INVESTING IN HIGH-TECH STOCKS: THE SEMICONDUCTOR INDUSTRY

By Michael Murphy

Most non-technology companies grow earnings by raising prices, by stealing market share, or by downsizing. In contrast, chip makers increase the value of their products by lowering the cost of calculating or storing information, and this reliable deflation creates its own demand for new products.

No matter what happens in computing devices, communications, the Internet, multimedia, robotic assembly, and even biotechnology, it seems to be driven by powerful new semiconductors. In fact, the percentage of semiconductor value in electronic systems continues to rise as more and more features are moved into silicon. But consumers get good value for this investment because of the constantly declining price per semiconductor function.

Most non-technology companies in the U.S. grow earnings by raising prices, stealing market share from one another, or (while they can) downsizing operations to cut costs. In contrast, every year semiconductor companies simply increase the value of their products by lowering the cost of calculating or storing information. This reliable deflation creates its own demand for new products.

While it is the semiconductor-equipment companies [covered in my article in the January 1999 *AAII Journal*] that enable the production of ever-faster, ever-smaller, ever-cheaper chips, it is the chip makers themselves who have taken advantage of the trend. In sharp contrast to, say, the automobile industry from 1915 to 1930, as this industry grows, there are more and more participants, not fewer and fewer. This article focuses on semiconductor companies and the whole chip industry.

INDUSTRY GROWTH

From 1988 to 1997, the semiconductor industry grew at a compound annual rate of 17.6% to $150 billion. The growth rate in dollars is all the more impressive when you remember that *prices per bit were falling* at a compound annual rate of 30% throughout this period. However, due to the sharp decline in chip prices in 1998, industry revenues fell to $126 billion and the 10-year growth rate fell to 10.0%. Revenues are increasing in 1999 and the industry will be back on a mid-teens growth track in 2000.

At the end of my last article, we reviewed the underlying drivers of the decline in semiconductor prices and concluded that there is no reason to expect Moore’s Law [that prices will drop 50% every 18 months] to change during the next 10 years. Falling prices create their own demand, so until everyone in the world has all the computing and communications power they can use, we see no reason for the demand for semiconductors to slow down.

GROWTH CYCLES

While the trendline growth in semiconductor manufacturing is strong, there are significant cycles around the trend.

At the bottom of a recession, no user wants to hold any inventory, as it only decreases in value. Buyers only purchase chips required for that day’s production. However, as the recession ends and business picks up, buyers grow more willing to build a few extra products each day in case they get a rush order, so they start buying more chips. Sooner or later, some chip or

Michael Murphy, CFA, is founder and editor of the California Technology Stock Letter, Half Moon Bay, California. He is also the author of “Every Investor’s Guide to High-Tech Stocks and Mutual Funds” (Random House, 800/733-3000).

another gets a little tight on supply, and the suppliers are able to ship only partial orders with a promise to fill the rest in a couple of days.

At that point, buyers start increasing their orders so that they have enough inventory to keep production humming. At the same time, the chip manufacturers are producing at high levels and making lots of money. But as orders increase beyond the supply level, buyers become nervous that they may run completely out of some crucial chip, so they may put in several orders to different companies, and whoever gets the chips out first, gets the business. Unfortunately, to the chip manufacturers this looks like an upsurge in orders, so they stretch lead times out further, creating at first additional concern—and later, panic—among the buyers. Of course, chip prices stop declining at their usual rate, and on the chips most in shortage, prices may rise. The upsurge in DRAM prices in late 1998 is a recent example.

Now the semiconductor companies are really in the driver's seat—production is high, so the cost per chip is low, prices are high and profits are exploding. This is a sure sign that this cycle has topped. And at that point, some Wall Street analyst will put out a think piece saying that the semiconductor industry is no longer cyclical, and amateur investors will rush into these now-inexpensive-looking stocks. A stock selling for 20 times earnings is a lot for a cyclical stock at the top of its cycle, but is cheap for a growth stock compounding at 30% a year.

Unfortunately, what is really happening is that chips are being hoarded in inventories all over the world. Sooner or later, there is a pause. Semiconductor manufacturers see that demand has flattened for some hot chips, so they trim prices a little to spur demand, and the buyers realize that prices have started to fall, which means now their inventories are losing value. So they trim orders and try to use up their expensive chips as fast as possible. And the cycle spirals down.

Notice that end-user demand did not have to decline at all to have the whole process play out. The entire cycle is caused by an inventory cycle—a buildup followed by a liquidation. This is exactly what happened in 1998.

Investors must remember that when semiconductor sales are booming and stock prices are high, customers are probably building inventory and setting the scene for a decline.

On the other hand, when sales are soft and the headlines are full of moaning and groaning about the death of the semiconductor industry, customers are probably buying chips hand-to-mouth and creating the bottom of the cycle. Stock prices are likely to be near their lows at this point. If you keep your head and remember that the industry cycles around a very attractive 18% growth rate, you can pick up some bargains.

HOW PROFITABLE IS IT?

There are three different business models in the semiconductor industry, serving three different business strategies.

First, there are companies that own their own fabrication facilities, or "fabs." This has its ups and downs: semiconductor fabs are expensive, so semiconductor manufacturers are almost the only technology companies that have substantial depreciation expenses. Because it takes so much capital to own their own means of production, their return on investment can look low even though profit margins are high. They also have to divert part of their research and development spending to improve the production process rather than just designing great new chips.

On the other hand, they should have lower costs of production than companies that use an outside manufacturer, and better control over the schedule of when certain products are built.

It costs a lot to build a chip fabrication plant—typically well over $1 billion today—which creates high operating leverage. Operating leverage means that low wafer volumes or low yields cannot cover the depreciation and operating expenses, leading to outsized losses. But once the plant is up to breakeven, as much as 90% of the sales over breakeven can fall right down to the profit line. That's high operating leverage.

Three companies that own their own facilities are Texas Instruments, LSI Logic, and Cypress Semiconductor. Their average gross profit is 39%, with a large chunk of this going for research and development, which averages 14% of sales. They also tend to spend another large chunk on selling, general, and administrative expenses, which averages 13%. That leaves them with average operating profits of 12%.

This financial model is typical for companies that own their factories, with the main variation being the level of gross profit, depending on how unique or hot their chip designs are. When you are evaluating a semiconductor company that owns its fab, look first at the gross profit margin (the higher the better) and then be sure the rest of its business model is in line with the average ratios of these three companies. Ask the investor-relations department about anything that seems substantially out of line.

The second business model is the "fabless" company that does not own a factory. This became a popular model beginning in the late 1980s, because it took advantage of inexpensive excess fabrication capacity in the Far East and allowed venture capitalists to build successful companies without laying out the extra capital for a fab. The fabless company focuses instead on design and marketing.

When the business is going well, gross profits can be as high as 70%.

But when fabrication capacity is tight, as it was in 1994 and early 1995, fabless companies had to pay extra or pay in advance to get their chips manufactured on a timely schedule. That hurt gross profits.

Three successful fabless companies are Xilinx, NeoMagic and PMC-Sierra. Considering good times and tight times, their average gross profit is 49%—10 percentage points higher than the companies that own their fabs. They also spend a lot on research and development to develop new designs, averaging 11%, and they spend an average of 19% on selling, general, and administrative expenses.

The average operating profits of these three companies is 19%, typical for the fabless industry. Because each company's business is different, there is no one ideal business model that fits all situations, but any fabless company that measures up to these averages is doing well.

The third business model is to have a patented product that absolutely everybody wants. It should have many different functions, thus capturing lots of value and justifying a high price. It should have a clear migration path to becoming faster and cheaper, reducing manufacturing costs while forcing customers to upgrade to the latest version lest they fall behind their competitors.

This business model produces gross profit margins of 55%. The fortunate company needs to spend only 8% on research and development to maintain its lead. Because customers must use the chip, sales and marketing expenses can be relatively low. While the company may not have to run lean and mean, there is no reason to waste a lot of money on selling, general, and administrative expenses—17% should cover it. That leaves whopping operating profits of 29%, far above the average for the other two business models.

Of course, there is only one product that produces this level of profitability, and only one company that enjoys this model: The microprocessor, and Intel.

THE CUSTOMERS

The customers for semiconductors are system-design engineers. These are the people designing products to be sold to system-assembly companies or to end users—computers, add-on boards, disk drives, communications gear, instruments, automobiles, appliances, video game consoles, and so forth.

The companies they work for may sell direct to end-users, like Compaq Computer, or they may manufacture an intermediate product, like disk drives to sell to Compaq.

In either case, the design engineer works with marketing to develop the specifications for a product and then chooses the semiconductors that will meet those specifications. Thus it is crucial for a semiconductor company to be in the running during this "design-in" phase.

Once the design is set, the winning chips are likely to be in that product during its entire life. Product cycles are so short that it is not worth redesigning a successful product to lower costs by substituting other chips.

COMPETITIVE STRATEGIES

The two key strategies in the semiconductor business are to make chips smaller (and therefore faster), yet lower-powered, and to continually integrate more and more functions onto a single chip.

For any given function, the smaller the chip, the less real estate it occupies on the silicon wafer. The less real estate it occupies, the more chips that can be squeezed onto a single wafer. Because the cost of processing a wafer is about the same no matter how many chips are on it, the cost per chip falls as the chip gets smaller. In addition, smaller chips run faster and often on lower power. That means that in a device like a laptop computer, the batteries will last longer, a strong selling point for the computer-systems assembler.

The other key strategy is to integrate more and more functions on a single chip. Someday a "fourth-socket" chip that does almost everything will be introduced.

The most likely companies to win the race to the fourth socket are Conexant, a spinout from Rockwell International, or PMC-Sierra, but no one has all the neceessary technologies in one place yet. Certainly, companies like S3, Creative Technology, Cirrus Logic, C-Cube Microsystems, and Trident Microsystems all have a shot at the gold ring.

THE NEXT BIG CHANGE

Many changes are coming in the semiconductor industry as the standard circuit width drops. Each of those steps enables a sharp drop in costs and much higher integration.

My pick for the single biggest change coming in the semiconductor area is the close integration of digital and analog chips—the "mixed-signal" devices. Digital chips deal with ones and zeros, the language of the imaginary world of binary mathematics. Analog chips deal with pressure, temperature, sound, color—the real world. Most consumer products have a high analog content, so as the electronics industry continues its shift toward more and more consumer products, mixed-signal semiconductors will be a pivotal technology. These chips will grow much more complex than they are today, enabling dramatically new products that will sell in very high consumer-level volumes.

You can track forecasts for semiconductors on the Internet at www.semi.org. Sematech, the industry's research consortium, publishes a detailed technology

TABLE 1. SEMICONDUCTOR WORLD LEADERS

Company	1998 Sales ($ bil)	1998 Mkt Shr (%)
Intel	22.8	23.5
NEC	7.4	7.6
Texas Inst.	6.5	6.7
Motorola	5.9	6.1
IBM Micro.	4.9	5.0
Toshiba	4.9	5.0
Hitachi	3.9	4.0
Samsung	3.8	3.9
STMicro.	3.7	3.8
Fujitsu	3.4	3.5
Total	**67.2**	**69.2**

Source: IC Insights

roadmap for the next several years. You can download a read-only copy (240 pages, 2.4 megabytes) from www.sematech.org/public/roadmap.

WHO ARE THE PLAYERS?

The top 10 worldwide semiconductor firms remained largely the same in 1998 and kept about the same share of the total market; they are listed in Table 1. The sales numbers in the table are "merchant" sales, i.e., to outside parties.

NEC, Toshiba, Hitachi, Samsung, and Fujitsu all derive a significant portion of revenues from DRAM, and will benefit if that market firms. Texas Instruments sold its DRAM business to Micron Technology but still moved up several slots based on the popularity of its Digital Signal Processors. IBM Microelectronics has a goal of increasing external sales to 70% of revenues, up from the current 30%. That emphasis boosted IBM Microelectronics three positions last year and will give them more market strength going forward. Fujitsu knocked Mitsubishi out of the top 10 mainly because it's less dependent on DRAM.

The top rankings of U.S. semiconductor producers (as shown in Table 2) moved slightly. AMD and Lucent switched places as AMD saw marginal improvements in Pentium clone sales and strength in sub-$1,000 PC sales. Micron and LSI also flip-flopped as the former's reliance on DRAM clobbered its revenues.

The semiconductor business always has been driven by a select, ever-changing list of "hot" products. For the next five years, IC Insight projections indicate that the hot products should include the following areas: DRAM; gallium arsenide integrated circuits; standard cell logic; digital signal processors; programmable logic; microprocessors; telco, other analog; and flash memory.

INVESTMENT STATISTICS

Table 3 provides useful financial statistics for the major semi-conductor companies. The technology industry changes fast, and of course prices change daily, so these numbers will be quickly outdated. However, they will provide you with guidelines for the kinds of investment criteria you should first focus on when investing in semiconductor companies.

The *revenue* figures are my estimates of the current rate. *Expected earnings per share growth rates* come from I/B/E/S, with some of my adjustments.

Market capitalization is the stock price times the number of shares outstanding and gives an indication of the size of the firm.

R&D relative to sales (research and development spending divided by annual sales) measures a firm's commitment to research and development. In this table, the figures are from the last fiscal year, although I adjusted a few numbers for companies that had unusual circumstances.

Annual sales growth is generally for the last three years, sometimes adjusted for unusual items. It provides an indication of how fast the business is growing, and ideally you should seek companies with sales growth of at least 15%.

Pretax profit margin (net income divided by revenues) is a blend of historical averages and my forecast for 1999. This figure provides an indication of how profitable the firm is. In general, you should seek technology companies with a pretax profit margin of 15% or better.

The *price-to-growth-flow ratio* provides a measure of relative valuation, while taking into consideration the amount of earnings spent on research and development. The figure adjusts the price-earnings valuation approach by adding the last fiscal year's research and development spending per share to normalized earnings per share to determine the growth flow; the stocks' share price divided by the growth flow produces the price-to-growth-flow ratio. Technology stocks are fairly priced when price-to-growth-flow ratios are around 10 to 14; anything under 8 is cheap while ratios of 16 and over are too expensive.

Remember that before you consider buying any technology stock, you should recalculate these ratios to use the most recent data and current prices. Any investment requires an in-depth analysis of the firm and its industry. ✦

TABLE 2. SEMICONDUCTOR U.S. LEADERS

Company	1998 Sales ($ mil)
Intel	22,800
Texas Inst.	6,500
Motorola	5,880
IBM Micro.	4,900
Lucent Tech.	2,750
AMD	2,473
National Semi.	2,115
LSI Logic	1,475
Micron Tech.	1,430
Analog Devices	1,210
Total	**51,533**

Source: IC Insights

TABLE 3. THE MAJOR SEMICONDUCTOR COMPANIES

Company	Ticker	Revenues ($ mil)	Market Cap ($ mil)	Expected Earnings Growth (%)	R&D Relative to Sales (%)	Annual Sales Growth (%)	Pretax Profit Margin (%)	Price-to-Growth Flow (X)	Sector*
Actel	ACTL	154	275	20	20	21	15	5.6	Programmable-logic circuits
Adaptec	ADPT	690	3,325	20	21	26	21	10.0	Storage/SCSI
Adv Micro Devices	AMD	2,542	2,710	16	22	9	3	6.6	Microprocessors
Altera	ALTR	654	6,900	25	9	36	35	26.8	Programmable-logic circuits
Anadigics	ANAD	86	370	27	22	24	17	15.6	Gallium arsenide circuits
Analog Devices	ADI	1,228	6,200	21	18	13	17	16.0	Analog/DSP
Applied Micro Circ	AMCC	105	1,380	31	21	23	20	32.8	Communications
ARM Holdings	ARMHY	60	1,840	35	29	50	24	32.2	Microprocessors
Artisan Components	ARTI	16	100	35	22	90	17	51.8	Embedded memory
Broadcom	BRCM	203	8.85	47	19	150	27	53.3	Communications
Burr-Brown	BBRC	258	1,170	22	15	9	18	14.7	Analog
C-Cube Microsys	CUBE	352	980	25	21	71	19	7.9	Digital video
Cirrus Logic	CRUS	954	460	15	19	22	6	2.4	Logic/mixed signal
Conexant	CNXT	1,180	3,740	23	22	15	4	12.5	Communications
DSP Group	DSPG	64	305	30	16	39	24	12.3	Digital signal processors
8x8	EGHT	32	70	27	31	12	5	20.3	Communications
ESS Technology	ESST	218	315	10	14	70	25	8.3	Mixed signal
Faroudja	FDJA	12	35	30	39	0	0	8.1	Digital video
Galileo Technology	GALT	52	635	28	21	50	30	19.7	Communications
Genesis Microchip	GNSS	31	260	40	29	100	28	20.6	Video
Intel	INTC	26,273	179,380	21	10	25	35	17.8	Microprocessors
Integrat Device Tech	IDTI	540	700	22	20	20	15	4.1	Logic/memory
Lattice Semi	LSCC	200	1,150	22	13	19	33	13.6	Programmable-logic circuits
Linear Technology	LLTC	485	8,100	24	10	26	54	34.9	Analog
LSI Logic	LSI	1,491	5,300	19	19	16	18	13.3	System on a chip
Maxim Integrat Circ.	MXIM	560	7,210	27	13	38	47	23.4	Analog
Microchip	MCHP	406	2,250	26	10	24	20	17.9	Microcontrollers
Micro Linear	MLIN	48	40	20	25	7	16	3.6	Analog/mixed signal
Micron	MU	3,012	9,485	17	8	29	5	28.7	DRAM memory
MIPS Technology	MIPS	57	1,120	45	76	25	5	16.1	Microprocessors
MMC Networks	MMCN	49	850	48	29	100	25	29.9	Communications
Motorola	MOT	29,400	49,935	15	10	12	7	12.2	Logic/DSP
National Semi	NSM	2,535	3,255	15	19	5	9	12.9	Communications
NeoMagic	NMGC	241	205	27	13	100	19	4.3	Logic/memory
Nvidia	NVDA	158	500	30	16	100	3	10.1	3D graphics
OPTI	OPTI	40	65	16	24	0	0	9.1	Core logic/USB
PMC-Sierra	PMCS	162	3,080	35	21	14	18	37.3	Communications
Qlogic	QLGC	117	1,945	31	21	9	21	31.8	Storage/SCSI
Rambus	RMBS	38	1,805	75	25	45	30	110.7	Interface designs
RF Micro Devices	RFMD	153	1,670	42	10	23	16	31.8	Communications
RF Monolithics	RFMI	55	30	21	9	22	8	4.8	Communications
Sandisk	SNDK	136	835	26	13	20	15	21.8	Flash memory
Silicon Storage Tech	SSTI	69	115	20	10	0	0	7.4	Flash memory
S3	SIII	225	355	25	35	15	15	6.7	3D graphics
Texas Instruments	TXN	8,460	42,875	22	14	0	7	17.9	Logic/DSP
3DFX	TDFX	203	305	25	17	100	15	6.3	3D graphics
3Dlabs	TDDD	45	45	20	9	100	15	3.8	3D graphics
TranSwitch	TXCC	44	780	41	25	29	14	30.6	Communications
Trident Microsystems	TRID	113	90	5	25	8	10	3.0	3D graphics
TriQuint	TQNT	112	335	33	18	27	10	10.2	Gallium arsenide circuits
Vitesse	VTSS	193	4,175	42	16	46	35	28.6	Gallium arsenide circuits
Xilinx	XLNX	662	6,425	25	13	28	29	24.2	Programmable-logic circuits

** SCSI: small computer systems interface; DSP: digital signal processor; USB: universal serial bus*