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**SEMATECH, Toxics, and U.S. Industrial Policy:
Why We Are Concerned**

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Dramatic changes in Eastern Europe have initiated the global warming of the cold war. These changes present an opportunity to redefine national and global security in terms of domestic needs rather than continued cold war political posturing. With economic, social and environmental problems in the U.S. requiring immediate attention, a real debate about U.S. industrial policy for the 90's is emerging.

At the same time, the American high technology manufacturing sector is being buffeted by fierce global economic competition. Business leaders are demanding relief, but Bush administration ideologues are opposed to any government intervention. Meanwhile, citizens and workers affected by high tech industrial development are crying out for help with significant economic, environmental and occupational health problems.

Within this context, the movement to combat toxics has emerged as one of the most energetic and potentially powerful social forces of the 90's. Following in the footsteps of earlier labor, civil rights, peace, and women's movements, the grass-roots environmental movement is galvanizing the American people to develop pollution prevention strategies that require the development of clean

technologies. As a social movement, we are challenging fundamental conceptions about the organization of production and consumption in our economy.

All of these threads — the thawing of the cold war, the emerging debate on industrial policy, the increase in global high-tech competition, and the growing demand for toxics use reduction intersect at Sematech — a high tech industry/ Pentagon research consortium. For business leaders, Sematech holds the promise of cooperative high tech innovation and the key to "competitiveness." For environmental advocates, Sematech may provide a model for developing long term solutions to eliminate high tech hazards. What role should Sematech play in the industrial policy debate?

What is Sematech?

Sematech is a non-profit consortium of fourteen U.S.-owned semiconductor manufacturers, based in Austin, Texas.¹ Half of its annual budget comes from member companies. The other half is paid by taxpayers through the administration of the Department of Defense.

The leaders of the U.S.-owned semiconductor industry formed Sematech in March 1987 to challenge the growing success of their Japanese-owned competitors. Though American-based firms retained their technological edge in chip design, Japan-based companies perfected techniques for the efficient, reliable fabrication of state-of-the-art integrated circuits.

Superior Japanese manufacturing technology had catapulted Japanese-based firms to dominance in the world market, especially for dynamic random access memory (DRAM) chips that are common in computers and mass-marketed worldwide. Consequently, the Japanese now hold more than half the

world market for semiconductors (compared to 28% in 1978). Six of the top ten merchant producers are also now Japanese.²

Sematech's primary goal is to develop methods and machinery for squeezing more and more circuit elements onto each flake of silicon.³ Building circuits — and ultimately computers — which are faster and smaller is seen as one of the main goals of the high tech quest. Sematech hopes to replicate patterns featuring linewidths of only 0.50 microns by 1992, and 0.35 microns by 1993 - compared to today's standard of 0.8 microns.⁴

Building smaller and faster circuits however, requires the use of more solvents and other chemicals to achieve the necessary requirements for clean components. As the geometries of production decrease, more solvents are needed to wash away ever smaller "killer particles" that could jam a circuit. Smaller and faster may also mean using even more toxic chemicals.

In addition to its own 500 employees, Sematech works with engineers from member companies. Through the Semiconductor Research Corporation, it funds nine "Centers of Excellence" at U.S. universities. In cooperation with the Semiconductor Equipment Manufacturers Institute (SEMI), it sponsors the development of new chipmaking equipment at U.S.-owned companies that specialize in production equipment.⁵

Why Federal Aid for Semiconductor Manufacturers

Arguing that the international competitiveness of the American semiconductor industry is critical to the economic and military future of our country, Sematech's founders sought Federal aid. They convinced Congress to allocate \$100 million per year for five years to Sematech. Among the strongest supporters of Sematech are liberal members of Congress who see this program as a giant step toward a comprehensive national industrial policy.

Sematech's supporters channeled the funds through the Pentagon's Defense Advanced Research Projects Agency (DARPA) because federal-level politicians believed no civilian agency could win as much political support as the Pentagon. And DARPA, particularly in the 1960s and 1970s, had shown itself capable of managing technologies with civilian, as well as military applications.⁶

Tension between DARPA and member companies delayed Sematech's start-up, but over its first three years of operation, chipmakers were generally pleased with the agency's approach. In April of this year, however, Pentagon officials transferred Craig Fields, director of DARPA, reportedly for his backing of programs to support civilian industry. Fields subsequently left the Department of Defense.

High Tech: A Major Pollution and Health Threat

Manufacture of computer components involves the use of many hazardous substances. The process of turning silicon into semiconductors is replete with dangerous conditions. Many serious accidents have occurred in the semiconductor industry that have resulted in industrial illness and significant environmental contamination. The industry uses toxic gases, solvents, etchants, heavy metals and volatile organic compounds that can adversely impact workers, communities and the environment. In addition, huge amounts of contaminated waste by-products are generated and must be handled and disposed of properly. Recent data from Silicon Valley reveals that the local industry has disposed more than 100,000 tons of hazardous waste off-site, and discharged over 12 million pounds of toxic waste into the environment.

The record of the microelectronics industry has been very poor. Improper handling of toxic substances in the workplace has harmed both workers and the environment. Employees of electronics firms are exposed to hazardous materials through spills, accidents, and chronic exposure that can produce severe burns, respiratory problems and immune system impairment.

Whereas much of the manufacturing and assembly takes place in "clean" rooms, these rooms are maintained to assure particle-free products rather than for the benefit of workers' health. In the highly competitive field of semiconductor manufacturing, production demands too often outweigh worker safety. The result is a worker illness rate reported to the California Division of Industrial Relations that is three times that of other manufacturing industries.⁷ Likewise, an epidemiological study at Digital Equipment Corp. found a miscarriage rate among production workers that was twice as high as the "norm."

The semiconductor industry has also been a principal cause of groundwater pollution in the Silicon Valley, the acknowledged "home" of the industry. Silicon Valley has 29 federal Superfund sites - more than any other area of the U.S. Most were caused by improper handling of toxic solvents used by semiconductor firms. More than 150 underground chemical leaks have contaminated over 200 public and private drinking water wells.. In addition, Silicon Valley has more toxic gas storage and usage and is responsible for discharging more ozone-destroying CFC's than any other area in the country.⁸

How Sematech Could Help Workers and Communities

Many major semiconductor producers are now spending large sums of money on the cleanup of spills and leaks, and most are struggling to cooperate with new laws designed to reduce the risk of environmental exposure. But the structure of the industry and

the short term economic demands it faces has limited progress in the design of safer production methods.

Chip production is intensely competitive, so companies focus almost all their manufacturing technology efforts on cutting costs and increasing reliability. Few companies have the additional resources to risk on entirely new ways of doing things. In addition, most process technology is introduced or improved by even smaller, independent equipment producers. These firms may be well situated to introduce new methods, but since they don't currently pay the price of pollution or pollution-control, they have no incentive to explore alternatives.

Sematech, by bringing producers together under one roof, allows companies to share the risk of new process development. And by issuing development contracts to equipment makers, Sematech can ask for or specify pollution prevention objectives directly. For instance, the consortium could help coordinate goals and timetables for phasing out reliance on toxic solvents, gases, glycol ethers, and other hazardous production chemicals.

Research in California has shown that the average life expectancy of a high tech facility is six years compared to thirteen for all other manufacturing in the state. Sematech could also play a leading role in coordinating investment to maximize community economic stability. High tech's ability to move production as if plants and workers were pawns in a global chess game has left communities economically devastated by sudden relocation of work. Sematech could help develop economic impact statements regarding the longevity of manufacturing facilities and skills needed. These Economic Impact Statements could accompany investment proposals where state or federal support was desired.

New Directions for U.S. Industrial Policy

Electronics companies and their Congressional allies are challenging the Bush administration's hostility to civilian industrial policy. Some are even calling for a civilian counterpart to DARPA, a Commerce Department agency that would fund Sematech and other commercially oriented high-tech programs. Wharton School of Management Professor Bruce Merrifield, former Assistant Secretary of Commerce for Technology Policy, has called for such a commerce-based agency that would fund up to 20% of the R&D costs for civilian led technological development.

In the long run, civilian control over Sematech funding would free the consortium from the anomalies of Pentagon spending. However, funding Sematech is good industrial policy only if the consortium redesigns its research program to provide good jobs for American taxpayers and it develops technologies to reduce the risk of worker illness and environmental degradation.

More than just civilian oversight of Sematech is needed. Neighbors of semiconductor companies and representatives of the high-tech workforce should be directly involved in decision making. Only substantial citizen participation in industrial policy will lead to the economic rejuvenation that policy makers and chip manufacturers seek.

Semiconductor Bailout: The Wrong Medicine?

Lack of government support did not cause the semiconductor industry's problems. Rather, the type of subsidy and guidance that the government gives has actually contributed to the current state of affairs. Hefty U.S. military contracts direct manufacturers towards technology that is rarely transferable to production for civilian markets.

Most military-funded high-tech projects over the last decade (as opposed to the 1960s) have been of little benefit to the commercial sector. Other military-funded programs are designed to develop chips exclusively for military use, or for short-batch chip manufacturing technology. However, Sematech is an important exception. Unlike many other military programs, up until now, DARPA has allowed Sematech to focus on commercially useful technologies.

Sematech wasn't approved because of the military importance of chips. Instead, most members of Congress thought it would help outpace Japan economically. Sematech's military significance is mostly used as an excuse by people who are reluctant to support a generalized national industrial policy and are looking for a way to consider semiconductor production an exception.

Grass Roots Participation Needed

Sematech, if supported at all by the government, must be managed by another Federal entity. Pentagon oversight sets (or reinforces) a precedent that DoD is the best agency of industrial policy. Further, as the Pentagon is forced to cut back, pressures to tailor Sematech to other DoD research goals will undoubtedly increase. Most importantly, there is no mechanism through which citizens groups and workers can shape the objectives of Sematech. DARPA just isn't used to letting many union representatives and environmentalists sit on its advisory committees.

In response to their problems, the U.S. semiconductor industry calls for trade sanctions, increased economic protection, and exemptions from U.S. anti-trust legislation. And, as is typical in other U.S. industries, the semiconductor industry blames Japan for its failures. This nationalistic approach not only ignores the root causes of the industry's problems, but obscures the decidedly

multi-national character of the semiconductor industry. While the U.S. semiconductor industry is always receptive to a government handout, many firms are simultaneously in the process of cutting their own deals abroad. Many major U.S., Japanese, and European firms have already linked up their businesses in joint ventures, and nearly all U.S.-owned merchant chip makers do most of their assembly offshore.

A more genuine effort to address the problems of the U.S. semiconductor industry would also address the self-defeating short-term demands of the U.S. economic structure. High interest rates for R&D and capital equipment financing have contributed more to the demise of the U.S. chip industry than any other factor. U.S. investors are much more impatient for high returns on their investments than their Japanese counterparts, who seem willing to accept short-term losses and wait for long-term gains. As a result, the Japanese are already way ahead in developing manufacturing technology that will dominate the 1990s.

The Campaign for Responsible Technology

The Campaign for Responsible Technology (CRT) is concerned with the environmental and health implications of the microelectronics industry and, more broadly, the role of Sematech in national high tech industrial policy. We believe that the work that Sematech is engaged in must include a strong commitment to making the research, manufacture and deployment of chip manufacturing technologies safer and less reliant on toxic substances.

Members of the campaign represent a broad cross-section of citizen, occupational health, environmental and labor groups that are concerned about these problems. We are primarily from geographic areas in the U.S. where microelectronics research, development and production is concentrated.

We believe that Sematech is in a strategic position to help implement badly needed reforms within the semiconductor industry. We believe that Sematech should:

¥ develop new technologies and processes that will be less dependent on toxic chemicals;

¥ introduce new health and safety procedures for microelectronics workers that will reduce the industry's shocking rates of occupational illness, reproductive hazards and diseases;

¥ provide increased information and education to Sematech member companies concerning health and community hazards, and appropriate solutions;

¥ ensure that scientists, engineers, and other Sematech staff are being trained in source reduction and toxic use reduction methods, and that they include occupational and environmental health factors in the design of new products and production processes;

¥ develop safeguards to insure that taxpayer investments in new technology create jobs for U.S. workers;

¥ create an advisory board composed of labor, environmental, and health professionals to oversee Sematech's environmental and occupational health programs.

¥ evolve towards a funding base less dependent on the Pentagon.

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Notes

1 . The fourteen member companies are Advanced Micro Devices, AT&T, Digital Equipment, Harris, Hewlett Packard, Intel, IBM, LSI Logic, Micron, Motorola, National Semiconductor, NCR, Rockwell, and Texas Instruments. These fourteen member firms represent approximately 80% of U.S. semiconductor manufacturing capacity at 67 semiconductor plant sites in the U.S. Sematech's annual budget is over \$200 million dollars.

2. Merchant firms sell chips on the open market, while captive semiconductor producers, such as IBM, produce for intra-company consumption.

3. Originally, some of Sematech's founders wanted to mass produce chips for sale on the open market, but a few of the larger participants insisted that Sematech's own plant be used only to prove new technologies in small, demonstration runs. Sematech's own chips are discarded, but the technologies developed for their manufacture are supposed to be disseminated speedily to member companies.

4. A micron is a metric unit of linear measure which equals one millionth of a meter.

5. Sematech has created the Tool Application Program (TAP) and an Equipment Improvement Program (EIP) to help U.S. equipment and materials suppliers develop new, or enhance existing, manufacturing equipment. Sematech's TAP and EIP Programs support suppliers by providing a manufacturing area within Sematech's fabrication facility as well as a team of engineering and manufacturing specialists to provide technical support and analysis. Some of the companies that have benefited from these relationships include ATEQ Corporation, Beaverton, OR; Eaton Semiconductor Equipment Division, Beverly, MA; Union Carbide Industrial Gases, Inc, (Linde Division) Danbury, CT; Semi-Gas Systems (subsidiary of Hercules, Inc.) San Jose, CA; Wilson Oxygen and Supply, Austin TX; GCA, Andover, MA; Hewlett Packard, Palo Alto, CA; NCR, Dayton, OH; ORASIS Corp., Sunnyvale, CA; Westech Systems Inc., Phoenix, AZ; Lam Research, Fremont CA; Genus Inc., Mountain View, CA.

6. ARPA, DARPA's predecessor, funded computer science research that help make possible such commonly used breakthroughs as computer time-sharing, interactive video displays, and the mouse.

7. Data on occupational illness rate compiled from CAL-OSHA statistics.

8. For more information on the pollution threats from the manufacture of computer components see Phil Woodward and Ted Smith, *The Toxic Life-Cycle of Computer Manufacturing: The Legacy of High-Tech Development* (Silicon Valley Toxics Coalition and The National Toxics Campaign, 1990).

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