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watchdogging "High Tech"

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IT'S A GaAs

Fortune magazine (June 24, 1985) says gallium arsenide (GaAs), a synthetic semiconducting compound, is "sexier and speedier than silicon." But, with arsenic as one of its two major elements, it's also deadlier—that is, it poses a large, but as yet unstudied threat to electronics workers and the environment.

The market research firm Frost & Sullivan projects that the U.S. gallium arsenide market will leap tenfold from 1985 to 1995, jumping from \$464 million to almost \$5.2 billion! It is likely that the growing market for gallium arsenide circuitry will result almost entirely from properties of particular interest to the military, such as its ability to resist radiation. The Pentagon presently holds 47% of the gallium arsenide market—compared to its roughly 10% of the U.S. silicon semiconductor market—and its share is expected to increase.

In some segments of high-tech industry, there is optimism that a heavy military investment in gallium arsenide could transform it into a commercially viable technology. For example, market researcher Robert Castellano of the Information Network told **Electronics** (October 30, 1986) that "only the U.S. military has the buying clout to spur GaAs development."

There is some historical precedent. In the early years of the germanium transistor, and silicon transistor, and the silicon integrated circuit, the U.S. military made it possible for manufacturers to develop mass production techniques by purchasing transistors and chips and prices well above what commercial customers were willing to pay.

In this case, however, the commercialization of nuclear power appears to be a more appropriate precedent. In that case, military funding (through the Navy and Atomic Energy Commission) created an industry that was not fully capable of competing commercially. Still, the industry developed the clout to win subsidies, lax environmental regulation, and sales. Only now are power companies realizing that nuclear energy was the wrong choice, and they remain unwilling to give up their investment in an inappropriate technology.

Still, there is time to prevent the development of a \$5 billion gallium arsenide industry. Pentagon investment in gallium arsenide should be challenged on two accounts: First, no one has investigated the environmental risks. Second, the only significant advantage offered by gallium arsenide is its ability to function in an environment characterized by high levels of ionizing radiation.

Enthusiasts for gallium arsenide cannot contain their enthusiasm. **Fortune's** Gene Bylinsky writes, "it's a synthetic compound that has moved from the high-tech doghouse to the high-tech penthouse now that the horrendous barriers to producing it properly have been overcome. It's launching a whole new era in electronics." Frost & Sullivan concludes, "the speed that electronics can move within gallium arsenide...will be yielding fewer busy signals on the telephone, less error in workplace data transmission, much faster computers, even better TV and superior electronic weapons for the military."

Indeed, gallium arsenide, as a substrate for semiconductor circuitry, does have theoretical advantages over silicon. Electrons move in GaAs four or five times as fast as they do in silicon. GaAs circuits can operate at a wider range of temperatures than silicon.

In the real world, however, GaAs rarely lives up to its press clippings. For example, gallium arsenide is made of elements much rarer than silicon, and it's a difficult compound to work with. Wafers, which today are only available in three-inch diameters, cost five to ten times as much as silicon.

In digital logic chips, GaAs circuit densities are at least two generations behind silicon. Fairchild Semiconductor's Hemraj Hingarh told **Electronics** (September 18, 1986), "GaAs is just now nudging into the LSI level, with gate densities ranging from 3,000 to 6,000 just now being considered. By comparison CMOS [complementary metal oxide on silicon] gate densities that are now going into production range from 25,000 to 125,000. Bipolar [the other major silicon circuit technology] digital logic is now at the 8,000-to-10,000 gate level, and it's moving toward 200,000 gates."

Supported by the Pentagon, Honeywell Inc. and Rockwell International have recently announced breakthroughs such as a 4-kilobit static RAM (random access memory) chip. While this is an accomplishment for GaAs, it is orders of magnitude behind silicon RAM circuits.

Conceivably, however, more military funding could help researchers and producers overcome the technological obstacles encountered when designing and building gallium arsenide chips. Since equipment and techniques can be adapted from silicon production, catch-up is not an impossible goal.

Rockwell and Honeywell have a \$24.5 million contract with the Defense Advanced Research Projects

(continued on page 2)

Agency, but why have dozens of other high-tech firms plunged ahead in gallium arsenide research and development. Some, to be sure, are just hedging their bets, maintaining GaAs labs just in case someone else solves production problems. More important, there is a widespread belief that a huge military market for GaAs circuits will soon materialize.

At present, the major military application of gallium arsenide circuitry is in analog circuitry for electronic warfare—radar, electronic intelligence, jamming, etc. In the long run, however, space weapons could be the most lucrative market. Since gallium arsenide circuits resist radiation interference and damage, they are likely to be more reliable than silicon circuits even during peacetime. For systems such as the Milstar communications satellite or the proposed "star wars" space defense system, radiation hardening is deemed a necessity.

Consequently, even if research does not drive down the cost of manufacturing gallium arsenide circuitry, the profits to be earned by supplying the electronic components for space weaponry are potentially enormous, and most American companies with GaAs programs appear to be waiting for "star wars."

Whether gallium arsenide enters mass production because the U.S. decides to deploy a space-based missile defense system, or because research for that system makes commercial GaAs viable, the environmental risks are enormous.

In high concentrations, arsenic and many of its compounds are lethal. At lower levels, it is still carcinogenic. Arsine, a highly lethal gaseous compound of arsenic and hydrogen, is already used in the manufacture of silicon semiconductors. But it is used in small amounts.

In gallium arsenide circuits, arsenic is present in much greater volumes. During the formation of gallium arsenide, toxic vapors are generated. They must be contained. When ingots are sliced into vapors, dust is created. Waste disposal is a problem, since waste drums of the compound can generate electrical currents, like a battery, causing corrosion and eventual leakage. Even gallium arsenide circuits, when they are discarded, can be the source of hazardous materials. (Corporate Times, June, 1985)

The U.S. government, in preparing the technological groundwork for space warfare, is creating an industry which soon, like the nuclear power industry, will have a massive financial interest in maintaining its momentum, despite the environmental risks.

However, despite the theoretical possibilities of gallium arsenide, it remains an unproven, unprofitable technology. There is still time to confine it to the few niches where it makes sense. Now the Pentagon should be forced to show that gallium arsenide—its production, use, and disposal—is, *at the very least*, as safe as silicon.

HEALTH RISK CONFERENCE

Representatives of industry, government, labor, and academia will address the occupational and environmental hazards associated with microelectronics, advanced materials, and biotechnology at a May 28-29 conference, "New Technologies: Responding to Future Risks," to be held in Worcester, Massachusetts.

The conference is sponsored by the New Technologies Safety and Health Institute, with the participation of the Center for Technology, Environment, and Development (CENTED) at Clark University, the Occupational Health Program of the University of Massachusetts Medical School, and the Division of Interdisciplinary Affairs at Worcester Polytechnic Institute.

For information or registration forms, contact Barbara Guthrie, Worcester Consortium for Higher Education, 37 Fruit Street, Worcester, MA, 01609 (617/754-6829).

ORANGE COUNTY

Orange County, just south of Los Angeles in Southern California, is well known for its right-wing political slant. However, it has long been one of the nation's major centers of high-technology electronics, as well as aerospace production. In fact, only Silicon Valley and Route 128 (suburban Boston) are more important high-tech centers.

Like Silicon Valley and many of the high-tech communities around Boston, Orange County originally developed as a suburb. It industrialized late, after World

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edited by Lenny Siegel

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War II. Its urban development patterns, consequently resemble those of the other high-tech havens.

In a November, 1986 study, "The Decline of Orange County's Suburban Oasis: Regional Problems in Employment, Housing and, Transportation," Talmadge Wright and Corinne Riave, of the Fair Housing Council of Orange County, analyzed the regional development of the area. They concluded, "Orange County's labor force, like those in other high-technology centers, is taking on the appearance of a bi-polar market where high wage jobs mingle with low-wage jobs with little in between."

Orange County suffers from a shortage of housing priced within range of the lower-income portion of the workforce. However, suggest Riave and Wright, "Unlike Silicon Valley, where there is a shortage of all types of housing, Orange County is typically known for having a large pool of high-priced apartments and a lack of low and moderate cost rental units."

Because the county's current housing and transportation resources do not adequately serve the needs of the high-tech workforce, many high-tech firms say they are planning to expand elsewhere. In addition, the *Los Angeles Times* (November 16, 1986) reports that heavy manufacturers are gradually leaving the county.

Providing affordable housing near centers of employment may be *physically* easier in Orange County than in Silicon Valley, where the major industrial suburbs are largely built out to their natural geographic boundaries. As in Silicon Valley, however, it is not clear where moderate-income outsiders will get the *political* clout to reverse the exclusionary planning practices of Orange County's cities.

For more information, write the Fair Housing Council of Orange County, 1425 East 17th Street, Suite E, Santa Ana, CA, 92701.

SILICON SOUTH

In *Everybody's Business: A People's Guide to Economic Development*, the Institute for Southern Studies and *Southern Exposure* magazine have pulled together a variety of essays on established industry and economic alternatives in the southern United States. Marc Miller's chapter, "The Low Down on High Tech," is of particular interest to *Global Electronics* readers.

Miller reviews the efforts of southern states to attract high technology firms, but he finds that success stories, such as North Carolina's Research Triangle Park, were few and far between.

His description of SCI Systems, a Huntsville, Alabama offshoot of NASA, illustrates the polarization of the high-tech workforce, found not only in the south, but throughout North America. The company's 1,100 well paid engineers and scientists do not interact with the 3,300 production workers whose work includes the assembly of circuit boards for IBM personal computers.

SCI's production workers earn less than \$4.00 per hour. Though the fruit of their current labor may be

advanced data processing machinery, their skills and treatment differ little from their earlier work picking peaches, sewing garments, and packaging chickens.

You can order single copies of *Everybody's Business* for \$3.00 from *Southern Exposure*, Box 531, Durham, NC, 27702

MOVING OFFSHORE

About two years ago, Xebec, a Silicon Valley-based producer of disk drive controllers for personal computers, vowed to take on the foreign competition. It announced plans for three automated plants, two in Nevada and one in Pennsylvania, to assemble controllers and other printed circuit boards. Soon, however, it closed the Pennsylvania plant; it abandoned plans to automate one of its Nevada facilities; and it opened its model robotic factory in Gardnerville more than a year late.

Among other problems, demand was not great enough to support the costs of automated production. The PC market did not grow as fast as the company anticipated. Many disk drive makers began incorporating controllers into their products. And IBM is expected to phase out its purchases of Xebec boards.

Xebec, to compete, is now marketing "intelligent" disk drives—drives that incorporate controllers. Most of them, however, are being built in Taiwan by Tatung, the island's largest home-grown electronics concern. The *San Jose Mercury News* (February 16, 1987) paraphrased Xebec founder and president James Toreson, the architect of the unsuccessful domestic manufacturing strategy, "Within a year, 50 to 75 percent of Xebec's total revenues will hinge on products manufactured by Taiwanese and Korean companies..."

Meanwhile, another Silicon Valley disk drive-maker that was committed to domestic production, Priam, is moving at least some of its production to its own new plant in Taiwan. The firm's executive vice-president told the *San Jose Mercury News* (February 9, 1987) that assemblers earn "about \$1.70 an hour in Taiwan, compared with about \$10 an hour in San Jose. An engineer in Taiwan would be paid \$10,000 to \$15,000 a year, compared with \$60,000 in San Jose." Presumably, he was referring to company payroll costs and not actual wage levels.

Finally, one company producing a different kind of high-tech product is finding the United States a better place to manufacture than Taiwan. Innovative Controls, a Houston Industries subsidiary that makes complex home security devices and decorative lighting controls, is closing a plant in Taiwan and laying off about 400 workers there. It is opening, instead, a 300-worker plant in Houston. Company officials say that superior American workmanship and lower freight bills outweigh the benefits of low wages in Taiwan. Furthermore, they say they have had difficulty communicating with Chinese-speaking employees. (*San Jose Mercury News*, January 29, 1987)

THAI CHIPS

Thailand's integrated circuit assembly industry apparently did better in 1986 than 1985, at least according to January-June figures published by the **Bangkok Bank Monthly Review** (October, 1986). Exports, primarily to the U.S. and U.S. plants in Malaysia and Singapore, grew 45% (comparing first-half figures), and the bank projected a 23% annual rise.

In part, Thailand gained due to the slowdown of assembly in the Philippines, where the industry has been plagued by political and labor unrest.

In an unusually frank analysis the bank evaluated the pluses and minuses of semiconductor assembly. The advantages:

The industry is providing job opportunities for a large number of people.

The integrated circuit industry is considered [a] springboard for Thailand's advanced technology industries.

The disadvantages:

The future of the Thai integrated circuit industry depends heavily on an uncontrollable factor, i.e. the expansion of parent companies.

About 90-95 percent of raw materials for producing integrated circuits [there] must be imported, resulting in little value added.

OFF-LINE DATA BASE

While wealthy individuals, major corporations, and government agencies are becoming increasingly reliant upon electronic information services, such as on-line data bases, for up-to-date news and data, a handful of activists are adapting computer technology to provide information to the forces of change.

For example, Arlington, Virginia-based Micro Associates, run by Vietnam-era draft resister Daniel Brandt, has developed a disk-based data base for power structure research. For \$35, an individual or non-profit organization (it's \$100 to others) can order several floppy disks containing a sophisticated search program plus data on over 26,000 powerful groups and individuals. At present, one can order disks for MS-DOS machines such as the IBM PC, for the Epson QX-10, and for Osborne, Morrow, or Kaypro (CP/M) machines.

The disks form a master index of 120 investigative books published since 1964 and thousands of pages of post-1973 periodicals. Subject areas include the intelligence community, the right wing, Latin America, the East Coast foreign policy establishment, domestic surveillance, assassinations, and big business.

To obtain this valuable yet inexpensive research tool, specify your computer and send a check for the correct amount to Micro Associates, Box 5369, Arlington, VA, 22205. For an additional \$25, you can order software for creating, maintaining, and printing a subscription list with up to 5,000 entries.

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