DRAM SCAM

HOW THE UNITED STATES BUILT AN INDUSTRIAL POLICY ON SAND.

BY BRINK LINDSEY

If you want to see how "industrial policy" actually works in practice, take a look at Sematech. This semiconductor research and development consortium, funded jointly by private industry and the federal government, is probably the country's biggest foray yet into this new-style interventionism. While Sematech currently is seeking an extension of federal funding, it is also serving as the model for other initiatives.

On the industry side, Sematech's 14 member companies account for 80 percent of combined U.S. semiconductor sales. These companies contribute half of Sematech's roughly $240-million annual budget. Government participation consists of $100 million a year from the Defense Department's Defense Advanced Research Projects Agency (DARPA), as well as various state and local subsidies. The declared goal of this government-industry "partnership" is to develop new technologies that will help U.S. industry to regain (from Japan, of course) world "leadership" in this economically and militarily "strategic" industry.

From the standpoint of industrial-policy supporters, Sematech would appear to have all the makings of an ideal test case. "Sematech was an experiment, but also a good model," says Daniel F. Burton Jr., executive vice president of the Council on Competitiveness, an umbrella group sympathetic to a more active federal role in industrial policy.

In the first place, Sematech's beneficiary is not some declining smokestack industry; rather, the focus here is on the cutting edge of high technology. Thus, the usual knock against industrial policy—that it favors dying "sunset" industries at the expense of emerging "sunrise" ones—is seemingly inapplicable. Furthermore, the fact that Sematech is dedicated to "precompetitive" R&D apparently dispenses with the other stock argument against industrial policy—namely, that government should not be in the business of picking winners and losers.

And indeed, the basic idea behind Sematech—that government should extend its R&D spending into overtly commercial areas and should do so by working directly with private companies—has been gaining popularity. The Reagan and Bush administrations have generally opposed anything that looks like industrial policy. Due largely to the influence of presidential science adviser D. Allan Bromley, however, the White House has now signaled that it supports government funding for development of commercial technologies, so long as they are sufficiently "generic" to be considered "precompetitive."

One notable example of this kind of policy is the Advanced Technology Program (ATP), administered by the Commerce Department's Technology Administration. ATP, which gives grants to private companies conducting high-tech R&D, started with a 1990 budget of only $10 million; the budget rose to $36 million in 1991 and will increase $46 million in 1992. Meanwhile, the push is now underway to extend federal support for Sematech, which ex-

pires at the end of 1992, for another five years.

Sematech's actual track record, though, should serve as a warning rather than a blueprint. Cutting through the high-tech jargon and reassurances about "precompetitive" assistance, a close look at Sematech confirms all the darkest suspicions of industrial-policy critics. For as it turns out, even microelectronics has its sunset industries, and even precompetitive R&D has its winners and losers.

Semiconductors, or "chips," are electronic devices that store, retrieve, and process information. They provide the hardware "smarts" not only for computers but also for televisions, fax machines, telephones, microwave ovens, cameras, car ignitions, and antilock brakes—not to mention Patriot and cruise missiles and all the other dazzling high-tech weaponry on display in the Gulf War. Usually made from silicon, with microscopic aluminum wiring deposited on the surface in multiple layers, chips are miracles of miniaturization: A single chip the size of a postage stamp can contain millions of electronic components, with features on its surface measured in fractions of a micron (a human hair is about 75 microns thick).

Semiconductors may be divided into two basic categories: memory chips and logic chips. Memory chips, as their name implies, store and retrieve data. The biggest-selling of these is the DRAM (dynamic random access memory, pronounced dee-ram), which provides short-term data storage for computers. DRAMs are relatively simple to design but excruciatingly difficult to manufacture—at least at production yields high enough to make selling them commercially viable. Accordingly, the key to competitive success in DRAMs is high-volume, low-defect, low-cost production. DRAMs and other high-volume memory chips have been dubbed "commodity" chips to reflect their fungibility and fluctuating prices.

Logic chips, on the other hand, juggle and manipulate data. They make decisions, route information to different destinations, perform calculations, and relay instructions. The best-known logic chips are microprocessors, which act as central control centers in personal computers. Since logic chips perform complex functions and frequently have highly specialized or even customized applications, the premium is on design rather than raw manufacturing efficiency. Unlike memory chips, logic chips compete in the marketplace based on what they can do, not how much they cost.

The origin of Sematech goes back to the mid-1980s, when U.S. companies staged a wholesale evacuation from the DRAM business. Although DRAM technology was pioneered in the United States (Intel invented the DRAM in 1971), by the early 1980s American chipmakers were seeing their profits and market share slip away in the face of fierce Japanese competition.

A glut in worldwide DRAM capacity, combined with a sharp drop in demand, caused prices to plummet in 1985. Faced with huge and mounting losses (though not as large as the losses being suffered by Japanese producers), one U.S. chipmaker after another bailed out of DRAM production. By 1986, only two American-owned companies were left making DRAMs for sale, Micron and Texas Instruments. The American industry, which had virtually monopolized the world market only a decade before, now claimed less than a 10-percent share. The Japanese, on the other hand, had increased their market share to more than 80 percent.

(By the way, these statistics do not take into account the U.S. "captive" producers—namely IBM and AT&T—that produce chips for their own use rather than for sale on the open market. Both companies have continued to manufacture DRAMs, and IBM remains the world's largest producer.)

The loss of DRAMs sent the industry into a panic. Many regarded commodity memory chips as the key "technology driver" in semiconductor production. In this view, the unceasing race to cram more and more memory onto less and less silicon at lower and lower cost spurs the innovations that are needed to stay competitive in all areas of chip manufacturing. Thus, the state-of-the-art DRAM in the late 1970s contained 16,000 bits of memory; today companies are beginning to sell DRAMs with 16 million bits of memory—a thousandfold increase. Drop out of this race, it was thought, and competitiveness in other more specialized semiconductors would soon falter as well.

Having failed in the marketplace, the big U.S. chipmakers turned to Washington for help. They prevailed upon the U.S. government to bring antidumping cases against Japanese producers, accusing the Japanese of selling below cost. (Since both American and Japanese chipmakers were losing money in the mid-1980s, they were all selling below cost in a sense. This is all that's required to trigger antidumping tariffs.) The antidumping cases threatened Japanese chip imports with punitive duties as high as 108 percent. To avoid this outcome, the government of Japan struck a deal with the U.S. trade representative in July 1986.

The agreement imposed worldwide controls on Japanese semiconductors. It established price floors for sales to the United States and third countries and targeted 20 percent of the Japanese market for U.S. and other foreign suppliers. To implement the agreement, Japan's Ministry of International Trade and Industry leaned on Japanese chipmakers to reduce output and shipments of DRAMs. The result was an acute worldwide shortage of DRAMs during 1988 that raised prices, bestowing windfall profits on Japanese chip companies and inflicting serious harm on U.S. computer makers, computer buyers, and anyone else who needed DRAMs. (Last summer this agreement, in somewhat altered form, was extended for another five years.)

Sematech represented the next step in the Washington strategy. After using political means to restrain foreign competitors, industry leaders now campaigned for outright government assistance. In March 1987, 14 U.S. chipmakers announced the formation of a consortium to take on the Japanese in developing advanced manufacturing techniques. They also announced that they wanted government funding for the project.

Initial planning for the consortium, called Sematech for "semiconductor manufacturing technology," had envisioned actually manufacturing DRAMs for sale. This idea was scuttled, first because the remaining American DRAM producers didn't want to create a new competitor, but also because IBM was afraid it would get stuck buying Sematech chips if other purchasers could not be found (not exactly a ringing endorsement of the consortium's prospects). Accordingly, project planners settled on the more limited goal of cooperative R&D, which members could then use in their own manufacturing operations. Even this degree of collaboration marked a dramatic shift from the rugged entrepreneurship that had always characterized the American microelectronics industry.

(The idea of a DRAM-making consortium was later resurrected in the form of U.S. Memories. Plans for this consortium, which was not to receive any direct federal funding, collapsed in 1990 due to the unwillingness of key computer companies to participate.)

Sematech's formation coincided neatly with the release the previous month of a Pentagon-sponsored study on "defense semiconductor dependency." The report concluded that "it is simply no longer possible for individual U.S. semiconductor firms to compete independently against world-class combinations of foreign industrial, governmental and academic institutions." As a result, "a direct threat to the technological superiority deemed essential to U.S. defense systems exists." The report's top recommendation: DOD funding of $200 million a year for five years to support the establishment of a "Semiconductor Manufacturing Technology Institute." This report was prepared by the Defense Science Board, whose advisory panel just happened to include a number of representatives from Sematech member companies.

The combination of competitiveness and national security concerns carried the day for Sematech, though the consortium got only half the money it hoped for: Congress authorized $100 million a year for five years. The money would come from DARPA, a small agency within DOD devoted to high-tech weapons research. Notwithstanding the national security justifications and the defense budget funding, the focus of Sematech's R&D would be explicitly commercial. Industrial policy had sneaked in through the Pentagon back door.

DESPITE THE NATIONAL-SECURITY JUSTIFICATIONS AND THE DEFENSE-BUDGET FUNDING, THE FOCUS OF SEMATECH'S R&D WAS EXPLICITLY COMMERCIAL FROM THE START. INDUSTRIAL POLICY SNEAKED IN THROUGH THE PENTAGON BACK DOOR.

As sold to Congress, Sematech's mission was to create a "world-class" manufacturing facility that would serve as a model for the industry. To this end, the consortium constructed a large chip factory (known in industry jargon as a "fab") in Austin, Texas, and hired more than 700 engineers and staff. The idea was that Sematech's demonstration fab could develop new manufacturing processes that would then be implemented by member companies. The idea didn't work.

Sematech had planned to pursue its mission in three phases. Phase one would involve experimental chipmaking at linewidths of 0.8 micron, then the state of the art. In phase two and phase three, Sematech would move on to 0.5 and 0.35 micron, respectively.

To help get Sematech started in phase one, IBM donated its designs and proprietary processes for making four-megabit DRAMs; in addition, AT&T contributed the technology for its 64-kilobit SRAM (static random access memory, a type of high-speed memory chip). With this assistance, Sematech achieved its phase-one goal in 1989. Meanwhile, private companies, including U.S. firms that didn't belong to Sematech, had been selling chips with 0.8-micron linewidths since 1986. In other words, Sematech was able to borrow technology from private companies and reproduce manufacturing results that other private companies had achieved years before—and do it with taxpayers' money.

After phase one, Sematech shifted attention away from process R&D. It retained the 0.5- and 0.35-micron goals, but now the focus was on the manufacturing equipment needed to make chips with those linewidths. Sematech had originally intended to spend 80 percent of its money on in-house research; after 1989, it began allocating more than half its budget to outside R&D contracts with equipment manufacturers. Within the Sematech fab, efforts now concentrate on evaluating the performance of new tools rather than the actual how-to of making chips.

The problem with the demonstration fab concept was simple: Sematech wasn't making real products for sale. To produce commercial chips would be to admit that Sematech's work wasn't really "precom-

petitive" and so wasn't a public good just like government-funded basic R&D. But not to produce salable chips was to undermine the whole enterprise.

"What really matters with a [semiconductor] technology is shipping it in production—that means you have it down," explains T.J. Rodgers, president of Cypress Semiconductor and probably Sematech's most vocal critic. Indeed, the relation between production efficiency and selling is so well established in high-tech industries that it has a name: the "learning curve." The theory of the learning curve is that production costs fall at a fixed rate (usually thought to be around 30 percent) with every doubling of cumulative production volume. Sematech, though, can at best simulate this process.

"There's no one in this business who believes you can go down the learning curve without manufacturing," says Rodgers. "But Sematech's kickoff charter, approved by Congress, was to learn without manufacturing. It was a preposterous charter, and I said so at the time."

Sematech's new mission, then, is to help American chipmakers indirectly—namely, by helping the American-owned companies that supply them with chip manufacturing equipment. And indeed, the U.S. equipment industry is besieged.

In 1983, U.S. companies supplied 69 percent of the world market in semiconductor manufacturing and test equipment; by 1990, the U.S. share had dropped to 45 percent. Meanwhile, Japanese market share has increased from 25 percent to 44 percent over the same period. In 1985, seven of the 10 largest equipment companies were American; now five of the six largest are Japanese.

Sematech has set out to arrest this decline. Its goal is to preserve at least one viable American-owned supplier in each of several key equipment areas. To this end, Sematech is now spending over $100 million a year in outside R&D contracts with equipment suppliers, either to improve existing equipment or to develop equipment for the next generation of semiconductor manufacturing.

Sematech justifies its new mission by trumpeting the dangers of depending on Japanese suppliers. In a controversial move last May, Sematech and Sen. Lloyd Bentsen (D-Tex.) charged Japanese equipment companies with intentionally withholding state-of-the-art technology from American chipmakers. Even some Sematech members felt obliged to distance themselves from these allegations: Intel, Texas Instruments, and Motorola all declared that they had never experienced difficulties getting top equipment from Japanese companies.

Furthermore, many of the specific examples of technology withholding dissolved under scrutiny. For example, Sematech had accused Nikon of withholding its G-5-D stepper (a machine that imprints the circuit pattern on the silicon wafer) from American buyers. As it turned out, only one of these machines was ever sold in the United States because the product had been so defective that it was soon replaced by another model. In other instances, Japanese suppliers had never received any U.S. orders for the machines they were accused of withholding. Nevertheless, Bentsen commissioned a General Accounting Office study to look into the issue.

The GAO report, issued last September, is a model of mushy equivocation. While the GAO did find that a number of U.S. chipmakers had experienced delays in getting advanced equipment from Japan, it was unable to cite any evidence that such delays were intentional or in any way commercially abnormal. Indeed, the report makes this sweeping caveat:

"GAO could not verify much of the information provided. The U.S. companies interviewed requested that GAO not discuss their specific problems with other U.S. firms or with foreign suppliers. Also, U.S. companies were not required to provide GAO with documented information. Moreover, GAO did not assess whether the practices of foreign suppliers were common business practices or whether they would violate any laws or international agreements." In other words, the GAO's findings and a couple of bucks will buy you a beer.

To the extent that Japanese equipment companies do supply their domestic market first, it is largely a matter of the way new equipment is developed in Japan. Chipmakers there tend to work closely with equipment companies in evaluating and "debugging" new machines. By contrast, U.S. semiconductor companies have traditionally maintained an arms-length relationship with their suppliers. Thus, Japanese companies buy equipment at an earlier stage of product development than American companies do. The Japanese approach has its advantages—early access to new technology—but it also requires a substantial commitment to working with equipment that is not yet fully operational.

"It really cuts both ways," says George Gilder, author of *Microcosm*. "I mean, do you really want to have that leading-edge piece of equipment that doesn't quite work perfected on your line? You have to have a very good relationship with a company to want to do that. It's not that big an advantage."

Sematech's assistance to equipment suppliers is premised on a "food chain" theory, according to which noncompetitiveness in the equipment industry leads inexorably to noncompetitiveness "up the food chain" in the chip industry. Even if this theory is faulty (and certainly the sensationalistic version peddled by Sematech, with its sinister Japanese conspiracies, is pure hokum), there is nonetheless a general consensus that Sematech has been doing some useful work, both in evaluating new equipment and improving working relations between chipmakers and suppliers.

"The major impact of Sematech is the communication that has been opened up between manufacturers and suppliers, allowing them to sit across the table in the board room and ask whether the manufacturers' needs are being met," says Eric Winkler, a spokesman for the Semiconductor Equipment and Materials Institute, a trade association. "Sematech has served as a conduit to allow our members access to information about the industry that would otherwise not be available to them." Now that suppliers and manufacturers have begun talking,

however, Winkler says he isn't sure Sematech is still necessary to promote that cooperation; the move toward closer relations may just continue on its own.

Indeed, if U.S. semiconductor producers truly feel threatened by a growing dependence on foreign-owned suppliers, they can do something about it without government aid. After all, total U.S. purchases of semiconductor equipment and materials came to several billion dollars last year. Chipmakers can easily use their purchasing decisions to ensure a continued U.S supplier base, if they think this is a priority. Sematech's $100 million a year in government-subsidized contracts may help a few favored suppliers, but overall Sematech can add very little to what private industry is already capable of doing for itself.

While Sematech was spending the last four years worrying about linewidths and equipment-supplier market shares, the U.S. chip industry has quietly gone about making a very impressive comeback. Since 1987, the combined U.S. share of the total world semiconductor market, adjusted for exchange-rate fluctuations, has been holding steady at around 35 percent. In 1990, U.S. companies actually gained market share on the Japanese.

To accomplish this turnaround, U.S. companies ignored just about everything Sematech's supporters have ever said about semiconductor competitiveness. The conventional wisdom held that commodity memory chips were the key to success in semiconductors generally. American chipmakers, though, have based their comeback on the growing market for complex logic chips. The conventional wisdom held that staying ahead in the chip business was possible only through constant incremental improvements in manufacturing technology. American companies instead concentrated on their strengths in innovative chip design. The conventional wisdom held that only vertically integrated giants or cartel-like consortiums could go head-to-head with the Japanese. The American resurgence, however, has been led by small, entrepreneurial start-ups.

Recall that commodity memories like DRAMs were supposed to be the "technology driver" upon which the whole future of the industry hinged. To quote from the Defense Science Board report that helped launch Sematech:

"The U.S. semiconductor industry may very soon, in fact, be competitive only in very small, 'specialty' segments of the overall market. This situation has arisen partly because of loss, in some areas, of technological leadership, resulting in an inability to compete with high-quality products in commodity markets."

Of course, this doom-and-gloom has not come to pass. Japanese companies do still dominate the market for commodity memory chips, holding a 62-percent share, compared to 23 percent for U.S. firms. DRAMs, though, have become a very ugly business. Not only are there a number of new Japanese entrants, but the Koreans and Taiwanese have also jumped into the game. Furthermore, sales of memory chips sank 17 percent last year. So more and more companies are chasing less and less money. As it turns out, the exodus of American companies from this high-anxiety, low-margin market—decried at the time by the industrial-policy crowd—looks in retrospect like a smart business move. (Interestingly, Intel, a major backer of Sematech and of industrial policy in general, was one of the first companies to walk away from DRAMs.)

Meanwhile, American companies have been thriving in those supposedly marginal "specialty" markets derided by the Defense Science Board. U.S. companies currently hold 48 percent of the market for complex logic chips, compared to 43 percent for the Japanese, and the American lead is increasing. Worldwide sales in this area jumped some 15 percent last year and are now one-third larger than sales of commodity memory chips. And unlike look-alike commodity chips, the distinctive features of logic chips allow their sellers to command big price premiums that translate into high profit margins.

What happened? Why were the DRAM devotees so wrong? The answer has to do with a revolution in the process of chip design that has dramatically accelerated the product development cycle. Through the use of "silicon compilers"—powerful software that automates major aspects of chip design—a small team of engineers using desktop computer workstations can now accomplish in a few months what droves of their colleagues using bulky central-

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ized mainframes would have taken years to complete.

Faster, cheaper chip design has triggered an explosion of new products made for specialized applications. "Because of the new design tools, there has been over a tenfold rise in the number of chip designs generated every year—from around 10,000 in the mid-'80s to over 100,000 today," says Gilder. "And all these new designs tend to be unique and thus for higher value-added products."

As a result, generic chips needing customizing software are giving way to already-customized hardware. This growing specialization of production means that design innovation, rather than manufacturing process, has become the key to creating new value for customers.

"We have just gone through a period over the past 30 years where fielding competitive electronic products has in large measure been determined by the ability to innovate in semiconductor manufacturing," explains Andrew Rappaport, president of The Technology Research Group and a leading industry consultant. "Today, though, competitiveness is much more determined by being able to transform broadly available semiconductor technology into some kind of useful product."

This novel situation may be described as a "silicon glut." The race to cram more and more transistors onto a single chip continues, but the field is crowded, the pace is brutal, and the rewards of winning are greatly diminished. "The ability to manufacture semiconductors has evolved to the point that marginal improvements in [the] manufacturing process don't necessarily contribute to increased value in all semiconductors," says Rappaport. Furthermore, "these improvements spread so quickly that the advantages to the company or country that is first to achieve this marginal advantage are very short-lived."

The competitive edge in chipmaking now belongs to companies that can take advantage of the silicon glut, not those that simply add to it. By focusing their resources on specialized, design-intensive logic chips, American companies have exploited the glut and cashed in accordingly.

When high-volume, standardized production was the name of the game, it made sense to think that large, vertically integrated companies had a competitive advantage. Commodity memories still adhere to this production model, so it's not surprising that Japanese conglomerates dominate the market. The growing prominence of design-intensive chips, however, gives the advantage to smaller or more nimble companies that can respond quickly and innovatively to changing market conditions. The silicon glut has played into the strengths of Silicon Valley's entrepreneurial start-up culture.

Indeed, much of the recent growth in the American semiconductor industry has come from new companies. If you take a look at the companies with the highest returns on equity last year, you will see names like Altera, Cirrus Logic, Cypress Semiconductor, Weitek, and Xilinx—names that no one had ever heard of back in the mid-1980s, when DRAMs were lost and the sky was falling. All of these companies have made their money by coming up with specialized products, particularly design-intensive logic devices.

Indeed, only Cypress actually manufactures its own chips. The other companies are "fabless" chipmakers; these firms contract out production of their designs to other chipmakers with excess fab capacity or to specialized "foundries" that only make other companies' chips. Rappaport, a strong (and controversial) booster of the fabless chipmakers, notes that "so long as aggregate investment in semiconductor manufacturing technology worldwide is large enough to continue the evolution of technology in a predictable and rapid way, then there's very little reason for a company exploiting that technology to control the investment in how that manufacturing improvement occurs."

Rappaport cites Xilinx, a company that makes logic devices that customers can program (and reprogram) for themselves: "Although the company farms out production mostly to Japan, it retains all the intellectual assets that have been created around its chip architectures. The low-value, commodity aspects have been farmed out to Japan, where the fabs make very low margins on the work they do for Xilinx. Xilinx, meanwhile, has increased margins and volumes on its own business, and therefore has more to invest in its own R&D."

Sematech has been at best irrelevant to this exciting revitalization of American chipmaking. Indeed, to the extent that Sematech has had any impact at all, it has actually hindered these positive developments by favoring older, more-established companies over innovative newcomers.

There is a fault line in the industry that separates the established, billion-dollar giants—the "dinosaurs," as T.J. Rodgers calls them—from newcomers like Cypress and the fabless companies. In contrast to the entrepreneurial dynamism on the newcomer side, the establishment side is characterized by sluggishness and even stagnation. (Intel, with its commanding position in microprocessors, is a spectacular exception.)

Six of the eight largest U.S. chipmakers lost money last year. Advanced Micro Devices, with $1.1 billion in annual sales, has made a profit only two out of the past six years; National Semiconductor, with $1.7 billion in annual sales, has been profitable only once in the past six years. In addition to their financial woes, the established giants also share another common trait: They all belong to Sematech.

When asked about niche companies like Cypress and the fabless chipmakers, the Council on Competitiveness's Daniel Burton gives the typical pro-industrial policy response. "My hat's off to them," he says, "but I think that especially in the semiconductor market not everyone can be a niche player." And Sematech, it seems, is designed to subsidize the companies that eschew niches.

But even with a restricted membership—its dues structure favors large companies—Sematech was supposed to generate "spillovers" that would benefit not only the larger chip companies but the entire U.S. economy. Yet Sematech's members appear to have kept spills to a minimum. Specifically, in testimony before Congress last July, Rodgers accused Se-

matech of 1) giving its members unfair advantages through "technology holdback" agreements and 2) using "kickback" schemes to funnel money back to members.

Rodgers tells the following story: "Back in 1989 my engineers were visiting a company called Westech, which makes wafer polishing equipment. They came back and told me that there was a piece of equipment in a back room they weren't allowed access to. When they asked about the equipment, all they got were evasive answers. I then called the president and V.P. of sales, but I got the same waffling answers."

The next year, Rodgers solved the mystery when he became involved as an expert witness in litigation between Sematech and Travis County, Texas. (Sematech was claiming that as a "charitable organization" it was exempt from local taxes.) Rodgers was able to get access to subpoenaed documents, including an R&D contract between Sematech and Westech regarding the equipment that Cypress had been unable to purchase.

According to Rodgers, the contract contained an explicit requirement that Westech withhold equipment developed under this contract "for a period of one year from the time of normal introduction" from all companies except Sematech members. Rodgers says he saw another similar contract with Westech, as well as one with Applied Materials, a major equipment supplier. Sematech admits that these "holdback" agreements existed and still defends them. "Since members were paying $100 million [for new technology], they should get the first chance to buy and use it," says Sematech spokesman Buddy Price. Sematech's current policy, however, allows companies contracting with Sematech to sell to anyone at any time.

Rodgers also objects to the way Sematech's equipment R&D contracts benefit Sematech members. In a number of "equipment improvement projects," Sematech has purchased newly developed machines and installed them at the fabs of member companies. In exchange for free use of a machine, the member evaluates it and reports back to Sematech. (At the end of the project, the member has the option of buying the machine from Sematech at a discounted price.) In other words, Sematech members are getting state-of-the-art equipment, free or on the cheap, that they might well have bought anyway.

ALTHOUGH IT'S SUPPOSED TO HELP THE WHOLE U.S. INDUSTRY, SEMATECH LOOKS LIKE A CLIQUE OF LARGE, ESTABLISHED, HIGH-PROFILE COMPANIES USING GOVERNMENT MONEY TO FEND OFF DOMESTIC AS WELL AS FOREIGN COMPETITION.

Using his access to court documents, Rodgers got the details on one such deal, which involved the installation of an advanced wafer-etching machine from Applied Materials at Intel. For assisting in the project, Intel got a $1.5 million piece of equipment for free. It also received $700,000 to defray installation costs and another $1.2 million to evaluate the machine. This bag of goodies was equivalent to a 23-percent reduction of Intel's yearly Sematech dues.

Other examples can be cited. National Semiconductor received a chemical vapor deposition system (worth around $2 million) from Applied Materials and a vertical furnace (worth over $400,000) from SVG. In the largest such project to date, Sematech installed 14 GCA steppers (about $2 million apiece) at four different members' fabs.

These examples suggest that the $120 million figure for the annual industry contribution to Sematech's budget may be misleading; when the giveaways are deducted from dues, the government proportion of the consortium's budget may rise substantially. Unfortunately, this public-private partnership considers its financial records proprietary. When REASON filed a Freedom of Information Act request for the audited annual reports Sematech is required by law to submit to the secretary of defense, we were first bounced from the GAO to the DOD and back, then told that Sematech is considered a government contractor—not a government agency—and therefore isn't subject to FOIA requirements. As of this writing, REASON has yet to obtain the records, although our efforts are continuing; congressional scrutiny during the upcoming hearings on Sematech's reauthorization could also turn up the elusive financial reports.

Sematech portrays itself as helping "the U.S. semiconductor industry" take on the Japanese. In fact, though, Sematech looks much more like a clique of large, established, high-profile companies using government money to fend off not just foreign competition but also up-and-coming rivals here at home. Burton, of the Council on Competitiveness, says that Sematech has made U.S. companies more competitive with their domestic rivals, not just with foreign firms. It "is not a trade protection group," he insists.

Buzzwords like *precompetitive* notwithstanding, Sematech is yet another example of government meddling in an industry to pick winners and losers. And as usual, the bureaucrats have backed the wrong horse. Within the sunrise industry of microelectronics, the government has managed to locate and subsidize the sunset companies, to the detriment of those young and dynamic companies that represent the industry's future.

But even if Sematech is high-tech pork barrel, what about national security? Maybe a government-funded consortium doesn't make sense from an economic point of view, but isn't it worth spending some money to preserve a high-volume chip manufacturing base in this country to service our defense needs—particularly in light of reports that all that wonderful Gulf War weaponry was chock full of Japanese semiconductors?

Sematech would certainly have you think so. Flip through its PR literature, and you'll find constant references to national defense. One old annual report goes so far as to feature this quotation from Shintaro Ishihara's *The Japan That Can Say No*, blown up and set against a red background: "Should Japan decide to sell its chips to the Soviet Union instead, that would instantly alter the balance of military power." Sematech even has a martial flag: It's a reworking of the coiled rattlesnake, "Don't Tread on Me" flag, except this time the snake has 14 rattles. More seriously, Sematech got its government funding in large part on the strength of national security concerns, as reflected in the Defense Science Board report.

Even before the Cold War ended, this line of argument was utterly without merit. Now it borders on the disingenuous. Simply put, it may be stated categorically that the United States is not now, nor in the foreseeable future will it be, militarily "dependent" on imported semiconductors or vulnerable to supply disruptions.

In the first place, the chips in which the Japanese are dominant—commodity memories mass-produced for the commercial market—are of limited military significance. The semiconductors that fly aboard advanced aircraft and missiles are highly specialized devices designed and tested to withstand radiation exposure, dramatic temperature fluctuations, and other extreme conditions completely irrelevant to production for the commercial market. This kind of specialized production remains an American specialty.

The chips that do the real heavy lifting on high-tech weapons systems are not commodity memories but complex logic chips. Devices that can compute trajectory, control guidance systems, recognize targets, and so forth contribute the real systems value to "smart" weapons—not bulk memory. The American lead in these products remains undisputed.

Furthermore, even in DRAMs the U.S. military has plentiful sources of supply. Among American companies, Texas Instruments, Motorola, and Micron all sell DRAMs commercially. Additionally, IBM and AT&T are large captive producers; they could certainly provide chips if the need arose. A number of Japanese manufacturers—NEC, Mitsubishi, and Fujitsu—make DRAMs on U.S. soil. Finally, if the Defense Department wants to import chips, it can turn to suppliers in Europe, Korea, and Taiwan in addition to Japan. It is pure nonsense to think that the United States could get cut off from all of these sources.

Sematech's original plan was to take government assistance only for the first five years, after which it would be self-sufficient. Like many of Sematech's plans, though, this one has changed.

With federal funding due to expire at the end of 1992, the consortium has decided that five more years of "partnership" with the Defense Department will be needed. The new five-year plan envisions continued funding levels of $100 million a year. This time, Sematech will put a greater emphasis on software and so-called computer-integrated manufacturing—yet another change of direction.

Whatever Sematech's future, its past has at least served to reaffirm some tried-and-true rules regarding government intervention:

❖ Rule number one: Whenever government decides to step in and "help" an industry, the effect, whether intentional or not, is usually to preserve the status quo and stifle beneficial change. This isn't because bureaucrats are stupid; it's because of the nature of politics. Government naturally favors interests with political clout, which means interests that are well-organized and well-funded. Accordingly, the political contest between industry giants—with their trade associations and Washington offices and PR offensives—and the entrepreneurial start-ups that are trying to upend them will always be a skewed one.

❖ Rule number two: "Strategic" industries are a dime a dozen. Every decent lobbyist can come up with several plausible-sounding reasons why the industry he represents is a linchpin of American economic strength and must therefore be preserved at all costs. The only real validation of such claims, though, is ongoing wealth-creation and growth. And if an industry meets this definition of "strategic," it doesn't need government help.

❖ Rule number three: Patriotism is the last refuge of scoundrels. National security may indeed take precedence over economic considerations, but arguments that the free market is undermining us militarily should be assessed skeptically. In most cases, what is at stake is the security of special interests, not the nation.

❖ Rule number four: Nothing lasts forever, but "temporary" federal assistance comes close. Whenever government does intervene in an industry, there is almost irresistible pressure for it to remain there. Not only do beneficiaries within the industry become addicted to government support, but bureaucrats become convinced that the industry can't run without them.

Sematech demonstrates that these rules apply just as much to high-tech industries as to agriculture, textiles, steel, automobiles, or any other sector of the economy. With these lessons learned, it's time to pull the plug on Sematech—if rule number four will allow it. ■

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BETTER BANG, FEWER BUCKS

BY T.A. HEPPENHEIMER

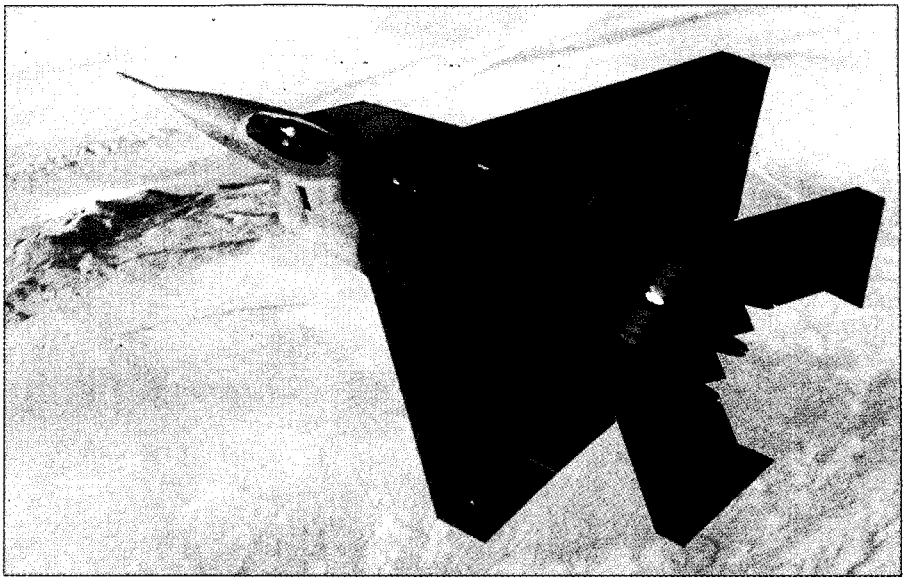
As the Jim Beam whiskey ad puts it, you always came back to the basics. The Pentagon seems to be doing this nowadays as it pursues its newest fighters, submarines, and tanks. Rather than attempting to build them by throwing together piles of money, the armed services are beginning to show a good measure of old-fashioned common sense. They are rediscovering such approaches as competition, flexibility in design, and making use of existing equipment.

The Air Force is leading the way with its newest top-of-the-line fighter project, the ATF. It follows a procedure one would think of as obvious: Have two companies build competing test versions from different designs, then try them in flight to see which is better. But this "fly before you buy" arrangement has been rare. Far more often, the Air Force or Navy picks a design after reading only paper studies.

The last time the military tried flying before buying, around 1975, it got one of the nation's outstanding military planes: the F-16 fighter, of which more than 4,000 have been built. The new ATF program has revived this procedure, pitting Lockheed's F-22 against the F-23 built by Northrop. The ATF program manager, General Joseph Fain, hasn't had to listen to bidders who might promise the moon. Instead he has had his people kick the tires and check performance in the air.

Last April, after the test runs, the Air Force picked Lockheed's F-22, although Northrop's F-23 was in some ways a better plane. The Northrop F-23 had higher speed and greater stealth, or invisibility, to radar and infrared detection. But Northrop has repeatedly blown the big ones in recent years, failing to deliver on major missile and guidance-system contracts while incurring huge delays and overruns on its B-2 stealth bomber.

Lockheed, by contrast, has shown its stuff by bringing in its F-117A stealth fighter, a star of the Gulf War, on time and within budget. John Pike, an analyst with the Federation of American Scientists who follows such matters closely, observes that "the Air Force wanted the F-23—but they didn't want to buy it from Northrop."



Bucking tradition, the Air Force actually demanded a chance to check the F-22 performance before buying it.

Rep. John Conyers (D-Mich.), chairman of a committee that held hearings on Northrop in 1990, said last spring that he "could only assume that there was some long overdue consideration of Northrop's dismal track record of test fraud, contract suspension, and fines." Picking Lockheed was just common sense. But common sense can be quite uncommon in Washington. Only a few years ago the Air Force would probably have picked the F-23, then tried to wash away Northrop's resulting problems with floods of taxpayers' money.

The terms of the contract itself show the Pentagon's newfound good sense. The arrangement calls for a "cost plus incentive fee" structure, whereby Lockheed stands to make a big profit if it does a particularly good job. The Pentagon guarantees the firm a profit of 4 percent of its total expense, but if the company delivers a really good airplane while keeping costs well controlled, this profit could rise as high as 13 percent. Lockheed thus has a very large incentive to do the job right.

Such a contract contrasts sharply with the type that used to be popular, "cost plus fixed fee." This traditional "cost-plus" contract specified the profit as a fixed percentage of expenses. Such arrangements led to some famous overruns, because plane builders could boost their profits by running up additional charges.

Still, the ATF is at an early stage in its development, with by far the largest costs to come later in this decade. It is far too soon to tell how the F-22 will fare, since it will have to overcome a basic fact: The Pentagon's culture is one of irresponsibility, with hugely overstaffed project-management offices, proliferating departments that slice responsibility micro-thin, and massive quantities of paperwork.

"It's so easy to say no," says Ben Rich, longtime head of Lockheed's advanced projects group, the Skunk Works. "They form committees so they can spread the blame."

The overstaffing is easy to see. In

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