to range from as low as $2.67 to a high of $3.90 for the fourth quarter of 1992. MITI guidelines call for a price of at least $3.00 for the 64K fast SRAM—which again means a shift away by Japanese suppliers.

Because the 64K fast SRAM has a longer product life cycle than the older 16K device, more suppliers will be likely to break the $3.00 barrier for 64K ICs over the long term (than are willing to price below $2.00 for the 16K part). Under current market conditions, users can expect continuing pricing competition for 64Kx1 25ns SRAMs throughout the period from 1991 through 1995. Dataquest forecasts a price of $2.80 for this 64K device during 1995.

8Kx8 45ns SRAMs

Users can expect the fast SRAM business to become more of a commodity-product arena over the long term, but some "micromarket" characteristics will persist. The pricing outlook—which in part is a function of the the user and supplier base—for 8Kx8 45ns SRAMs (PDIP) differs from other 64K fast SRAMs (e.g., 64Kx1 25ns SRAMs or even 8Kx8 25ns SRAMs).

The information in Table 1 projects the North American bookings price for 8Kx8 45ns SRAMs (PDIP) in 20,000-piece orders to be $3.26 for the year 1991. Users and suppliers anticipate the price for this part to range from $2.57 to $3.25 for the fourth quarter of 1992. The price of $2.57 is the lowest price collected from the survey for a 64K fast SRAM for that period.

This 45ns device has a narrower user and supplier base, however, than other 64K fast SRAMs such as 64Kx1 25ns SRAMs, 16Kx4 25ns SRAMs, or 16Kx4 35ns SRAMs. Several major users may enjoy a low price of $2.57 for 8Kx8 45ns SRAMs in the future. However, Dataquest does not believe that the market will receive this price. The supplier base for this

45ns part might narrow somewhat after 1993. We expect a flat pricing profile for 1993 through 1994 (at a price of $2.81), with the price rising to the level of $3.00 for 1995.

A Long-Term Decline in Prices for 256K Fast SRAMs

Users can expect prices for 256K fast SRAMs to decline over the long term, especially as Japan-based suppliers battle for market share. There could be some micromarket differences in terms of suppliers and pricing, but this segment should become much more of a commodity market over time than lower-density devices such as 16K fast SRAMs.

For example, the information in Table 1 forecasts the North American bookings price for 32Kx8 35ns SRAMs (PDIP) in 20,000-piece orders to be $8.98 for 1991. Survey participants expect the price for this 256K IC to range widely—from $6.00 to $7.75—for the fourth quarter of 1992. This wide spectrum of prices for a device that is still in the growth stage of the life cycle—and will be fully supported by Japan-based suppliers—signals competitive, if not aggressive, prices in the years ahead. Dataquest expects prices to decline to the level of $5.60 by 1995.

Slow SRAM: A Different Scenario

The long-range scenario is different in the slow SRAM marketplace, where Japanese suppliers—who are heavily influenced by MITI directives—control the business. For example, in early 1991, MITI bluntly directed Japanese suppliers to raise the price of surface-mount versions of slow 256K SRAMs in order to avoid charges of dumping in the United States. Users can expect continuing MITI surveillance and influence over the long term in the slow SRAM segment, barring a major (and unexpected) change in the supplier base.

32Kx8 100ns SRAMs (PDIP)

Dataquest forecasts the bookings price in North America for 32Kx8 100ns SRAMs (PDIP) in 50,000-piece orders to be $4.03 for 1991. As noted, the MITI directive appears aimed mostly at surface-mount versions of this product. For 1993, users can expect a slightly lower price of $3.76 for the PDIP version. Users who continue to use this 256K slow SRAM over the long term can anticipate a flat pricing profile during the 1993 through 1995 period. Dataquest projects a price of $3.54 for the year 1995.

Steady Declines in Prices for 1Mb Slow SRAMs

Japan-based suppliers will be more willing to give ground on prices for 1Mb slow SRAM over the long term because this product is still in the growth stage of its life cycle. The North American bookings price for 128Kx8 100ns SRAMs (PDIP) in 50,000-piece orders should be $16.29 for 1991.

As shown in the table, survey participants forecast a price of just under $11.50 for this 1Mb part during the fourth quarter of 1992—a clear sign of continuing price erosion. By 1993, the 1Mb slow SRAM will just be approaching the maturity (or peak) stage of its product life cycle—with several years of high-level demand to follow. In line with this supply-demand outlook, users can expect a 1993 price of $9.30 for volume orders of 128Kx8 100ns SRAMs, dropping to $7.00 for 1995.

NONVOLATILE MEMORY: COMPETITIVE LONG-RANGE PRICES

North American users of nonvolatile memory devices such as ROMs and EPROMs can look forward to price trends more competitive in the 1990s than in prior periods (for example, ROM prices during the late 1980s). A major factor is the approaching demise of the foreign market value (FMV) system, which should enable Japan-based suppliers to become more price-competitive in North America (such as for EPROM). Another factor is the aim of suppliers of flash memory to win new design-ins. A third factor is global expansion of the supplier base for products such as ROMs.

128Kx8 ROMs

Users can anticipate somewhat stable long-term prices for ROMs in densities of 1Mb or less, but sharper price declines for higher-density parts. For example, as shown in Table 1, Dataquest forecasts a price of $2.29 for CMOS 128Kx8 150ns and above ROMs (28-pin PDIP) in 50,000-piece orders during 1991. For the fourth quarter of 1992,

the price for this 1Mb ROM as reported in Dataquest's quarterly survey of users and suppliers should run from $1.60 to $2.25. The low end of this price range indicates the possibility of sub-$2.00 pricing over the long term. Dataquest expects a flat price profile, however, during the 1993 through 1995 period—at the level of $2.05—because this product will then be moving through the late saturation and decline stages of its life cycle.

Table 1 shows a different outlook for 4Mb ROMs. Life cycle analysis partly explains the difference. Two trends—the emergence of non-Japanese suppliers of ROMs and system applications that require wider ROM configurations—are two "whys" behind the 4Mb ROM scenario.

512Kx8 ROMs

Dataquest forecasts a price of $3.91 for CMOS 512Kx8 200ns ROMs and above (32-pin PDIP) in 50,000-piece orders during 1991. Survey participants anticipate a wide price range of $3.50 to $5.50 for this 4Mb ROM during the fourth quarter of 1992. By 1993 the 4Mb ROM will be at the peak stage of its product life cycle. The spectrum of pricing and life cycle analysis points to continuing long-term declines in prices. Users can expect the price of this 512Kx8 ROM to move down to $3.22 for 1995.

256Kx16 ROMs

Dataquest clients have requested prices on ROM devices in the less familiar x16 configuration (that is, 64Kx16 and 256Kx16), which is used in new system applications, where suppliers confront a new set of challenges and opportunities in terms of meeting market demand for higher-density and/or higher-speed ROMs in wider configurations. One resulting trend is increased price competition as a growing base of global suppliers battle for system designs. The pricing outlook for CMOS 256Kx16 ROMs (150ns and above; 40-pin PDIP) reflects this change in the ROM marketplace.

Dataquest expects the North American bookings price for this 256Kx16 ROM in 50,000-piece orders to be $5.17 for 1991. Survey participants expect prices for this device during the fourth quarter of 1992 to range widely—from a low of $4.00 to a high of over $7.25 (the latter being a new market entrant). This price spread reflects the entirely different strategies and capabilities of suppliers—more familiar companies as well as new entrants—in terms of winning business in the 4Mb ROM arena over the long term. Because the supplier base for this x16 device is ultimately likely to be narrower than for x8 products, Dataquest conservatively forecasts a relatively flat price profile for the 1993 through 1995 period. The price should hit $3.92 for the year 1995.

32Kx8 EPROMs: Rising Prices Ahead?

Users should be prepared for possible price increases for EPROMs with densities of 256K and less. Dataquest forecasts a price of $1.97 for 32Kx8 150ns and above EPROMs (windowed CERDIP) in 50,000-piece orders during 1991. For the fourth quarter of 1991 (survey participants did not provide year-end 1992 pricing information on EPROMs), the price for this 256K EPROM as reported in Dataquest's quarterly survey of users and suppliers should run from $1.90 to $2.02. Dataquest expects price increases during the 1992 through 1995 period because this product will move through the saturation and decline stages of its life cycle, with a likely contraction of the supplier base. We forecast a price of $3.00 for this 256K EPROM in 1995. We will carefully monitor trends associated with this product. Market changes such as the expiration of FMVs could change the long-term price outlook.

128Kx8 EPROMs: Declining Prices Ahead

The pricing outlook differs for EPROMs with densities of 1Mb and above. Japan-based suppliers will be free of FMVs during the earlier stages of the product life cycle of these devices, which means pricing competition for all market players.

Dataquest expects a price of $4.78 for 128Kx8 EPROMs at 150ns and above (windowed CERDIP) in 50,000-piece orders during 1991. Survey participants forecast a price range of $4.50 to $5.00 for this 1Mb EPROM during the fourth quarter of 1991. By 1993 the 1Mb ROM will stand at the maturity or peak stage of its product life cycle. The life cycle analysis signals lower prices over the long term. Users can expect the price of this 1Mb EPROM to decrease to the level of $4.01 for 1994 and then to stabilize at that level.

DATAQUEST CONCLUSIONS

Despite the occurrence of war, Dataquest believes that system manufacturers must plan for long-term IC price trends. This newsletter has looked—from a user's perspective—at the long-term price forecast in North America for SRAMs, ROMs, and EPROMs. We predict the sharpest price declines in the higher-density devices, such as 256K and above in SRAMs, 1Mb and above in EPROMs, and 2Mb and above in ROMs.

DATAQUEST RECOMMENDATIONS

Under current conditions, Dataquest makes the following recommendations to North American users:

- Users of 16K and 64K fast SRAMs must plan for a change in the supplier base. Suppliers from North America, Europe, and Korea will displace some Japan-based suppliers. In turn, Japan-based firms will migrate to fast SRAMs with densities of 256K and above.
- Users of both slow and fast SRAMs must monitor MITI's actions and advisories regarding SRAMs in order to anticipate pricing/supply trends that are directly influenced by this quasigovernmental group.
- Users of ROM should plan for a change in the supplier base, which is still largely Japanese. It will become more price competitive as suppliers from North America, Europe, and Korea move into this business. Suppliers will fight hard for both mainstream x8 and emerging x16 design applications.
- Users of EPROMs can expect increased competitive pricing on the part of Japan-based suppliers as the threat of FMVs diminishes.

Ron Bohn

Dataquest
a company of
The Dun & Bradstreet Corporation

January 29, 1991

SEMICONDUCTOR USER INFORMATION SERVICE

ERRATA

Dear Client:

In our January research bulletin entitled "January Market Watch: Near Term Chip Demand Wavers While Inventories And Prices Remain Under Control" there were some errors. Please substitute the enclosed revised newsletter for the one previously issued.

We apologize for any inconvenience this may have caused. If you have any questions, please call Maria Valenzuela at (408) 437 8262.

Sincerely,

Kimberlie C. Southern
Document Coordinator

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Dataquest
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Research *Bulletin*

JANUARY MARKET WATCH: NEAR-TERM CHIP DEMAND WAVERS WHILE INVENTORIES AND PRICES REMAIN UNDER CONTROL

The *Market Watch* is a monthly Dataquest bulletin that is released after the SIA book-to-bill Flash Report. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL RATIO RISES, YET THE OUTLOOK REMAINS MIXED

The book-to-bill ratio for December rose to 0.95, up from November's nadir of 0.90 as seen in Figure 1. The actual numbers that make up this

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

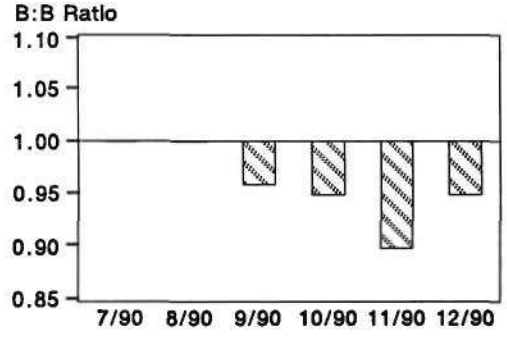


Figure 2
DOC Computer Demand

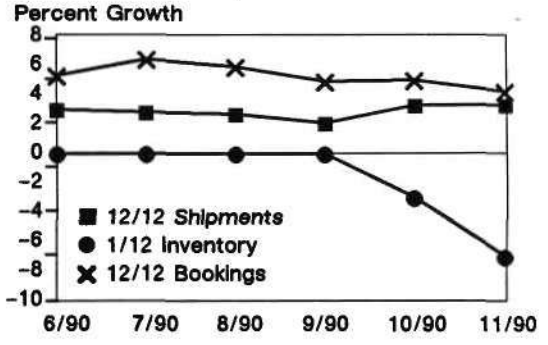


Figure 3
Semiconductor Inventory Level

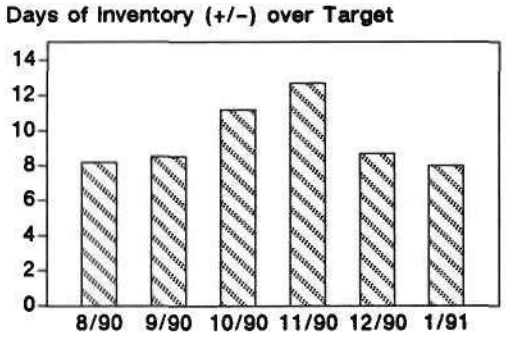
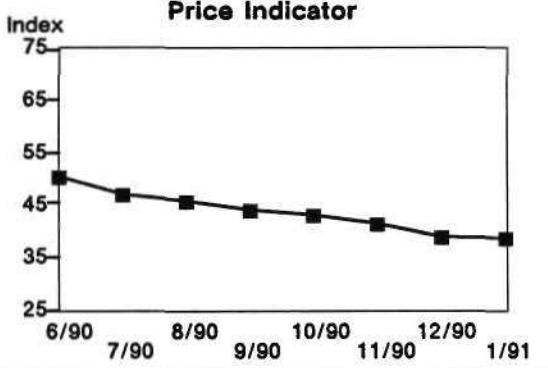


Figure 4
U.S. Weighted Semiconductor Price Indicator



Source: WSTS, US Department of Commerce, Dataquest (January 1991)

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ratio tell a different story, however. The three-month average booking and billing numbers both *declined* in December, a five-week month, compared with November. This decline also runs counter to the traditional year-end semiconductor sweep outs that often resulted with this same material coming back as returns in the following quarter. The year-end drop in shipments is also a sign that semiconductor suppliers are running operations with low finished goods inventories and did not have excess parts to ship. The overall low-inventory levels of users and improved forecasting now experienced in the industry also have affected the resistance to this year-end "tradition." As mentioned in January's Procurement Pulse, SUIS Newsletter 1991-02, semiconductor users expect to buy more semiconductors in January in line with an improved six-month systems sales outlook of 6.9 percent growth.

COMPUTER BOOKING AND INVENTORY RATES SLIP, SHIPMENTS FLATTEN

The Department of Commerce data shown in Figure 2 noted a leveling off of the annualized shipment and inventory rates compared with year-ago levels, while the bookings rate slipped less than 1 percent. The 12/12 rates for November shipments and bookings are a respective 3.3 percent and 4.2 percent, compared with October's rates of 3.3 percent and 5.0 percent. Currently occurring from month to month is a seesaw pattern of quarterly booking rates that historically confirms the slow/low growth trend expected in the near term. For example, the 3/12 booking rate of change for computers was 4.4 percent in November, 1.4 percent in October, 4.2 percent in September, and 0.03 percent in August. With no new product expected to greatly increase demand, combined with the uncertainty surrounding developments in the Middle East, Dataquest expects this slow/low growth demand pattern to continue for the next six months.

SEMICONDUCTOR INVENTORY TARGET/ ACTUAL LEVEL STABILIZES

The difference between targeted and actual semiconductor inventory levels improved less than one (0.7) day (see Figure 3) per this month's procurement manager survey. The respective targeted and actual semiconductor inventory levels now are 19.6 and 27.6 days versus last month's corresponding 19.0 and 27.7 days. The relatively unchanged inventory picture continues to cement the notion that cost control and forecasting accuracy have become a standard procedure and not the latest fad. The increased positive outlook of systems companies (see January 1991 *Procurement Pulse*, SUIS Newsletter 1991-02) should quickly be reflected in increased semiconductor orders due to the current low-inventory levels once the actual systems orders are backlogged.

PRICE DECLINES CONTINUE DESPITE PRODUCTION CUTBACKS

Prices continue their downward slide per this month's review of *The DQ Monday Report*, as seen in Figure 4. Memory prices have slowed their rate of decline and in some cases have stabilized or risen slightly due to aggregate fear of an "upcoming shortage" prophesied by some Japanese suppliers. Once the shortage is seen for what it is, (i.e., hype) prices (including memory) are expected to continue to decline at a slow and steady rate due to the lack of sustained increase in demand that can overshoot planned capacity levels. This steady level of demand is being tested by uncertainties about the Middle East, which also will dampen price levels. As mentioned in last month's Market Watch, overall semiconductor prices will continue to decline regardless of supplier or Middle East actions.

DATAQUEST CONCLUSIONS

The demand picture for the overall electronics market remains positive, but at a sustainable slow growth rate. Semiconductor availability remains very good, which should not hamper reactions to any increases in system demand. Cost control is forcing both users and chip suppliers to keep inventories as lean as possible, again allowing them to adjust quickly to demand changes at the order level. The best method to avoid surprise price swings is to maintain regular forecast schedules with suppliers, communicating demand needs as soon as possible. Dataquest does not expect to see dramatic shifts in near-term demand that would alter the current supply/demand situation.

Mark Giudici

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Research Newsletter

SEMICONDUCTOR PRICE SURVEY: BUSINESS AS USUAL—AS WAR WAGES?

EXECUTIVE SUMMARY

A Middle East war wages. The North American electronics market is in weak but not terrible shape. The war has not yet affected market conditions. For example, Dataquest's recent price survey reveals that major DRAM buyers can still look forward to lower prices—widely publicized claims of a "shortage" notwithstanding (see Table 1). The Japanese Ministry of International Trade and Industry (MITI) still exerts "administrative guidance" in the SRAM arena. Big news ahead: Users of the 80486-25 can look forward to a major price cut by the second quarter of 1991. Dataquest recommends that users plan for little market impact from AMD's 80386-type IC until midyear 1991 at the earliest—but to plan now for a 1991 contraction of the standard logic supplier base (family-by-family basis).

NOTICE: The pricing analysis presented here correlates with the quarterly price tables mailed to Semiconductor User Information Service (SUIS) clients on December 20, 1990, and the *Source*

TABLE 1
Semiconductor Pricing and Lead-Time Trends
(North American Bookings, Volume Orders)

	Price Trend (Dollars)		Lead Times		
Part	Q4 Price Range	Q1 Forecast	Current	Trend	Other Trends
1Mbx1 DRAM—80-100ns, DIP/SOJ	4.25 - 4.82	4.29	1 - 8 weeks	1 - 2 weeks longer	No 4Mb crossover till Q2 1991
4Mbx1 DRAM—80-100ns, 300- to 350-mil SOJ	21.25 - 25.10	19.80	2 - 10 weeks	Steady	Demand accelerates; market trend toward 300-mil SOJ
64Kx4 SRAM—25ns, PDIP	11.90 - 12.70	11.00	4 - 12 weeks	Steady	Growth stage of life cycle
512Kx8 ROM—CMOS, 32-pin PDIP, 200ns & above	4.25 - 5.90	4.02	4 - 12 weeks	Steady	Wide spectrum of pricing
80486-25—CPGA	685 - 704	690	6 - 8 weeks	Steady	Major price cut during Q2 1991
74AC138—PDIP	0.35 - 0.387	0.345	2 - 6 weeks	Steady	Early maturity stage of life cycle
CMOS 22V10—25ns to < 35ns	3.00 - 4.80	3.88	2 - 6 weeks	Steady	Narrow supplier base

Source: Dataquest (January 1991)

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Dataquest report entitled "Semiconductor Price Outlook: First Quarter 1991" and dated January 1991. For SUIS clients that use the SUIS on-line service, the quarterly pricing presented here correlates with the quarterly price tables dated December 1990 in the SUIS on-line service. For additional product coverage and more detailed product specifications, please refer to those sources.

MEMORY TRENDS

North American users of 1Mb DRAMs continue to enjoy competitive pricing during the first quarter of 1991. The DRAM spot market remains volatile. The latest rumor is that DRAM prices will rise as the supply contracts. Major buyers can expect little impact from this "shortage." Other memory devices such as SRAMs and nonvolatile products remain in ample supply, with few exceptions.

Megabit-Density DRAM

As shown in Table 1 and Figure 1, large-volume contract buyers in North America can expect a steady decline in prices for 1Mbx1 80 to 100ns DRAMs (DIP/SOJ) during the first half of 1991. In North America, the large-volume bookings price for the 1Mb DRAM should decline to the level of $4.29 during the first quarter of 1991 and to $4.08 for the second quarter.

Look for a Second-Quarter Crossover to the 4Mb DRAM

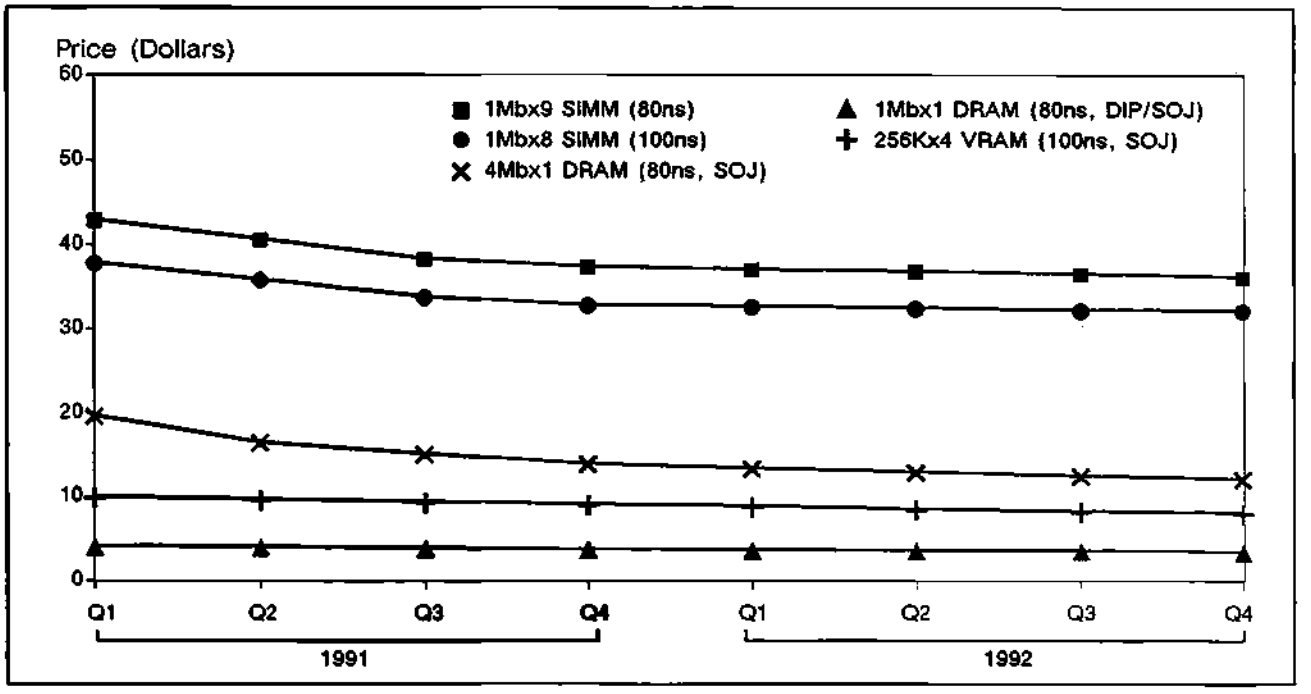
Despite the challenge for *some* suppliers regarding yield rates, Table 1 and Figure 1 also show that the large-volume price for 4Mb 80ns DRAMs should decrease to the level of $19.80 during the first quarter of 1991 and to a price of $16.55 for the second quarter. This rate of price attrition means a second-quarter crossover (4:1 unit-price ratio) to the 4Mb DRAM.

The Range of DRAM Pricing

As noted in prior newsletters, survey confidentiality limits disclosure of exact pricing points; however, the survey responses capture the dynamics behind Dataquest's forecast. For example, Dataquest bases the first quarter 1991 forecast price

FIGURE 1

Estimated DRAM Price Trends (North American Bookings)
(Volume: 100,000 Units)



Source: Dataquest (January 1991)

of $4.29 for the 1Mbx1 DRAM on actual fourth quarter 1990 prices that ranged from $4.25 to $4.82.

Likewise, the first quarter 1991 forecast price of $19.80 for the 4Mbx1 DRAM is based on actual prices during the fourth quarter of last year that ran from $21.25 to $25.10. As an indication of future pricing volatility, survey participants expect prices for this device to range widely—from $11.00 to $18.75—during the fourth quarter of 1991.

Dataquest Recommendation on Megabit DRAM

As noted, Dataquest anticipates that major users will not face rising DRAM prices during the first half of 1991, although the rate of price declines might be slower than originally expected. We continue to recommend weekly monitoring of worldwide DRAM pricing trends through Dataquest's *On-Line DQ Monday* service.

Fast SRAM

Look for MITI's Influence

Despite shifts in the supplier base, users can anticipate lower prices for most fast SRAMs during 1991. Japan's MITI still exerts powerful "administrative guidance" in this arena, however, which for users translates into a bottom floor on pricing.

16K Fast SRAMs: A $2.00 Barrier

Although some suppliers and users expect prices for 16K fast SRAMs to break $2.00 by the end of 1991, the market price should remain above this level. Dataquest anticipates that the North American bookings price for 4Kx4 25ns SRAMs (PDIP) in 20,000-piece orders will decrease to about $2.51 during the first quarter of 1991.

Based on our survey of users and suppliers, this 25ns product should range in price from $1.80 to $2.55 during the fourth quarter of 1991. Dataquest foresees a $2.25 price in the fourth quarter of 1991. Why this price? Prices below $2.00 could force some suppliers from the market during 1991.

64K Fast SRAMs: A $3.00 Floor

Under present market conditions, users can continue to expect steady price declines for 64K fast SRAMs during 1991. As revealed in Figure 1, the survey results and analysis for the 64K segment parallel those of the 16K market: In the 64K market, a floor of $3.00 serves as the key pricing point for many Japan-based suppliers.

256K Fast SRAM Suppliers Compete on Pricing

Prices for 256K fast SRAMs continue to decline as suppliers compete for users' business. Dataquest forecasts that the North American bookings price for 64Kx4 25ns SRAMs (PDIP) in 20,000-piece orders will decrease to the level of $11.00 during the first quarter of 1991 and to $9.90 in the second quarter. Supplier competition is likely to heighten during 1991 and result in a price of $8.60 for the fourth quarter.

Slow SRAM

MITI's Effect on the 256K Slow SRAM

As 1991 begins, users remain concerned regarding the availability and pricing of the slow SRAM. At press time, MITI was attempting to make Japan-based suppliers increase 256K slow SRAM prices through production cutbacks to avoid charges of dumping in the United States. Dataquest forecasts that the North American bookings price for 32Kx8 100ns SRAMs (PDIP) in 50,000-piece orders will decline to $4.27 during the first quarter of 1991. The MITI directive appears aimed mostly at surface-mount versions of this product.

As noted, we recommend that users of slow SRAMs monitor lead time, pricing, and related market trends via the *On-Line DQ Monday* service.

The Impending 1Mb Slow SRAM Crossover

The market now approaches the crossover (4:1 unit-price ratio) to the 1Mb slow SRAM. The North American bookings price for 128Kx8 100ns SRAMs (PDIP) in 50,000-piece orders should fall to $19.27 during the first quarter of 1991 and to $17.00 for the second quarter. This rate of 1Mb slow SRAM price attrition indicates a crossover to the 128Kx8 product by early in the third quarter of 1991 or late in the second quarter.

Dataquest Recommendation on 64K Slow SRAMs

Dataquest restates its prior recommendation that users of this device be prepared to forge special long-term arrangements with suppliers to assure a steady supply of the device. Users also can

redesign systems using this product in order to incorporate higher-density slow SRAMs.

Nonvolatile Memory—ROM

As the year 1991 begins, prices for nonvolatile memory continue to be competitive. For example, ROM prices for densities of 1Mb or less have stabilized but at competitive levels. A wider price spectrum exists for higher-density ROM, however, as shown in Table 1. During the fourth quarter of 1990, the price for CMOS 512Kx8 ROM (200ns and above; 32-pin PDIP) in 50,000-piece orders ranged from $4.25 to $5.90, as reported in Dataquest's quarterly survey of users and suppliers.

The North American bookings price for CMOS 4Mb ROM, as specified, should decrease to $4.05 during the first quarter of 1991. Users can anticipate that prices will move to the level of $3.92 for the second quarter of 1991. Survey participants expect prices for this device to run from $3.80 to $5.76 during the fourth quarter of 1991.

MICROPROCESSOR TRENDS

Litigation—in one form or another—continues to rear its head as an MPU market dynamic. In the process, more fundamental market factors must not be ignored.

The Law as a 1991 Market Dynamic

Litigation to determine the right (subject to ultimate legal scrutiny) of Advanced Micro Devices (AMD) to market an 80386-type device has generated much noise to date but little market effect. The market impact of AMD's sale of the 80386-type IC will not be known until midyear 1991 at the earliest.

Litigation in the form of Intel's suit against Cyrix over the 80387 adds another law case to the list of cases to be tracked by users of microcomponents.

MPU Market Trends

As this newsletter was being written, Motorola still was shipping a limited supply of 68040s. Users can expect lower pricing for Motorola's 25-MHz 68020 device. The North American bookings price for the 25-MHz 68020 IC (CPGA) in orders of 1,000 to 5,000 pieces should reach the $100 level during the first quarter of 1991 and decrease to $89 for the fourth quarter of 1991. Users of the 16-MHz 68030 part may see a flat price profile ($120.50) during 1991 as Motorola de-emphasizes this component. Users *can* expect continued decline in pricing for the 25-MHz 68030 (CPGA) IC. The North American bookings price for this Motorola part in orders of 1,000 to 5,000 pieces should be $167 for the first quarter of 1991, dropping to $155 during the fourth quarter.

The supply of Intel's 80386 devices balances with demand; however, users should expect Intel's commitment to the 80386 to decrease this year. Intel also will shift users to the 20-MHz 80386SX and 80386SL. Lead times for 80386SX devices now run as low as nine weeks, and there is as yet no end to the 80286-80386SX battle.

25-MHz 68040 IC: Production Keys Pricing Outlook

Dataquest forecasts that the North American bookings price for the 25-MHz 68040 part (CPGA) in orders of 1,000 to 5,000 pieces should decline to the level of $635 during the first quarter of 1991 *if output successfully ramps*. The price should decline to the level of $491 for the fourth quarter of 1991 if, but only if, volume ramps.

A Major Break in Pricing for the 25-MHz 80486?

As shown in Table 1, the North American bookings price for the 25-MHz 80486 part (same volume) should hover at a price of $690 for the first quarter of 1991. Users should expect a major price break by the second quarter—a drop in price to $524 as Intel ramps up. By the fourth quarter, users can anticipate a price of $434.

STANDARD LOGIC TRENDS

The long-term supply and supplier base remain subject to change as suppliers evaluate their product strategies and commitments to this business. The prices of standard logic products have become more stable. Lead times run in the range of two to seven weeks.

Products such as the 74S, 74HC, and ECL10K are at a late stage of the product life cycle. Others such as the 74F, 74AS, and 74ALS have hit the maturity stage of the cycle. Users should expect a narrowing of the standard logic supplier base during 1991 on a family-by-family basis.

At the other end of the life-cycle spectrum, suppliers are introducing new BiCMOS/advanced BiCMOS parts targeted at bus drive applications.

ASICs

ASIC prices remain competitive. As shown in Figure 2, price declines for 1.0-micron, 1.2-micron, and 1.5-micron CMOS gate arrays and 1.0-micron, 1.2-micron, and 1.5-micron cell-based ICs (CBICs) in terms of *millicents per gate* can be anticipated during 1991—barring supplier base contraction. Japanese suppliers have been more competitive on their quotes as the demise of FMVs approaches.

Higher NRE Charges

Users should also expect higher nonrecurring engineering (NRE) charges, however. For example, many suppliers that were among the low-cost leaders in terms of NRE have withdrawn from the market. The trend among suppliers is to require users to pay NRE charges in the early stage of the ASIC life cycle. Previously, users could amortize NRE cost over a device's full production cycle.

PLDs: A Sharp Break in CMOS PLD Prices?

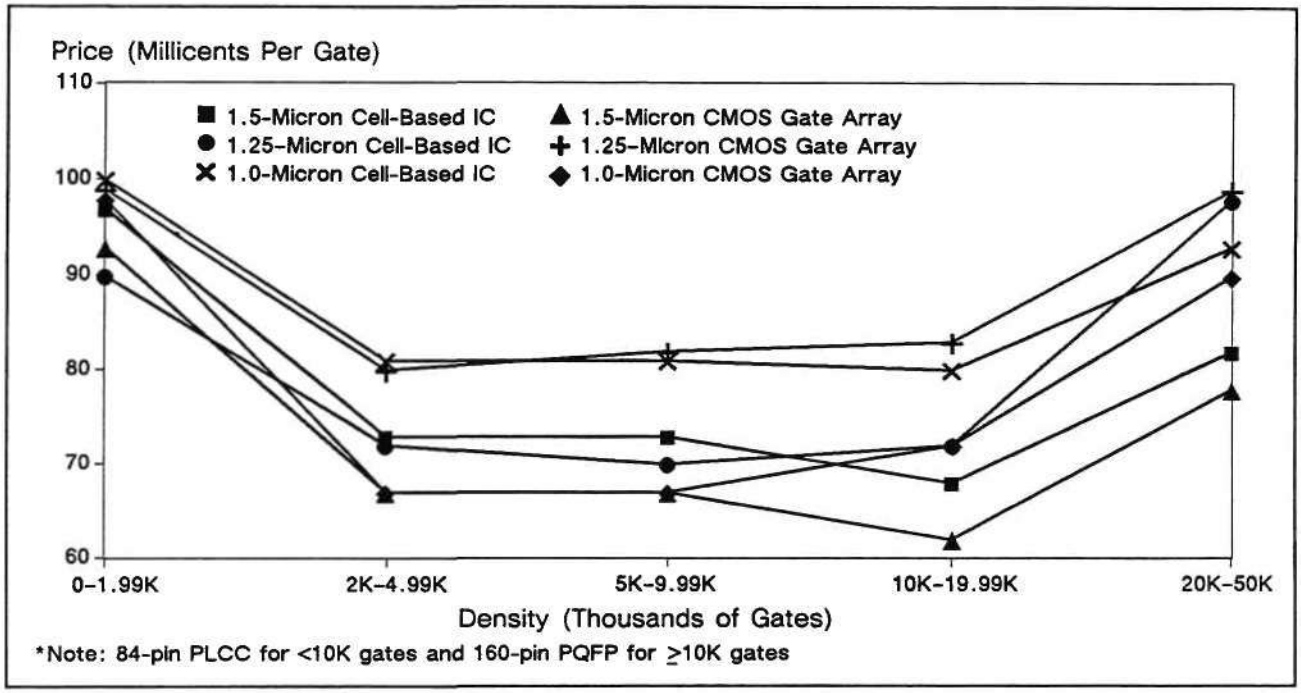
PLD suppliers continue to battle for design wins. Now CMOS PLD suppliers send signals of a sharp break downward in pricing, leading to more pricing pressure for suppliers of TTL devices. For example, Table 1 shows a wide range of prices for CMOS 22V10s (25ns to < 35ns)—a sign of impending price competition. As shown in Figure 3, under present market conditions, most PLD users can expect sharp price declines in the first half of 1990.

DATAQUEST CONCLUSIONS

With a Middle East war waging, the North American electronics market remains weak—but

FIGURE 2

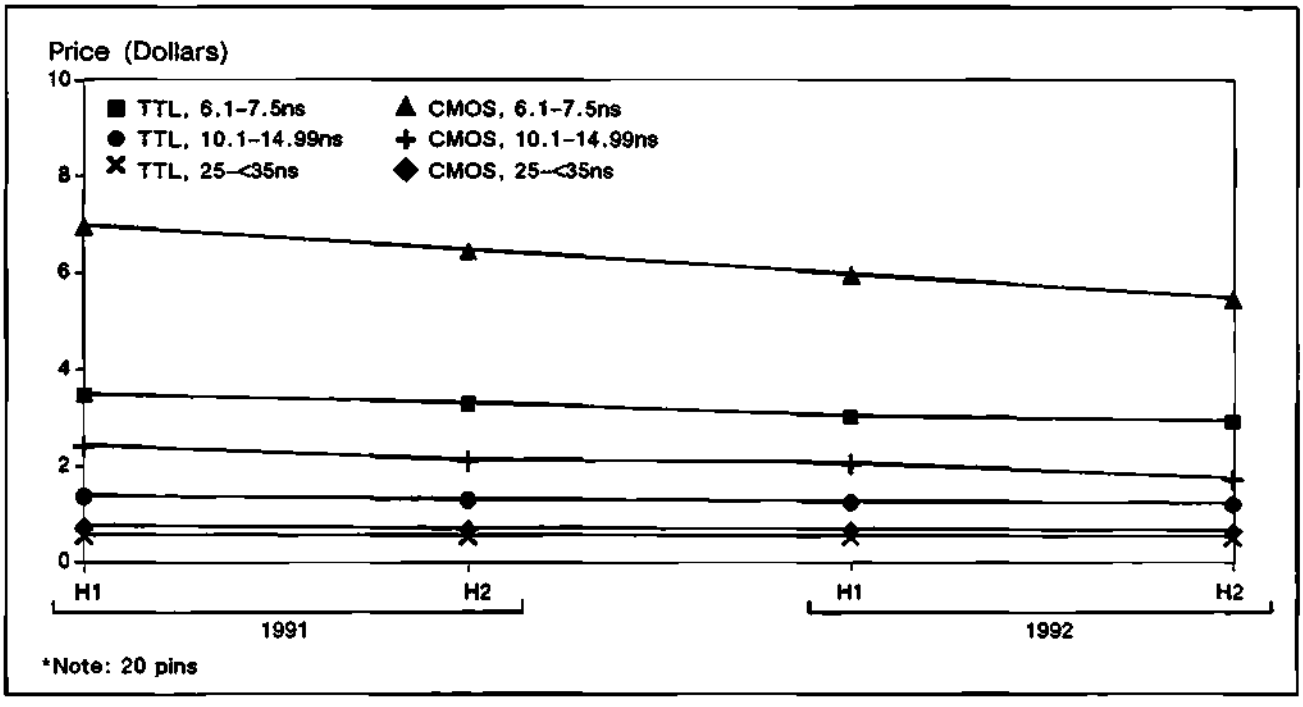
Estimated 1991 ASIC Price Trends (North American Bookings)*
(Volume: 10,000 Units; Utilized Gates; Excluding NRE)



Source: Dataquest (January 1991)

FIGURE 3

Estimated PLD Price Trends (North American Bookings)*
(Volume: 10,000 Units; PDIP or PLCC)



Source: Dataquest (January 1991)

stable. Dataquest's November-December 1990 survey of semiconductor users and suppliers shows that major buyers of DRAMs can look forward to lower prices. For example, the rate of 1Mb DRAM price attrition might be slower than the pace of prior quarters, but pricing for major buyers is *not* expected to increase. Users of the 25-MHz 80486 can expect a major price cut by the second quarter of 1991. Users of ASICs should anticipate more aggressive pricing for CMOS PLDs—but higher NRE costs for other ASICs. MITI has been exerting considerable "administrative guidance" in the SRAM arena. Nevertheless, users can anticipate lower prices for most fast SRAMs during 1991.

DATAQUEST RECOMMENDATIONS

Under current conditions, Dataquest makes the following recommendations:

- Users should plan for 4Mb DRAM crossover in the second quarter of 1991—and continue weekly monitoring of worldwide DRAM pricing trends through Dataquest's *On-Line DQ Monday* service.
- Users of 64K slow SRAMs should prepare to forge special long-term arrangements with suppliers to assure a steady supply of this device. As with DRAMs, users of 256K slow SRAMs should monitor market trends via the *On-Line DQ Monday* service—with an eye on MITI.
- Users should plan for little market impact from AMD's 80386-type IC until midyear 1991 at the earliest.
- Users should evaluate and then communicate with their suppliers of standard logic—in expectation of a 1991 contraction of the supplier base (on a family-by-family basis).

Ronald A. Bohn

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January 10, 1991

Dear Client:

Enclosed is a newsletter that was researched and written by an analyst in Dataquest's ASIC service. The ASIC group of Dataquest's Semiconductor Division regularly does research on the trends and issues of the changing ASIC market.

If you have any questions about this newsletter, please call me at (408) 437-8258. I will continue to keep an eye on research pertinent to semiconductor users done by other groups here at Dataquest.

Sincerely,

Mark A. Giudici

Mark Giudici
Product Manager
Semiconductor User Information Service

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Research *Bulletin*

JANUARY PROCUREMENT PULSE: BUSINESS UPTICK FORESEEN; AVAILABILITY REMAINS GOOD

The *Procurement Pulse* is a monthly update of critical issues and market trends based on surveys of semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

PLANNED INCREASES IN SEMICONDUCTOR ORDERS BACKED BY SYSTEM SALES EXPECTATIONS

Figure 1 shows how this month's respondents expect to increase their semiconductor order levels compared with the last five months. The large

Figure 1
Averaged Monthly Semiconductor Orders

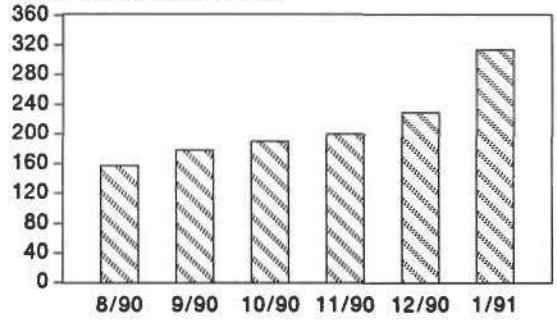


Figure 2
Averaged Semiconductor Lead Times

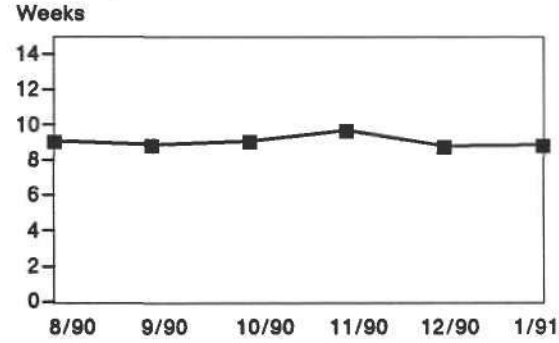


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

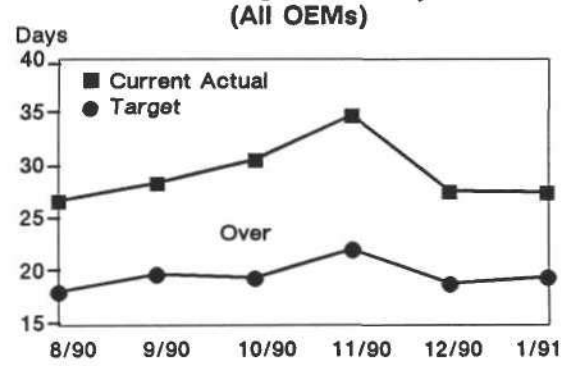
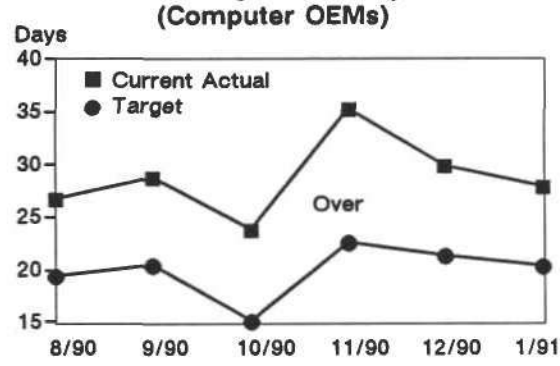


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (January 1991)

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(37.1 percent) expected jump in orders is attributable to a combination of the following:

- Inventory replenishment, now that year-end financials have been recorded
- Positive system demand signals
- Additional purchases of some safety stock DRAMs on the off chance that Japanese supplier warnings of DRAM production cutbacks affect availability

For the second consecutive month, the six-month outlook for overall system and computer sales has increased from a respective 4.1 percent and 6.7 percent for last month to a current 6.9 percent and 8.5 percent. Dataquest still expects to see continued low growth in electronics, even if the worst-case scenario occurs in the Middle East.

LEAD TIMES REMAIN FLAT, EDGING UP TO 9.0 WEEKS

Figure 2 illustrates that, for all practical purposes, semiconductor lead times have centered around a 9.0-week average for the past six months. This month's average response of 9.0 weeks is up two days from last month's 8.9 weeks, reiterating that availability is very manageable. Aside from the problems with video RAM availability mentioned by one respondent, there were no problems with semiconductor deliveries despite stated cutbacks in production by some Japanese suppliers. Some smaller users of 32-bit microprocessors have been notified that allocations for these high-end parts will remain in effect through 1991. Midsize to large system companies should not have availability concerns through the next six to nine months, as capacity levels are more than adequate to meet current demand levels. A wild card to watch is AMD's "386-type" product. When and if it is legally produced, it will further improve an already improved availability situation for the high-end Intel microprocessor offerings. The key issues this month are cost reductions and domestic ECL supplies.

INVENTORIES STABILIZE AT SUB-30-DAY LEVELS

The overall average targeted and actual inventory levels stabilized at a respective 19.6 and 27.6 days from 19.0 and 27.7 days noted last month, a sub-30-day average inventory that remains a very laudable achievement. The computer subset's targeted and actual inventory levels declined from last month's 21.5 and 30.0 days to this report's 20.5 and 28.0 days, respectively. The minor increase in overall inventories is a by-product of last month's uptick in orders that weren't quickly shipped out. In line with this month's expected order increase, it is likely that another slight increase in inventories may be reflected in next month's *Procurement Pulse*.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Despite increased Middle East tensions, the outlook for system sales and semiconductor orders remains increasingly positive. Inventory levels are low, which will force any shift in system demand to correlate with semiconductor demand. In spite of Japanese suppliers' continued statements of limited DRAM supplies, these parts are expected to remain abundant for the foreseeable future as other suppliers are capable of picking current levels of demand. The continued ease of semiconductor availability is allowing predictable prices and delivery schedules that help system companies cope with the uncertain economic situation. Dataquest still sees a low-growth market for both systems and semiconductors for the next six months as the economy reacts to the outcome of the Middle East crisis.

Mark Giudici

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January 10, 1991

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Research Newsletter

FPGAs: THE USER'S PERSPECTIVE

FPGAs ADDRESS MARKET NEED

Because of their cost-effectiveness and versatility, gate arrays have enjoyed considerable market success, catapulting the market from a mere $135 million in 1981 to today's estimated $4 billion. However, the industry is also driven by the desire to reduce its risk in terms of both NRE costs and time to market. Although gate arrays offer considerable economies of scale when ordered in high volume, in today's fast-moving markets, the increased emphasis is on time to market because of ever-diminishing product life cycles. Many companies cannot afford the time delays associated with custom masked gate array production.

On the other hand, although standard products represent a low risk and offer ready availability, they tend to be poor conduits for product differentiation. Another product alternative is the PLD, which, although a standard product, is customizable by the user. However, until recently, these devices did not offer sufficiently high levels of integration to address even the lowest gate array density requirements. The shortcomings of these various product implementations represented a challenge that some companies viewed as opportunities. In 1985, Xilinx introduced a new product concept to the market, which has been coined field-programmable gate arrays (FPGAs). The advent of FPGAs held the promise of addressing some of these basic product issues. FPGAs are used as replacements for multiple TTL and PAL parts and also are affecting low-density/low-volume gate array designs today. They could potentially impact medium-density/medium-volume gate array designs. Dataquest expects the FPGA market to experience rapid growth, increasing from a $61 million market in 1989 to $510 million in 1994, a compound annual growth rate of 52.9 percent.

FPGAs: A DESCRIPTION

FPGAs are user-programmable like PLDs but are like gate arrays in that device performance is a function of the fixed delays of the logic elements as well as the variable delays of the interconnect paths. The implications of the variable interconnect delays are significant because they necessitate timing analysis of the circuit.

The basic architecture of an FPGA consists of its logic block function, interconnection structure, and I/O block design. The block diagrams in Figure 1 show the implementations of the differing architectures of the leading suppliers to this market—Xilinx and Actel, respectively.

Actel's product portfolio is based on antifuse technology, and Xilinx's products are implemented in SRAM technology. These fundamentally different approaches mean that the Xilinx solution requires a dedicated EPROM to configure the FPGA in start-up mode. An FPGA may share an EPROM already on-board or one EPROM may be shared among several FPGAs. Although Xilinx uses a two-chip approach, it has the advantage of offering dynamic reprogrammability. On the other hand, the Actel single-chip solution is not reprogrammable. This inability to reprogram raises the importance of test-built-in circuitry to facilitate factory testing.

THE USER'S VIEW

Things have changed radically in the FPGA market since its inception in 1985. Many are just learning how to use FPGAs. Basing assumptions on data and experience from first-generation products may mean that users could be summarily

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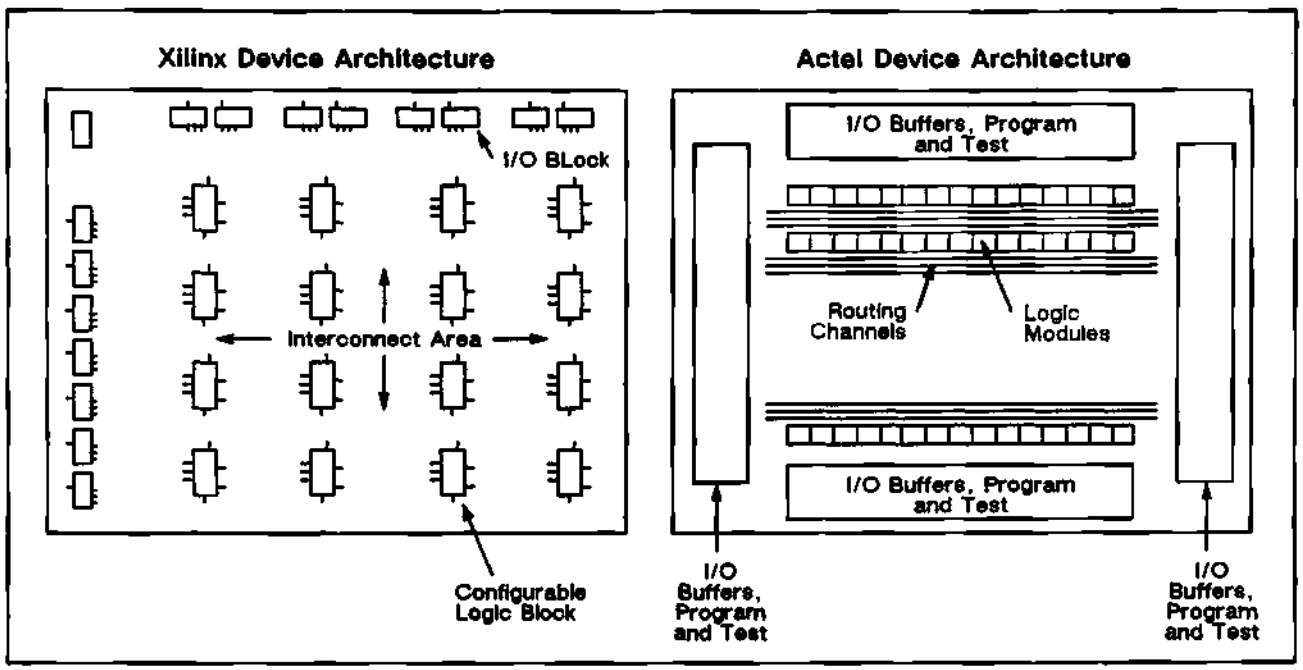
FIGURE 1
Block Diagrams of Xilinx and Actel Product Architectures



Source: Actel Corporation, Xilinx, Inc.

dismissing FPGAs as a viable product alternative. Dataquest decided to reassess market acceptance of the product by polling a number of FPGA users for their opinions. Below, we present a summary of the results of our informal survey. For convenience, we have grouped the responses according to the following key issues: turnaround time, reduced risk, performance, technology, density, cost, and tools. Generally, users were satisfied with FPGAs as a design solution. High on their wish lists were (of course) denser, faster parts at a lower cost. But as things continue to change rapidly in this market, the expectation is that some of these items will be forthcoming.

Turnaround Time

Perhaps the number one issue among FPGA users we spoke to was time to market, which was an overriding consideration in many product decisions. Incorporating an FPGA into a product design often allows the company to design, demonstrate, and manufacture in a timely manner.

Reduced Risk

The prospect of reduced risk through FPGAs is an important benefit. FPGAs offer reduced risk on at least two fronts. On one hand, they offer an alternative to the upfront design time, potential risk, and expense incurred in a gate array implementation. On the other hand, as a long-term strategy, the use of FPGAs facilitates a more aggressive product strategy. System companies that frequently experience design changes quite far along in the design of a system value FPGAs for the flexibility they ensure in their product designs. A company can introduce several high-risk products to the marketplace, migrating the successful ones to a gate array implementation while replacing unsuccessful products with new ones. This ability to react quickly to the market mitigates the downside when taking an aggressive approach to product introduction and gives a company the opportunity to prove its product and technology.

Performance

With system clocks running at 50 MHz, speed was an important user criterion. Some users chose to do hand routing to eke out some extra speed. Many users did not choose to incorporate FPGAs in the speed-critical portions of their design. New product announcements from FPGA suppliers show that they are also tackling the issue of system performance by incorporating enhanced system features on-chip.

Technology

Users of both Actel and Xilinx products espoused the merits of their chosen solution. Their different approaches represent an exercise in trade-offs. For example, there is a trade-off between cell size and device performance. The larger kernel of Xilinx's logic blocks can increase performance, but a larger cell size does entail the risk that, in some cases, the cell may not be fully utilized. Actel users, however, laud its minimum building-block approach, whose granularity facilitates migration to a gate array. Although Xilinx places no restrictions on the number of interconnections that can be made, Actel aims for greater timing predictability by limiting the number of connections between blocks. Some Xilinx product users thought of the product's volatility as a feature because it enables dynamic programming.

Density

From an integration standpoint, FPGAs compete with low gate-count gate arrays. However, the issue of utilization of FPGAs is not a straightforward one. A large number of users could not describe their utilization in gate terms, instead referring to utilization of logic modules and CLBs (configurable logic blocks)—terminology employed by Actel and Xilinx, respectively. Most users estimated that their logic block utilization was in the 85 to 95 percent range. This does not translate exactly into a gate count because use of the entire block internally must also be determined. One experienced Xilinx user hazarded the view that actual total gate usage most likely averaged about 55 to 60 percent, while an Actel user estimated usage at about 75 to 80 percent of the total gates. Different applications affected these percentages quite substantively.

FPGA companies continue to work on increasing product density. Actel has introduced a next-generation product family, the Act-2 family, claiming as many as 8,000 usable gates. According to Xilinx, its next-generation product, the XC4000 family, will provide up to 20,000 usable gates. Sample shipments of the first family member offering 5,000 equivalent gates will commence in the first quarter of 1991.

Cost

With first- and second-generation parts costing between $15 and $50 (and even less in very high volumes) and recent products listing for several hundred dollars, the device cost for FPGAs is considered to be quite high. From the survey feedback we received, there is a perception among users that Actel products are more expensive than those from Xilinx. However, it is very difficult to assess the accuracy of this perception because the complexity of a comparative price-per-gate analysis is compounded by the fact that each supplier counts gates differently.

Xilinx positions its products as the volume solution and has been forthcoming about price reductions on its older-generation products. Although Xilinx offers a hardwired Logic Cell Array (LCA), the company does not actively promote a path to a gate array alternative. This point is a major distinction between the two companies' philosophies. Actel has aggressively aligned itself with other merchant semiconductor suppliers to facilitate the route to gate arrays. For a cost-reduction approach, Dataquest still expects volume shipments of products with long life cycles to migrate to gate arrays. Moreover, although it is possible that not as many users will avail themselves of this migration path as inquire about it, it is an option that assuages users' concerns about the cost of going to volume production. With the next-generation product announcements and new suppliers entering the market, it can be expected that price competition will beset this market, too, in the future.

Tools

Generally, users indicated that tools for these devices were at least adequate. As a long-term strategy, product experts agreed that the best design approach is to manage the schematic in order to ensure automatic forward compilation. The automatic place-and-route tools for Actel products were viewed favorably. Companies that use EDA tools to perform schematic capture for Actel products like the easy migration this approach provides to gate arrays. Many users were acquainted with Xilinx products and expressed dissatisfaction with their tools. Perhaps because Xilinx was first with product to market, it is not fair to compare more recent product support for Actel products with what was initially offered for Xilinx products. Xilinx has been addressing the issue of EDA tools, and although no one we spoke to could comment on the new tools, we believe that they are considerably more user-friendly than before. Users are not only becoming increasingly more sophisticated in their

needs but also becoming more ambitious. In response to customer feedback, the company has recently announced the XACT 4000, a completely redefined development system promising 100 percent automatic place and route.

DATAQUEST CONCLUSIONS

FPGA suppliers should keep in mind that their gate array competitors are a moving target. Leading gate array vendors profess themselves unconcerned by the competitive threat posed by FPGAs as the gate array vendors target high gate-count users. Gate array vendors continue to keep the pressure on their FPGA competitors by continued improvements in turnaround times as well as by offering very economical silicon and sophisticated tools.

Although more expensive than gate arrays on a per-gate basis, FPGAs can provide greater flexibility and can prove more economical in terms of time, test, and inventory savings. However, the user must be willing to accept trade-offs. The attractiveness of FPGAs in their current stage of evolution relies on a delicate balance between economic and engineering savings to offset considerably higher prices and less-than-optimum performance. The justification for using an FPGA can evaporate quite rapidly if the savings do not materialize. The realization of the time-to-market advantage lies in the ease of use of the tools. Poor, user-hostile tools can cause users to forfeit the time-to-market advantage achievable through FPGAs, and trying to compete with gate arrays on the basis of price and performance is not a winning platform for FPGAs. In Dataquest's opinion, continued investment in more user-friendly, sophisticated tools will reap significant dividends for the FPGA supplier.

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Mark Giudici
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Semiconductor User Information Service Newsletters 1990

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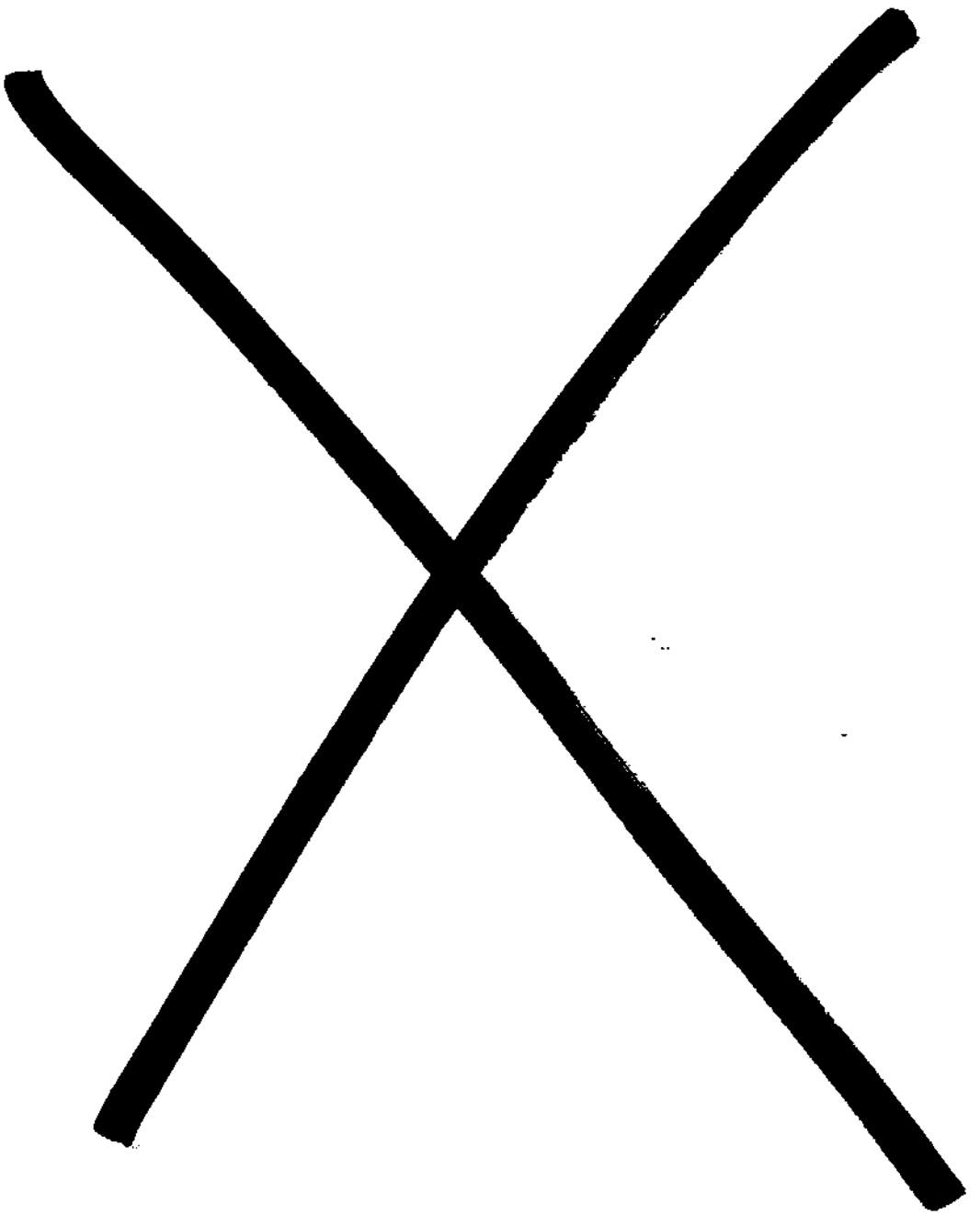

January-March

The following is a list of the newsletters in this section:

- **January Procurement Pulse: Orders and Inventories Rebound Up, Prices and Lead Times Fall** (1990-01)—The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This month's *Procurement Pulse* discusses order rates picking up appreciably, primarily in anticipation of new systems sales and partially to refill key inventory levels. Dataquest believes that the next six-month system sales outlook is moderately optimistic and that component availability is at a 12-month high.
- **January Market Watch: The Market Pickup May Be a False Start** (1990-02)—The *Market Watch* is a monthly bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months. This month's *Market Watch* focuses on the existing optimism in the systems markets. Semiconductor suppliers are doing an excellent job of supporting their customers through these highly competitive times. Until a definite change in the end markets takes shape, we expect this static shipment/demand/inventory situation to continue.
- **Semiconductor Price Survey: Megabit-Density DRAM Crossover, Single-Sourced ICs Highlight the Start of 1990** (1990-03)—Semiconductor users can continue to look forward to lower prices (with several exceptions), although the overall pace of price declines should slow somewhat from the pace of 1989. The first quarter of 1990 should be a period of declining semiconductor prices, although the declines will not be as sharp as during 1989. This newsletter discusses Dataquest's three-point recommendation.
- **Users' Microprocessor Dilemma: The Limited Future of the 80286 Versus a Limited Allocation of the 80286SX** (1990-04)—Currently, systems manufacturers are experiencing a change from a multisourced component world to an increasingly sole-sourced arena. For users, this strategic concern means a tactical challenge—deciding whether to continue building machines based on the 80286 or to move to a product such as Intel's 80386SX, which is single-sourced. Dataquest believes that the move from a multisourced component world to a single-sourced arena means changing strategies and tactics for supply-base managers.
- **February Procurement Pulse: Billings, Lead Times, Orders Flat While Inventories and Sales Expectations Remain Up** (1990-05)—This month's *Procurement Pulse* examines how stabilizing order rates and lowering lead times, combined with an upbeat system sales outlook, set the stage for a moderate growth scenario that hinges on accurate forecasting.
- **Will There Be Another DRAM Shortage in 1990?** (1990-06)—Dataquest has not eliminated the possibility of a DRAM shortage in 1990, considering recent events that are similar to those that sparked the two-year DRAM shortage that began in 1987. However, other factors make this situation different than in 1987, leading us to conclude that a shortage, if it does occur, should be short and temporary. DRAM purchasers should continually give the suppliers a true and accurate forecast of their future requirements and not rely excessively on spot buys.

- **February Market Watch: Market Still Growing, but Mixed Signals Appear** (1990-07)—This month's *Market Watch* discusses how once again mixed signals are on the rise. Dataquest still expects the first quarter of 1990 to be a mild improvement over the last quarter of 1989 despite the return of mixed market signals. It is becoming increasingly difficult to characterize the improvement because, as in any weak market, some companies will feel it and some will not.
- **1990 Semiconductor User Survey Focus Changes from Availability to Supplier Performance** (1990-08)—Three key findings were a result of the Fifth Annual Dataquest Semiconductor User Survey. Respondents expect to increase their 1990 semiconductor purchases by 9.6 percent. Medium-size semiconductor users are the most optimistic about growth opportunities in 1990. The top three issues are on-time delivery, price, and cost control. This newsletter summarizes the presentation given at the Semiconductor User and Applications Conference and highlights the key findings of this survey.
- **True or False: User/Supplier Relationships to Change in the 1990s?** (1990-09)—This newsletter summarizes the conference by discussing the changes affecting the semiconductor industry today, ways in which Dataquest clients can seize opportunities while hedging the downside. It also covers industry forecasts for the 1990s, and Dataquest's second annual "Semiconductor Supplier of the Year" award.
- **Global Regional Pricing Strategy Brings Key Advantages to Semiconductor Users and Suppliers** (1990-10)—At Dataquest's Semiconductor Users and Applications Conference, the authors of this newsletter spoke of strategic and tactical IC pricing trends. This newsletter highlights Dataquest's key strategic recommendations, with special emphasis on the advantages of a global regional pricing strategy. In addition, Dataquest recommends that suppliers and users actively track and manage world regional IC pricing differentials.
- **March Procurement Pulse: Bookings and Sales Outlook Steady; Inventories, Lead Times, Prices Decline** (1990-11)—Stable semiconductor order rates and the low-key optimism forecast in system sales continue to provide optimum conditions for predictable supply cost forecasts. Frequent forecasts will allow for the current supply situation to continue.
- **March Market Watch: The Market Keeps Slowly Chugging Along** (1990-12)—This month's *Market Watch* examines rising book-to-bill ratios, computer demands stabilizing while inventories plummet, and prices rising slowly. The overall market continues to bump along with steady but unspectacular demand, and suppliers have cut supplies to match this unexciting goal. Dataquest believes that the test is whether or not users can accurately forecast their real six-month needs and suppliers can meet this test.
- **Chips & Technologies Product Expands Beyond PC Boundary** (1990-13)—Chips & Technologies, Inc., recently introduced a new chip set product—The Multi-Processor Architecture Extension (MPAX). MPAX is a modular system architecture (MSA) standard that is designed to allow system OEMs to easily implement multiple-processor computer products based on PC platforms. The introduction of a new standard is a departure from the typical Chips strategy of bringing to market products based on established standards.

- **IBM and Siemens in 64Mb DRAM Project** (1990-13)—Siemens, the largest European manufacturer of DRAMs, and IBM have teamed up to develop the technology required for the 64Mb DRAM. This bulletin discusses the implications of this joint venture for the DRAM market and both companies.

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June 18, 1990

Dear Client,

Enclosed is a newsletter written by our Semiconductor Industry Service that I thought might interest you. Recently, there has been a great deal of interest in the chip set market, and this newsletter highlights the preliminary trends. In the future, when other newsletters are written that would be of interest to semiconductor users, I will pass them on to you as well. If you have any questions about this newsletter, please call me at (408) 437-8258.

Regards,

Mark A. Giudici

Mark A. Giudici
Acting Director
Semiconductor User Information Service

Dataquest
a company of The Dun & Bradstreet Corporation

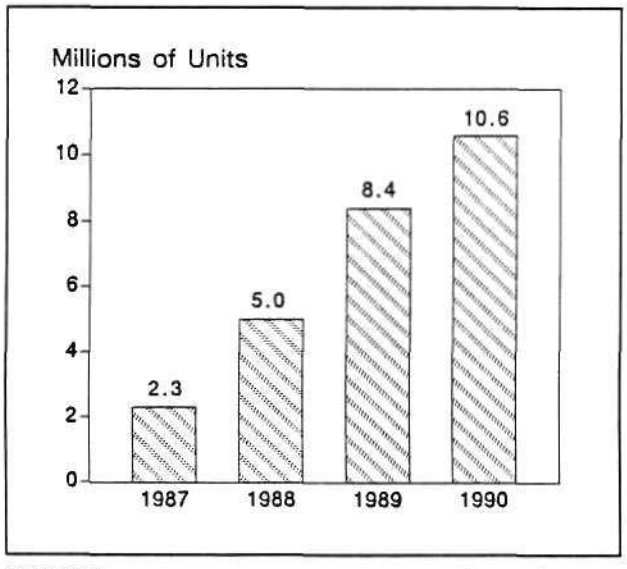
Research Newsletter

PRELIMINARY GRAPHICS CHIP SET FORECAST SHOWS REVENUE DECLINE

SUMMARY

Dataquest is expecting substantial growth in the DOS PC market as a result of high growth in the notebook and hand-held computer segments. This equates to an improved market for PC graphics chip sets. Based on survey results, Dataquest estimates the size of the merchant chip set market to be 8.4 million units in 1989, increasing to 10.6 million units in 1990 (see Figure 1). This market had 12 vendors in 1989, and the number is growing; therefore, Dataquest anticipates intense competition, coupled with declining prices and profit margins. VGA will become the dominant graphics standard in the low-end market as HGA, CGA, and EGA become obsolete.

FIGURE 1
Total Low-End Merchant PC Graphics Chip Sets Estimated Worldwide History and Forecast (Units)



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Source: Dataquest
May 1990

THE FORECAST

Volume Up, Revenue Down

Based on preliminary forecasts from Dataquest's Personal Computer Group, we derived the total low-end graphics chip set solution forecast through 1990 (see Table 1). The merchant chip set market is expected to continue its growth to 10.6 million units in 1990, up 25.8 percent over 1989. Average selling prices (ASPs) took a dramatic drop as a direct result of competition and fell 18.4 percent to $19.50 in 1989. Merchant chip set revenue increased 36.1 percent to $163.8 million but is expected to decline slightly in 1990 as rising unit shipments are unable to offset falling ASPs.

VGA Dominates with 65 Percent of the Market

Figure 2 depicts the graphics survey results by graphics standard. As discussed, VGA is the dominant standard in the low-end market. Dataquest believes that over time HGA, CGA, and EGA will become obsolete as VGA prices decline. VGA and SVGA (super VGA) will be the key PC graphics solutions through the mid-1990s.

We expect to see a new graphics standard begin to erode VGA growth in the long term; however, the shift to a new standard will not occur as rapidly as it has in the past. Dataquest believes that the IBM 8514/A will be the eventual successor to VGA in the mainstream PC market.

As the PC market grows, Dataquest predicts that almost every PC produced will have a graphics chip set by the mid-1990s. As the portable notebook and laptop markets take off, we can expect VGA to be a standard item found on these PCs.

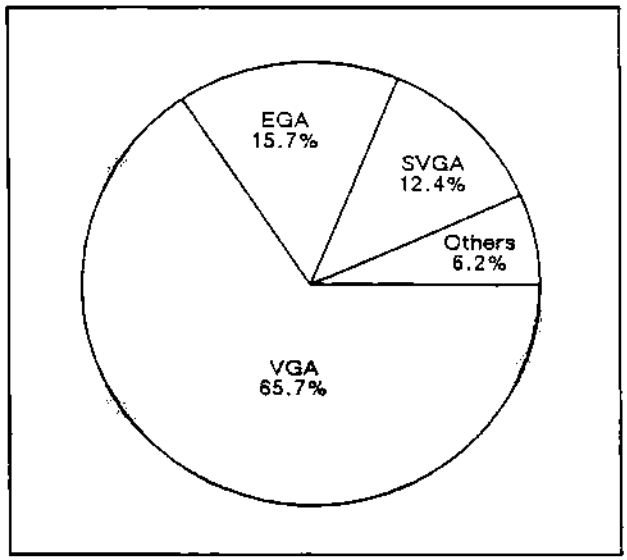
TABLE 1
Merchant Graphics Chip Set Market—Estimated Worldwide History and Forecast (Millions of Units)

	1987	1988	1989	1990
Total DOS PC Shipments	10.6	13.7	16.5	18.8
Growth Rate		29.2%	20.4%	13.9%
Low-End Graphics Chip Sets	5.0	8.7	11.9	14.5
Growth Rate		75.7%	36.6%	21.9%
Saturation[1]	46.7%	63.5%	72.0%	77.0%
Merchant Graphics Chip Sets	2.3	5.0	8.4	10.6
Growth Rate		116.5%	66.7%	25.8%
Saturation[2]	47.0%	57.9%	70.7%	73.0%
Merchant Graphics Chip Set ASP	$26.1	$23.9	$19.5	$15.0
Growth Rate		(8.6%)	(18.4%)	(23.1%)
Merchant Graphics Chip Set Revenue ($M)	$60.8	$120.3	$163.8	$158.5
Growth Rate		98.0%	36.1%	(3.2%)

[1] As a function of DOS PCs
[2] As a function of low-end graphics chip sets

Source: Dataquest May 1990

FIGURE 2
1989 PC Graphics Survey Results
Shipments by Solution Type



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Source: Dataquest May 1990

WHO ARE THE PLAYERS?

Table 2 represents the product matrix for the 13 vendors in the PC graphics chip set market. Notice that all 13 vendors offer VGA products. The top three merchant vendors—Western Digital, Tseng Labs, and Cirrus Logic—accounted for 56.8 percent of the merchant revenue in 1989. In comparison, in 1988, the top three vendors—Western Digital, Chips & Technologies, and Cirrus Logic—accounted for approximately 75.0 percent (see Figure 3). Market shares will continue to shift among vendors as more chip set vendors enter the market. Major semiconductor manufacturers will begin to enter the market. As the business shifts from add-in boards to motherboard implementations, an extended product line including mass storage, communication solutions, and system logic will be a key success factor in this market.

Western Digital

Western Digital emerged from the lethargic times following the Faraday acquisition to become a streamlined, highly focused operation. The company is one in a handful that offers an extended product line including core logic, storage, data communications, and video chip sets. With this broad product offering, Western Digital is able to service multiple segments as well as offer a full-system solution.

Tseng Labs

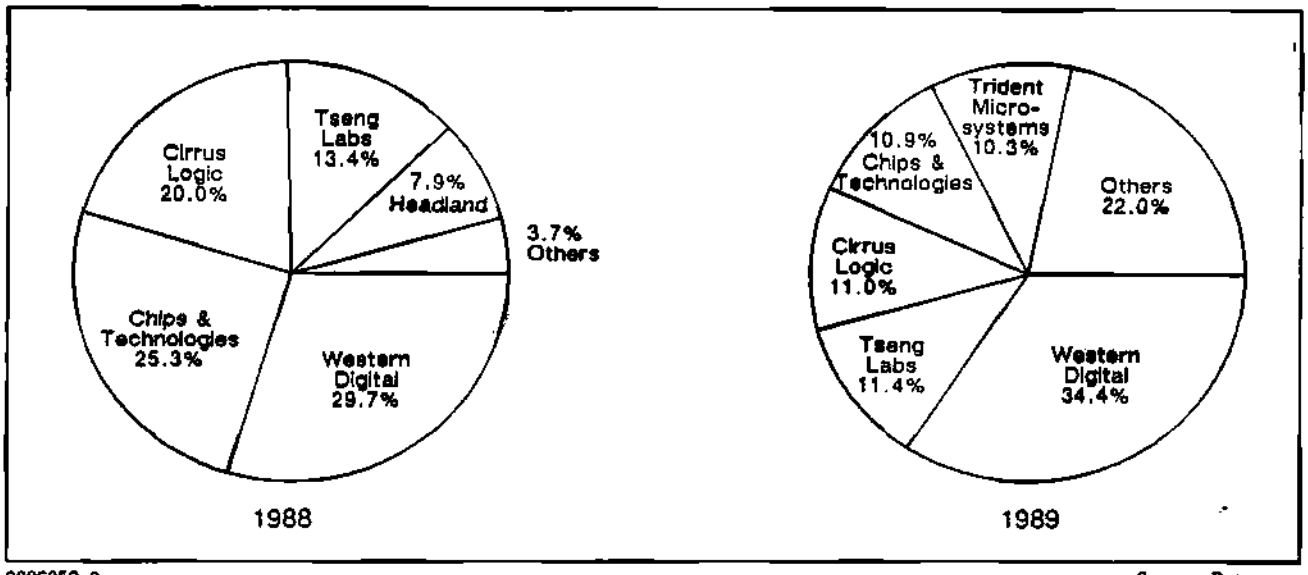
Founded seven years ago, Tseng Labs has emerged as the number two player in the PC

TABLE 2
Vendor Product Matrix

Vendor	SVGA	VGA	EGA	CGA	8514/A	TIGA
Chips & Technologies	X	X	X	X	X	
Cirrus Logic		X				
Genoa		X				
Headland		X	X			
Intel		X				
NSI Logic	X	X	X			
Oak Technology	X					
Renaissance GRX	X	X				X
Texas Instruments						X
Trident Microsystems		X				
Tseng Labs		X	X			
Western Digital		X	X	X	X	
ZyMOS	X					

Source: Dataquest
May 1990

FIGURE 3
1988 and Preliminary 1989 Low-End PC Graphics Merchant Chip Set
Revenue Market Share by Manufacturer



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Source: Dataquest
May 1990

graphics chip set market. Employing 36 people and based in Newtown, Pennsylvania, the company uses outside foundries to make its chips. As a small company, Tseng is better equipped to take advantage of technological changes. Following standards announced by IBM, Tseng offers both EGA and VGA solutions, selling the boards to large computer makers and the chips to graphics board makers.

Cirrus Logic

Founded in 1984, Cirrus Logic offers a growing product portfolio including mass storage, display graphics, data communications, and print graphics solutions. The company was the first to offer a product that brought VGA quality to liquid crystal display (LCD) panels. Capitalizing on its display graphics capabilities, Cirrus is targeting the portable PC market.

ZyMOS/Renaissance

ZyMOS recently acquired Renaissance GRX, a manufacturer of TIGA graphics boards. In acquiring Renaissance, ZyMOS will enter the high-end graphics chip set market by offering devices that support Texas Instruments' (TI's) TIGA standard. ZyMOS apparently believes that it can carve out a niche for itself in this high-end market by supporting TIGA. Dataquest believes that this is probably a sound strategy for a small chip set company. In choosing TIGA, ZyMOS will not have to compete with the likes of Chips & Technologies, Headland, and Western Digital, all of which have committed to adopt the IBM 8514/A graphics standard. In the long run, if TIGA is to move down the product curve and penetrate the mainstream PC market, the TIGA solution will likely have to be implemented on the motherboard, suggesting a one- or two-chip solution.

DATAQUEST CONCLUSIONS

Dataquest believes that VGA will be the dominant PC graphics standard through the mid-1990s as the market moves along the product life cycle to maturity. In the high-end graphics chip set market, the 8514/A standard will begin its path along the product life cycle. Dataquest believes that extended product lines and complete solutions will be factors to success for companies wishing to compete in the volatile PC graphics chip set market. We can expect to see those vendors that have had success focusing on graphics begin to enter the systems logic market if they have not already done so, and vice versa.

Lori Kulwin

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Research Newsletter

IBM AND SIEMENS IN 64M DRAM PROJECT

SUMMARY

Siemens, the largest European manufacturer of DRAMs, and IBM have teamed up to develop the technology required for the 64M DRAM. This joint venture highlights the concern that developing state-of-the-art DRAM products is becoming prohibitively expensive, and the cost must be shared if any return on investment is to be made within the product lifespan of the device, typically little more than three years. The R&D and total factory investment costs of the 64M DRAM are estimated to be in the region of $7.0 billion, as shown in Table 1, which is to be compared to the estimated worldwide total available market (TAM) for all densities of DRAM, forecast to be $7.7 billion in 1990, as shown in Figure 1.

This bulletin discusses the implications of this joint venture, both for the DRAM market and for each respective company.

OUT OF THE SHADOWS

IBM has never directly featured in the merchant DRAM market, as it only ever supplies one customer: itself. This makes it difficult to estimate the company's strength in terms of DRAM unit production, but we estimate IBM is one of the top three worldwide, presently supplying at least half its internal demand for DRAM, with the remainder being purchased from the merchant market. To a certain extent this places the company at the mercy of foreign DRAM suppliers, the majority of which are vertically integrated and therefore competitors to IBM in the computer equipment market. Also, a percentage of every dollar spent with a foreign DRAM supplier is fed back into these suppliers' R&D and capital for future generation DRAMs. IBM has attempted to change this by planting the seeds for a homegrown supply of DRAMs, in offering its DRAM technology to a number of North American semiconductor suppliers (Micron Technology, Cypress, the defunct U.S. Memories consortium, to name a few). However, the success of these efforts has been limited.

This latest announcement marks the company's first semiconductor alliance with a foreign DRAM supplier. Interestingly, Siemens is also a competitor to IBM in the computer industry, particularly in Europe's largest computer market, West Germany, where Siemens now has a controlling interest in Nixdorf Computer. IBM and Siemens (including Nixdorf) rank first and second in terms of European computer shipments value. Dataquest

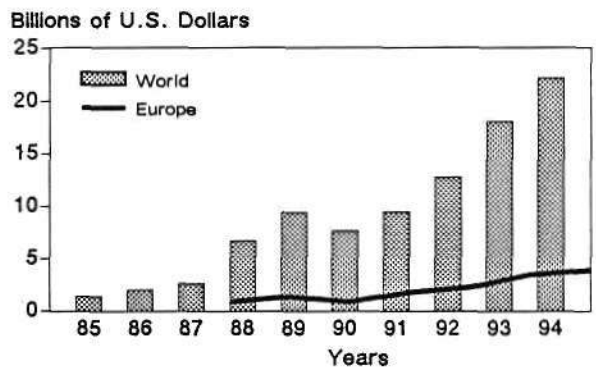
TABLE 1
Estimated DRAM Investment by Generation (Billions of U.S. Dollars)

Cost	64K	256K	1M	4M	16M	64M
R&D	0.12	0.18	0.36	0.38	0.51	1.00
Factory Investment*	0.19	0.40	1.30	1.60	3.70	6.00
Total	0.32	0.58	1.66	1.98	4.21	7.00

*Over useful lifetime

Source: Siemens

FIGURE 1
Worldwide DRAM TAM Forecast



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Source: Dataquest March 1990

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estimates that in 1988, IBM totaled $20.1 billion in European computer shipments and Siemens (including Nixdorf) $7.9 billion.

Development of the 64M DRAM generation is planned to be undertaken at Siemens' R&D facilities in Munich and at IBM's Advanced Semiconductor Technology Center in East Fishkill, New York State, where the company has already been investing in X-ray lithography equipment to attain the short wavelength radiation to produce the 0.35-micron architectures needed for this complexity. Finally, 64M DRAM production will take place at each company's plants in the United States and West Germany.

Oxford Instruments, based in the United Kingdom, won the order from IBM for the X-ray synchrotron system and, coincidentally, joined forces with Siemens in May last year to launch a new medical electronics company called Oxford Magnet Technology Ltd. This, together with Siemens' takeover of Rolm, IBM's private branch exchange (PBX) equipment subsidiary, late in 1988, provides momentum for the DRAM joint venture to work.

AN INVITATION TO THE PARTY

A further timely development has been the invitation from the board of the Joint European Submicron Silicon (JESSI) program for IBM Europe "to participate in selected JESSI projects." One of JESSI's goals is to have pilot production of 64M DRAM in 0.35-micron architecture by 1996. JESSI made it clear in its planning outline in February 1989 that the industry has to be free to look outside the European framework, in the case of an inadequate European base to develop essential advanced equipment. JESSI has said that the Siemens/IBM agreement will speed up the European industry's market access to 64M DRAM. IBM is also a prominent member of the U.S. Semiconductor Manufacturing Technology (Sematech) consortium, and it is thought that the company may be influential in opening the door to cooperation between the two research programs as, till now, Sematech has been firm on its policy of U.S.-only membership. Dataquest expects both research programs to be swiftly reviewed following these developments, with announcements to follow.

DATAQUEST ANALYSIS

Dataquest expects Siemens and IBM to form a strong partnership. Both companies already have trench capacitor 4M DRAM process in production, with 16M DRAM devices at the design stage, so strengthening their commitment to common DRAM technology. Continuing price erosion and oversupply of 1M DRAM devices will hurt suppliers in 1990, as the market turns sharply in the buyers' favor. There may be a shakeout of those suppliers which decide to curtail their investment in further generations of DRAM, as occurred in the 1984 industry downturn. This could limit the potential number of 64M DRAM players, which would be good news for IBM and Siemens, both for their merchant business and for the competitive edge their computer divisions would gain through the 4M, 16M, and ultimately, 64M DRAM technology.

There is another possibility to consider. Dataquest believes that IBM is accelerating its 8-in. wafer 4M DRAM production such that it is likely to be the number one worldwide unit producer of DRAMs in the very near future. If this production ever exceeds internal demand during computer industry downturns, the company will need to decide whether to build inventory or sell to the merchant market. The latter option would be difficult, as IBM has no semiconductor marketing/distribution network, but an established vendor could act as distributor. This could be Siemens.

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Byron Harding

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Research Newsletter

CHIPS AND TECHNOLOGIES PRODUCT EXPANDS BEYOND PC BOUNDARY

SUMMARY

Chips and Technologies, Inc., recently introduced a new chip set product—the Multi-Processor Architecture Extension (MPAX). MPAX is a modular system architecture (MSA) standard that is designed to allow system OEMs to easily implement multiple-processor computer products based on PC platforms. The introduction of a new standard is a departure from the typical Chips strategy of bringing to market products based on established standards. For the MPAX to be successful, system OEMs must be convinced of its viability as an MSA standard that will gain broad acceptance. If successful, Chips is likely to see a change in its customer base that will reflect the different distribution channels and greater technical support required for these products as compared with single-user PC or workstation products.

THE CHANGING CUSTOMER BASE

Chips is well known for its role in pioneering the PC chip set market, offering VLSI implementations of PC system logic that have enabled systems manufacturers to reduce costs, speed design time, and decrease time to market. It has been argued also that chip sets have accelerated the rate at which leading-edge technologies and products are brought within reach of the mainstream end user.

The MPAX product continues the Chips tradition of facilitating systems design and introduction, but the systems we are now talking about are not single-user PC products. Multiprocessor systems, which are typically multiuser, multitasking environments, are the domain of the mainframe and superminicomputer vendors, and selling into this segment requires more sophistication and support than might be expected from some of Chips' current PC chip set customers. Because of this, Chips is likely to see a whole new type of customer—mainframe and superminicomputer vendors.

OPPORTUNITIES AND POSSIBLE ALLIANCES

For PC vendors, a product such as the MPAX offers the opportunity to build minicomputer products using familiar PC architectures, enabling them to expand into higher-performance markets. To accomplish this expansion, PC vendors will require increased technical support from Chips, and they will need to restructure their support and distribution channels.

Viewed from the mainframe and superminicomputer vendor position, this is an opportunity to expand into the departmental computing market. These vendors have the incentive to produce such a product and the distribution channels and support capabilities to bring it to market.

It is probable that MPAX and similar products that are likely to be introduced will spawn alliances between some of the PC vendors and mainframe or minicomputer vendors. PC vendors offer PC platform manufacturing expertise and capacity, and mainframe and minicomputer vendors offer access to distribution channels and technical support.

STANDARDS

The MPAX represents a proposal by Chips for a new computing standard, a modular system architecture. Thus, MPAX represents a departure from the typical Chips strategy of offering only products based on established standards. From the proliferation of computing standards proposed by system vendors, it would be difficult to guess that

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in survey work and focus groups the system end users have been pleading for fewer standards and more compatibility. If one looks at just the IBM PC-compatible arena alone, end users (translates to "paying customers") have to decide among bus architectures (XT, AT, MCA, EISA); microprocessors (8086, 80286, 80386SX, 80386DX, 80486); speed grades (4, 8, 10, 12, 16, 20, 25, 33, 40 MHz); and graphics platforms (EGA, VGA, 8514/A, TIGA).

The fact is that end users don't care what is on the inside of the computer. They don't care whose standard it is or what it is called. They only care about whether or not the box will adequately perform the intended function and application, if it is compatible with their current investment in hardware and software, if it will be upgradable and compatible with their future investments in hardware and software, and if there is a sufficient support organization to back them up now and in the future.

Because MPAX would allow multiprocessor systems to be built based on a PC platform, an MPAX system would be 100 percent DOS-PC compatible but could also run UNIX and have a combination of RISC and CISC processors. The benefit of the MPAX is that it allows complete backward compatibility (in terms of hardware, software, and connectivity) to the PC environment while implementing UNIX without any loss in performance. The ability to build multiprocessor systems that are compatible with and can be connected to existing PCs could be a key competitive advantage. Current multiprocessor systems typically do not allow mixed processors and run DOS through emulation. The loss of performance associated with the DOS emulation may not be acceptable to users.

DATAQUEST CONCLUSIONS

It is difficult to achieve technical progress without occasionally having to generate new standards. But standardization issues are the prime concern of customers, and customers confused by these issues will put off making buying decisions or may not buy at all. This is the environment in which Chips must work, and the job is to convince both the system OEM and the end user that the MPAX is an acceptable solution.

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Ken Pearlman

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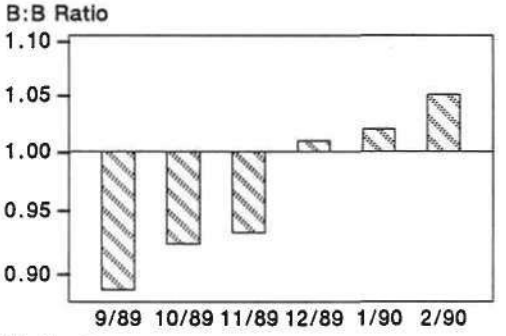
Research *Bulletin*

MARCH MARKET WATCH: THE MARKET KEEPS SLOWLY CHUGGING ALONG

Market Watch is a monthly Dataquest bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

Figure 1
U.S. Semiconductor Book-to-Bill Ratio



*Estimate

Figure 2
DOC Computer Demand

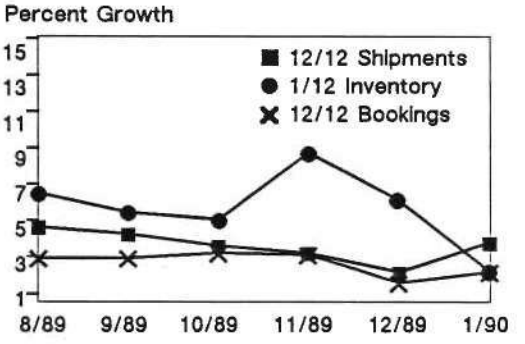


Figure 3
Semiconductor Inventory Level

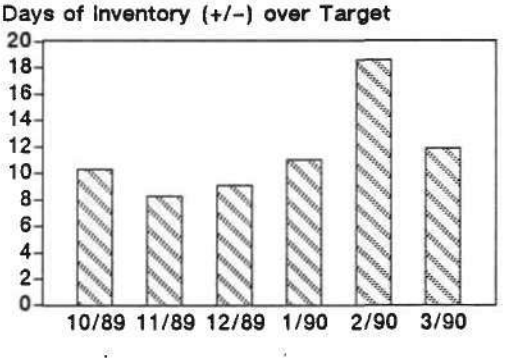


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Figure 4
U.S. Weighted Semiconductor Price Indicator

Source: U.S. Department of Commerce
World Semiconductor Trade Statistics
Dataquest
March 1990

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THE BOOK-TO-BILL CONTINUES TO RISE

The February book-to-bill ratio of 1.05 (see Figure 1) appears on the surface to bode well for the semiconductor industry, but the actual numbers tell a different story. For the last two months, both three-month average bookings and billings have declined in dollar terms. In effect, the billings dollar average has declined faster than the bookings average! This phenomenon primarily is due to the last five months' price erosion, which now is being felt as billings. The volume of units still remains steady, and there are signs of unit growth in the upcoming months. With the recent stabilization in memory prices, bookings dollars should rise faster even if unit shipments remain flat.

JANUARY COMPUTER DEMAND STABLE, BUT INVENTORIES PLUMMET

The bookings and shipments of computers have remained relatively flat, but system inventories have dropped substantially (see Figure 2). The 3/12 booking rate-of-change indicator is still rising faster than the annualized 12/12 rate (4.5 percent versus 2.7 percent). This early indicator of annualized growth reflects what buyers have been saying in our monthly procurement surveys (see the *Procurement Pulse* bulletins). What is encouraging is the trend of inventory rates relative to shipment and bookings rates. For the first time in eight months, the 1/12 inventory rate is equal to the annualized bookings rate for computers. Inventory control of both systems and components is allowing for quicker response time to the needs of the market.

SEMICONDUCTOR INVENTORIES OF USERS ALSO FALL

The reduced gap in actual versus targeted inventory levels dipped this month, as shown in Figure 3, even though targeted inventory levels declined slightly. The bulge of semiconductor inventories in February was worked down by increasing system shipments and slowing some order levels. The importance of inventory control was emphasized by the reduction of average inventories by more than one week in a month's time (30.0 days versus 37.3 days). This fairly brisk 12 turns of inventory per year is a reminder to semiconductor suppliers that low inventories continue to require very close communication between buyer and seller.

PRICES ON AVERAGE ACTUALLY CREEP UPWARD!

Semiconductor supplies in aggregate have at last come into balance with demand; the price indicator has risen $0.24 since our last analysis (see Figure 4). DRAM production cutbacks announced late last year are being felt now as anticipated. Coinciding with the memory supply situation is the Intel 32-bit microprocessor supply hiccup that has stretched lead times out to 18 weeks and flattened steady price reductions. Intel expects to meet demand within three months, but the DRAM supply is dependent on how well users forecast their next six to nine months of requirements and how well suppliers meet that demand. It will take three months to see a trend change in the market once any uptick in demand is acted upon with increased wafer starts. Therefore, until at least June, Dataquest expects to see stable prices while system demand remains flat.

DATAQUEST CONCLUSIONS

The overall market continues to bump along with steady but unspectacular demand, and suppliers have cut supplies to match this unexciting goal. Inventories of both systems and components are under control and are expected to remain so for the near future as a result of the close communication most suppliers have with their key customers. We continue to see positive outlooks coming from our monthly procurement surveys, concurring with the historical Department of Commerce trend lines. Now that supply has slowed and met demand, Dataquest believes that the test is whether or not users can accurately forecast their *real* six month needs and whether or not suppliers can meet this test. Overall cost levels for 1990 hang on the results of this exercise.

Mark Giudici

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Research Newsletter

GLOBAL REGIONAL PRICING STRATEGY BRINGS KEY ADVANTAGES TO SEMICONDUCTOR USERS AND SUPPLIERS

At Dataquest's Semiconductor Users and Applications Group conference (held in San Francisco, California, on February 12 and 13), the authors of this newsletter spoke on strategic and tactical IC pricing trends. This newsletter highlights Dataquest's key strategic recommendations, with special emphasis on the advantages of a global regional pricing strategy. For example, Dataquest expects the 4:1 unit/price crossover from the 1Mbx1 DRAM to the 4Mbx1 device (100ns versions) to occur in North America during the first quarter of 1991. For DRAM users and suppliers, a global regional strategy emphasizes insight into the factors—including government mandates—that will affect the timing of this critical crossover in different world regions.

STRATEGIC RECOMMENDATIONS

Dataquest analysts made the following five pricing strategy recommendations during the conference:

- Semiconductor users and suppliers must learn to *jointly manage* higher IC prices for enhanced system value.
- Users, *in alliance* with suppliers, must manage competitiveness despite single-sourced IC products.
- Users should develop component pricing and procurement strategies based on *system cost* impact analysis.
- Suppliers and users must manage world *regional pricing differentials*.
- Suppliers and users should *stay close* to each others' manufacturing activities and production plans.

This newsletter shows how management of global regional price trends helps suppliers and users control rising IC prices.

RISING IC PRICES?

Figure 1 shows a surprising component price trend: the weighted average IC price has increased since the mid-1980s and Dataquest predicts that it will climb even higher in the 1990s.

What is the fundamental reason for higher average IC prices? The integration of functions, or system capability, onto the average IC has been happening so rapidly that the IC system integration process has slowed IC unit shipment growth relative to dollar growth.

The trend of rising IC prices underscores the first strategic recommendation: users and suppliers must learn to jointly manage IC supply, demand, and pricing in order to increase system value, especially as users employ more single-sourced ICs in systems. With many aspects of semiconductor technology really becoming systems-on-a-chip, both OEMs and semiconductor suppliers need to approach pricing on a system value basis. This strategy rings most true for products such as ASICs, 32-bit microprocessors, and application-specific standard products (ASSPs), in which price comparisons often are not possible because of the uniqueness or single-source nature of the product.

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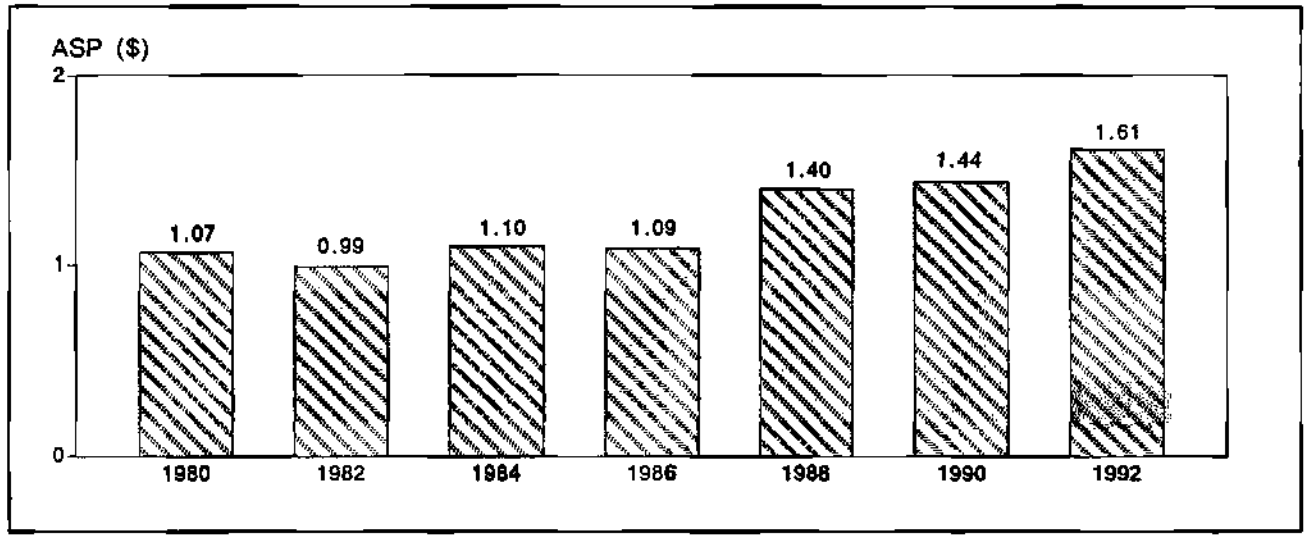
FIGURE 1
Overall Average
IC Selling Price Is Up



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Source: Dataquest
March 1990

GLOBAL REGIONAL SOURCING AND SUPPLY STRATEGIES

The challenge of managing higher IC prices connects directly with the next element of the pricing equation—strategic management of *global regional trends* in IC prices. For example, suppliers must manage world regional pricing differences in order to assess and respond to their competitive strengths and weaknesses in the world regions. Users must learn to manage a search for world regional differences in IC pricing that can mean significantly lower total system costs and higher system profit margins.

WORLD REGIONAL PRICE TRENDS

Figure 2 uses information from the on-line *DQ Monday* service to illustrate world regional price differences as of February 12, 1990, for three critical products: the 1Mbx1 DRAM 100ns, the 32Kx8 SRAM 100ns, and the 16-MHz 80386SX. The U.S. price serves as the base, and Figure 2 shows the pricing difference—the percentage greater or less than the U.S. base price. The product mix includes two multisourced devices (DRAMs and SRAMs) and a sole-sourced part (the 80386SX). Pricing in Europe and South Korea has moved sharply since the mid-February conference, which reinforces the need for users and suppliers to monitor global regional trends constantly.

Figure 2 shows that as of February 12, users that source the 1Mbx1 DRAM in Japan pay 12 percent *more* than users that source in the United States. By contrast, buyers of the 32Kx8 slow SRAM pay 13 percent *less* in Japan than in the United States. Users that procure the 80386SX microprocessor in Japan pay almost 20 percent more than buyers that source in the United States.

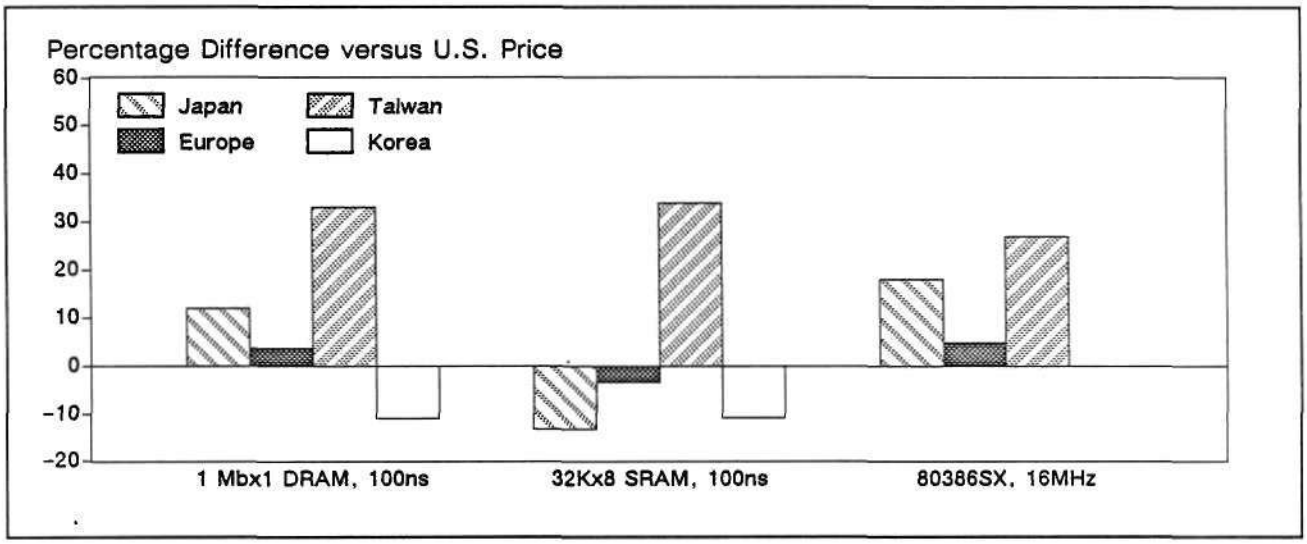
Users that buy memory products in Europe pay prices that are in the same range as U.S. prices, but buyers that source the 16-MHz 80386 microprocessor in Europe pay 5 percent more than in the United States.

Buyers that procure in South Korea—which typically are members of a vertically integrated firm—pay prices that are 10 to 11 percent lower than U.S. prices for the memory products specified above. In contrast, users that source in Taiwan—which typically are *not* part of vertically integrated enterprises—pay much higher prices across the board.

FACTORS BEHIND GLOBAL REGIONAL PRICING VARIATIONS

Two main factors lie behind global pricing variations: the strength of regional system-application markets and the home region of major IC suppliers. For example, the United States is a strong application market for workstations and

FIGURE 2
Price Trends by World Region Compared with U.S. Price (as of February 12, 1990)



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Source: Dataquest March 1990

PCs, both of which are DRAM-intensive systems, so users that source DRAMs in the United States now enjoy favorable pricing. Regarding the home regions of major suppliers, Japan is a world leader in production of slow SRAMs and ROMs, so buyers that source in Japan currently pay less for those devices.

DRAMs

Dataquest notes that in the case of DRAMs, the United States' strength in DRAM-intensive applications means competitive DRAM pricing in the United States *despite* Japan's world leadership in DRAM production. DRAM pricing was higher in United States than in Japan during the supply crunch of 1987 and 1988. The presence today of a global network of DRAM suppliers (European, South Korean, and U.S. suppliers as well as Japanese firms), which competes for strong U.S. demand, has kept DRAM pricing lower in the United States than most regions. Wild card DRAM suppliers such as Samsung of South Korea and Siemens of West Germany, impede trends toward formation of supplier cartels.

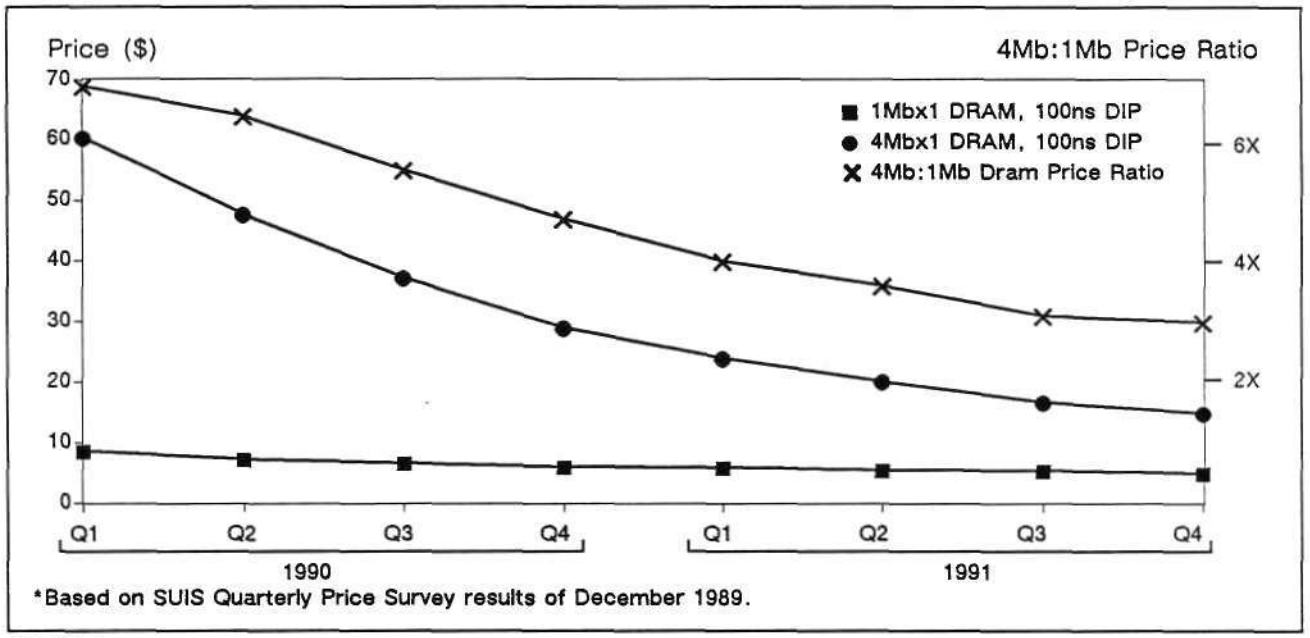
Looking to the future, Japan might emerge as a strong application market for high-definition television (HDTV), a DRAM-intensive system for the mid-1990s and beyond. That prospective reality, combined with Japan's likely continuing strength in DRAM technology, *could* translate over the long term into a distinct pricing advantage for users that source DRAMs in Japan.

THE 1Mb-TO-4Mb DRAM PRICE CROSSOVER BY WORLD REGION

Global regional differences, particularly in DRAM pricing, mean immediate challenges and opportunities for semiconductor suppliers and users. Users that track world pricing trends will discover large pricing differences that can lower system costs. For suppliers, accurately forecasting world regional DRAM demand and operating fabs to support this demand means risky but potentially lucrative business.

For DRAM users and suppliers, a central issue now is the timing of the 4:1 unit/price crossover from the 1Mb DRAM to the 4Mb product. As presented at the conference, Figure 3 shows North America megabit-density DRAM price trends by quarter for 1990 and 1991. The top line of this figure is read along with the *right axis* to show the 4Mbx1:1Mbx1 DRAM unit/price ratios during this period. For North America, Figure 3 forecasts the 4:1 unit/price crossover from 1Mb DRAMs to 4Mb DRAMs to occur during the first quarter of 1991.

FIGURE 3
North American
Megabit-Density DRAM Price Trends*



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Source: Dataquest
March 1990

After the speech, a member of the audience asked how North America's fair market value (FMV) system and Europe's floor reference pricing system would affect the crossover scenario. First, the effect of FMVs on North American DRAM pricing was considered in the crossover projection shown in Figure 3. Dataquest still expects the crossover in North America to occur during the first quarter of 1991.

Second, European DRAM pricing controls to date are *delaying* the crossover in Europe. The pricing mandate currently means 1Mb DRAM price declines in Europe because the reference price sits *below* the market price—with users demanding the lower reference price in current negotiations. The effect of European government controls on 1Mb DRAM pricing can not be fully assessed at this time, but Dataquest expects the megabit-density DRAM unit/price crossover in Europe to occur during early 1991 at the earliest.

Third, in Japan, first-tier suppliers of 4Mb DRAMs plan to move users to the 4Mb device by the end of this year; however, suppliers are backing down from this goal. Recent cutbacks in 1Mb DRAM production by suppliers in Japan signal some price stabilization for the 1Mb device. The elusive issue of the internal transfer price for DRAMs within vertically integrated firms will play a major role in the crossover in this region. *If* leading-edge suppliers of 4Mb DRAMs in Japan reach all of their goals on yield rates, design wins, and production ramp up, users that source in Japan might cross over later this year or during early 1991.

Finally, the continuing drop in 1Mb DRAM pricing in South Korea signals a crossover after other world regions—during the second or third quarter of 1991.

DATAQUEST CONCLUSIONS

At the conference, Dataquest recommended that semiconductor users and suppliers learn to jointly manage rising IC prices toward the goal of enhanced system value. To meet that objective, we make an allied recommendation: suppliers and users must actively track and manage world *regional IC pricing differentials.*

For DRAM users and suppliers, a global regional pricing strategy links a host of factors—such as the home region of suppliers, the strength of regional application markets, government controls, internal-transfer pricing—that will affect the

timing of the critical megabit-DRAM crossover in different world regions. The effects of U.S., Japanese, and European government controls on the crossover scenario are as follows:

- The effect of FMVs on North American DRAM pricing were considered in the crossover projected for the first quarter of 1991.
- European pricing controls as currently proposed are starting to extend the crossover in Europe, which should occur *after* the North American regional crossover.
- First-tier suppliers of 4Mb DRAMs in Japan now appear to be retreating from their prior goal of crossing users over from the 1Mb device to the 4Mb product by the end of this year. The DRAM transfer price within vertically integrated firms plays a special role in Japan's crossover, which is likely to happen during early 1991.
- In other world regions, the crossover should occur by mid-1991.

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Gregory Sheppard

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Research Newsletter

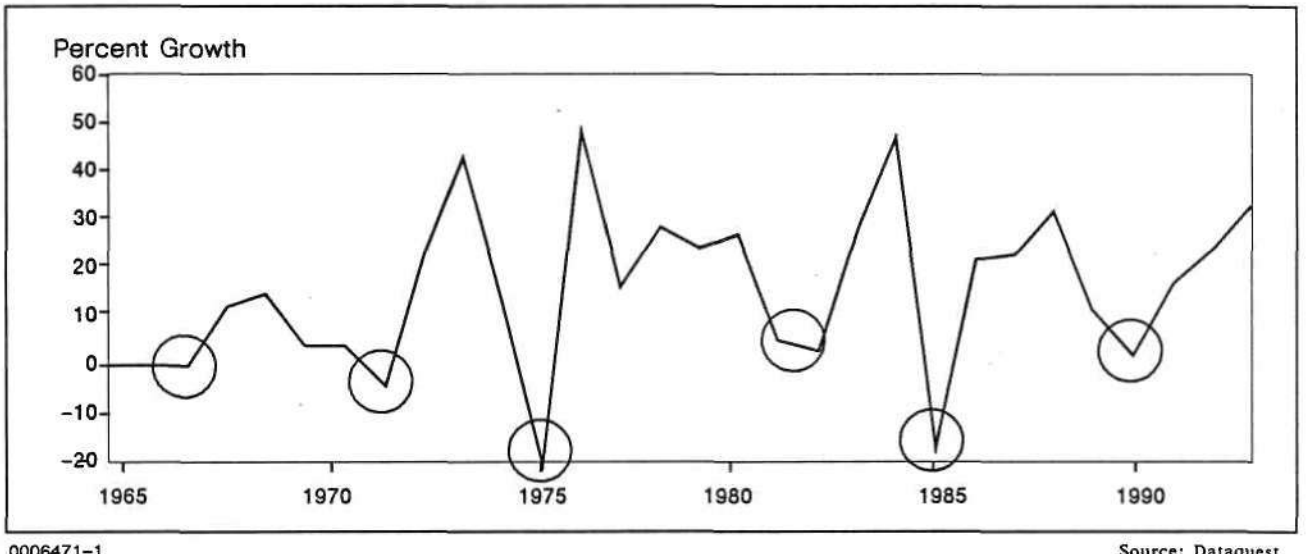
TRUE OR FALSE: USER-SUPPLIER RELATIONSHIPS TO CHANGE IN THE 1990s?

Strategic partnering was proposed in the early 1980s to describe how semiconductor customers and suppliers should conduct business with each other. But when the industry had a severe downturn in 1985, suppliers scrambled after every deal, and prices fell through the floor. When the industry finally had a mild boom in 1988, buyers chased after every available part, DRAM shortages developed, and spot-market lead times and prices went through the roof. Then in 1989, DRAMs became plentiful again and prices fell to record lows.

Is *strategic partnering* the solution to reducing the wild swings (see Figure 1) that have occurred in the semiconductor industry during the past 25 years? Buyers and sellers had a chance to find out at Dataquest's annual conference for semiconductor users and suppliers, held again this year in San Francisco, California. The more than 180 attendees to the two-day February conference included buyers (45 percent), sellers (40 percent), and persons from government agencies, investment firms, and the trade press (15 percent). Eleven of the top 15 North American users (e.g., those that purchased more than $7 billion of semiconductors in 1989) were represented, along with delegates from 13 of the top 15 worldwide semiconductor suppliers.

This newsletter summarizes the conference by discussing the changes affecting the semiconductor

FIGURE 1
Estimated Worldwide Semiconductor Industry Revenue (Would Closer User-Supplier Relationships Reduce the Swings?)



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industry today, ways in which Dataquest clients can seize opportunities while hedging the downside, industry forecasts for the 1990s, and Dataquest's second annual "Semiconductor Supplier of the Year" award.

CHANGES AFFECTING THE INDUSTRY TODAY

The worldwide electronics industry continues to evolve, and developments in microelectronics show no signs of slowing down. Regions and technology are the two major areas of change affecting the industry today.

Regions

A supplier with headquarters located in one world region must deal effectively with customers located in different world regions. "(Having) resident experts in foreign countries is the key to success," explained Linn Nelson, executive vice president and cofounder of Barnel International. "To be global means to act local," echoed Kevin McGarity, senior vice president and manager of worldwide marketing for Texas Instruments' Semiconductor Group.

Distributors will either decline or prosper in the 1990s as the electronics industry becomes more global in scope. It all depends on whether or not distribution channels can adapt to changing needs such as VLSI/ULSI and customer-specific products. "Distribution must skate to where the puck will be," urged Charles Clough, president and chief executive officer of Wyle Laboratories, "if U.S. distributors are to increase the competitiveness of American equipment manufacturers and maximize the marketing efficiency of American semiconductor manufacturers."

What should a U.S. or Asian semiconductor supplier do to be competitive in the European Community? "Learn how to communicate," replied Jean-Pierre Melia, member of the board of Fiat Semelco and purchasing director of its Magneti Marelli France division. True buyer-supplier partnerships are important for risk sharing, forecasting, and long-term commitment, with technical cooperation preserving mutual interest during booms and crises. "The European electronics industry *believes* in 1992, European industry *is* restructuring now, and new opportunities *exist* beyond 1992," predicted London-based Jim Eastlake, senior industry analyst for Dataquest's European Semiconductor Industry Service.

Technology

The high R&D food chain of specification through design is collapsing as semiconductor companies focus on implementing systems with application-specific standard products (ASSPs). "System and semiconductor companies are coming together," stated John Rizzo, vice president of marketing for Momenta Corporation.

During 1989, 1Mb DRAMs went from shortages in the first half, to oversupply and multitier pricing in the third quarter, to production cutbacks and severe price erosion in the fourth quarter. The 4Mb DRAM is expected to have an unusually difficult market introduction in 1990. "The rules for memory ICs have not changed; each cycle is just different," concluded Fred Jones, associate director of Dataquest's Semiconductor Industry Service and manager of the Memory segment.

ASICs are integrated circuits that are dedicated to a single user. One type of ASIC, the MOS gate array, will have an increase in usage of 25 percent between 1984 and 1994. "ASICs allow a shorter time to market for a greater total product revenue," reported Jerry Banks, senior industry analyst for Dataquest's Semiconductor Industry Service. Mixed-mode ASICs, which combine both digital and analog circuits on the same IC, allow a reduction in the number of ICs in the equipment and reduce the problems of interconnection between ICs while optimizing circuit operation. "Users must learn about mixed-signal ASICs and suppliers must learn to specialize in markets and applications for this segment of ASICs to maximize its potential," advised Gary Grandbois, senior industry analyst for Dataquest's Semiconductor Industry Service.

SEIZING OPPORTUNITIES WHILE HEDGING THE DOWNSIDE

Change brings uncertainty, which creates risk. The industry can hedge risk by specializing in a segment of the electronics manufacturing cycle, forming closer user-supplier relationships, and exploring the possibility of a futures market for key electronic components.

Specializing

Greater product complexity and new market and product needs have led to specialized markets and products, which in turn have led to innovations such as fabless semiconductor companies.

Executives now have a greater choice in organizing an enterprise to serve a market, and customers benefit from the better service. "Semiconductor companies in 1990 are based on either technology, specialized products and technology, or design," summarized Michael Canning, vice president of manufacturing for fabless Cirrus Logic.

Relationships

What's in store for the 1990s is the sharing of problems to develop joint solutions users and suppliers need to form partnerships for R&D, applications, design, process, and applications success. "Do what the customer wants when he wants it done," recommended Charles Thompson, senior vice president and director of world marketing for Motorola's Semiconductor Products Sector.

Japanese semiconductor companies assimilate the local culture and business practices when they form a subsidiary in a foreign country because their customers demand it. "U.S. equipment manufacturers want to be treated the same all over the world and at the same time treated as a Japanese equipment manufacturer would be treated in Japan," revealed Robert Brown, senior vice president of semiconductor operations for Toshiba America Electronic Components. "Global service issues include early access to new technology, technical assistance, logistic support, local manufacturing, flexibility, and quality products."

The automotive industry is sometimes cited as a role model for the electronics industry because of close relationships between the users and suppliers of automotive assemblies. "Improved supplier responsiveness is (a) win/win (situation)," proclaimed Gene Richter, executive director of corporate procurement for Hewlett-Packard. Mr. Richter's newness to data processing electronics—he has been in this field for 18 months—enables him to evaluate the issues of the day with the objective eye of an outsider. Based on more than a decade of experience in the industrial and automotive sectors (with Black and Decker and Ford Motor Company), he challenged suppliers to pay more attention to fundamentals (e.g., planning, communicating, measuring, and follow-up) and to upgrade sales organizations (e.g., more resources, more training, more clout, and more global in scope).

Users today expect minimal inventory, guaranteed lead times, and a reduced vendor base. Sole-sourced components, however, still make users nervous unless they have formed a mutually dependent partnership with a supplier. A supplier, in turn, can use this opportunity to provide a total cost and value analysis for the user. To keep sole-source suppliers honest, Frank Gill, senior vice president of sales for Intel, reminded the audience that "a socket may be sole-sourced, but the electronic function is not."

Multichip modules are packages with two or more VLSI die, which make it possible to build higher-performance systems. Many technical and business challenges still face this new but promising idea. "Relationships between single IC suppliers, system houses, and strong package suppliers are required," recommended Dr. William Steingrandt, director of product development and marketing for Alcoa Electronic Packaging.

Futures

DRAM price volatility, coupled with its commodity nature, suggests futures as a familiar risk-management tool for modern business. "A DRAM is a small sliver of highly refined sand," explained Hoon Won, chief executive officer of Memory Clearing Corporation, "and can be traded like any other commodity." If the DRAM futures market does become a reality in upcoming months, it would be regulated by the Commodity Futures Trading Commission.

INDUSTRY FORECASTS FOR THE 1990s

Every year at this conference, Dataquest forecasts markets, applications, and prices for the upcoming year and the next five years. Dataquest and The Dun & Bradstreet Corporation presented these latest forecasts.

Markets

The U.S. economy is going global in the 1990s because of structural changes taking place in the international economy. "Real GNP for the U.S. economy is expected to grow only 2.4 percent in 1990 and 3.4 percent in 1991," summarized Joseph Duncan, vice president, corporate economist, and chief statistician for The Dun & Bradstreet Corporation.

The U.S. equipment industry is healthy with an orders-to-shipments ratio at parity or greater and an equipment inventory that is being well managed. "Worldwide electronic equipment production is expected to grow 5.4 percent in 1990, 7.3 percent

in 1991, and 8.6 percent in 1992," predicted Terrance Birkholz, research analyst for Dataquest's Semiconductor User and Applications Group.

Although equipment production increases each year at a steady 5 to 10 percent, semiconductor production swings between negative 20 and positive 50 percent (see Figure 1). "The semiconductor industry pauses every five years to catch its breath," concluded Hal Feeney, group vice president and director of Dataquest's Components Group. The industry is projected to grow at a compound annual growth rate (CAGR) of 18 percent between 1990 and 1994 (see Figure 2).

In every region of the world, offshore semiconductor manufacturers are becoming local producers. "The next five years will continue the trends of new sources and regions. There will be adequate capacity," predicted George Burns, industry analyst for Dataquest's Semiconductor Equipment and Materials Service. Because of the effects of trade policies and subsidies, however, the possibility of overcapacity in 1995 looms on the horizon.

Costs, not availability, are the overall key issues among users this year. "Top user issues in 1990 include on-time delivery, pricing, and cost control," summarized Mark Giudici, product manager and senior industry analyst for Dataquest's Semiconductor User and Applications Group. Overall, respondents to Dataquest's annual purchasing survey plan to have a 9.6 percent semiconductor purchasing growth in 1990, with medium-size semiconductor companies the most optimistic about growth. However, "survey respondents expect 1990 growth to be at almost half that of 1989," reported Carolyn Doles, industry analyst for Dataquest's Central Research Group, which supports the Components Group.

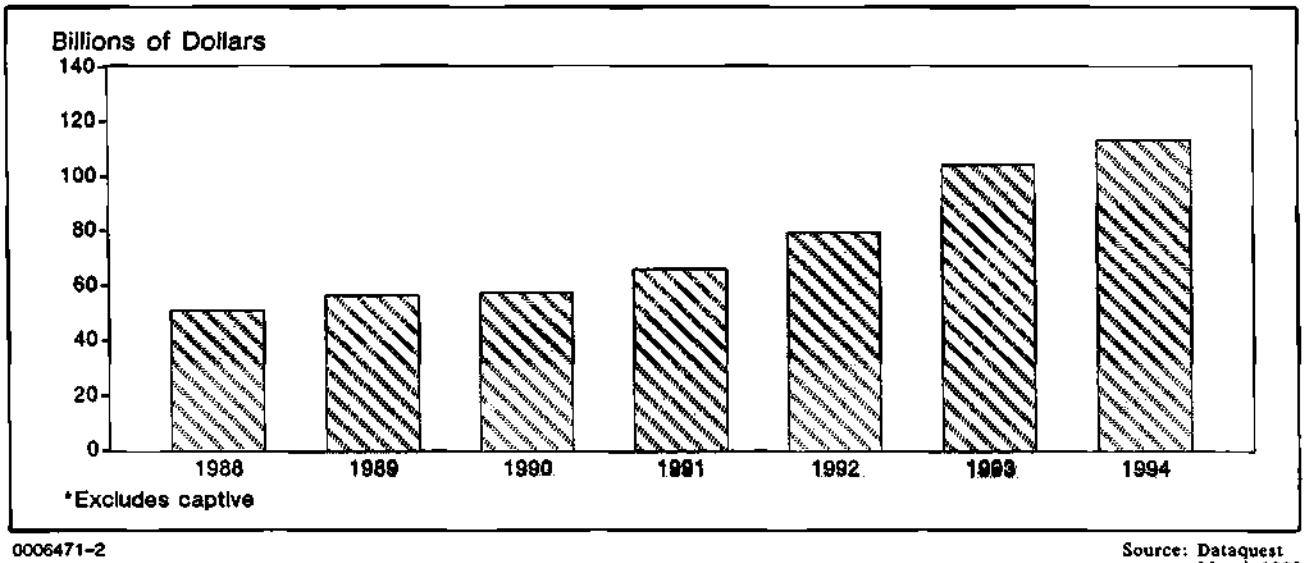
Applications

Multimedia PCs are expected to have a major impact on semiconductor demand by 1994. Between now and then, however, semiconductor companies have to keep their lines filled with wafers if they want to remain in business. "Market drivers for 1990 include 386-based PCs, workstations, rigid drives, LANs, laser printers, and facsimile machines," explained Kevin Landis, industry analyst for Dataquest's Semiconductor User and Applications Group.

Prices

The sticker shock of higher-priced, sole-sourced ICs is mitigated by high value. "Develop pricing and procurement strategies based on the system cost impact and keep close to manufacturers' activities and production plans," advised Greg Sheppard, senior industry analyst in Dataquest's Semiconductor User and Applications Group. Microprocessor, memory, and ASIC prices are expected to continue to decline in 1990 and 1991. (The estimated worldwide 1Mb DRAM

FIGURE 2
Worldwide Semiconductor Industry Revenue Forecast*



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Source: Dataquest
March 1990

pricing for 1987 to 1990 by quarter is presented in Figure 3.) "The crossover from 1Mb DRAMs to 4Mb DRAMs is expected to occur as early as the fourth quarter of 1990," predicted Ron Bohn, industry analyst for Dataquest's Semiconductor User and Applications Group.

SEMICONDUCTOR SUPPLIER OF THE YEAR AWARD

For the second consecutive year, Motorola's Semiconductor Products Sector was the recipient of Dataquest's annual "Semiconductor Supplier of the Year" award. Charles Thompson, senior vice president and director of marketing for Motorola's Semiconductor Products Sector, accepted the award from Gene Norrett, corporate vice president and general manager of Dataquest's Technology Information Division and Hal Feeney, group vice president and director of Dataquest's Components Group (see Figure 4).

The award is based on an annual Dataquest survey of more than 800 procurement site personnel representing the top 200 U.S. electronics companies that use semiconductors. Those surveyed were asked to rate semiconductor suppliers in the following five areas: quality, on-time delivery, pricing, technical support, and customer service. Motorola received the highest overall rating, with Texas Instruments ranking second, National Semiconductor third, Hamilton-Avnet fourth, and Intel fifth.

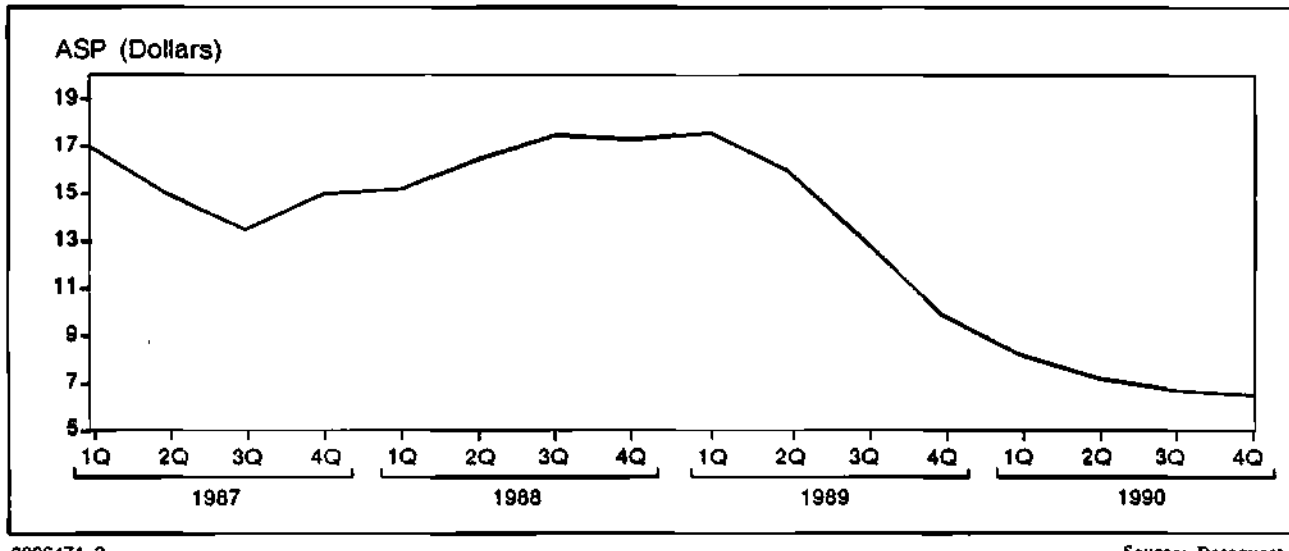
DATAQUEST ANALYSIS

Conclusions

Dataquest concludes that user-supplier relationships will indeed change for the better in the 1990s. We believe that the adversary attitudes of users and suppliers helped cause the wild swings experienced by the industry in the past 25 years (see Figure 1). Practices reflecting such attitudes as "they got us last time, so we'll get them this time" must give way to partnerlike cooperation because the fates of users and suppliers are becoming more tightly linked than ever before.

The conference did provide a forum to discuss changes that currently are under way in world regions and semiconductor technology, as well as how these changes are likely to affect users and suppliers. For example, the stakes in microelectronics are rising, with state-of-the-art fabs expected to cost as much as $1 billion by the year 2000. No supplier would ever make such an investment without first establishing that markets exist for the production, because the cost of an error is just too great—that is why users must share their technology and purchasing needs with suppliers. Likewise, no user would ever jeopardize its equipment business by depending on components that are inappropriate or unavailable for its needs—that is why suppliers must share their technology and capacity plans with users.

FIGURE 3
Estimated Worldwide 1Mb DRAM Pricing Quarterly: 1987-1990



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Source: Dataquest March 1990

FIGURE 4
Second Annual Semiconductor Supplier of the Year Award (left to right) Gene Norrett, Charles Thompson, Hal Feeney

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Source: Dataquest March 1990

Recommendations

Dataquest recommends that clients watch component market developments closely if they want to stay ahead. For that purpose, Dataquest publishes monthly reports such as the following:

- *Market Watch*—A bulletin released after the SIA book-to-bill *Flash Report* to give deeper insight into the monthly trends in the semiconductor market and an analysis of what is expected during the following six months
- *OEM Monthly*—To provide insight into application markets so that Dataquest clients can make better strategic and technical marketing decisions
- *Procurement Pulse*—An update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers
- *SAMonitor*—An update that closely monitors changes in key electronic equipment markets

We also recommend that field and factory personnel have a basic understanding of electronics since this technology has become pervasive. For example, if a company has people who define CMOS (pronounced "SEA-moss") as green plants that grow on rocks at the beach rather than a semiconductor technology that offers high density and low power consumption, that company may consider implementing a training course at its facility.

Roger Steciak

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Research Newsletter

1990 SEMICONDUCTOR USER SURVEY FOCUS CHANGES FROM AVAILABILITY TO SUPPLIER PERFORMANCE

SUMMARY

Results of the Fifth Annual Dataquest Semiconductor User Survey were presented at Dataquest's Semiconductor User and Applications Conference held in San Francisco, California, on February 12 and 13. The three key findings were as follows:

- Respondents expect to increase their 1990 semiconductor purchases by 9.6 percent.
- Medium-size semiconductor users are the most optimistic about growth opportunities in 1990.
- The top three issues are on-time delivery, price, and cost control.

This newsletter summarizes the presentation and highlights the key findings of this survey.

METHODOLOGY

As in the past, Dataquest used the *Electronic Business* Top 200 company listings as a basis for the survey. We removed the sample companies that made or distributed semiconductors or software to ensure that we dealt with potential semiconductor users. This reduction brought our sample down to 188 companies. From this base, we surveyed by telephone 882 procurement sites of these companies and received 324 responses (37 percent). As seen in Figure 1, the majority (53.7 percent) of the respondents were from the Pacific and Northeast regions because of the larger concentration of technology manufacturing in those areas.

Table 1 shows the total respondent breakdown by application segment.

The military/areospace segment had the highest percentage in terms of response, partly because of the higher average selling prices (ASPs) relative to commercially priced semiconductors. The purchasing power of the 1989 sample represented 26.4 percent of total U.S. merchant shipments and is forecast to rise to 28.8 percent of the U.S. total in 1990.

SEMICONDUCTOR USER OUTLOOK

User Expectations

More than one-half (51.5 percent) of the respondents expect to have higher system sales in 1990. This figure, combined with 33.6 percent of those expecting flat sales, adds to a healthy total of 85.1 percent of the respondents that expect steady-to-increased sales this year. Mirroring this optimism in system sales, the respondents expect to purchase 9.6 percent more semiconductors in 1990 than in 1989. Relative to the past forecasts, this less-than-10 percent increase is historically conservative. Compared with semiconductor supplier forecasts that we have seen, this is an optimistic forecast in an otherwise flat market. Since the survey was taken, many large system companies have announced lower growth expectations, but our monthly survey data to date still show steady growth outlooks from the purchasing managers and mixed outlooks from the supplier community.

The brightest outlook for procurement growth is coming from midsize data processing and military/aerospace companies. The data processing respondents foresee higher growth opportunities in the high-end PC/workstation market and positive growth in the high-density storage and add-on memory board sectors of the industry. Countering common wisdom, midsize military/aerospace companies expect to see higher-than-average purchases

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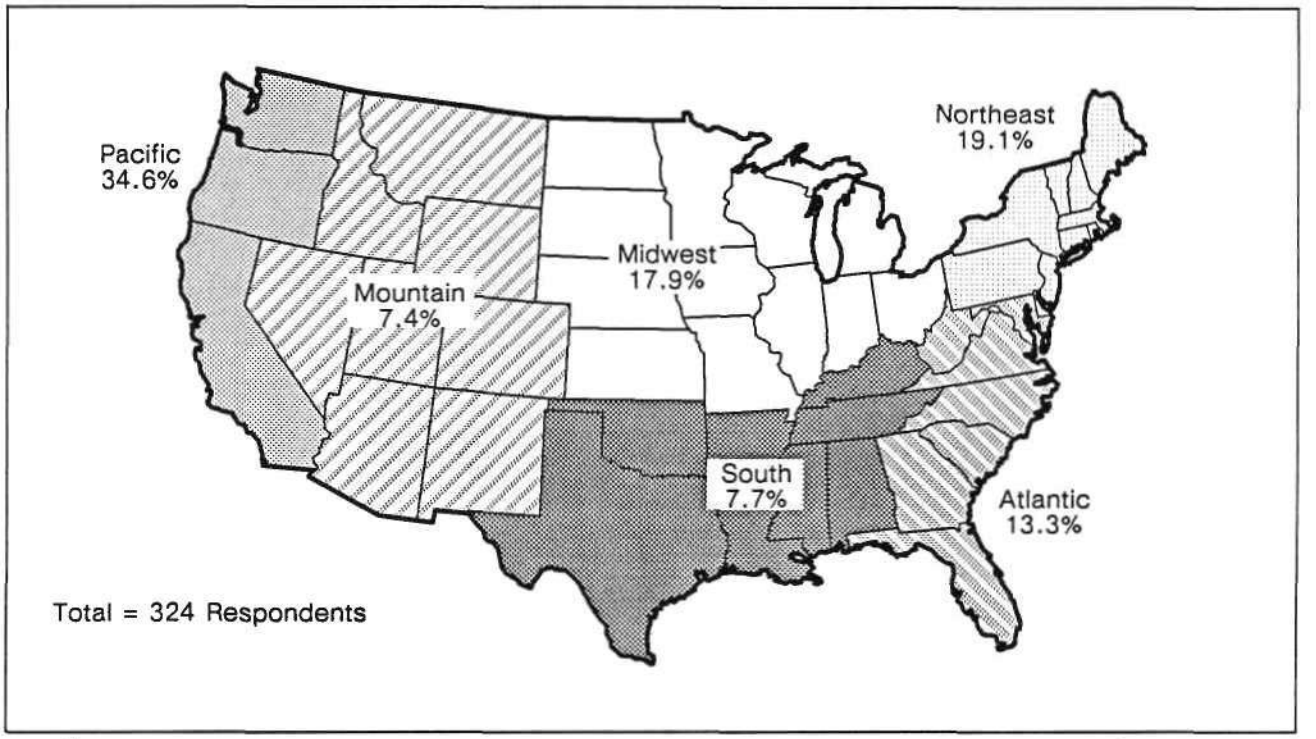
FIGURE 1
Procurement Survey Audience



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Source: Dataquest
March 1990

TABLE 1
1989 Survey Respondents' Purchasing Dollars

Military/Aerospace	35.6%
Industrial	23.9
Communications	17.9
Data Processing	12.8
Consumer	8.1
Transportation	1.7
Total	100.0%

Source: Dataquest
March 1990

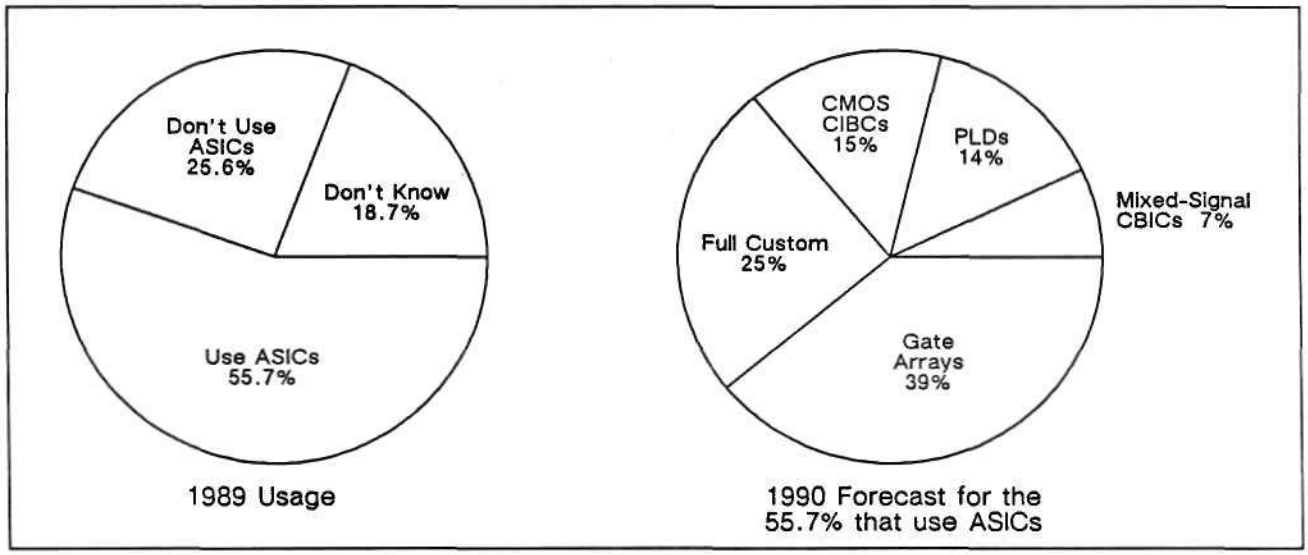
this year due to the clear status of many key programs. Last year, these programs had uncertain futures because of budget cuts. The programs that remain are comparatively secure and will receive a higher portion of funding than in 1989. More than one-half (55.7 percent) of the respondents used ASIC devices last year. A potentially larger marketing opportunity still remains for ASIC suppliers because 44.3 percent of the respondents either don't know if they use ASICs or simply don't use them at this time. The 1989 expenditure and forecast for 1990 are shown in Figure 2.

User Plans

The U.S. supply base for this year's respondents gained market share in 1989 at the expense of Japanese suppliers as a result of the improved availability of DRAMs relative to 1988. The 17.4 percent Japanese market share for the sample now reflects pre-1988 levels of market support. The trend toward manufacturing sites to offshore locations has abated, and 84.5 percent of the respondents plan not to move at all. Those that have facilities overseas now are beginning to use them to supply the local markets in addition to their traditional use as a source of low-cost production.

Last year's plans to reduce inventory levels have occurred, as seen in Figure 3. More than three-fourths (81 percent) of the respondents plan on either reducing or stabilizing their inventory levels this year. The respondent-targeted inventory

FIGURE 2
ASIC Usage



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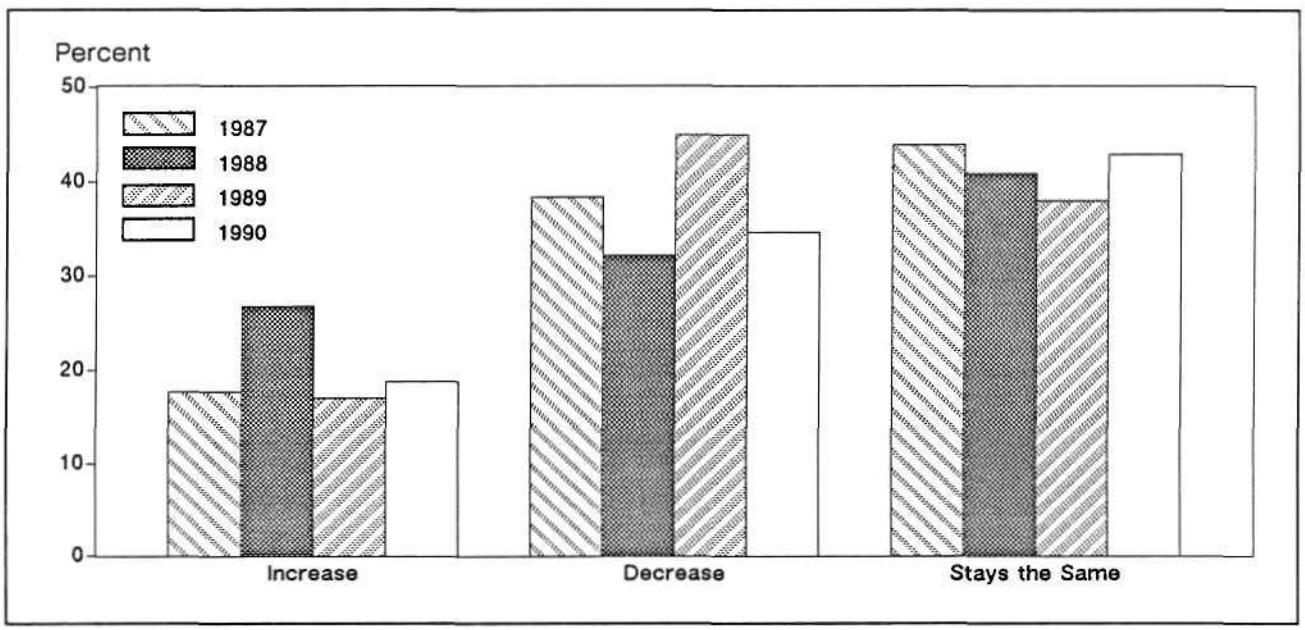
Source: Dataquest March 1990

FIGURE 3
Expected Change in Target Inventory Levels (Percent of Total Respondents)



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Source: Dataquest March 1990

level averaged out to 47 days. This relatively high target level is partly due to the inclusion of the military inventory requirement to have, on average, 180 days of inventory on hand. Our monthly survey reflects a target level for February of 19 days, which is more representative of the overall commercial market.

Top User Issues—The Focus Now Is on Supplier Performance

The biggest change in this year's survey was noting the shift of key issues away from product-related to supplier-related problems (see Table 2). For instance, the fifth-ranked problem for both 1988 and 1989 was memory. This year, memory availability was not even ranked as a top 20 issue! Focus has shifted to how well a given supplier performs on its commitments in terms of delivery, price, and meeting forecast needs. The number three issue, cost control, is the subtheme this year with all of the issues revolving around it. All semiconductor suppliers should take note that now, more than ever, meeting customer needs will be *the* determining factor in supplier loyalty this year. As mentioned in the Dataquest newsletter entitled "True or False: User-Supplier Relationships to Change in the 1990s," that chronicled the conference, Motorola again won the Semiconductor Supplier of the Year Award as voted by this year's respondents. In the buyers' eyes, Motorola met these needs by being perceived as the best in overall delivery, price, quality, technical support, and customer service. Next year's winner would be wise to address this new list of issues.

DATAQUEST CONCLUSIONS

This year's survey confirmed many trends that Dataquest had previously noted and also provided new insights as to what the user community is planning for 1990. The relatively conservative procurement estimates for this year reflect the uncertain outlook for system sales, yet most of the respondents were optimistic about the end markets at the time of the survey. Current surveys still show a steady undercurrent of semiconductor sales that is keeping low growth forecasts on track. It is important to note that the most growth in semiconductor procurement will be coming from

TABLE 2
User Issues

1990 Ranking		1989 Ranking	1988 Ranking
1	On-time delivery	3	3
2	Pricing	2	2
3	Cost control	7	4
4	Availability	1	1
5	JIT/inventory control	6	9
6	Quality/reliability	4	6
7	New products/obsolescence	8	8
8	Reducing vendor base	—	7
9	Forecasting	—	—
10	Government regulation	—	—

Source: Dataquest
March 1990

midsize companies, primarily in the data processing and military/aerospace industries. These two markets have the largest potential for higher sales for the following reasons:

- New products in the workstation and high-end PC markets as well as for more powerful peripherals
- Completed military budget cuts, resulting in steady procurement plans for surviving programs

Dataquest believes that the overall change of theme from availability issues to supplier performance underlines the efforts to reduce overall costs from every angle. Those companies that excel in supporting their customers will differentiate themselves and grow accordingly.

Mark Giudici
Carolyn Doles

January–March Index

The following is a list of the newsletters in this section:

January–March Index

- **February Procurement Survey: Lead Times Fall while Order Rates Stabilize** (1989–06)—Lead times for semiconductors are improving and order rates are steady, yet overall inventory levels have increased since last month's survey. This bulletin discusses the current actual versus target semiconductors inventory levels for all OEMs and for computer OEMs. Dataquest concludes that the easing of lead times and coinciding increases of inventory levels may be an aberation that will smooth out as companies strive to achieve their targeted goals.

- **The Cost of Quality: Prevention versus Cure** (1089–07)—The total cost of a semiconductor component can be broken down into three main categories: unit price, inventory cost per unit, and rework costs due to component or system failure This bulletin discusses the break–even point where the preventative cost of quality and the remedial cost of quality are equal. Dataquest concludes that by analyzing quality cost, one can quantify where improvements are needed and prove the adage that "Quality is free."

- **Chips & Technologies Enters the Mass Storage Controller Business** (1989–08)—Chips & Technologies' newly formed Mass Storage Organization announced its first drive controller chip set, the Micro Channel Fixed Disk Adapter CHIPSet, on February 21. This bulletin analyzes the company's strategy and estimates the hard drive controller market. Dataquest concludes that the entry of a first–rate chip set vendor such as Chips & Technologies into this market will have a catalytic effect, enhancing competition and therefore innovation among all chip set manufacturers.

- **March Procurement Survey: Equipment Sales Up, Orders and Lead Times Down** (1989–09)—This month's respondents continued to see overall lead times fall as systems sales climbed relative to February. This bulletin discusses the current actual versus target semiconductor inventory levels for all OEMs and for computer OEMs. Dataquest concludes that as the current business cycle rolls on, the specter of semiconductor supplies overshooting aggregate demand is rearing its disruptive head.

- **The Analog IC Market: A Barometer for the Semiconductor Industry** (1989–10)—A well–known fact is that the analog IC market neither grows as fast nor suffers the same severe downturns as the digital market. This newsletter provides a new look at analog IC market growth and how it relates to the total market. Dataquest concludes that the movement of the analog IC market should be of interest to more than the suppliers and users of analog ICs.

January–March Index

- **Fourth Annual Procurement Survey: Old Issues Remain Hot; Accurate Forecasting is the Key** (1989–11)—The fourth annual Dataquest procurement survey results were announced at the Semiconductor User and Applications Conference that was held in San Francisco, California, in late February. This newsletter discusses the survey structure and findings. Dataquest concluded that the underlying thread that ran through this year's survey was that the availability of key components pervaded all areas of procurement.

- **Strategic Implications of Living in a DRAM Technology–Dependent World** (1989–12)—At Dataquest's recent Semiconductor User and Applications Group Conference, users and suppliers of cutting-edge semiconductors such as DRAMs and ASICs expressed deep concern about industry survival, given the challenge of technology dependence. This newsletter focuses on the serious strategic implications for systems manufacturers and chip suppliers in a technology–dependent world. Dataquest concludes that suppliers should make the necessary capital expenditure and strategic plans for their companies to survive profitably over the long term by dependably meeting user demand for cutting–edge semiconductors such as DRAMs and ASICs.

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Research *Newsletter*

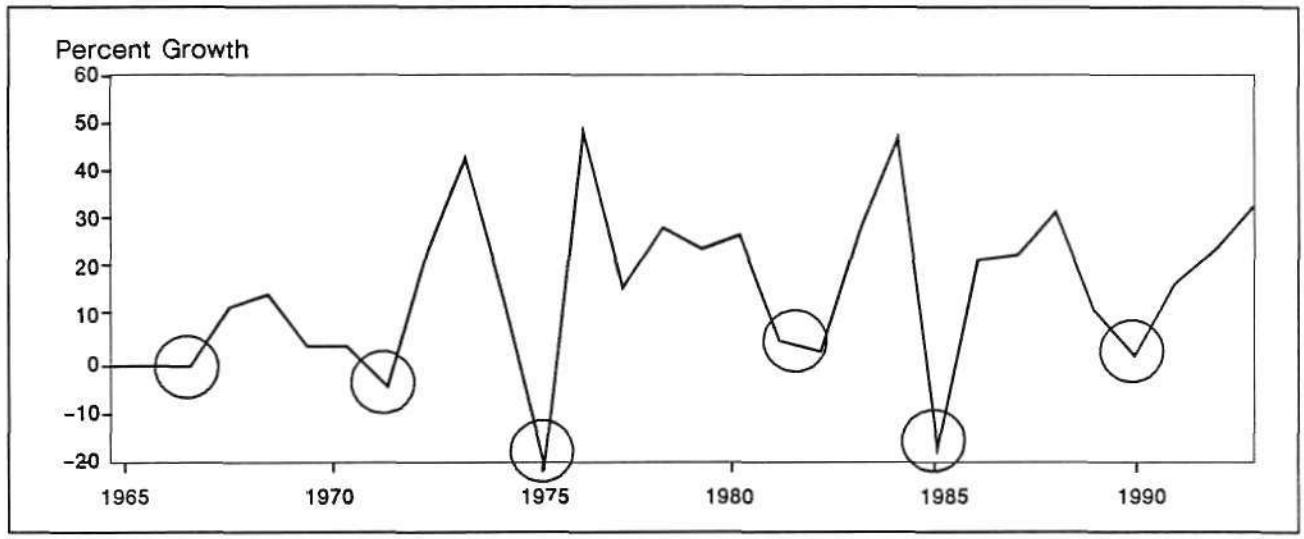
TRUE OR FALSE: USER-SUPPLIER RELATIONSHIPS TO CHANGE IN THE 1990s?

Strategic partnering was proposed in the early 1980s to describe how semiconductor customers and suppliers should conduct business with each other. But when the industry had a severe downturn in 1985, suppliers scrambled after every deal, and prices fell through the floor. When the industry finally had a mild boom in 1988, buyers chased after every available part, DRAM shortages developed, and spot-market lead times and prices went through the roof. Then in 1989, DRAMs became plentiful again and prices fell to record lows.

Is *strategic partnering* the solution to reducing the wild swings (see Figure 1) that have occurred in the semiconductor industry during the past 25 years? Buyers and sellers had a chance to find out at Dataquest's annual conference for semiconductor users and suppliers, held again this year in San Francisco, California. The more than 180 attendees to the two-day February conference included buyers (45 percent), sellers (40 percent), and persons from government agencies, investment firms, and the trade press (15 percent). Eleven of the top 15 North American users (e.g., those that purchased more than $7 billion of semiconductors in 1989) were represented, along with delegates from 13 of the top 15 worldwide semiconductor suppliers.

This newsletter summarizes the conference by discussing the changes affecting the semiconductor

FIGURE 1
Estimated Worldwide Semiconductor Industry Revenue
(Would Closer User-Supplier Relationships Reduce the Swings?)



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Source: Dataquest
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industry today, ways in which Dataquest clients can seize opportunities while hedging the downside, industry forecasts for the 1990s, and Dataquest's second annual "Semiconductor Supplier of the Year" award.

CHANGES AFFECTING THE INDUSTRY TODAY

The worldwide electronics industry continues to evolve, and developments in microelectronics show no signs of slowing down. Regions and technology are the two major areas of change affecting the industry today.

Regions

A supplier with headquarters located in one world region must deal effectively with customers located in different world regions. "(Having) resident experts in foreign countries is the key to success," explained Linn Nelson, executive vice president and cofounder of Barnel International. "To be global means to act local," echoed Kevin McGarity, senior vice president and manager of worldwide marketing for Texas Instruments' Semiconductor Group.

Distributors will either decline or prosper in the 1990s as the electronics industry becomes more global in scope. It all depends on whether or not distribution channels can adapt to changing needs such as VLSI/ULSI and customer-specific products. "Distribution must skate to where the puck will be," urged Charles Clough, president and chief executive officer of Wyle Laboratories, "if U.S. distributors are to increase the competitiveness of American equipment manufacturers and maximize the marketing efficiency of American semiconductor manufacturers."

What should a U.S. or Asian semiconductor supplier do to be competitive in the European Community? "Learn how to communicate," replied Jean-Pierre Melia, member of the board of Fiat Semelco and purchasing director of its Magneti Marelli France division. True buyer-supplier partnerships are important for risk sharing, forecasting, and long-term commitment, with technical cooperation preserving mutual interest during booms and crises. "The European electronics industry *believes* in 1992, European industry *is* restructuring now, and new opportunities *exist* beyond 1992," predicted London-based Jim Eastlake, senior industry analyst for Dataquest's European Semiconductor Industry Service.

Technology

The high R&D food chain of specification through design is collapsing as semiconductor companies focus on implementing systems with application-specific standard products (ASSPs). "System and semiconductor companies are coming together," stated John Rizzo, vice president of marketing for Momenta Corporation.

During 1989, 1Mb DRAMs went from shortages in the first half, to oversupply and multitier pricing in the third quarter, to production cutbacks and severe price erosion in the fourth quarter. The 4Mb DRAM is expected to have an unusually difficult market introduction in 1990. "The rules for memory ICs have not changed; each cycle is just different," concluded Fred Jones, associate director of Dataquest's Semiconductor Industry Service and manager of the Memory segment.

ASICs are integrated circuits that are dedicated to a single user. One type of ASIC, the MOS gate array, will have an increase in usage of 25 percent between 1984 and 1994. "ASICs allow a shorter time to market for a greater total product revenue," reported Jerry Banks, senior industry analyst for Dataquest's Semiconductor Industry Service. Mixed-mode ASICs, which combine both digital and analog circuits on the same IC, allow a reduction in the number of ICs in the equipment and reduce the problems of interconnection between ICs while optimizing circuit operation. "Users must learn about mixed-signal ASICs and suppliers must learn to specialize in markets and applications for this segment of ASICs to maximize its potential," advised Gary Grandbois, senior industry analyst for Dataquest's Semiconductor Industry Service.

SEIZING OPPORTUNITIES WHILE HEDGING THE DOWNSIDE

Change brings uncertainty, which creates risk. The industry can hedge risk by specializing in a segment of the electronics manufacturing cycle, forming closer user-supplier relationships, and exploring the possibility of a futures market for key electronic components.

Specializing

Greater product complexity and new market and product needs have led to specialized markets and products, which in turn have led to innovations such as fabless semiconductor companies.

Executives now have a greater choice in organizing an enterprise to serve a market, and customers benefit from the better service. "Semiconductor companies in 1990 are based on either technology, specialized products and technology, or design," summarized Michael Canning, vice president of manufacturing for fabless Cirrus Logic.

Relationships

What's in store for the 1990s is the sharing of problems to develop joint solutions users and suppliers need to form partnerships for R&D, applications, design, process, and applications success. "Do what the customer wants when he wants it done," recommended Charles Thompson, senior vice president and director of world marketing for Motorola's Semiconductor Products Sector.

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Although equipment production increases each year at a steady 5 to 10 percent, semiconductor production swings between negative 20 and positive 50 percent (see Figure 1). "The semiconductor industry pauses every five years to catch its breath," concluded Hal Feeney, group vice president and director of Dataquest's Components Group. The industry is projected to grow at a compound annual growth rate (CAGR) of 18 percent between 1990 and 1994 (see Figure 2).

In every region of the world, offshore semiconductor manufacturers are becoming local producers. "The next five years will continue the trends of new sources and regions. There will be adequate capacity," predicted George Burns, industry analyst for Dataquest's Semiconductor Equipment and Materials Service. Because of the effects of trade policies and subsidies, however, the possibility of overcapacity in 1995 looms on the horizon.

Costs, not availability, are the overall key issues among users this year. "Top user issues in 1990 include on-time delivery, pricing, and cost control," summarized Mark Giudici, product manager and senior industry analyst for Dataquest's Semiconductor User and Applications Group. Overall, respondents to Dataquest's annual purchasing survey plan to have a 9.6 percent semiconductor purchasing growth in 1990, with medium-size semiconductor companies the most optimistic about growth. However, "survey respondents expect 1990 growth to be at almost half that of 1989," reported Carolyn Doles, industry analyst for Dataquest's Central Research Group, which supports the Components Group.

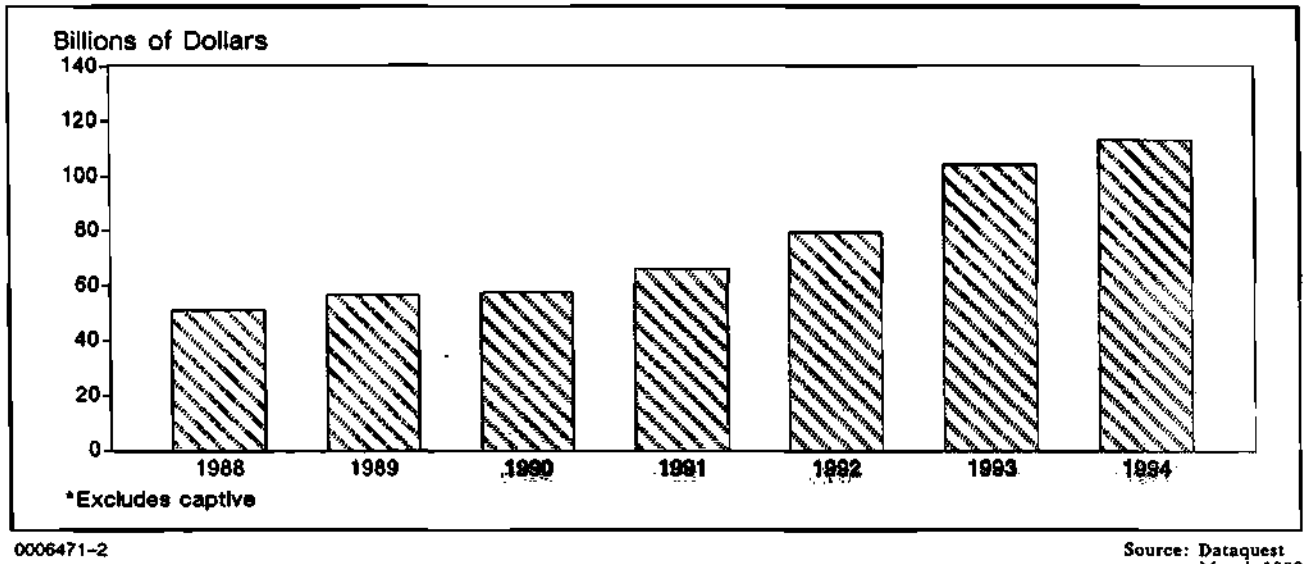
Applications

Multimedia PCs are expected to have a major impact on semiconductor demand by 1994. Between now and then, however, semiconductor companies have to keep their lines filled with wafers if they want to remain in business. "Market drivers for 1990 include 386-based PCs, workstations, rigid drives, LANs, laser printers, and facsimile machines," explained Kevin Landis, industry analyst for Dataquest's Semiconductor User and Applications Group.

Prices

The sticker shock of higher-priced, sole-sourced ICs is mitigated by high value. "Develop pricing and procurement strategies based on the system cost impact and keep close to manufacturers' activities and production plans," advised Greg Sheppard, senior industry analyst in Dataquest's Semiconductor User and Applications Group. Microprocessor, memory, and ASIC prices are expected to continue to decline in 1990 and 1991. (The estimated worldwide 1Mb DRAM

FIGURE 2
Worldwide Semiconductor Industry Revenue Forecast*



0006471-2

Source: Dataquest
March 1990

pricing for 1987 to 1990 by quarter is presented in Figure 3.) "The crossover from 1Mb DRAMs to 4Mb DRAMs is expected to occur as early as the fourth quarter of 1990," predicted Ron Bohn, industry analyst for Dataquest's Semiconductor User and Applications Group.

SEMICONDUCTOR SUPPLIER OF THE YEAR AWARD

For the second consecutive year, Motorola's Semiconductor Products Sector was the recipient of Dataquest's annual "Semiconductor Supplier of the Year" award. Charles Thompson, senior vice president and director of marketing for Motorola's Semiconductor Products Sector, accepted the award from Gene Norrett, corporate vice president and general manager of Dataquest's Technology Information Division and Hal Feeney, group vice president and director of Dataquest's Components Group (see Figure 4).

The award is based on an annual Dataquest survey of more than 800 procurement site personnel representing the top 200 U.S. electronics companies that use semiconductors. Those surveyed were asked to rate semiconductor suppliers in the following five areas: quality, on-time delivery, pricing, technical support, and customer service. Motorola received the highest overall rating, with Texas Instruments ranking second, National Semiconductor third, Hamilton-Avnet fourth, and Intel fifth.

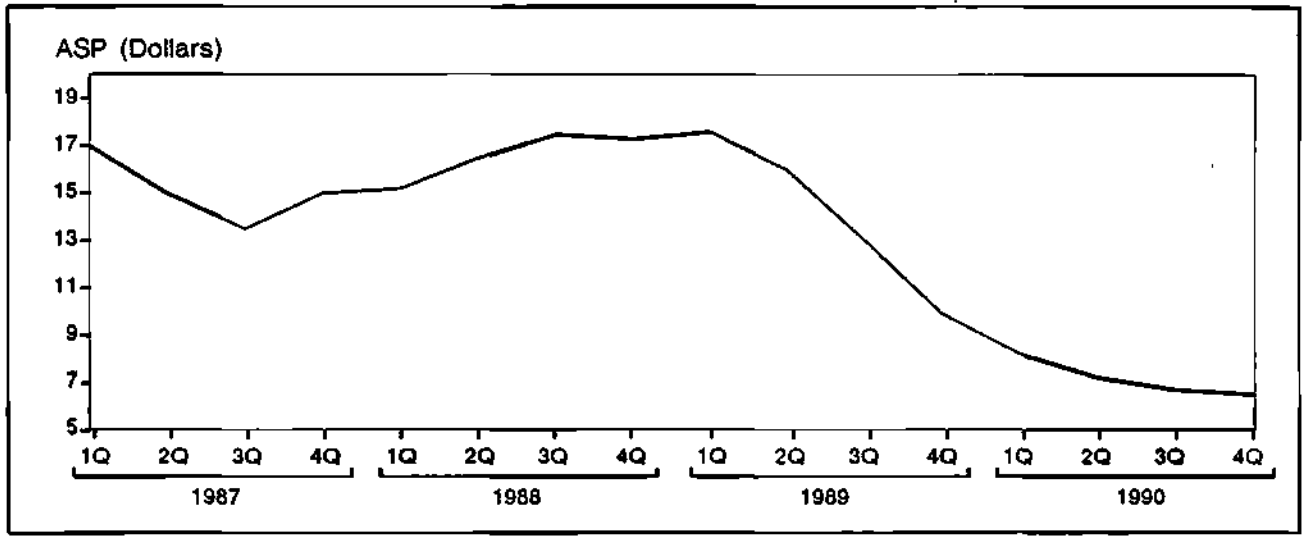
DATAQUEST ANALYSIS

Conclusions

Dataquest concludes that user-supplier relationships will indeed change for the better in the 1990s. We believe that the adversary attitudes of users and suppliers helped cause the wild swings experienced by the industry in the past 25 years (see Figure 1). Practices reflecting such attitudes as "they got us last time, so we'll get them this time" must give way to partnerlike cooperation because the fates of users and suppliers are becoming more tightly linked than ever before.

The conference did provide a forum to discuss changes that currently are under way in world regions and semiconductor technology, as well as how these changes are likely to affect users and suppliers. For example, the stakes in microelectronics are rising, with state-of-the-art fabs expected to cost as much as $1 billion by the year 2000. No supplier would ever make such an investment without first establishing that markets exist for the production, because the cost of an error is just too great—that is why users must share their technology and purchasing needs with suppliers. Likewise, no user would ever jeopardize its equipment business by depending on components that are inappropriate or unavailable for its needs—that is why suppliers must share their technology and capacity plans with users.

FIGURE 3
Estimated Worldwide 1Mb DRAM Pricing Quarterly: 1987-1990



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Source: Dataquest March 1990

FIGURE 4
Second Annual Semiconductor Supplier of the Year Award (left to right) Gene Norrett, Charles Thompson, Hal Feeney

0006472-4

Source: Dataquest March 1990

Recommendations

Dataquest recommends that clients watch component market developments closely if they want to stay ahead. For that purpose, Dataquest publishes monthly reports such as the following:

- *Market Watch*—A bulletin released after the SIA book-to-bill *Flash Report* to give deeper insight into the monthly trends in the semiconductor market and an analysis of what is expected during the following six months
- *OEM Monthly*—To provide insight into application markets so that Dataquest clients can make better strategic and technical marketing decisions
- *Procurement Pulse*—An update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers
- *SAMonitor*—An update that closely monitors changes in key electronic equipment markets

We also recommend that field and factory personnel have a basic understanding of electronics since this technology has become pervasive. For example, if a company has people who define CMOS (pronounced "SEA-moss") as green plants that grow on rocks at the beach rather than a semiconductor technology that offers high density and low power consumption, that company may consider implementing a training course at its facility.

Roger Steciak

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Research *Bulletin*

MARCH PROCUREMENT PULSE: BOOKINGS AND SALES OUTLOOK STEADY; INVENTORIES, LEAD TIMES, PRICES DECLINE

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

Figure 1
Averaged Monthly Semiconductor Orders

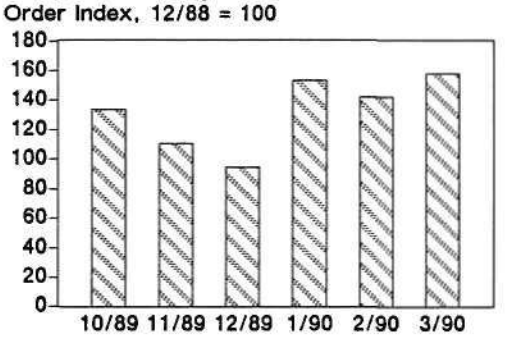


Figure 2
Averaged Semiconductor Lead Times

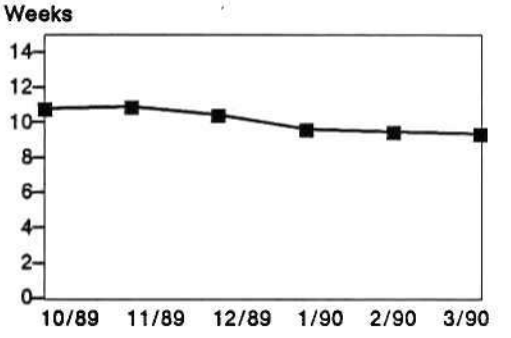


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

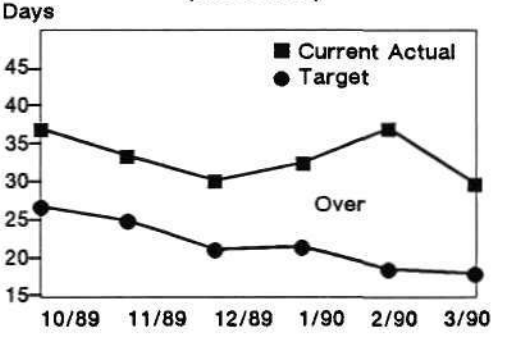
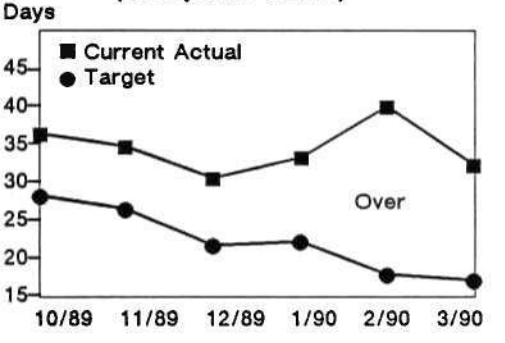


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



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Source: Dataquest
March 1990

SUIS Newsletters 1990: January-March 1990-11

0006539

SEMICONDUCTOR ORDER RATES STABILIZE, MATCHING SYSTEM SALES EXPECTATIONS

This month's respondents expect to balance a forecast increase in system sales with slightly higher semiconductor order levels. This increase in orders is being tempered by the slight bulge in inventories that existed last month. Figure 1 shows that since January there has been a steady, higher level of order rates, which was partly due to the replenishment of exhausted inventory but primarily was in response to higher system sales. The overall sales outlook continues to increase in optimism, going from a six-month forecast of 6.0 percent in January to 7.2 percent in February and resulting in a current 9.5 percent outlook for March. The respective outlook for the computer company respondents is positive, but it has stabilized slightly—January at 5.8 percent, February at 8.2 percent, and March at 7.4 percent. For the second consecutive month, no respondents anticipated negative sales during the next six months (the range remains from a flat growth rate to positive 20 percent). Combined with current sales of 2.3 percent over last year's levels seen for the whole sample, the steady optimistic sales outlook for the next six months allows for manageable component forecasting.

AVAILABILITY REMAINS GOOD WITH ISOLATED POCKETS OF LENGTHY LEAD TIMES

The overall availability of semiconductors remains excellent, as seen in Figure 2, with overall lead times now running at 9.5 weeks. The only smudge in an otherwise clear picture is the continued lengthy lead times for SOIC standard logic and 80386SX products. Currently, there is *much furor* over *rumored DRAM shortages* and the availability outlook for the next three to six months. As stated in last December's *Procurement Pulse*, the production cutbacks that were set then would most likely affect the spot market in February, which did happen. Spot pricing and lead times have risen slightly, but *contractual orders* continue to *receive priority* by all DRAM suppliers. Users should place top priority on *accurate and frequent forecasting* for the next six to nine months to ensure adequate memory supplies.

INVENTORY TARGETS STABILIZE WHILE ACTUAL LEVELS FALL

Actual inventory levels have fallen in aggregate, as seen in Figures 3 and 4. Cost control programs that are religion in most companies continue to ensure that inventory costs remain manageable. A relatively bright sales outlook is allowing order rates to remain up while concurrent inventory reduction programs continue. The overall targeted inventory levels declined less than a day for both the overall and computer OEM samples, down to 18.1 and 17.2 days, respectively. The large drop in actual inventories for overall and computer OEMs resulted in levels of 30.0 and 32.5 days on hand, respectively. This drop results in an average reduction of more than a week of inventory in one month! If DRAMs are taken out of the actual inventory equation, the results are 27.8 and 29.2 days for the overall and computer samples, respectively. This fact implies that *user DRAM inventories are adequate* and negates the need for a panic-buy psychology that could cause supply shortages.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Stable semiconductor order rates and the low-key optimism forecast in system sales continue to provide optimum conditions for predictable supply cost forecasts. Dataquest has heard that some system companies are shirking the responsibility of forecasting DRAM requirements on a regular basis, preferring instead to take opportunistic pricing on short notice. With DRAM supplies remaining stable for the next three to six months and system demand appearing to increase, it is imperative that users communicate their short- and long-term supply needs on a regular basis. What applies to memory also is key for other critical components—for instance, 32-bit microprocessors and SOIC logic parts also require constant focus. Product pricing remains steady and in many cases continues to decline. Lead times for most products remain within eight weeks. Suppliers that are unsure of demand often opt for the safe course of the status quo. In times of incremental demand increase, staying with the status quo can result in shortages. Frequent, accurate forecasts will allow for the current supply situation to continue.

Mark Giudici

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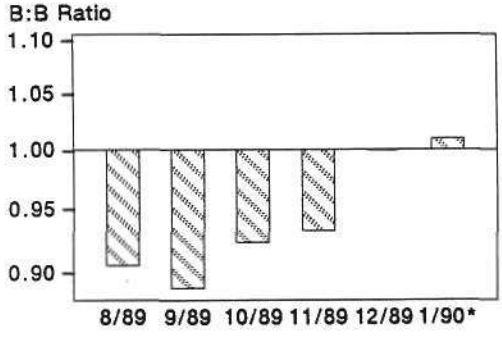
Research *Bulletin*

FEBRUARY MARKET WATCH: MARKET STILL GROWING, BUT MIXED SIGNALS APPEAR

INDUSTRY BOOK-TO-BILL EXPECTED TO RISE ABOVE PARITY

Dataquest expects the January book-to-bill ratio to rise above parity to approximately 1.01 because of convincing indications of improved bookings by major semiconductor manufacturers and a jump in semiconductor orders (see the January *Procurement Pulse*). It is mostly non-memory manufacturers that are seeing the order improvements. Despite the continuing severe price drops in all DRAM densities, even memory manufacturers see some users beginning to order two to three months in advance because of rumors of potential shortages in 1990.

Figure 1
U.S. Semiconductor Book-to-Bill Ratio



*Estimate

Figure 2
DOC Computer Demand

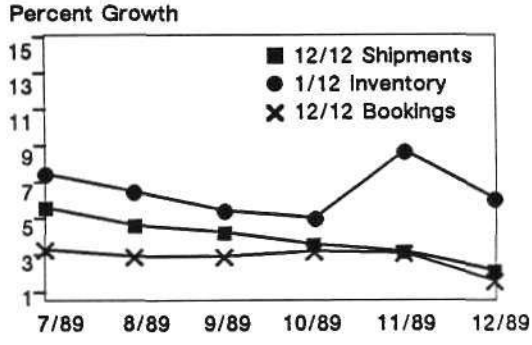


Figure 3
Semiconductor Inventory Level

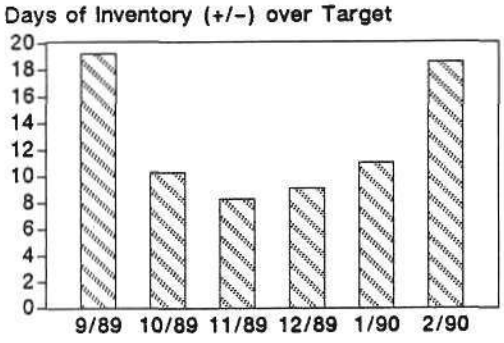
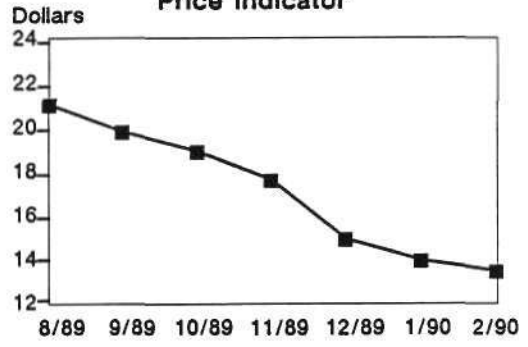


Figure 4
U.S. Weighted Semiconductor Price Indicator



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Source: U.S. Department of Commerce
World Semiconductor
Trade Statistics
Dataquest
February 1990

SUIS Newsletters 1990: January-March 1990-7

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DECEMBER COMPUTER ORDERS SLOW DOWN

The December computer order growth rate slowed, reflecting typical December performance, while shipment growth rose to use up part of the inventory that built up heavily during November. These year-end patterns offer little conclusions other than the fact that inventories have risen and did not decline enough in December to alleviate semiconductor industry concerns. What will matter will be the results of the upcoming months: will the computer industry bounce back from its woes? Again, the trend in the past four months would suggest so, with order rates stabilizing and the computer industry book-to-bill reaching parity since September.

OEM SEMICONDUCTOR INVENTORY LEVELS RISE

Although January order rates were inspiring, OEM semiconductor inventory levels have risen dramatically in February, suggesting a slower usage of purchased products. Surveyed users have revised their target inventory levels downward by 14 percent as a result, while actual inventory levels rose by 14 percent. Semiconductor manufacturers should cautiously watch this trend in inventory buildup.

PRICE TRENDS ARE ENCOURAGING

Dataquest's price index of a basket of key semiconductor products has returned to its original rate of decline after a worrisome December drop. Memory prices still are rapidly declining, but the index is being held up by firming prices in microprocessors that are the result of spotty shortages of the 80386 and 80386SX and stable prices of logic devices.

DATAQUEST CONCLUSIONS

Dataquest still expects the first quarter of 1990 to be a mild improvement over the the last quarter of 1989 despite the return of mixed market signals. It is becoming increasingly difficult to characterize the improvement because, as in any weak market, some companies will feel it and some will not. Microcomponent and logic-based suppliers should see shipment and order improvements, while memory manufacturers should see continued price-driven revenue declines. Large users may see inventory buildup and mild order rates, but Dataquest's surveys show that midsize OEMs are likely to carry most of the semiconductor purchasing growth in the first half of 1990.

Victor de Dios
Mark Giudici

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Research *Bulletin*

WILL THERE BE ANOTHER DRAM SHORTAGE IN 1990?

SUMMARY

Dataquest has not eliminated the possibility of a DRAM shortage in 1990, considering recent events that are similar to those that sparked the two-year DRAM shortage that began in 1987. However, other factors make this situation different, leading us to conclude that a shortage, if it *does* occur, should be short and temporary.

THE FIRST SHORTAGE SCENARIO: DEMAND VERSUS SUPPLY

DRAM shortages cost the computer industry billions of dollars in revenue each time they occur. Today, rumors of an impending shortage are rushing through the market despite the fact that we just emerged from one six months ago. Can we possibly have another shortage so soon? Some facts, listed as follows, seem to indicate so:

- The computer industry has been improving, reaching book-to-bill parity in September 1989 and experiencing accelerating order growth rates since then. Dataquest's surveys indicate a high level of optimism among semiconductor purchasers since January, with purchases forecast to grow by 9.6 percent from 1989. Already, the market sees spot shortages of key advanced microprocessors.
- As in early 1987, DRAM manufacturers do not share the same opinion. Most major Japanese manufacturers have cut production in the past six months after seeing a rush of cancellations, increasing turns business, and plunging prices. Many companies are losing sight of their customers' future requirements. In 1987, this shortsightedness led to a DRAM shortage that lasted two years.
- OEM inventory levels are low, especially for DRAMs, because of the abundance of product and very short lead times. Any sudden increase in computer demand will require sudden DRAM purchases.
- DRAM manufacturers may not be able to respond quickly to a sudden increase in demand because their production rates have been reduced, their inventory levels are high but not exceedingly so, and they would need at least three months to increase production rates.
- In any transition period from excessive to deficient DRAM supply, gray market channels tend to play a significant role. The channels compete in the buying of products for resale, thereby exacerbating the shortage.

Dataquest believes that if a shortage occurs, however, it will be short and temporary, lasting less than six months. There are major differences between the 1987 shortage and a potential 1990 shortage. Manufacturers have learned to manage the FMV system, unlike in 1987. South Korean and other suppliers have gained a more significant role in the DRAM market, minimizing the impact of Japanese production cuts. Although demand may suddenly increase, it is not expected to be as strong as it was in 1987 and 1988.

THE SECOND SCENARIO: DUMPING PENALTIES AGAIN?

The obvious market share gains of South Korean manufacturers may tempt their competitors to push for dumping penalties. Although South Korean manufacturers have observed and hopefully have learned from the misfortunes of their Japanese counterparts, the investigation alone may prove disruptive to South Korean DRAM availability.

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If penalties are imposed, an immediate shortage would take effect that would certainly not be short in duration.

The likelihood of dumping penalties against South Korean companies seems remote today. The purchasing community would probably not take this action lightly. As a definitive move to ensure survival, U.S. computer companies have effectively opened the door to South Korean DRAM manufacturers as a safeguard against increasing Japanese company control over the DRAM market. There appears to be a weaker and less united front among semiconductor manufacturers in pushing for South Korean dumping penalties, what with Texas Instruments' reliance on Hyundai for 256K DRAMs and Intel's DRAM sales agreement with Samsung.

DATAQUEST RECOMMENDATIONS

Knowledge of a potential shortage can help prevent one. DRAM purchasers should continually give their suppliers a true and accurate forecast of their future requirements and not rely excessively on spot buys. Accurate forecasts and closer communications will be invaluable in preventing a severe and extended DRAM shortage.

Victor de Dios

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Research *Bulletin*

FEBRUARY PROCUREMENT PULSE: BILLINGS, LEAD TIMES, ORDERS FLAT WHILE INVENTORIES AND SALES EXPECTATIONS REMAIN UP

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

Figure 1
Averaged Monthly Semiconductor Orders

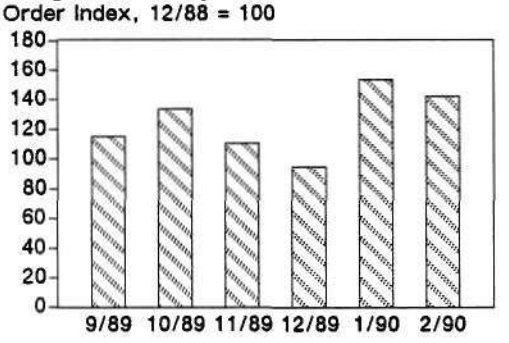


Figure 2
Averaged Semiconductor Lead Times

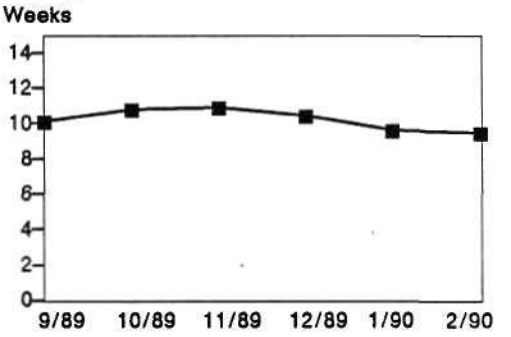


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

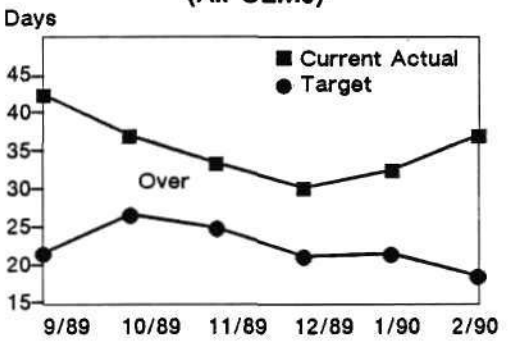
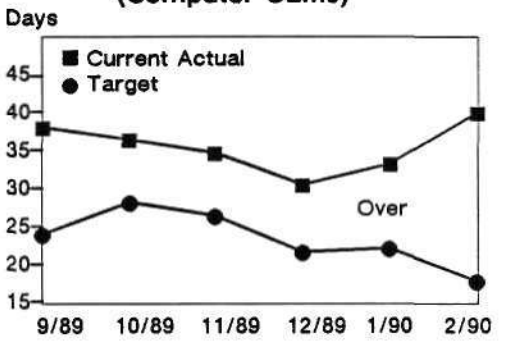


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



0006326-1

Source: Dataquest
February 1990

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0006326

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SEMICONDUCTOR ORDER RATES STABILIZE, MIRROR BILLINGS

This month's respondents maintained their overall order rates, with slight downward adjustments made to account for inventory growth trends. As shown in Figure 1, the relative increases in semiconductor orders that began in January have been maintained, while optimistic system sales expectations promise to keep the current semiconductor pipeline flowing. Compared with last month's 6.0 percent growth forecast, the next six-month outlook is for an average of 7.2 percent overall growth, while computer companies expect an 8.2 percent increase in sales versus their 5.8 percent outlook last month. Another bright sign is that, for the first time in six months, no negative sales expectations appear in this month's responses (the range is from flat to positive 20 percent). This rosy outlook, combined with higher current sales relative to the last six months (2.8 percent versus 1.1 percent), shows a steady, moderate growth pattern that has become very manageable.

CURRENT AVAILABILITY GOOD, OUTLOOK MURKY—LEAD TIMES DIP TO 9.6 WEEKS

Another drop in the average semiconductor lead time, as shown in Figure 2, is evidence that overall semiconductor availability is good. What is clouding an otherwise fine picture are continued spot shortages of SOIC standard logic parts and some 32-bit microprocessors, and the threat of Japanese DRAM supplies being controlled to the point of undershooting lowered demand forecasts. Lead times currently range from four to eight weeks for mature commodity DIP logic, 8- and 16-bit microprocessors, most EPROMs, and 120ns DRAMs. The high-speed RAM and 32-bit microprocessors, along with SOIC logic, are currently keeping overall lead times up.

INVENTORY TARGETS DROP AGAIN, BUT ACTUAL LEVELS RISE—JANUARY SEMICONDUCTOR BOOKINGS COME HOME TO ROOST

Ready availability of devices and last month's *higher order rate* have translated into a *slight inventory bulge* versus targeted levels. This increase in component inventory in users' hands points out how important accurate forecasting is in balancing system demand with component order rates. For example, a slight change in inventory level has developed between the computer OEMs and the overall sample, with targets of 18.0 days and 18.7 days, respectively, being fairly consistent. The actual levels show the main difference, with computer OEMs showing an average of 40.2 days of inventory while the overall sample is now 37.3 days. Although this apparent relaxation of component forecasting reflects only two months of data (see Figures 3 and 4), ongoing cost-control programs will not allow this minitrend to continue. We expect to see contractions in specific component booking rates in order to balance inventory levels within targeted ranges.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Dataquest believes that stable semiconductor order rates and lowering lead times, combined with an upbeat system sales outlook, set the stage for a moderate growth scenario that hinges on accurate forecasting. As seen this month, dependent component inventories will rise quickly due to the ready availability of products on the market if system sales levels are not realized. The effects of memory production cutbacks have not been seen yet; commodity prices and lead times still are very reasonable. There still are some spot delays for orders of SOIC standard logic and in some areas of 80386SX products. We expect the standard logic situation to ease within the next one or two months, as some suppliers fear that they have put in too much SMT capacity to meet current market needs. Again, accurate forecasts are critical. Specific 32-bit microprocessor availability/shortages have been seen sporadically and appear to have been caused by a combination of forecast error and a shift of production capacity from the 16-MHz device to the newly announced 20-MHz 386SX part. Aside from these current minor annoyances, semiconductor availability, pricing, and service levels are very good and should continue to be for the next three months. Memory production levels and how well they are controlled will determine if any spot shortages occur beyond three months.

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Research *Bulletin*

USERS' MICROPROCESSOR DILEMMA: THE LIMITED FUTURE OF THE 80286 VERSUS A LIMITED ALLOCATION OF THE 80386SX

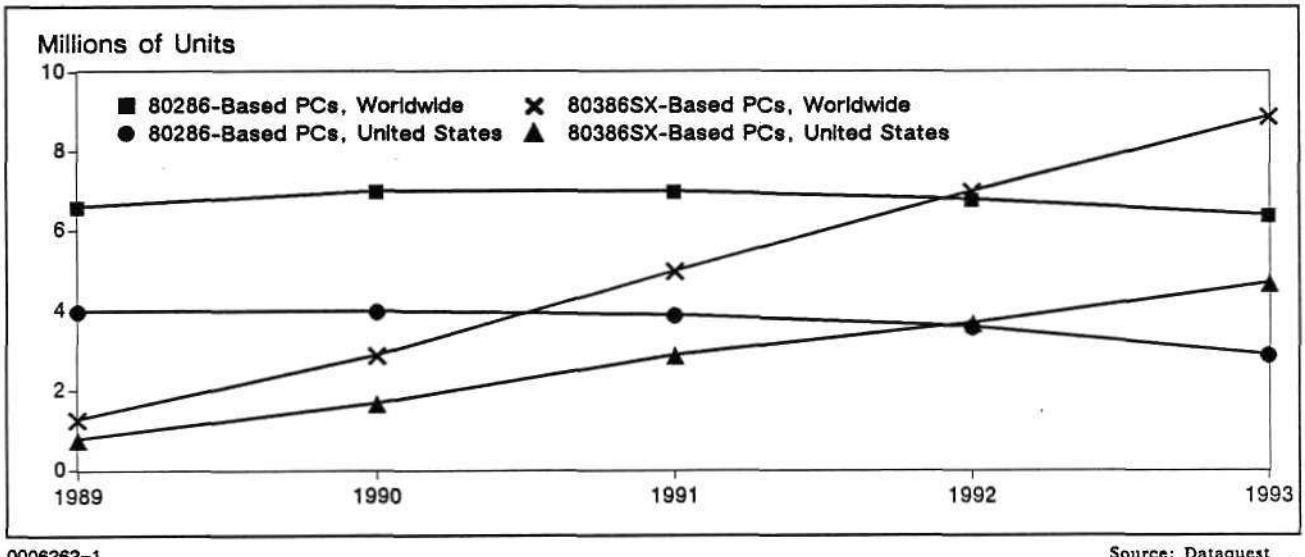
SUMMARY

Currently, systems manufacturers are experiencing a change from a multisourced component world to an increasingly sole-sourced arena. For users, this strategic concern means a tactical challenge—deciding whether to continue building machines based on the 80286, a multisourced device, or to move to a product such as Intel's 80386SX, which is single-sourced. As shown in Figure 1, the future for 80286-based systems differs by world region. Other complicating factors include reports by *some* users of limited allocation of the 80386SX 16-MHz device and Intel's introduction of a 20-MHz version of this device.

THE DEMISE OF THE 80286?

Figure 1 shows the projected future for 80286-based and 80386SX-based systems. One clear point is that the 80286 has not died, although the best opportunities for systems that use this device lie in markets outside of North America. For example, a proposal was just announced that could partially open the Eastern European market (i.e., Hungary, Poland, Czechoslovakia) to exports of the 80286 device by early 1991 and of 80286-based PCs thereafter. In terms of life cycles, 80286-based systems are moving toward their decline stage in the United States and through the maturity/saturation stage in other world regions, but are just

FIGURE 1
Estimated 80286-Based and 80386-Based PC Shipments 1989-1993



0006262-1

Source: Dataquest January 1990

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approaching the introductory stage in the USSR and Eastern Europe.

LIMITED ALLOCATION OF THE 16-MHz 80386SX FOR SOME USERS

Figure 1 clarifies another point: world shipments of systems based on Intel's 80386SX chip should expand robustly. For systems manufacturers, use of this single-sourced device can be a rewarding strategy; however, the present reality is challenging for *some* users that are now reporting limited allocation of the 16-MHz 80386SX.

Dataquest believes that at least two factors account for the supply crunch confronting affected users. First, major users made long-term contracts, perhaps at higher prices, to ensure uninterrupted supply today. Not all users report limited supply. Second, Intel, which is the product's only source, experienced a tremendous growth in demand during the second half of 1989, which caught some users and Intel off guard. In addition, Intel is introducing a 20-MHz version of the 80386SX, which, in effect, starts the wind down of the life cycle of the 16-MHz part. In terms of life cycles, some users are confronting a risk associated with use of single-sourced components: miscoordination between the system cycle and the component cycle.

DATAQUEST CONCLUSIONS AND RECOMMENDATIONS

Dataquest believes that the move from a multisourced component world to a single-sourced arena means changing strategies and tactics for supply-base managers. System manufacturers must coordinate system-component life cycles while keeping an ever-sharper eye on world regional markets.

We advise users of the 80286 to pause before retiring systems based on this multisourced device. Users must develop a path to higher-performance systems although some market opportunities still exist for 80286-based machines. The U.S. and Western European markets are declining, albeit slowly, and developments in the the Soviet bloc signal possible extension of 80286-based PC life cycles. Users should not only monitor export proposals in Washington D.C. and other world capitals but also participate in the decision-making process. New geographic markets can extend the life cycle of products that are otherwise on the decline.

On a tactical level, Dataquest recommends that users of the 80386SX 16-MHz device brace for possible shortages during the first half of 1990. Limited allocation of supply—*not* extended lead times—will cause the major impact on users of this device. *Not* all users will experience a supply constraint. On a strategic level, users must learn to manage the lurking trade-off associated with single-sourced ICs such as microprocessors or ASICs: enhanced system value *may* entail some sacrifice of control by users over system life cycle. In the short term, users must work closely with Intel regarding 80386SX 16-MHz supply forecasts and be prepared to adjust system production schedules. Another alternative is to move to the 20-MHz version.

Ronald Bohn

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Research Newsletter

SEMICONDUCTOR PRICE SURVEY: MEGABIT-DENSITY DRAM CROSSOVER, SINGLE-SOURCED ICs HIGHLIGHT THE START OF 1990

SUMMARY

As shown in Table 1, semiconductor users can continue to look forward to lower prices (with several exceptions), although the overall pace of price declines should slow somewhat from the pace of 1989. For most users, the 1Mb-to-4Mb DRAM crossover will occur during early 1991—*not* this year. The exceptions to the general price trend signal new challenges for users, such as managing in the single-sourced world of the 1990s.

STANDARD LOGIC TRENDS

As shown in Figure 1 and Table 1, suppliers are making a market move to newer CMOS families such as AC or BiCMOS and will lower prices for these products in the process. Users also should anticipate critical exceptions, however, to the downward trend in standard logic pricing (e.g., the 74 LS).

Suppliers Resist Downward Trend in Standard Logic Pricing

The exceptions reflect the reality that suppliers are carefully evaluating which older product families (e.g., LS, ALS) they will no longer support because of slim profit margins. The anticipated result during the first quarter of 1990 is that users can expect supplier resistance—including firmer

TABLE 1
Semiconductor Pricing and Lead Time Trends (North American Bookings)

	Pricing Trend		Lead Times	
Part	Fourth Quarter	Forecast	Current	Trend
74LS	0.6-2.6% down Add 0-3% for surface mount	0-2.4% up	4-8 weeks Add 4 weeks for surface mount	Steady
74F	5.6-12.3% down Add 0-5% for surface mount	0.7-3.4% down	4-8 weeks Add 4 weeks for surface mount	Steady
32-bit MPUs	4%-11% down	4%-13% down *except* for 1.5% decline in 80386-16 and 80386SX-16 ASPs	5-10 weeks	Steady
1Mx1 DRAM 100ns, DIP/SOJ	19.0% down	14.0% down	4-16 weeks	1 week shorter
4Mx1 DRAM 100ns, DIP	40.0% down	36.0% down	8-20 weeks	Steady

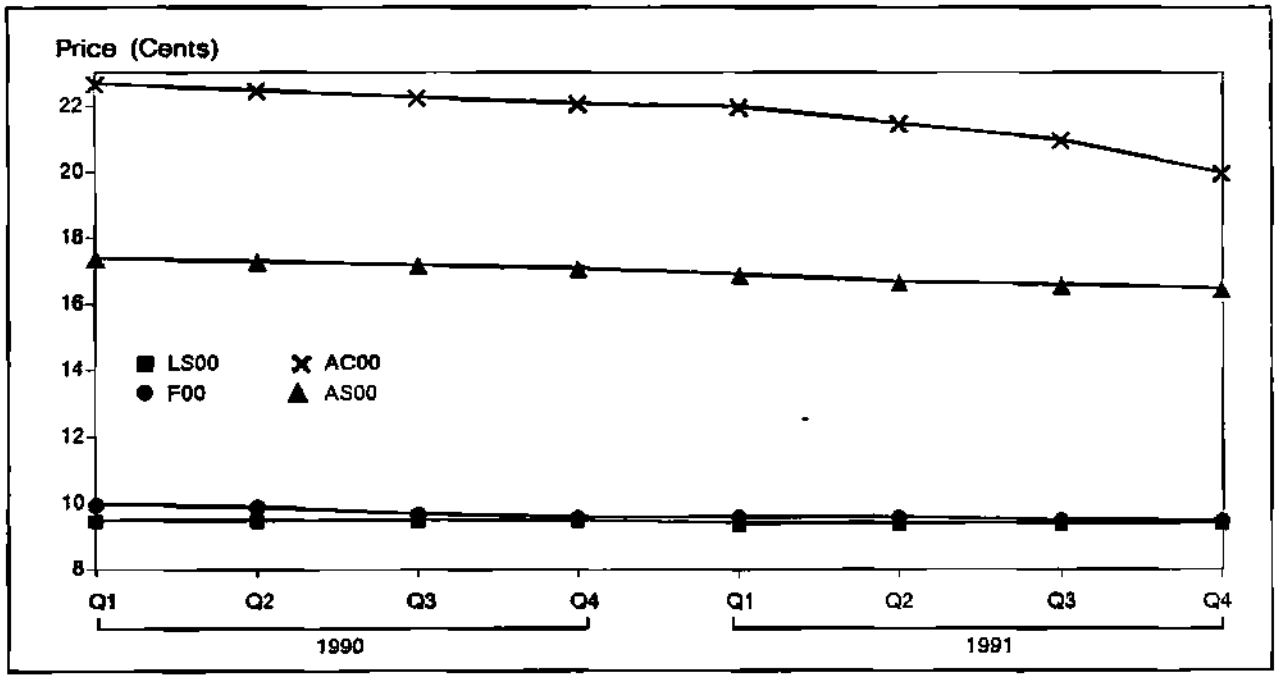
Source: Dataquest
January 1990

SUIS Newsletters 1990: January-March 1990-3

0006240

Dataquest Incorporated, 1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

FIGURE 1
Standard Logic Price Trends (North American Bookings) (Volume: 100,000 Units)



0006240-1

Source: Dataquest January 1990

pricing if not some *higher* price quotes, depending on the particular supplier/product—as suppliers narrow their standard logic product lines.

Some Relief for Users of Surface-Mount Packages

Although suppliers remain unable to meet aggregate demand for surface-mount devices, market conditions improved for users during the fourth quarter of 1989 and should continue to do so throughout the first half of this year. For volume users, the pricing premium for surface-mount devices (over the DIP) narrowed at the end of 1989 from as much as 10 percent to as little as 0. Users still face extended lead times of four weeks over the lead times for the dual in-line package (DIP), an improvement for some users of two weeks since last quarter.

MICROPROCESSOR TRENDS

In the microprocessor (MPU) marketplace, lead times should remain steady in the range of four to ten weeks (see Table 1). Two exceptions to the overall trend downward in MPU pricing—the 16-MHz versions of the 80386 and 80386SX products—again signal difficult choices for users.

Limited Allocation of 80386SX Products

As forecast last quarter, suppliers of higher-speed 80286 MPUs (e.g., 12 MHz and faster) continue to wage a fierce pricing battle against Intel's 80386SX product. For some users, however, the real news during early 1990 has been their inability to obtain a full supply of the 80386SX device from Intel. Major users increased demand for the 80386SX 16-MHz chip during the second half of 1989, which now means limited allocation for other users.

As reflected in Dataquest's latest forecast, prices for the 80286 12-MHz product should continue to decline under current market conditions; however, prices for the 386SX device should be stable. For example, the 80286 12-MHz product is expected to drop from a fourth quarter 1989 price

of $19.26 to a price of $17.25 in the first quarter of 1990, a decline of 10.4 percent. By contrast, pricing for the 80386 16-MHz product should be stable with a price of $61.75 during the first quarter of 1990 versus $62.55 at year-end 1989.

32-Bit MPUs: User Management in a Single-Source World

In last quarter's forecast, Dataquest noted that 1990 marks the growth stage in the life cycle of 32-bit MPUs that operate at speeds of greater than 16 MHz. As illustrated by the current allocation on 80386SX products, 1990 also marks a big step for some users into the challenging world of single-sourced ICs.

For users, single-sourced products require a tradeoff. The enhanced system value that users gain through use of proprietary processors entails some sacrifice of control by users over critical component procurement decisions—and ultimately users' system life cycles.

The market dynamics of the 32-bit MPU business at the outset of 1990 clearly reflect this reality. As shown in Table 1, users of 32-bit MPUs can expect price declines of 4 to 13 percent during this quarter *except* for single-sourced devices that operate at 16 MHz. For example, pricing for the 80386 16-MHz device—which currently is sole-sourced by Intel—will be relatively stable during the first quarter because Intel aims to move users to higher-speed products such as the 80386 20 MHz or 80386 25 MHz.

MEMORY TRENDS

The plunge in price for 1Mb DRAMs and the emergence of 4Mb DRAMs set the stage for the memory world at the outset of 1990. Given the criticality for users, Dataquest will devote its attention to megabit-density DRAMs in the following paragraphs.

The Volatile Megabit-Density DRAM Arena

As reflected in Figure 2 and Table 1, North American users of the 1Mbx1 DRAM can expect a first quarter 1990 price decline of 14 percent that should drop the average selling price (ASP) to $8.72. Users can expect prices for the newer 4Mbx1 product to drop by 36 percent during the first quarter to $60.50. However, several major suppliers just announced production cutbacks of the 1Mb product, which translates into heightened volatility in this capricious marketplace.

The Full Range of DRAM Pricing

Survey confidentiality limits disclosure of exact pricing points; however, the survey responses capture the dynamics behind the forecast numbers. The main point is *industry* uncertainty about 1Mb to 4Mb DRAM pricing.

For example, the forecast first quarter ASP of $8.72 for the 1Mbx1 DRAM is based on prices that range from a low of slightly more than $7.00 to a high of $9.65. One-half of survey participants anticipated a price in the $8.00 to $9.00 range. The survey average of $8.72 serves as the first quarter forecast for the 1Mb product.

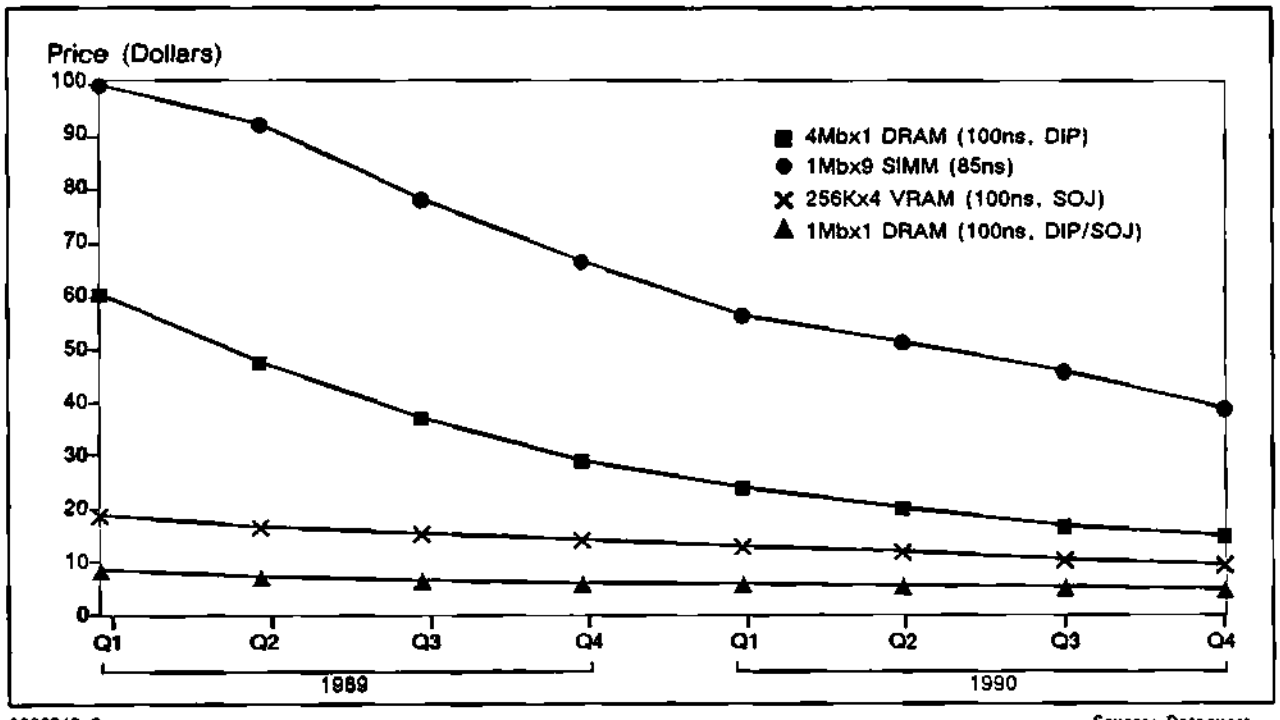
The forecast first quarter ASP of $60.50 for the 4Mbx1 DRAM is based on prices that range from a low of slightly more than $50.00 to a high of $105.00. Users generally forecast a price of *$67.00 or less*, and suppliers forecast *$60.00 or more*. Additional information, such as a given company's position in the market and global trends, was used in making the first quarter projection of $60.50 for the 4Mb device.

The 1Mb-to-4Mb DRAM Crossover

Each week, Dataquest receives inquiries as to the timing of the crossover (4x ratio) to the 4Mb DRAM from the 1Mb device. As noted in last quarter's forecast, a major factor stimulating the downward surge in 1Mb DRAM pricing has been the effort by a small group of 4Mbx1 DRAM suppliers to win an early design-in for this next-generation product. New factors in the equation are recently announced and widely publicized cutbacks in 1Mb DRAM production that aim to stabilize pricing for this part.

Dataquest expects the crossover to occur during the first quarter of 1991. Dataquest foresees a fourth-quarter 1990 price of $6.12 for the 1Mbx1 DRAM and a price of $29.05 for the 4Mbx1 product. These prices translate into a 4.7:1 ratio. For the first quarter of 1991, we project that the price of the 1Mb device will be $6.00 and the

FIGURE 2
DRAM Price Trends (North American Bookings) (Volume: 100,000 Units)



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Source: Dataquest
January 1990

4Mb part will be \$24.01—a crossover price ratio of 4:1. Dataquest recognizes that a limited number of first-tier buyers might make the crossover during the second half of 1990 but does not anticipate that the market as a whole will do so until the first half of 1991.

The 1Mb-to-4Mb DRAM Crossover: A Closer Look

Taking a closer look, forecast prices for the fourth quarter of 1990 are based in part on the following survey inputs: 1Mbx1 DRAMs should range from a little more than \$5.00 to almost \$7.75, and 4Mbx1 DRAMs should range from \$40.00 to almost \$85.00. The forecast prices for the first quarter of 1991 are based in part on these inputs: 1Mbx1 DRAMs have a range from less than \$5.00 to more than \$7.00 and 4Mbx1 DRAMs show a narrow spread from slightly less than \$31.00 to almost \$33.00. In addition to the survey information, Dataquest believes that other suppliers of 4Mb DRAMs aim to drive down the product's pricing even more aggressively.

The Crossover Wild Card

In last quarter's forecast, Dataquest viewed the 4Mb DRAM as the wild card, saying that if *each* of the five to seven prospective 4Mb DRAM suppliers can achieve *each* of its 1990 goals, then *some* major users of DRAM could make the crossover by late 1990.

In this quarter, the pricing of the 1Mbx1 DRAM has become the wild card in the crossover equation: How low can the price go and during what time frame? History shows that as leading-edge suppliers move to the next generation of DRAMs (in this case, the 4Mb device), other suppliers of the current-generation part, such as the 1Mb product, will increase production quickly in order to meet unsatisfied demand and drive down the price in the process.

Based on current production plans and survey information, Dataquest expects aggressive pricing by a changing set of 1Mb DRAM suppliers to preclude a 1990 market crossover to the 4Mb device.

ASIC TRENDS

As shown in Figure 3, ASICs should continue to decline in price during 1990. Although declines in terms of price per gate should be somewhat moderate this year versus the torrid pace of 1988 and 1989, users of gate arrays and cell-based ICs can expect sharp declines in nonrecurring engineering expenses (NRE). Dataquest sees signs of ASIC price moderation during 1991 (see Figure 4).

User Management in a Single-Sourced World

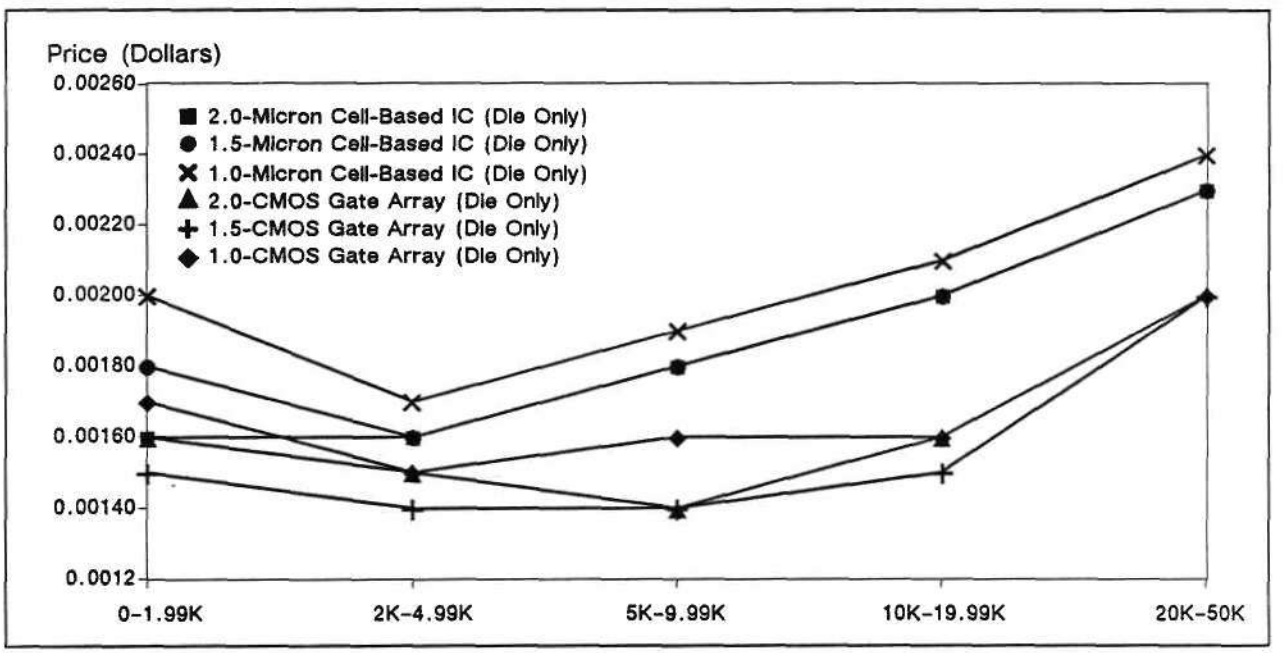
As with 32-bit MPUs, the impending move for some users from bipolar standard logic to ASICs means a step from the multisourced/commodity world of the past to the single-sourced/value-added world of the 1990s. Users confront a new set of challenges when procuring single-sourced ASICs, including the development of a new approach to pricing. Users must be able to determine the system price/performance tradeoffs available depending on whether users migrate to CMOS gate arrays or to PLDs, which may at first glance appear to be less expensive than CBICs, but which may *not* be the case when a system's MPU and memory needs are fully factored.

As noted in last quarter's newsletter, a range of technical factors such as system applications, ASIC density, and packaging make ASIC supplier-by-supplier pricing comparisons a stiff challenge at best. Nevertheless, meaningful pricing information can and *must* be developed as users stake systems' futures on a single supplier's product.

Answering Questions Never Before Asked

For example, for this newsletter, Dataquest made a current comparison of 1.5-micron CMOS gate arrays and CBICs in terms of price per gate—including die, test, and NRE—across a spectrum of product densities. The comparison showed the obvious price advantage of gate arrays against CBICs, but it also showed a subtle and consistent relationship. The fact is that as of today, whether a user utilizes 1.5-micron gate arrays *or* CBICs, the user pays the lowest price in terms of fully amortized price per gate through use of a

FIGURE 3
1990 ASIC Price Trends (North American Bookings) (Volume: 10,000 Units; Plastic Package)



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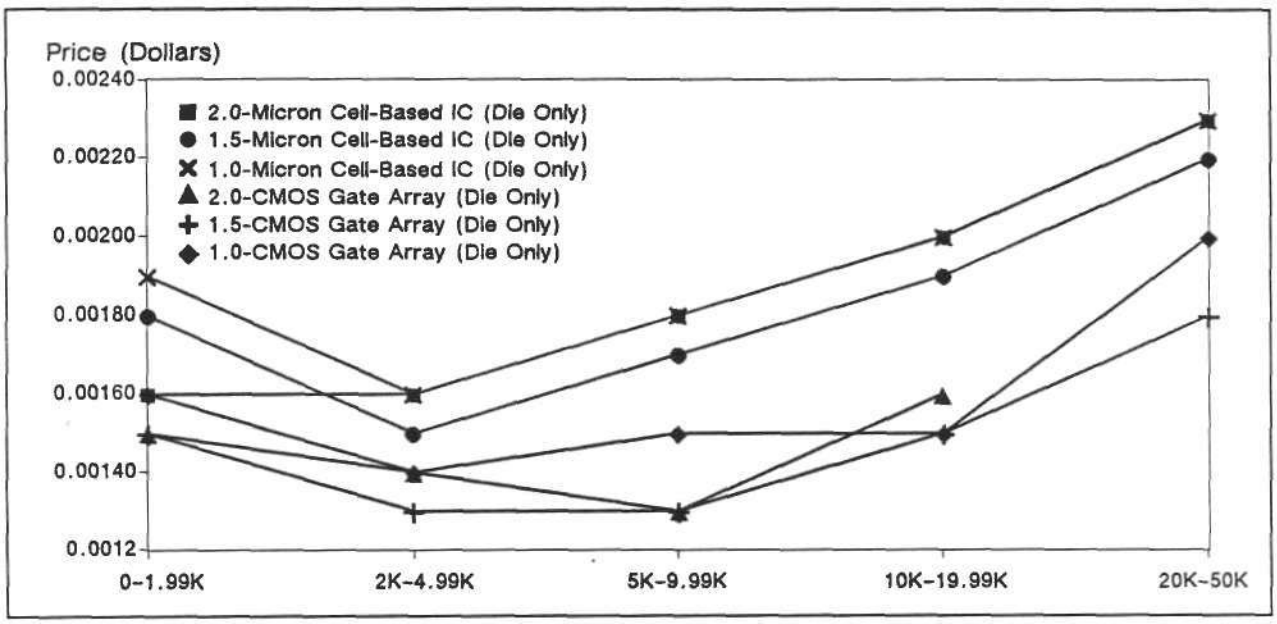
Source: Dataquest January 1990

FIGURE 4
1991 ASIC Price Trends (North American Bookings) (Volume: 10,000 Units; Plastic Package)



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Source: Dataquest January 1990

7,500-gate-count device. In *each* case, the next best user choice in terms of low-cost pricing is a 15,000-gate-count device.

The main point is that in order to manage the pricing challenge associated with single-sourced ASICs, users—in association with Dataquest—must ask questions never before asked and then develop new approaches for answering them.

DATAQUEST CONCLUSIONS AND RECOMMENDATIONS

The first quarter of 1990 should be a period of declining semiconductor prices, although the declines will not be as sharp as during 1989. Under these conditions, Dataquest recommends the following:

- Dataquest still recommends that system manufacturers, except for first-tier preferred buyers, plan for a 1991 crossover from 1Mb to 4Mb DRAMs. The megabit-density DRAM arena will be as volatile this year as ever, and, despite temporary production cutbacks during the year, users of the 1Mb device can look forward to a year-end ASP of $6.12.
- Users of standard logic should treat the prospective firming of bipolar product prices—an exception to the overall downward trend in pricing—as a signal for decision making. Dataquest recommends that users of bipolar standard logic should forge long-term procurement contracts with a carefully chosen supplier or else migrate to younger CMOS or BiCMOS families or ASICs.
- Dataquest recommends that users of 32-bit CISC MPUs as well as ASICs make strategic plans for life in a single-sourced world. Tactically, during the first half of 1990, users of 16-MHz versions of 32-bit MPUs must work closely with suppliers to minimize as much as possible disruption of systems production. Strategically, Dataquest advises users of single-sourced processors and ASICs to develop new pricing approaches—in effect, to seek answers to system/pricing questions never before asked in the commercial arena—and to expect firm support from Dataquest toward achievement of that goal.

Ronald Bohn

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Research *Bulletin*

JANUARY MARKET WATCH: THE MARKET PICKUP MAY BE A FALSE START

Market Watch is a monthly bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

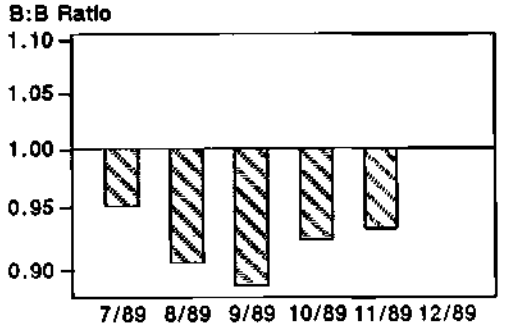


Figure 2
DOC Computer Demand

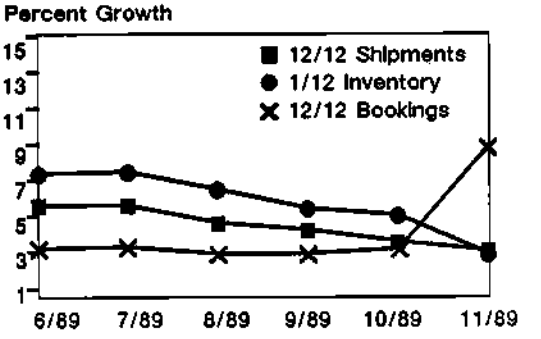


Figure 3
Semiconductor Inventory Level

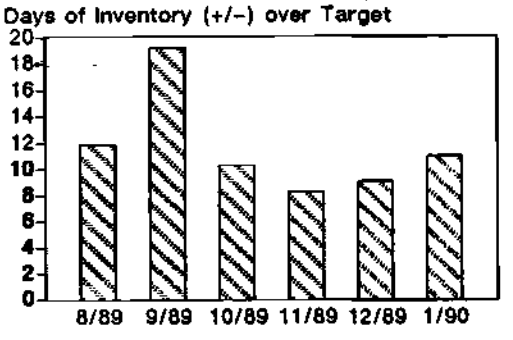
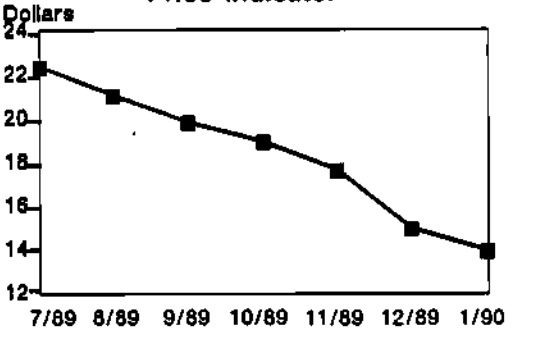


Figure 4
U.S. Weighted Semiconductor Price Indicator



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Source: U.S. Department of Commerce
World Semiconductor
Trade Statistics
Dataquest
January 1990

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THE BOOK-TO-BILL JUMPS TO PARITY

December's book-to-bill ratio of 1.00 (see Figure 1) can be attributed to a combination of two forces; orders for replenishment stock of key component inventories being run down for year-end financials and the oblique optimism for system sales that also has shown up in past monthly surveys. The December increases of 4.2 percent for bookings and 6.7 percent for billings over November are other positive signs that order rates of systems and components are close together. Another positive indicator is the month of December's 1989-over-1988 growth rates of 6.5 percent in bookings and 3.7 percent in billings that reflect the steady system demand that is pulling the market. Dataquest does not expect to see large gains in the book-to-bill ratio in the near future, but rather, foresees a replacement order scenario until system sales move higher.

COMPUTERS: DEMAND STABILIZES WHILE INVENTORIES RISE

Bookings and shipments of computers have remained relatively flat, but system inventories have risen substantially (see Figure 2). The 3/12 booking rate-of-change indicator has again risen for the third consecutive month. As mentioned in last month's *Market Watch*, this rise is an early indicator of where the 12/12 rate of change is headed. The recent inventory buildup appears to be the result of slower-than-normal year-end system sales combined with selected increases of new systems for 1990 introduction. Continued pressure on system companies' profit margins is forcing retrenchment in selected areas and increased demands on supplier flexibility.

USERS' SEMICONDUCTOR INVENTORIES ALSO RISE

The gap in actual versus targeted inventory levels rose this month (see Figure 3) due to unchanged average target levels and an increase in the number of parts being shipped early to users. Even with the increase, the actual level of inventories is a relatively low 32.7 days. One healthy sign is the users' continued confidence in suppliers to meet demand as evidenced in steady, low inventory targets (currently 21.7 days or 11.4 turns/year). In the face of sluggish system demand, efforts to adjust inventory levels to the bare essentials is an ongoing task at most user sites and will continue to force suppliers to excel in delivery commitments.

PRICES SLIP BUT NOT BY MUCH

The semiconductor supply juggernaut continues to overshoot demand, resulting in a continued decline in prices (see Figure 4). Most price competition continues to be in the commodity memory (DRAMs, SRAMs, and EPROMs) and microprocessor areas, mirroring the fierce computer market competition currently under way. Although most of the major Japanese and South Korean DRAM suppliers have formally announced scaled back production levels to better match demand, we do not expect availability and price trend changes to be noticeable in the market until the latter half of the second quarter. The availability/market delay is due to suppliers' high inventory levels and bureaucratic inertia that will need to be altered. We believe that spot and distribution pricing for these parts will be affected first, with long-term contracts the best hedge for consistent cost control.

DATAQUEST CONCLUSIONS

Optimism in the systems markets remains muted but still exists. Semiconductor suppliers are doing an excellent job of supporting their customers through these highly competitive times. Although the current inventory hiccup will be addressed, the forecasting mechanisms should ensure quick correction. The combination of the short-term DOC data and the mildly upbeat outlook from our surveys leads us to believe that although boom times may not be ahead, at least they won't be bust times. As mentioned in earlier reports, Dataquest expects the first quarter of this year to be relatively strong in semiconductor shipments (compared with the rest of 1990) as evidenced by the latest book-to-bill ratio. Until a definite change in the end markets takes shape, we expect this static shipment/demand/inventory situation to continue.

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Victor de Dios

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Research *Bulletin*

JANUARY PROCUREMENT PULSE: ORDERS AND INVENTORIES REBOUND UP, PRICES AND LEAD TIMES FALL

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

Figure 1
Averaged Monthly Semiconductor Orders

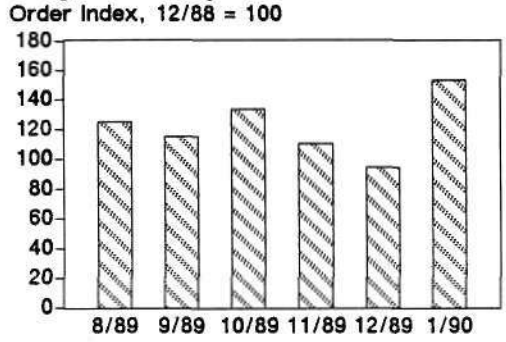


Figure 2
Averaged Semiconductor Lead Times

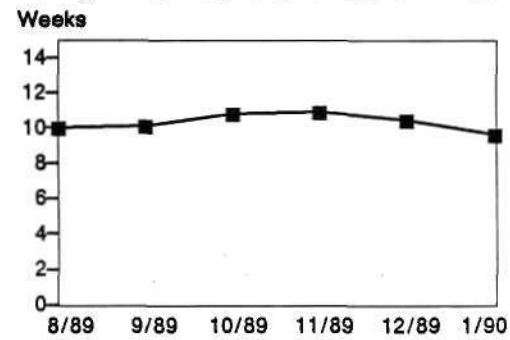


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

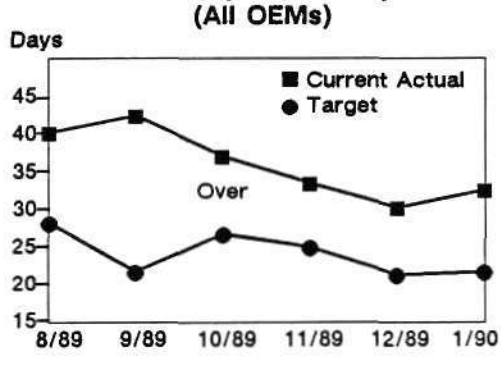
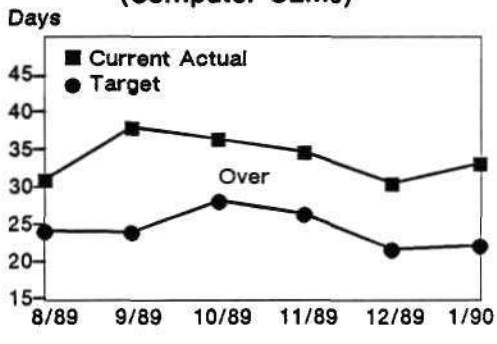


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



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Source: Dataquest
January 1990

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SEMICONDUCTOR ORDERS JUMP UP, PREPARING FOR HIGHER SYSTEM SALE EXPECTATIONS

Order rates for semiconductors are expected to rise above levels set in October 1989 as companies return to "normal" buying patterns (see Figure 1). Year-end financial austerity programs have pared operations to the bone and buyers now are purchasing components needed for anticipated new system sales in the upcoming six months. This renewed optimism appears to take off from where we left it last November, as system companies are expecting an average of 6 percent sales growth during the next two quarters (individual estimates range from negative 5 percent to positive 20 percent). It is important to note that the lone negative forecast originated from a defense systems company and that the other companies in the sample expect flat to higher growth in the next six months. Availability of key semiconductors at predictable prices is allowing procurement managers to better match their buying patterns with system sales movement.

LEAD TIMES DIP SLIGHTLY, BREAKING THE AVERAGE 10-WEEK BARRIER

Semiconductor lead times have declined one full week since our last survey and are now down to 9.7 weeks, as seen in Figure 2. The only parts that are keeping this average up are SOIC-packaged standard logic devices, which are adding a four- to eight-week delivery delay due to lead frame shortages. Most other parts, from DRAMs to microprocessors, have lead times ranging from four weeks (stock) to eight weeks, depending on the supplier.

INVENTORY TARGETS STABLE, ACTUAL LEVELS UP SLIGHTLY

Another indicator of good inventory control is how the movement of inventory levels matches forecast system sales movements. As seen in Figures 3 and 4, both overall OEM target and actual inventory levels (21.1 and 32.7 days, respectively) and computer OEM target and actual inventory levels (22.3 and 33.4 days, respectively) are still within one day of each other. If DRAMs are taken out of the equation, inventory levels remain relatively unchanged, with all OEMs at 20.9/32.3 days and computer OEMs at 21.4/33.3 days target versus actual, respectively. This relative stability of inventory levels is primarily because of the ready availability of DRAMs. Production cutbacks of up to 10 percent by major Japanese and South Korean DRAM suppliers targeted at stabilizing prices will test the forecasting accuracy of users. Now is the time to ensure the commitment of adequate supplies of products through the next six months.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Order rates have picked up appreciably, primarily in anticipation of new system sales and partially to refill key inventory levels. Dataquest believes that the next six-month system sales outlook is moderately optimistic and that component availability (based on prices and lead times) is at a 12-month high. Major memory suppliers are attempting to avert a price debacle similar to the one in 1984 and 1985 by matching supplies with forecast demand. It is key that all major IC users accurately forecast their component requirements for the next six months because it takes that long for any shift in demand to be felt in IC market availability. As mentioned in previous bulletins, the current cutbacks that began late last year will not be noticed in the market until February or March. Predictable, not dramatic, price declines are a result of the combination of good forecasting, good price negotiations, and good inventory control. Ensuring the first allows for the rest.

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Victor de Dios

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February 14, 1990

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TITLE:	Prices (Menu)
VOLUME:	Industry Trends
TAB:	Prices
PAGES:	1
FILING INSTRUCTIONS:	This menu replaces the existing one entitled "Prices" which should now be discarded.

TITLE:	Fourth Quarter 1989 Price Update
VOLUME:	Industry Trends
TAB:	Prices
PAGES:	16
FILING INSTRUCTIONS	This section replaces the existing one entitled "Third Quarter 1989 Price Update" which should now be discarded.

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VOLUME:	1988-1989 Newsletters
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VOLUME:	1988-1989 Newsletters
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March 1, 1990

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TITLE:	Table of Contents
VOLUME:	Worldwide Shipments and Forecasts ✓
TAB:	Table of Contents
PAGES:	i through ii
FILING INSTRUCTIONS:	This section replaces the current one entitled "Table of Contents", which should now be discarded.
TITLE:	List of Contents
VOLUME:	Newsletters
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L. Ferguson

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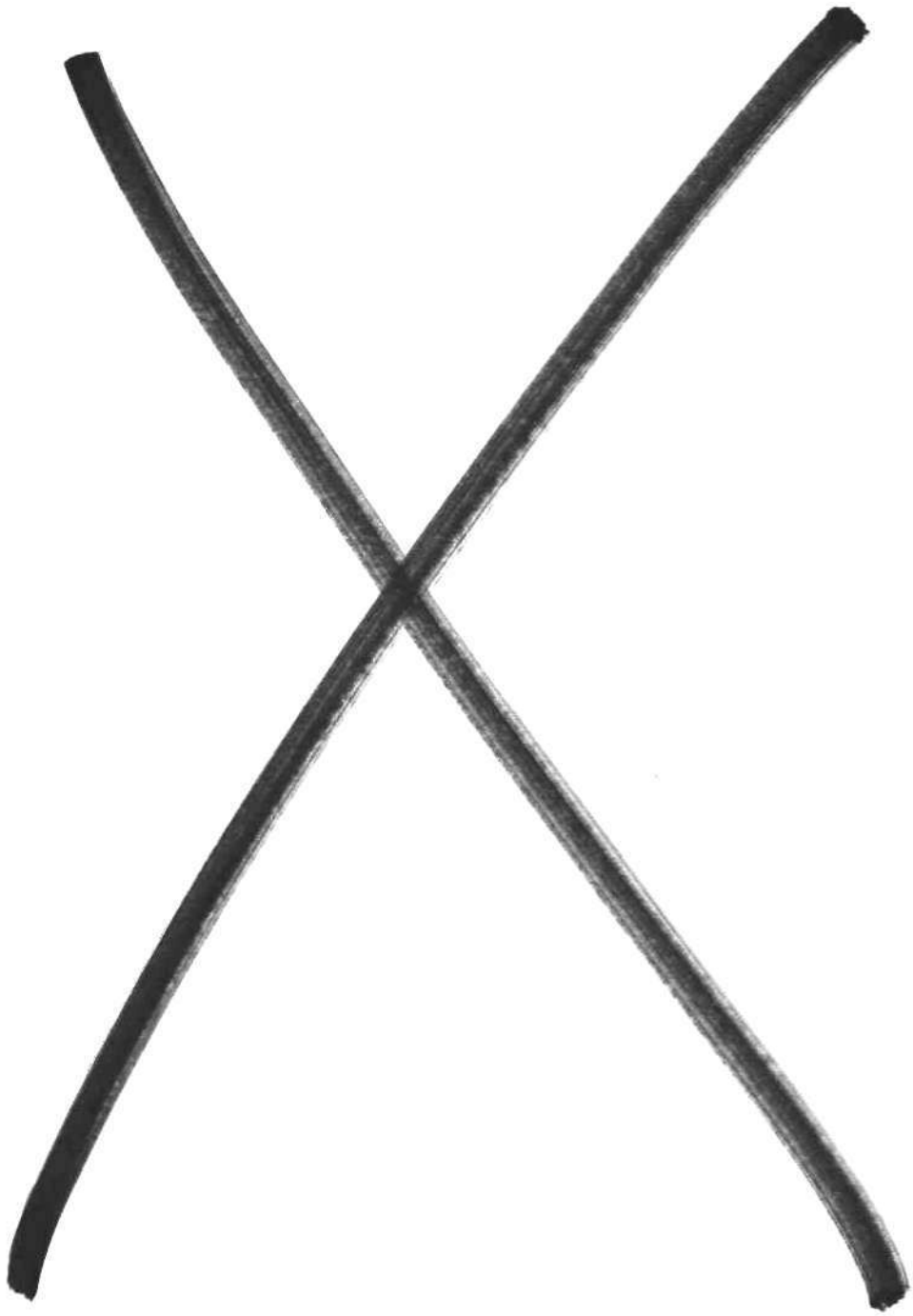

SUIS April–June Index

The following is a list of newsletters in this section:

SUIS April–June Index

- **The ASIC Package Proliferation** (1989–18)—Surface-mount technology now is mainstream. This newsletter discusses the packages currently being used or under development for ASICs, and it also reviews the issues and choices pertaining to standards involved in ASIC packaging. Dataquest believes that package proliferation will continue as the ASIC market develops.

- **North American Market Watch, April 1989: Signs of a Weakening Market Ahead** (1989–19)—The North American Market Watch is a monthly bulletin, released after the SIA book-to-bill flash report, that is designed to give a deeper insight into the monthly trends in North America semiconductor consumption. It indicates that prices have not declined significantly in the first quarter and semiconductor bookings remain considerably strong. However, Dataquest believes that the signs indicate a second half of 1989 that is not as rosy as the first.

- **National Semiconductor Restructures** (1989–20)—National Semiconductor has undergone a tremendous amount of change in its struggle to identify a structure that will result in profitable operations. This newsletter brings our Semiconductor User clients up to date on National's restructuring efforts. Dataquest believes that National's method of positioning its broad line of components products will bear watching as the company stakes its future on being a pure-play semiconductor company.

- **Semiconductor Users Eye the Risky "CISC-Y" World of 32-Bit Microprocessors** (1989–21)—Systems manufactures are confronting urgent decisions that could carry companies to prosperity or doom during the 1990s. They must decide which 32-bit CISC, RISC, or MPC to use and from which manufacturer. This newsletter highlights key issues of how Intel and Motorola are demonstrating to semiconductor users the continuing viability of CISC-based systems in the areas of performance, software, pricing, time to market, and worldwide manufacturing capability.

- **May Procurement Pulse: Inventory Levels Improve, DRAM Market Amiss** (1989–22)—The Procurement Pulse is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin presents the results of the survey and analyzes what this information means to both semiconductor users and manufacturers. Dataquest concludes that accurate forecasting and inventory control by both users and vendors will be critical in preventing any slowdown from becoming a recession.

- **The Super Section 301: 1986 Trade Arrangement Déjà Vu?** (1989–23)—The May 30 Super Section 301 announcement raised many of the same questions that were asked in the summer of 1986 regarding semiconductors and their procurement. This newsletter briefly reviews the chronology of and the most common questions asked about this portion of the 1988 Ombudsman Trade Bill, analyzes what is in store for users of semiconductors in the wake of the announcement, and makes recommendations.

SUIS April–June Index

- **Japanese Wafer Fab Update: New Fabs, Advanced DRAMs, and 8–inch Wafers** (1989–24)—In 1988, a three–month joint research project between Dataquest's San Jose and Tokyo offices was launched in order to provide in–depth information on Japan's semiconductor manufacturing activities. Thirteen production and pilot–based silicon fabs went into production during 1988. Japan has been very consistent about the addition of new fabs when compared with the United States. Dataquest concludes that if the Japanese rapidly adopt the single–generation DRAM fab strategy, a large bubble of advanced and low–cost capacity would begin to move into ASIC, MCU, and MPU production. By 1992, Japanese companies should be enjoying the fruits of their current ASIC and MPU efforts, which include many technology exchange agreements and joint development projects being conducted on– and offshore.

- **ISDN: Plans, Potentials, and Pitfalls** (1989–25)—Integrated Services Digital Network (ISDN) is an opportunity with high rewards and high risks for the semiconductor industry. This newsletter discusses the purpose behind ISDN, circuits and applications, and suppliers and demand. Dataquest concludes that ISDN represents an opportunity disguised as a challenge.

- **May Market Watch: System Shipment Rates Decline, Semiconductors Temporarily Steady** (1989–26)—This month's Market Watch focuses on the slowdown in booking growth, system shipment and order growth rates, low OEM semiconductor inventories, and the gradual decline reflected in Dataquest's price indicator. Despite the projected slowdown in the second half of 1989, Dataquest believes that the systems and semiconductor markets will remain healthy.

- **June Procurement Pulse: Order Rates Improving; Inventory Mix Changing** (1989–28)*—This month's Procurement Pulse survey results focus on the increased market confidence as June orders rise, lead times remain flat, and overall inventory levels drop. Dataquest does not expect the surge in June orders to be the beginning of a trend but rather a result of inventory adjustments, especially in memories.

* The number 27 (e.g., 1989–27) has been omitted.

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Research *Bulletin*

JUNE MARKET WATCH: WITNESS A PLACID ELECTRONICS MARKET, MADE OF STABLE DEMAND AND ADEQUATE SUPPLIES

Market Watch is a monthly Dataquest bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL JUMPS TO A ROBUST 1.14!

Reflecting the positive but slow growth in systems demand, the May book-to-bill ratio rose sharply from 1.09 in April to the current

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

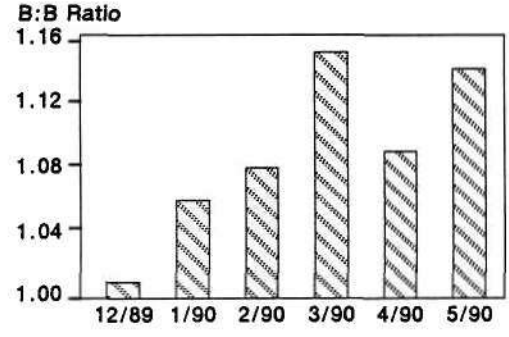


Figure 2
DOC Computer Demand

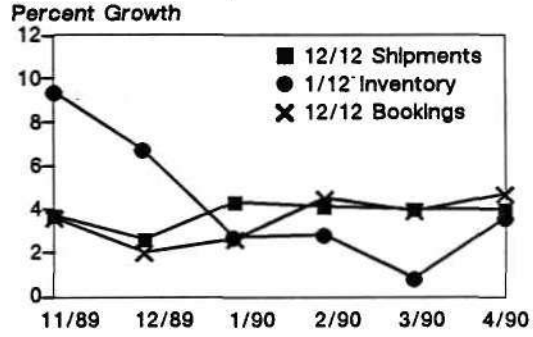


Figure 3
Semiconductor Inventory Level

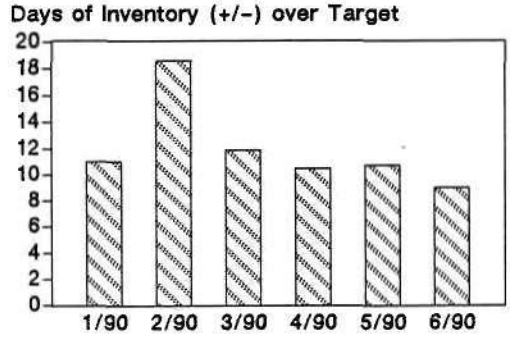
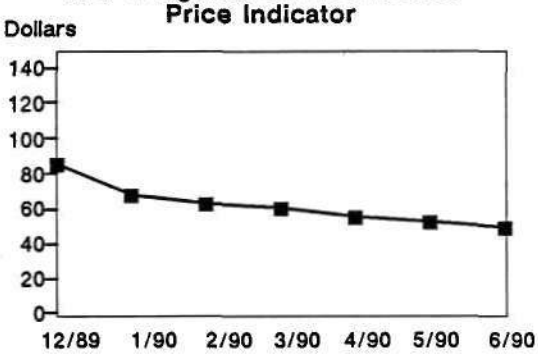


Figure 4
U.S. Weighted Semiconductor Price Indicator



Source: U.S. Department of Commerce, World Semiconductor Trade Statistics, Dataquest (June 1990)

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1.14 (Figure 1). The actual numbers for May on a three-month moving average show a 7.8 percent increase in bookings and a 5.7 percent rise in billings over April. This strong semiconductor booking activity appears to be linked with the continued optimistic system sales outlook and confidence that inventories can be controlled. As noted in last month's *Market Watch*, the continuation of a positive book-to-bill ratio is expected for the remainder of the summer because of the sustained dynamics of the systems market. What was not anticipated was the increase in bookings activity over the prior month's levels. Dataquest still expects a positive book-to-bill ratio for the next three months, but at a rate that is more in line with system sales growth.

APRIL SYSTEM SALES AND BOOKINGS REMAIN FLAT WHILE INVENTORIES RISE TO NORMALCY

The US Department of Commerce data on computer sales and inventories (Figure 2) illustrates that 12/12 system booking and shipment rates of 4.8 and 4.1 percent, respectively, have been relatively constant since the first of the year. Last month's dip in inventory levels relative to last year's levels appears to be an anomaly that has now returned to more traditional levels. While annualized computer shipments stabilize at a positive rate, the short-term 3/12 bookings rate continues to grow. (The 3/12 bookings rate is currently at 8.7 percent.) The positive system sales outlook that has been reported by our surveyed procurement managers for the past four months in the *Procurement Pulse* is being realized in actual bookings now. Procurement managers' continued optimism for the next six months, combined with adequate semiconductor supplies, should provide for manageable procurement and inventory control in the upcoming months.

SEMICONDUCTOR INVENTORIES REASONABLY CONTROLLED

Both target and actual semiconductor inventory levels dipped slightly (to 20 and 29 days, respectively), resulting in a smaller gap between target and actual of 9 days for this month (Figure 3). Because of the relative sluggishness in system sales, cost-control measures remain the main focus on earnings growth for most, if not all, of the companies polled. Although inventory levels have not reached targeted levels, they remain at a stable and controlled 12 turns a year. There continues to be room for improvement, especially regarding DIP standard logic and PLD supplies versus forecasts, but generally the inventory situation is under control.

PRICES PREDICTABLY DECLINE IN LINE WITH EXPECTATIONS

Figure 4 illustrates that semiconductor prices continue to decline slowly, primarily because of competition in the DRAM and SRAM markets and coinciding with the easing of 32-bit MPU availability/pricing. Some price stability continues in the standard logic DIP segment due to an aggregate supplier shift to SMT products that left existing DIP demand unmet in some cases. Adequate supplies of all semiconductors (TTL PLDs and DIP logic included) are now, or soon will be, noticed in the market. Compared with the unspectacular but steady growth of system sales, the chip supply is expected to keep downward pressure on overall prices for the next four to six months.

DATAQUEST CONCLUSIONS

Dataquest believes that semiconductor procurement from both a buyer and a supplier perspective is currently predictable relative to the same situation a year ago. Some areas of improvement still remain and are being addressed. The "religion" of cost control and the accompanying need for forecasting accuracy has become the norm for most large users. The ancillary benefit for smaller companies is that the increased discipline to meet delivery commitments for larger companies is improving the overall market. Dataquest expects continued improvements in most semiconductor supplies throughout the summer months. In the absence of a large increase in aggregate demand, semiconductor availability and procurement will remain predictable.

Mark Giudici

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Research *Bulletin*

JUNE PROCUREMENT PULSE: INVENTORIES CONTROLLED WHILE BOOKINGS AND LEAD TIMES INCH UPWARD

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDER LEVELS EXPECTED TO RISE, KEEPING PACE WITH SYSTEM SALES EXPECTATIONS

The order rates for semiconductors are expected to increase in June, which is in line with the past four months of system sales expectations.

Figure 1
Averaged Monthly Semiconductor Orders

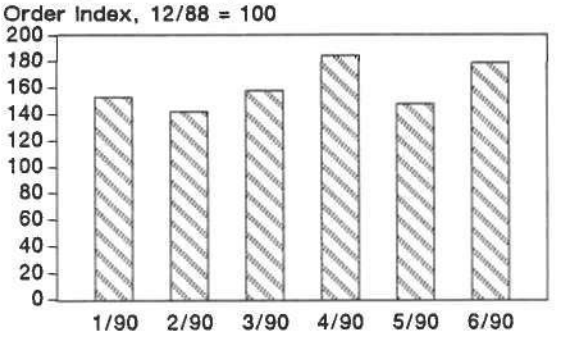


Figure 2
Averaged Semiconductor Lead Times

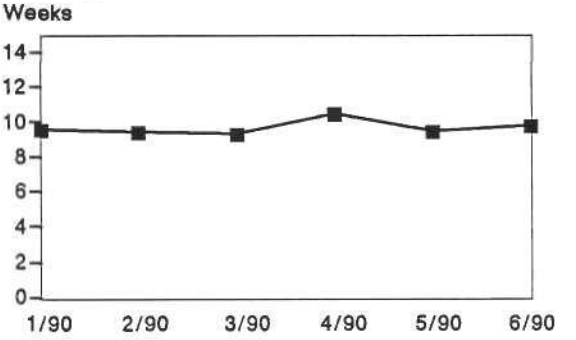


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

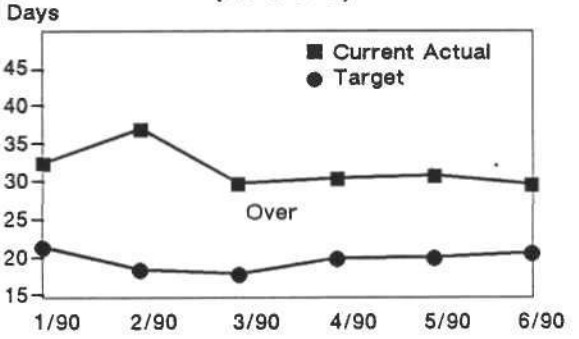
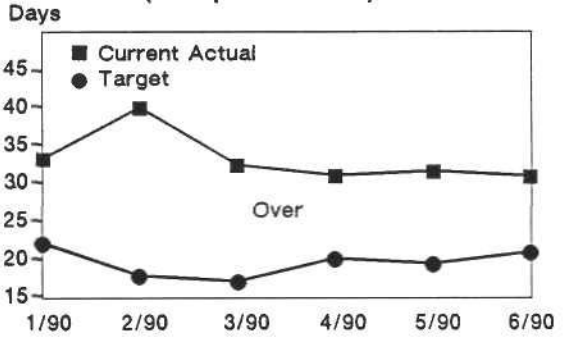


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (June 1990)

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This month's respondents expect to order 20 percent more semiconductors over last month's slight dip in bookings. Over the past six months, order levels have seesawed around the 150 index level (see Figure 1), which indicates that buying patterns have stabilized. The continued optimism of the procurement community regarding system sales is now considered a trend. For an unprecedented four months in a row, the lowest system sales forecast is flat, while the highest forecast indicates a 25 percent increase. The overall average outlook for the next six months has risen from last month's 7.8 percent growth to the current 9.4 percent growth. The upcoming slow summer months again will be a good test of system sales resiliency. As it stands now, the outlook continues to be good.

LEAD TIMES RISE BY THREE DAYS, BUT AVAILABILITY STILL GOOD

Respondents to this month's survey are seeing lead times stabilize at between 8 to 13 weeks, with an average of 9.9 weeks versus last month's 9.6-week level (see Figure 2). The availability of Intel 32-bit MPUs has begun to ease as capacity increases begin to be seen in the market. Another availability issue is DIP-packaged standard logic, which still has an additional two- to four-week lead time over similar SOIC logic parts. It appears that SOIC capacity has finally surpassed aggregate demand levels at the expense of DIP capacity, while DIP logic demand has remained steady. The continued shift to surface-mount products will resolve this minor irritation. The only other availability problem is the TTL PLD supply crunch, which is still stretching lead times out beyond 16 to 18 weeks for some parts. As mentioned in last month's *Procurement Pulse*, this crunch appears to be a supply problem and not a large increase in aggregate demand. Supplies should begin to improve within 30 to 60 days as wafer-start increases begin to enter the market.

INVENTORY LEVELS ABOVE TARGET, BUT UNDER CONTROL

As seen in Figures 3 and 4, inventory levels have remained very constant for the past three months. Although targeted levels are not being reached, the overall level of actual inventory on hand hovers at approximately 30 days (currently 29.9 days). This inventory turn rate of 12 (360 days/30 days inventory) is being well managed, allowing for future improvements toward the targeted turn rate of 18 (360 days/20 days targeted). Continued scrutiny of overall costs is keeping both buyers and suppliers in close communication regarding supply requirements and direct inventory levels. Delivery still remains a problem for some users in our survey; it could reduce actual inventory levels further if improved.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Stability in the overall electronics market has been the norm now for the past four months. With electronic system demand in a slow growth mode, the corresponding semiconductor supply (with few exceptions) is meeting demand adequately at reasonable prices. Dataquest believes that the current situation is not a cosmic flaw in an otherwise chaotic business cycle. Rather, the aggregate focus on cost control and the mandatory forecast improvements have resulted in many, if not most, electronics companies keeping material costs down in face of unspectacular sales. The availability of semiconductors continues to improve, based on aggregate available capacity, and demand levels are such that no shortages are foreseen for the rest of 1990. Dataquest anticipates that the continued exchange of accurate forecast information will help make 1990 a relatively healthy year for both the electronics and semiconductor industries in an otherwise flat market.

Mark Giudici

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Research Newsletter

RISK AND OPPORTUNITY IN EASTERN EUROPE: THE VIEW FROM FINLAND

SUMMARY

Mikhail Gorbachev's June 1990 visit to Silicon Valley will follow his earlier sweeps through Europe's high-tech centers. Systems manufacturers in Western Europe, North America, Japan, and Rest of World now confront a broad strategic decision: Should they target newly emerging markets in the USSR and Eastern Europe, and if so, what will be the time frame and business approach? Strategic planners at systems houses must carefully weigh the possible benefits of doing business in these new markets against an immediate set of hard risks (see Table 1).

During a recent business trip to London, Dublin, Paris, Brussels, Stockholm, and Helsinki we found Dataquest clients in Europe consistently stating that investment payback from these Eastern regions should occur over the long term—at the earliest. For companies committed to success in these emerging regions, Dataquest recommends a look at Finland as a safe and ultimately cost-effective stepping-stone to long-term market goals.

WHAT ARE THE BENEFITS OF ENTERING THESE MARKETS?

The prospective benefits of doing business in the USSR and Eastern Europe sound similar to the rationale for *entering* the China market. These benefits include the following:

- A huge consumer market "hungry" for the latest Western technology and consumer goods
- The availability of an enormous pool of low-cost labor for export or domestic market production
- Access to several specialized technologies (e.g., Soviet expertise in thin-film coatings)

A constant theme in the discussion of these benefits is that an early presence in these emerging

TABLE 1
Risk/Benefit Trade-Offs of Doing Business in the USSR and Eastern Europe

Prospective Benefits	Possible Risks
Early stake in emerging regional economic markets	Unfavorable or nonexistent currency exchange rate systems
Extended life cycle for mature systems (e.g., 80286 PCs)	Legal and political uncertainty (e.g., investment expropriation)
Potential low-cost manufacturing locales	Distant investment payback period
Access to several advanced technologies (e.g., thin-film coatings)	Continuing limitation on flow of technologies into these markets
	Stiff social and linguistic barriers

Source: Dataquest
May 1990

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regional economic markets should translate into a key long-range advantage in terms of market success. Indeed, some companies believe that failure to establish a presence now could mean a company's demise in global markets by the end of this decade.

Extended Life Cycle for Mature Systems

For electronic systems manufacturers, Dataquest already spots some relatively concrete opportunities and benefits for suppliers targeting the USSR and Eastern Europe. These countries represent newly emerging markets for data processing, telecommunications, and related systems. For example, Dataquest expects the installed base of personal computers in the USSR to grow from 150,000 during 1988 to 28 million by the mid-1990s. Demand will focus on lower-cost, user-friendly systems with a well-developed software base (e.g., 80286-based systems). In effect, the regional emerging markets could provide an opportunity for system manufacturers to sharply extend the life cycle of mature equipment.

U.S./USSR "Silicon Summit"

At the end of Mr. Gorbachev's visit to California's Silicon Valley, U.S. systems manufacturers will meet with the USSR's high-technology leaders. Dataquest expects North American companies such as Atari to use these meetings as a starting point for satisfying long-term Soviet demand for PCs and other systems. For example, at the time this article was written, Atari was negotiating to trade its PCs for 256K DRAMs produced at the Soviet state-owned fab in Zelenograd, USSR.

WHAT ARE THE RISKS OF ENTERING THESE MARKETS?

As discussed with clients in Europe, the risks of doing business in the USSR and Eastern Europe *also* sound similar to the reasons for *avoiding* the China market. They include the following:

- Unfavorable or nonexistent currency exchange rate systems
- Legal and political uncertainty (e.g., dramatic domestic political change)
- Lengthy investment payback periods
- Continuing and uneven U.S.-Western European limits on technology exports
- Daunting social, religious, and linguistic barriers to doing business

Unfavorable Exchange Rate Systems

There is an old saying that the only thing worse than an unfavorable exchange rate system is a *nonexistent* exchange rate system. At best, foreign manufacturers that enter these newly emerging markets confront primitive and unfavorable systems. At worst, the dysfunctional systems will force Western businesses into awkward, unfamiliar, and often disadvantageous countertrade arrangements (e.g., bartering PCs for beer, vodka, and raw materials).

Legal and Political Uncertainty

At best, legal systems in the USSR and Eastern Europe are rudimentary in comparison with Western systems. The Eastern legal systems could move into synchronization with international business law over time, but *only* in the absence of sharp domestic political change (as occurred in China during the past two years).

For example, the specter of the Russian military hung over Mikhail Gorbachev's shoulder during early May 1990 as the Soviet conflict with Lithuania, Estonia, and other Soviet Baltic republics continued. Indeed, Mr. Gorbachev's popularity seemed higher in Western Europe than in the USSR. Most European clients quietly supported U.S. President Bush's decision to not pressure Mr. Gorbachev about the Lithuania embargo, although they also expressed concern for the Soviet Baltic people.

The main point is that legal change in these regions will take time; nevertheless, virtually overnight, sudden domestic political change can completely alter the investment landscape.

Limits on Technology Exports

Systems manufacturers face continuing limits on systems technologies that may be sold into these new markets. The members of the European Community (EC) and the North Atlantic Treaty Organization (NATO) announce new embargo

relaxations each month; however, the process remains slow, cumbersome, and uneven in the eyes of many would-be exporters. Suppliers vigilantly honoring the law often hear reports—confirmed as well as unverified—that proscribed systems/technologies surreptitiously make their way into the Eastern markets or already are being manufactured quietly there. In either case, Western systems manufacturers confront the risk that the window of opportunity will be narrower than expected. In like fashion, uncertainty regarding technology controls makes long-term planning on system "technology road maps" and production schedules for these emerging markets quite speculative.

Distant Investment Payback Periods

The clear message from Dataquest's European clients as Europe moves toward 1992 is this: Any payback from investment in the USSR and Eastern Europe will not occur until after 1995 or perhaps early next century. Most European systems manufacturers are willing to allow a few global giants such as AT&T or Siemens to take the lead into these emerging markets. Many European companies are waiting to see if Western Europe reaches its economic-financial unification goals by 1992; if so, they may target their plans for the Eastern Bloc to commence two to five years later. Again, they expect the payback from investments in the USSR and Eastern Europe to occur much later this decade or during the next decade.

THE VIEW FROM HELSINKI, FINLAND

Regardless of the enormous risk and challenge, some systems manufacturers want to enter these new markets as soon as possible. Strategic planners at these companies should consider Finland as a base from which to begin the task.

In terms of geographic proximity, language, and business experience, Finland marks a safe entry point for Western companies interested in doing business in the USSR and the Baltic states *without* making a large, risky initial investment in those areas. For example, the Finnish language is most like the Estonian language, and Estonia is the one region where the Finns can be understood while speaking Finnish. The Finnish business community is also comfortable with doing business in English.

Finland has had a long and challenging history of relations with the USSR and the Baltic states. For example, since World War II, Finland often has been the USSR's leading trade partner among Western nations. Finnish companies do a good amount of business in these emerging regions, and Finnish banks are quite adept at handling the exchange rate/currency conversion and countertrade arrangements. Helsinki is considered an expensive city. However, establishing an office and facility there should prove less expensive in the long term than plunging directly into the USSR or Eastern Europe with costly physical investments.

Table 2 summarizes how Finland can help Western systems manufacturers minimize the risk of doing business in these new regions.

TABLE 2
How Finland Minimizes Business Risks in Eastern Europe

The Risk	The Finnish Alternative
Investment Payback Risk	Finnish physical investment is not vulnerable to government expropriation. Initial small modular Finnish investment can expand as USSR/Eastern European markets prove themselves and eventually allow for large-scale investment in these regions.
Exchange Rate Risk	Finnish banks and trading companies have long-time experience in Soviet-style countertrade.
Government Risk	Finnish facilities are not vulnerable to swings in the USSR and Eastern European legal/political/military structure.
Linguistic Barriers	Finnish staff can communicate in both Estonian and English.

Source: Dataquest
May 1990

DATAQUEST CONCLUSIONS AND RECOMMENDATIONS

A recent visit to leading European cities and high-technology centers reveals that the payback from investments in the Soviet Union and Eastern Europe should occur in the distant future at the earliest. Systems manufacturers that target these newly opening markets face a host of risks in terms of monetary exchange systems, technology controls, language, and government stability that signal caution on the part of strategic decision makers. Nevertheless, Dataquest does not advise companies to close their eyes to the prospect of doing business in these regions, especially in the glare of Mr. Gorbachev's anticipated visit to Silicon Valley during early June 1990 and the related U.S./USSR "Silicon Summit."

Balancing prospective return with current hard risk, Dataquest makes the following recommendations:

- Dataquest recommends that major systems manufacturers with deep pockets and a well-established position in Europe make direct investment in these regions during the next several years only if the company can endure a 10- to 15-year investment payback period or, in a worse case, withstand a complete loss of invested capital.
- For systems manufacturers of whatever scale that are firmly targeting the USSR and Eastern European markets—but are averse to risk—Dataquest recommends the establishment of facilities in Finland and/or the formation of alliances with Finnish banks and trading companies.
  - This route should serve as a cost-effective way of reducing investment exposure.
  - Should the markets develop, the presence in Finland can be expanded or used as a stepping-stone for larger direct investment in the emerging markets.
- Otherwise, Dataquest recommends that systems manufacturers establish a foothold presence in these regions now—for strategic information-gathering purposes on business customs, opportunities, and alliance candidates—by creating small "satellite" offices that can lay the foundation for future expansion within the next 5 to 10 years.

Ronald Bohn

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Research *Bulletin*

MAY MARKET WATCH: DEMAND REMAINS STEADY WHILE SUPPLIERS FINE-TUNE PRODUCTION LEVELS

Market Watch is a monthly Dataquest bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL STABILIZES AT A HEALTHY 1.09

As seen in Figure 1, the April book-to-bill ratio has steadied at a strong 1.09 level. This stability again reinforces the notion that the overall systems business remains steady, with no large

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

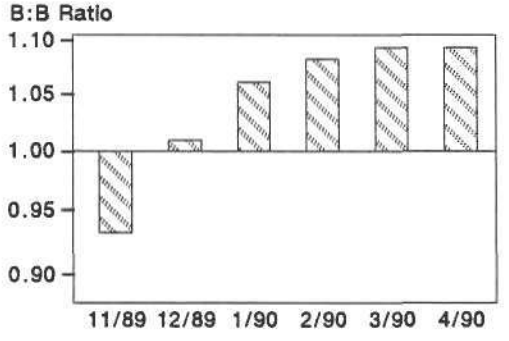

Figure 2
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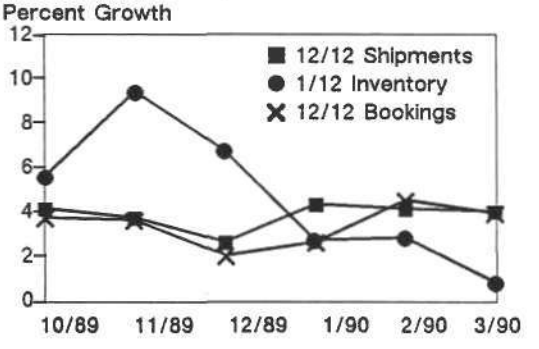

Figure 3
Semiconductor Inventory Level

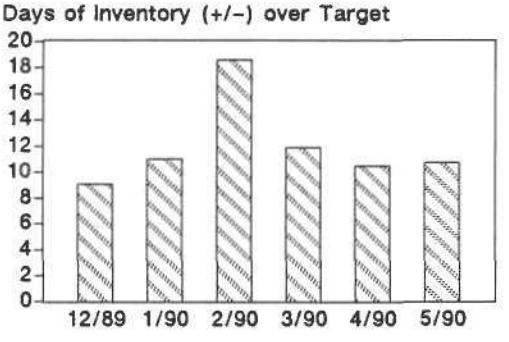

Figure 4
U.S. Weighted Semiconductor Price Indicator

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Source: U.S. Department of Commerce
World Semiconductor Trade Statistics
Dataquest
May 1990

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fluctuations either up or down foreseen. Although April 1990 bookings are 2.7 percent lower than those of April 1989, they are 3.8 percent higher than January 1990 (the last first month of a quarter), signifying continued stable growth. Billings for April 1990 are also higher than for January 1990 by 5.8 percent, reflecting an increase in volume as well as price stabilization that has occurred over the past three months. Dataquest believes that the positive semiconductor business generated in the first four months of this year and the upbeat six-month system sales outlook (see SUIS newsletter number 1990-19, entitled "Bookings and Lead Times Dip, Inventories Remain Unchanged"), will keep the book-to-bill ratio positive through the next four months.

MARCH COMPUTER BOOKINGS AND BILLINGS BALANCED, INVENTORIES DIP

Figure 2 illustrates that both booking and billing 12/12 rates of change for computers in March balanced out at 4.0 percent and 4.1 percent, respectively. The 3/12 bookings rate of 6.8 percent points out that recent bookings continue to outpace annualized rates and indicates continued growth. In addition, system inventory levels relative to last year have fallen, ensuring that replenishments also will stimulate semiconductor order levels. As just-in-time (JIT) philosophies permeate the industry, some of this inventory reduction may become permanent, however. As mentioned last month, these data continue to corroborate our *Procurement Pulse* findings of purchasing managers' positive system sales outlooks. Indicators continue to point to gradual improvements for near-term system and semiconductor markets.

SEMICONDUCTOR INVENTORIES ALSO STABILIZE

The gap between target and actual semiconductor inventories remained the same as last month because of unchanged aggregate levels this month (see Figure 3). The continued emphasis on cost control is forcing inventory control. This management of inventory levels is dependent on good communication between suppliers and users, and the current controllable inventory level (still 12 turns/year) is evidence that good working relations pay off on the bottom line. No matter how good communication is now, users still require suppliers to continue working on delivery performance improvement to increase the inventory turns ratio.

PRICES CONTINUE TO DECLINE GRADUALLY

The combination of DRAM production controls, 32-bit MPU demand increases, and now PLD allocations has not stopped the gradual price erosion shown in Figure 4. Memory prices have continued to decline slowly despite the efforts of major Japanese manufacturers to match supplies with demand. Both DRAM and SRAM prices continue to slip as non-Japanese competitors and some second-tier manufacturers vie for market share increases. Aside from the Intel 32-bit MPU world, 8- and 16-bit microprocessors are being marketed aggressively with some 80286-12 products going for under $10! Although currently there is some lengthening of PLD lead times, supplies should soon increase to meet the unanticipated quick upturn in demand. Dataquest expects overall prices to continue to decelerate slowly or at most remain the same over the next few months. We expect some suppliers to continue trying to gain market share via price reduction in the face of relatively steady demand.

DATAQUEST CONCLUSIONS

Both users and suppliers continue to closely watch the very steady electronics market for any signs of change (either up or down) that would require changes in procurement plans. As of now, forecast information and semiconductor supplies are adequate to match a predictable, if unspectacular, electronics market. Although there is always room for improvement in the art of forecasting, those that are achieving three- to six-month forecasts as accurately as possible are consistently keeping their overall inventories and costs lower than average. Dataquest expects current tight supplies of some key devices to improve, beginning next month, in response to production decisions made last month. We believe that these increases in supply combined with accurate forecasts will continue to lower overall inventory costs.

Mark Giudici

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Research *Bulletin*

MAY PROCUREMENT PULSE: BOOKINGS AND LEAD TIMES DIP, INVENTORIES REMAIN UNCHANGED

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDER RATES DIP, YET SYSTEM SALES OUTLOOK STILL UPBEAT

Although this month's respondents expect to order approximately 24 percent fewer semiconductors in May than in April (see Figure 1), the system

Figure 1
Averaged Monthly Semiconductor Orders

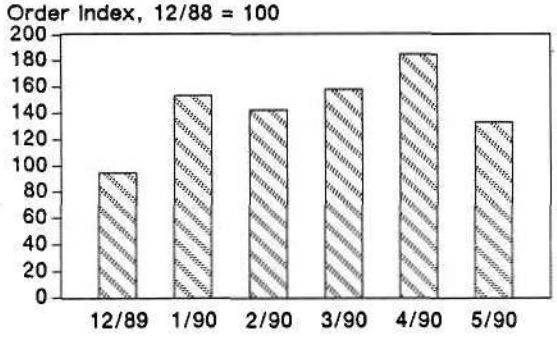


Figure 2
Averaged Semiconductor Lead Times

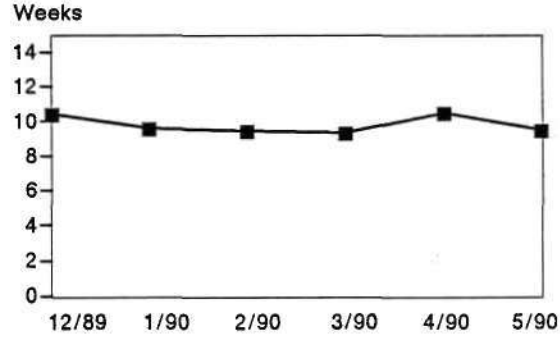


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

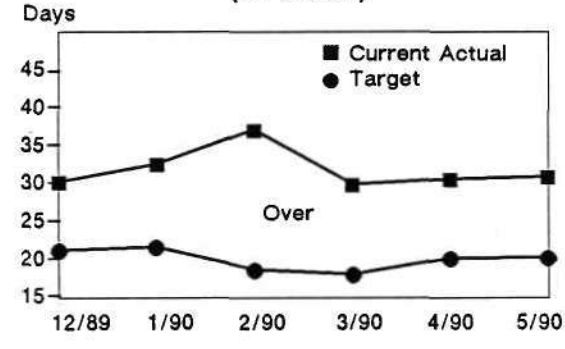
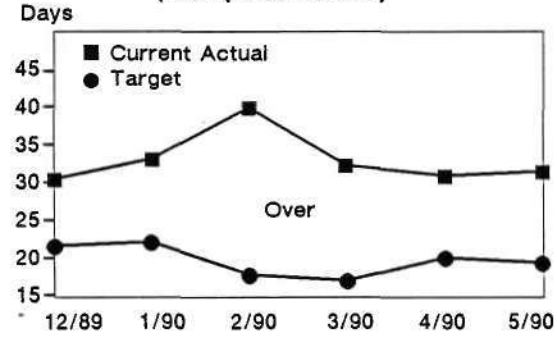


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



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Source: Dataquest
May 1990

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sales outlook for the next six months remains positive. Procurement managers' six-month system sales forecast for overall OEMs is 7.8 percent, while computer OEMs will have an 8.0 percent increase through October. In addition to the positive forecast, last month's system sales rose by 4.2 percent overall, while computer OEMs had a 6.4 percent sales increase. The continued stability in semiconductor supplies relative to consistent demand is resulting in a very manageable (on the verge of routine) procurement situation. This type of market is written about in textbooks but seldom lasts—all participants are carefully watching every indicator for any sign of change. For now, the "cautious optimism" cliché is apropos.

AVAILABILITY CURRENTLY GOOD AND GETTING BETTER: SOIC LOGIC HAS SHORTER LEAD TIMES THAN SIMILAR DIP PRODUCT!

Overall lead times continue to be a very manageable 9.6 weeks, as shown in Figure 2. Some products still have long (over 14 weeks) lead times, including Intel 32-bit MPUs, some DIP standard logic products, and, new to the list, TTL PLDs. The availability of the 386SX and -DX parts will begin to improve by mid-June as Intel's production ramp-up begins to reach the market. Standard logic surface-mount capacity appears to have met pent-up demand, yet DIP demand continues to remain steady, straining the reduced capacity of overall DIP products. The net result is that SOIC logic lead times are 2 to 4 weeks shorter than comparable DIP lead times. As the trend of user demand for SMT increases, this short-term imbalance is expected to be corrected in 4 to 10 weeks. The PLD allocation situation (with lead times as long as 20 weeks for some high-speed parts) is not due to any large increase in demand. AMD's recent sale of its San Antonio, Texas, fab to Sony and selected consolidation of some older MMI fabs has decreased some of the worldwide PLD capacity, but not to the extent of causing threefold increases in lead times. Although prices have not yet risen appreciably, we will be closely watching the developments of this situation.

INVENTORY LEVELS STABILIZE

The reductions of targeted and actual inventory levels accomplished over the past two months appear to be stabilizing in line with reduced order rates and steady system demand. As seen in Figures 3 and 4, the overall level of targeted versus actual inventories (20.3 days versus 31.0 days, respectively) and computer OEM target (19.6 days) versus actual (31.7 days) inventory levels illustrates the continued difficulty in reaching an inventory goal of less than 30 days. If DRAMs are removed from the inventory count, there is less than one day's difference to these figures in targeted versus actual inventory levels. This fact emphasizes that DRAM availability is good and continues to be well managed. Lead-time improvement and on-time delivery remain issues that need attention, according to this and last month's respondents. As these two areas improve, the chasm between actual and target inventory levels will continue to shrink.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

The continued stability of the overall systems market provides procurement managers the opportunity to manage both material costs and inventory levels because of the absence of any major "fire-fighting" problems. The user need for improved lead times and scheduled deliveries points out that although the market is running smoothly, it is not the time to become complacent. Most, if not all, indicators show ready availability of ICs through the summer and fall months. Barring any large upswing in demand, this market will allow users to cement good business relationships with their suppliers and also let superior suppliers stand out.

Mark Giudici

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Research Newsletter

SEMICONDUCTOR USERS STILL EYE THE RISKS OF SOLE-SOURCED CISC 32-BIT MPUs

SUMMARY

As discussed in prior newsletters, systems manufacturers continue to confront tough decisions about which 32-bit complex-instruction-set computing (CISC) or reduced-instruction-set computing (RISC) microprocessor(s) to use and from which manufacturer. The broad strategic decision of whether to use single- or multisourced ICs will challenge systems manufacturers throughout the 1990s. Currently, although users reported to Dataquest a rising interest in future use of RISC MPUs, systems manufacturers remain largely committed to 32-bit CISC devices. Table 1 shows that using single-sourced 32-bit CISC MPUs carries a special set of risk/benefit trade-offs—as illustrated by the recent stunning legal ruling on the 68030 microprocessor.

OVERVIEW

This newsletter is based on the information presented in Table 1, with focus on the risks associated with the use of single-sourced ICs—specifically, CISC 32-bit MPUs—and recommendations to users for reducing risk exposure. Table 1 centers on two critical user issues: competitive component/system pricing and global availability of single-sourced ICs. Dataquest will provide a user perspective on the emerging RISC technology in a future newsletter.

STRATEGIC IC PRICING RISKS

As shown in Table 1, users typically pay higher prices for single-sourced ICs such as CISC 32-bit MPUs than for components that are available

TABLE 1
A User View of Single-Sourced CISC 32-Bit Microprocessors

Prospective Benefits for Users	Possible Risks for Users
Enhanced system value and competitiveness by use of proprietary technology	Higher IC ASPs (versus second-sourced 32-bit MPUs)
Protection against shortages through long-term contracts	Inconsistent world regional IC supply, quality, and pricing
More accurate production forecasts per close user/supplier relationships	Periodic allocations to users in times of product scarcity
Clear system/technology road map	Inability to meet system production and life cycle plans
Improved supply/pricing of ICs used along with the 32-bit MPU	Legal uncertainty associated with patent enforcement and other claims

Source: Dataquest
May 1990

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from multiple sources. In addition, all component buyers, whether of single- or multisourced ICs, confront other pricing/availability risks: inconsistent IC pricing, supply, and quality among the different world regions.

Higher IC ASPs

Although the use of sole-sourced ICs in systems typically means higher IC pricing vis-à-vis multisourced devices, the use of these higher-priced components *can* translate into enhanced system performance and profitability. Users of sole-sourced ICs must realize, however, that the long-term pricing trend for these higher-priced devices is likely to be different than the historical pattern.

IC Life Cycle Pricing

Historically, semiconductor users have grown accustomed to rapid attrition in IC pricing during the early (or forward) stages of the IC life cycle, especially for multisourced devices such as standard logic or memory products. This pattern of semiconductor pricing is called life cycle or forward pricing.

Users of sole-sourced 32-bit CISC devices should expect a somewhat different pricing structure. The huge expense (e.g., R&D, fab construction, legal protection) of producing these complex chips motivates suppliers of 32-bit MPUs to resist stiff price declines during the early years of the IC's life cycle. Pricing for these devices typically declines between 5 and 9 percent per quarter during the growth stage. By contrast, pricing for multisourced devices often declines at a quarterly rate of between 10 and 30 percent during the forward stages.

Depending on the CISC 32-bit MPU supplier, product pricing *for major buyers* should either stabilize or continue to decline moderately during the later years of the life cycle. When pricing stabilizes, a higher-speed product typically costs no more than a lower-speed version for long-term customers (i.e., 16-MHz and 20-MHz price parity).

WORLD REGIONAL SUPPLY RISKS

Inconsistent IC pricing among different world regions relates directly to global supply/demand trends. For systems manufacturers that develop coordinated international procurement/manufacturing/marketing plans, management of world regional IC supply/pricing trends should become a central concern. Over the long term, some *suppliers* might be able to sell ICs at uniform prices worldwide, but that remains a future goal.

For users of CISC 32-bit MPUs, global pricing management requires, at a minimum, that users monitor suppliers' worldwide manufacturing capabilities, preferably taking an active role in shaping the global fab plans of the sole-sourced supplier. This strategy can help reduce the likelihood of another risk associated with use of single-sourced products: periodic allocations to users in times of product scarcity, as is now occurring for users of Intel's 80386/80386SX devices. Depending on supply/demand trends, a product can be on allocation in one or more world regions but be more readily available in other areas.

The 32-Bit CISC MPU Global Fab Networks of Intel and Motorola

Table 2 weighs the global manufacturing strengths of Intel and Motorola regarding production of 32-bit CISC devices. These components include Intel's 80386, 80386SX, and 80486 products and Motorola's 68020, 68030, and 68040 devices.

Manufacturing by World Region

Table 2 reveals that Motorola and Intel are well positioned to serve long-term North American demand. Motorola's United Kingdom fab puts suppliers in a good position to supply European users. Intel currently supplies European users of 80386 partly with products from the Israel fab. The approach of 1992 could mean expanded capacity for that region.

Table 2 also shows that users in Japan and Rest of World (ROW) know firsthand of the challenges involved in globally sourcing single-sourced ICs. Motorola's alliance and joint-fab arrangement with Toshiba should enable Motorola to serve the Japan market effectively over the long term.

The Risk of Allocation

Nevertheless, unexpectedly strong market demand can overwhelm the ability of the formidable single-source suppliers to meet all user

TABLE 2
32-Bit CISC MPU Worldwide Manufacturing Capability—Intel and Motorola (as of May 1990)

	Motorola 32-Bit CISC MPUs[1]	Regional Total	Intel 32-Bit CISC MPUs[1]	Regional Total
		Number of Fabs by World Region		
North America	2	4	3	7
Europe	1	3	1[3]	1[3]
Japan	1[2]	1[2]	0	0
ROW	0	0	0	0
Total number	4	8	4	8
		Square Feet of Clean Room by World Region		
North America	76,900	91,800	72,000	182,000
Europe	34,000	94,600	24,000[3]	24,000[3]
Japan	0	23,800[2]	0	0
ROW	0	0	0	0
Total	110,900	210,200	96,000	206,000

[1]Intel and Motorola fabs largely dedicated to 32-bit CISC MPUs
[2]Joint Motorola/Toshiba facility
[3]Israel

Source: Dataquest May 1990

needs, as is now occurring with Intel's 80386/80386SX products. SUIS clients that forged long-term contracts with Intel for these products report little interruption of supply, unlike buyers that operate on the spot markets.

At the time of this writing, Dataquest had been informed that the supply/demand imbalance is not expected to improve in North America and Europe until the second or third quarter of 1990. The imbalance in Japan and ROW also should not improve until the third or fourth quarter of this year.

LEGAL RISKS

Users of 32-bit CISC MPUs must be ready to confront another risk: potential legal uncertainty surrounding the validity of sole suppliers' patents and other intellectual property. For example, an invalid patent ultimately vitiates the benefits presented as rationales for using sole-source devices. As shown in Table 1, these benefits include enhanced system value through use of proprietary MPU technology and clear long-term system/technology road maps.

68030 Litigation

The stunning decision in the Hitachi/Motorola case concerning microprocessor (and microcontroller) patent infringement claims shocked users of the 68030 microprocessor. Regarding the CISC 32-bit MPU arena, the case could have severe and unanticipated consequences for Motorola and users of this device.

Setback for Users?

Users continue to receive shipments of 68030 products from Motorola during the second quarter of 1990. In late June 1990, barring a prior settlement, Hitachi and Motorola will return to court. A major issue is whether or not Motorola should be allowed to continue shipments during the lengthy appellate process. If not (again, barring a settlement), users will experience major disruption of 1990 system production plans and long-term uncertainty regarding their systems life cycles and technology road maps.

A Fairly Speedy Settlement?

Dataquest believes that both Hitachi and Motorola have good reasons for seeking a resolution to their litigation. In Motorola's case, the threat of injunction hangs over a product that Dataquest believes garnered revenue in the $120 million to $150 million range in 1989. As noted, of greater long-term significance is the fact that stopping the flow of 68030s represents a serious hardship to Motorola's customers. Succinctly, major users are dependent on the 68030 as the sole-source heart of significant portions of their systems sales.

Hitachi also is motivated to come to terms. Although U.S. sales of its H8 product may not be as monetarily significant as the 68030, sales of the H8 in Japan would be jeopardized if the final destination of domestic equipment was the United States. As has been demonstrated by Intel and Texas Instruments, invoking the powers of the International Trade Commission (ITC) in defense of one's intellectual property can empower customs to seize imports of equipment containing an offending product. Consequently, many of Hitachi's customers also probably want a hasty resolution of the issue.

Given the stakes involved for both Hitachi and Motorola, Dataquest anticipates a fairly speedy settlement and an end to the jitters felt by 68030 customers. The settlement may cost Motorola the millions of dollars it might have hoped to gain from Hitachi when it first pressed its lawsuit more than one year ago. Nevertheless, the current bottom line is that users of the sole-sourced 68030 remain waiting for a legal resolution that could occur as soon as tomorrow or not for several years.

A User Eye on Unresolved Legal Issues

Dataquest strongly recommends that users carefully monitor legal developments associated with *all* sole-sourced ICs—not only the 68030 MPU, but also 80386/80386SX products and application-specific ICs (ASICs).

Regarding the 68030 litigation, the resolution of the following issues could have a forceful impact on users' 1990 production schedules and long-term technology road maps:

- If Hitachi and Motorola do not settle the litigation, how long will users have to wait before the case is resolved?
- Would a cross-license deal, as part of a settlement, imply access to selected technologies or outright second-sourcing of the 68030?
- Is Hitachi at all interested in producing the 68030?
- If the 68030 were to be second-sourced to Hitachi, how would this affect Motorola's agreement with Toshiba, with which it has a DRAM/microprocessor joint venture?
- Will pricing for 68030 products be higher than originally expected (e.g., pass-on of Motorola's royalty payments), unaffected, or lower (i.e., Hitachi as second source)?

More Legal Shocks for Users of Sole-Sourced 32-Bit MPUs?

Dataquest will be tracking the 68030 case with an eye on these issues. As noted in previous newsletters, the recent events surrounding the 68030 product augur future shocks for supply-base managers at systems companies that use single-sourced CISC 32-bit MPUs. For example, users of 80386 devices must monitor the arbitration case between AMD and Intel over 80286 products. AMD claims a right to produce *80386* devices. Should AMD win that argument—as stunning as the scenario seems—AMD might emerge as a supplier of 80386 products. The unresolved issues surrounding the 68030 litigation could become for users—with some modification—the unresolved issues surrounding *the 80386 case*.

DATAQUEST CONCLUSIONS AND RECOMMENDATIONS

Dataquest believes that users of sole-sourced ICs such as CISC 32-bit microprocessors confront a challenging set of risks in terms of pricing, worldwide supply, and legal claims. Use of these proprietary processors can mean enhanced system value and competitiveness, provided that the risks are minimized. Generally, risks can be minimized through close user/supplier relations that include the mutual sharing of sensitive forecast information.

Specifically, Dataquest also makes the following recommendations:

- To manage pricing risks (higher prices; no life cycle pricing), users must actively monitor suppliers' R&D/capital equipment plans to make certain that these plans coordinate with users' long-term *worldwide* system production goals and technology road maps.

- To manage global supply risks, users must track their single-sourced suppliers' worldwide network of fabs *as well as* world regional demand patterns in order to gauge the periodic likelihood of limited allocation *on a world regional basis.*
- To manage legal risks, users must monitor any legal developments surrounding any single-sourced IC and require from suppliers information on any such products currently involved or likely to be involved in a legal dispute.

Ronald Bohn

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Research *Bulletin*

APRIL MARKET WATCH: DEMAND PICKS UP WHILE OVERALL SUPPLIES CURRENTLY KEEP UP WITH THE PACE

Market Watch is a monthly Dataquest bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL JUMPS HIGHER THAN EXPECTED

The March book-to-bill ratio jumped up to 1.09 (see Figure 1), which reflects a combination of quarter-end business and price firming in memories

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

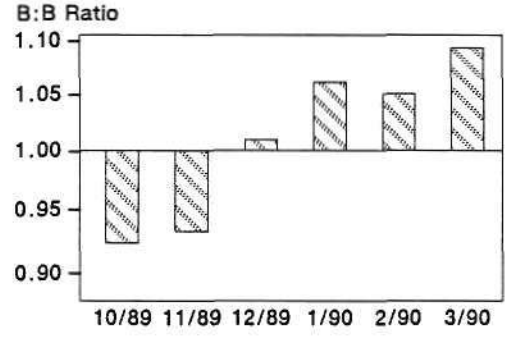


Figure 2
DOC Computer Demand

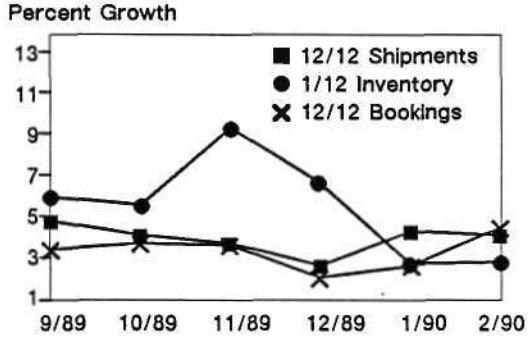


Figure 3
Semiconductor Inventory Level

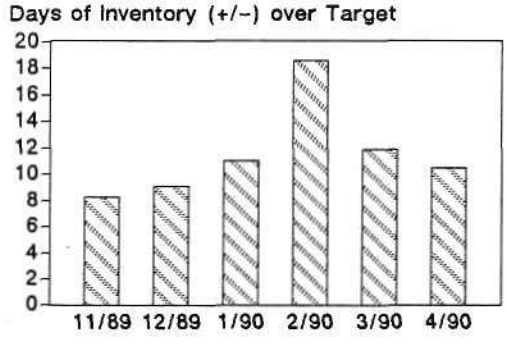
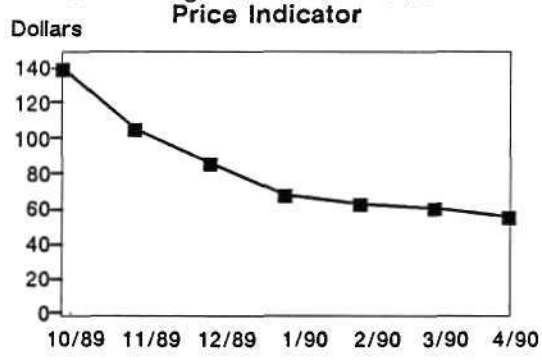


Figure 4
U.S. Weighted Semiconductor Price Indicator



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Source: U.S. Department of Commerce
World Semiconductor Trade Statistics
Dataquest
April 1990

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as mentioned last month. March 1990's bookings (3.2 percent) and billings (5.9 percent) show an upturn relative to the last five-week month, which was December 1989. However, compared with one year ago (March 1989), bookings are up only 0.2 percent and billings are down 5.3 percent. Prices for many product families (e.g., some volatile memories, standard logic, 32-bit microprocessors) continue to stabilize, a fact that is contributing to the higher bookings level in dollars, yet the volume in units remains fairly flat. Because of the three- to four-month delay in any market effect based on any supply changes made now, Dataquest expects the book-to-bill to continue to remain positive for the upcoming three- to six-month time frame.

FEBRUARY COMPUTER DEMAND AND INVENTORY STABILIZE WHILE BOOKINGS PICK UP

As shown in Figure 2, the latest DOC computer shipment and inventory rates have remained flat relative to last month, while the annualized bookings rate has risen slightly. These data correlate with the Dataquest *Procurement Pulse* surveys that also have shown optimism in the computer shipment outlook. What is *important to note here is that the bookings rate (4.6 percent) finally has risen above the shipments rate (4.2 percent) for the first time since April 1988!* The last time the 12/12 bookings curve crossed over the 12/12 billings curve was in January 1987, when it continued to pull shipment rates up for the next 21 months. The gradual and steady nature of the 12/12 rate analysis ensures that overall computer business will improve; the question is, for how long? At this point, Dataquest does not foresee any large help or hindrance that would alter this gradual, positive trend for the remainder of 1990.

SEMICONDUCTOR INVENTORIES FALL FURTHER

The gap between target and actual semiconductor inventory levels again has declined, as shown in Figure 3. Besides the target/actual variance reduction, the absolute levels for both have remained relatively static. With inventory at low and controllable levels (12 turns per year), the communications between semiconductor suppliers and users that are necessary to maintain this momentum are being made. Continued emphasis on cost control will keep pressure on inventory levels even as systems business picks up.

PRICE REDUCTIONS CONTINUE AT A S-L-O-W-E-R RATE

Figure 4 shows the continued reduction in overall price based on our biweekly survey in *The DQ Monday Report*. To better reflect changes in market demand, Dataquest changes this report's product mix on a periodic basis. This month's price curve reflects the updated product mix of historical pricing for the existing *DQ Monday Report* product mix. Because of the relatively flat pricing for 32-bit MPUs, DRAMs, and standard logic, the overall price decline curve has flattened and, as mentioned last month, will continue to remain flat due to production corrections for these product families that were implemented in the first quarter of this year. As demand picks up in the equipment arena, suppliers will want clear signs that it is sustainable. Some suppliers will continue to take advantage of the current price stability by trying to gain market share via price cuts. We forecast continued price stabilization through June, but aggressive suppliers will keep the price reduction train on track thereafter.

DATAQUEST CONCLUSIONS

The unspectacular yet positive market dynamics train that currently is keeping bookings, shipments, and inventory levels manageable continues to roll along. Demand for computers and systems in general appears to be rising slowly relative to the past, and component supplies currently are managing to meet this recent uptick. Barring any overt market control scheme (either government or consortia devised), suppliers of critical semiconductors will manage to meet demand once the average three-month fabrication cycle begins. A very competitive market still exists for key semiconductors, and the suppliers involved in no way want their constraints to benefit their competitors. The combination of a competitive market and users continuing to provide constant, accurate six-month rolling forecasts will allow strategically astute suppliers to meet this demand and grow with the end markets.

Mark Giudici

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Research *Bulletin*

APRIL PROCUREMENT PULSE: BOOKINGS AND LEAD TIMES RISE, WHILE INVENTORIES TUMBLE

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDER RATES ACCELERATE WHILE SALES OUTLOOK REMAINS ROSY

This month's survey respondents expect to book an average of 17 percent more semiconductors this month over last month because past forecasts in system sales have turned into orders

Figure 1
Averaged Monthly Semiconductor Orders

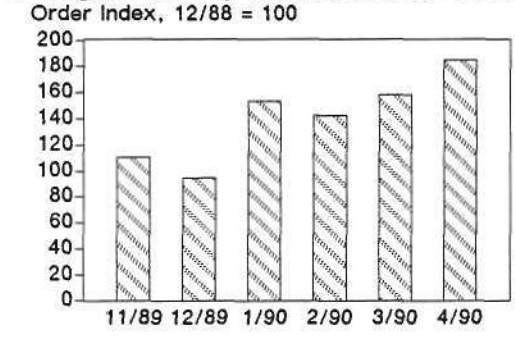


Figure 2
Averaged Semiconductor Lead Times

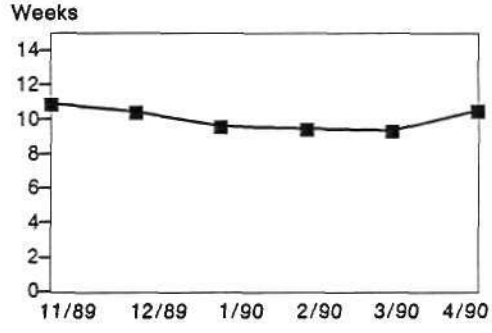


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

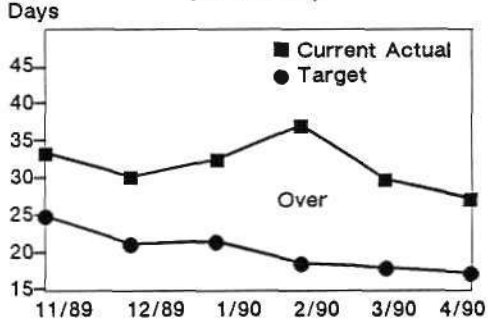
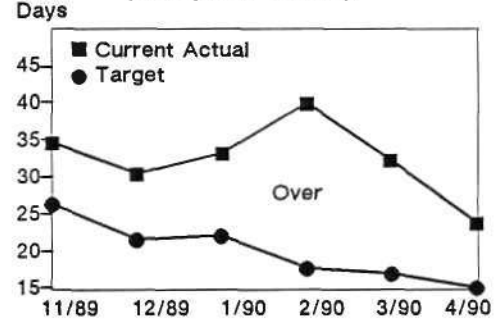


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



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Source: Dataquest
April 1990

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that are now being built and shipped. As seen in Figure 1, the semiconductor booking rate of the past three months has been relatively steady yet higher than the previous three months. Coinciding with this procurement activity is an overall system sales forecast that continued to rise from 6.0 percent in January to the 9.1 percent recorded this month. The outlook for computer OEMs is brighter than last month, with expected sales of 8.9 percent over the next six months compared with a similar outlook of 7.4 percent that was taken in our last survey. The overall market dynamics that provide stability from which consistent, predictable procurement plans can be implemented are in place.

OVERALL AVAILABILITY REMAINS MANAGEABLE; SOIC LOGIC AND 32-BIT MPU SUPPLIES STILL TIGHT

Figure 2 shows a slight uptick in lead times over last month's level (10.6 weeks versus 9.5 weeks). This upturn was mainly due to the continued shortage of SMT standard logic devices, Intel 32-bit microprocessors, and, to a lesser extent, some high-speed DRAM products. Customers under contract note little or no impact to increased lead times that now are affecting the spot market. Improvement in the supply of SMT logic has taken awhile but is expected to occur by midyear. Intel expects to increase shipments of the 386SX and DX parts by midyear to meet pent-up demand. The reason given for delaying increased supplies (e.g., expenditure) has been to see whether or not demand for SOIC logic would be sustained. Dataquest believes that the Motorola-Hitachi patent snafu that temporarily sent shock waves through the 68030 user base will be quickly resolved out of court. Supplies for these critical parts should not be hampered by legalities.

BOTH TARGET AND ACTUAL INVENTORY LEVELS ARE REDUCED

In light of stable system demand and overall reliable supplies of semiconductors, users have lowered both targeted and actual levels of inventories this month relative to last month's poll (overall levels are 17.4 versus 27.4 days, and computer OEM levels are 15.3 versus 24.1 days, respectively). If DRAMs are taken out of the inventory equation, inventory targets and actuals turn out to be overall at 16.7 and 24.2 days and computer OEMs at 14.6 and 20.3 days, respectively. This fact emphasizes that DRAM inventories are healthy, and shortage fears are unfounded. As seen in Figures 3 and 4, there has been a steady improvement in inventory control over the past six months if February's results are disregarded. This progress is partly because of improved communications and implied trust between suppliers and users and the overriding issue of cost control. One of the main concerns that arose in this month's responses was the need for improvement on delivery commitments. On-time delivery, which is the number one user issue as noted in our annual procurement survey, apparently still requires additional attention by suppliers.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Dataquest believes that the perception of stability in the systems and components markets is allowing procurement managers to improve their forecasting and internal cost-control mechanisms. Implicit in this control is increased dependency on key suppliers by users that require fine-tuned deliveries that are on time. With a few isolated exceptions, overall pricing continues to decline; however, not at the pace seen in the first quarter of this year. As users shift their focus to supplier performance to keep their own costs down, suppliers must strive to maintain this level of confidence by meeting customer needs to the letter. We do not expect any major semiconductor supply disruptions in the next six to nine months, which provides an opportunity for users to hone their inventory and cost-control skills and judge their semiconductor supply base.

Mark. Giudici

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Research Newsletter

SEMICONDUCTOR PRICE SURVEY: USERS SHOCKED BY LEGAL RULING ON 68030 MPUs

SUMMARY

As shown in Table 1, the sharp downward trend in pricing for megabit-density DRAMs persisted during the first quarter of 1990. For major buyers, the rate of 1Mb DRAM price declines should be slower than during prior quarters, but pricing reductions are expected to continue during the second quarter of 1990. A *major shock* for users occurred as the first quarter ended with the ruling in the Motorola-Hitachi case on the 68030 microprocessors (MPUs). Another shock may be coming for users of sole-sourced 32-bit MPUs. Table 1 also shows that users can anticipate sharp cuts in pricing for CMOS gate arrays and cell-based ICs (CBICs).

MEMORY TRENDS

An end to plunging pricing for 256K DRAMs and 1Mb DRAMs marks a new trend in this segment of the semiconductor memory business. Pricing for slow SRAMs and EPROMs should be aggressive during the first half of 1990. As noted last quarter, Dataquest expects the 4:1 unit/price crossover from the 4Mb DRAM to the 1Mb device to occur in North America during the first quarter of 1991.

TABLE 1
Semiconductor Pricing and Lead Time Trends

	Pricing Trend		Lead Times	
Part	First Quarter	Forecast	Current	Trend
1Mbx1 100ns DRAM, DIP/SOJ	28% down	10% down	4 to 12 weeks	1 week longer
4Mbx1 100ns DRAM, DIP	44% down	24% down	6 to 20 weeks	Steady
1Mbx8 100ns SIMM	34% down	13% down	3 to 10 weeks	Steady
32-Bit MPUs/Peripherals	1 to 10% down	0 to 10% down	5 to 9 weeks	1 week shorter
74AC	1 to 3% down	1 to 3% down	8 to 10 weeks	Steady
CMOS 1.5um Gate Arrays	1 to 4% down	Flat to 4% down	(Production) 9 to 14 weeks	Steady
CMOS and TTL PLDs, ≤ 20 pins	3 to 11% down	2 to 7% down	TTL: 3 to 14 weeks CMOS: 4 to 12 weeks	1 week more Steady

Source: Dataquest
April 1990

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SUIS Newsletters 1990: April-June 1990-15

Dataquest Incorporated, 1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

DRAMs

Some Price Stabilization in the DRAM Arena

As shown in Table 1 and Figure 1, large-volume contract buyers in North America can expect pricing for 1Mbx1 100ns DRAMs to decline by 10 percent during the second quarter, following a 28 percent drop in the first quarter of 1990. The moderate price decline of this quarter should bring the 1Mb DRAM price to $6.55. Pricing for 256Kx1 100ns DRAMs should decline by 5 percent during the second quarter. As the supplier base shifts, pricing for 256K DRAMs should approach the $2 level in this quarter.

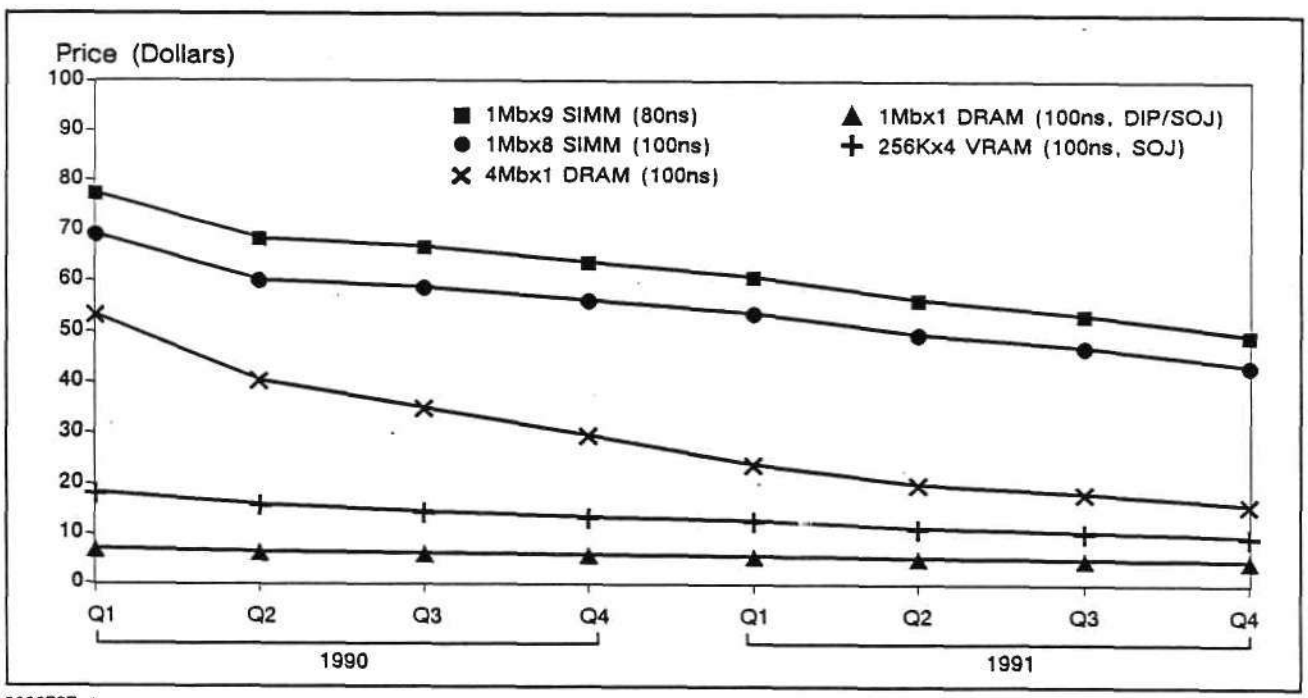
By contrast, as reflected in Table 1 and Figure 1, pricing for next-generation 4Mbx1 100ns DRAMs continues to decline at a relatively rapid rate: a 24 percent decline during the second quarter of this year versus a 44 percent drop in the first quarter. Users can expect pricing for the 4Mbx1 product to decline to $40.48 in the second quarter.

The Full Range of DRAM Pricing

As noted last quarter, survey confidentiality limits disclosure of exact pricing points; however, the survey responses capture the dynamics behind Dataquest's forecast numbers. For example, Dataquest bases the forecast second quarter price of $6.55 for 1Mbx1 100ns DRAMs on survey prices that range from a low of less than $6.50 to a high of nearly $7.60. One-half of survey participants expect a price in the $6.35 to $6.60 range. Similarly, the forecast second quarter price of $40.48 for 4Mbx1 DRAMs is based on survey prices that range from a low of slightly less than $40 to a high of nearly $50. Most respondents—suppliers as well as users—foresee a second quarter price of $45 *or less* for this device.

Users recently have expressed concern to Dataquest regarding the supply and pricing for 256K DRAMs. Survey responses reflect the shifts in this changing marketplace, which is marked by the departure of a few familiar suppliers *and the entry* of some newer firms. For example, the forecast second-quarter price of $2.05 is based on survey prices that range from a low of almost $1.50 to a high of nearly $3.00. Nevertheless, most

FIGURE 1
DRAM Price Trends (North American Bookings)
(Volume: 100,000 Units)



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Source: Dataquest
April 1990

survey respondents reported pricing close to the forecast price of $2.05.

New Direction to 1Mb DRAM Pricing?

In March, 1Mb DRAM prices stabilized somewhat following recent cutbacks in production by some suppliers. Dataquest has received some reports of an upturn in pricing in the spot market. Nevertheless, for large-volume contract buyers, pricing should continue to decline during the second quarter of 1990, although at a slower rate than in prior quarters.

Dataquest strongly recommends that North American and European buyers *avoid* panic buying (and associated stockpiling) of 1Mb DRAMs on the spot markets and instead continue to purchase on the basis of long-term volume contracts with established suppliers.

SIMMs: An Expanding User/ Supplier Base

Both users and suppliers express great interest to Dataquest regarding this segment of the memory market. Supply/pricing trends for single in-line memory modules (SIMMs) link to DRAM market developments. For example, when 1Mb DRAM pricing plunged during late 1989 and early 1990, pricing for 1Mbx8 and 1Mbx9 SIMMs fell precipitously. As shown in Table 1, pricing for SIMMs declined 34 percent and 37 percent during the first quarter. Adding fuel to the pricing decline is the recent expansion of the SIMM supplier base.

Dataquest anticipates that second-quarter 1990 price declines will be slightly steeper than declines in standard DRAM pricing. Pricing for 1Mbx8 100ns SIMMs should decline by 13 percent from the first-quarter level of $69.50 to a second-quarter price of $60.26. The price of 1Mbx9 85ns SIMMs is expected to decline by 12 percent, from $77.62 in the first quarter to $68.52 in the second quarter. The price of 256Kx9 100ns SIMMs should decrease by 13 percent during the second quarter to $19.60 versus $22.50 in the first quarter. Pricing for 256Kx36 85ns SIMMs should erode more slowly—a 5 percent decline from $93.42 in the first quarter to $88.20 in the second quarter—because of a narrower supplier base than other SIMMs.

SRAMs

Slow SRAMs: DRAM-Related Pricing Declines during 1990

Cutbacks in DRAM capacity *can* mean increased supply of slow SRAMs (allowing several months lag for fab conversion). For example, pricing for 32Kx8 100ns SRAMs fell 20 percent during the first quarter, following capacity shifts from 1Mb DRAMs to 256K SRAMs in the second half of 1989. The price for the 256K slow SRAM should decline by 10 percent from $6.90 in the first quarter to $6.23 in the second quarter.

Buyer Advisory on 1Mb Slow SRAMs

Clear links exist between the supply and demand for 4Mb DRAMs and for 1Mb slow SRAMs. Users must be aware that strong demand for 4Mb DRAMs during 1990—which has not yet materialized—would reduce capacity for 1Mb slow SRAMs and stabilize pricing later this year. By contrast, weak demand for 4Mb DRAMs during 1990 would mean increased supply of 1Mb slow SRAMs and lower pricing. Current and prospective users of 128Kx8 100ns SRAMs must monitor 4Mb DRAM market trends for indications of impacts on 1Mb slow SRAM supply/pricing.

Users of the 128Kx8 100ns device can look forward to a steady drop in price under current market conditions. Users can anticipate a 15 percent decline during the second quarter to a price of $43.

EPROM: Aggressive Pricing Trends

Prices of higher-density EPROMs should decline sharply during the first half of 1990 because of increased supplier competition. For example, Dataquest expects the price for 32Kx8 EPROMs to fall to less than $2 during the second quarter, a 12 percent decline from last quarter. Pricing for the 128Kx8 product plummeted by 22 percent during the first quarter and should decline 6 percent during the second quarter to $7.48. As forecast, pricing for the 64Kx8 product broke the $4 barrier during the first quarter of 1990. Under current aggressive pricing conditions, the price should decline by 15 percent during the second quarter and approach (or break) the $3 level.

MICROPROCESSOR TRENDS

During the first quarter of 1990, some users were shocked by the limited allocation of 80386SX and 80386 devices from Intel, which is currently the sole source. Under current market conditions of 80386SX/80386 allocation, pricing for the 80386SX 16-MHz part should be stable during the second quarter; however, pricing for the 10-MHz and 12-MHz 80286 products should continue to decline sharply as suppliers try to cut into unsatisfied demand for the 80386SX component.

Another Shock for Users of Sole-Sourced 32-Bit MPUs

At the beginning of the second quarter, users were shocked by the legal ruling that Motorola's sale of 68030 MPUs infringes on patents held by Hitachi. Motorola is the current sole source of the 68030 products. A subsequent injunction permits Motorola to ship this critical device as the case moves through the federal appellate courts. As noted in prior forecasts, the recent supply-base shocks illustrate that the use of single-sourced ICs such as the 68030 and 80386 MPUs involves a risky set of system/component performance/profitability/availability trade-offs.

At the time of this writing, Dataquest had not yet assessed the impact of 68030 ruling on 68030 product pricing. With shipments by Motorola continuing, the pricing outlook for the second quarter of 1990 should remain in accord with original expectations, but pricing could change quickly depending on legal events. For example, Dataquest expects pricing for the 16-MHz 68030 during the second quarter to decline by nearly 10 percent to $140.94. This pricing scenario stems partly from the fact that 68030 products generally are at an earlier stage of the life cycle than other 32-bit devices (e.g., the 68020). Similarly, Dataquest expects the price of the 68030 25-MHz device to decline by 6 percent during the second quarter to $198.32. This product is now moving through the growth stage of its life cycle.

More Shocks for Users of Sole-Sourced 32-Bit MPUs?

The stunning events surrounding the 68030 product augur future shocks for supply-base managers at systems companies that use this component and other single-sourced MPUs. Motorola could win on appeal. If not, Motorola and Hitachi could settle. If so, pricing is likely to be higher (as Motorola passes along to customers the cost of settlement) or Hitachi might emerge as a supplier. Another scenario is that Hitachi could win on appeal and possibly emerge as the sole source.

Users of the 80386 devices should be aware that an important element of the arbitration case between AMD and Intel over 80286 products concerns AMD's alleged right to produce *80386* devices. As amazing as it seems, if AMD wins that argument, it might emerge as a supplier of 80386 products.

STANDARD LOGIC TRENDS

As shown in Figure 2 and Table 1, suppliers are making a market move to newer CMOS families such as the 74AC and will lower prices for these products in the process. Regarding bipolar families, suppliers continue to evaluate carefully which mature or declining families (e.g., S, LS, ALS) they will deemphasize because of narrow profit margins.

Recommendation

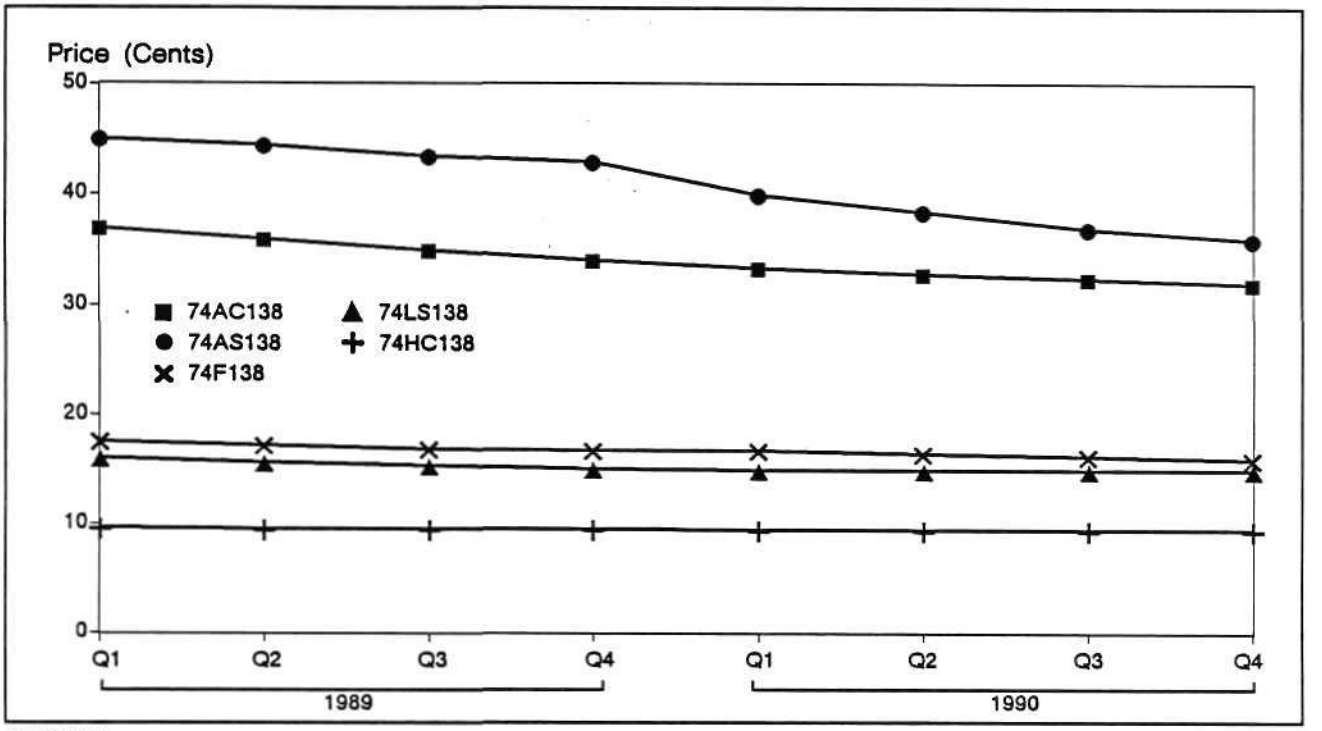
Dataquest restates its recommendation that users of mature standard logic—especially lower-density versions of the HC, LS, and ALS families—plan now to migrate from these products to a younger logic family such as 74AC or to ASICs. In line with that recommendation, we will look at the pricing war that appears to be developing among suppliers of CMOS gate arrays and CMOS CBICs—and the response by manufacturers of CMOS standard logic and PLDs—as suppliers battle to replace bipolar logic in systems' sockets.

ASICs

As noted in prior forecasts, the ASIC supplier base has become very competitive. As shown in Figure 3 and Table 1, users can expect aggressive pricing during the second quarter of 1990 among suppliers of 1.0- and 1.5-micron CMOS gate arrays and CBICs.

For example, Table 1 shows that users of CMOS gate arrays can look forward to declines of as much as 4 percent in pricing for 1.5-micron devices during the second quarter. Similarly, the sharp downward trend in pricing for 1.0- and 1.5-micron CBICs should maintain momentum during the second quarter. Users of CBICs can anticipate declines of as much as 3.5 percent in pricing for 1.0- and 1.5-micron products.

FIGURE 2
Standard Logic Price Trends (North American Bookings)
(Volume: 100,000 Units; PDIP)



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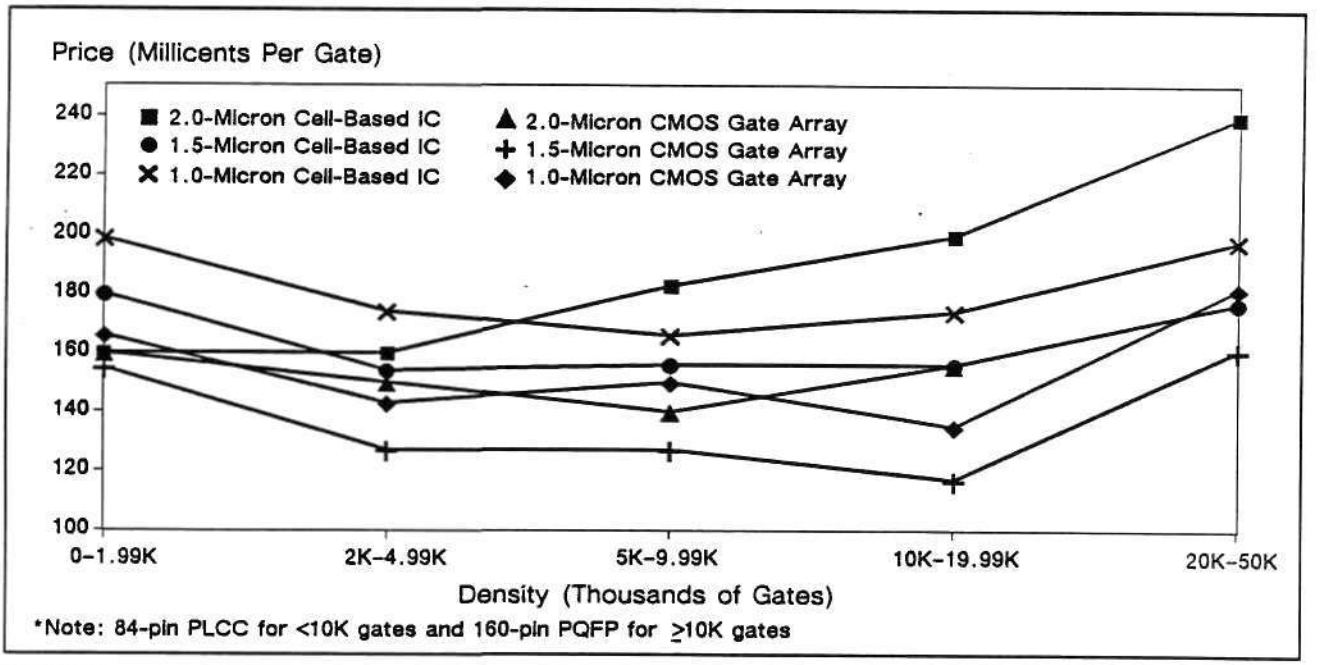
Source: Dataquest
April 1990

FIGURE 3
1990 ASIC Price Trends (North American Bookings)
(Volume: 10,000 Units; Utilized Gates; Excudes NRE)



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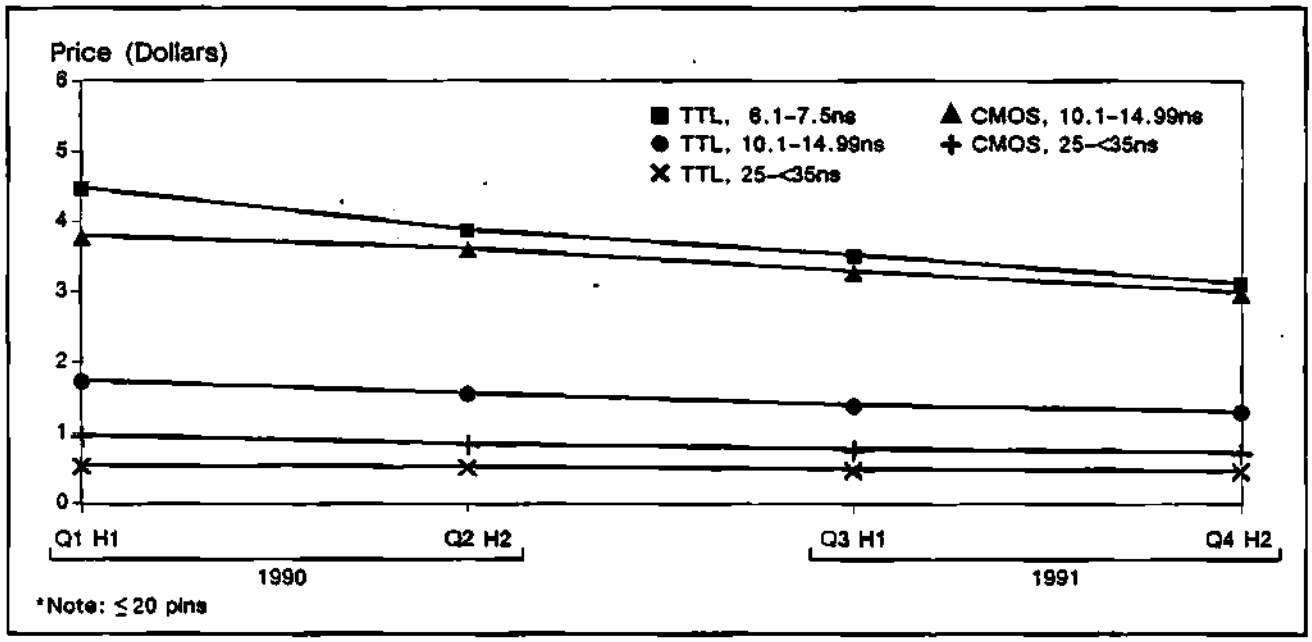
Source: Dataquest
April 1990

FIGURE 4
PLD Price Trends (North American Bookings)
(Volume: 10,000 Units; PDIP or PLCC)



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Source: Dataquest April 1990

As shown in Table 1 and Figure 2, suppliers of CMOS standard logic are striving for pricing competitiveness against the ASIC onslaught. Users can anticipate price declines of as much as 3 percent for 74AC parts during the second quarter of 1990.

PLDs

As stated in prior forecasts, users of PLDs can expect periods of accelerating and decelerating price competition during 1990. For example, at the time of this writing, several suppliers of TTL PLDs indicated more stable pricing; however, others indicated a continuation of pricing competition.

Regardless, suppliers of PLDs continue to battle against each other as well as against suppliers of standard logic and other ASICs for design wins. As shown in Table 1 and Figure 4, of 1990 users can anticipate pricing declines in the range of 2 to 9 percent for TTL PLDs during the second quarter. CMOS PLD prices are expected to decrease between 1 and 7 percent this quarter.

DATAQUEST CONCLUSIONS

The results of Dataquest's first quarter 1990 price survey show that the rate of 1Mb DRAM and 256K DRAM price declines should be slower than in previous quarters, but reductions are expected to continue during the second quarter of 1990. The ruling in the Motorola-Hitachi case on 68030 MPU patent claims shocked the entire industry. Users can anticipate aggressive pricing during the second quarter for EPROMs, slow SRAMs, CMOS gate arrays, CMOS CBICs, and competitive pricing for PLDs and newer families of CMOS standard logic. Under current conditions, Dataquest makes the following recommendations.

DATAQUEST RECOMMENDATIONS

Dataquest strongly recommends that North American and European buyers of 1Mb DRAMs and 256K DRAMs *avoid panic buying and instead continue to purchase on the basis of long-term volume contracts with established suppliers. Users in North America, Japan, and Europe should plan for the 4:1 unit/price crossover from the 4Mb DRAM to the 1Mb device to occur during early 1991.*

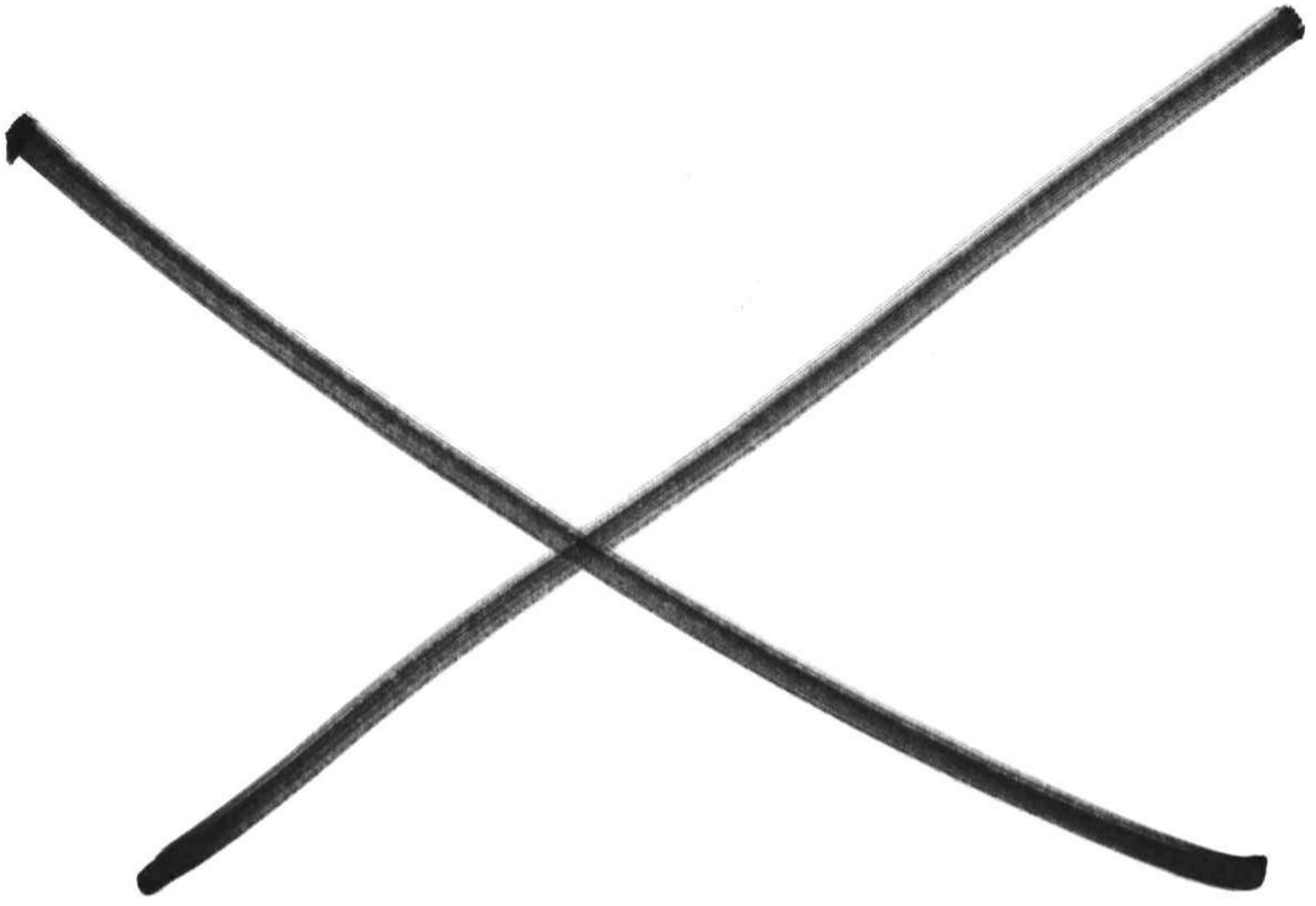
Dataquest recommends that users give careful consideration to the use of SIMMs in prototypes and as a hedge as the volatile DRAM market moves toward the crossover to 4Mb DRAMs. The SIMMs supplier base is expanding.

Users of single-sourced 32-bit MPUs must track legal developments surrounding both the 68030 products *and* the 80386 devices.

Users of 128Kx8 100ns SRAMs should monitor 4Mb DRAM market developments, which can have an impact on 1Mb slow SRAM supply and pricing.

With the stabilization of bipolar standard logic pricing, users should take advantage of pricing competition this year among suppliers of CMOS standard logic, CMOS gate arrays, CMOS CBICs, and PLDs.

Ronald Bohn



July – September Index

The following is a list of the newsletters in this index:

July – September Index

- **Systems–Demand Slowdown Sparks Sharp Drop in Worldwide 1Mb DRAM Prices** (1989–34)—An expanding 1Mb DRAM supply from a growing number of suppliers hit a midyear demand slowdown that to DRAM suppliers looks like a second–half recession. Until worldwide system production/DRAM demand patterns change, Dataquest recommends that systems manufacturers on a worldwide basis aggressively negotiate for lower 1Mb DRAM prices.

- **July Procurement Pulse: Inventories/Orders Down, Memories on a Seesaw** (1989–35)—This month's Procurement Pulse explains what inventory order rate corrections mean to both semiconductor users and manufacturers. Dataquest expects low inventory levels (especially for non–DRAMs) to continue and to cause more spot orders, or at least more orders that require deliveries within three months. It is now a buyer's market.

- **July Market Watch: MOS Memory Joins Slowdown, Turns Business Increases** (1989–36)—This month's Market Watch examines increases in June's book–to–bill despite 0.99 ratio, decreasing system demand and inventory, and plunging indicator prices. Dataquest believes that the industry will see fluctuating, rather than continuously declining, order patterns from month to month as buyers adjust their inventory mix or respond to sudden production demands.

- **Semiconductor Price Survey: MPUs and 1Mb DRAMs Lead Way in Sharp Price Break** (1989–37)—Suppliers of 16–and 32–bit microprocessors (MPUs) and 1Mbx1 DRAMs have cut pricing aggressively in response to a recent slowdown in U.S. systems shipments. This newsletter highlights the key points of Dataquest's latest North America–based price survey and forecast. Dataquest reinforces its previous recommendation that systems manufacturers negotiate for better lead times. Dataquest again recommends that users give CDICs a close look vis–à–vis gate arrays for these products along with local customizing capability.

- **The Shape of Post 1992 Distribution in Europe** (1989–38)—Today, distribution represents 28.2 percent of the European semiconductor market; by 1993, Dataquest expects this to increase to 33.1 percent. This newsletter examines the current restructuring of the European distribution network and assesses the future shape of distribution in Europe after 1992. Dataquest believes that more global distributors will emerge in 1992, with a few U.S. distributors in the European market. The most dramatic change will occur when Japan–based trading houses forge links with some of their global distributors.

July – September Index

* The number 39 (e.g., 1989–39) has been omitted.

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Research Newsletter

SEMICONDUCTOR PRICE SURVEY: NORTH AMERICA—A GLOBAL ISLAND OF HIGH DRAM PRICES DURING THE 1990s?

EXECUTIVE SUMMARY

Iraq's invasion of Kuwait changed world market conditions dramatically during the third quarter of 1990. The US economy is moving closer to recession, and most nations' economies strain under the effect of business uncertainty and rising oil prices. For users of megabit-density DRAMs, a different kind of "big news" has emerged. North American buyers of DRAMs right now face a pricing disadvantage vis-à-vis European purchasers—an apparent reversal of historic trends (see Table 1). Will this trend hold true? This newsletter focuses on the DRAM issue, but as shown in Table 1, does not ignore recent major shifts in the 32-bit MPU, SRAM, nonvolatile memory, and standard logic markets.

The pricing analysis presented in Table 1 correlates with the quarterly price tables mailed to

TABLE 1
Semiconductor Pricing and Lead Time Trends (North American Bookings)

Part	Pricing Trend: Third Quarter	Pricing Trend: Forecast	Current Lead Times	Product/Market Trends
1Mbx1 100ns DRAM, DIP/SOJ	6% down	15% down	2-10 weeks	1Mb price cuts delay 4Mb crossover until second quarter 1991
4Mbx1 100ns DRAM DIP	17% down	22% down	4-8 weeks	Price in Europe 10-15% lower than in North America
16Kx4 25ns SRAM	4% down	3% down	6-14 weeks	64K SRAM supply base contraction
128Kx8 100ns SRAM	20% down	15% down	2-10 weeks	Crossover from 256K slow SRAM likely by second quarter 1991
512Kx8 ROM CMOS, 200ns and above	12% down	15% down	4-10 weeks	Signs of pricing war
CISC and RISC 32-bit MPU	2-9% down	2-11% down	5-10 weeks *except* for 80386SX, 68040	New strategies for 80386/80486; ramp up of 68040 delayed to fourth quarter 1990
74HC	0-2% up	0-2% up	4-6 weeks	Oil-related plastic package price rise*

*Applies to all standard logic in plastic packages.
Source: Dataquest (October 1990)

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SUIS Newsletters 1990-34

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SUIS clients on September 21, 1990, and the SUIS service section entitled *Third Quarter 1990 Price Update* and dated October 1990. For SUIS clients that use the SUIS on-line service, the quarterly pricing presented herein correlates with the quarterly price tables dated September 1990 in the SUIS on-line service. For additional product coverage and more detailed product specifications, please refer to those sources.

MEMORY TRENDS

North American and European users of 1Mb DRAMs continue to enjoy aggressive pricing during the second half of 1990. The DRAM spot market has been very volatile. In fact, relentless drops in 1Mb DRAM pricing should delay the ever-impending 4:1 unit/price crossover to the 4Mb DRAM in North America and Europe until the second quarter of 1991.

The midyear 1990 oversupply of DRAM devices appears to be extending to other memory products such as high-density SRAMs, ROMs, and EPROMs.

DRAM

Megabit-Density DRAM

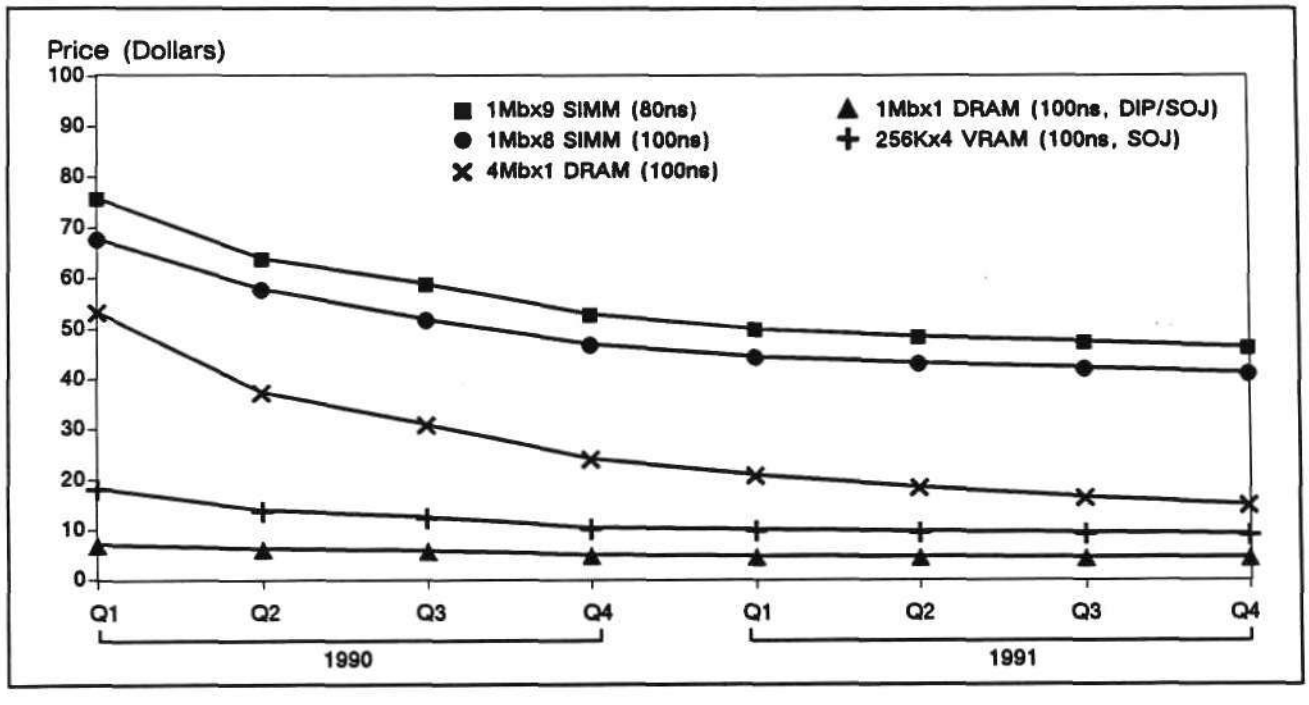
As shown in Table 1 and Figure 1, large-volume contract buyers in North America can expect a sharp decline in pricing for the 1Mbx1 100ns DRAM during the fourth quarter of 1990 and steady declines during 1991. Spot market prices for the 1Mb DRAM had fallen below $5 at the time this newsletter was written. Volume contract pricing in North America should fall by 15 percent and reach the $5 level *or below* during the fourth quarter.

North American users can expect pricing for 4Mbx1 products to decline to the $24 level during the fourth quarter of 1990, a decline of 22 percent from the third quarter price. Several suppliers continue to call for a market crossover to the 4Mb DRAM by year-end 1990; as noted, however, Dataquest expects a crossover during the second quarter of 1991.

The Range of DRAM Pricing

As noted in prior newsletters, survey confidentiality limits disclosure of exact pricing points;

FIGURE 1
DRAM Price Trends (North American Bookings) (Volume: 100,000 Units)



Source: Dataquest (October 1990)

however, the survey responses capture the dynamics behind Dataquest's forecast. For example, Dataquest bases the third quarter contract-volume price of $5.97 for the 1Mbx1 100ns DRAM on survey prices that range from a low of $5.20 to a high of nearly $6.45. The third quarter contract-volume price of $31.00 for the 4Mbx1 DRAM reflects survey prices that range from a low of $30.00 to a high of $34.00.

North America and Europe: A Reversal of Long-Term DRAM Price Trends?

At the time this newsletter was written, the contract volume price for 1Mbx1 DRAMs was 3 to 4 percent lower in Europe than North America—a reversal of a historical pattern. European users of the 4Mbx1 DRAM were enjoying an even greater advantage vis-à-vis North American purchasers—10 to 15 percent lower prices.

This recent anomaly has been the result of the Reference Pricing (RF) system, which is Europe's government-mandated system for pricing Japanese-produced DRAMs. North American semiconductor manufacturers have protected themselves against Japanese suppliers' dumping of *underpriced* ICs in North America through the foreign market value (FMV) system. By contrast, in Europe, IC buyers now press, through the European Community (EC), for protection against *higher-priced* DRAM prices from Japan-based companies via the RF system.

There is no quick answer to the immediate concern of some North American buyers: will the ebb and flow of regional pricing keep North America an island of high DRAM prices vis-à-vis Europe, Japan, and Rest of World (ROW)? The possibility now exists. Conversely, European purchasers do not desire a return to the "status quo ante" in which they paid higher prices for DRAMs than did most buyers around the globe. Government and industry negotiators from Europe, Japan, and North America have begun to confront the issue; South Korea might also formally participate. Even so, government intervention in economic markets—like the law of physics—typically causes an equal and opposite reaction *somewhere* in the marketplace.

Dataquest Recommendation on Global Procurement of DRAM

For SUIS clients that purchase on the global spot markets, Dataquest recommends weekly monitoring of worldwide 1Mb DRAM and 4Mb DRAM pricing trends through Dataquest's *On-Line DQ Monday* service. Dataquest does *not* recommend a sudden shift by North American purchasers to Europe-based procurement. Dataquest *does* reinforce prior recommendations that systems manufacturers follow the trend toward "local-market" procurement—including purchasing by North America-based companies in Europe as they make systems for local European customers *and* procurement by Europe-based companies in North America as they produce for local customers in that region.

Fast SRAM: Supplier Base Contraction

National Semiconductor, Philips-Signetics, and VLSI Technology departed the fast SRAM arena during the third quarter of 1990. Understandably, SUIS clients express concern regarding SRAM supply and supply base during 1991. Table 1 shows that users can expect some contraction of the supplier base for fast 64K SRAMs as suppliers shift to higher-density SRAMs or emphasize other ICs. At the time this article was written, the 64K fast SRAM pricing forecast, which calls for steady if not aggressive declines, was consistent.

Dataquest Recommendation on 64K Slow SRAM

Because of a likely contraction of the 64K slow SRAM supply base, Dataquest recommends that users of this device either migrate to higher-density devices or forge special long-term arrangements with suppliers to assure a steady supply of this device.

Higher-Density SRAM

Users can expect more aggressive pricing competition for SRAM in densities of 256K and above. For example, Dataquest's recent survey shows somewhat sharper declines in pricing than originally expected for 256K fast SRAMs and 128K slow SRAMs. Pricing has been competitive for 256K slow SRAMs, especially on spot markets, and contract buyers can expect continued declines in pricing during the fourth quarter of 1990. The 256K slow SRAM supply/demand scenario has been clouded by the recent market events.

A Buyer Advisory on the 1Mb Slow SRAM Crossover

As shown in Table 1, under these market conditions suppliers might shift emphasis to the

1Mb slow SRAM device (from lower density slow SRAMs) more quickly than originally expected. The 4:1 unit/price crossover to the 1Mb slow SRAM could occur as soon as the second quarter of 1991. Dataquest restates its prior advice that prospective users of 128Kx8 100ns SRAMs must monitor 4Mb DRAM market trends as a leading indicator for 1Mb slow SRAM trends and *extends* this recommendation to a similar monitoring of the 256K slow SRAM segment.

Nonvolatile Memory Price Wars?

Table 1 shows that suppliers of nonvolatile memory now face a possible price war. EPROM pricing should continue to be competitive following a pricing battle earlier this year. At the time this newsletter was written, Dataquest had not yet seen signs of a sharp downward trend in pricing for these devices; however, users are advised to monitor ROM market trends that could signal more volatile (or stable) EPROM pricing patterns.

Recent world market events in the ROM arena confirm signals garnered during *last* quarter's survey of an intensified pricing competition among suppliers of CMOS ROM with densities of 512K and greater. Current ROM market conditions are marked by weak demand from the PC and video game end markets. The supplier base has been expanding and now includes a host of competitors from Japan, North America, and Taiwan.

North American pricing for CMOS 128K ROM (150ns and greater) dropped by 17 percent during the third quarter to $2.75. Under these conditions, pricing should decrease 9 percent during the fourth quarter to $2.50. As shown in Table 1, the price for CMOS 512Kx8 ROMs (200ns and greater) declined by 12 percent during the third quarter to the $5.00 level. During the fourth quarter, pricing is expected to decline *more* sharply—by 15 percent—and reach the $4.25 level. The results of Dataquest's recent survey show a premium of approximately 20 percent for the 256Kx16 device.

MICROPROCESSOR TRENDS

Table 1 shows that North American and European users of high-speed 16- and 32-bit microprocessors (MPUs) can expect continued pricing competition among major suppliers of CISC and RISC ICs. Market demand for more mature MPUs appears to be slowing.

Increased Supply of 80386 and 80386SX MPUs

As a result of capacity expansion by Intel, users can expect shorter lead times for 80386 (6 to 8 weeks) and 80386SX (10 to 12 weeks) products. For orders of less than 5,000 units, buyers can look forward to a mild downward movement in price of the 16-MHz 80386SX to a fourth quarter 1990 level of $61.50. Pricing for 25-MHz 80386 products should decline by 5 percent during the fourth quarter to $173.00.

The plunge in 80286 pricing continues. The price of the 10-MHz 80286 device should break the the $9 barrier during the fourth quarter, and pricing for the 12-MHz 80286 is now on a path to converge with the price of the 10-MHz version during 1991.

Intel's New Product Strategy

Intel also announced a new product strategy for blunting the effort of any prospective 80386 competition, including RISC MPU suppliers. Prospective new products include a more fully integrated version of the 80386SX, which could counter chip set competitors in the laptop and hand-held PC markets. Another product is an 80486SX device targeted for PC applications that do not need floating-point capabilities. Other prongs of the strategy include a 50-MHz 80486 that is targeted against RISC IC suppliers and an 80960 RISC IC for embedded control applications.

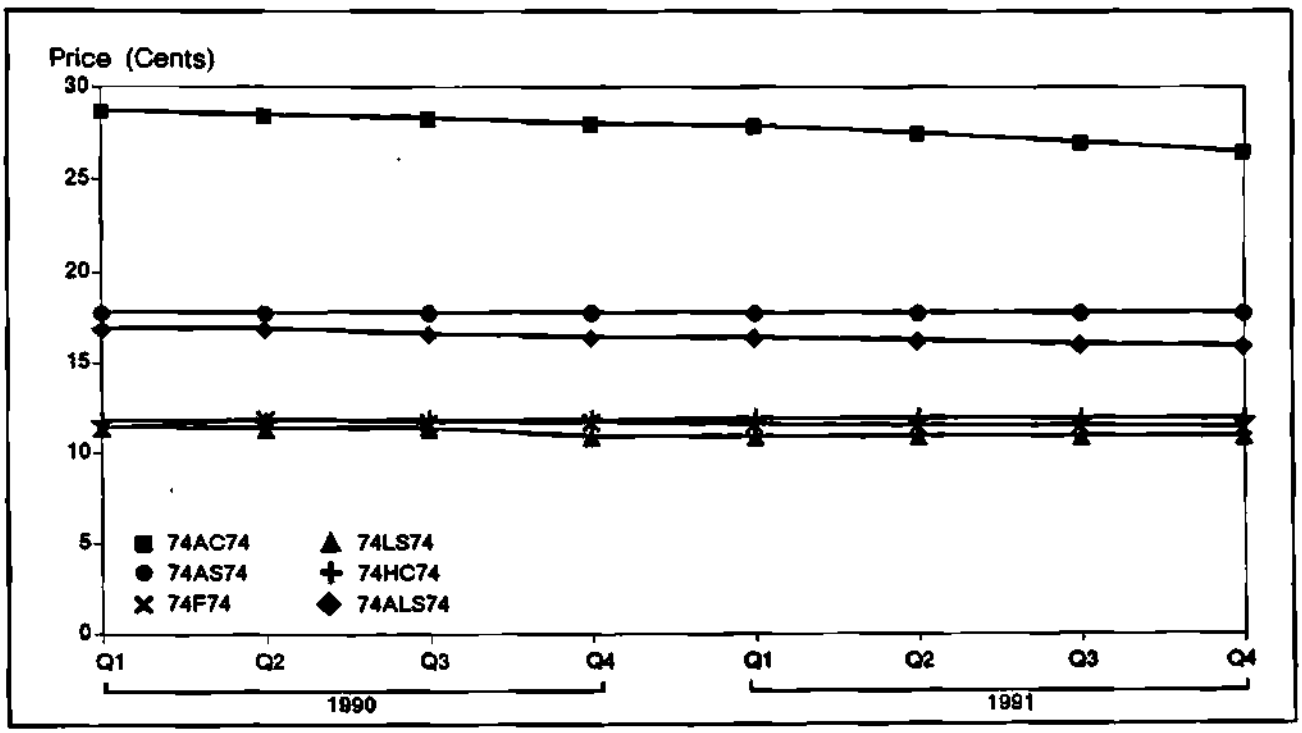
Expect Learning Curve Price Declines for 68040 and 80486 MPUs

The ramp up in output of the 25-MHz 80486 IC has begun, with the concomitant sharp drop in pricing. The scenario for the 25-MHz 68040 product should be similar as long as Motorola experiences no more delays in ramping up. For 1,000- to 5,000-unit orders, pricing for the 25-MHz 80486 should decline by 7 percent during the fourth quarter almost to the $700 level. Barring production delays during the fourth quarter, pricing for the 25-MHz 68040 device in the same volume is expected to drop by 11 percent to the $635 level.

STANDARD LOGIC TRENDS

As shown in Figure 2 and Table 1, prices for some older standard logic products are increasing;

FIGURE 2
Standard Logic Price Trends (North American Bookings)
(Volume: 100,000 Units; PDIP)



Source: Dataquest (October 1990)

however, the big news this quarter is the rising cost of plastic dual-in-line package (PDIP) because of higher oil prices.

Buyer Advisory on Rising PDIP Prices

Throughout 1990, users of standard logic have endured a series of supply/demand imbalances (i.e., availability of PDIP and surface-mount package). Dataquest advises users of products in the PDIP to expect rising prices—or at least firm pricing—unless the Middle East crisis is quickly resolved. The cost of plastic epoxy material—whether oil-based or *not*—has been increasing rapidly in synch with rising oil prices. As an alternative, users can move to either surface-mount packages or other application-specific ICs (ASICs)—in which the package represents a smaller percentage of total device cost.

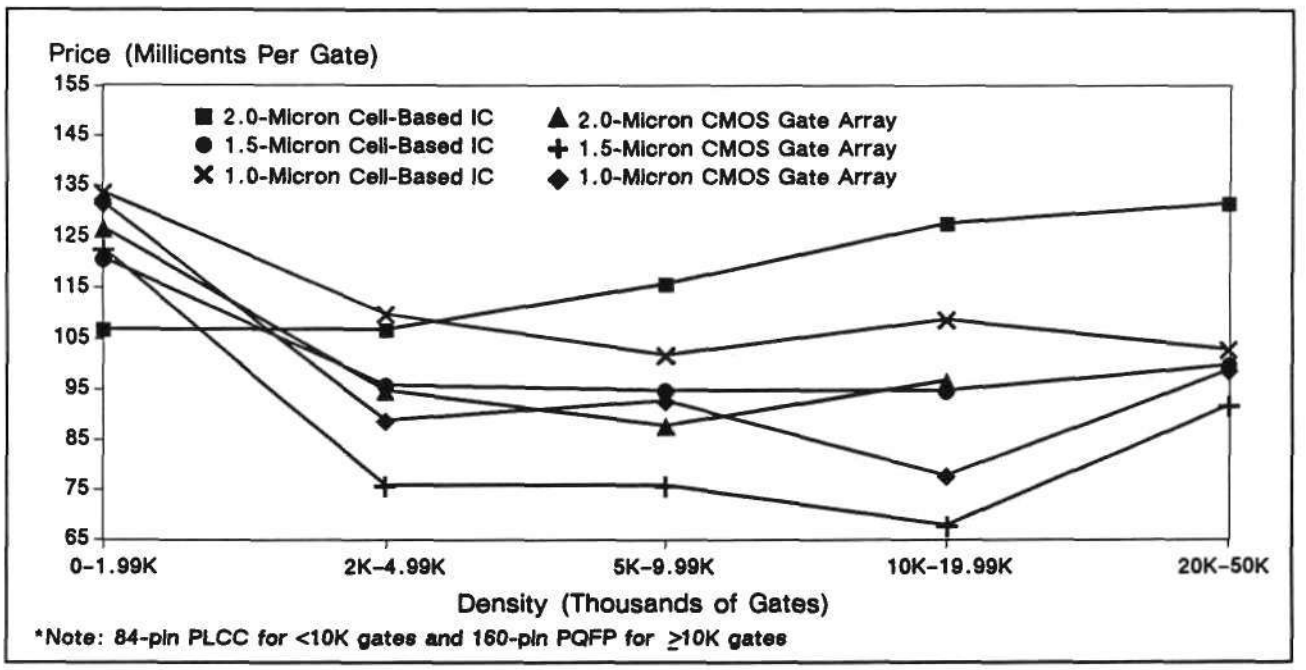
ASICs

Pricing for ASICs remains aggressively competitive, as evidenced by National Semiconductor's recent departure from the cell-based IC (CBIC) business. As shown in Figure 3, pricing for 1.0- and 1.5-micron CMOS gate arrays and 1.0- and 1.5-micron CBICs collapsed during 1990. Dataquest analysts also report sharp price cuts for 0.8- and 1.2-micron CMOS gate arrays and 0.8- and 1.2-micron CBICs. Field programmable gate arrays (FPGAs) represent a new source of pricing pressure in these markets.

Field Programmable Gate Arrays (FPGAs)

Dataquest views FPGAs—which are in fact a standard product akin to a programmable logic device (PLD)—as a challenging alternative to low-density masked gate arrays for system design starts. FPGA solutions provide systems manufacturers with the benefit of faster time to market than gate arrays, especially for device densities with 6,000 gates or less. The major advantage of FPGAs over gate arrays is system time to market—*not* price—but more rapid time to market can mean lower system cost and higher profit margins for systems using FPGAs.

FIGURE 3
1990 ASIC Price Trends (North American Bookings)*
(Volume: 10,000 Units; Utilized Gates; Excludes NRE)



Source: Dataquest (October 1990)

PLDs: General Supply/Demand Equilibrium

Supply and demand for PLDs has moved into market equilibrium except for slower-speed TTL devices. Under these conditions, pricing for TTL PLDs and CMOS PLDs declined between 1 and 9 percent during the third quarter of this year *except* for an increase in pricing for some 24-pin TTL devices that operate at speeds of 15 nanoseconds (ns) or slower. As shown in Figure 4, under current market conditions, most PLD users can expect steady and, in some cases, such as with newer, faster devices, sharp declines in pricing during the fourth quarter of 1990. As stated in prior forecasts, PLD suppliers will continue to battle each other as well as suppliers of standard logic and other ASICs for design wins.

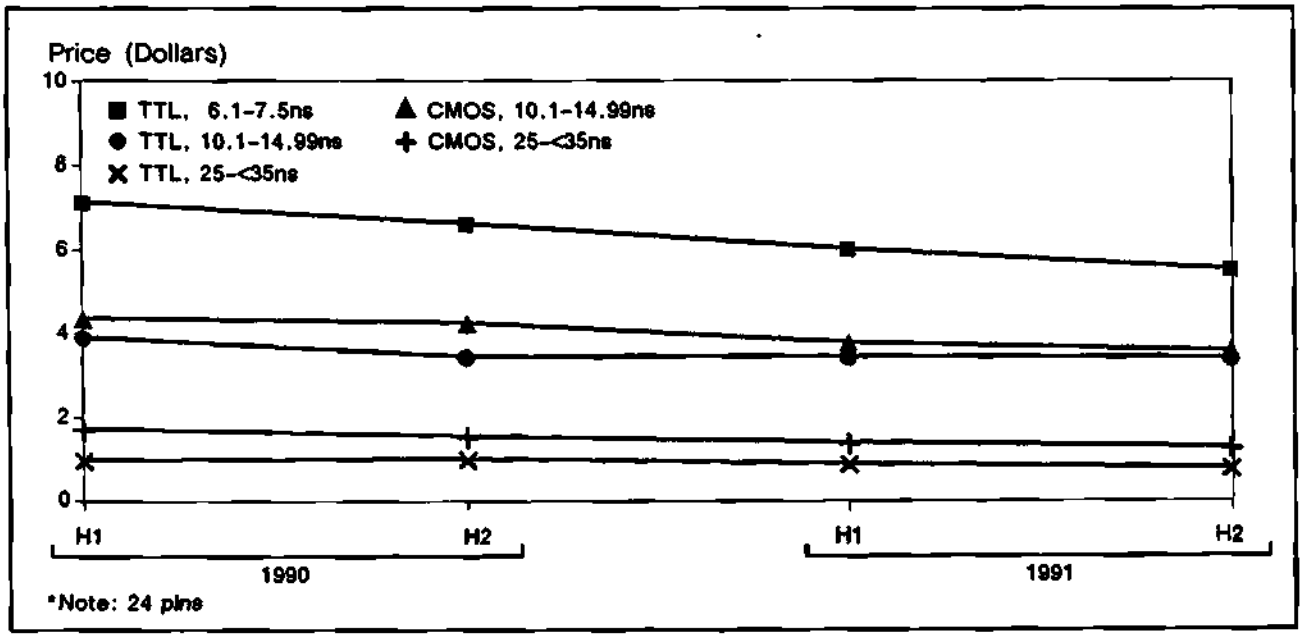
DATAQUEST CONCLUSIONS

The crisis in the Middle East overshadowed significant semiconductor market shifts during the third quarter of 1990. Dataquest's August-September 1990 survey of semiconductor users and suppliers reveals that contract-volume buyers of DRAM can expect sharp pricing declines as the year ends, with the steep drop in 1Mb DRAM pricing delaying the 4Mb DRAM crossover until the second quarter of 1991. The big news is that North American DRAM purchasers face a pricing disadvantage vis-à-vis European buyers, although it is too early to say whether North America will become a global island of high DRAM prices during the 1990s. For example, at the time of the writing of this newsletter, Dataquest had learned of the likely termination of the FMV system during 1990. Other significant market shifts include Intel's increased capacity for 80386/80386SX devices and a new product strategy; signs of a price war in the ROM arena; contraction of the SRAM supplier base; and rising costs for the PDIP version of standard logic via rising oil prices.

DATAQUEST RECOMMENDATIONS

Dataquest recommends that major North American and European buyers of 1Mb DRAMs should book DRAM orders at a price of $5.05 *or*

FIGURE 4
PLD Price Trends (North American Bookings)*
(Volume: 10,000 Units; PDIP or PLCC)



Source: Dataquest (October 1990)

lower. Do not plan on a fourth quarter 1990 crossover to the 4Mb DRAM (4:1 unit/price ratio). Under current market conditions, *most* users should expect the crossover to occur during the second quarter of 1991.

Users also should plan for a second quarter 1991 crossover (4:1 unit/price ratio) to 1Mb slow SRAMs from 256K slow SRAMs. Supply of 256K slow SRAMs could tighten during 1991, so Dataquest recommends that users provide suppliers with accurate demand forecasts or book 1991 orders now, with a provision for renegotiation of 256K product price at a later date.

Users of standard logic products should continue to monitor PDIP pricing-supply-demand trends through use of Dataquest's *On-Line DQ Monday* service.

Dataquest recommends that users facing competitive system time-to-market constraints evaluate the use of FPGAs, especially for device densities with 6,000 gates or less.

Ronald A. Bohn

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Research Newsletter

DESIGNING FOR DOLLARS: WIN WITH FPGAs

OVERVIEW

With the introduction of high-density devices, Dataquest expects manufacturers of field programmable gate arrays (FPGAs) to challenge low-density masked gate array suppliers for design starts. Just as gate arrays have affected the market for custom ASICs, FPGAs currently are impacting the gate array market at the lower densities. Dataquest believes that an FPGA product with a 6,000-gate density should allow the ASIC manufacturer to address one-half of today's worldwide MOS gate array design starts.

Although FPGAs now can compete with masked gate arrays on the basis of density, they are far from being price competitive with their gate array counterparts. However, FPGA solutions do offer systems manufacturers the benefit of faster time to market than a gate array solution. In the context of a system life cycle, this time-to-market advantage should translate into a healthy increase in profitability for systems suppliers. Dataquest believes that the choice of an FPGA solution may, in fact, increase margin dollars by more than 25 percent over those attainable with a masked gate array solution.

ASSUMPTIONS

Our analysis of the time-to-market advantage attained through the use of FPGAs is based on a number of assumptions, as summarized in Table 1. First, we assume a system product lifetime of 12 months and a system cost of $1,200 for the product utilizing the gate array solution. In addition, we assume a selling price of $2,000 (at introduction) for the complete system and a fixed quantity of 5,000 units sold per month for each logic array solution. Also, we assume a time-to-market advantage of 3.3 months for the FPGA over a masked gate array. This final assumption is based on the fact that a gate array will take 3.3 months to reach production status once final design is completed, compared with immediate production of the FPGA. Dataquest considers 3.3 months the best-case scenario for gate array production, based on fully functional first silicon.

Our example is based on an ASIC requirement of 6,000 gates and a volume of 5,000 units per month. We assume a price of $6 for a 6,000-gate masked gate array. The price for a 6,000-gate FPGA is assumed to be $60. Because of the price difference between the solutions, the cost of the system using an FPGA solution will be $1,254. A final assumption is that systems vendors using gate array solutions capture a 40 percent margin at the time of product introduction, declining linearly to 20 percent by the end of the twelfth month. The price level, then, drops from $2,000 at product introduction to $1,500 at the end of the product's life.

THE MODEL

Figure 1 illustrates the margin dollars available in the lifetime of a typical system product in a competitive market. The straight line plots margin dollars per month with respect to time. In this model, the product is introduced at month 0, where

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TABLE 1
Assumptions for FPGA Time-to-Market Model

Logic Array Density	6,000 gates
Monthly System Shipments	5,000 units
Market Window	12.0 months
Gate Array Solution	
Time to Market	3.3 months
System Life Cycle	12.0 months
System Cost without Array	$1,194
Gate Array ASP (Includes NRE)	$6
Total System Cost	$1,200
At System Introduction	
Margin per System ($)	800
Margin per System (%)	40
At System Life End	
Margin per System ($)	300
Margin per System (%)	20
FPGA Solution	
Time to Market	0 months
System Life Cycle	15.3 months
System Cost without Array	$1,194
FPGA ASP	$60
Total System Cost	$1,254
At System Introduction	
Margin per System ($)	746
Margin per System (%)	37.3
At System Life End	
Margin per System ($)	246
Margin per System (%)	16.4

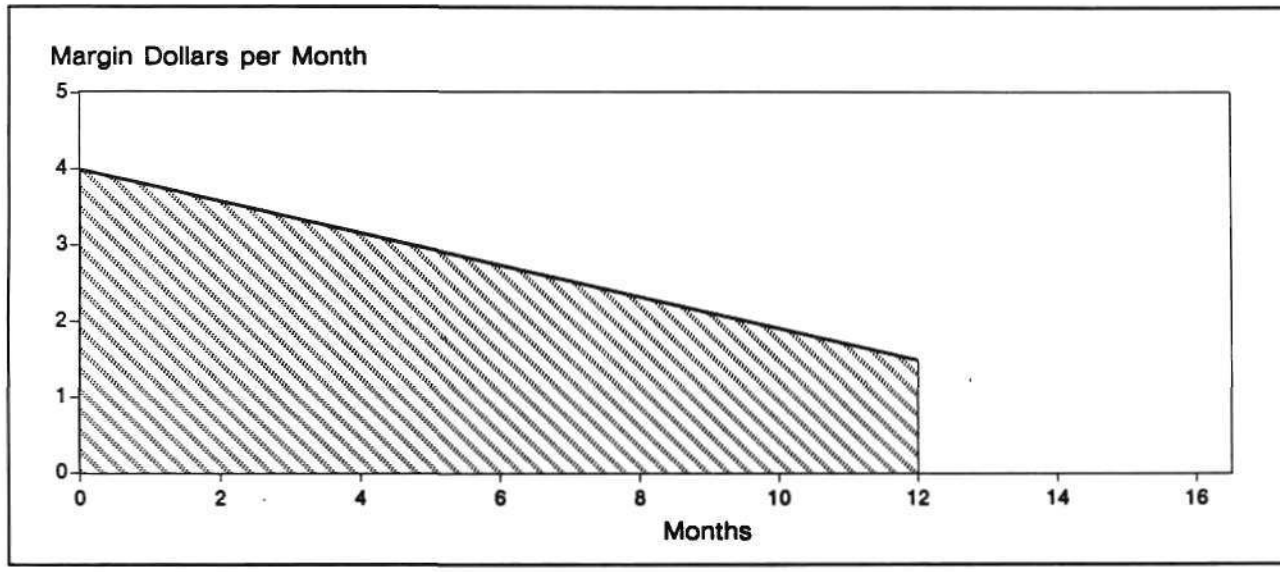
Source: Dataquest (September 1990)

the margin is at its maximum level. Assuming a constant rate of monthly unit sales, margin dollars per month will decline throughout the product's life until, at month 12, the product is discontinued.

Figure 2 compares the margin dollars earned by a system product with a gate array solution with a system product using an FPGA solution. If we begin with a 12-month product lifetime, the use of an FPGA solution gives us an early introduction by 3.3 months. Effectively, then, FPGA use allows us to shift the Y axis of Figure 1 to the left by 3.3 months. So, the system utilizing the FPGA solution is introduced at month 0, while that using the masked gate array solution enters the market at month 3.3. Each product is discontinued at month 15.3.

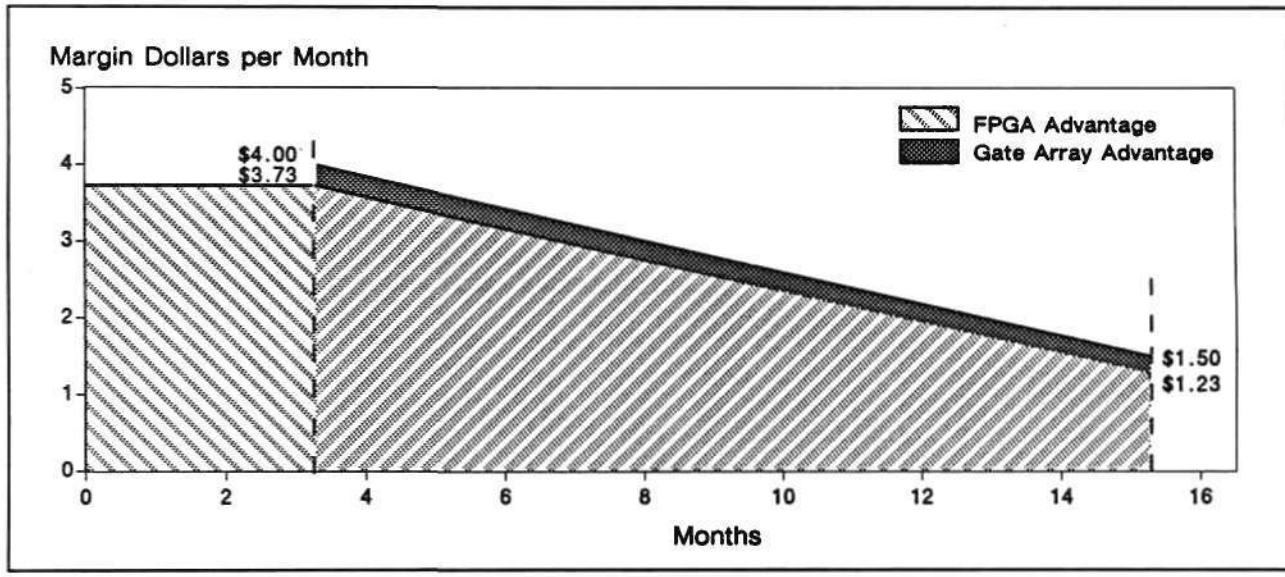
Because the FPGA-based product is introduced 3.3 months ahead of the rest of the market, the manufacturer of this system may be able to hold prices and margins high prior to the introduction of competitive products (shown by the horizontal segment of the line). As the second manufacturer, using the gate array solution, enters the market, however, the margins for each manufacturer begin to decline and continue to decline throughout the life of the product.

FIGURE 1
Margin Dollars Earned—Typical System Product



Source: Dataquest (September 1990)

FIGURE 2
Margin Dollars Earned—FPGA Compared with Gate Array Solution (Millions of Dollars)



Source: Dataquest (September 1990)

The line representing the margin dollars of the gate array solution is higher than that of the FPGA solution, because of the lower cost per unit of the system with the gate array solution. So, the area between the two lines represents an advantage in margin dollars of the gate array solution over the FPGA solution. However, because the system with the gate array solution is not introduced until month 3.3, the FPGA solution captures high margin dollars for a full 3.3 months before the second product is introduced.

It is easy to see from the graph that the FPGA solution captures more margin dollars than the gate array solution. This time-to-market advantage can be evaluated quantitatively by computing the area under each line. The area under the FPGA line equals $42.1 million, while the area under the gate array line equals $33.0 million. This calculation

shows that the product with the FPGA solution has a $9.1 million advantage, in terms of margin dollars, over the system with the gate array solution.

DATAQUEST ANALYSIS

The results of our model show that a time-to-market advantage may offer significant benefits to systems manufacturers. A 27.5 percent increase in total margin dollars was realized over the lifetime of the system product used in our model.

The FPGA lead-time advantage is absolutely dependent on the production lead time for the gate array. For our example, we chose a conservative product lead time, assuming working first silicon in the gate array production. In reality, this period could be much longer than the 3.3 months we used for the purposes of our model. The manufacturer that achieves early introduction can expect to earn high margins throughout the early introduction period and thus earn more margin dollars over the lifetime of the product than can other manufacturers.

A number of other benefits existing outside the framework of this model could provide further advantages to users of FPGAs. For example, early introduction could result in a market leadership position in terms of market share, which translates into higher unit sales for the vendor that uses an FPGA solution, thus leading to an even greater advantage in margin dollars. In addition, a manufacturer able to gain a time-to-market advantage in several generations of systems will be in position to gain high margins at the beginning of a product life cycle and then exit to a new product with higher margins as the margins in the first generation deteriorate.

Obviously, there are many possible scenarios with differing margin levels, product lifetimes, and early introduction periods. The values we chose for these factors are ones that Dataquest believes to be quite typical in the current industry environment. We believe that this model provides a useful framework for the evaluation of the FPGA alternative.

DATAQUEST CONCLUSIONS

Dataquest expects FPGAs to increasingly challenge masked gate arrays for design starts as FPGA products continue to increase in density. Despite the large cost differential between FPGA and gate array solutions, FPGAs may offer substantial returns because of the inherent time-to-market advantage of these products. We have shown that this advantage can be quite attractive to the system manufacturer. As system designers begin to explore the FPGA solution more thoroughly, Dataquest expects more semiconductor vendors to address this growing market, which currently is dominated by two players, Actel and Xilinx.

To our systems clients, we recommend evaluating the use of FPGAs in systems products, especially where time to market is a crucial issue. To our semiconductor clients, Dataquest recommends a hard look at this rapidly growing market segment.

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Mark Giudici
Phil Mosakowski
Jerry Banks

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Research *Bulletin*

SEPTEMBER MARKET WATCH: SEMICONDUCTOR AVAILABILITY EXCELLENT WHILE DEMAND STABILIZES, REFLECTING STABLE SYSTEMS BUSINESS

Market Watch is a monthly Dataquest bulletin that is released after the SIA book-to-bill Flash Report. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL SLIPS BELOW THE 1.00 MARK TO 0.99

This month's book-to-bill ratio slipped slightly to 0.99 from last month's 1.00 level, as seen in Figure 1. Seasonality aside, this dip is not an unprecedented event. However, looking at the

Figure 1
US Semiconductor Book-to-Bill Ratio

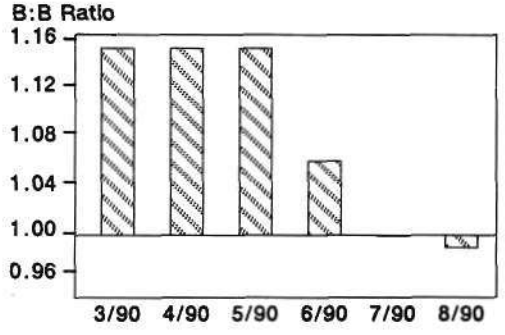


Figure 2
DOC Computer Demand

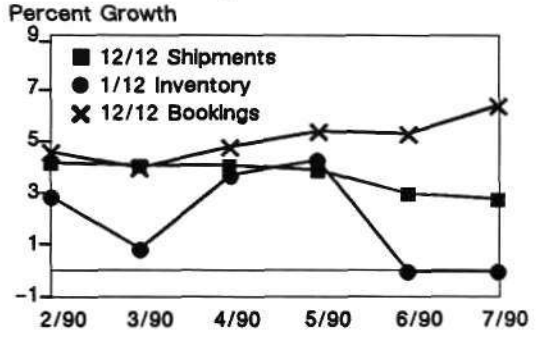


Figure 3
Semiconductor Inventory Level

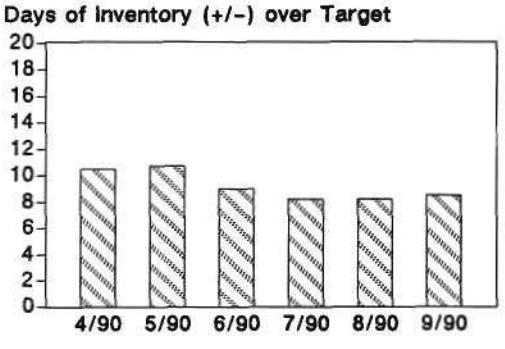
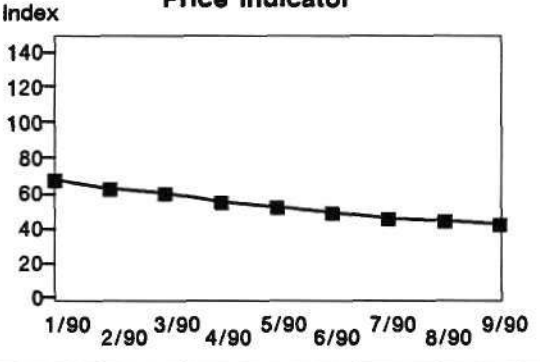


Figure 4
US Weighted Semiconductor Price Indicator



Source: WSTS, US Department of Commerce, Dataquest (September 1990)

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actual booking and billing dollars highlights an interesting situation that may be developing. The actual three-month averages of *bookings and billings both unexpectedly rose* over last month's averages. The 16.6 percent rise in August billings over July's levels can be partly attributed to the billing of comparatively higher-priced DRAMs that were booked in June and July. The 0.9 percent higher bookings level in August over July is interesting in that Dataquest has not seen any large-scale price stabilization or unit order increases that would warrant this type of growth. It is possible that the anticipated year-end sales push has begun a month early because the respondents to this month's *Procurement Pulse* (SUIS newsletter number 1990-31) survey expect to order 13.0 percent more semiconductors in September than in August. The last time a positive annualized billings growth rate occurred in August after a negative rate in July was in 1986, the beginning of the most recent positive growth cycle for semiconductors.

THE COMPUTER BOOKING RATE CONTINUES TO CLIMB, SHIPMENTS RATE REMAINS FLAT, AND INVENTORIES DIVE

The US Department of Commerce (DOC) data shown in Figure 2 illustrate that although the latest annualized shipment rate slipped to 2.8 percent from last month's 3.0 percent, computer companies actually had less inventory on hand relative to the same time last year. The last time the 1/12 inventory rate was less than 1.00 was November 1987. The annualized bookings rate rose again, from June's 5.3 percent to July's 6.4 percent, showing how continued strength in system demand is buoying up an otherwise lackluster market. The continued expansiveness of computer demand may be tested, due to the uncertainty surrounding the Iraq crisis. It is likely that some percentage of those companies planning capital expenditures may delay purchases that in turn will affect the aggregate near-term demand for systems. The annualized shipment rate most likely will not be appreciably affected by these near-term perturbations due to the momentum of prior months' bookings. The trickle-down effect of postponed (lost) system demand most likely will impact the semiconductor industry in the mid- to late fourth quarter, exacerbating an already abundant supply situation.

SEMICONDUCTOR INVENTORY LEVELS REMAIN CONTROLLED, READY TO RESPOND TO ANY DEMAND CHANGE

The stability in the delta between targeted and actual inventory levels of 8.5 days relative to the last two months' 8.2-day difference points out how well inventory levels remain under control (see Figure 3). There was a slight increase in both targeted and actual semiconductor inventories of 20 and 29 days versus last month's respective levels of 18 and 27 days. This increase primarily is due to anticipation of stronger fourth-quarter system sales. The ebb and flow of system demand is being directly transferred toward semiconductor inventory levels. Any change in system demand (up or down) will be reflected in semiconductor inventory levels, thus keeping the order pipeline flowing.

STABLE DEMAND + ABUNDANT SUPPLIES = CONTINUED LOWER PRICES

Abundant supplies of all semiconductors continue to allow gradual price reductions for the average semiconductor "breadbasket," as seen in Figure 4. The largest price declines have come in the DRAM (expected) and microprocessor (unexpected) families. Despite efforts of some DRAM suppliers to match flat demand levels with like supplies, other suppliers bent on gaining market share have aggressively taken business with lower prices. Flat demand for systems has finally caught up with the midrange to high-end microprocessor market. Lead times for most Intel 32-bit microprocessors have been reduced to within a 10- to 12-week interval, and prices also have declined somewhat, matching demand levels. The other semiconductor families (logic, ASIC, and linear) that already were at rock-bottom prices have not had much price movement.

DATAQUEST CONCLUSIONS

The inventory controls of semiconductor suppliers and buyers are maintaining an adequate order flow of chips in the face of static demand. Now that availability is a nonissue, many large users are focusing on lead time predictability and reduction, which is very feasible in many areas. The uncertainty surrounding the overall economy as it relates to the Middle East may have some negative fallout on semiconductor growth, but it will alleviate semiconductor users' shortage fears. Forecasting accuracy and commitments—both of which, to date, have been well executed—are of paramount concern for both users and suppliers.

Mark Giudici

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Research *Bulletin*

SEPTEMBER PROCUREMENT PULSE: ORDERS TO PICK UP WHILE INVENTORIES STABILIZE

The *Procurement Pulse* is a monthly update of critical issues and market trends based on semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDER LEVELS EXPECTED TO RISE

The respondents to Dataquest's monthly procurement survey expect to increase their semiconductor order levels 13 percent over last month's

Figure 1
Averaged Monthly Semiconductor Orders

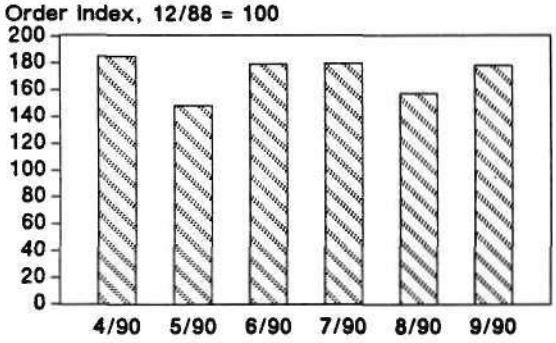


Figure 2
Averaged Semiconductor Lead Times

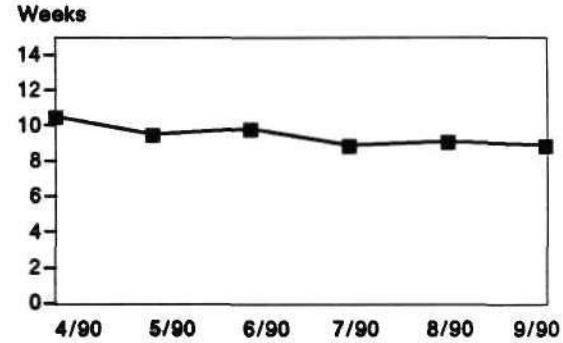


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

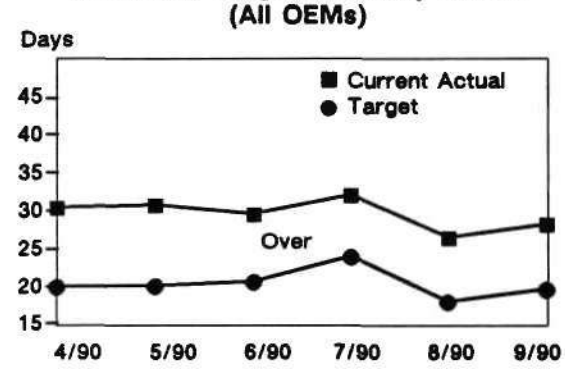
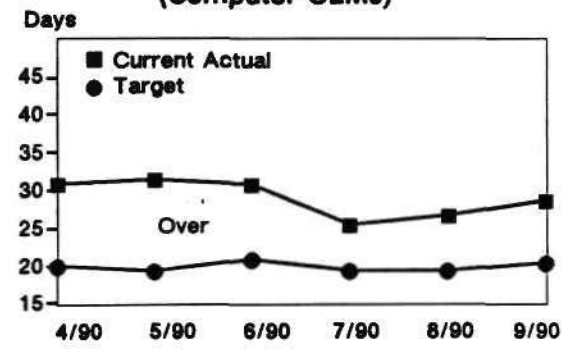


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (September 1990)

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levels. It appears that the overall demand level for semiconductors is returning to presummer levels (see Figure 1). We still expect system sales for the next six months to be positive on average, ranging between negative 20 percent and positive 20 percent. Continuing the trend of the past six months, the only negative sales outlook is that of the military segment. The current system sales outlook for the next six months is for 4.2 percent positive growth compared with the 5.5 percent six-month growth forecast that was expected last month. The computer outlook currently is for a 6.1 percent six-month growth rate versus last month's forecast of 8.3 percent. Although one month of increased order expectations does not make a trend, the anticipated fourth-quarter upturn in business may be beginning early.

NO SURPRISE! AVAILABILITY A NONISSUE WHILE AVERAGE LEAD TIMES REMAIN UNCHANGED AT NINE WEEKS

Figure 2 shows the closest thing to a straight line in lead times, with a variance of no more than one week over the past six months. The current lead time average is 9 weeks and ranges from 6 to 12 weeks. All respondents except one are not having *any* problems in procuring parts at this time. One respondent still is having some difficulty in getting high-end Intel microprocessors. According to recent survey work, the availability of Intel devices also will become a nonissue. The only collective issue seen this month is for shorter lead times. For the first time, 100 percent of the respondents are using surface-mount technology, and only one company is noting problems with handling and testing.

SEMICONDUCTOR INVENTORIES RISE BY ONE DAY; STILL UNDER 30 DAYS!

In correlation with anticipated higher order rates in September, inventory levels are expected to rise slightly for both targeted and actual levels, as seen in Figures 3 and 4. For both the overall and computer respondents, the targeted and actual inventory levels are forecast to be 20 and 29 days, respectively. Inventory control still remains one of the most visible areas for cost cutting. There was only one day of actual inventory increase over last month's levels that relates to this month's anticipated higher order rate. The continued attention paid to improved lead times should have a positive effect on inventory levels as forecasting accuracy continues to improve.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Despite the uncertainty surrounding the Mideast crisis, this month's respondents expect to increase order rates and will raise inventory levels slightly to account for the anticipated increased year-end business push. Forecasting accuracy still is a major concern for suppliers and users as both continue to work hard at keeping their respective inventory levels low and controllable. With inventory levels historically very low, the upturn in anticipated system sales should be reflected in increased semiconductor orders, as this month's results attest. Currently, there are no problems with semiconductor availability, and Dataquest does not expect to see any future problems through the rest of the year.

Mark A. Giudici

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Research *Bulletin*

AUGUST MARKET WATCH: THE MIDSUMMER SLOWS SETTLE IN, AND THE AVAILABILITY IS EASY

Market Watch is a monthly Dataquest bulletin that is released after the SIA book-to-bill Flash Report. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL SLIPS TO PARITY

Continuing the summer slide that began in late May, July's book-to-bill declined to 1.00 from June's 1.06 level. The expected lower semiconductor bookings, noted in last month's *Procurement*

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

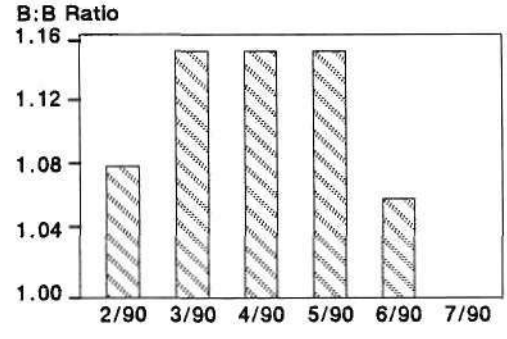

Figure 2
DOC Computer Demand

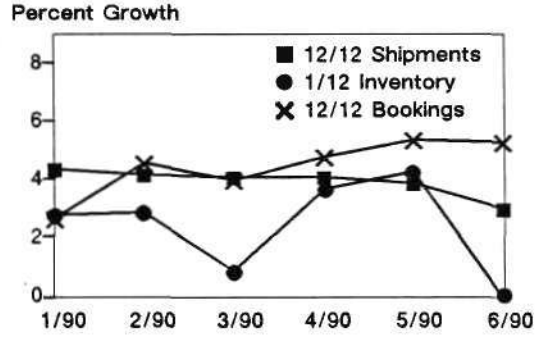

Figure 3
Semiconductor Inventory Level

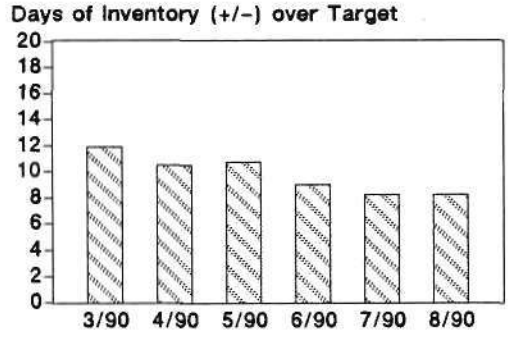

Figure 4
U.S. Weighted Semiconductor Price Indicator

Source: WSTS, US Department of Commerce, Dataquest (August 1990)

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Pulse as being based on seasonal factors, have resulted in the current lower book-to-bill ratio. Compared with the five-week month of June, July's bookings declined 6.4 percent and billings were down 16.7 percent. Because there was 20 percent less time to ship product in July than in June, the lower figures appear to be in line. Looking at the prior quarter's activity highlights seasonality. The reduction in booking activity for July was 12.8 percent lower than the comparable April 1990 figure (the prior four-week month that followed a five-week month), while billings were 4.9 percent less than last April. This slight decline in semiconductor business will continue because of lower (but still positive) growth in system sales expectations in the next six months, combined with good inventory control.

SYSTEM SALES AND INVENTORY RATES DIP, YET BOOKINGS RATE RISES

The US Department of Commerce (DOC) historical data (Figure 2) shows that the computer shipment rate slipped to an annualized (12 month) rate of 3 percent growth compared with the comparable year-earlier 12-month period ending in June. For the same time period, the bookings rate rose to 5.3 percent, while the June 1990 inventory rate was flat compared with the June 1989 rate. Although the shipment rate declined slightly from last month's 3.9 percent level, the bookings rate has continued to rise as discussed in the past three *Market Watch* issues. This occurrence is due to the expanded pervasiveness of computers in the economy and the current upgrade (not necessarily new machine) trend that is being fueled by continually lower-cost memory. As noted in this month's Procurement Pulse (newsletter SUIS-28), the 6-month system sales outlook remains positive but a bit lower at 7.3 percent versus last month's 9.5 percent response. This forecast is mostly due to year-end (December) versus January sales expectations of most companies. Although concern exists regarding the effect of an oil shock on the economy, it is too early to determine to what extent the events occurring in the Middle East will impact the electronics industry. We soon will publish a newsletter on this topic.

SEMICONDUCTOR INVENTORIES REMAIN UNDER CONTROL

The current delta between targeted and actual inventory levels of semiconductors remained unchanged from last month's gap of 8.2 days (Figure 3). Overall targeted and actual inventory levels have declined to slightly lower than average levels of 18 and 27 days, respectively, compared with the 24 and 32 days seen last period. The reduction in average inventory levels points out how closely inventory control matches business activity levels. Although we are not in the middle of a boom market, controlled inventory levels will ensure that there is a more direct relationship between system sales and semiconductor demand.

SLACK DEMAND FUELS STEADY PRICE DECLINES

Prices continue to slip, primarily in the spot memory arena as some companies resort to aggressive pricing to maintain or grow market share in the face of steady and/or seasonally lower demand. The SRAM and EPROM markets also are being affected by market-share-hungry suppliers forcing some of these prices down. There appears to be relative pricing calm in the mature standard logic and linear markets, primarily because of their already very low prices. Another area of price stability is in the 32-bit microprocessor market, where sole-source marketing is gaining few friends in the user community. Although lead times have improved for Intel devices, prices have not declined as predictably as expected. As overall availability improves, prices will continue to decline for the rest of the summer, primarily in the commodity volatile memory markets and for some 16-bit Intel devices as well. Logic, linear, and 32-bit microprocessor pricing will continue to remain relatively flat for the different reasons mentioned above.

DATAQUEST CONCLUSIONS

The continued abundance of commodity memory and logic semiconductors relative to flat demand is forcing lower prices and related lower revenue for semiconductor suppliers. Suppliers' performance remains a key determinant in incremental business and the retention of existing business as some long-term contract buyers have begun to consider taking advantage of limited spot-market buys. Inventory control remains the gospel, and system companies' requirement for components will quickly correspond with system sales levels relative to past business cycles. Now is a good time to solidify long-term supply arrangements that will benefit both parties in the upcoming year.

Mark A. Giudici

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Research Newsletter

EUROPEAN COMMISSION DRAM REFERENCE PRICES BEHIND THE SCENES

INTRODUCTION

The reference price mechanism for Japanese-sourced DRAMs was formally defined by the European Commission in Council Regulation No. 2112/90 of July 23, 1990. It was provisionally defined on January 23, 1990, as Commission Regulation No. 165/90 and subsequent extension 1361/90. The regulations are published in full in the *Official Journal of the European Communities.*

SUMMARY

Since the publishing of our February Research Bulletin (1990-4) on the subject of the DRAM reference price, second- and third-quarter reference prices have been issued to participants of the agreement. The reference prices for the third quarter of 1990 are currently in force for all DRAM orders confirmed in this quarter. Documented compliance with reference prices by participants of the agreement provides exemption from the 60 percent antidumping duty on all DRAMs sourced from Japan.

Only the Commission and the 11 participants have direct access to these reference prices. However, in the normal process of a sales negotiation, a DRAM buyer may also be quoted the reference price by a participant supplier to support the selling price. It comes as no surprise, therefore, that the electronics press also finds access to the reference price as soon as it is released. Bold criticisms of the reference price, many of which are open to debate, have been made in the media.

This newsletter takes a detailed look at the reference price mechanism, and gives Dataquest perspectives of the following issues and their impact on the market:

- Reference price stability, a concern
- Exchange rate stability, a concern
- Reference prices for DRAM SIMMs, a potential concern
- Reference prices for new generations of DRAM, an explanation

REFERENCE PRICE STABILITY

The reference prices (RPs) for 1M and 4M DRAMs in the third quarter of 1990 are understood to have significantly declined from the second quarter. In fact, Dataquest believes that the 1M DRAM RP for the third quarter of 1990 is a 35 percent decline from the second quarter, while the 4M DRAM RP is a 55 percent decline. This sudden drop has led some critics to accuse the European Commission of making an error in the calculation of the average cost of production, upon which the RP is based. However, the Commission has emphasized that, although RPs will follow the learning curve for each density of DRAM in the long term, there will be short-term deviations on a quarterly scale. Dataquest identifies four major causes of RP instability, as outlined below.

Supply and Demand

Short-term deviations are, in part, a consequence of swings in supply and demand, which in turn affect production capacity and therefore cost of production, upon which the RP is based.

Cost of Production

Another short-term factor that can affect RPs is the error margin in *projected* cost of production

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TABLE 1
EC DRAM Reference Price Methodology

	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91
3Q90 RP	1. 2Q90 Cp estimated	1. 3Q90 RP released for new bookings 2. 2Q90 Ca calculated	1. 3Q90 RP applied to all confirmed bookings			
4Q90 RP		1. 3Q90 Cp estimated 2. 2Q90 (Ca – Cp) added to 3Q90 Cp	1. 4Q90 RP released for new bookings 2. 3Q90 Ca calculated	1. 4Q90 RP applied to all confirmed bookings		
1Q91 RP			1. 4Q90 Cp produced 2. 3Q90 (Ca – Cp) added to 4Q90 Cp	1. 1Q91 RP released for new bookings 2. 4Q90 Ca calculated	1. 1Q91 RP applied to all confirmed bookings	
2Q91 RP				1. 1Q91 Cp produced 2. 4Q90 (Ca – Cp) added to 1Q91 Cp	1. 2Q91 RP released for new bookings 2. 1Q91 Ca calculated	1. 2Q91 RP applied to all confirmed bookings

RP = Reference Price
Cp = Projected Cost of Sales
Ca = Actual Cost of Sales
Source: Dataquest (August 1990)

versus *actual* cost of production. For instance, the 3Q90 RP, which applies to orders confirmed in the third quarter, is released to participants in the middle of the second quarter. It is based on *projected* cost of production for the second quarter, as estimated in the first quarter. However, the *actual* cost of production for the second quarter is not known until early in the third quarter, and a comparison has to be made between the projected and actual costs. Any difference is added to or subtracted from the calculation of the next quarter's RP, as shown in Table 1. The net effect of this in the long term is to balance any errors in cost projection. But the effect in the short term is to add a random element in the calculation of RPs.

Die Testing

A long-term factor, which can significantly reduce cost of production, is to miss out die testing altogether, with test after assembly only. This move is viable only for the largest suppliers with high yields of a maturing DRAM, although the weighting mechanism means that these suppliers also have the strongest influence in the calculation of the RPs.

Depreciation

Another long-term factor that can affect cost of production is the unique Japanese procedure of *retrograde depreciation*. It is this that is believed to be the main cause behind the sudden drop in the 3Q90 RP. All capital investment in equipment is depreciated over the lifetime of the equipment. This depreciation is accounted for under operating costs, which is an element in the calculation DRAM reference prices. Depreciation also affects profit margins, which have been under stress from DRAM price erosion through 1989. In fact, by the close of the Japanese fiscal year 1989 ending March 31, 1990, average selling prices for 1M DRAM had halved, which strongly affected profit margins.

Dataquest believes that one or more major Japanese DRAM suppliers discovered that they would have to declare very small margins in fiscal 1989 unless they found a way of reducing their operating costs over the reporting period. One way to achieve this is to defer depreciation. However, Japanese companies are also allowed to backdate their depreciation by up to five years, this being known as *retrograde depreciation*. Dataquest believes that one or more Japanese DRAM suppliers chose to backdate some of their fiscal 1989 depreciation to fiscal 1987, as profit margins in fiscal 1987 were high enough to withstand the consequential erosion. Also, as fiscal 1987 accounts are two years old, only summary revisions need to be shown in an annual report.

The projection for the 3Q90 RP, as outlined earlier, was based on production costs available in the first quarter, which for one or more major suppliers was believed to have excluded some depreciation. Therefore, without intervention from the Commission, a sharp drop in the 3Q90 RP was inevitable. The Commission accepts the legal accounting practices of Japan and so had to allow the anomaly to take its course. The 4Q90 RPs are expected to return to normal levels, with depreciation being counted in the projection of manufacturing costs for the third quarter.

EXCHANGE RATE STABILITY

All DRAM reference prices are calculated in yen. This is the natural currency to work in since the participants are all Japanese (except for Texas Instruments, which has a Japanese factory) and the majority of all production, sales, and administration costs are determined in yen. The Commission provides exchange rates to the participants for the purpose of translating their overseas costs, such as freight, handling, insurance, and sales costs from foreign currency into yen. These exchange rates remain fixed throughout the reference price calculation to minimize confusion; that is, they are used at the beginning of the process to translate overseas elements of cost of sales into yen and at the end of the process by European sales offices to translate reference prices in yen back into local currencies. Hence, to translate a 3Q90 RP into local currency, a first quarter exchange rate is used.

Obviously, if the yen strengthens during this period, the RP expressed in local currency according to Commission exchange rates will be less than when expressed in local currency according to market rates; if the yen weakens the reverse is true. In fact, throughout 1990, the yen has been weakening against European currencies, with the effect that local currency 3Q90 RPs derived from Commission exchange rates are on average 9 percent higher than those derived from market rates.

When DRAM market prices are close to RPs, as occurred in the second quarter, Japanese vendors and their customers will want to know if Commission exchange rates or market exchange rates will

provide the lowest floor on pricing. If, as in the present case, market exchange rates provide the lowest prices, then the vendor may choose to accept payment in yen. However, not all vendors are currently able to process local orders in yen. Consequently, some users have begun dealing with the headquarters of these vendors to negotiate contracts in yen for shipment to Europe. The extra time and effort this entails would be saved if the Commission chose to use dynamic, rather than fixed, exchange rates. Of course, this would make the administration of the agreement more complex. The gains of using market exchange rates at the sales end of the agreement may therefore be lost by increasing the complexity of the calculation of RPs.

There has been no request for a dynamic exchange rate as yet, but a slowdown in the Japanese economy or further growth in European economies may make the currency displacements too large to ignore.

REFERENCE PRICES FOR DRAM SIMMs

A single in-line memory module (SIMM) consists of memory ICs mounted onto a printed circuit board, which is mounted vertically onto a motherboard as a component with single in-line pins. SIMMs are used primarily to save board space when large amounts of memory are required in a system. The RP agreement treats DRAM SIMMs simply as a collection of DRAMs, and so the RP of a SIMM is determined by adding up the RPs of the DRAMs mounted on it. The cost of the board and of mounting the DRAMs is ignored. This typically amounts to about 10 percent of the total cost.

Dataquest estimates that between 20 and 40 percent of Japanese suppliers' European DRAM shipments are in the form of SIMMs, depending on their individual customer base. This is expected to increase over time as the thin small-outline package (TSOP) version of the DRAM gains popularity. Large OEMs have often mounted dual in-line packages (DIP) and small out-line packages (SOP) onto SIMMs themselves, but the TSOP is beginning to stretch the limits of their board assembly equipment. This is because the TSOP DRAM is difficult to mount, being only 1.2mm thick and having a pin pitch of 0.5 millimeter.

Because Japanese TSOP DRAM manufacturers already have expertise in mounting these packages on SIMMs, Dataquest believes that OEMs will increasingly order them already mounted. Also, as a SIMM RP is only the sum of the RPs of the mounted DRAMs, pricing is expected to be very competitive. The board assembly facilities of these OEMs, as well as those of related subcontractors, may therefore see underutilization of their capacity.

However, there is no problem in this unless there is a complaint from a European manufacturer of DRAM SIMMs, and so for the moment it is just an interesting exclusion in the agreement.

REFERENCE PRICES FOR NEW GENERATIONS OF DRAM

The RPs for sample quantities of new generations of DRAM do not follow the same rules as for DRAMs in production. In order to encourage potential users to sample this new product, a DRAM supplier has to sell at below cost for small quantities. Yet production costs are the main basis for the calculation of an RP, which are very high when a new generation is introduced.

Therefore, in order to allow new generations of DRAM to circulate in the market as soon as possible, the Commission has stated that while the *calculated* RP of a new DRAM density is greater than ten times that of the previous density, the *applicable* RP of the new density is fixed at just ten times that of the previous density. When the calculated RP of the new density drops below this ten-times factor, the calculated RP then becomes applicable.

The Commission believes that, within 18 months of the introduction of a new generation of DRAM, the RP of that device should reach ten times that of the previous generation. For reference, Dataquest analysis of worldwide market prices shows that the ten-times crossover point for 4M ASPs versus 1M DRAM ASPs occurred early in the fourth quarter of 1989, about 16 months after the first samples of the 4M density were available. The first example of the ten-times rule RP will be for the 16M DRAM, expected early in 1992.

A further concession is that the Commission allows the shipment of one free sample of up to a thousand pieces per user per supplier.

DATAQUEST ANALYSIS

The reference price was always intended to be a low-profile *safety net* against dumping from Japanese suppliers, and in this respect Dataquest

believes that it is succeeding, although we do have some concerns:

- The stability of the reference price needs to be maintained for it to be a useful benchmark in the industry. Short-term instability such as the errors between projected and actual costs must be minimized, and long-term instability such as creative accounting should be corrected.
- Dataquest believes that the normal patterns of purchasing are being influenced by the leaking of reference prices to the media. There is evidence that the widespread publication of alleged 3Q90 RPs has influenced some DRAM purchasers to wait for market prices to drop closer to these RPs before placing overdue orders. This modulates the normal quarterly swings in market demand and destablizes the industry.

The level of the 3Q90 RP should mean that DRAM prices are controlled by market forces only, as if there was no lower limit. In cases where DRAM market prices are close to reference prices, as occurred in the second quarter, then suppliers offering products manufactured elsewhere than Japan have the competitive edge. It is claimed that North American and Korean DRAM suppliers have been quoting low prices for DRAMs to attract business away from Japanese suppliers. The Commission is believed to be examining some of these claims.

Nevertheless, the ultimate issue should not be clouded too much by external influences. The European semiconductor industry is learning to compete in the European market on its own, as a stepping-stone to competing on the world market. The Commission's reference price agreement serves to provide a greenhouse market for European DRAM manufacturers to grow their customer base. It is important for these manufacturers to take full advantage of this environment to secure sizable market shares in Europe and the world.

The European Community will soon be host to the fabrication facilities of some of the largest DRAM manufacturers in the world, and products from these facilities will not be subject to any tariffs or reference prices. The time available for European manufacturers to gain a foothold may be less than the period between successive generations of DRAM, namely three and a half years.

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Byron Harding

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Research *Bulletin*

AUGUST PROCUREMENT PULSE: SEASONALITY SLOWS ORDERS, BUT INVENTORIES STILL UNDER CONTROL

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDERS SLIP SEASONALLY

The semiconductor order level of respondents is expected to decline by 21 percent this month, primarily because of the traditional summer slowdown in bookings (see Figure 1). This month's

Figure 1
Averaged Monthly Semiconductor Orders

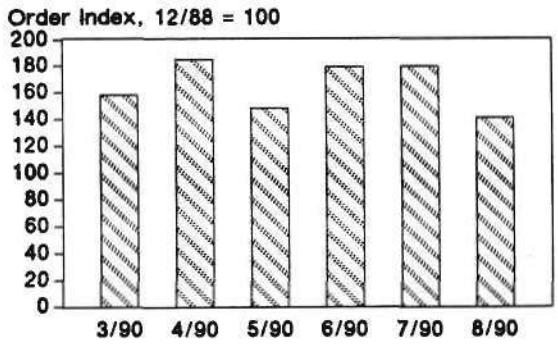


Figure 2
Averaged Semiconductor Lead Times

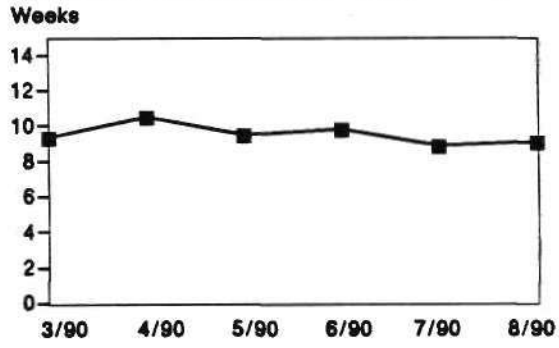


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

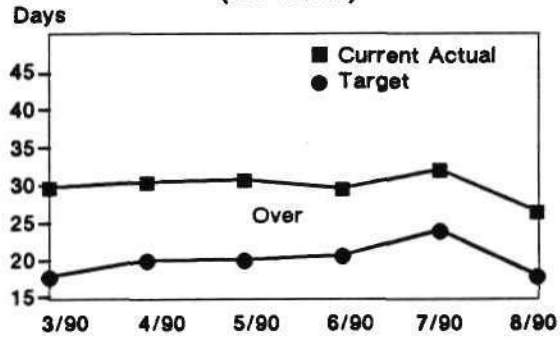
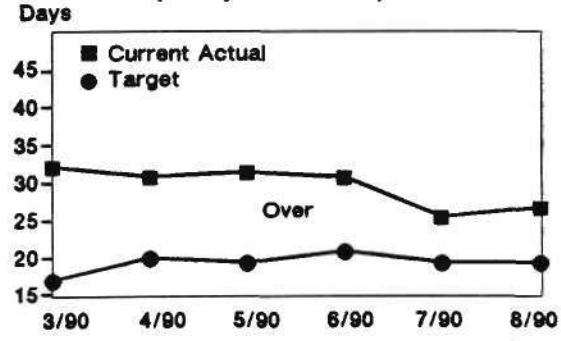


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (August 1990)

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respondents also expect another slight decline in system sales primarily because of seasonal demand patterns that were also noticed last month. The range of responses still predicts systems sales growth to be between negative 20 percent and positive 25 percent during the next six months. It is important to note that the only negative forecast was from a military-system respondent. The current six-month outlook forecasts 5.5 percent overall systems sales growth and 8.3 percent positive growth in the computer sector, compared with last month's rates of 7.3 percent and 11.0 percent, respectively. Dataquest expects the seasonal slowdown to continue through September, at which time order levels should increase to meet year-end demand.

LEAD TIMES STABILIZE AT NINE PLUS WEEKS, AVAILABILITY REMAINS EXCELLENT

Although Figure 2 shows a slight lead time increase of 9.3 weeks over last month's 9.0 weeks, the range in responses has narrowed, with a low of 6.0 and a high of 12.0 weeks. Aside from some isolated problems with 80386SX availability, no other product problems were noted. The DIP shortage in standard logic has been effectively resolved with the combination of reduced demand and increased capacity. Currently, there is no difference in price or lead time for most SMT or DIP standard logic products. Isolated problems still exist for some SMT users regarding testing and handling of parts and the availability of engineering-status SMT devices.

SEMICONDUCTOR INVENTORIES GO WITH THE SEASONAL FLOW . . . LOW AND UNCHANGED

As seen in Figures 3 and 4, inventory levels for all of this month's respondents are expected to decline this month to a targeted and actual level of 18 days and 27 days, respectively. The computer segment of the sample has stabilized with targeted inventories at 20 days, but actual levels have risen 1 day to 27 days. Inventory control still is the main cost-cutting "religion," and efforts to cut the target to actual deltas are ongoing. With semiconductor inventories at their current low levels, upticks in system demand expected this fall should quickly translate into increases in semiconductor order levels. The focus on the current improved availability and lead times will continue through forecasting improvements as demand picks up.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

With the summer slow season in full swing, the control of inventories and the focus on supplier performance are getting priority because availability and predictable pricing now are nonissues for most users. Forecast accuracy and the 1991 plans of many users continue to force the regular communication of short- and longer-term needs to suppliers. Semiconductor supplies are expected to remain abundant for the rest of this year, allowing users an opportunity to create or cement supplier relationships for reliable and cost-effective deliveries. Suppliers should continue to see the order pipeline remain constant through the summer, with the traditional fall system order increase translating readily into semiconductor bookings.

Mark Giudici

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Research Newsletter

POWER TRANSISTORS: MARKET STRENGTH IN AN ERA OF INTEGRATION

SUMMARY

The control of power for lighting, motors, and other electrical equipment still is the domain of discrete power devices. Less than 22 percent of the semiconductor power control market by revenue is supplied by power ICs. The demand for high currents and high voltages is still best and most cost-effectively met by power discrete transistors and power thyristors. Although many find the power discrete marketplace less exciting than that of other semiconductors, it represents a keystone for the growth of embedded control and application-specific smart power ICs. It has demonstrated a growth rate consistent with that of ICs and a continued offering of new products and technologies to answer the needs of the marketplace.

POWER CONTROL MARKET

The total power control semiconductor market (which excludes power diodes) is divided into three main product types—power transistors and thyristors, which comprise the discrete side and power ICs, which are considered to be part of the analog IC category. Table 1 lists the revenue and growth rates associated with each of these constituent product types.

Power ICs, with a 22 percent market share, still have considerable room for growth. Smart power, the combination of logic and power transistors on an IC, supplies less than 8 percent of the total power control semiconductor market.

Definition of Power

Power semiconductors are defined as discrete devices or ICs that can control one or more amps of current, dissipate one or more watts of power, or are capable of operating with voltages exceeding 100 volts. In the discrete area, transistors that do not meet these criteria are designated as small-signal transistors.

Power Transistors

As a dominant part of the power control market and with a continued strong growth rate, power transistors are expected to retain their dominant position in power control throughout the upcoming decade. The power transistor market

TABLE 1
Total Power Control Device Market

	1989 Revenue ($ Millions)	1989-1994 Forecast CAGR
Power Transistors	2,278	11.9%
Thyristors	594	6.4%
Power Integrated Circuits	785	13.9%
Total Power Control Semiconductors	3,657	11.4%

Source: Dataquest (August 1990)

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grew at a compound annual growth rate (CAGR) of 12.9 percent in the five-year period from 1984 to 1989. Power transistors have shown a strong growth trend in recent years as automotive electronics, motor controllers, switching power supplies, and other electronic controls have multiplied.

Dataquest expects power transistors to grow by an 11.9 percent CAGR from 1989 through 1994. These figures represent a continued strong growth rate, although the slow growth of 1989 to 1990 lowered the CAGR somewhat. Figure 1 shows power transistor revenue for the past five years (1984 to 1989) as well as the forecast revenue for the next five-year period (1990 to 1994).

Bipolar versus MOSFET Transistors

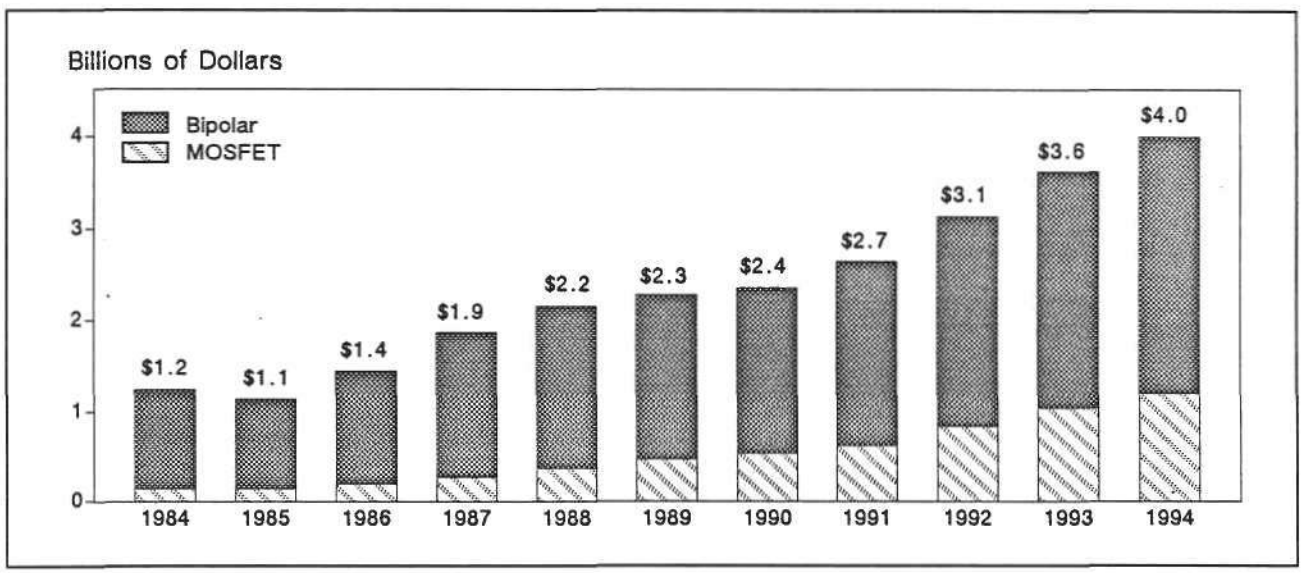
Although they have been touted as bipolar killers for more than a decade, MOSFET power devices are only now making a dent in the bipolar market with a 20 percent share in 1989. Significant price reductions, coupled with new and improved product offerings within the past few years, have helped increase the applications and usage of these products.

Why the trend toward power MOSFETs? Because of their shorter rise and fall times, power MOSFETs can switch substantially faster than bipolar power transistors, resulting in higher efficiency and lower power dissipation in switching applications. However, not all applications need high switching speeds. In some cases, the high switching speed of the MOSFET can create destructive voltages when driving inductive loads (dI/dt) that were not present in a bipolar implementation. Additional advantages of power MOSFETs are high-input impedance and gain and a simple interface with standard logic circuits. However, the bipolar power transistor is still the preferred technology for high-voltage, high-current applications because of its low ON-state saturation voltage, which is significantly lower than the ON resistance of MOSFETs. The problem is that power MOSFETs have an ON resistance (R_{ON}) that increases geometrically (to the 2.6th power) with the voltage rating.

The more recently introduced insulated gate bipolar transistor (IGBT) offers a solution to this ON resistance dilemma for MOSFETs. The IGBT combines the high-impedance input characteristics of the MOS transistor with the low-saturation voltage of the bipolar transistor. The bipolar action in the current path of the IGBT offers a low-resistance path, even with a high-voltage capability. Although IGBTs are slower than their MOSFET counterparts, they interface just as readily with MOS logic while reducing the power loss and dissipation problems that the high ON resistance would normally cause. Because of this capability, IGBTs are helping expand the market for MOSFET devices.

IGBTs are also called COMFETs (COnductivity Modulated FETs), MBTs (MOS-Bipolar Transistors), or GEMFETs. Dataquest classifies IGBTs within the general MOSFET category.

FIGURE 1
Power Transistor Revenue History and Forecast



Source: Dataquest (August 1990)

The difference between bipolar and MOS power transistors is summarized in Table 2. This table emphasizes the mixed bipolar/MOS performance characteristics of IGBTs.

Smart Power Transistors

Some power MOSFETs are offered with an additional control terminal that provides a "sense" output to monitor the current through the device. This current sensing allows the control electronics to compensate for inductance and monitor current overloads and provides a smart power system with improved features and performance.

POWER TRANSISTOR FORECAST AND HISTORY

Table 3 shows the five-year revenue history and forecast for both bipolar and MOS power transistors. The MOSFET segment of the power transistor market is growing rapidly and is expected to account for 30.0 percent of total power transistor revenue by 1994, as shown in Table 4. Power MOSFET revenue is expected to grow at a 20.3 percent CAGR from 1989 through 1994. In contrast, bipolar power transistors should grow at only a 9.2 percent CAGR during the same time frame. Figure 1 illustrates these different growth trends.

POWER TRANSISTOR MARKET SHARE

Dataquest estimates that the top ten worldwide suppliers of power transistors accounted for 68.7 percent of the $2.28 billion market in 1989. The estimated top 20 suppliers are shown in Table 5.

Many of these companies are involved in both bipolar and MOSFET power transistors to various degrees. Table 6 shows the estimated market share ranking for the top ten MOSFET power transistor suppliers, and Table 7 shows a similar listing for bipolar power transistor suppliers.

MOSFET Prices Dive

MOSFET average selling prices (ASPs) declined dramatically during the past year. As these power devices move out of the realm of niche products into a more mainstream power position, the pressure on selling price increases. In addition to this normal ASP decline as MOSFETs compete for bipolar sockets, the slow 1989 market caused many vendors to cut prices rapidly. International Rectifier (IR) and Samsung, in particular, made strong moves to gain market share.

Two casualties of this pricing battle have been IR and Siliconix. IR essentially mortgaged the company for power MOSFET business and has been in tight financial straits for the past three

TABLE 2
Performance Comparison: Bipolar versus MOS Power Transistors

Feature	Bipolar	MOSFET	IGBT
Control Parameter	Current	Voltage	Voltage
Switching Speed	Low-Medium	Fast	Low
Speed Temperature Sensitivity	High	Low	High
ON Resistance	Low	High	Low
Ruggedness	High	Moderate	Moderate
Input Impedance	Low	High	High
Interface to Logic	Complex	Simple	Simple
Thermal Runaway	Yes	No	Yes
Can Parallel Devices	No	Yes	No
ESD Sensitivity	None	Some	Some

Source: Dataquest (August 1990)

years. A major competitor, Siliconix, which also invested heavily in a 6-inch fab for power MOSFET production, has been reeling from its losses of the past year and recently filed for Chapter 11 protection from its creditors (including IR royalty payments). Siliconix raised prices on its power MOSFET line, which will further reduce its participation in this market. A recent settlement between Siliconix and IR regarding patent infringement resulted in a $12 million payment by Siliconix to IR over a two-year period.

Figure 2 illustrates the ASP decline for MOSFETs over the past five years. Mature bipolar devices, on the other hand, actually have shown ASP increases over this same period. Although MOSFETs may not reach price parity with bipolar devices any time soon, prices are expected to continue declining over the next five years.

TABLE 3
Worldwide Power Transistor Revenue (Millions of Dollars)

			1984-1989 Actuals				CAGR
	1984	1985	1986	1987	1988	1989	1984-1989
Bipolar	1,095	993	1,246	1,598	1,778	1,801	10.5%
MOSFET	145	143	196	273	375	477	26.9%
Total	1,240	1,136	1,442	1,871	2,158	2,278	12.9%
Annual Growth		(9.2%)	26.9%	29.8%	15.3%	5.5%	

			1989-1994 Forecast				CAGR
	1989	1990	1991	1992	1993	1994	1989-1994
Bipolar	1,801	1,820	2,025	2,300	2,585	2,800	9.2%
MOSFET	477	540	675	840	1,040	1,200	20.3%
Total	2,278	2,360	2,700	3,140	3,625	4,000	11.9%
Annual Growth		3.6%	14.4%	16.3%	15.4%	10.3%	

Source: Dataquest (August 1990)

TABLE 4
Worldwide Power Transistor Revenue (Percentage of Total by Type)

			1984-1989 Actuals			
	1984	1985	1986	1987	1988	1989
Bipolar	88.3%	87.4%	86.4%	85.4%	82.4%	79.1%
MOSFET	11.7%	12.6%	13.6%	14.6%	17.6%	20.9%

			1989-1994 Forecast			
	1989	1990	1991	1992	1993	1994
Bipolar	79.1%	77.1%	75.0%	73.2%	71.3%	70.0%
MOSFET	20.9%	22.9%	25.0%	26.8%	28.7%	30.0%

Source: Dataquest (August 1990)

DATAQUEST CONCLUSIONS

Electronic power control, whether for complex systems or simple electronics, embedded or accessible, is growing strongly and carrying both ICs and discrete devices with it. IC solutions to power control applications are limited in their capabilities and require significant cost trade-offs. Because of this, the discrete power transistor market continues to grow at a rate only slightly below that of the IC marketplace. This strong growth, coupled with the issues of MOS/bipolar competition, the proper partitioning/positioning of ICs and power discretes, and a continuing stream of technology developments, brings to the discrete market the same dynamics more commonly seen in the IC arena.

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Gary Grandbois

TABLE 5
Estimated 1989 Market Share for Power Transistors

Rank	Company	Percent Share	Revenue (Millions of Dollars)
1	Toshiba	13.3%	302
2	Motorola	13.0	297
3	NEC	8.3	190
4	SGS-Thomson	7.0	160
5	Hitachi	5.5	125
6	Mitsubishi	4.8	110
7	Philips	4.6	105
8	Matsushita	4.5	102
9	Sanyo	4.2	96
10	Harris	3.4	78
11	Fuji Electric	3.4	78
12	Sanken	2.8	63
13	International Rectifier	2.7	62
14	Siemens	2.5	58
15	KEC	2.2	49
16	Texas Instruments	2.0	45
17	Samsung	1.9	44
18	Siliconix	1.4	32
19	Rohm	1.3	30
20	Shindengen Electric	1.2	28
	Others	10.0	224
	Total	100.0%	2,278

Source: Dataquest (August 1990)

TABLE 6
Estimated Top Ten Suppliers of Power MOSFETs Ranked by Revenue

Rank	Company
1	Motorola
2	International Rectifier
3	SGS-Thomson
4	Toshiba
5	Siliconix
6	NEC
7	Samsung
8	Harris
9	Fuji Electric
10	Hitachi
Total MOSFET Revenue	$477 million

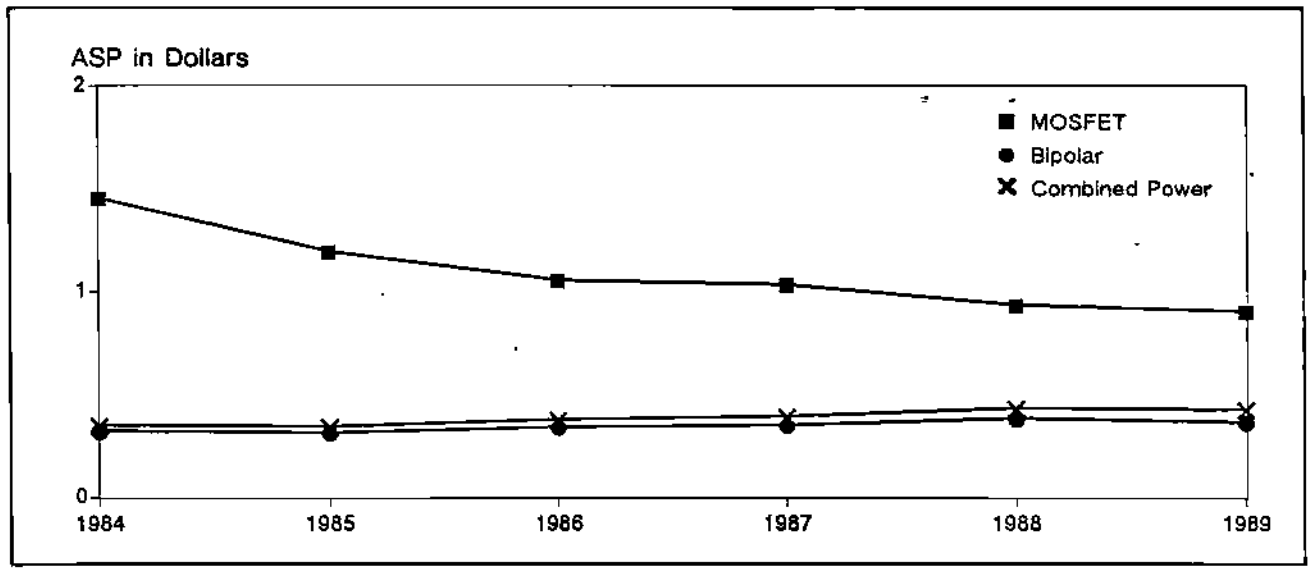
Source: Dataquest (August 1990)

TABLE 7
Estimated Top Ten Suppliers of Bipolar Power Transistors Ranked by Revenue

Rank	Company
1	Toshiba
2	Motorola
3	NEC
4	Hitachi
5	SGS-Thomson
6	Mitsubishi
7	Philips
8	Matsushita
9	Sanyo
10	Sanken
Total Bipolar Revenue	$1,801 million

Source: Dataquest (August 1990)

FIGURE 2
Power Transistor ASP Trend



Source: WSTS, Dataquest (August 1990)

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Research *Bulletin*

JULY MARKET WATCH: WITH DEMAND FLAT, SUPPLIES REMAIN ABUNDANT

Market Watch is a monthly Dataquest bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

WHAT GOES UP. . .THE BOOK-TO-BILL SUCCUMBS TO SUMMER

The June book-to-bill dropped to 1.06 from May's 1.14 level, reflecting the seasonal slowdown in bookings and the residual high billings levels

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

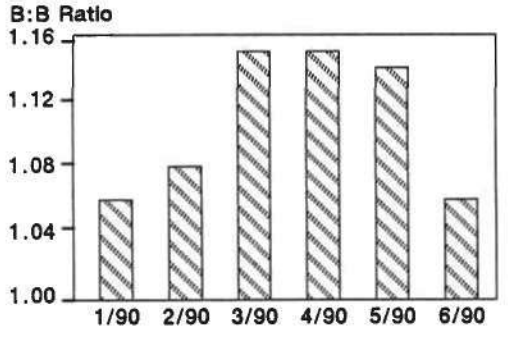


Figure 2
DOC Computer Demand

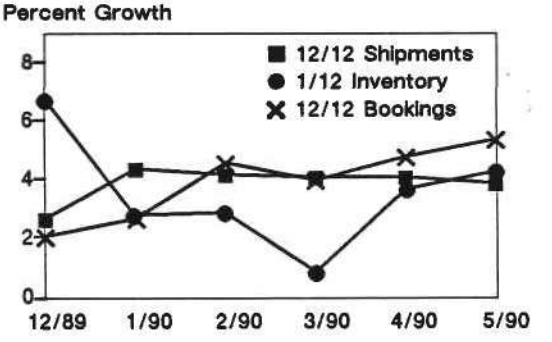


Figure 3
Semiconductor Inventory Level

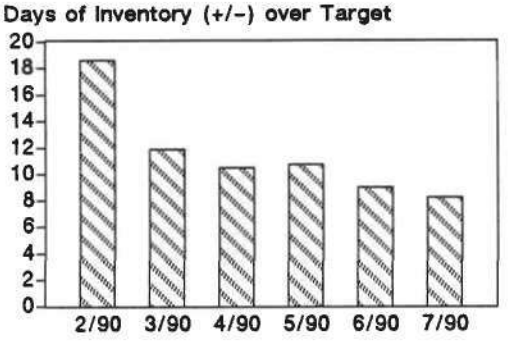
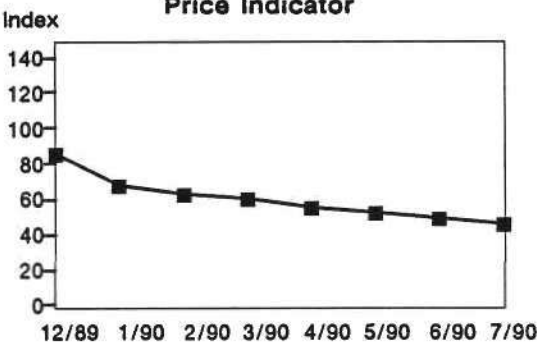


Figure 4
U.S. Weighted Semiconductor Price Indicator



Source: US Department of Commerce, World Semiconductor Trade Statistics, Dataquest (July 1990)

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from the last three months of increased bookings (see Figure 1). Although the "summer slows" are not a new phenomenon, the relative level of bookings decline this June is within the norm. The three-month moving average bookings rate for June is almost 8 percent (7.9 percent) less than May's peak. Comparing the last quarter-ending month (March 1990) with June, we see also that June bookings are down close to 5 percent (4.7 percent). Demand for semiconductors remains positive, although at a lower level, primarily due to seasonality rather than a real drop-off in end-system demand. Dataquest still expects to see positive book-to-bill ratios for the next two months because of the inertia of the past three months of bookings working through the system relative to static booking levels that are forecast by the respondents of our monthly procurement survey.

SYSTEM SALES RATE FLATTENS WHILE BOOKINGS RATE RISES

The US Department of Commerce (DOC) data on computer sales and inventory rates shown in Figure 2 illustrate the relatively positive demand picture that users have been forecasting for the past five to six months in our monthly procurement surveys. May's 12/12 booking rate of 5.4 percent is above the 4.7 percent level recorded for April, while the 12/12 billing rate has remained a constant 3.9 percent for both months. Quarterly data show that the 3/12 bookings and billings rates both declined in May to 6.4 percent and 2.9 percent from April's 8.2 percent and 5.2 percent, respectively. This dip in near-term (3/12) booking and shipment rates is seasonal, historically lasting from May through August (prompting the semiconductor summer slowdowns) and should not be taken as a lack of system demand. Continued optimism exists for system sales for the next six months, as per our sampled procurement managers (see the July issue of *Procurement Pulse*, SUIS newsletter number 1990-24). This optimism, as well as the DOC data, leads us to anticipate that continued positive system sales and readily available semiconductors will be the norm for the remainder of the year.

SEMICONDUCTOR INVENTORIES REMAIN MANAGED

The gap between targeted and actual semiconductor inventory levels again declined to 8.2 days from last month's 9.0-day delta (see Figure 3). Overall targeted and actual inventory levels have risen slightly to 24 and 32 days from 20 and 29 days, respectively. This rise is due primarily to an increased sample size and is not indicative of a trend to downplay the importance of inventory control. It appears that, despite good intentions, the actual inventory levels continue to hover around 12 turns a year, which is historically very good considering that 4 to 5 turns a year was considered average five years ago. Inventory control remains a priority, is being well managed, and is allowing more time to be spent on fine-tuning forecasting accuracy.

ABUNDANT SUPPLIES + FLAT DEMAND = DECLINING PRICES

Prices continue to decline, partly due to flat demand levels, but primarily because some DRAM suppliers are aggressively pricing 256K and 1Mb devices in efforts to gain market share. Isolated areas of aggressive SRAM and EPROM pricing also are keeping overall memory pricing down. Pricing for standard logic continues to remain unchanged, with improvements in DIP capacity now beginning to ease the lead time extensions that have plagued these parts lately. Microprocessor pricing historically changes very slowly, and this month is no exception. Supplies of Intel 32-bit devices have increased, easing the three- to six-month lead times that some customers had to accept a few months ago. The overall semiconductor supply picture continues to improve, with prices and lead times expected to become increasingly manageable.

DATAQUEST CONCLUSIONS

The summer slows have arrived, and they have brought with them the seasonal forecasting and backlog jitters that perennially mark the season. With flat order rates, focus is being put on delivery commitments and incoming quality levels. Looking beyond the near term, even if system sales remain at their current levels of 4 to 5 percent growth, the corresponding semiconductor growth should come very close to Dataquest's forecast of negative 3.5 percent US growth for 1990, primarily due to the price erosion now being seen.

On the positive side, inventory levels of approximately 30 days ensure that the order pipeline will remain filled. Component supplies continue to remain predictable and abundant, while demand is steady but low. Solid foundations for long-term supplier-user relations can be cemented in markets like this.

Mark Giudici

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Research *Bulletin*

JULY PROCUREMENT PULSE: DEMAND STABILIZES WHILE INVENTORIES REMAIN LOW BUT MIXED

The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDERS SEASONALLY LEVEL OFF

As seen in Figure 1, this month's respondents expect to maintain the order levels of last month mainly because of the traditional summer-month slow period that is affected by vacation schedules.

Figure 1
Averaged Monthly Semiconductor Orders

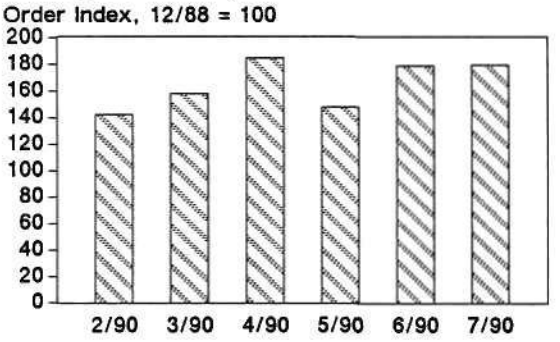


Figure 2
Averaged Semiconductor Lead Times

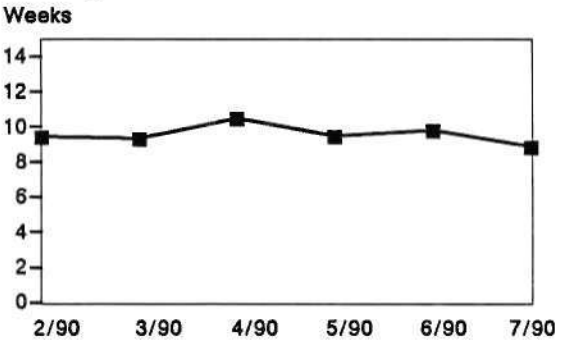


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

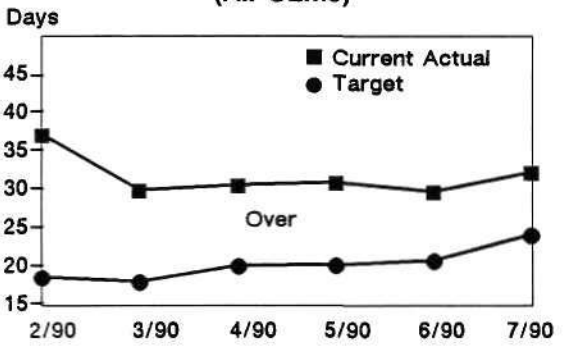
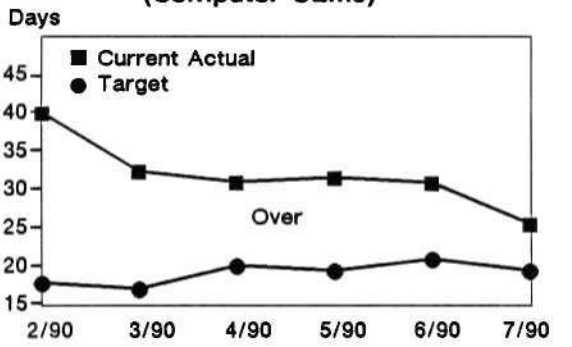


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (July 1990)

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Reflecting the seasonal stabilization in semiconductor orders is a slight decline in the six-month system sales outlook. There is also a break in the last four months' trend of a unanimously positive system sales outlook. The range now spreads from a low of negative 20 percent to a high of 25 percent. The only negative respondents (two) came from the military and telecommunications industries. The current outlook is for 7.3 percent overall systems sales growth through January 1991 (versus 9.4 percent in our last survey). The computer company respondents expect to see an increase of 11.0 percent in sales compared with last month's outlook of 9.6 percent. Even with the improved forecasting and inventory control measures in place, the effects of vacation schedules on order rates still impact business. Dataquest expects overall semiconductor orders to continue this steady to slower pace until the end of summer, after which most buildups for year-end sales begin.

LEAD TIMES DIP TO NINE WEEKS, AVAILABILITY OUTLOOK EXCELLENT

Reflecting the continued improvement of semiconductor availability, current average lead times have dropped to 9.0 weeks from last month's 9.9 weeks with a range of 6.0 to 15.0 weeks for this reporting period (see Figure 2). For the most part, respondents to this month's survey noted no major product problems. The DIP-packaged standard logic shortage is beginning to ease as a result of selected increases in capacity and the aforementioned stabilization of demand.

The continued shift to surface mount also is easing longer lead times for DIP products. As expected in earlier reports, the TTL PLD availability also is improving as capacity increases catch up with demand. Some supply problems still plague the 80386SX parts, but they are expected to be resolved by the end of the summer as capacity ramp-ups are completed.

OVERALL INVENTORIES SLIGHTLY UP, COMPUTER COMPANIES DOWN

Figures 3 and 4 illustrate that overall target and actual semiconductor inventories have risen while the computer company subset has declined somewhat. This is due to an increase of noncomputer companies that responded to the survey. The overall inventory situation is still very manageable, with an average of 32 days of inventory on hand versus a 24-day target. Computer companies continue to improve inventory control, with 26 days of inventory on the shelf versus a 20-day target. With inventory under control, attention is focusing on suppliers' delivery and lead-time commitments, especially for surface-mount devices.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

The stability in the electronics market is now weathering the summer slow season. Inventories remain under control, while order rates are expected to remain flat for the next month or so. Even with seasonality considered, the focus on cost control and accurate forecasts combined with readily available components is keeping the order pipeline filled. Semiconductor supplies are expected to remain abundant for the rest of 1990. In the absence of major problems, the focus now is on improving upon current levels of forecasting accuracy and delivery schedules. As these fundamentals of procurement continue to be improved, the overall order flow pipeline as a result will remain full.

Mark Giudici

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Research Newsletter

SEMICONDUCTOR PRICE SURVEY: DRAM PRICE DECLINES—OTHER GOOD NEWS FOR USERS

SUMMARY

Table 1 shows that the steady downward trend in pricing for megabit-density DRAMs continued during the second quarter of 1990. For major buyers, Dataquest's DRAM forecast remains consistent with last quarter's outlook. Pricing reductions are expected to continue during the second half of 1990, although not at the torrid pace of the latter half of 1989. Demand for 4Mbx1 DRAMs has been slower than originally expected by leading-edge suppliers. Good news for users: Major suppliers have increased output of TTL PLDs that operate at speeds of greater than 15ns. More good news: Motorola and Hitachi appear to have an "agreement to agree" regarding settlement of the 68030 litigation. Lead times for standard logic in a dual in-line package (DIP) should improve during the third quarter, although supply and demand will not balance until year-end 1990.

Please note that the pricing analysis presented here correlates with the quarterly price tables mailed to Semiconductor User Information Service (SUIS) clients on June 21, 1990, and the SUIS service section entitled "Second Quarter 1990 Price Update" dated July 1990. For SUIS clients that use the SUIS on-line service, the quarterly pricing presented here correlates with the quarterly price tables dated June 1990 in the SUIS on-line service. For additional product coverage and more detailed product specifications, please refer to those sources.

TABLE 1
Semiconductor Pricing and Lead Time Trends (North American Bookings)

	Pricing Trend		Lead Times	
Part	Second Quarter	Forecast	Current	Trend
1Mbx1 100ns DRAM, DIP/SOJ	12% down	3% down	4-12 weeks	1 week shorter
4Mbx1 100ns DRAM, DIP	30% down	9% down	4-8 weeks	Steady
1Mbx8 100ns SIMM	15% down	4% down	3-10 weeks	Steady
74F	3% down to 4% up	3% down to 4% up	8-12 weeks	2 weeks shorter
CISC and RISC 32-bit MPU	0-10% down except for 80386SX	1%-9% down	5-10 weeks except for 80386/80386SX	1 week shorter
TTL PLDs, ≤ = 20 pins				
< 15ns	6%-11% down	5%-6% down	3-9 weeks	1 week shorter
≥ or = 15ns	2%-6% down	1%-3% up	3 weeks to allocation	1 to 4 weeks shorter

Source: Dataquest (July 1990)

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MEMORY TRENDS

The second half of 1990 shows indications of aggressive pricing for 1Mb DRAMs—especially on contracts to be forged during the last quarter. Spot market pricing for DRAMs should continue to be erratic and volatile. Users should expect aggressive pricing for higher-density SRAMs (256K and above) during the second half of this year. As noted last quarter, Dataquest expects the 4:1 unit/price crossover to the 4Mb DRAM to occur in North America during the first quarter of 1991.

Megabit-Density DRAMs

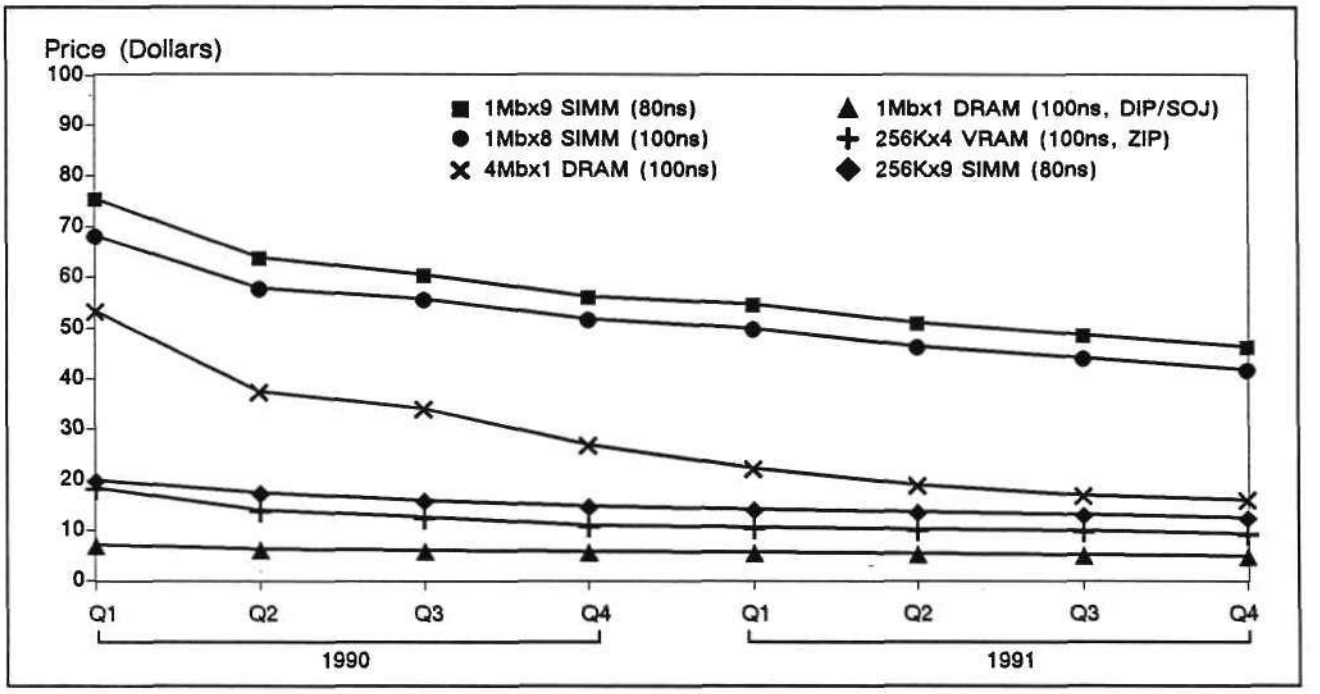
As shown in Table 1 and Figure 1, large-volume contract buyers in North America can anticipate steady declines in pricing for 1Mbx1 100ns DRAMs for the next six quarters. The supply/supplier base continues to expand on an overall basis. A modest price decline during the third quarter should bring the 1Mb DRAM price to $6.15 or lower. On the spot market, 1Mb DRAM prices have fallen below $6.00 at the time that this newsletter was written. Volume contract pricing should fall below the $6.00 level during the fourth quarter of this year.

Table 1 and Figure 1 depict learning-curve rates of price attrition for 4Mbx1 100ns DRAMs, although demand has been slower than expected by leading suppliers. North American users can expect pricing for 4Mbx1 products to decline below the $35.00 level for the third quarter and to a price of $26.90 for year-end 1990. A *few* suppliers call for a fourth-quarter price in the range of $17.00 to $19.00 for 4Mbx1 DRAMs—the goal being a crossover from the 1Mb part by year-end. Dataquest foresees the crossover early next year.

The Range of DRAM Pricing

As noted in prior newsletters, survey confidentiality limits disclosure of exact pricing points; however, the survey responses capture the dynamics behind Dataquest's forecast numbers. For example, Dataquest bases the forecast third-quarter price of $6.15 for the 1Mbx1 100ns DRAM on survey prices that range from a low of $5.70 to a high of nearly $6.45. Two-thirds of survey participants expect a price of $6.20 or less for this product. The

FIGURE 1
DRAM Price Trends—North American Bookings
(Volume: 100,000 Units)



Source: Dataquest (July 1990)

forecast third-quarter price of $34.00 for the 4Mbx1 DRAM is based on survey prices that range from a low of $30.00 to a high of $35.00.

Volatile 1Mb DRAM Spot Market Pricing

During late May and June, Dataquest received reports of an oversupply of 1Mb DRAMs and a consequent sharp downturn in spot market pricing. For large-volume contract buyers, pricing should continue to decline during the third quarter of 1990, although at a slower rate than on the turbulent spot markets.

DRAM Recommendations

For SUIS clients purchasing on the global spot markets, Dataquest recommends weekly monitoring of worldwide 1Mb DRAM and 4Mb DRAM pricing trends through Dataquest's On-Line *Monday* service. This service is geared to track trends that signal developments such as a wholesale collapse in pricing *or* supplier cutbacks in output.

For SUIS clients that purchase 1Mbx1 DRAMs on the basis of volume contracts with established suppliers, Dataquest recommends a continuation of that policy. The clear market trend for second-half bookings, however, should be pricing in the lower range ($5.80-$6.00) and *not* the higher range of prices.

SIMMs: Pricing Competition Increases

As noted in prior newsletters, Dataquest expects steady expansion of the SIMM market in terms of supply and demand with concomitant downward pressure on pricing. This quarter's survey confirms Dataquest's original expectations.

For example, Figure 1 shows that pricing for 1Mbx8 100ns SIMMs declined by 15 percent during the second quarter to a price of just under $58.00. Users should expect a third-quarter price of $55.76 for this device. As a sign of supplier competitiveness, third-quarter pricing should run a narrow range from $54.00 to $56.00.

Another sign of competition in this arena—pricing for 1Mbx9 85ns SIMMs—*also* decreased by 15 percent during the second quarter, moving to a level of $64. Pricing should approach the level of $60 during the third quarter. Pricing for this SIMM is expected to range from $58 to $65.

Slow SRAM: DRAM-Related Pricing Declines During 1990

Oversupply of DRAMs typically means a drop in slow SRAM pricing as memory IC suppliers seek non-DRAM business. For example, pricing for a 32Kx8 100ns SRAM fell 23 percent during the second quarter to a price of $5.55 as suppliers responded to competitive forces in the memory marketplace. Dataquest expects pricing for 256K slow SRAMs to approach the level of $5.00 during the third quarter, with prices ranging from $4.00 to nearly $6.00.

Another example of the DRAM-slow SRAM link was discussed in last quarter's newsletter. Weak demand this year for 4Mb DRAMs means increased supply of 1Mb slow SRAMs. The result was a 30 percent slash in pricing during the second quarter for 128Kx8 100ns SRAMs and an expected decline of 17 percent during the third quarter. Third-quarter pricing should range from $25 to the low $30s.

Nonvolatile Memory: Shifting Price Trends

Suppliers of nonvolatile memory confront 1990 pricing pressure. However, the pressure has hit different product segments at different times. For example, prices for high-density EPROMs declined rapidly earlier this year as suppliers grappled for market share. The rates of price decrease for EPROMs at densities of 256K and greater are expected to slow from double-digit rates to single-digit rates during the third quarter. Prices will remain competitive. Pricing for 256K EPROMs should range from $1.80 to nearly $2.40 and from $6.00 to $9.00 for 1Mb products.

The results of this quarter's price survey and other sources reveal signs of increased pricing competition among suppliers of CMOS ROMs (especially densities of 512K and greater). Pricing for these devices declined at double-digit rates during the second quarter, and similar decreases are expected for the third quarter.

Current ROM market conditions are marked by expanding North American production by Japan-based suppliers and a growing US supplier base. Under these conditions, the price of CMOS 128Kx8 ROMs should range from $2.22 to $3.60 with CMOS 256Kx8 ROMs ranging from under $4.00 to nearly $5.00 during the third quarter.

MICROPROCESSOR TRENDS

Some users continue to confront extended lead times and/or limited supply of 80386SX and 80386 devices. A 5 percent price increase for 80386SX 16-MHz MPUs during the second quarter refueled price competitiveness among suppliers of 80286 10-MHz and 80286 12-MHz products. Users should expect the price of 80386SX 16-MHz devices to remain virtually flat at the $64 level during midyear 1990. By contrast, users can expect pricing for 80286 12-MHz chips to fall below the $11 barrier during the third quarter.

Pricing for 80386 16-MHz devices should be relatively stable in the mid-$160 range next quarter. Pricing for 80386 25-MHz parts should decline by 2 percent during the third quarter to a price of $186.

Prospective Settlement of 68030 Patent Litigation

At the time that this newsletter was written, Hitachi and Motorola had revealed that progress was being made on a settlement of the 68030 case. Motorola continues shipping this device. Should an accord be reached, a likely date for settlement would be August or September 1990.

Dataquest pricing forecast for 68030 products remains consistent with last quarter's expectations. For example, pricing for 68030 16-MHz MPUs declined as anticipated during the second quarter to a price of $141. Dataquest forecasts a third-quarter price of $131 with prices ranging from $127 to $132. We expect the price of the 68030 25-MHz device to decline by 3 percent during the third quarter to a price of $193. Prices should range from $184 to $195.

Motorola Slashes Pricing of 68030s in Surface-Mount Packages

During the second quarter, Motorola announced sharp price cuts for 68030 parts packaged in a ceramic quad flatpack (CQFP) versus devices packaged in ceramic pin grid arrays (CPGA). The CQFP product is the surface-mount version and is priced as much as 50 percent lower than CPGA parts. Motorola's goal is part of a long-term strategy to capture a larger share of PC design wins.

STANDARD LOGIC TRENDS

As shown in Figure 2 and Table 1, pricing for standard logic families should stabilize—with some exceptions—during the third quarter, especially for DIP devices.

DIP Supply Constraint

During the second quarter, the standard logic market experienced a supply/demand imbalance for standard logic devices in the DIP. Lead times stretched by 4 to 8 weeks for families such as 74LS, 74F, and 74HC in DIP. Users of DIP products can expect some relief during the third quarter, although the shortage will not ease completely until the fourth quarter of 1990.

ASIC TRENDS

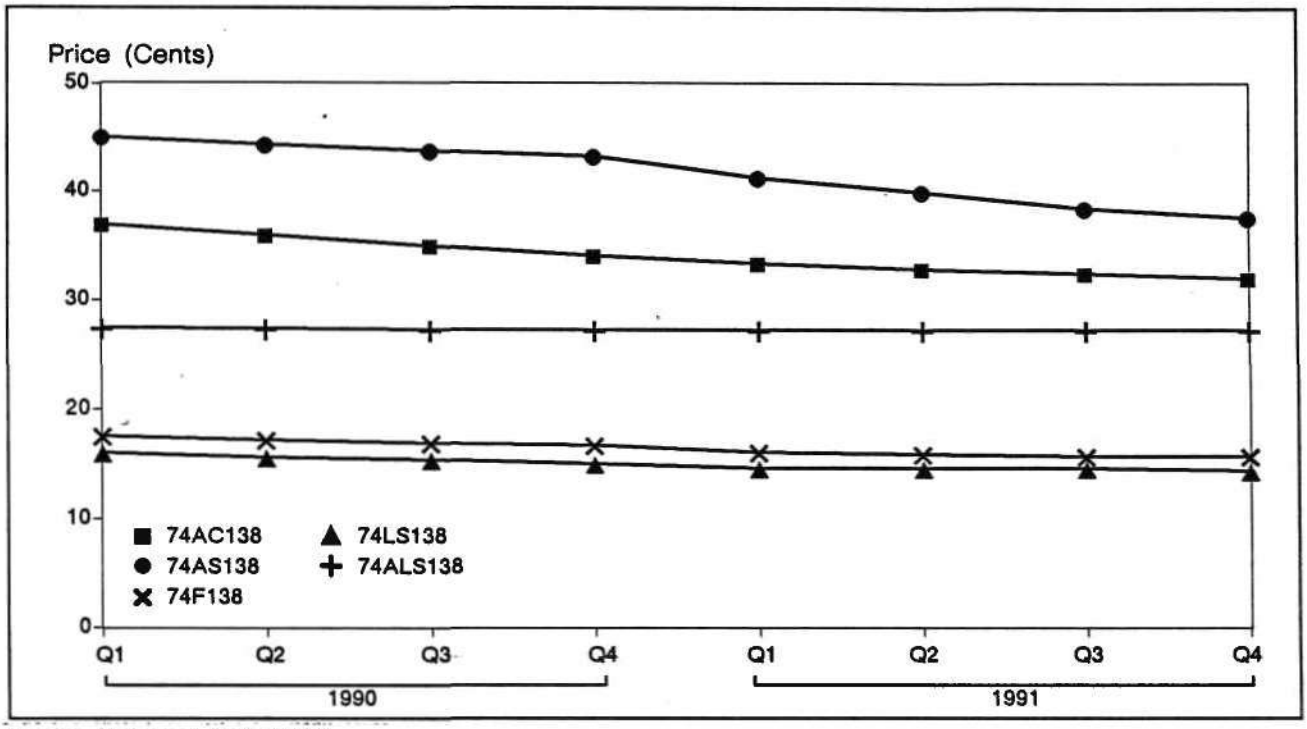
Pricing for ASICs remains very competitive. As shown in Figure 3, users can continue to look for aggressive pricing by suppliers of 1.0-micron and 1.5-micron CMOS gate arrays and 1.0-micron and 1.5-micron cell-based ICs (CBICs). Dataquest analysts also report sharp price cuts for 0.8-micron and 1.2-micron CMOS gate arrays and 0.8-micron and 1.2-micron CBICs.

For example, users of CMOS gate arrays or CBICs can look forward to declines of as much as 5 percent in pricing for 1.0-micron devices during the third quarter. Figure 3 illustrates the sharp downward trend in pricing for 1.0-micron and 1.5-micron gate arrays. We expect 1.0-micron and 1.5-micron CBICs to maintain momentum—if not accelerate—during the second half of this year.

PLD TRENDS

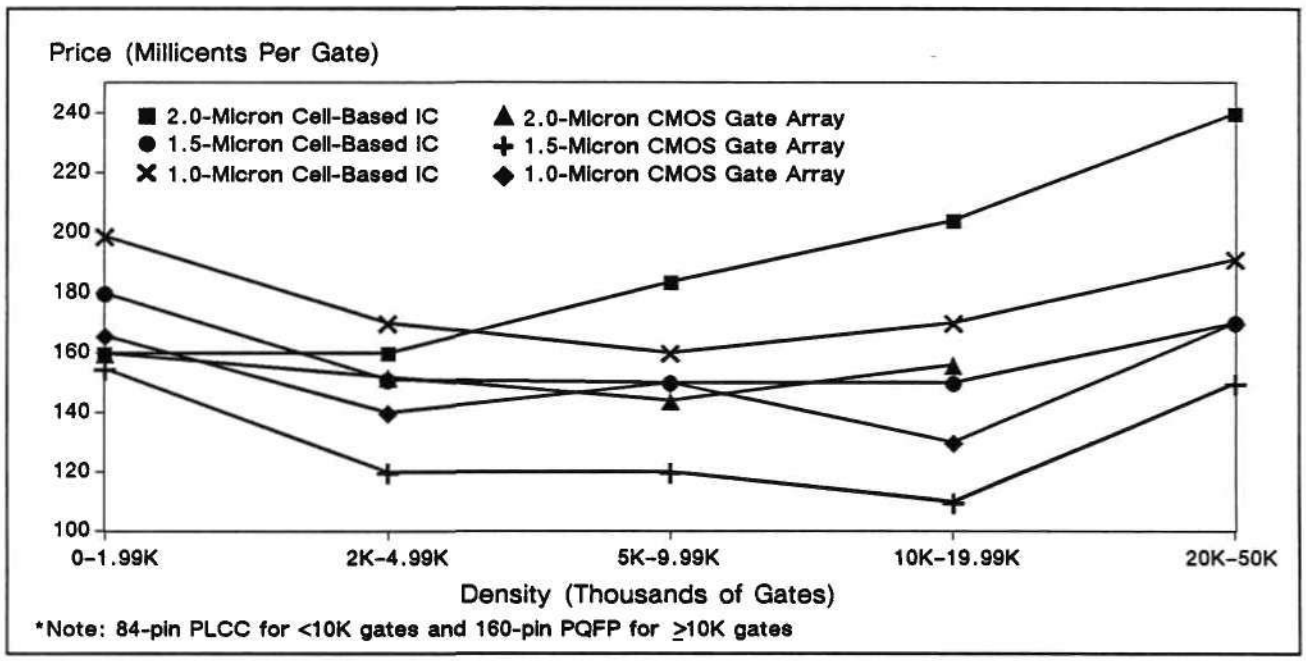
As shown in Table 1 and Figure 4, users of TTL PLDs—which represent the majority of design wins—can expect steady pricing declines and manageable lead times *except* for devices that operate at speeds of 15ns or slower. The recent supply constraint affecting the TTL PLD segment has been alleviated by increased supplier capacity except for the slower-speed products. Users of CMOS PLDs were not affected by the TTL PLD supply/demand imbalance. As stated in prior forecasts, suppliers of PLDs will continue to battle against each other as

FIGURE 2
Standard Logic Price Trends—North American Bookings
(Volume: 100,000 Units)



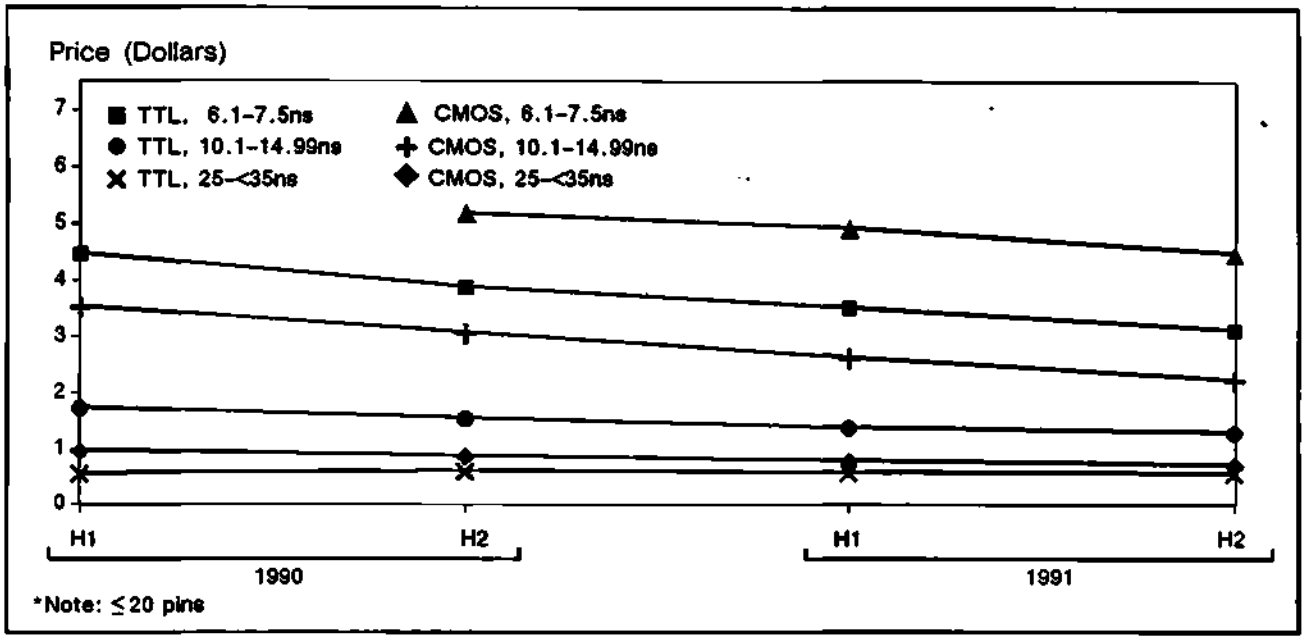
Source: Dataquest (July 1990)

FIGURE 3
ASIC Price Trends—North American Bookings
(Volume: 10,000 Units; Utilized Gates; Excludes NRE)



Source: Dataquest (July 1990)

FIGURE 4
PLD Price Trends—North American Bookings*
(Volume: 10,000 Units; PDIP or PLCC)



Source: Dataquest (July 1990)

well as against suppliers of standard logic and other ASICs for design wins.

Varying PLD Lead Times

As shown in Table 1, lead times for TTL PLDs that operate at speeds of 15ns or slower stretched dramatically—to more than 20 weeks in some cases—during the second quarter. Lead times for these parts should slowly improve over the second half of 1990. Lead times for faster-speed TTL PLDs are manageable and range from 3 to 9 weeks. These times should decrease by 1 week during the next quarter.

Lead times for CMOS PLDs that operate at speeds slower than 10ns continue to range from 4 weeks to 12 weeks. Lead times for faster-speed CMOS PLDs range from 4 weeks to 18 weeks. CMOS PLD lead times should hold steady.

DATAQUEST CONCLUSIONS

The information gathered during Dataquest's May to June poll of semiconductor users and suppliers and from other sources shows that contract-volume buyers of DRAMs can anticipate steady or sharp pricing declines during the second half of 1990. Pricing has been very aggressive on the low side in the volatile and erratic global DRAM spot markets. Motorola and Hitachi now appear to have an "agreement to agree" regarding a settlement of the 68030 litigation. North American users can look forward to competitive pricing during the third quarter for megabit-density DRAMs, slow SRAMs, CMOS gate arrays, CMOS CBICs, and PLDs (except for slower speed TTL devices). Under current conditions, Dataquest makes the following recommendations.

DATAQUEST RECOMMENDATIONS

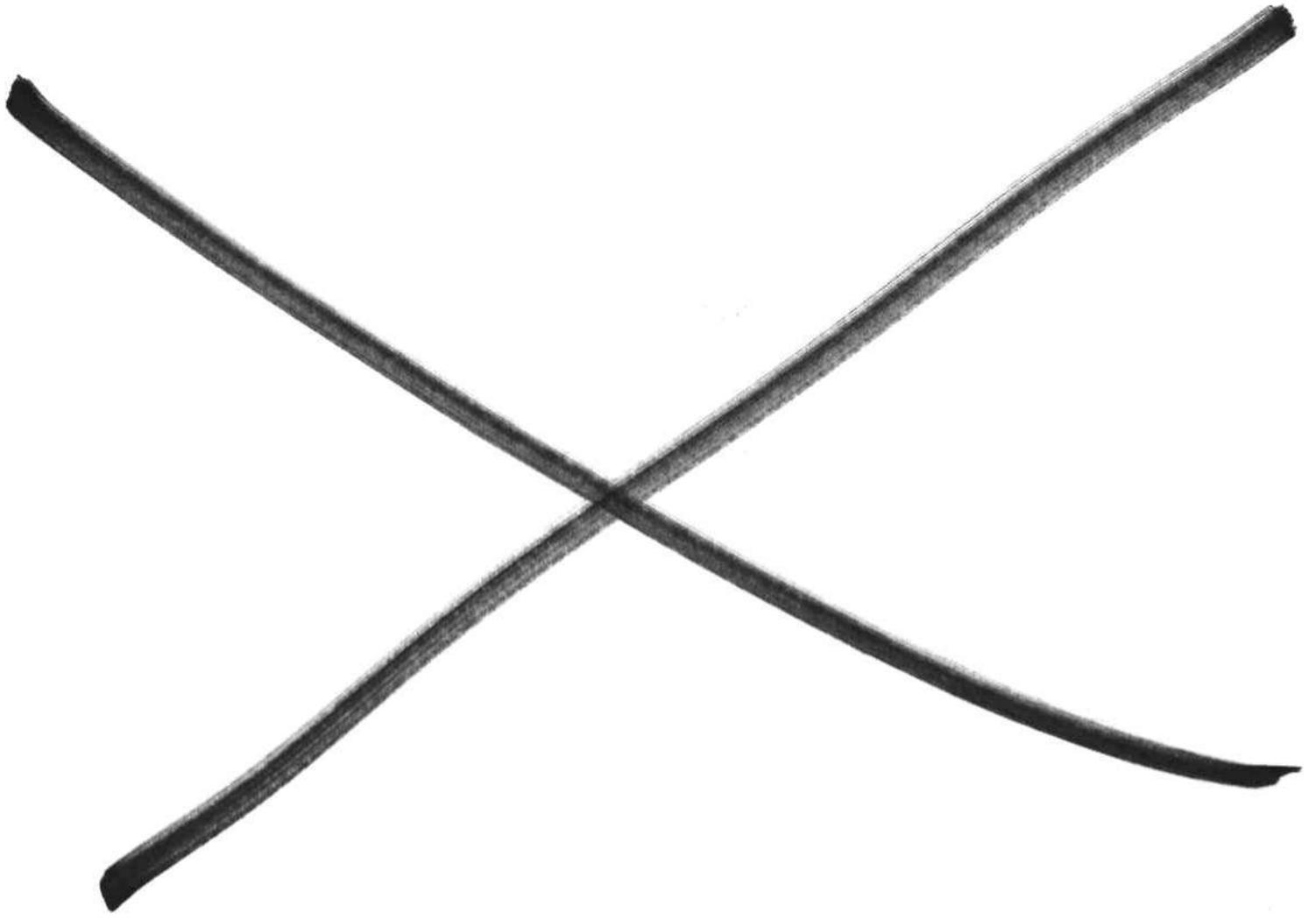
Dataquest recommends that major North American and European buyers of 1Mb DRAMs and 256K DRAMs should continue to purchase on the basis of long-term volume contracts with established suppliers. For third-quarter bookings, Dataquest's recent poll shows a 1Mbx1 DRAM price range from $5.80 to $6.43. Under current market conditions, users should plan to book DRAM

orders on the lower side of the range (i.e., below $6.00). For another 1Mb memory product—128Kx8 100ns SRAMs—users must monitor 4Mb DRAM market developments because of the strong impact that 4Mb DRAM trends have on 1Mb slow SRAM supply and pricing.

Users of standard logic products and TTL PLDs should carefully watch supply/demand trends through the use of Dataquest's On-Line *Monday* service. These markets continue to move in and out of supply/demand balance, depending on factors such as product package (e.g., DIP versus SMT standard logic) or device speed (TTL PLDs that operate at speeds faster or slower than 15ns). On-Line *Monday* is designed to capture early signals of changes in semiconductor demand and supply and assist users in avoiding supply constraints such as those that recently affected these segments.

Dataquest restates the prior recommendation that users that incur firmer bipolar standard logic pricing migrate during 1990 to newer CMOS standard logic families, CMOS gate arrays, CMOS CBICs, or PLDs (except for slower-speed TTL devices).

Ronald Bohn



January-March

The following is a list of the newsletters in this section:

- **January Procurement Pulse: Orders and Inventories Rebound Up, Prices and Lead Times Fall** (1990-01)—The *Procurement Pulse* is a monthly update of critical issues and market trends based on Dataquest's monthly survey of major OEM semiconductor procurement managers. This month's *Procurement Pulse* discusses order rates picking up appreciably, primarily in anticipation of new systems sales and partially to refill key inventory levels. Dataquest believes that the next six-month system sales outlook is moderately optimistic and that component availability is at a 12-month high.
- **January Market Watch: The Market Pickup May Be a False Start** (1990-02)—The *Market Watch* is a monthly bulletin that is released after the SIA book-to-bill *Flash Report*. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months. This month's *Market Watch* focuses on the existing optimism in the systems markets. Semiconductor suppliers are doing an excellent job of supporting their customers through these highly competitive times. Until a definite change in the end markets takes shape, we expect this static shipment/demand/inventory situation to continue.
- **Semiconductor Price Survey: Megabit-Density DRAM Crossover, Single-Sourced ICs Highlight the Start of 1990** (1990-03)—Semiconductor users can continue to look forward to lower prices (with several exceptions), although the overall pace of price declines should slow somewhat from the pace of 1989. The first quarter of 1990 should be a period of declining semiconductor prices, although the declines will not be as sharp as during 1989. This newsletter discusses Dataquest's three-point recommendation.
- **Users' Microprocessor Dilemma: The Limited Future of the 80286 Versus a Limited Allocation of the 80286SX** (1990-04)—Currently, systems manufacturers are experiencing a change from a multisourced component world to an increasingly sole-sourced arena. For users, this strategic concern means a tactical challenge—deciding whether to continue building machines based on the 80286 or to move to a product such as Intel's 80386SX, which is single-sourced. Dataquest believes that the move from a multisourced component world to a single-sourced arena means changing strategies and tactics for supply-base managers.
- **February Procurement Pulse: Billings, Lead Times, Orders Flat While Inventories and Sales Expectations Remain Up** (1990-05)—This month's *Procurement Pulse* examines how stabilizing order rates and lowering lead times, combined with an upbeat system sales outlook, set the stage for a moderate growth scenario that hinges on accurate forecasting.
- **Will There Be Another DRAM Shortage in 1990?** (1990-06)—Dataquest has not eliminated the possibility of a DRAM shortage in 1990, considering recent events that are similar to those that sparked the two-year DRAM shortage that began in 1987. However, other factors make this situation different than in 1987, leading us to conclude that a shortage, if it does occur, should be short and temporary. DRAM purchasers should continually give the suppliers a true and accurate forecast of their future requirements and not rely excessively on spot buys.

- **February Market Watch: Market Still Growing, but Mixed Signals Appear** (1990-07)—This month's *Market Watch* discusses how once again mixed signals are on the rise. Dataquest still expects the first quarter of 1990 to be a mild improvement over the last quarter of 1989 despite the return of mixed market signals. It is becoming increasingly difficult to characterize the improvement because, as in any weak market, some companies will feel it and some will not.
- **1990 Semiconductor User Survey Focus Changes from Availability to Supplier Performance** (1990-08)—Three key findings were a result of the Fifth Annual Dataquest Semiconductor User Survey. Respondents expect to increase their 1990 semiconductor purchases by 9.6 percent. Medium-size semiconductor users are the most optimistic about growth opportunities in 1990. The top three issues are on-time delivery, price, and cost control. This newsletter summarizes the presentation given at the Semiconductor User and Applications Conference and highlights the key findings of this survey.
- **True or False: User/Supplier Relationships to Change in the 1990s?** (1990-09)—This newsletter summarizes the conference by discussing the changes affecting the semiconductor industry today, ways in which Dataquest clients can seize opportunities while hedging the downside. It also covers industry forecasts for the 1990s, and Dataquest's second annual "Semiconductor Supplier of the Year" award.
- **Global Regional Pricing Strategy Brings Key Advantages to Semiconductor Users and Suppliers** (1990-10)—At Dataquest's Semiconductor Users and Applications Conference, the authors of this newsletter spoke of strategic and tactical IC pricing trends. This newsletter highlights Dataquest's key strategic recommendations, with special emphasis on the advantages of a global regional pricing strategy. In addition, Dataquest recommends that suppliers and users actively track and manage world regional IC pricing differentials.
- **March Procurement Pulse: Bookings and Sales Outlook Steady; Inventories, Lead Times, Prices Decline** (1990-11)—Stable semiconductor order rates and the low-key optimism forecast in system sales continue to provide optimum conditions for predictable supply cost forecasts. Frequent forecasts will allow for the current supply situation to continue.
- **March Market Watch: The Market Keeps Slowly Chugging Along** (1990-12)—This month's *Market Watch* examines rising book-to-bill ratios, computer demands stabilizing while inventories plummet, and prices rising slowly. The overall market continues to bump along with steady but unspectacular demand, and suppliers have cut supplies to match this unexciting goal. Dataquest believes that the test is whether or not users can accurately forecast their real six-month needs and suppliers can meet this test.
- **Chips & Technologies Product Expands Beyond PC Boundary** (1990-13)—Chips & Technologies, Inc., recently introduced a new chip set product—The Multi-Processor Architecture Extension (MPAX). MPAX is a modular system architecture (MSA) standard that is designed to allow system OEMs to easily implement multiple-processor computer products based on PC platforms. The introduction of a new standard is a departure from the typical Chips strategy of bringing to market products based on established standards.

- **IBM and Siemens in 64Mb DRAM Project** (1990-13)—Siemens, the largest European manufacturer of DRAMs, and IBM have teamed up to develop the technology required for the 64Mb DRAM. This bulletin discusses the implications of this joint venture for the DRAM market and both companies.

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Research *Bulletin*

DECEMBER MARKET WATCH: DEMAND SLOWS, BUT INVENTORIES AND PRICING DECLINE IN KIND

The *Market Watch* is a monthly Dataquest bulletin that is released after the SIA book-to-bill Flash Report. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL RATIO DIPS TO 0.90; SHORT-TERM ORDER LEVELS MIXED

The book-to-bill ratio declined to a new low, 0.9, after two subparity months in September and October (see Figure 1). The three-month average

Figure 1
U.S. Semiconductor Book-to-Bill Ratio

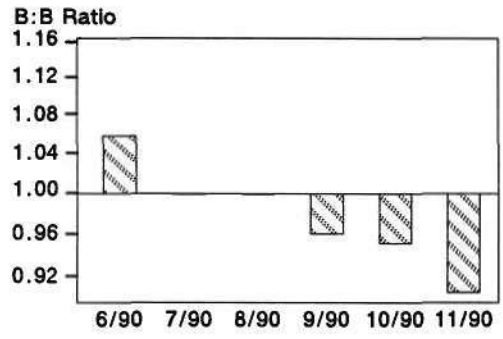


Figure 2
DOC Computer Demand

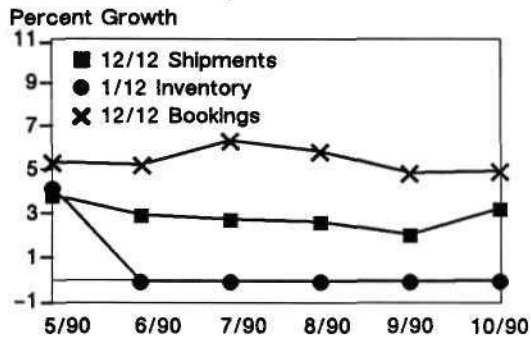


Figure 3
Semiconductor Inventory Level

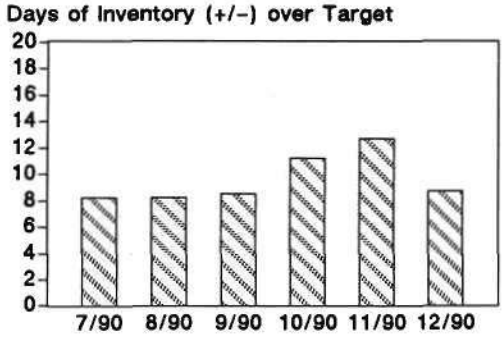
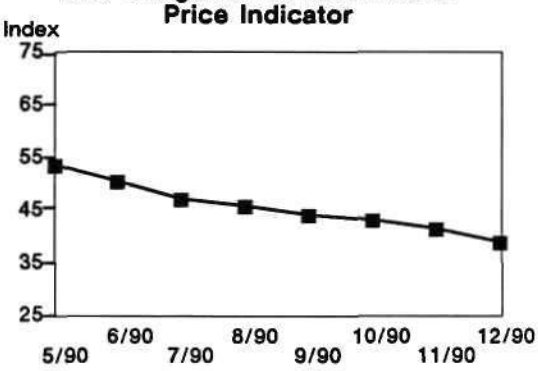


Figure 4
U.S. Weighted Semiconductor Price Indicator



Source: WSTS, US Department of Commerce, Dataquest (December 1990)

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bookings level dropped 6.0 percent from October's level and fell 5.4 percent from the November 1989 mark. Total semiconductor billings (three-month average) for November rose 2.1 percent over October 1990 levels and were essentially flat (negative 0.1 percent) compared with November 1989 billings. The current level of semiconductor business as shown in dollars is fairly consistent with the end-market business dynamic that is trying to maintain a low year-end cost of sales for both finished goods and raw materials. The semiconductor inventory bubble discussed in last month's *Market Watch* also contributed to a reduction of some major companies' orders. As mentioned in the December *Procurement Pulse* (SUIS newsletter 1990-43), the current low-growth forecast for system sales has possibly bottomed out, with procurement managers expecting a 4.0 percent six-month increase in system sales relative to last month's 3.1 percent growth outlook. To meet this demand, in December buyers expect to increase semiconductor orders 29.4 percent over November's levels. The steady demand for systems and ready availability of semiconductors combined with controlled inventories is allowing procurement to closely match order levels of ICs with end-system shipments. Even with proposed cutbacks in Japanese memory products, Dataquest expects this environment to continue for the next six months.

COMPUTER INVENTORIES FLAT, BOOKINGS STABILIZE, AND SHIPMENTS CLIMB

Figure 2 shows a fairly balanced low-growth scenario that is predicated on abundant, stable supplies of raw material (i.e., semiconductors). The annualized (12/12) shipment level rate rose in October to 3.3 percent over last month's 2.0 percent level, reinforcing earlier data that shipment levels will remain at low-growth levels through year-end. The new order bookings 12/12 rate rose slightly to 5.0 percent relative to last month's 4.8 percent level, foretelling steady growth during the next two quarters. Looking at the near-term historical comparison of bookings, the current three-month period (August to October) versus the previous three-month period (May to July) for new computer orders shows an increase of 1.0 percent, confirming this low-growth trend. Dataquest does not foresee any change in near-term demand patterns that would alter this low-growth trend.

SEMICONDUCTOR INVENTORIES REDUCED; TIME FOR YEAR-END AUDITS

Figure 3 illustrates how the delta between targeted and actual inventories declined this month. Also important is that the targeted and actual inventory levels have declined as well, from 22.2 and 34.9 days to 19.0 and 27.7 days, respectively. The ready availability of semiconductors and improved forecast reviews have allowed for quick corrections to above-plan inventory levels, as seen in this month's fix to last month's inventory increase. As mentioned in last month's *Market Watch* (SUIS newsletter 1990-40), this correction was anticipated as companies finalize their year-end sales pushes and moderate semiconductor orders. Beginning next month, Dataquest expects to see a return to pre-year-end buying patterns that are based on system sales expectations.

PRICES CONTINUE TO DECLINE AS DEMAND FLATTENS OUT

Figure 4 shows how semiconductor abundance continues to cause prices to decline as semiconductor demand becomes more a direct function of system sales. Because of the relatively slow and steady growth of computers (see Figure 2) and electronics as a whole and the overshoot of semiconductor supply relative to that demand, we expect prices to continue their gradual decline for the next six months. The direction that the Middle East crisis takes will have some effect on capital spending plans which, in turn, may negatively impact semiconductor sales because of close association with system and semiconductor shipments. Regardless of the crisis' outcome, semiconductor prices are expected to continue to decline.

DATAQUEST CONCLUSIONS

Overall electronic system demand remains in a low and steady growth mode which, considering the alternatives, is relatively positive. The implications of this market environment on semiconductor procurement depends on frequent and accurate forecast updates with suppliers. Visibility of short- and midterm demand currently is forcing suppliers to readjust quickly to changes in annual contracts, which results in lower inventories for both users and suppliers. Dataquest expects the current method of forecast-update-procure on a quarterly (or more frequent) timetable to continue as long as this slow electronics market continues. Although time-consuming and cumbersome, it is proving to be the best way yet to control costs and improve service.

Mark Giudici

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Research *Bulletin*

DECEMBER PROCUREMENT PULSE: ENDING THE YEAR ON A POSITIVE NOTE

The *Procurement Pulse* is a monthly update of critical issues and market trends based on surveys of semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

A RISE IN SEMICONDUCTOR ORDERS PLANNED

Figure 1 illustrates how this month's survey respondents expect to increase semiconductor orders by 29.4 percent over last month's levels. Last month's expected 5.0 percent rise in orders was

Figure 1
Averaged Monthly Semiconductor Orders

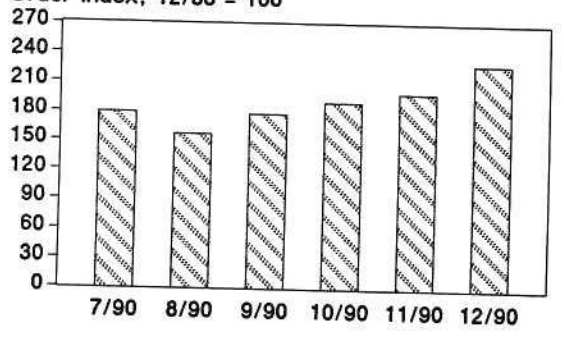


Figure 2
Averaged Semiconductor Lead Times

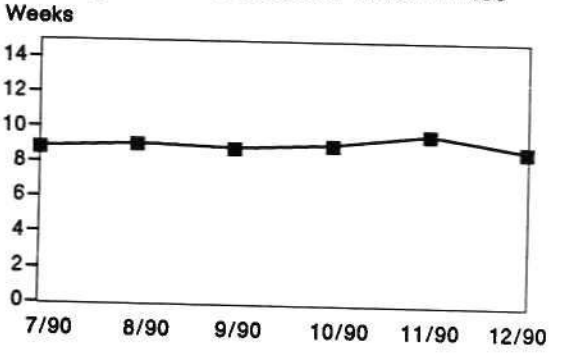


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

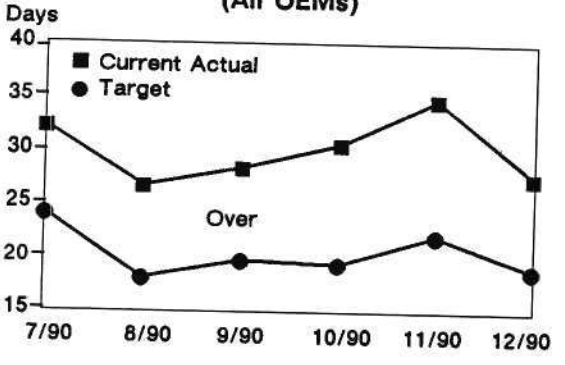
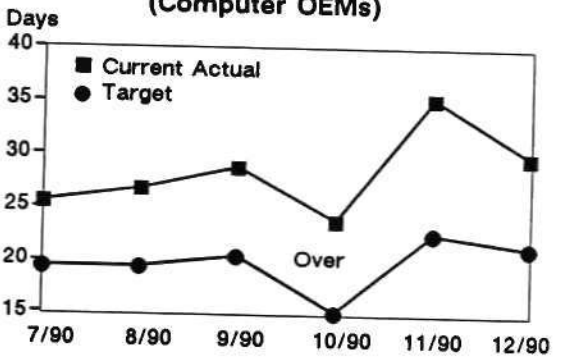


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (December 1990)

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tempered by a slight increase in inventories that, as shown later in this bulletin, has been corrected. The most recent buying optimism reflects an increase of confidence in system sales. For the first time in six months, buyers expect a slight rise in system sales from last month's overall 3.0 percent growth level to 4.1 percent. The computer system buyers' outlook also is up, to 6.7 percent from last month's 6.0 percent level. Although one month does not make a trend, this slight uptick in system sales expectations possibly signals a bottoming of the "low-growth" sales scenario of the past few months. Dataquest sees little indication that a large downturn in systems or semiconductor business will occur in the next six months.

LEAD TIMES REMAIN STEADY—DIP TO BELOW NINE WEEKS

This month's average lead time dipped to 8.9 weeks from last month's 9.8-week level, as shown in Figure 2. For the *fourth consecutive month, all survey respondents reported no problem products,* attesting that availability continues to be a nonissue. Although many products are available with sub-eight-week lead times, it appears that many users prefer a six-to-eight-week planning window that allows for adjustment to month-to-month system shipment variances. Overall pricing declined an average of 2.1 percent since last month. Dataquest continues to see no impediment to ready availability and lower pricing for all semiconductors for the next two quarters, because current capacity should be more than enough to meet demand levels for the next six months. Quality and obsolescence are the main concerns facing semiconductor users this month; both are areas in which suppliers may be able to stand out in this very competitive market.

SEMICONDUCTOR INVENTORY LEVELS ARE ADJUSTED DOWNWARD

Both targeted and actual inventory levels declined this month, reflecting the combination of corrections to last month's uptick and efforts to improve financial reports. As shown in Figures 3 and 4, the overall targeted and actual inventory levels declined to 19.0 and 27.7 days, respectively, compared with last month's comparable levels of 22.2 and 34.9 days. The computer segment's targeted and actual inventory levels dropped to 21.5 and 30.0 days, respectively, versus last month's comparable 22.8- and 35.5-day levels. As mentioned in last month's *Procurement Pulse,* these reductions in inventory were expected. Semiconductor billing levels are expected to rise by 8.1 percent this month after last month's negative 3.2 percent average, which effectively reduced inventories. The current average billing increase illustrates how semiconductor procurement is becoming more closely tied to the overall cycle of the electronics industry. Despite intentions to target inventory levels to about a 20-day average, it is becoming apparent that the actual average of 30 days (±3 days) is the norm.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

The low-growth systems sales outlook and tightly controlled inventory level trend continues. Because no large volume "new" product is pulling demand, semiconductor capacity levels are able to exceed current needs. Availability, predictable pricing, and delivery performance have become the mainstay at current business levels. Many suppliers have noted improvements in forecast accuracy from users, which is helping keep overall inventory levels (for both users and suppliers) manageable. Dataquest continues to expect steady (but low) system and semiconductor demand for the next two quarters until the overall economy sorts itself out and the Middle East crisis is resolved.

Mark Giudici

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Research *Newsletter*

PACKAGING TECHNOLOGY: FROM AFTERTHOUGHT TO ENABLER

SUMMARY

Over the next decade, the demands of high-performance electronics systems will cause a dramatic shift in interconnect technology from the traditional dual in-line package (DIP) to advanced surface-mount technology (SMT) applications such as tape-automated bonding (TAB), flip-chip, and chip-on-board (COB). As the semiconductor industry approaches the 21st century, single-chip packaging solutions will increasingly give way to multichip modules (MCM) as the semiconductor industry enters an era of high-density interconnect (HDI).

During the next decade, the demands of the high-end ASIC business, particularly gate arrays, will have the biggest influence on the growth of SMT packaging. As we approach the year 2000, the technical workstation market, especially through its impact on microprocessor architectures, will play an increasingly important role in the advancement of MCM technology.

Given the necessary investments in developing an HDI infrastructure, the cost of penetrating a rapidly expanding packaging market will be enormous. As a result, industry participants that realize the critical performance factors necessary to high-performance system design will be forced to make investments in interconnect R&D similar to those made in semiconductor technology during the last decade. The high end of the data processing market of the 1990s could very well be dominated by the region that approaches the interconnect challenge in the most expedient fashion.

This newsletter looks at ASIC and reduced-instruction-set computer (RISC) trends as they affect worldwide packaging production over the next ten years. The analysis and data on which this newsletter is based are the result of an 18-month multiclient study conducted by Dataquest's Semiconductor Consulting Group, which culminated in the June 1990 publication of Dataquest's *VLSI Packaging Study*, a 400-page report on the future of the semiconductor packaging market.

FROM TH TO SMT: THE NEXT FIVE YEARS

Table 1 presents Dataquest's forecast for worldwide packaging production over the next five years, with a ten-year leap to the year 2000. The table describes the market as we believe it will act if the emerging interconnect technologies or their enhancements are not superseded by others. Although the traditional through-hole (TH) packages will maintain a sizable but declining share of the market, as shown in Table 1, SMT is expected to reach a 71 percent share of worldwide packaging production by 1994.

THE ASIC IMPACT

Over the next five years, Dataquest believes that the transformation of electronics industry designs from standard ICs to ASICs will be the most significant force in changing package interconnect. This is true not only because of the trend in higher-pin-count devices, but also because of the sheer pervasiveness of ASIC devices. Dataquest believes that from an $8.6 billion market in 1989, ASIC consumption will reach nearly $18.0 billion by 1994.

The largest segment of the worldwide ASIC market during this period will continue to be gate arrays, which will grow in revenue from just under $4 billion to almost $11 billion. Gate arrays will be the product area contributing most to both package proliferation and developments through the year 2000. The shift in gate array package production over the next decade from DIP, chip carrier, and PGA to SMT and MCM solutions is illustrated in Figures 1 and 2.

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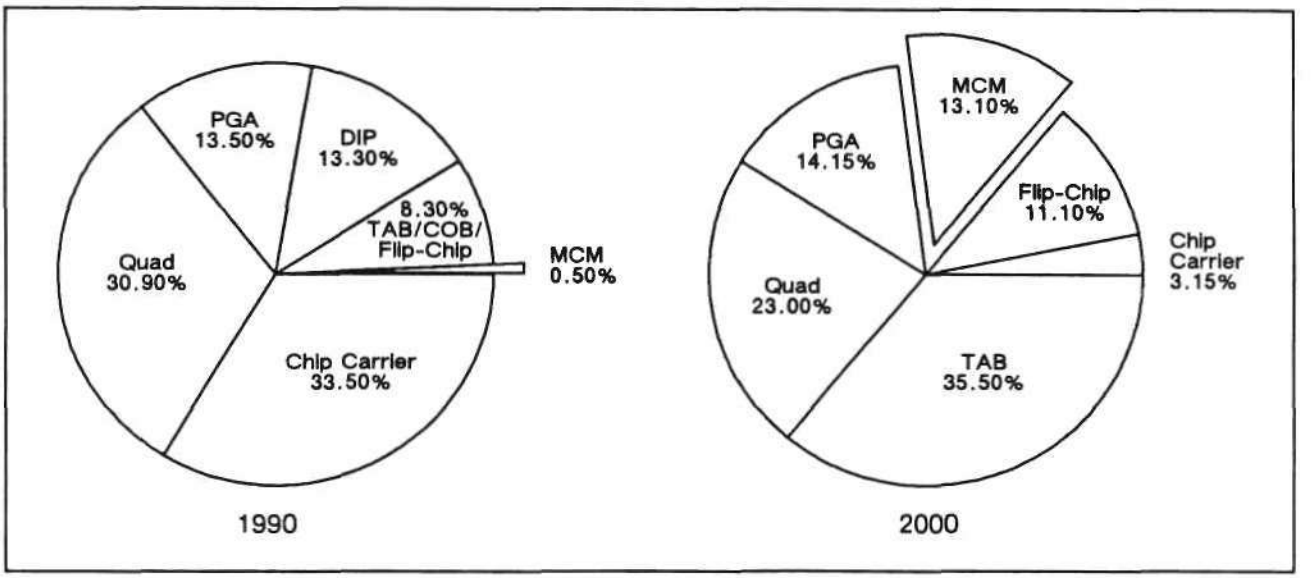
TABLE 1
Estimated Worldwide Package Production
(Millions of Units)

	1987	1988	1989	1990	1991	1992	1993	1994	2000
Plastic DIP	18,749	22,870	22,632	20,359	18,128	16,209	14,700	11,401	1,839
Ceramic DIP	3,479	3,958	3,583	3,251	3,206	3,039	2,922	2,621	1,327
QUAD	281	735	1,857	2,718	4,312	7,053	14,100	14,990	28,300
Ceramic Chip Carrier	138	191	246	270	302	405	431	387	160
Plastic Chip Carrier	203	332	425	466	623	809	899	804	341
SO	1,596	2,921	4,737	5,584	7,277	8,860	11,810	12,430	14,607
Ceramic PGA	49	137	181	256	410	641	807	862	482
Plastic PGA	11	34	85	147	248	554	770	904	587
TAB/COB/Flip-Chip	410	1,014	1,605	2,219	4,223	7,812	13,042	16,204	53,843
Total (Single Chip)	24,916	32,192	35,351	35,270	38,729	45,382	59,481	60,603	101,486
MCM (Units)	0	0	1	13	99	388	1,631	3,228	45,828

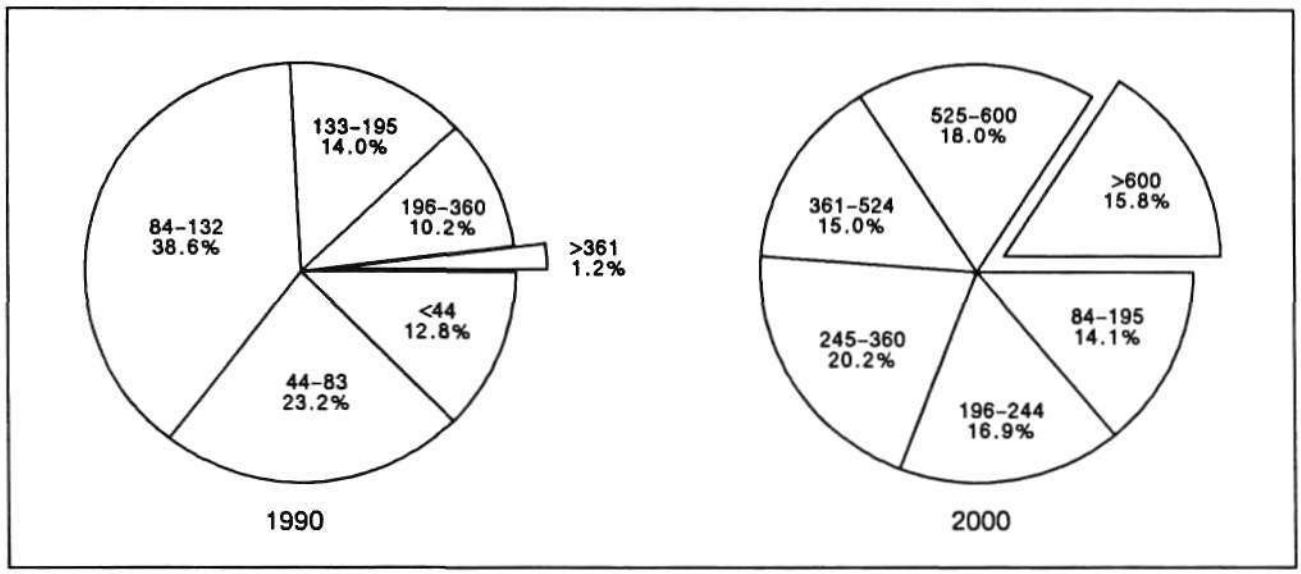
Note: MCM value = number of unit or chip demand.
Source: Dataquest (December 1990)

FIGURE 1
Estimated Worldwide Gate Array Package Production by Package Type
1990 versus 2000
(Percentage of Units)



Source: Dataquest (December 1990)

FIGURE 2
Estimated Worldwide Gate Array Package Production by Pin Count 1990 versus 2000 (Percentage of Units)



Source: Dataquest (December 1990)

THE WORKSTATION EXPLOSION

Although ASIC devices will be the technology driver for high-pin-count packages, the next generation of microprocessors (MPUs) will be the system performance drivers of MCM implementation—a trend owing to the continued growth of the technical workstation market. At a systems level, technical workstations are the electronic equipment products that will offer the greatest opportunity for change in process and packaging interconnect technology during the next decade.

According to Dataquest's Technical Computer Systems Industry Service (TCSIS), technical workstation industry revenue currently has a compound annual growth rate (CAGR) of 30.0 percent. In terms of architectural design, complex-instruction-set computing (CISC)-based workstations were the primary drivers of revenue growth in the technical workstation market of 1988. In the five years following 1988, however, TCSIS analysts expect RISC-based workstations to grow 57.5 percent in revenue and an impressive 89.9 percent in units. By 1993, as shown in Figure 3, RISC-based systems will account for 51.0 percent of workstation unit shipments, while CISC-based workstations will claim 49.0 percent.

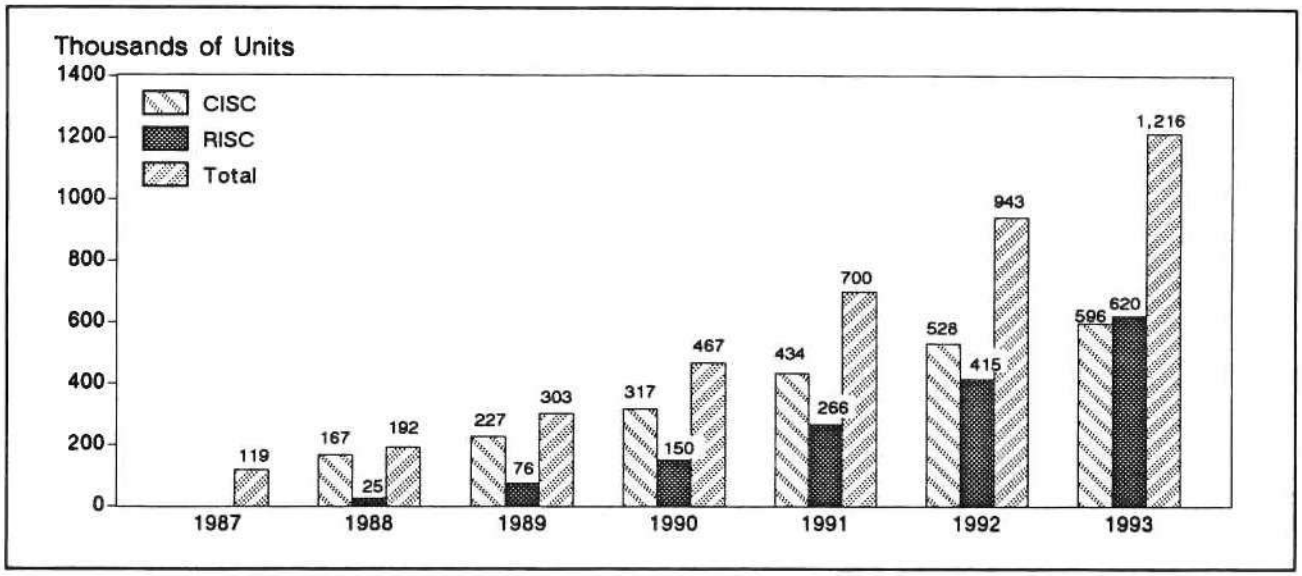
THE RISC IMPACT

Because most systems in the mid-1980s had relatively low, 10-MHz clock frequencies, interchip travel time was not a major concern of systems manufacturers. However, system clock frequencies currently are exceeding 30 MHz and are expected to reach 50 MHz by 1991 and 100 MHz by 1994—leaving only 20 and 10 nanosecond (ns) clock periods for calculation cycles. Currently available HDI technologies already have offered speed improvements of 15 percent or more at 50-MHz clock rates, with greater improvements at higher clock rates. HDI, just as much as developments in submicron manufacturing, will be critical to the continued improvement of high-performance MPUs.

HITCH YOUR WAGON TO A STAR

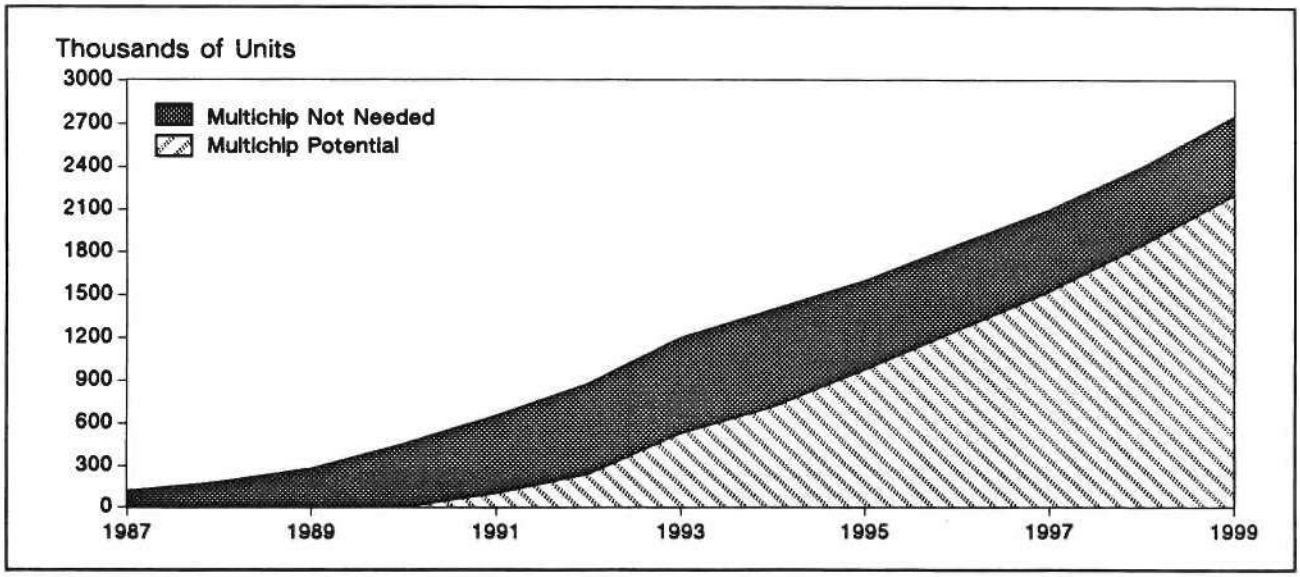
By the year 2000, workstations operating at 50 MHz and above will constitute 80 percent of the workstation market as measured in unit shipments. The increased penetration of RISC-based systems will in turn represent a tremendous opportunity for MCM producers. As illustrated in Figure 4, the number of workstations requiring MCM solutions will grow from approximately 70,000 units to over 2 million units during the next decade. This growth

FIGURE 3
Estimated Worldwide Technical Workstation Shipments
CISC versus RISC
1987-1993



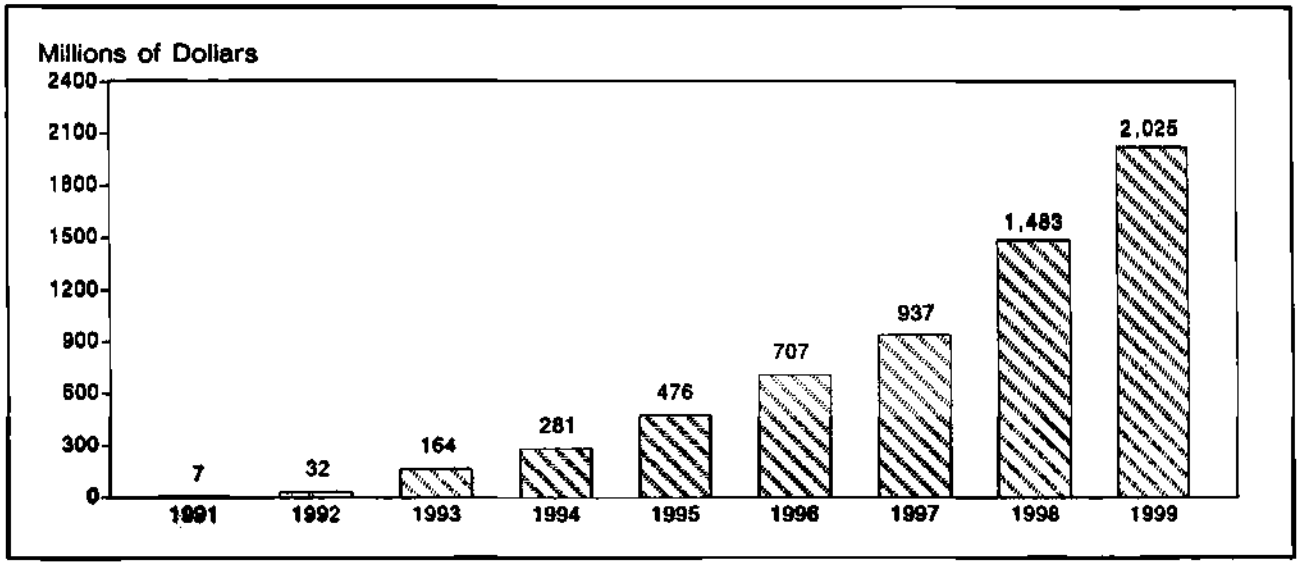
Source: Dataquest (December 1990)

FIGURE 4
Workstations Using Multichip Modules



Source: Dataquest (December 1990)

FIGURE 5
Multichip Module Revenue Potential in Workstations



Source: Dataquest (December 1990)

is significant not only in terms of numbers, but also because of its relationship to high-margin products. The MCM requirements of future workstations will create a market that could grow from only $7 million in 1991 to more than $2 billion by the turn of the century, as seen in Figure 5.

THE FUTURE LOOKS GREAT . . . BUT FOR WHOM?

The technical workstation market, and high-performance data processing and telecommunications applications in general, will offer numerous opportunities for SMT and HDI suppliers beyond those identified with MPU technology. As has been continually demonstrated in the electronics industry, new solutions create new problems that in turn engender new solutions. As RISC architectures answer the performance demands of next-generation technical workstations, increased CPU performance will in turn require new process and performance solutions in primary and secondary cache memory and the migration of main memory from fast SRAM/DRAM approaches to BiCMOS processes capable of operating in the 24 to 45ns range. Extended memory will, in turn, evolve from DRAM-based to solid disk-based technologies. The impact of all of these changes on memory, logic, and microcomponent package requirements will create high-growth markets for packaging technology.

The capital costs involved in making the transition to HDI will be huge, particularly given the priority that has historically been placed on process development in North American R&D spending. Increased emphasis on packaging solutions, however, is now a strategic necessity rather than a marketing afterthought. From its historic contributions to form-factor improvements in electronic systems to its more recent role in solving the pin-count challenges of increased logic integration, packaging is becoming an enabling technology in meeting the high-performance demands of 21st century data processing systems.

The interconnect requirements of the 1990s add yet another variable to the make-or-buy equation that worldwide systems companies must agonize over. Particularly in North America, systems companies must hope that their merchant IC suppliers not only keep pace in process and manufacturing technologies, but also find the resources to tackle the changes taking place in packaging. North American semiconductor suppliers have their work cut out for them: according to Dataquest's *VLSI Packaging Study*, MCM production by Japan and Europe will account for roughly 57 percent of units shipped worldwide in the year 2000.

Note: Contributors to the consulting study cited in this newsletter include Mary Olsson, Howard Bogert, and Mel Thomsen.

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Mark Giudici
Michael J. Boss

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Research Newsletter

JAPANESE SEMICONDUCTOR ALLIANCES 1990

INTRODUCTION

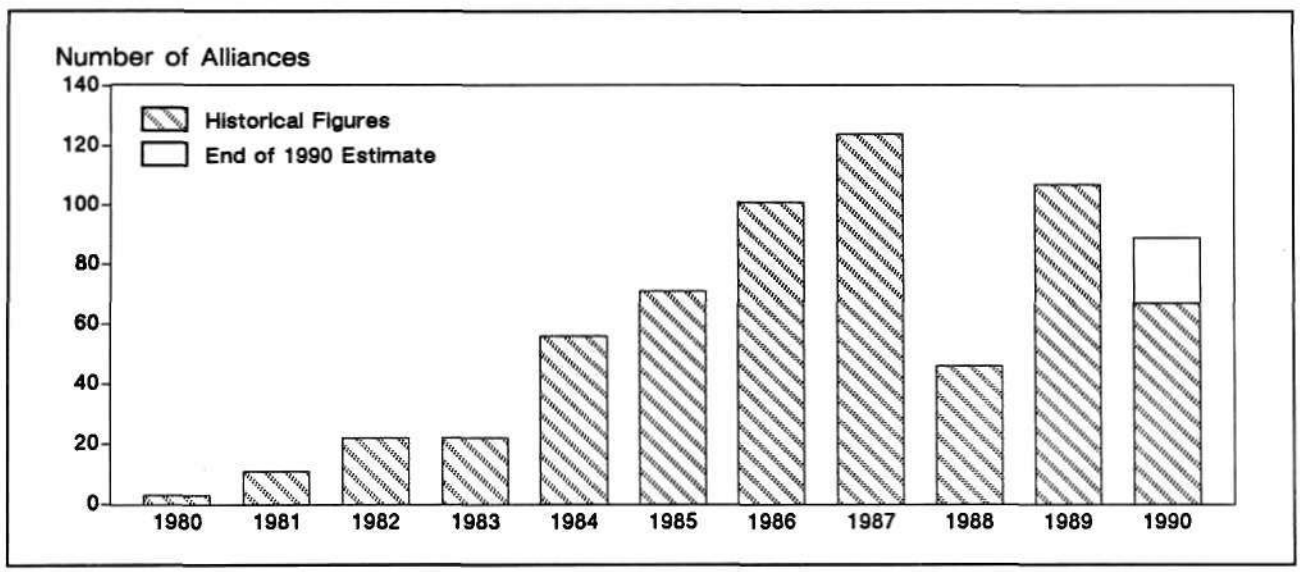
Strategic alliances were established as an important method of doing business in the semiconductor industry during the 1980s. Dataquest has been tracking alliances in the Japanese semiconductor sector since 1980. The rate of new alliance formation increased constantly during the early 1980s, peaked in 1987, and has decreased during the last three years. However, Dataquest believes that Japanese semiconductor companies have not had any fundamental change in their attitudes regarding strategic alliances.

This newsletter examines the historical trends observed in Japanese semiconductor alliances during the past decade and offers some projections concerning the outlook for 1990.

ALLIANCE PACE SLOWS

Figure 1 shows the number of Japanese semiconductor alliances that Dataquest recorded between 1980 and 1989 and includes an estimate for 1990. In 1987, the year following the US-Japan Semiconductor Trade Arrangement, the Japanese semiconductor industry experienced a surge in new alliances. The fear of being unable to compete with collaborating competitors drove many companies in the Japanese semiconductor industry to find their own form of security, usually in the form of counterbalancing partnerships or alliances. This phenomenon was fueled somewhat by the Japanese group mentality, which exists even at the corporate level. In comparison with the 1989 alliance formation rate, when we recorded approximately 9 new

FIGURE 1
Number of Japanese Semiconductor Alliances (1980-1990)



Source: Dataquest (December 1990)

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alliances per month, the pace of approximately 7.4 new agreements per month as of September 1990 represents a clear slowdown. Several possible reasons could explain this trend. The dwindling number of potential alliance participants that have not yet committed to a prior arrangement could possibly be the cause of the decline in the rate of new alliances formed each year. In theory, a finite number of participants could cause a saturation, a slow decline, or even an oscillation, with a period equal to the average alliance contract duration, in the new alliances formation rate.

POLITICAL ENVIRONMENT AFFECTS ALLIANCES

Table 1 summarizes related alliance activities involving Japanese companies during 1990. Due to the impending expiration of the 1986 US-Japan Semiconductor Trade Arrangement, some recently formed Japanese alliances, particularly those that boost foreign chip procurement levels, can be interpreted as efforts to avoid a possible conflict when the trade agreement expires.

TABLE 1
Japanese Semiconductor Alliances by Specific Categories

Date	Company 1	Company 2	Product
Foreign Chip Procurement			
1/90	NMB Semiconductor	Intel	4Mb DRAMs
2/90	Matsushita	Intel	EPROMs, DRAMs, MPUs
2/90	Mitsubishi	AT&T	256, 1Mb SRAMs
3/90	NEC	AT&T	ASICs, CAD tools, MPUs
3/90	Hakuto	Integrated Logic Systems	MP gate arrays
5/90	NEC	National Semiconductor	256 SRAMs
7/90	Fujitsu Device	Cypress Semiconductor	SRAMs, EPROMs, ASICs
Automotive			
1/90	Isuzu Motor	Fujitsu	Automotive electronics
6/90	Toyota Motor	Five companies	
7/90	Toyota Motor	Delco Electronics	
7/90	Matsushita Comm.	National Semiconductor	
8/90	Nissan Motor	Hitachi	
8/90	Toyota Motor	Fujitsu	
European Community			
2/90	Oki	SGS-Thomson	4Mb DRAMs
3/90	Mitsubishi Group	Benz	Multiproduct projects
5/90	Sanyo	SGS-Thomson	All semiconductors
6/90	Sony	Texas Instruments	Linear ICs
8/90	Kanematsu Trading	Rex Service	All semiconductors
9/90	Toshiba	Motorola	4Mb DRAMs

Source: Dataquest (December 1990)

Foreign Chip Procurement

In March 1990, NEC announced cooperation with AT&T on a wide range of semiconductor projects. This arrangement with AT&T is intended to be one of several steps taken by NEC to reach its self-imposed goal of 23 percent of internal chip consumption originating from foreign chip suppliers. NEC already has reached a level of chip consumption at which 20 percent comes from foreign chip manufacturers. In December 1989, the Electronics Industry Association of Japan (EIAJ) proposed ten suggestions to both US and Japanese semiconductor companies to increase the foreign chip market share in Japan. In this proposal, the EIAJ recommended more technology exchange arrangements, joint ventures, and strategic alliances. In October 1990, the United States' Semiconductor Industry Association (SIA) and Computer Systems Policy Project (CSPP) suggested that the US government renew the US-Japan Semiconductor Trade Arrangement for an additional five years. This extension to the 1986 agreement has yet to be endorsed by the US government; however, it is clear that the Japanese semiconductor industry and the Ministry of International Trade and Industry (MITI) wish to avoid the same circumstances that originally caused the trade friction. Hence, many Japanese companies are continuing to implement their own agendas toward purchasing and working with foreign chip suppliers. Alliances often prove to be an efficient means of achieving this goal, as well as having many beneficial side effects for preparing multinational companies for the next round of competition in semiconductor markets.

Automotive Semiconductors

Whether because of government pressure or for their own reasons, Japanese automobile companies have been increasingly willing to purchase products from foreign semiconductor companies. To develop sophisticated automobile systems, cooperation between semiconductor suppliers and automakers, starting from the earliest design stages, is an important factor in implementing control systems that marry diverse technologies to integrated circuits. In December 1989, SIA and EIAJ organized a meeting of US semiconductor vendors and Japanese users and distributors for the purpose of promoting business transactions and joint ventures. To date, most of the US companies working with Japanese auto manufacturers are large corporations; EIAJ, however, has been encouraging even small US companies to submit job proposals to Japanese automakers.

European Community Market

Wishing to avoid a repetition of the conflict that led to the 1986 US-Japan Semiconductor Trade Arrangement, Japanese semiconductor companies have been careful to establish themselves in the European market. In August 1990, the European Community (EC) Committee withdrew part of its proposal requiring a specific minimum content of EC-made semiconductors in board products, which previously defined a board as "made in Europe," to protect and promote the European semiconductor industry. The initial proposal had forced both US and Japanese semiconductor companies to establish manufacturing sites on European territory. The recent EC proposal change however, is likely to cause a slowdown of US and Japanese facility investments in Europe. Instead of direct investments, US and Japanese semiconductor makers may enter into more alliances among themselves and with European companies, as relatively inexpensive and conservative alternatives to establishing a presence in the 1992 EC market.

STEEL COMPANIES ENTER ALLIANCES

In recent years, there has been an observable trend among Japanese steel and heavy industry companies toward diversification into the electronics industry. Table 2 shows the semiconductor relationships formed by five Japanese steel companies.

Although steel companies are not naturally compatible with the semiconductor business, there is no doubt that manufacturing semiconductors is capital intensive and thus chipmakers are willing to utilize venture capital regardless of source. Steel companies in Japan generally are cash-rich industries that have been making a difficult transition from a protected industry to one that sees limited onshore growth due to the cost-of-labor advantage of less industrialized countries of the Far East.

DATAQUEST CONCLUSIONS

Although alliances in Japan have declined since 1987, Dataquest believes that this form of business practice will remain a permanent fixture

TABLE 2
Japanese Steel Company Semiconductor Alliances

Company	Date	Partner	Product
Kawasaki Steel	5/88	SDA Systems	ASIC CAD tools
	6/88	LSI Logic	LSI manufacturing
	6/89	Harris Semiconductor	LSI chips
	2/90	Kodak, Olivetti	Optoelectronics disks
Kobe Steel	3/90	Texas Instruments	ASICs
Kubota	3/90	Rasna Corp.	CAE software
	3/90	Megatest	LSI testers
NKK	4/89	Oki Electric Industry	ASICs, DRAMs
Nippon Steel	6/88	Minnesota Mining	Tape automated bonding
	11/89	VLSI Technology	ASICs

Source: Dataquest (December 1990)

of the global semiconductor business environment. For nontraditional businesses such as the automobile and steel industries, the alliance mechanisms offer additional benefits to the pooling of financial resources and the reduction of risk through diversification. Automobile companies can use alliances to develop ASICs, which they could not otherwise develop in a cost-effective manner. Steel companies can use alliances to diversify while learning the complexities of manufacturing semiconductor products.

The Japanese government may be reacting to political pressure from the US government to increase the market share held by US chipmakers in Japan. Japanese automobile and steel manufacturers appear to be receptive to forming alliances with foreign semiconductor manufacturers.

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Junko Matsubara

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Research *Bulletin*

NOVEMBER MARKET WATCH: CONTINUED FLAT DEMAND AND ABUNDANT SUPPLIES KEEP PRICES DOWN AND LEAD TIMES LOW

The *Market Watch* is a monthly Dataquest bulletin that is released after the SIA book-to-bill Flash Report. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL RATIO STABILIZES AT 0.95 AND LIFE GOES ON

The book-to-bill ratio for October remained at the 0.95 level set last month for September, as seen in Figure 1. On the bookings side, the October 1990 three-month moving average for new

Figure 1
US Semiconductor Book-to-Bill Ratio

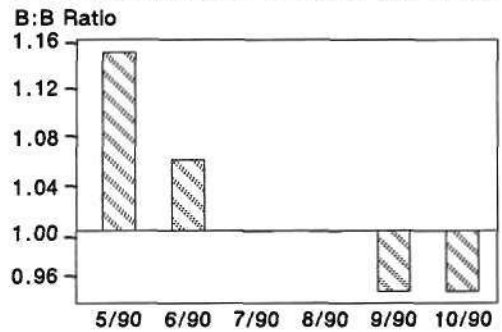


Figure 2
DOC Computer Demand

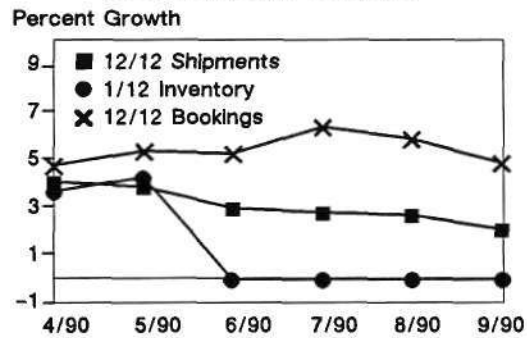


Figure 3
Semiconductor Inventory Level

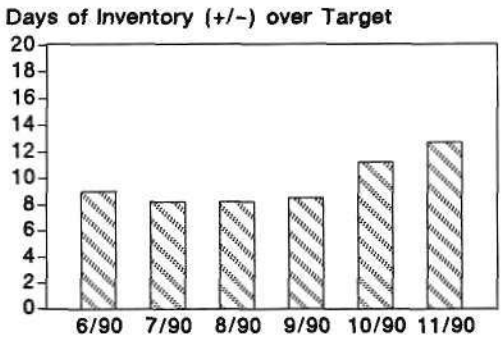
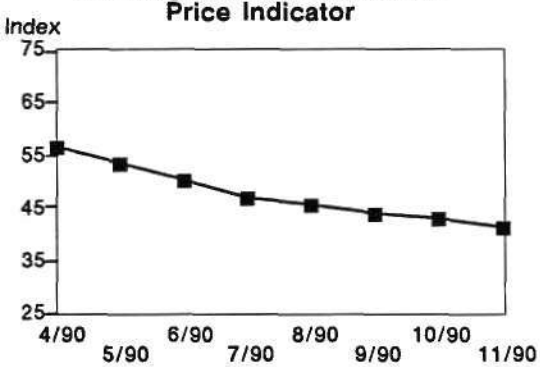


Figure 4
US Weighted Semiconductor Price Indicator



Source: WSTS, US Department of Commerce, Dataquest (November 1990)

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orders remained flat at September's average level and was 5.1 percent higher than the relative booking level set in October 1989. The October 1990 billing level dropped 13.8 percent from September, which is in line with a shift from a five-week month to a four-week month. The October 1990 monthly billings were 0.5 percent lower than the October 1989 level. What do these numbers mean? When these data are combined with the relatively positive six-month procurement outlook (see the November *Procurement Pulse*, SUIS newsletter number 1990-39) and the current Department of Commerce (DOC) data (see Figure 2), the message is that bookings levels are accurately reflecting end-system demand levels. Although the semiconductor business is not booming, it is stable and currently above last year's level. The expected steady system demand will continue to keep semiconductor order levels relatively stable for the next three to six months.

COMPUTER INVENTORIES RATE REMAINS FLAT, BUT ANNUALIZED SHIPMENT AND ORDER RATES SLIP

This month's DOC historical data for computers again reflect what Dataquest's procurement surveys have intimated earlier this year—system demand is positive but not spectacular. On an annualized basis, the shipment rate remained above 2.0 percent, at 2.1 percent (down from last month's 2.7 percent level). This dip is a function of the annualized ratio being affected by earlier flat bookings rates set this summer. The 12/12 bookings rate slipped from 5.9 percent to 4.9 percent, mainly as a result of a past near-term decline in the bookings rate that has corrected itself this month. The 3/12 bookings rate rose in October to 4.3 percent from September's zero growth rate, which in turn was down from August's 6.6 percent 3/12 bookings rate. This uptick in quarterly bookings rates reinforces the notion that overall system demand remains positive (although low) and that supporting semiconductor orders will continue to remain flat to positive in units if not in revenue.

USER SEMICONDUCTOR INVENTORIES RISE, YEAR-END CORRECTION EXPECTED

Besides the rise in actual (34.9 from 30.7 days) and targeted (22.2 from 19.5 days) inventory levels seen this month, the delta between the two also increased, to 12.7 days. This unanticipated rise is due mainly to lower-than-anticipated October system sales, which left some raw material on the shelves. Based on past inventory control corrections seen this year, Dataquest expects average inventories to drop to approximately the 30-day level within two months for, if nothing else, year-end financials. An expected end-of-year systems sales push will eat into inventory levels, although many buyers are planning on incrementally increasing semiconductor purchases in the short term.

STABLE DEMAND + OVERABUNDANT SUPPLIES = CONTINUED LOWER PRICES

The semiconductor abundance of the past few months has transformed into an oversupply in some cases, as suppliers now are able to ship some logic, non-32-bit MPUs, and SRAM devices from stock. Because users still are closely watching costs via inventory control and delivery scheduling (as well as price), suppliers that meet or exceed performance commitments are gaining user share of mind. Overall lead times are still under 10 weeks (9.8 weeks), with the longer delivery times going to 32-bit MPUs. All other products are being delivered with no problems seen by the user community. It also appears that the uncertainty over oil prices has not and most likely will not affect the cost of plastic-packaged parts. The current perceived easing of tensions in the Middle East also is keeping orders free of recession-based cutbacks. The abundance of semiconductor supplies and the expected steady demand over the next six months will allow for the planning of controlled price declines for all components.

DATAQUEST CONCLUSIONS

The demise of electronics industry growth presaged by economic doomsayers is a bit premature. Although the market is not booming, and there are signs of softness in some areas, the overall picture is for flat to low (less than 5 percent) growth for approximately the next six months. Inventory control by users and suppliers is keeping business up to a sustainable level, and the semiconductor business is mirroring the end-market trends remarkably well. What semiconductor users need now are ways to keep costs low while simultaneously improving the quality, delivery, and service provided by their suppliers. Suppliers in turn require forecasts that are accurate and reliable so that performance levels can rise. Dataquest expects the current uncertain business environment to continue on through the end of the year. Realistic performance requests by users and commitments kept by suppliers will keep the market buoyant through these trying times.

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Research *Bulletin*

NOVEMBER PROCUREMENT PULSE: EXTERNAL ECONOMICS AFFECT CURRENT SYSTEM SHIPMENTS—SEMICONDUCTOR ORDERS AND INVENTORIES INCH UPWARD

The *Procurement Pulse* is a monthly update of critical issues and market trends based on surveys of semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDERS EXPECTED TO INCREASE

Figure 1 shows that this month's respondents expect to order approximately 5.0 percent more semiconductors than last month's estimate. It is interesting to note that for the first time, buyers in

Figure 1
Averaged Monthly Semiconductor Orders

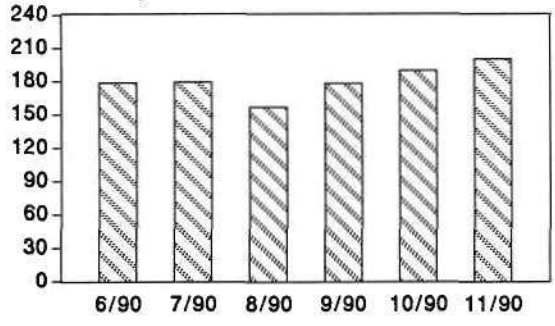


Figure 2
Averaged Semiconductor Lead Times

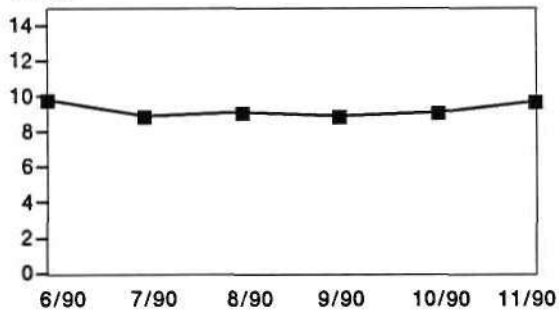


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

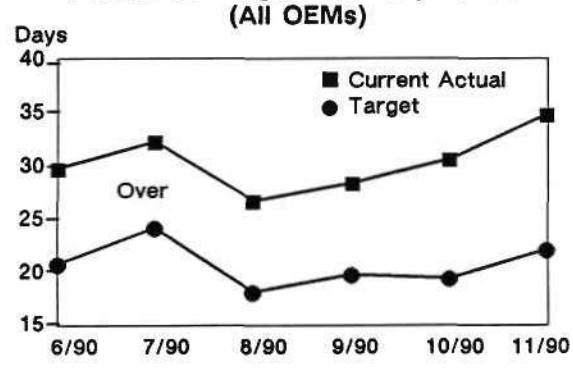
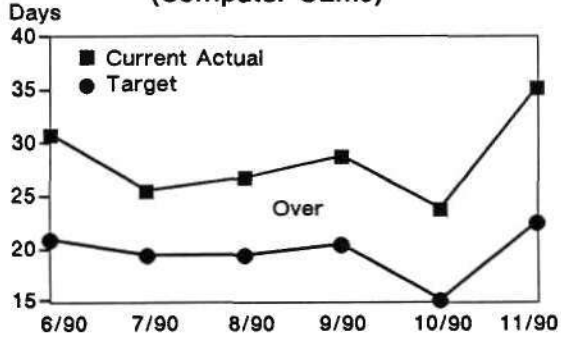


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (November 1990)

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aggregate expect to buy at twice the level of the 12/88 index of 100 shown in the graph. The overall six-month system sales outlook still remains positive at an overall average of 3.0 percent relative to last month's 3.4 percent, while the outlook for computer sales during the same period is up slightly to 6.0 percent from last month's 5.9 percent. This continued relatively positive outlook in the face of daily negative economic news highlights the notion that the electronics industry does not necessarily follow the national economic mood. The flat-to-positive outlook reflected in this US survey is also prevalent in Europe, based on feedback from a recent European trip. Although pockets of slow growth exist in both regions, the overall outlook is for slow, not negative, growth over the next six months.

LEAD TIMES IRRELEVANT AS SUPPLIES REMAIN ABUNDANT

The average lead time rose slightly to 9.8 weeks over last month's 9.3-week level, as seen in Figure 2. This increase of two days is not to be seen as a tightening of supply or an increase in demand. Instead, it reflects minor adjustments of users to better coordinate overall system demand with component delivery. For the past seven months, the average lead time has remained below 10 weeks, with some averages as low as 6 weeks because of abundant supplies. For the third consecutive month, respondents noted *no component availability problems*. Dataquest expects all semiconductors to remain plentiful for at least the next six months because of current and planned available fab capacity and demand levels. Concerns over quality and phaseouts of obsolete parts were voiced this month, highlighting an area that suppliers need to work on. There were no problems with surface mount packages again this month.

SEMICONDUCTOR INVENTORIES RISE SLIGHTLY AS END SYSTEM BILLINGS DROP

Billings for overall end systems were down by a negative 3.2 percent for the first month in a year as the slowdown in demand seen in the past three months begins to be seen in shipment levels. On an average, Figures 3 and 4 show that inventories of semiconductors incrementally rose this month both for targeted and actual levels due to these lower system shipments that left some components on the shelf. The good inventory control systems now in place generally take no more than two months for any adjustment to be made relative to end-system demand. One respondent company plans to drastically reduce semiconductor order levels in order to control inventories. The targeted and actual levels of semiconductors for the overall sample rose to a current 22.2 and 34.9 days, respectively (versus 19.5 and 30.7 days last month), while the computer segment showed a targeted and actual rise of 22.7 and 35.5 days, respectively (versus last month's levels of 15.3 and 24.0 days). This large rise in the computer segment's semiconductor inventories appears to be a one-month aberration due to the slowdown in system demand and will be watched very closely in the upcoming months.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

Although semiconductor order levels are expected to increase and six-month system demand remains flat to positive (both in the United States and in Europe), some signs are evident of near-term softness in the US electronics sector that is being felt by semiconductor suppliers. Availability, price, and customer service are not current problems for users, but in some cases, quality issues and end-of-life buys are. Inventory control is being rigidly maintained to avoid large swings in order levels. The cliché of forecast accuracy continues to be a major tool not only to gauge system demand, but also to control raw material inventories. The end-of-year sales push is now beginning, and many companies will ramp up shipments while trying to keep inventories lower than average to improve financial statistics. Continuous, accurate forecasts that fine-tune any change in need (through December 31 and then for next year) continue to be the way many companies are coping with the current market.

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Research *Bulletin*

CLARIFYING INTEL MICROPROCESSOR MIGRATION PLANS

INTRODUCTION

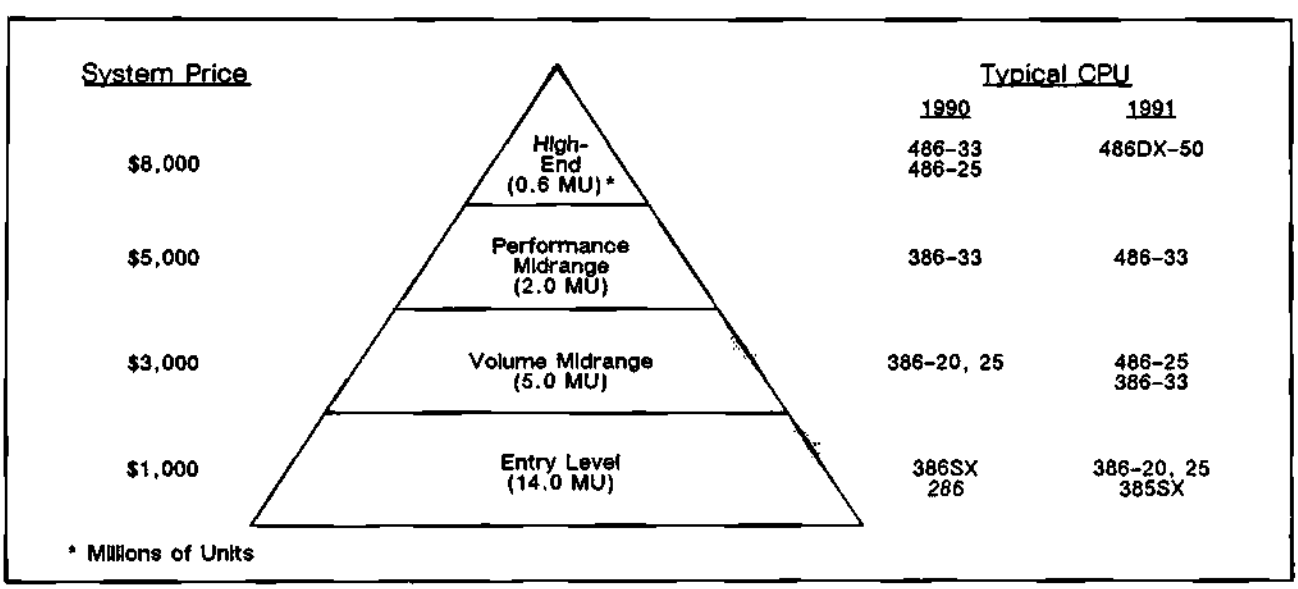
At its third quarter financial analysts meeting on October 25, Intel Corporation provided further insight into plans for its i386 microprocessor family. David House, general manager of the Microprocessor Components Group, presented a chart illustrating the system segment targets for the range of i386 products (see Figure 1). This information is important to system OEMs because it allows them to better plan their product development and support strategies. It is also important to semiconductor vendors participating in the PC peripherals and logic markets.

SYSTEM SEGMENT TARGETS

As the chart illustrates, Intel clearly will continue to target and position the i386 products in specific system market segments. Intel divides the market into four segments that correspond to specific system price ranges. The high-end segment, with a system price of about $8,000, was addressed by the 486-33 and 486-25 in 1990 and is expected to migrate to the 486-50 in 1991. The performance midrange segment, at approximately $5,000, is a 386-33 market moving to 486-33 in 1991. The volume midrange segment, at about $3,000, is 386-25 and 386-20 going to 486-25 and 386-33 in 1991. The entry-level segment costs approximately $1,000 and currently is served by the 286 and the 386SX. Intel intends to target the 386-25 and 386-20 as well as the 386SX at this segment. (The designations 386 and 486 are registered trademarks of Intel Corporation.)

System vendors have voiced concern recently about the rapid proliferation of new microprocessor products and speed grades, which in turn led to a

FIGURE 1
1991 PC Market Segmentation
(Approximate 1991 Volumes)



Source: Intel

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proliferation of system products. Such proliferation has caused an increased burden for the system vendor, in terms of new product development and support, and has helped to blur the lines of product differentiation. When asked why Intel continues with this proliferation, Mr. House answered that he would be glad to slow the pace of development and spend fewer R&D dollars if he could only convince Intel's competitors to do the same.

In fact, it is clear from the chart and from other remarks made at this meeting that Intel understands this issue and is attempting to better control product segmentation. Intel intends to continue driving the technology at a rapid pace but will not necessarily proliferate products through speed upgrades. New products will be based on architectural and manufacturing process improvements. Horizontal versions that address specific application or form factor issues, such as the 386SL, also will be forthcoming.

OBSOLESCENCE AND THE ANTICLONE STRATEGY

Mr. House admitted that the 386DX shipments had peaked in 1990, the product is being "squeezed at both ends" by the 486 and the 386SX, and it will be phased out. The 386DX-16 is not going to be supported, therefore, and it is not likely that there will be a 40-MHz version of the part. Intel's goal is to establish the image of performance and desirability for the 486 product. This goal probably will mean substantial price reductions for the 486, particularly the 486-25, during 1991. We can see also from Figure 1 that there will not be a 40-MHz version of the 486. The company intends to go directly from a 33-MHz to a 50-MHz version.

As for the 286, apparently it falls off the chart in 1991. However, it is not clear from the figure either when or if Intel plans to discontinue support of the 286. What is clear is that the company does intend to continue emphasizing the 386 family (which includes the 486 and, presumably, the 586) and promoting the move toward 32-bit computing. No matter how strongly some protest, the 286 is in the waning years of its product life cycle. The product may get a temporary reprieve as a result of its use in notebook PCs and possibly from a boost in sales to Eastern Bloc countries, but this reprieve will be short-lived.

A more interesting issue than the fate of the 286 is the potential for 386 clones. Advanced Micro Devices is expected to release a 386 clone, and others may follow. Intel's campaign to kill off the 286 already is giving way to a similar effort to obsolete the 386DX, as evidenced by remarks at the analysts meeting that the 386DX will be phased out. Intel hopes that the rapid introduction of new generations of microprocessors, along with horizontal versions such as the 386SX and 386SL, will keep pursuers lagging far behind.

Ronald Bohn
Ken Pearlman

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Research *Bulletin*

A MAJOR GLOBAL BREAK IN 4MB DRAM PRICES?

SUMMARY

Firm signs of a slowdown in orders for computer systems have emerged during the second half of 1990 (see Figure 1). Business uncertainty partly associated with the Middle East crisis reinforces this trend. At the same time, some suppliers now report accelerating demand for 4Mb DRAMs in North America and Europe. A stark prospect—excess DRAM capacity. The result—extremely volatile 4Mb pricing trends. This bulletin recommends that buyers closely monitor 4Mb DRAM pricing trends: a current bout of DRAM market volatility indicates a break in pricing in *some* world regions, but the market signs are mixed and vary by world region.

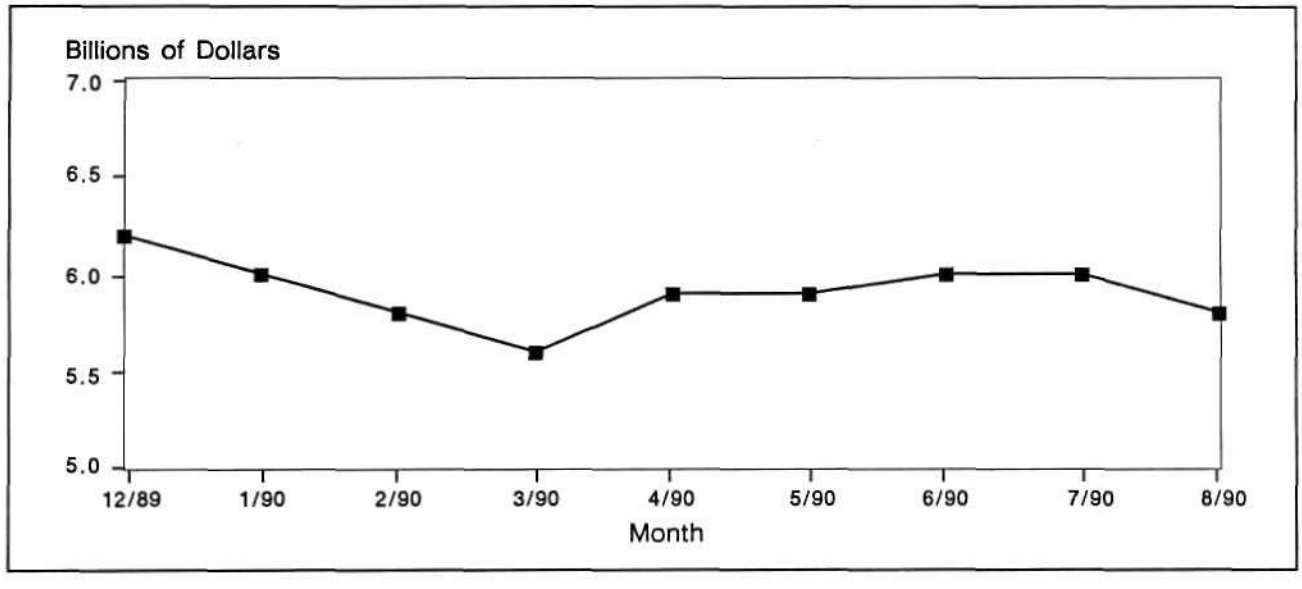
TREND IN NEW ORDERS FOR US COMPUTERS

As shown in Figure 1, the growth rate in new orders for US computing equipment slowed in July. This slowdown continued during August. (September-October 1990 results are not yet available.) This figure translates into fierce market competition for DRAM suppliers serving demand in North America, and a similar picture can be drawn for other world regions.

CURRENT PRICING TRENDS FOR 4MB DRAMS

The first signs of a sharp break in 4Mb DRAM pricing emerged from Europe. From

FIGURE 1
New Orders for US Computers and Office Equipment (Three-Month Moving Average)



Source: US Department of Commerce

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October 15 to 22, several 4Mbx1 DRAM suppliers in Europe consistently reported aggressive price cuts for 4Mbx1 DRAMs. Pricing dropped nearly 30 percent to $17 (100,000 volume) versus $24 two weeks earlier.

The market signs are less clear and consistent in North America. During the same week, some 4Mb DRAM suppliers in North America reported accelerating demand for 4Mb DRAMs *but also* expressed concern about suppliers' ability to achieve satisfactory yield rates during the impending ramp-up stage. Lower yield rates mean *less* aggressive pricing. Pricing dropped a modest 4 percent to $27 (100,000 volume) versus $28 two weeks earlier.

During the week of October 22 to 29, Dataquest received reports of dropping 4Mb DRAM pricing in North America and Japan. The market signs are mixed. For example, Dataquest analysts in Japan have firm reports of a recent sharp drop in pricing for 4Mb DRAMs as of October 25. Pricing, which had been between $35 and $40 (100,000 volume), declined nearly 22 percent to $30.23 at the same volume and exchange rate (US$1=¥137.3). As of October 26, *some* users report that 4Mb DRAM pricing in Japan has fallen below the $27 level.

Once again, the signals are less clear and consistent in North America. Dataquest has received a few reports of aggressive 4Mb DRAM pricing (sub-$20), but most reports confirm the aforementioned analysis. Demand for 4Mb DRAMs has accelerated, but the challenging ramp-up process thwarts price slashing *at this time*. A possible scenario is that suppliers are reducing inventory of the 350-mil product in line with a market shift to the 300-mil device.

DATAQUEST CONCLUSIONS

In the volatile DRAM arena, pricing shifts can be swift and deep. If the current global pricing trends hold true—and they may not, given this market's volatility—users that source in North America *may* see a price plunge similar to the one that occurred in Europe in mid-October. No firm signals yet, however, point to such an abrupt price shift in North America. The effects on the 4Mb DRAM crossover scenario also remain unclear at this time—the response of 1Mb DRAM suppliers will be a wild card.

DATAQUEST RECOMMENDATIONS

Dataquest recommends that buyers closely monitor 4Mb DRAM pricing trends in Europe, Japan, and North America; but they should also watch 1Mb DRAM pricing, which is approaching the $4 level for *some* spot market orders. Dataquest restates its prior recommendation that users evaluate DRAM modules as a cost-effective hedge for dealing with the impending 4Mb DRAM crossover.

Ronald Bohn

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Research *Bulletin*

OCTOBER MARKET WATCH: AVAILABILITY REMAINS A NONISSUE WHILE DEMAND STABILIZES

The *Market Watch* is a monthly Dataquest bulletin that is released after the SIA book-to-bill Flash Report. It is designed to give a deeper insight into the monthly trends in the semiconductor market and an analysis of what to expect in the next six months (see Figures 1 through 4).

THE BOOK-TO-BILL CONTINUES TO SLIDE . . . DOWN TO 0.95

This month's book-to-bill ratio slid to 0.95 from last month's 0.99 level, indicating at first glance that the market is softening (see Figure 1).

Figure 1
US Semiconductor Book-to-Bill Ratio

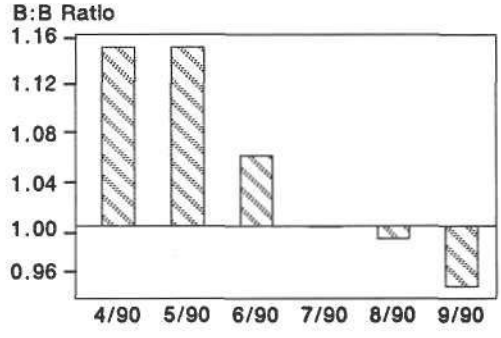


Figure 2
DOC Computer Demand

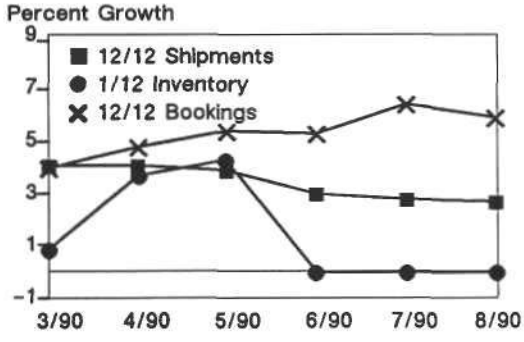


Figure 3
Semiconductor Inventory Level

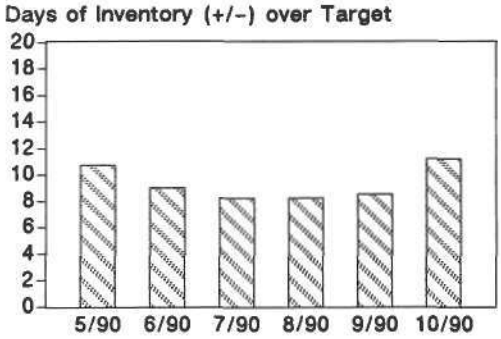
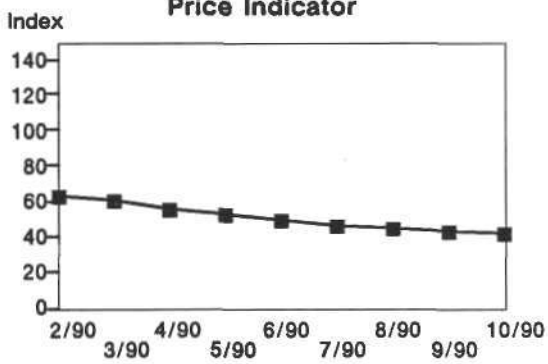


Figure 4
US Weighted Semiconductor Price Indicator



Source: WSTS, US Department of Commerce, Dataquest (October 1990)

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Although the ratio is below parity for the second consecutive month, the absolute numbers show that continued strength exists in both bookings and billings relative to comparable time periods. The good news is that this year's September bookings were 9.8 percent higher than last year's September booking level, and billings for September tied the record high set in March 1989. The not-so-good news is that September 1990 bookings were 0.9 percent lower than August and 7.1 percent lower than the last quarter-end month (June 1990). Last month's question regarding why August booking and billing levels rose over July has been partially resolved. The preliminary July figures have now been finalized upward, resulting in a lower booking and flat billing average for August. Once the August book-to-bill totals are finalized, the decline trend noted in the last three months' *Procurement Pulse* should reflect that semiconductor booking levels are in synch with system order rates.

COMPUTER SHIPMENT RATE FLAT, ORDERS OFF, AND INVENTORIES STEADY

The Department of Commerce (DOC) historical data on computer and office machine shipment and booking activity (see Figure 2) confirm what our surveyed procurement managers have been forecasting for the past three months. System shipment growth has stabilized, and booking rates are expected to flatten out through the end of the year. The actual 12/12 shipment and bookings rates of 2.7 percent and 5.9 percent, respectively, indicate moderate growth for the year, but what is disconcerting is the shorter-term 3/12 bookings rate showing zero growth in bookings relative to the same period last year. This amount compares with the 6.6 percent positive 3/12 rate posted last month. This flat near-term system bookings level will negatively impact the long-term 12/12 booking and corresponding shipment rates by year-end if sustained. Referring again to the surveyed procurement managers six-month outlook, we can expect 0 to 5 percent system sales growth during the next six months. Users' low inventory levels of both systems and semiconductors should allow for quick adjustment of order levels, depending on system demand. In other words, if there is a system demand slowdown, the current inventory situation will not allow a repeat of the 1984 to 1985 inventory balloon fiasco that effectively stopped orders because of large inventory stocks on buyers' shelves.

SEMICONDUCTOR INVENTORY LEVELS REMAIN STEADY

The delta between targeted and actual semiconductor inventory levels rose slightly to 11.2 days over last month's 8.5-day difference, mainly because of lowering the system demand relative to forecast. Semiconductor order rates are expected to be reduced to offset this difference, because system sales are expected to remain flat for the next three months. The average actual semiconductor inventory level of 31.0 days versus last month's 29.0-day level still is historically low, and inventory control programs should correct this blip in inventory within one or two months. Average target levels declined slightly to 19.0 days from last month's 20.0-day level. As mentioned in last month's *Market Watch*, shifts in system demand are directly affecting inventory levels.

SEMICONDUCTOR PRICES CONTINUE TO DECLINE SLOWLY

The continued abundance of all semiconductors, combined with steady but flat demand, is allowing buyers the opportunity in some cases to lower prices and increase supplier support levels above and beyond ongoing long-term supplier/user relationships. Respecting long-term arrangements and improving supplier support levels have allowed many suppliers to cement and gain market share in established accounts. Overall lead times remain steady at nine weeks. Most of the price declines noted were in the volatile memory (DRAM and SRAM) area, while logic, linear, and microprocessors remained relatively stable. We expect to see continued price erosion in volatile memory products and, to a lesser extent, in the EPROM arena. Because of the large percentage of plastic (oil-based) package costs in standard logic devices, a possibility of future price increases for these parts exists because of perceived/real oil price increases related to the Middle East crisis.

DATAQUEST CONCLUSIONS

Availability, lead times, and quality levels currently are given in the market. Suppliers are meeting user needs with supply and support. In return, users are trying to fine-tune their forecasting accuracy in order to prevent excess inventory and improve delivery performance in the face of an increasingly cost-competitive environment. It is too soon to note any impact of the Middle East crisis on system or semiconductor sales, but if prolonged, the crisis may negatively impact market psychology, which would delay some capital expenditures. Order delays are net lost business, and inventory controls become even more critical. Forecast accuracy and adherence to delivery commitments will continue to be key areas of concern in the next three to six months.

Mark A. Giudici

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OCTOBER PROCUREMENT PULSE: UNCERTAINTY IN THE MARKET STAGNATES ORDERS, OVERALL INVENTORY AND LEAD TIMES REMAIN CONSTANT

The *Procurement Pulse* is a monthly update of critical issues and market trends based on surveys of semiconductor procurement managers. This bulletin explains what inventory and order rate corrections mean to both semiconductor users and manufacturers.

SEMICONDUCTOR ORDERS TO LEVEL OUT

As seen in Figure 1, this month's respondents expect in aggregate to reduce their semiconductor orders approximately 4.0 percent over last month's

Figure 1
Averaged Monthly Semiconductor Orders

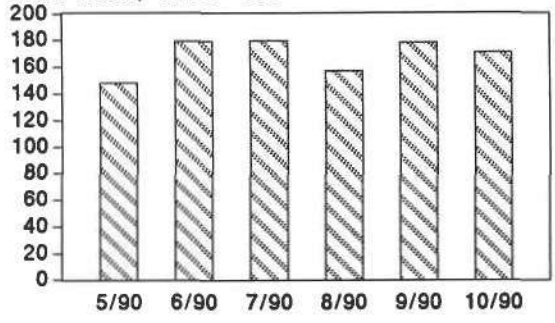


Figure 2
Averaged Semiconductor Lead Times

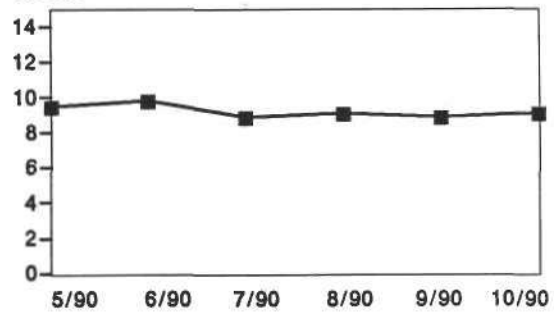


Figure 3
Actual vs. Target Inventory Levels (All OEMs)

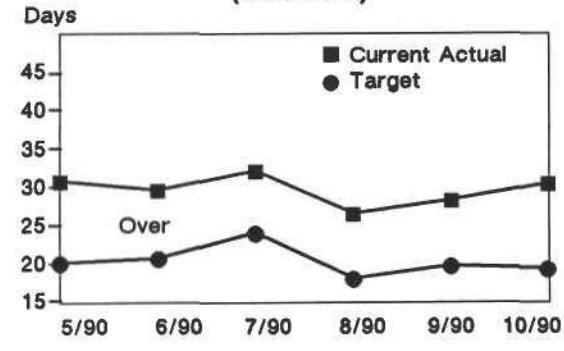
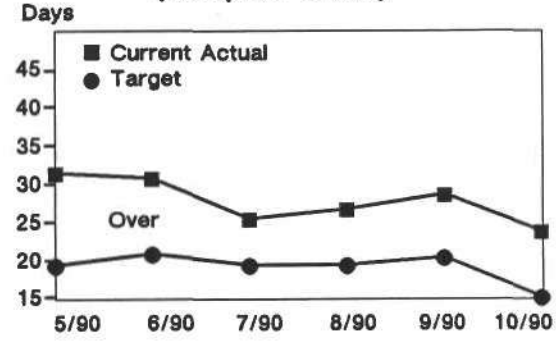


Figure 4
Actual vs. Target Inventory Levels (Computer OEMs)



Source: Dataquest (October 1990)

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estimate. This is due in part to the uncertainty of overall system demand and to the ready availability of components. The overall outlook for system demand during the next six months remains positive, although at a much lower rate than last month's expectations. The high and low sales outlook range remains at negative 20.0 percent to positive 20.0 percent, but the overall average has declined to 3.4 percent from last month's 4.1 percent average. The computer system outlook average dipped to a lesser extent, from 6.1 percent to 5.9 percent. Although the market outlook is lower than in the past few months, it is important to note that the outlook is still positive. We expect the market to continue to muddle along for the next six months with low to flat growth becoming more the norm.

LEAD TIMES VERY MANAGEABLE AS AVAILABILITY OF PRODUCT REMAINS EXCELLENT

The average lead time increased slightly (by one day) to 9.2 weeks over last month's responses. As seen in Figure 2, the stability of lead times gravitating around a nine-week average has been the norm for the past six months. This month's respondents effectively are having *no* availability problems and Dataquest expects the availability situation to remain good for the next six months. The recent ruling favoring AMD in the protracted AMD/Intel 80286-80386 litigation still leaves many issues unresolved, including the availability of second-sourced 80386 devices. There are a few surface-mount product problems regarding handling and test and some new product offerings. Other than these minor irritants, availability is good and is expected to remain so.

OVERALL SEMICONDUCTOR INVENTORIES REMAIN STABLE WHILE COMPUTER LEVELS DECLINE

Overall semiconductor inventories remained stable compared with the targeted and actual estimates reported last month, as shown in Figures 3 and 4. The current target and actual inventory levels of 19.5 days and 30.7 days, respectively, compare closely with the corresponding 19.9 days and 28.5 days set last month. The computer segment reported a decline in both target and actual semiconductor inventory levels. Computer semiconductor inventories are now down to a target and actual level of 15.3 days and 24.0 days, respectively, versus last month's levels of a corresponding 20.6 days and 28.8 days. These low and well-managed inventory levels ensure that any change in the overall demand for systems will be reflected quickly in semiconductor order rates. Forecast accuracy and adherence to contracted delivery schedules are getting large amounts of attention now that inventories have proven to be manageable.

DATAQUEST ANALYSIS AND RECOMMENDATIONS

The ripples of uncertainties surrounding the Middle East crisis appear to be affecting the overall electronics market. Although not negative, the current outlook is less positive than in the past. Semiconductor availability is currently excellent and, as yields improve with the 4Mb DRAM, will only improve. Inventories remain under control, much to the relief of both suppliers and users. What is now being emphasized is the need to forecast accurately and to adhere to delivery commitments. As one supplier mentioned, now that semiconductor inventories are in line with end-system demand, "the (semiconductor) order pipeline will be kept running, even though it may be a smaller-diameter pipe."

Mark A. Giudici

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Research Newsletter

SEMICONDUCTOR PRICE SURVEY: NORTH AMERICA—A GLOBAL ISLAND OF HIGH DRAM PRICES DURING THE 1990s?

EXECUTIVE SUMMARY

Iraq's invasion of Kuwait changed world market conditions dramatically during the third quarter of 1990. The US economy is moving closer to recession, and most nations' economies strain under the effect of business uncertainty and rising oil prices. For users of megabit-density DRAMs, a different kind of "big news" has emerged. North American buyers of DRAMs right now face a pricing disadvantage vis-à-vis European purchasers—an apparent reversal of historic trends (see Table 1). Will this trend hold true? This newsletter focuses on the DRAM issue, but as shown in Table 1, does not ignore recent major shifts in the 32-bit MPU, SRAM, nonvolatile memory, and standard logic markets.

The pricing analysis presented in Table 1 correlates with the quarterly price tables mailed to

TABLE 1
Semiconductor Pricing and Lead Time Trends (North American Bookings)

Part	Pricing Trend: Third Quarter	Pricing Trend: Forecast	Current Lead Times	Product/Market Trends
1Mbx1 100ns DRAM, DIP/SOJ	6% down	15% down	2-10 weeks	1Mb price cuts delay 4Mb crossover until second quarter 1991
4Mbx1 100ns DRAM DIP	17% down	22% down	4-8 weeks	Price in Europe 10-15% lower than in North America
16Kx4 25ns SRAM	4% down	3% down	6-14 weeks	64K SRAM supply base contraction
128Kx8 100ns SRAM	20% down	15% down	2-10 weeks	Crossover from 256K slow SRAM likely by second quarter 1991
512Kx8 ROM CMOS, 200ns and above	12% down	15% down	4-10 weeks	Signs of pricing war
CISC and RISC 32-bit MPU	2-9% down	2-11% down	5-10 weeks *except* for 80386SX, 68040	New strategies for 80386/80486; ramp up of 68040 delayed to fourth quarter 1990
74HC	0-2% up	0-2% up	4-6 weeks	Oil-related plastic package price rise*

*Applies to all standard logic in plastic packages.
Source: Dataquest (October 1990)

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SUIS clients on September 21, 1990, and the SUIS service section entitled *Third Quarter 1990 Price Update* and dated October 1990. For SUIS clients that use the SUIS on-line service, the quarterly pricing presented herein correlates with the quarterly price tables dated September 1990 in the SUIS on-line service. For additional product coverage and more detailed product specifications, please refer to those sources.

MEMORY TRENDS

North American and European users of 1Mb DRAMs continue to enjoy aggressive pricing during the second half of 1990. The DRAM spot market has been very volatile. In fact, relentless drops in 1Mb DRAM pricing should delay the ever-impending 4:1 unit/price crossover to the 4Mb DRAM in North America and Europe until the second quarter of 1991.

The midyear 1990 oversupply of DRAM devices appears to be extending to other memory products such as high-density SRAMs, ROMs, and EPROMs.

DRAM

Megabit-Density DRAM

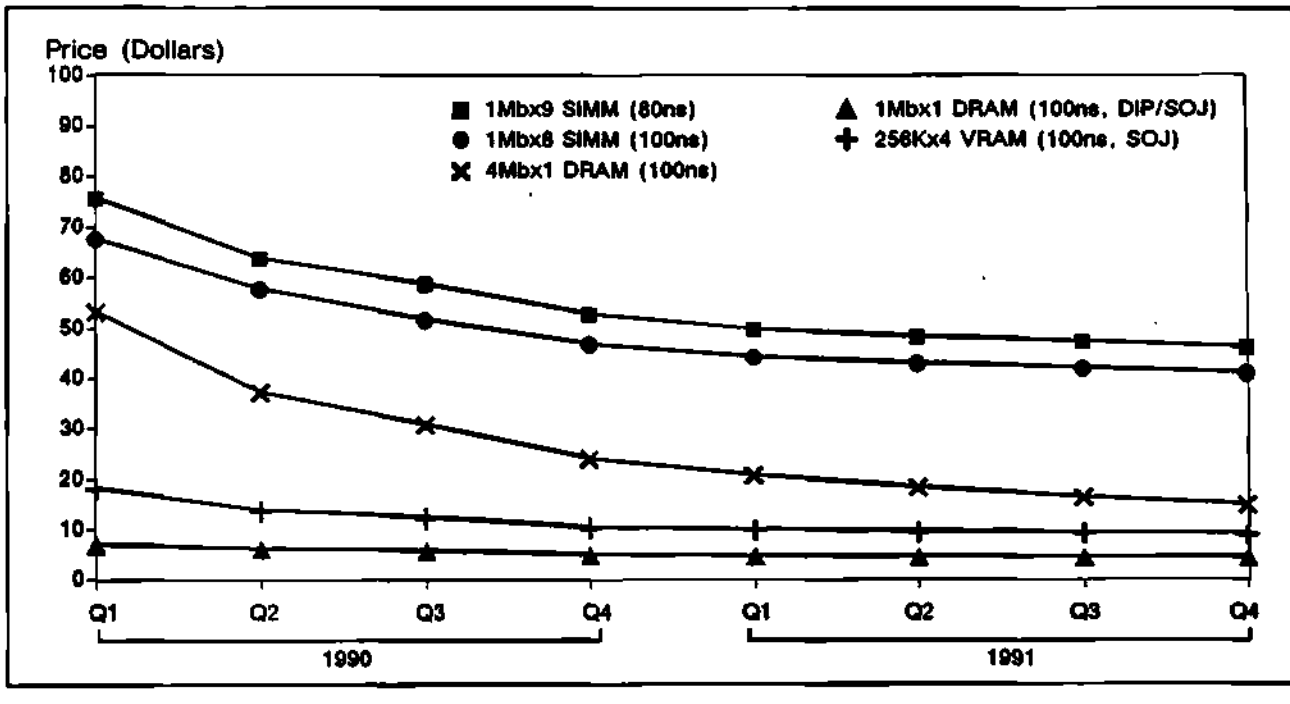
As shown in Table 1 and Figure 1, large-volume contract buyers in North America can expect a sharp decline in pricing for the 1Mbx1 100ns DRAM during the fourth quarter of 1990 and steady declines during 1991. Spot market prices for the 1Mb DRAM had fallen below $5 at the time this newsletter was written. Volume contract pricing in North America should fall by 15 percent and reach the $5 level *or below* during the fourth quarter.

North American users can expect pricing for 4Mbx1 products to decline to the $24 level during the fourth quarter of 1990, a decline of 22 percent from the third quarter price. Several suppliers continue to call for a market crossover to the 4Mb DRAM by year-end 1990; as noted, however, Dataquest expects a crossover during the second quarter of 1991.

The Range of DRAM Pricing

As noted in prior newsletters, survey confidentiality limits disclosure of exact pricing points;

FIGURE 1
DRAM Price Trends (North American Bookings) (Volume: 100,000 Units)



Source: Dataquest (October 1990)

however, the survey responses capture the dynamics behind Dataquest's forecast. For example, Dataquest bases the third quarter contract-volume price of $5.97 for the 1Mbx1 100ns DRAM on survey prices that range from a low of $5.20 to a high of nearly $6.45. The third quarter contract-volume price of $31.00 for the 4Mbx1 DRAM reflects survey prices that range from a low of $30.00 to a high of $34.00.

North America and Europe: A Reversal of Long-Term DRAM Price Trends?

At the time this newsletter was written, the contract volume price for 1Mbx1 DRAMs was 3 to 4 percent lower in Europe than North America—a reversal of a historical pattern. European users of the 4Mbx1 DRAM were enjoying an even greater advantage *vis-à-vis* North American purchasers—10 to 15 percent lower prices.

This recent anomaly has been the result of the Reference Pricing (RF) system, which is Europe's government-mandated system for pricing Japanese-produced DRAMs. North American semiconductor manufacturers have protected themselves against Japanese suppliers' dumping of *underpriced* ICs in North America through the foreign market value (FMV) system. By contrast, in Europe, IC buyers now press, through the European Community (EC), for protection against *higher-priced* DRAM prices from Japan-based companies via the RF system.

There is no quick answer to the immediate concern of some North American buyers: will the ebb and flow of regional pricing keep North America an island of high DRAM prices vis-à-vis Europe, Japan, and Rest of World (ROW)? The possibility now exists. Conversely, European purchasers do not desire a return to the "status quo ante" in which they paid higher prices for DRAMs than did most buyers around the globe. Government and industry negotiators from Europe, Japan, and North America have begun to confront the issue; South Korea might also formally participate. Even so, government intervention in economic markets—like the law of physics—typically causes an equal and opposite reaction *somewhere* in the marketplace.

Dataquest Recommendation on Global Procurement of DRAM

For SUIS clients that purchase on the global spot markets, Dataquest recommends weekly monitoring of worldwide 1Mb DRAM and 4Mb DRAM pricing trends through Dataquest's *On-Line DQ Monday* service. Dataquest does *not* recommend a sudden shift by North American purchasers to Europe-based procurement. Dataquest *does* reinforce prior recommendations that systems manufacturers follow the trend toward "local-market" procurement—including purchasing by North America-based companies in Europe as they make systems for local European customers *and* procurement by Europe-based companies in North America as they produce for local customers in that region.

Fast SRAM: Supplier Base Contraction

National Semiconductor, Philips-Signetics, and VLSI Technology departed the fast SRAM arena during the third quarter of 1990. Understandably, SUIS clients express concern regarding SRAM supply and supply base during 1991. Table 1 shows that users can expect some contraction of the supplier base for fast 64K SRAMs as suppliers shift to higher-density SRAMs or emphasize other ICs. At the time this article was written, the 64K fast SRAM pricing forecast, which calls for steady if not aggressive declines, was consistent.

Dataquest Recommendation on 64K Slow SRAM

Because of a likely contraction of the 64K slow SRAM supply base, Dataquest recommends that users of this device either migrate to higher-density devices or forge special long-term arrangements with suppliers to assure a steady supply of this device.

Higher-Density SRAM

Users can expect more aggressive pricing competition for SRAM in densities of 256K and above. For example, Dataquest's recent survey shows somewhat sharper declines in pricing than originally expected for 256K fast SRAMs and 128K slow SRAMs. Pricing has been competitive for 256K slow SRAMs, especially on spot markets, and contract buyers can expect continued declines in pricing during the fourth quarter of 1990. The 256K slow SRAM supply/demand scenario has been clouded by the recent market events.

A Buyer Advisory on the 1Mb Slow SRAM Crossover

As shown in Table 1, under these market conditions suppliers might shift emphasis to the

1Mb slow SRAM device (from lower density slow SRAMs) more quickly than originally expected. The 4:1 unit/price crossover to the 1Mb slow SRAM could occur as soon as the second quarter of 1991. Dataquest restates its prior advice that prospective users of 128Kx8 100ns SRAMs must monitor 4Mb DRAM market trends as a leading indicator for 1Mb slow SRAM trends and *extends* this recommendation to a similar monitoring of the 256K slow SRAM segment.

Nonvolatile Memory Price Wars?

Table 1 shows that suppliers of nonvolatile memory now face a possible price war. EPROM pricing should continue to be competitive following a pricing battle earlier this year. At the time this newsletter was written, Dataquest had not yet seen signs of a sharp downward trend in pricing for these devices; however, users are advised to monitor ROM market trends that could signal more volatile (or stable) EPROM pricing patterns.

Recent world market events in the ROM arena confirm signals garnered during *last* quarter's survey of an intensified pricing competition among suppliers of CMOS ROM with densities of 512K and greater. Current ROM market conditions are marked by weak demand from the PC and video game end markets. The supplier base has been expanding and now includes a host of competitors from Japan, North America, and Taiwan.

North American pricing for CMOS 128K ROM (150ns and greater) dropped by 17 percent during the third quarter to $2.75. Under these conditions, pricing should decrease 9 percent during the fourth quarter to $2.50. As shown in Table 1, the price for CMOS 512Kx8 ROMs (200ns and greater) declined by 12 percent during the *third* quarter to the $5.00 level. During the fourth quarter, pricing is expected to decline *more* sharply—by 15 percent—and reach the $4.25 level. The results of Dataquest's recent survey show a premium of approximately 20 percent for the 256Kx16 device.

MICROPROCESSOR TRENDS

Table 1 shows that North American and European users of high-speed 16- and 32-bit microprocessors (MPUs) can expect continued pricing competition among major suppliers of CISC and RISC ICs. Market demand for more mature MPUs appears to be slowing.

Increased Supply of 80386 and 80386SX MPUs

As a result of capacity expansion by Intel, users can expect shorter lead times for 80386 (6 to 8 weeks) and 80386SX (10 to 12 weeks) products. For orders of less than 5,000 units, buyers can look forward to a mild downward movement in price of the 16-MHz 80386SX to a fourth quarter 1990 level of $61.50. Pricing for 25-MHz 80386 products should decline by 5 percent during the fourth quarter to $173.00.

The plunge in 80286 pricing continues. The price of the 10-MHz 80286 device should break the the $9 barrier during the fourth quarter, and pricing for the 12-MHz 80286 is now on a path to converge with the price of the 10-MHz version during 1991.

Intel's New Product Strategy

Intel also announced a new product strategy for blunting the effort of any prospective 80386 competition, including RISC MPU suppliers. Prospective new products include a more fully integrated version of the 80386SX, which could counter chip set competitors in the laptop and hand-held PC markets. Another product is an 80486SX device targeted for PC applications that do not need floating-point capabilities. Other prongs of the strategy include a 50-MHz 80486 that is targeted against RISC IC suppliers and an 80960 RISC IC for embedded control applications.

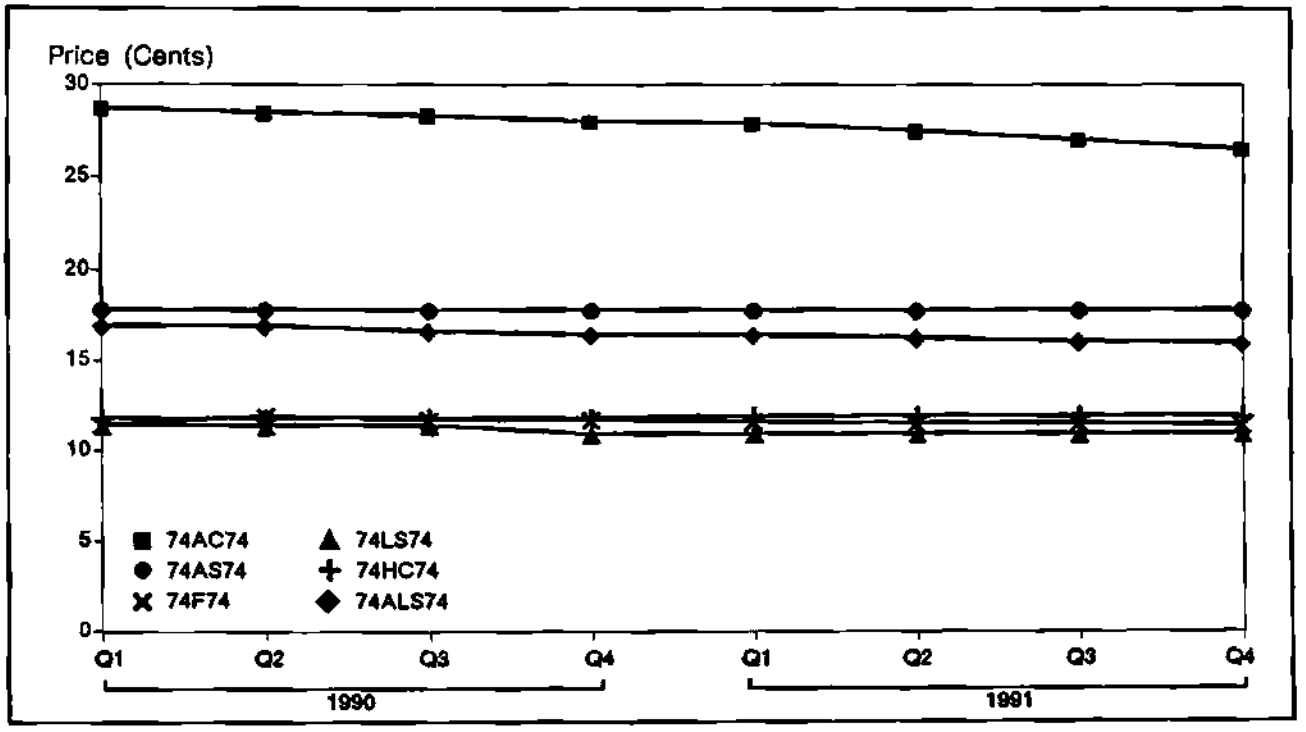
Expect Learning Curve Price Declines for 68040 and 80486 MPUs

The ramp up in output of the 25-MHz 80486 IC has begun, with the concomitant sharp drop in pricing. The scenario for the 25-MHz 68040 product should be similar as long as Motorola experiences no more delays in ramping up. For 1,000- to 5,000-unit orders, pricing for the 25-MHz 80486 should decline by 7 percent during the fourth quarter almost to the $700 level. Barring production delays during the fourth quarter, pricing for the 25-MHz 68040 device in the same volume is expected to drop by 11 percent to the $635 level.

STANDARD LOGIC TRENDS

As shown in Figure 2 and Table 1, prices for some older standard logic products are increasing;

FIGURE 2
Standard Logic Price Trends (North American Bookings)
(Volume: 100,000 Units; PDIP)



Source: Dataquest (October 1990)

however, the big news this quarter is the rising cost of plastic dual-in-line package (PDIP) because of higher oil prices.

Buyer Advisory on Rising PDIP Prices

Throughout 1990, users of standard logic have endured a series of supply/demand imbalances (i.e., availability of PDIP and surface-mount package). Dataquest advises users of products in the PDIP to expect rising prices—or at least firm pricing—unless the Middle East crisis is quickly resolved. The cost of plastic epoxy material—whether oil-based or *not*—has been increasing rapidly in synch with rising oil prices. As an alternative, users can move to either surface-mount packages or other application-specific ICs (ASICs)—in which the package represents a smaller percentage of total device cost.

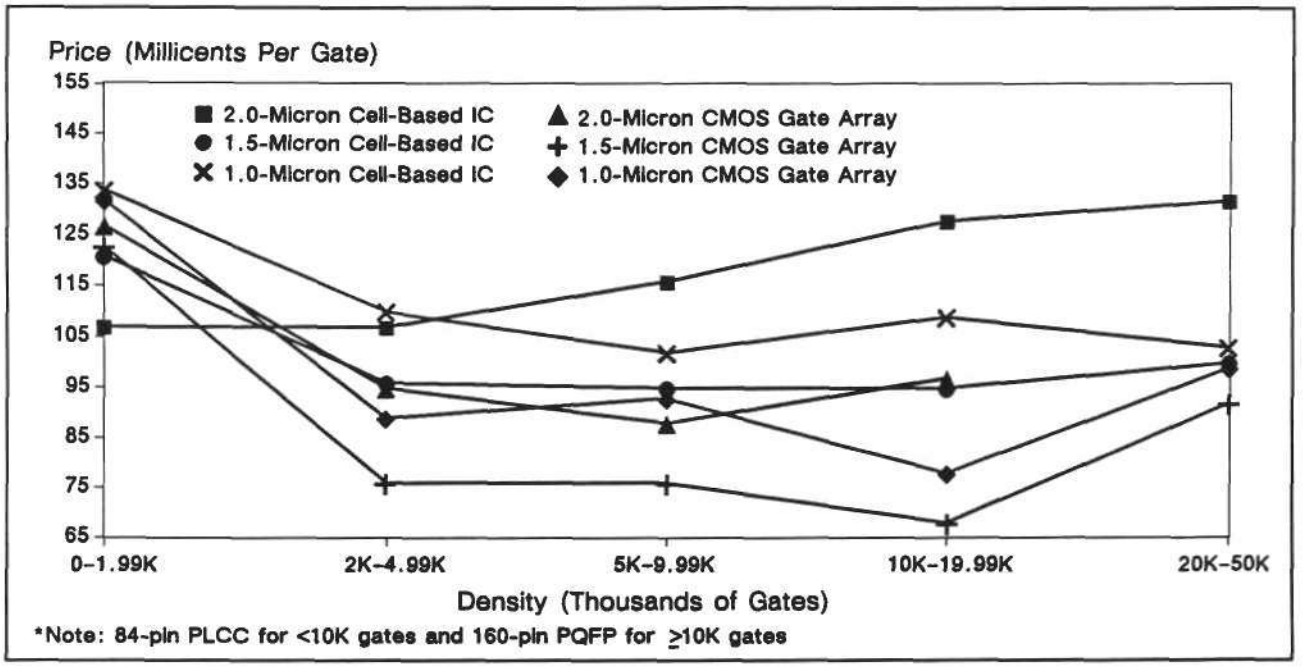
ASICs

Pricing for ASICs remains aggressively competitive, as evidenced by National Semiconductor's recent departure from the cell-based IC (CBIC) business. As shown in Figure 3, pricing for 1.0- and 1.5-micron CMOS gate arrays and 1.0- and 1.5-micron CBICs collapsed during 1990. Dataquest analysts also report sharp price cuts for 0.8- and 1.2-micron CMOS gate arrays and 0.8- and 1.2-micron CBICs. Field programmable gate arrays (FPGAs) represent a new source of pricing pressure in these markets.

Field Programmable Gate Arrays (FPGAs)

Dataquest views FPGAs—which are in fact a standard product akin to a programmable logic device (PLD)—as a challenging alternative to low-density masked gate arrays for system design starts. FPGA solutions provide systems manufacturers with the benefit of faster time to market than gate arrays, especially for device densities with 6,000 gates or less. The major advantage of FPGAs over gate arrays is system time to market—*not* price—but more rapid time to market can mean lower system cost and higher profit margins for systems using FPGAs.

FIGURE 3
1990 ASIC Price Trends (North American Bookings)*
(Volume: 10,000 Units; Utilized Gates; Excludes NRE)



Source: Dataquest (October 1990)

PLDs: General Supply/Demand Equilibrium

Supply and demand for PLDs has moved into market equilibrium except for slower-speed TTL devices. Under these conditions, pricing for TTL PLDs and CMOS PLDs declined between 1 and 9 percent during the third quarter of this year *except* for an increase in pricing for some 24-pin TTL devices that operate at speeds of 15 nanoseconds (ns) or slower. As shown in Figure 4, under current market conditions, most PLD users can expect steady and, in some cases, such as with newer, faster devices, sharp declines in pricing during the fourth quarter of 1990. As stated in prior forecasts, PLD suppliers will continue to battle each other as well as suppliers of standard logic and other ASICs for design wins.

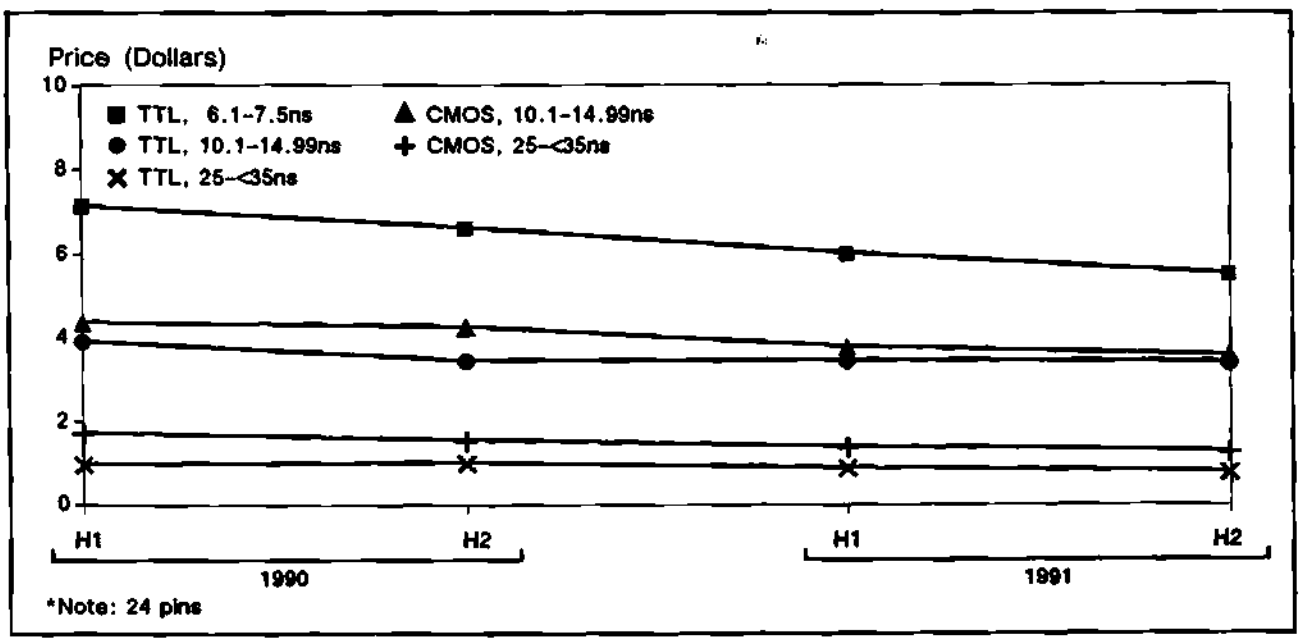
DATAQUEST CONCLUSIONS

The crisis in the Middle East overshadowed significant semiconductor market shifts during the third quarter of 1990. Dataquest's August-September 1990 survey of semiconductor users and suppliers reveals that contract-volume buyers of DRAM can expect sharp pricing declines as the year ends, with the steep drop in 1Mb DRAM pricing delaying the 4Mb DRAM crossover until the second quarter of 1991. The big news is that North American DRAM purchasers face a pricing disadvantage vis-à-vis European buyers, although it is too early to say whether North America will become a global island of high DRAM prices during the 1990s. For example, at the time of the writing of this newsletter, Dataquest had learned of the likely termination of the FMV system during 1990. Other significant market shifts include Intel's increased capacity for 80386/80386SX devices and a new product strategy; signs of a price war in the ROM arena; contraction of the SRAM supplier base; and rising costs for the PDIP version of standard logic via rising oil prices.

DATAQUEST RECOMMENDATIONS

Dataquest recommends that major North American and European buyers of 1Mb DRAMs should book DRAM orders at a price of $5.05 *or*

FIGURE 4
PLD Price Trends (North American Bookings)*
(Volume: 10,000 Units; PDIP or PLCC)



Source: Dataquest (October 1990)

lower. Do not plan on a fourth quarter 1990 crossover to the 4Mb DRAM (4:1 unit/price ratio). Under current market conditions, *most* users should expect the crossover to occur during the second quarter of 1991.

Users also should plan for a second quarter 1991 crossover (4:1 unit/price ratio) to 1Mb slow SRAMs from 256K slow SRAMs. Supply of 256K slow SRAMs could tighten during 1991, so Dataquest recommends that users provide suppliers with accurate demand forecasts or book 1991 orders now, with a provision for renegotiation of 256K product price at a later date.

Users of standard logic products should continue to monitor PDIP pricing-supply-demand trends through use of Dataquest's *On-Line DQ Monday* service.

Dataquest recommends that users facing competitive system time-to-market constraints evaluate the use of FPGAs, especially for device densities with 6,000 gates or less.

Ronald A. Bohn