

Dodging Dilemmas?

Environmental and Social Accountability in the Global Operations of California-Based High Tech Companies

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This report was produced for the California Global Corporate Accountability Project (CAP), a collaboration of the Nautilus Institute for Security and Sustainable Development, the Natural Heritage Institute, and Human Rights Advocates.

The Project had two aims: 1) to examine the global challenges facing US multinational corporations in two sectors—oil and high tech--in terms of environment, labor and human rights; and 2) to articulate policy innovations which would strengthen global corporate environmental and social performance. To enable us to explore not only national but also state-level policy initiatives, the Project focused on companies headquartered or with significant business in California.

In addition to this Report, the Project produced *Whose Business? A Handbook on Corporate Responsibility for Human Rights and the Environment?* A Public Policy Report, which will include the oil and high tech studies, will be available in July 2002. For more information or to obtain reports, see www.nautilus.org/cap/index.html.

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Acronyms

AEA: American Electronics Association
BAASD: Bay Area Alliance for Sustainable Development
CEO: Chief Executive Officer
EHS: Environmental Health and Safety
EMS: environmental management system
EPA: US Environmental Protection Agency
FTSE: Financial Times Stock Exchange
GDP: Gross Domestic Product
HSIP: Hsinchu Science-based Industrial Park
ILO: International Labor Organization
ISO: International Standards Organization
IT: Information Technology
MNC: Multinational Corporation
NEPSI: National Electronics Product Stewardship Initiative
NGO: Non-Governmental Organization
NRIE: Northern Region Industrial Estate
OSHA: Occupation Safety and Health Administration
ODS: Ozone Depleting Substances
PFC: perfluorocompound
SIA: Semiconductor Industry Association
SVEP: Silicon Valley Environmental Partnership
SRI: Socially Responsible Investment
UN: United Nations
VOC: Volatile Organic Compounds
WEEE: Waste from Electrical and Electronic Equipment

I. INTRODUCTION

This report examines the dilemmas, as well as the promise, of the high tech industry in terms of global environmental sustainability, worker rights and welfare, and social justice. It focuses primarily on the "hardware" part of the industry--the manufacture of silicon chips and semiconductors, as well as the assembly of circuit boards and computers.

The central aim of the report is to build the capacity and momentum to identify—and implement—both voluntary corporate initiatives and supportive public policies to improve global sustainability outcomes in the high tech industry.

Many companies have already made substantial efforts to reduce their environmental impacts. However, it is not clear that *any* companies have come to terms fully with either the sustainability or global ethical dilemmas confronting them, including in their supply chains. To do so will require substantial innovation born out of constructive dialogue between companies and local communities, NGOs, workers, scientists and health professionals, investors and other stakeholders. This report aims to encourage and enrich the basis for such dialogue.

Why Focus on High Tech?

Compared to "smokestack" industries like petroleum or steel, high tech is "clean", at least in terms of reported air and water pollutants. Moreover, many industry jobs are highly-paid and highly skilled, especially relative to other options in developing countries. Many high tech CEOs are socially progressive and support corporate philanthropy to improve community welfare.

Planners around the world have tried to reproduce the Silicon Valley high tech-growth model. A successful high tech cluster generates upstream linkages to local suppliers, driving local industrial development. No wonder countries and communities from New Mexico and Costa Rica to Malaysia, China and India compete hard to attract investment by American, European, and Japanese high tech multinationals.

Why, then, focus advocacy and policy attention on high tech? First, despite its "clean and green" image, the high tech industry struggles with major environmental and social problems. The most serious problem is the use of toxic materials. Embedded in the current production of silicon chips, semiconductors and computers are highly toxic substances, which even under the best current standards, can pose threats to worker and/or community health and safety. In the absence of adequate product stewardship and disassembly standards, high tech products end their useful lives leeching toxic wastes into landfills and rivers—even if they are exported to developing countries for "recycling".[1]

The high tech industry also has serious social, especially labor, issues to confront. The industry's widespread reliance on mandatory overtime, sub-contractors, and temporary, often immigrant, workers raises ethical questions about fair treatment and family values. A large gap between the highest and lowest paid workers suggests that the industry may be

spawning not just a "digital divide" but an occupational and, in some cases, racial divide as well. [2]

A second reason to focus on high tech is to gain more information about performance and risk. Compared to other industries, high tech companies have strong Environment, Health and Safety (EHS) policies. Little is known, however, about whether and how companies actually comply with their EHS policies, especially in their overseas operations.

Moreover, despite the use of known carcinogens in chip production—arsenic, benzene, cadmium, lead--companies to date have refused to divulge internal data that would allow greater scientific understanding of risks to occupational and community health. In the past decade, workers have brought high-profile suits against high tech companies such as National Semiconductor and IBM, charging that chemical exposure led to miscarriages, birth defects and cancer. In the face of insufficient scientific evidence, one case was settled out of court. Others are pending.

Finally, with its high rate of managerial and technological innovation, the global high tech industry has the potential to contribute significantly to ecologically sustainable development. With sufficient corporate attention, non-toxic and resource-conserving process and product designs could be built into new generations of products. Through external engagement and internal leadership, the high tech industry could live up to its potential.

The Regulation Gap

Many of the social and environmental problems of high tech companies afflict both domestic and overseas operations. In developing countries, however, the problems are exacerbated by three factors: 1) lack of adequate environmental regulation and enforcement; 2) insufficient waste management facilities and expertise; and 3) an absence of protection for civil and political rights which allow workers and communities to advocate for themselves.

US (or other) multinationals operating in developing countries confront the problem of managing their subsidiaries, who operate in different legal, socio-economic and regulatory contexts. Moreover, the emergence of global product and supply chains, often involving piecework at home or in tiny shops, bedevils regulatory as well as corporate oversight in any country.

The management problems of operating in a global economy are not unique to the high tech sector. Multinationals in all sectors confront the fundamental dilemma of a global "normative gap". Regulation and/or enforcement are missing at two levels: *international*--there are no binding, enforced environmental, labor or human rights norms, either for multinational corporations or governments;[3] and *local*- regulatory oversight by national or municipal governments is often lacking or inadequate in many developing countries.

In this context, multinationals confront fundamental ethical choices : should they follow local practice, set and follow their own, company-wide standards, or peg their performance to global industry norms of 'best practice'? Many US companies have embraced at least some aspects of best practice, especially on environmental management. However, it is not clear how well these voluntary initiatives are working.

One problem is lack of information. Disclosure requirements are minimal and those that do exist, such as the Toxic Release Inventory, cover only domestic operations. Many companies provide information about environmental performance in annual reports or on their websites. However, it is based on internally generated data—there is no external verification of performance. Even external verification under management systems like ISO 14001 reports on self-selected and often non-comparable goals.

Another problem is the lack of a comprehensive sustainability planning by local and regional governments where high tech companies are located—whether in northern California or Hsinchu Province, Taiwan. In the absence of regional environmental objectives where high tech companies cluster, companies individually set their own standards. Even if met, these company objectives may fall far short of what could be considered sustainable resource use—and of what would be possible if targets were set in concert with regional environmental indicators and sustainability plans.

Methodology and Structure of the Report

This report is based largely on commissioned case studies spanning Taiwan, India, Malaysia, and Thailand, as well as a field investigation in Costa Rica and a policy analysis of the high tech regulation in the US and California. Undertaken by researchers with extensive local knowledge and contacts, the case studies identified the most pressing local social and environmental issues. They also examined the state and quality of corporate environmental and social governance and local regulatory oversight. To determine if there was a role for innovative government action at the state level, the case studies focused primarily on the overseas operations of California-based operations.

Research methodology was based on interviews with local company and government personnel, as well as experts, non-governmental organizations (NGOs) and labor organizations. Every study revealed significant environmental health and safety problems, including insufficient monitoring of worker health and workplace safety; inadequate waste management infrastructure, and severe watershed pollution.

The report is structured as follows. Part One examines the global structure of the industry. Part Two outlines the major environmental and social concerns generated by the industry's phenomenal global growth. Part Three details specific insights from the case studies, including the California experience. Part Four examines what is, and is not, being done doing by leading California-based high tech companies to improve social and environmental performance. Part Five explores the potential for innovative government action, at both the national and state levels, to improve global corporate accountability in the high tech sector.

II. GOING GLOBAL: THE EMERGING STRUCTURE OF THE INDUSTRY

The high tech or Information Technology (IT) sector is one of the fastest growing and most important segments of the US and the global economy.[4] The Standard Industrial Codes manual defines the IT sector to include hardware, software, and communications. Hardware includes computers and printed circuit boards, semiconductors, office equipment, other electronic components, and instruments for measurement and laboratory analysis.

The IT sector's share of US GDP grew from 4.9 per cent in 1985 to an estimated 8.2 per cent by 1998.[5] Revenue is expected to be $175.4 billion in 2001,down from $204.4 billion in 2000. Global demand for high technology is broadening in geographic terms. The Semiconductor Industry Association forecast reports that the two largest semiconductor markets—the Americas and Asia-Pacific—today make up less than 60 per cent of the total worldwide market. Ten years ago, the United States and Japan alone accounted for two-thirds of the global market.[6]

A. Global Division of Labor

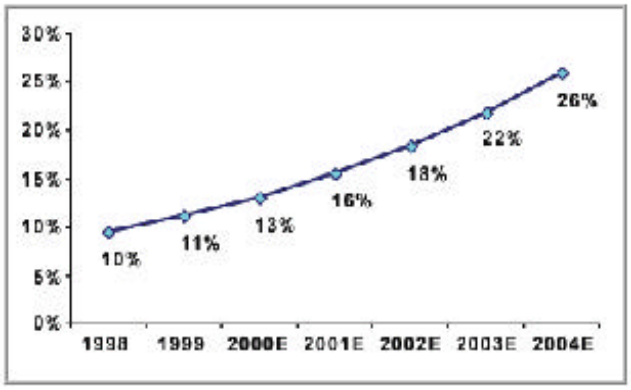
For the most part, IT hardware is sold under the brand name of some thirty manufacturers, most of them US, European or Japanese. Very few —Santa Clara-based Intel Corporation is the significant exception—produce and assemble their own products. Beginning in the 1990s hardware firms, both semiconductor manufacturers and computer makers, increasingly began contracting out parts of their production to third party suppliers. Many US and Japanese computer manufacturers, for example, obtain semiconductors fabricated in Taiwanese plants, and assemble computers in locations around the world. Companies who supply components, like Seagate Technology, do not produce their own chips at all: they are "fabless" and depend entirely on suppliers to provide parts which Seagate assembles.

A growing proportion of the industry is serviced by contract manufacturers like Flextronics and Solectron, who produce to the specifications of the name-brand manufacturers, and also produce wireless telecommunications and related products. Begun in earnest in the 1980s, contract manufacturing had grown into a $120 billion worldwide industry by 2001 and is forecast to skyrocket to over $250 billion by 2004 (Figure 1).[7] Throughout the industry, "flexible production" is the goal: keeping costs low while being able to switch product lines or technical specifications quickly in response to changing demands.

The most elaborate production networks have appeared in Asia, where the electronics sector has been a driver of export-oriented growth since the 1960s.[8] Japanese, US and European firms define product characteristics, spearhead research and management functions, and produce the highest-value systems and components domestically. Korean firms have emerged as "fast followers" in appliances and components with large-scale economies. Taiwanese firms are prominent in computer chip-production s and produce both low-value components and high-value niche products.

Singapore is the regional administrative base and acts as an assembly platform for high-value products. Malaysia is an intermediate-value assembly platform. Thailand, the Philippines, Vietnam, Indonesia, and increasingly, China, undertake mostly low-value assembly.[9] India, already a leader in the software sector, is aggressively trying to improve its manufacturing capabilities; on a smaller scale, Costa Rica is trying to develop a Latin America-focused software industry.

Figure 1
Percentage of Outsourced
Information Technology Manufacturing
(Source: Technology Forecasters) (E = estimate)



Since 1989, US and other multinationals have concentrated their European investments in the established investment zones in Great Britain. Scotland, for example, hosts computer plants belonging to Sun Microsystems, National Semiconductor, NEC and IBM, and has earned the name "Silicon Glen." Ireland is also an important site for semiconductor production, while assembly is now extending to Central Europe.[10] Contract manufacturers have been especially aggressive in that region, opening plants in Hungary, Poland and the Czech Republic. With the exception of an Intel assembly plant in Costa Rica, an assembly corridor in Guadalajara, Mexico, and a few Brazilian firms, little high tech manufacturing takes place in Africa or Latin America.

Firms do not simply seek out the lowest labor costs. Specialized product and process capabilities, adequate infrastructure, and skilled labor are equally or more important. According to industry officials, the main reasons they expand overseas are to diversify risk and be close to markets. The location of peripheral and final assembly operations in a range of electronic products are more likely to be driven by labor cost concerns.

Seagate Technology, for example, the world's largest disk-drive manufacturer, is heavily invested in Southeast Asia. Seagate set up shop in Singapore in 1982 and rapidly expanded operations in Malaysia and Thailand. By the mid-1990s, Seagate employed over 40,000 in Thailand and 20,000 in Malaysia, most of them of non-managerial status and the overwhelming majority low paid women. In the last few years, however, jobs have been shed rapidly as the disk drive has shrunk in size and cost. The impact on local electronics-dependent communities has been devastating.[11]

Table 1
OVERSEAS SITES OF CALIFORNIA-BASED HIGH TECH COMPANIES

Company	**Product**	**Net Revenue (US$ billions)***	**Sites of Overseas Operations**
Advanced Micro Devices	Semiconductors Memory chips	4.6	China, Europe**, Japan Malaysia, Thailand Singapore
Agilent Technologies	Semiconductors	10.8	Australia, China, Europe Japan, Korea Malaysia Singapore
IDT Technologies	Semiconductors Memory chips	0.7	Philippines, Malaysia
Intel Corporation	Semiconductors Memory chips	33.7	China, Costa Rica, Europe (Ireland), Israel, Malaysia, Puerto Rico Philippines
Hewlett Packard	Hardware, peripherals	48.8	Canada, Europe, Mexico Brazil, China, India Japan, Korea, Malaysia Singapore
National Semiconductor	Semiconductors Memory chips	2.1	Malaysia, Philippines Singapore, Scotland
Seagate Technologies	Hard drives	*	China, Europe (Ireland) Malaysia, Singapore Thailand
Solectron	Product manufacturing	14.1	Australia, Brazil, Europe, India, Indonesia, Japan Mexico, Singapore Malaysia, Taiwan, China

* FY2001
**Private company, figure not available.
(Source: company websites and annual reports)

Industry structure is highly dynamic. Taiwanese companies, for example, are beginning to shift some of their low-end manufacturing operations to China, creating complex supply chains that reach from China through Taiwan, then to Singapore or directly to the US or Japan. A recent poll by the Taipei Computer Association found that 90 per cent of Taiwan-based high-technology companies had invested or planned to invest on the mainland. By some accounts, China could become the world's largest producer of high tech hardware within a decade.[12]

B. Leaders and Laggards

The world of multinational chip, semiconductor, and other IT hardware companies is divided into two tiers. On the first tier are leading edge companies whose competitive advantage is based in large part on being technological innovators. These name-brand companies invest heavily in research and development, have a technically skilled workforce, and push the envelope in terms of production processes and products. They tend to have newer plants and more employees. Most sell to consumers or industry under their own brand name and invest significantly in building and protecting their reputation.

Leading edge companies tend to have relatively sophisticated environmental management systems and dedicated environmental health and safety staff, including internal monitoring of environmental impacts. They generally provide some public information on their environmental commitments.

On the second tier are companies who derive their competitive advantage not from being innovators but from serving mass markets with relatively stable products. Second tier companies also include contract suppliers who sell everything from peripherals to full low-end computers, but generally do not put their own name on the final product. These companies spend less on research and development, utilize older and dirtier production technologies, and employ lower skilled and lower paid labor than first tier companies. Laggards in technology, they tend to lag in environmental management systems implementation and staffing, make available less information on environmental and social practices, and generally have a worse environmental record.

Both leaders and laggards are heavily enmeshed in external sub-contracting and sub-sub-contracting relationships, primarily for generic products such as motherboards. Companies in Taiwan, for example, are major suppliers for brand-name US companies, while they themselves have extensive sub-contracting relationships with companies in southern China.

Within the US, sub-contractors span the gamut from small and medium size *bona fide* companies to shady "sweatshop" operations involving piecework done at home. Whether in Silicon Valley or South China, little is known about the extent or the conditions of home-based production. It is completely unregulated in terms of labor conditions, worker (and family) exposure to toxic substances, or emissions to the environment.[13] These supply chain relationships make the division between leaders and laggards a fluid one.

III. CLEAN AND GREEN—OR TOXIC AND MEAN? ENVIRONMENTAL AND SOCIAL CHALLENGES

The high tech industry enjoys, relative to other industries, an image of being clean and green. In the US, the high tech sector has often been embraced by Socially Responsible Investment (SRI) funds. These funds manage retirement and mutual fund accounts by investing in corporate stock in accordance with ethical values and performance. SRI funds evaluate and engage companies on a variety of ethical issues, including their environmental practices, employee and community relations, and human rights policies.

In the bull market of the '90s, SRI funds had a large exposure to "new economy" technology companies, including semiconductor and silicon chip manufacturers. The British FTSE 4 Good index, for example, which offers a series of benchmarks and indices to determine a " socially responsible" company, includes Intel and Texas Instruments. The oldest ethical index, the Domini Social Index, includes Microsoft, Intel and Cisco Systems in their top ten holdings. [14]

Some high tech companies rank high in SRI funds because of specific ethical indicators, such as board diversity or the production of regular corporate environmental reports. By and large, however, high tech companies have not been subject to intense scrutiny either of their overseas operations or of a broader range of labor, human rights and environmental issues. Calvert Funds, one of the oldest SRI firms in the US, is an important exception. Calvert has recently unveiled the first socially responsible technology-focused mutual fund, and indicates they will begin to engage the semiconductor companies on workplace safety and toxics.[15]

Despite its clean and green image, four environmental and social dilemmas plague the high tech industry and present significant ethical and public policy challenges:

- Highly toxic and hazardous materials used in production and assembly and embodied in consumer products;
- High intensity of water and energy use in manufacture and assembly of silicon chips and semiconductors;
- Inadequate standards for working conditions and protection of labor rights;
- Poor oversight of global supply chains.

In addition, high tech companies tend to agglomerate in geographic pockets like Bangalore in India or Penang in Malaysia. Rapid growth in the absence of adequate physical infrastructure, including housing and transport, has triggered a host of social impacts such as traffic congestion and high housing costs.

Another concern is the 'digital divide'. The global spread of information and communication technologies may exacerbate the difference between plugged-in elites and

poor people who may not have access to electricity, much less state-of-the-art information technology.. A number of high tech companies have identified the digital divide as both a problem and a market opportunity. .[16]

A. Toxic and Hazardous Materials

The semiconductor manufacturing process involves the use of a wide variety of gases and materials to etch, clean and process the chips. Many of those substances are toxic to humans or other life, whether absorbed by workers during the production process, or emitted as waste into air, water or land. The bunny suits worn by workers in "clean rooms" are intended to protect the purity of the product, not necessarily the exposure of workers**.** Due in large part to careless use of such chemicals in the past, Silicon Valley has the largest concentration of Superfund toxic sites in the United States.[17] As the industry has expanded its global reach, the risks have spread as well.

When pressed by clear scientific evidence of hazard—and the threat of regulation—the high tech industry has been able to respond quickly. The rapid reduction in the industry's use of ozone-depleting chemicals, long used for cleaning chips, is a telling example. The Semiconductor Industry Association reports on its web site that reportable ozone-depleting emissions from the industry have dropped by 75 per cent from their 1987 level.[18] SIA members have also signed a Memorandum of Understanding with the EPA to significantly reduce use of perfluorocompounds (PFCs), one of the most widely used chemicals and a potent greenhouse gas.

However, two structural problems make it difficult for the industry to make steady progress towards improvements in health and safety. First, the speed at which new products and technologies are introduced makes it difficult to assess potential risks. Risk assessment takes years of trials, while production processes change continually.

According to leading industry analyst Jan Mazurek, "Chip plants use, emit, and transport a host of constantly shifting substances that are known to be among the most toxic used in contemporary industrial production."[19] Because the chemical mix is constantly changing, it is difficult to determine precisely which chemicals may cause problems.

The speed at which new products and technologies are introduced is driven in large part by marketing. Companies work hard to gain market share by being 'first movers,' that is, by creating and marketing new products and new features. "Moore's law" which decrees ever-smaller chips, is both an engineering and marketing strategy.

Industrial hygienists working in the industry admit that accelerated product cycles mean that, for many substances, they have little idea what, if any, occupational or community health hazards exist. For others, the chemicals themselves have been around for years, but the combinations of chemicals, and their potential cumulative effects, are new. And in the case of substances with known hazards, such as PFCs, no substitute chemical or process has yet been proven viable on an industrial scale.[20]

Second, industry leaders complain that they themselves are often in the dark in relation to the characteristics and risks associated with different process chemicals because they receive inadequate information from the chemical manufacturers. Regulators, who largely depend on company-produced studies for their information, are even farther behind in identifying potential problems.

Nor is it clear how a chemical-by-chemical control regulatory strategy could ever keep up with the continuing changes in production processes. In this area, traditional exposure limits may always be inadequate. New approaches are sorely needed, especially product and process design innovations which reduce or eliminate the use of hazardous and toxic chemicals.

B. Air and Water Pollution

The earliest environmental problems in Silicon Valley involved toxic solvents and wastes seeping into groundwater, often from underground tanks or pipes that ruptured or leaked. There are more than 150 contaminated groundwater sites in Santa Clara County.[21] The problem is not nearly as significant today in California, as tanks and pipes are generally maintained above ground, underground tanks must be double-walled, and wastes are recycled or reused. However, semiconductor production sites overseas still grapple with significant problems of waste storage and disposal.

In Taiwan, for example, local villagers have complained about severely polluted rivers and groundwater, including major sources of drinking water caused by toxic discharges traceable to the high tech industry. The high tech companies contract with licensed waste handlers to transfer the waste off-site, but these then subcontract with unlicensed haulers who have dumped some of the waste into the local rivers.[22]

In the Philippines and Costa Rica as well, the lack of appropriate hazardous waste disposal facilities means that companies must ship their wastes back to the country of origin, creating transport hazards and the risk of careless handling by hauling and disposal firms. In India, there are only three licensed hazardous waste dumps in the entire country, and much solid waste containing heavy metals and other hazardous substances is simply landfilled. Despite the tightening of regulations in 2000, the Government of India still has not produced guidelines for waste management in the IT sector.[23]

Conventional and hazardous air emissions were once a significant source of air pollution in Silicon Valley.[24] Conventional air pollutants contribute to smog, and in high tech manufacturing come largely from the use of volatile organic (VOC) solvents used in cleaning. Rapid innovation, and a combination of better pollution control, process changes and chemical substitution has allowed leading-edge firms to reduce both conventional and hazardous air pollutants in their facilities. For example, between 1990 and 1994, Intel's semi-conductor production increased by 98 per cent, but VOC emissions during the same period increased only 18 per cent.

At this point, air pollution problems in Silicon Valley stem more from the number of cars choking local roads than from the high tech industry. In the developing countries where much low-end manufacturing has moved, however, air pollution problems may be significant, and may come from surprising sources. In India, for example, the use of diesel generators to provide a reliable power source to high tech companies has exacerbated air pollution problems in urban areas.[25]

End-of-Life Waste Disposal

Once computers and other high tech devices are born, they have to go somewhere to die. Accelerated product cycles and rapid technological change mean that the lifespan of a given IT product gets shorter and shorter. According to a report for the National Safety Council, some 315 million computers will have become obsolete in the US between 1997-2004.[26]

What happens to all those old computers? Many remain stored in people's closets and garages. Others end up in local landfills. According to the EPA, only 13 per cent of the 20 million computers which became obsolete in 1998 were reused or recycled.[27] Recycling efforts have been slow to gain momentum, largely because the market for scrap metal and plastic does not pay enough to make disassembly and re-use profitable.

Consumer demand for recycling, however, is increasing. According to a March, 2002 report, 'Exporting Harm: The High Tech Trashing of Asia', some 12.75 million computers (including monitors and keyboards) will be recycled in 2002. The report estimates that 50 to 80 per cent of these recycled computers will be exported to developing countries, especially China, India and Pakistan, for disassembly.[28]

Computers include a host of substances that make it impossible to safely dispose of them in a landfill, including lead, cadmium, chromium and mercury, as well as brominated flame retardants. Each computer monitor contains an average of four to eight pounds of lead, which can leach into landfills and into groundwater. . In China, open burning of wires and other parts is common in recovering metals such as steel and copper. Dioxins and furans can be expected due to the presence of PVC and brominated flame retardants in the electronic refuse.[29]

Computers and peripherals also use plastics and other potentially recyclable materials which have not been engineered for easy or safe disassembly or reuse of parts. Disposal of plastics by incineration, the preferred alternative in many parts of Europe, releases dioxins, extremely toxic substances now subject to international phase-out.

One strategy for dealing with end-of-life computer and electronic device disposal is to make producers responsible for it. Beyond cost internalization, the concept of Extended Producer Responsibility for the product from birth to grave means that producers have powerful incentives to minimize waste and maximize reuse. At its most effective, these incentives can spur redesign of production processes to eliminate the use of toxic substances altogether.

The US debate over producer responsibility has been driven largely by a European Union directive on Waste from Electrical and Electronic Equipment (WEEE Directive). Under the directive—approved by the European Parliament in April, 2002--companies must pay for the collection and disposal of computers and other electronic goods from consumers as well as businesses. To protect against 'free riders,' the law requires companies to provide upfront guarantees of future financing of disposal.[30] Spurred by European regulatory efforts, a global coalition of NGOs, municipal governments and others have created an international network on e-waste (GAIA) to push for industry take-back.

Industry response has been mixed. The US Electronic Industry Association fought the WEEE Directive tooth and nail, claiming that it is unnecessary, that it would single out the industry and saddle it with the costs of cleaning up "historic" waste, and that it is a barrier to trade.[31] On the other hand, individual companies have implemented voluntary take-back programs in European countries and a few US states, arguing that no legislation is needed.

Sony, for example, now runs a take-back program in Minnesota, and IBM and HP have implemented customer take-back plans in the US. In addition, the Electronics Industries Alliance is participating with governments and NGOS in the National Electronics Product Stewardship Initiative (NEPSI). NEPSI aims to establish a take-back and recycling infrastructure for the US[32]

Industry consortia, including US EPA's *Design for Environment Printed Wiring Board Project* (and Japanese companies in the *Global Environmental Coordination Initiative*) are also working to develop alternatives to lead for soldering.[33] A few companies including Sony, Kodak, and Matsushita have announced they will switch to lead-free solder. To date, a majority of the industry has not followed suit.

Rather than mandatory take-back and toxic phase-outs, the US industry has proposed "shared responsibility" with municipal waste handling systems, or fees levied on consumers to fund take-back programs. Even where such programs formally exist, however, it is unclear how well they are being implemented, outside of European and US markets. Field studies revealed, for example, that the Indian sales office of a well-known US computer maker had no knowledge of the company's much-touted take-back programs. On the other hand, the existence of a vast "gray market" for used computer components in India may alleviate pressure on companies to resolve the disposal problem.

C. Water and Energy Use

The manufacture of silicon chips and semiconductors requires large quantities of both clean water and reliable energy. A fab producing six-inch silicon wafers uses 2 million gallons of de-ionized water per day.[34] Indeed, industry officials have indicated that a lack of adequate water and energy infrastructure has limited investment in new silicon chip and semiconductor "fabs" in developing countries.[35]

Within the US, large semiconductor plants have been built in arid or semi-arid areas like Arizona and New Mexico, creating local concerns about the impact of large-scale water use on aquifers and water quality. Intel's water use at its New Mexico facilities, for

example, rose by 30 per cent between 1994 and 1995. As Intel has expanded its operations in New Mexico, water tables have concurrently dropped by as much as 10 feet per year in some areas as a result of over-pumping.[36]

Intel's thirst for water has forced it to buy from a finite supply of water rights that independent *acequia* farmers depend on, a move that prompted widespread local opposition. In its 2000 EHS report, the company reports a $15 million investment in water reclamation and reuse facilities that have saved 800 million gallons of water in New Mexico.[37] While this is a significant improvement, the statistics do not indicate whether it represents best practice—or if it is enough to ensure the sustainability of water supply in New Mexico.

The energy impact of the high tech industry is complex. The industry overall uses relatively little energy in production compared to "old economy" sectors like chemicals or steel. However, the manufacture of semiconductors and other high tech components is a highly energy-intensive. Energy use comprises up to 40 per cent of a semiconductor manufacturer's total costs, primarily because semiconductors must be produced under extremely sterile conditions. "Clean room" facilities run high-powered fans, air pumps, and vacuums to circulate the air and maintain the proper conditions. High energy costs mean high potential for savings through energy efficiency. According to Amory Lovins of the Rocky Mountain Institute, a 92 per cent reduction in carbon emissions per microchip is currently profitable.[38]

For several reasons, however, most high tech manufacturers have failed to aggressively pursue energy efficiency. There is a general reluctance to disclose internal company data that would enable the creation of an industry wide benchmark for energy use. There is a paucity of information on state of the art building design that is transferable to mainstream users. Companies, in their quest to be "first to market," focus research and development on products and leave building design and operation to traditional systems.

Energy use is a prime example of rhetoric falling short of action. The semiconductor industry prides itself on its climate change mitigation partnership with the EPA while largely ignoring the energy intensity of its own operations. The industry has responded to energy concerns primarily through the EPA's voluntary "energy star" program and through the development of "sleep" functions that minimize the use of energy when the computer is not being used.

One company that has aggressively pursued energy efficiency as a key component of profit making is the European firm STMicroelectronics, the largest chip manufacturer in Europe. It may be the only company in the industry with a Corporate Environmental Steering Committee chaired by the CEO. The company is on its way to achieving its goal of being carbon neutral by 2010. At the company's state of the art facility in Singapore, energy consumption per unit of production was reduced by a factor of 2.5 from 1991 to 1997. Energy savings increased by 29 per cent over the period 1994-2000.[39]

Expanding societal use of computers increases demand on the energy grid. Rising demand, however, may be offset by gains from reduced driving through e-commerce and telecommuting, less construction of new stores and offices, inventory reductions, and an increased ability to monitor and pinpoint energy-saving possibilities. A recent study concludes that the US economy is becoming somewhat less energy-intensive, due in large part to expanding use of information technology.[40]

D. Worker Health and Safety

The highly toxic character of semiconductor production poses potential health and environmental risks to both communities and workers. To date, industry been unwilling to seriously grapple with potential long-term risks to human health. Companies have consistently refused to carry out or permit studies of the health effects of working in different aspects of high tech production, especially so-called "clean rooms."

Only one large-scale health study has ever been undertaken and made public. Carried out by Dr. Joseph LaDou in the 1980s, that study found, among other things, significantly higher miscarriage rates among women who worked in clean rooms.[41] Industry concluded that the most likely culprit was glycol ether, a class of solvents which has since largely been phased out of use, at least in the US. Other studies were less conclusive, finding that glycol ether was only one of seven chemicals linked to higher spontaneous abortion rates.[42]

Moreover, other chemicals such as replacement solvents and etching chemicals may be equally or even more problematic. Follow-up studies of miscarriage rates have not been done. Companies that report on their occupational health and safety records often combine accident rates, which are below average, with illness rates, obscuring the true frequency of chemical exposure incidents at high tech facilities. According to a recent medical study, the manufacture of microelectronics products is accompanied by a high incidence of occupational illnesses, which may reflect the widespread use of toxic materials.[43]

Moreover, while most of the focus has been on "clean room" hazards in chip production, significant hazards may arise even from exposure to well-known hazards like lead. A U.C. Berkeley master's thesis documented potential sources of lead ingestion beyond OSHA limits in circuit board assembly plants in Silicon Valley. Surprisingly, the most prevalent source of high exposure was the cleaning and maintenance of wave solder machines, which can be done either by solder machine operators or by separate maintenance services.[44]

According to the same study, inadequate monitoring and communication of hazards, especially to a largely limited English-speaking workforce, exacerbated the potential risks of overexposure. Small and medium assemblers tended to have far fewer protections in place. Although companies often point to a dearth of OSHA violations to argue that no problem exists, the study interviewed a number of OSHA inspectors and concluded that both inadequate staffing and limited monitoring techniques (especially of night/weekend maintenance work) could easily result in underestimating violations.[45]

Lead is used as solder in circuit board assembly. It is also released upon disassembly, for example for recycling, creating new hazards for workers in the nascent computer recycling industry. Management standards for exposure to hazardous metals and organic substances in disassembly operations do not yet exist in the US, much less overseas. These hazards can only grow as states and countries discourage disposal of old computers in municipal waste streams. A few companies, including Sony, Kodak and Matsushita, have announced that they will switch to lead-free solder . Other companies say they will remove other heavy metals from their products altogether.

To date, however the industry has been largely reluctant to proactively confront health and safety issues. Companies fear litigation brought on behalf of workers claiming that their cancers and other illnesses were caused by exposure to toxic substances at work. Suits have been filed against IBM and National Semiconductor on behalf of workers in New York, California and Scotland. Another group of workers in Taiwan has accused RCA (now owned by Thompson Multimedia, a French conglomerate) of exposing them to substances that caused high rates of cancers.[46]

The case against IBM in California, for instance, alleges that the company maintained a "corporate mortality file," a database showing disproportionately high rates of brain and other cancers among IBM workers. According to the complaint, deaths from brain cancer occurred at a rate two and a half times greater among IBM workers than among the general population.[47] Alleged exposure pathways include the concentration of organic chemicals caused by the re-circulation of clean-room air, exposure to known carcinogen xylene in epoxies, and the use of hazardous solvents.[48]

The British Health and Safety executive reported in December 2001 that its study of National Semiconductor workers in Scotland showed higher than average rates of four different kinds of cancer, including brain cancer, but also found that overall worker mortality was lower than average. The report urged more study before definitive conclusions could be reached.[49]

One of the cases against IBM was recently settled for undisclosed terms, but the continuing threat of litigation has made companies hunker down and refuse to investigate. In 1998, after initially agreeing, the Semiconductor Industry Association (SIA) refused to cooperate in a health study proposed by the US Environmental Protection Agency and the California Department of Health Services. The EPA-funded study was to examine cancer and birth defect rates among California semiconductor workers.

Under intense pressure, the SIA agreed in 1999 to appoint a scientific advisory committee to review existing data and decide if broader impact studies are needed. In 2002, the SIA announced that it would "conduct a preliminary review to determine if it is possible to conduct" a study of health risks.[50] The results of such a study may require substantial innovations in chip production. But public health is at stake. As the San Jose Mercury, Silicon Valley's leading newspaper, opined, "Chip makers must do toxic chemical studies, not just consider them." [51]

E. Labor Rights and Working Conditions

Much of the focus on corporate social responsibility in chip and semiconductor manufacturing has been on improving environmental performance. Almost all companies refer to EHS commitments in their mission statements and provide some data as to environmental impacts.

Labor standards and working conditions, however, are not on the industry's radar screen, whether in the US or globally. Despite early academic and activist concerns about women workers in high tech assembly lines,[52] the prevailing view is that the industry employs mostly highly paid and qualified engineers. In terms of US public policy, the industry's main labor concern has been the lack of sufficient highly trained personnel, a gap which the industry has tried to overcome by the practice of "bodyshopping," especially in India.[53]

Public concerns about labor rights have also largely bypassed the high tech sector. In high profile campaigns, a wide array of consumer, student, ethical investor, faith-based, labor and other groups have targeted the apparel, retail, footwear and sporting goods industries for the employment of "sweatshop" labor in their global supply chains. At the heart of their concerns are low wages, mandatory overtime, and the lack of protection for workers' right to advocate for themselves.

The blindness to labor concerns means that most high tech companies have no internal manager or function within human resource departments which corresponds to EHS in terms of corporate accountability issues related to labor. Indeed, researchers for this report generally found it hard to find the right company person to interview about any issues relating to labor standards and worker protections beyond health and safety. If such functions exist, they are dispersed among human resources, community, government or investor relations, and legal and procurement/supply chain functions.

One reason that high tech companies are slow to recognize the importance of a social responsibility approach to labor management may stem from the—actual or mythological—origins of some of the leading companies. These leaders originated with a "bunch of guys in a garage shop" who worked long hours for no pay to pursue an inspired vision. Years and thousands of employees later, some companies continue to scoff at the notion that labor rights and standards are as much or even more a part of the "new economy" as the old.

Temporary Workers, Mandatory Overtime, and Occupational Stratification

Flexibility is one of the industry's primary needs: the ability to grow and shrink, in size, composition and location of its staff at all levels. The demands of just-in-time manufacturing and rapid product turnover have made flexibility even more of an imperative. Yet by pursuing labor flexibility at all costs, the industry has created not only a footloose labor force with little commitment to a company or location, but also a tiered—and a tired--labor force.

The tiered structure of the labor force stems from the industry's widespread reliance on independent contractors and temporary labor. Independent contractors ostensibly work for themselves, and bring their own tools and work techniques to each jobsite. They are not considered employees so the company need not pay them benefits, pension, or give them vacation and sick time. The company is also not generally liable for their actions, or their injuries. Temporary workers generally are employed by a private employment agency, which contracts them out as needed. Workers from several employment agencies may converge at a single site.

Both independent contractors and temporary workers are widely used in the high tech industry. Companies will often spin off parts of their operations to separate, independent companies. For example, IBM's San Jose facility uses independent contractors to handle chemicals stored on site, while Intel in Costa Rica spun off their janitorial service.[54] As mentioned, waste handlers are typically independent contractors. The strategy insulates the core company from liability or labor problems, and may also multiply employment opportunities if the spun-off business finds additional customers. But it also makes it more difficult for both the companies and outsiders to track responsibility, measure performance and prevent problems.

Temporary workers may include packers, maintenance crews and line workers, but also highly skilled engineers, software designers and writers. The word "temporary" is a relative term: at Microsoft's Redmond, Washington campus, some temporary workers have been at the company for many years. They work on the same projects as permanent employees, but they get no health insurance, overtime pay, vacation leave or stock options.[55] In Silicon Valley, temporary packing workers complained of headaches and respiratory problems after working with HP printers, but neither the company nor the temporary agency was willing to take responsibility for investigating health and safety problems at the packing operations.[56]

For an industry whose image connotes horizontal management structures, casual dress and a single cafeteria for the CEO and assembly worker, the high tech industry remains highly stratified by ethnic origin and gender. At the top are white and Asian men. Under them are immigrant engineers and technicians, especially from South Asia, who will accept wages and working conditions that are light-years better than those at home but still far less than their non-South Asian counterparts. At the bottom are the line workers, who in California are largely Mexican, Vietnamese and other Asian immigrants, and the cleaning crews, who are largely Mexican.

In overseas locations as well as in Silicon Valley, an overwhelming majority of assembly and testing workers are women, mostly young women. In 1998, a survey of sixteen large multinational electronics companies in Penang, Malaysia, showed that 77 per cent of the jobs described as managerial, professional, supervisory or technical were held by men, while women held 87 per cent of the jobs classified as clerical, general or semi-skilled (i.e., assembly).[57] Similar percentages characterize labor forces in Silicon Valley.[58]

To their credit, some employers have recognized the problem and have tried to expand educational and training opportunities for women that would allow them to advance through the ranks. Other companies support technical education programs through universities or technical schools. Intel's Teach for the Future program promotes computer literacy, while other programs seek to enhance technical education at the university level, although without a specific focus on women. Most major high tech MNCs have supported technical education in the countries where they operate. But the persistence of these disparities two decades after the gender gap in high tech production was first analyzed and discussed with the companies suggests that more may be required.

The US high tech industry has also been plagued with problems of racial stratification and exclusion. According to the Bureau of Labor Statistics, only 175 of 1,434 Silicon Valley high tech companies working on federal contracts reported statistical information about the racial composition of their staff. Within the 175 companies, minorities comprised 35 per cent of 172,000 employees—a glaringly low figure in the context of California's heterogeneous population.[59]

In a 1999 report, a White House advisory group noted that African Americans, Hispanics and Native Americans comprise 25 per cent of the total US workforce, but only 6.7 per cent of the information and computer science workforce and 5.9 per cent of the engineers. Asian Americans, who comprise 4 per cent of the nation's population, tend to be over-represented, at least double their proportion to the general public.[60] In 1999, Jesse Jackson announced that he would invest $100,000 in high tech companies in Silicon Valley. In the same sentence, he chided these companies for not meeting the affirmative-action requirements that their federal contracts demand. His Wall Street Project would invest in the 50 largest publicly traded Silicon Valley companies and participate in a kind of "shareholder activism" to ensure more racially balanced staffing.

Freedom of Association and Unionization

In an industry where flexibility, management prerogatives and secrecy are paramount, labor unions are unlikely to be welcomed. Indeed, the high tech sector has been highly resistant to the creation of workers' organizations. In part, technical workers are unlikely to see themselves as "workers" in need of unionization. The relatively high salaries and superior working conditions, at least compared to other industries, means that people are reluctant to jeopardize their positions by making trouble. There is, in many companies, a sense of ownership, encouraged by stock options, as well as 'percs' such as access to exclusive schools or housing areas. Companies will often set up worker committees to air grievances or consult with management.

Structural characteristics of the industry also make it hard to organize. Many technical workers are considered exempt from National Labor Relations Act protections. Temporary workers are considered employees of the temporary personnel agency, not the company they report to in the morning. In order to create a bargaining unit, they must involve all the temps working for a given agency, who they have no way of identifying or contacting, and whose interests and concerns may be quite different.

Contracted out services, like janitors, may also find that no one—not the contracting agency, not the client company—takes responsibility for working conditions. In some countries like Malaysia, local law prohibits meetings of more than five people, in effect making any type of organizing drive impossible.

F. Supply Chain Management

The oversight of global supply chains presents particular ethical dilemmas and management challenges for the high tech industry. Even for a single manufacturer, companies, regulators and the public have trouble keeping track of the environmental and social impacts. With the exception of Intel, however, almost all high tech hardware producers now use outside suppliers to make part or all of their products. These long and increasingly complex supply webs span many countries and may include different combinations and collaborations among companies.

The amount of information and monitoring needed to assure that suppliers are acting in environmentally and socially responsible ways (leaving aside the definitional problems) is daunting for any company. Procurement and supply chain managers are hard-pressed simply to coordinate and manage time-to-market, product mix and quality issues, much less these additional tasks.

The diffusion of responsibility through supply chains can exacerbate problems. Sub-contractors tend to be small or medium sized firms, with razor-thin profit margins and less ability to dedicate staff to monitoring environmental or social concerns. Moreover, the potential pressure for improvement that comes with brand-name identification is absent.

Silicon Valley Toxics Coalition's annual ranking of access to information about social practices showed that those manufacturers who put their own names on the final product scored consistently higher than those who produce under contract for other brands.[61] Labor problems in Silicon Valley have concerned smaller companies who sell to the large industry leaders. Toxic hazards, and lack of knowledge about them, are also worse among small companies. The problem of managing suppliers afflicts both leaders and laggards. Indeed, laggards are often suppliers to leaders.

Many name-brand computer companies have policies which prefer environmentally responsible suppliers. AMD's Total Supplier Rating System, for example, includes an annual assessment of suppliers, which covers their environmental initiatives. Intel's supplier contracts contain EHS requirements. IBM requires all suppliers to comply with applicable laws and regulations, and carries out substantive environmental evaluations for those suppliers whose operations entail significant environmental risk or where their work is unique to IBM. Hazardous waste and product disposal vendors are periodically scrutinized as part of the companies' EHS audit procedures.

Hewlett Packard (HP) has the most extensive requirements for suppliers. The company says that it requires its suppliers to develop and adhere to an environmental improvement policy, have an implementation plan with defined metrics, and eliminate certain substances from manufacturing. Wastes must be disposed of "in compliance with local waste disposal

regulations," and substances that may be problematic in disposal, like nickel-cadmium batteries, must be labeled (see Table 2). In addition, HP encourages a wider range of environmentally responsible behavior from suppliers. Apple, Sun Microsystems and other major manufacturers likewise encourage suppliers to be environmentally responsible and to minimize waste, packing materials, and the like.

It is difficult to evaluate, however, whether these policies are operative in practice. Suppliers with an adequate EMS in place might be more likely to achieve superior, or at least adequate, performance. ISO 14001 itself encourages but does not require supplier adherence to the standard, and to date that seems to be the dominant response of large IT firms as well. Few firms require an outside ISO certification of their suppliers. The main monitoring and enforcement mechanism for all supplier-related policies appears to be questionnaires; there are just too many suppliers to make on-site inspection feasible for more than a handful of the most sensitive suppliers. Only if a problem arises, or, in some cases, if the good supplied entails particularly acute environmental risks, do compliance officers from headquarters pay a visit.

From the suppliers' point of view, the various requirements of multiple buyers, each of which has their own questionnaire and set of conditions, can be overwhelming. The smaller the supplier, the more onerous these requirements can become. The area of supplier performance cries out for sector-specific standardization of requirements and for greater monitoring, especially independent monitoring and/or verification.

Unfortunately, attempts at independent monitoring confront the companies' unwillingness to disclose the names and locations of suppliers. In a rapidly changing industry where profit margins on any one component can be miniscule, companies worry that disclosing the names of suppliers to the public (or even to independent verifiers) could result in the information being passed on to competitors. A credible monitoring system would have to build confidentiality concerns into its design, and balance them against the public's need for disclosure of health or environmental hazards.

IV. CASE STUDIES

The high tech industry began going global in the early 1960s and 1970s, with the burst of parts and assembly operations by US and Japanese electronics firms in Southeast Asia. For the most part, these operations produced products for export to the US and Japan. In the 1990s, however, the global demand for computers and other high tech products skyrocketed.

While market growth was rapid everywhere, growth in East Asia was especially dynamic. East Asia has emerged as an important production and consumer base for the high tech industry. Japan, Korea, Singapore and Taiwan, as well as India, China Malaysia, Thailand, and the Philippines have all actively pursued high tech development as part of larger industrialization strategies. While most of the high-end design and chip fabrication continues to be done in the US, companies in Asia and, to a lesser extent, Eastern Europe will take a larger share of assembly and component production in the future.

High tech has been seen to a cutting edge industry, offering great economic development benefits in terms of jobs, knowledge, technology transfer, and boost to local supplier companies. But what have been—and are likely to be—the environmental and social impacts? How responsive are US companies to the special requirements of operating in countries that typically lack environmental management infrastructure and regulatory oversight? What kinds of initiatives—by companies, workers, governments, and/or NGOs—could improve social and environmental performance?

This section presents synopses of the case studies commissioned for this report spanning Taiwan, Thailand, India, Malaysia and Costa Rica.[62] It also scans some of the key issues at stake in Silicon Valley. The studies were based on extensive interviews with company and government personnel, as well as academics, NGOs and labor groups.[63]

A. Taiwan: Toxic Legacy

Taiwan's rapid ascendance into the global market by way of the Information Technology (IT) industry has wrought an economy envious of most developing nations. The government of Taiwan played a strategic role in the development of a high tech sector by promoting policies that attract IT investment and building the needed infrastructure. This has resulted in a highly successful IT industry that is a major provider of employment, especially jobs that advance the intellectual capital of the Taiwanese workforce. IT workers are generally highly educated and skilled—approximately 38 per cent have a bachelor's or an advanced degree.

Between the 1970s and 1990s, Taiwan emerged as an important player in the global IT industry. It became an original equipment manufacturer for leading US and Japanese personal computer firms, including Compaq, Dell, Hewlett Packard, IBM, Mitsubishi, Motorola and Toshiba. The most important procurement relationship is with Compaq, which accounted for a third of the value of hardware production in Taiwan in 1998. Hewlett Packard is also an important player: in 1998, fifty per cent of HP personal computers were manufactured and assembled in Taiwan. Taiwanese companies also produce directly for consumer markets under the Acer and other brand names.

In terms of industry growth, Taiwan's economic development plan has clearly worked. But the untold story is that the IT sector has produced a legacy of environmental devastation and growing economic inequality. Moreover, the real impact is just beginning to unravel.

Directed by Dr Shenglin Chang and the Taiwan Environment Action Network, the case study focused on the Hsinchu Science-Based Industrial Park (HSIP)—where $60 billion over seventeen years has been invested to develop the infrastructure for high tech production facilities. Unfortunately, investment did not include adequate environmental infrastructure such as waste management facilities with sufficient capacity for the amount and types of waste generated. Nor did it include adequate monitoring capabilities or regulatory oversight. Indeed, for two reasons, companies operating in the Park largely ignored the environmental laws and control mechanisms enacted in Taiwan in the 1990s.

First, the dynamic growth of high tech industries based on short product cycles and intensive chemical use made it impossible to develop comprehensive toxic inventories. Such inventories play a key role in controlling and monitoring toxic waste. Second, the local environmental authority in Hsinchu was unable to force the administratively separate HSIP to obey the law. The long-term pro-development policy of the national government, and the lack of local autonomy under the 50-year one-party rule of the Kuomintang, crippled the environmental practice of local governments.

The lack of adequate environmental protection has created a severe and widespread problem of water and coastal pollution. Lacking adequate waste management infrastructure and regulatory oversight, the toxic and hazardous wastes of the HSIP were apparently—and secretly—dumped in the Kaoping and other rivers. In July 2000, one of Taiwan's largest waste handlers, the Shengli Chemical Company, was caught in the practice after a dumping incident which severely polluted the Kaoping and left the people of Hsinchu without water for two days (see box). The incident was widely reported and set off alarm bells throughout Taiwan. For the first time, the public questioned whether the IT industry was in fact "clean" and what hidden costs they would have to pay for the fabulous wealth accumulated in the last twenty years.

The problem, however, continues. Local NGO environmentalists claim that 60,000 tons of toxic water is generated daily in the HSIP. However, the HSIP confirms that only 20,000 tons of wastewater is treated. Investigations by NGOs suspect that the discrepancy, some 40,000 tons, is dumped into the water system and in neighboring villages.

Furthermore, IT companies in the HSIP are not only major polluters but major users of water, accounting for about 31 per cent of the region's daily water consumption 3.5 million tons. Already, four dams have been built in Hsinchu County to meet the region's water demand and a fifth will be completed by 2007. The construction of dam projects has seriously threatened the regional ecosystem, including fish. No well-documented environmental impact assessment was conducted before the dam construction projects started.

The impacts of the IT sector on human health, both for workers and the general public, are largely uncharted. Little data is available and workers are reluctant to report illness or injury or even discuss occupational health and safety issues. There are no labor unions in the HSIP and no attempts by employees to form one. Employees are also shareholders and anxious to protect the company's public image. The only health concern HSIP workers reported was gout, which is a general concern in the Taiwanese population.

Shengli Toxic Dumping Incident

When the local nursery owner on Poshan Road noticed white dried dots on the leaves of his plants, he stopped using the groundwater for irrigation. This nursery is located next to the Hinschu Science-Based Industrial Park (HSIP), the "Silicon Valley" of Taiwan.

Three years later, the source of what may have caused white dots, as well as the death of thousands of fish along the Ker-ya riverbank and the black and yellow stains with the strong burning-sugar cane smell, has been unearthed.

On July 18, 2000, in a front page story in the China Times, the Shengli Chemical Company was uncovered to be illegally dumping hazardous and toxic chemicals in the Kaoping River—one of two major water systems and reservoir for the second largest city in Taiwan. More toxic dumps were found in several creeks in northern, central and southern Taiwan. For years, Shengli had legally transported waste from the HSIP. However, it had commissioned unlicensed companies to dump it in the river.

The discovery sent shock waves throughout Taiwan, not least because Shengli was ISO 14,001 certified.
The EPA immediately revoked Shengli's license. Still, it was the largest licensed contractor to manage chemical toxic waste from the HSIP. About 52,000 tons of toxic solvent and 78,000 tons of non-toxic solvents are produced each year in the HSIP. For years, Shengli handled the waste from 84 companies, about 80per cent of all the companies operating in the HSIP, including 20per cent of all the solvents.

Jeopardizing drinking water and agricultural production for millions throughout the Hsinchu region, the Shengli incident set off alarm bells in Taiwan. A Cabinet study found gross failures and inadequacies both in waste management capacity and regulatory oversight. Although the HSIP had been in operation for sixteen years, no toxic waste treatment plants had been built. A good part of the waste was apparently dumped in the river, raising questions about longterm health and environmental consequences for the entire water system in Hsinchu.

Source: Shenglin Chang et al, *Environmental and Social Aspects of Taiwanese and U.S. Companies in the Hsinchu Science-Based Industrial Park,* Nautilus Institute, April. 2001.

Public health data is also scarce. A number of incidents, however, suggest that a public health crisis could be brewing. In 1997, pungent smells caused a teacher at the Bible College in Hsinchu to faint. In epidemic tests conducted by the Department of Health in Hsinchu City, 56 per cent of the students and local residents tested were found to have abnormalities in blood tests and 41 per cent in urine tests. Moreover, a review of health records found complaints of eye problems, asthma, tiredness, headache, chest pain, dizziness and muscle pain.

A group of former workers at the RCA plant have filed suit accusing the company (which shut down its facility in 1992) of contaminating the ground and drinking water at its

Taoyuan facility. The workers have collected evidence of over 1375 cancer cases, including 216 deaths, among those who worked at the plant and drank the contaminated water.[64]

Company-Community-Government Engagement

The challenge of improving environmental protection and worker and public health and safety will require initiatives by both government and companies. The manufacturing process is divided among firms, with each firm possessing partial knowledge of the chemical uses. Although firms may routinely check the safety of new chemicals, the sophistication of the formulas makes the potential risks unlikely to be known in the short term. Because of the structure of the HSIP, it is impossible to tell which firms are generating the odors and pollutants that end up in the wastewater stream.

The most important initiative is to increase the authority and capacity of local environmental agencies. The only authority the local government has currently is to review and monitor the environmental management system of each company application. Local government also generates very little tax revenue from firms in the HSIP. Under the policy that created the HSIP, IT companies receive tax exemptions for the first five years of investing and then an additional four years if they invest in another start-up. Tax exemptions translate into huge losses in tax revenue from sales generated at the HSIP.[65]

Firms also pay reduced rent in order to lower production costs that give them a comparative advantage in the global market. Finally, the application and review process is expedited, spanning just two months for authorization to start-up at HSIP. All these factors combined form a weak local governance structure that is encourages abuse and mismanagement.

The immense wealth created by the IT sector has dramatically tipped the social and political balance of the Hsinchu region and Taiwanese society. Though many are employed in the industry, local communities have suffered both health problems and social ills, including traffic congestion. The IT elite bears tremendous influence over policymaking by the new government regarding IT industrial development and Chinese-Taiwanese economic relations. There is growing unrest by non-IT personnel and non-HSIP residents over the disparity in public services and the unaccounted burdens placed on Hsinchu as a result of the IT industry.

As a result of growing public pressure, companies have begun to invest in cleaner production, particularly with the help of public and private groups aiding in the establishment of environmental management systems, such as ISO 14001, eco-labeling, eco-efficiency, and life cycle analysis. Tax credits and investment incentives have been offered to industry to control pollution, promote energy efficiency, conservation, recycling, and waste reduction. For example, a manufacturer would be eligible for a 5–20 per cent tax credit for environmental protection equipment or energy conservation technology. To encourage research in innovative technologies, low-interest loans are available for anti-pollution investment plans and construction projects. These resource conservation

practices have led to economic gains for these companies in the ballpark of NT$537 million.[66]

Despite these efforts, it is still clear that local residents need to advocate for policy reform in the Hsinchu province. Environmental and labor laws need to be strengthened to ensure the safety of workers and residents in the HSIP. Part of this strategy should include disclosure laws that require environmental information to be easily accessible to the public. Now, there is no right-to-know law, and local communities and governments have little or no access to information. All these changes will require that the HSIP and Hsinchu city government establish and maintain a good partnership.

While these policy changes occur on a domestic front, it is crucial for Taiwan to seek international expertise on investigating and monitoring high tech industries. The need for information sharing with transnational NGOs is vital, particularly environmental groups with expertise in waste management. Furthermore, since many firms in the HSIP are semiconductor producers that mainly supply to Silicon Valley companies, this poses a rare opportunity for Taiwanese to engage US stakeholders to use their consumer purchasing power to enforce international labor and environmental standards. In addition, many NGOs in developed economies have insights regarding company-community partnership, which could help Hinschu residents encourage high tech corporate involvement and philanthropy at the local level.

B. Thailand: Workplace Hazards

Thailand has experienced dramatic economic growth in recent decades through a strategy of export-oriented, low cost manufacturing. The IT sector, particularly US and Japanese affiliates, makes a substantial contribution to Thailand's overall manufacturing growth. In 2001, electronics accounted for 18 per cent of Thailand's total exports.[67] IT companies enjoy a favorable reputation in Thailand for being "clean" and providing higher than average wages to workers.

Conducted by Thai consultant Tira Foran, the case study focused on nine multinational electronics firms in Thailand. Six firms have significant commercial ties to California:

- Seagate Technology
- Advanced Micro Devices
- Read-Rite
- IBM
- Lucent Technology
- Hana Microelectronics (Thai-owned).

The first three of these companies make hard-disk drive components; the last three assemble and test semiconductors. None fabricate semiconductor wafers. The study focused on occupational health and safety management and labor relations.

The growth of the IT sector in Thailand has come at a significant price in human health, particularly due to workplace exposure to toxics. The response of the Thai government and the companies to chronic worker illness and a series of workplace deaths has been one of

obstruction and avoidance. Improving the safety of workers will depend on whether the nascent network of civil society groups can force companies and government regulators to change their policies and actions.

An overwhelmingly female workforce with minimal union representation and weak government oversight characterizes the IT sector in Thailand. Only one company out of the nine that were studied (Philips) has a union and no current attempts to unionize workers could be perceived by the study. Regulatory capacity is fragmented and overshadowed by the Board of Investment, which has a mandate to attract foreign investment to Thailand's low cost industries.

According to the Bangkok Post, "The head of the BOI said that it had been visiting many large foreign companies to invest in Thailand, especially in industrial estates where environment and safety standards could be controlled." On at least one occasion, the Board of Investment used high-level government contacts to seriously disable the Ministry of Public Health's only occupational medicine clinic after it investigated the practices at Seagate, an incident described below.

Occupational health problems became visible in Thailand in the early 1990s when four workers at a Seagate disk drive facility died after a pattern of fatigue and fainting. In response to the occurrence, the country's most prominent practitioner of occupational health, Dr. Orapan Metadilogkul,[68] was asked to investigate the deaths. She concluded that approximately 200 employees had blood levels that suggest chronic lead poisoning, possibly aggravated by solvent exposure. Seagate responded by disputing the study and the causes of the illnesses, and pressuring Thailand's government to prohibit Dr. Orapan from practicing occupational medicine.

Seagate's position on the case was that job applicants already have high levels of lead in the blood due to high levels of exposure from the extensive use of leaded gasoline in urban areas; and that no Seagate employee has ever reached the blood level that is considered dangerous by the Thai government. The divergent viewpoints illustrated that the evidence was inconclusive and called into question the effectiveness of the Thai occupational safety standards for lead exposure.

In 1993, while the illnesses were heading towards litigation, a separate pattern of illness and death among electronic workers occurred at the Northern Region Industrial Estate (NRIE), near Chiang Mai. Half the companies in the Estate are in the electronics sector, many of them Japanese-owned component makers. By September 1994, between ten and 23 people were reported as having died after working in electronics factories.[69] Industry spokespeople denied any connection to the deaths; a Ministry of Public Health team sent in by the government to investigate never made their report public. According to one researcher, "neither government agencies nor researchers have been able to get permission to conduct research on health and safety in the Estate."

Local laws exacerbate the lack of access to reliable health and safety data. Employees have no right to know about occupational hazards, nor do they have a right to decline certain

types of work. Firms must set up employee safety committees, but are free to choose their members. Law requires employee medical exams, and many firms have in-house clinics, but employees have no right to choose the doctor, define the scope of examination or see the results. Each labor inspector monitors, on average, over a thousand sites. Third party organizations are unable to assist in monitoring conditions due to the same lack of information that workers face.

The same issues plague environmental protection in Thailand. Although environmental regulation generally dates from the 1990s, overlapping and confusing jurisdictions among agencies, and the predominance of Ministry of Industry-based agencies in the administration of industrial estates, mean that environmental agencies usually have little clout.

Emergence of Citizen Advocacy

The prevailing state-business alliance marginalizes the environmental NGO community. As a consequence, NGOs are largely not party to the process of environmental policy formulation for important issues such as the controversial Yadana pipeline running from Burma to Thailand. Some toxics such as dioxins are still completely unregulated. Although some companies such as Seagate and Advanced Microdevices emphasize their ISO 14001 compliance, none of the firms appeared to invite third parties to help formulate policies or establish performance targets.

The reluctance of industry managers to make health and safety information available may derive from fears that such information could spur unionization drives. Indeed, one reason for the aggressive reaction of local Seagate managers to reports of occupational illness may have been a 1991 union organizing drive at Seagate, which resulted in some 700 workers being fired.[70]

In 1998, frustrated by a lack of government action in the wake of the Seagate and NRIE incidents, a coalition of civil society groups began campaigning for legislation to set up an independent national institute for occupational safety, health and environment. The firms themselves had reacted, often under pressure from home offices, by implementing environmental management systems, improving internal health monitoring, and/or looking for ways to cut down on solvent and lead use. On the other hand, none of the firms visited had posted health hazards disclosures.

The proposed legislation contains such measures as independent review of workers' compensation cases and more power sharing between government regulators and victims of workplace injury and illness. At the time of this writing, this proposal and a more modest Ministry of Labor proposal were still under consideration.

The workplace accidents of the 1990s galvanized Thai civil society to organize and demand improvements. Firms in the IT sector pledge "continuous improvement" and claim to keep regular employee health records. However, because they do not disclose this information, it is impossible to tell whether improvement has taken place. Moreover

baseline information, such as historical blood lead levels, is lacking. Are Seagate facilities in Thailand safer than at the time of the deaths in the early nineties? Seagate recently opened a new, automated plant, which should result in far less exposure for workers to hazardous substances—although the plant will employ fewer workers.

Another basic unanswered question is whether voluntary health and safety systems in general reduce the risk to workers of chronic occupational illness. The kind of science based advocacy that has been useful in North America and Europe in applying essential pressure to enforce voluntary systems is minimal in Thailand. An effective environmental health and safety system and the progress of corporate social responsibility in Thailand will depend on the development of this type of credible, grassroots advocacy.

The Thai government has a pivotal role to play in increasing worker protection and environmental health. The first steps are stronger disclosure laws which would strengthen and improve the quality of citizen and labor advocacy. The government could also play a convening role, working to strengthen ties and collaborative initiatives between firms and local communities. Stronger and clearer international environmental, labor and product content/take-back standards will also play a critical role in encouraging both the Thai government and electronics firms operating in Thailand to improve manufacturing processes.

C. India: Growth Without Regulation?

The electronics industry has emerged as the fastest growing segment of Indian industry both in terms of production and exports. Since 1990, market liberalization and new fiscal incentives have led Indian subsidiaries of multinational corporations to make significant investments in the software and increasingly the hardware parts of the IT industry. Centered largely around Bangalore and more recently Hyderabad, India's IT industry and has been propelled by active government support and is poised to explode in the coming decade.

The growth of the IT industry is not only transforming India's economy but is creating new environmental and social problems that the Government of India has yet to address. In order to minimize the concomitant pollution, hazardous waste, and quality of life issues that accompany high tech growth, farsighted planning by the government, corporations, and civil society will be crucial.

The key questions are: what have the environmental and social impacts of this industry been to date and what lessons can be applied for the future? Given that investment by multinationals is likely to continue, how can public policy, company initiatives, and community action help to promote company accountability and social responsibility?

Conducted by Dr Radha Gopalan of the Environment Management Centre in Mumbai, this case study analyzed the evolution of the Indian IT sector, the existing and emerging environmental and social issues and the associated regulatory framework.[71] It also made

recommendations on how policy and governance measures can ensure accountability and environmental and social responsibility of the IT industry.

The primary environmental and social issues facing the existing and emerging Indian IT industry are:

- Solid and hazardous waste management both during manufacturing and at the end of the IT products' useful life;
- Phasing out ozone depleting substances from the electronics sector;
- Implications of the increasing energy demands given the power scarcity in the country and congestion;
- Pressure on local infrastructure such as land, roads, housing, water and power.

India does not currently have fabrication facilities for silicon chips and semiconductors. The industry is concentrated on software and some assembly operations. The magnitude of issues like hazardous and solid waste management in manufacturing are not, therefore, as large as countries where there are fabrication facilities. However, solid and hazardous waste management at the end-of-life stage could very soon become a significant issue in India.

There are insufficient facilities in India to deal with waste created either from production or product end of life. No reliable statistics on hazardous waste generation exist. There are some 116 industrial incinerators, which are likely to release significant amounts of dioxins and furans, especially if disposing of plastics. There are no official guidelines for waste management in the IT industry to promote take-back programs or hazardous material phase out.

The current, centralized environmental protection regime in India is inadequate to manage the problems associated with high tech sector growth. While comprehensive environmental laws exist, the government lacks sufficient resources to properly enforce them. Moreover, until very recently the electronics industry has been designated as non-polluting, which has exempted it from most environmental regulations. Environmental impacts have been exacerbated by India's insufficient energy supply. High tech companies are forced to rely on highly polluting diesel generators to maintain production.

The issue of hazardous materials is a special case in India due to the large grey market and scavenging that occurs when computer and other equipment is discarded. In the absence of recycling facilities and regulations, people simply discard equipment in garbage dumps. Other people, the enterprising urban poor, scavenge for the equipment and recycle it by selling either parts or reassembled products in local street markets. As they pick apart motherboards and disk drives, the recyclers release into the environment and are themselves exposed to lead, cadmium, and an assortment of other toxic heavy metals. This

is an immediate environmental and human health problem in India and a portent for other developing nations who pursue an IT-led development strategy.

The emergence of the grey market was stimulated in part by protectionist policies that make hardware parts expensive. In addition to a public health hazard, the extensive grey market poses a challenge for the phase out of Ozone Depleting Substances (ODS). India is a signatory to the Montreal Protocol and has a manufacturer phase out date of 2003 with the exception of medical purposes. However, small and medium sized enterprises still use large volumes of ODSs in an informal manner, which makes government control very difficult.

The labor issues facing the industry center on:

- retaining the intellectual property in the country;
- prevailing and changing working conditions;
- health and safety at the work place;
- wages and the role of collective bargaining in the Indian IT industry.

New Roles for Government

The IT industry has virtually no unions. Even so, a number of labor laws that the government deems overly stringent are being simplified to further promote high tech investment. The Indian government sees the more relaxed labor markets and "union free" export processing zones in Southeast Asia as its major competition. Workers in IT companies have few avenues in which to raise concerns or register grievances.

The industry's response to the challenge of being socially responsible differs distinctly between MNCs and domestic players. MNCs have, by and large, adopted corporate codes of conduct covering environmental management, including take back programs, and workplace health and safety. For domestic companies, environmental and health and safety issues are not a priority at present. Most Indian companies disclose little or no information on environmental or workplace safety performance and have no product stewardship mechanisms such as take back programs. Even for the MNCs, however, it is far from clear whether and to what extent the codes translate into better on-the-ground performance.

With the Indian government moving toward "simplifying" environmental and labor laws, the oversight role of corporations and stakeholders has increased. Global competition has essentially created "regulatory freeze" in India. To be effective, environmental and labor protection must be flexible and involve the companies and third party stakeholders. A "tripartite" regulatory framework is needed in which the government's role is to enact legislation, set benchmarks, and facilitate engagement among all sectors. The role of stakeholders is to monitor performance and apply pressure on companies, while the role of corporations is to engage with government and stakeholders, develop internal management

and monitoring systems, and disclose information to government and stakeholders. To lay the foundation for such a framework, the central government should:

1) Enact legislation to improve monitoring, measurement and disclosure of key indicator issues, particularly facility specific information;

2) Create uniform zoning of hardware and software facilities in light of expansion into less-developed states;

3) Create incentives for resource efficiency in the IT industry to reduce the long term demand for energy;

4) Promote proactive and preventive approaches to environmental management as well as product stewardship and asset recovery;

5) Ensure a balance between flexibility and worker rights within labor law reforms especially in regards to gender issues;

6) Strengthen the role of civil society organizations in order to improve stakeholder engagement.

Emerging regulatory reforms attempt to address many of these issues. A National Program on Environmental Management in the Semiconductor and Printed Circuit Board Industry is taking the first steps. A partnership between the newly formed Ministry for Information Technology and the UN Development Program, the project will focus on gathering baseline information, clean technology, waste minimization techniques, and institutional reform to improve environmental management.

The most glaring need at this time is to improve measurement tools and performance indicators. Better information tools would provide decision makers with the necessary "outlook" on the current state of environmental and labor issues and what future challenges are likely to be. For civil society, improved access to information could be the impetus it needs to organize and beginning demanding better performance by IT companies.

E. Malaysia: Manufacturing Growth With Social Deficits

High tech is Malaysia's leading manufacturing industry. Electronics and electronics components make up about 60 per cent of Malaysia's total exports, and the US is the second largest market.[72] Since the early 1970s, Malaysia has worked to maintain rapid economic growth through an export-oriented industrialization strategy based on foreign direct investment. The main industrial centers are located on the West Coast of Malaysia in the States of Selangor, near Kuala Lumpur, Johore Bahru and Penang.

Conducted by Prof Arne Wangel, this case study examined the structure and the regulation of the high tech industry in Malaysia, with a special focus on Penang.[73] In

2000, more than a third of Malaysia's electronic exports were manufactured in Penang.[74] Electronics industries employed nearly 172,000 workers in Penang in 1999, accounting for about seventy per cent of all industrial employment (Table 2).

Table 2
Industrial Employment in Penang, June 1999

Based on surveys

Industry	Employment	No. of factories
Electronics/Electrical	171,832	152
Fabricated Metal	14,496	160
Plastics	8,750	81
Chemical/Fertiliser	4,670	52
Paper/Printing	5,054	63
Textiles/Garments	12,484	26
Others	28,279	181

The high tech industry in Penang was launched in November 1969, when the Penang Development Corporation (PDC) was formed. The Malaysian government commissioned an American consulting firm, Robert Nathan and Associates, to draw up a Master Plan for Penang. The Nathan report called for the restructuring of Penang's economy and the establishment of Free Trade Zones under attractive conditions, including the operation of subsidiaries wholly owned by foreign firms.

In the early 1970s, Bayan Lepas was established as Penang's first Free Trade Zone. Seven companies - five American, one German and one Japanese - began operations: Advanced Micro Devices, Hewlett Packard (now Agilent Technologies), Intel, Litronix (now owned by Siemens), National Semiconductor, Bosch, and Clarion.

The first phase of Penang's industrialization process (1970-1986) was largely based on the abundant local pool of cheap and trainable labor, as well as the availability of pioneer status incentives. A global glut in 1984-86 forced several small, mainly local, electronics firms to close. During the late 1980s, another wave of investment began in Penang, this time including participation from Taiwan. During this period, utilization of robotics and automation increased.

By the early 1990s, Taiwanese companies had become the largest high tech investors in Penang and drove the emergence of peripherals manufacturing.. Also, Kulim High Tech Park was established in the neighboring State of Perak. Enjoying strong land and tax incentives for high tech and strategic industries, it managed to attract wafer fabrication and other redesigning projects, primarily as government directed spillovers from Penang.

American companies continue to be heavily involved in Penang. In June, 2001, subsidiaries of sixteen US companies were manufacturing electronics or components in Penang, including Seagate Technology, Agilent Technology, Advanced Micro Devices, Intel, and others (Table 3).

Despite the large inflows of foreign direct investment in the past thirty years, high tech manufacturing Malaysia has not moved up the value chain and continues to rely on low wages for competitive advantage. Sequestered in Free Trade Zones and kept by government policy at arm's length to local markets, the high tech sector has not built strong linkages to the local economy.[75] With shallow roots, Malaysian high tech manufacturing is vulnerable to pull-out by large multinationals attracted to other locations by cheaper wages and lucrative terms.

Penang is caught in a 'medium technology trap', squeezed at one end by Singapore, which remains the first choice for high-end technology investors in South East Asia, and the other end by other low wage countries in Asia, including China.[76] As a result, environmental and labor protections are low priorities for government regulators.

Major foreign-owned subsidiaries have put in place systems of self-regulation, either on their own initiative or as instructed by corporate headquarters. All companies have implemented environmental management systems, either as certification to an international standard such as ISO 14,001 or as a set of company-specific policies.

Foreign owned companies are considered the leaders. Intel is considered the top performer, with 12 employees devoted to Environmental Health and Safety department. For a number of reasons, including cost and business culture, most Malaysian firms, often suppliers to foreign firms, have not followed suit.

A survey of 136 companies in the high tech sector in 2000, conducted by the National Institute for Occupational Safety and Health (NIOSH), showed that 22 companies (16 per cent) had not even yet established a committee to address OSH issues. Fifty three companies had active committees, while forty five committees were barely active, and eleven were inactive. Five companies did not respond.[77]

The lack of private sector, as well as government, attention translates into a number of social and environmental problems that are not be sufficiently addressed. The most pressing issues are toxic waste disposal; and an absence of social security to assist workers and their families during frequent company retrenchments.

Since high tech production began in Malaysia in the early 1970s, the most serious environmental problem has been the disposal of toxic industrial waste Before a private toxic waste disposal facility, Kualiti Alam, was established in the mid 1990s some companies, mostly foreign owned, stocked the waste on site. Often private contractors were employed whose methods of disposal are unknown.

Table 3

US Electronic Companies in Penang, June 2001

Advanced Micro Devices Agilent Technologies Dell Asia Pacific Fairchild Semiconductor Integrated Device Technology Intel Technology Iomega Knowles Electronics	KOMAG USA Linear Semiconductor M.C.M.S. Motorola Technology Quantum Peripherals Seagate Technology (Penang Seagate Ind.) Solectron Technology Xircom Operations
Source: Penang Development Corporation and American Malaysian Chamber of Commerce	

It took several years for the Kualiti Alam facility in Bukit Nanas to become fully functional. Surveys concluded that only major companies would utilize the facility, due to the lack of enforcement of environmental regulations, as well as the resistance to any added cost by small and medium sized enterprises (SMEs). In response, a pricing system was proposed which caused a lengthy dispute with industry. The alarming result is that the incinerator capacity is 100 tons per day while as much as 300 tons per day has been arriving on-site. The remainder likely finds its way into the local environment.

Another problem facing workers in the Malaysia high tech sector is the absence of social security. During the Asian financial crisis of the late 1990s, companies laid off workers with very little in the way of retraining or compensation. The investigation discovered that the modest welfare schemes which are available target only the hard-core poor, that is, old and jobless people, broken families and children without parents. Moreover, the Training Scheme for Unemployed Workers has only benefited a small number of workers (572 in 1998 and 426 in 1999).[78]

Government and Company Initiatives

The report outlined a number of recommendations that would improve environmental and social outcomes in the Malaysian high tech sector.

- Enforcement of already enacted laws is sorely needed. . Enforcement could be facilitated by greater transparency and empowerment of workers vis-à-vis companies and government regulators

- Workers generally lack awareness on occupational health and safety and regard illnesses and ailments as 'normal'. This should be addressed with improved education and training.
- Disposal of and worker exposure to toxic substances should be immediately addressed. There is currently an acute lack of expertise in Malaysia in this field.

Workers and citizens have traditionally been denied a role in the monitoring of the environmental, health and safety performance of the companies in their communities. This issue should be reevaluated, possibly in a 'dialogue for the future' among the stakeholders of Malaysia's high tech sector. The government, firms, and workers have a common interest in the enfranchisement of workers through skills training, OHS education, and performance monitoring. Such a partnership could be instrumental in lifting Malaysia out of its current 'medium technology trap.'

F. Costa Rica: Responding to Stakeholders

In the mid 1990s, Intel sought to expand its presence in Latin America, both to gain global market share and as part of an overall strategy to reduce production risks and diversity sites. After intense lobbying by a number of Latin American markets, Intel chose Costa Rica. In 1998, the company opened an assembly and testing plant in San Antonio de Belen, near the airport and several industrial zones. The plant currently employs some 2000 people and assembles Pentium processors and other components for export around the world.

Conducted by law professor Naomi Roht-Arriaza, the field investigation in Costa Rica focused on the interplay between local NGOs and Intel management decisions.[79] In many ways, the Costa Rica experience offers a model of how stakeholder engagement can work to improve company environmental and social performance.

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Intel selected Costa Rica because it offered a critical mass of technically qualified labor, "legal certainty", that is, a lack of widespread corruption and violence, a working judiciary and an easy-to-understand political and legal system. Costa Rica also had other large global companies, reasonably developed infrastructure, quality of life sufficient to attract management personnel, and a compatible national work culture.

From the viewpoint of the Costa Rican government, the Intel plant fitted nicely into a development strategy focused on attracting and growing local industries around leading firms from services, high-tech, pharmaceutical and other sectors. The government provided extensive tax breaks, ran new electrical lines and provided land for the new plant.

Local concerns about the plant surfaced before the plant was built. Initial concerns centered on its location over several groundwater sources and near a river. Intel was allowed to build partially on land that had been designated a reserve because of its proximity to watershed. In addition, the Health Ministry re-designated the plant as "inoffensive" based solely on Intel's assurances that they were engaged only in assembly

and testing, not chip production. However, there was no independent investigation of Intel's environmental impacts. As a result, an environmental NGO--Justicia Para la Naturaleza (Justice for Nature)-- brought an administrative challenge to the Ministry's redesignation. In response, the environmental ministry (SETENA) established a list of conditions that the plant had to comply with in order to operate:

- Application of the strictest possible environmental standards, at a minimum California standards;
- Implementation of ISO 14001;
- Establishment of an Environmental Manager, who monitors the plant monthly, with a counterpart in the government (paid for by Intel);
- Those hazardous wastes that cannot be adequately treated in the country to be exported per the terms of the Basel Convention—a bilateral agreement with the US was subsequently concluded specifically in order to export Intel's waste;
- Support for SETENA in the preparation and instrumentation of monitoring for the electronics sector;
- Support and cooperation with a Monitoring and Supervision Commission coordinated by SETENA that includes representatives of state institutions, the company, the local government and local community;
- Provision of funds for external environmental audits to be conducted at SETENA's request;
- 1 per cent of total investment funds held as a guarantee of environmental performance.

As of July 2000 when this field study was conducted, both Intel and the local government person in charge of environment agreed that the company had fulfilled these conditions. The plant has an on-site treatment plant for conventional wastes (i.e., from lunchroom, offices) and recycles some 35 per cent of their waste. In terms of emissions from production processes, especially to water, Intel's aim is not to exceed the permit limits for a similar size plant in California. Company officials insist there is not a problem with trace amounts of lead and other heavy metals being washed off the boards after soldering and into the water supply.

The company has dug a number of perimeter wells around the site, and tests groundwater monthly. All biological loads are composted and used for fertilizer on company grounds. Intel has installed protective membranes and secondary containment systems in all areas where chemicals or oil are handled. In terms of air quality, the goal is to remain a "minor source" under California law, and to date they have managed to do so (less than 25 tons/year of any conventional pollutant).

The city has an air monitoring program of conventional pollutants only and Intel says it is not venting toxics. The company uses class II ozone-depleting substances in coolants, and has installed systems to recapture fugitive emissions of these substances. Lead is the major indoor air quality worry, generated because of touch-up soldering which uses a 60 per cent lead compound. There are tubes to remove lead-laced gases as well as protective clothing for workers. The plant monitors the composition of air within the lead-using areas, but has found it impossible to eliminate use of lead altogether. Hazardous waste is exported to the US, about three quarters of which is lead, and the rest solvents and oils. . In general, in applying California law where no Costa Rican law exists, Intel tries to use the spirit of the law, not the details where they're inapplicable.

The export of hazardous wastes remains something of an Achilles heel. Wastes must be trucked over mountains to the sea, then shipped to Houston, and then to a hazardous waste site in Arizona. The company initially given the contract, Romic, based in California, has been cited for worker health and safety violations. It is not clear how much oversight of its contractors Intel employs, although to date no major incidents have been reported.

Sustaining Community Participation

One of the results of initial community concern was an increase in proscribed levels of monitoring. The Monitoring and Supervision Commission at first met every two weeks. Intel came prepared with environmental indicators, plans and problems, and listened to suggestions and problems. Every three months, the Health Ministry or another regulatory authority sends an inspector to the plant. The plant is also subject to regular inspections from Intel's corporate-wide EHS department. Local government officials appreciate the company's willingness to provide environmental data, even if it is not legally required.

Community interest in the Commission dwindled, however, as feared problems did not materialize, as the head of the local community watchdog group was elected mayor, and as other NGOs ran out of money to support the group. In 1999, meetings were held every three months. As of July, no meeting had yet been held in 2000. The experience provides lessons both about the efficacy of NGO advocacy and about the support needed to sustain community input into decision-making.

New issues are emerging. Livability concerns are becoming a bigger issue as the surrounding area develops. Once Intel received permission to build in what had been a protected area, other companies have sought the same benefit. The result is growth without adequate infrastructure. Housing prices have skyrocketed, making it difficult for some local families to remain in the area. Condo construction may prove to be more of a drain on local resources than the plant itself.

In terms of labor issues, Intel applies US occupational safety standards to its contractors, especially for construction work, and is proud of changing local safety practices. Three quarters of the 2000 employees are production workers, and of those 80 per cent have a

post-secondary technical degree. Only 18 per cent are women, which Intel attributes to the lack of women in technical and engineering careers in Cost Rica. Intel is focusing on improving education to increase the number of women in their workforce. The plant pays about the average of other firms their size. They also provide stock options and bonuses in the same proportion (although not the same amount) as other Intel sites worldwide.

As to suppliers, Intel applies an EHS evaluative screen to large international suppliers, but not to small local suppliers because none of them have adequate policies in place. They import most supplies and inputs. One issue raised by a local NGO was the outsourcing of many support services that would normally be done by employees, including things like maintenance.

The company has extensive community relations and community development programs. It has agreements with the University of Costa Rica and two Technical Institutes to promote technical and engineering education (equipment, scholarships, exchanges) and underwrite the national science and technology fair. Intel has been extremely active in supporting local schools, creating school recycling and environmental education programs, supporting the local Red Cross, police and fire departments, and helping build an air quality monitoring station.

According to Intel, they ask the local community what the priorities are before deciding where to invest. However, it is unclear what form this process takes. Although not required by law, Intel recently decided to pay its local taxes to the municipality, out of a sense that they were causing extra strain on local infrastructure. Intel's contribution will come to one third of the municipal budget. Although the company does pay some taxes and contributes voluntarily to community programs, it also receives enormous tax breaks. As a result, the company gets to choose what community benefit programs to support, rather than paying into a tax fund and having elected local officials decide on local priorities.

In general, the initial opposition to the project motivated Intel to pay attention and make positive changes. The government-imposed conditions both improved the project and enhanced the incentives for the company to monitor and evaluate performance on its own. Currently, reviews are largely positive, even from local government officials and NGOs who had previously expressed doubts.

E. California: From Revolution to Planning?

The high tech revolution began in Northern California and, through the enormous wealth and innovation that it created, spawned a community and state of mind known as "Silicon Valley". From what began as garage operations during the 1960s, the engines of technology that drive Silicon Valley are now highly diversified, ranging from computer design and information services to bioscience and aerospace. In the 1990s, 220,000 new jobs were created in Silicon Valley,[80] a large number of which were highly paid, technical positions.

The technology-led growth that has propelled California and the US to global supremacy is an attractive model. Around the world, local and national development planners seek to attract leading edge technology industries, especially MNCs from the US, Europe and Japan.

The strategy, however, poses new risks and challenges for the world's aspiring "Silicon Forests and Glens". As the California experience shows, if the growth of a high tech cluster is not accompanied by adequate investments in public infrastructure, the quality of life for everyone may suffer through social stratification in the workplace and community, environmental impacts such as groundwater contamination, congestion, and urban sprawl.

The first generation of problems connected to high tech expansion in the Valley centered on water, groundwater and ground contamination from toxic chemicals. After years of organizing, lawsuits, administrative hearings and public pressure, the industry has changed its practices to make further contamination less likely.

To the extent these new practices—and government knowledge of the severity of potential problems—infuse global operations, new high tech clusters elsewhere may be less prone to repeat the same mistakes. But intense market competition and the diffuse structure of production offer great temptations to cut corners. In addition, even as the industry has stopped the worst groundwater contamination practices, other problems have arisen.

Working Too Hard? Piecework, Mandatory Overtime, Social Capital

One of the "dark sides" to California's revolution is the emergence of--largely immigrant-based--sweatshops. A number of investigative journalist reports have documented practices of piecework and homework by subcontractors to major computer manufacturers.[81]

The use of household work raises possible violations of minimum wage and hours laws, child labor laws, and health and safety laws. Piece workers may not make the equivalent of the minimum wage, may involve underage family members in production, and may work with dangerous chemicals or lead solder without adequate information or precautions about the hazards involved. The immigrant labor force involved may be unaware of labor law protections or afraid to make a complaint.

In California, hearings on overtime abuses were held in 2000 in the state legislative Labor Committee. Federal and state investigators provided evidence that the practice was more widespread than previously thought, including among subcontractors who produced components for large brand-name manufacturers. However, no further action was taken and the probes were closed. A proposal to increase the number of labor investigators assigned to Silicon Valley died in a state legislative committee. A lawsuit by a Cambodian immigrant worker resulted in a settlement and a pledge by the subcontractor to cease industrial homework. A coalition of women's, labor and immigrant rights groups has formed to combat the practice.[82]

A different set of issues confronts technical and professional staff of high tech related firms. Excessive work hours, and a work culture that requires complete devotion to the company, are one common complaint. Certain technical and managerial employees in the US technology sector making over $27.63 an hour are not subject to the requirements under the Fair Labor Standards Act such as overtime pay beyond a certain number of hours.[83]

Excessive use of these provisions has resulted in admonitions from the Labor Department that the employee categories involved should be narrowly defined. While an exemption from overtime rules for those running start-ups seems reasonable, the grueling hours required of many middle- and upper-level employees of even well-established companies means less hours available for child rearing, family and community life. In the long run, the quality of collective and individual life suffers.

The dangers became evident in the 2001 meltdown of the dot.com sector, when reports surfaced of highly paid technical staff, now laid off, seeking refuge in San Jose homeless shelters. These "techies" had lived at the office, falling asleep on office sofas and showering at the local health club, and suddenly found they had nowhere to go.

A recent study showed that the communities of Silicon Valley indeed lag behind the United States in terms of cohesion and "social capital".[84] Coined by political scientist Robert Putnam, "social capital" refers to the norms, networks and trust that enable people to work together in the pursuit of shared objectives.[85] According to the study, although Silicon Valley residents display a high level of social and interracial trust, it also shows low levels of community and involvement and social interaction. The lack of civic engagement hinders the region's ability to creatively address communal problems such as education, affordable housing, and transportation gridlock. In the long run, the lack of civic and cultural innovation jeopardizes the region's technological and economic progress.[86]

Gridlock and Urban Sprawl

Silicon Valley's population has grown by 31 per cent since 1980.[87] One of the most visible manifestations of this influx are the choked freeways on any given weekday morning or evening. By some measurements, the San Francisco-Oakland Bay Area now has the nation's third worst traffic congestion. Some $3 billion annually is lost in wasted fuel and lost time.[88] For workers without access to public transportation, congestion means countless extra hours on top of an already long workday.

Technology was supposed to alleviate traffic congestion through telecommuting. A decade ago, federal research predicted that as much as 10.4 per cent of the nation's work force would, by decade's end, routinely work out of their homes or nearby telework centers several days a week. In Seattle, another high tech city burdened with a critical mass of automobiles, only 0.6 per cent of workers telecommute more than two days a week on average, according to a survey of the state's largest employers.[89] Although statistics are not available for Silicon Valley and Northern California, the story is likely to be similar.

Gridlock on freeways is indicative of the general pattern of land use in Silicon Valley and all over the United States. Cities "sprawl" outward through economic and population growth and public transportation does not keep pace. In Silicon Valley, only 37 per cent of new housing and 32 per cent of new jobs in 2000 were located near public transit.[90] Environmental regulators have done a respectable job maintaining the region's air quality in the face of the growing number of cars. However, watershed health has suffered under the strain of proliferating non-point sources of pollution, increasing demand for water, and loss of open, green space.

Indicators: Toward Regional Sustainability Planning

Complex environmental management issues resulting from broad social patterns of production, consumption and habitation generally fall outside the purview of the command and control regulatory system. They represent the new horizon that regulators are attempting to come to terms with. Unlike point source air and water pollution, targeted by the first generation of environmental protection, these issues have complex causes that will require rigorous involvement on the part of governments, private firms, and the public to address.

One emerging California strategy to deal with these issues is the development of indicators that enable close monitoring of overall environmental health in a region or watershed. Quantitative flows such as hazardous waste generation are measured at time intervals and the trends are analyzed to determine whether current policies are effective and what issue areas should be prioritized. The use of indicators was pioneered in the Netherlands and has been adopted by municipalities worldwide, including in Silicon Valley.

The Silicon Valley Environmental Partnership (SVEP) released the latest version of its Environmental Outlook in 1999.[91] Despite California's famously stringent environmental regulations and progressive policies of the region's high tech companies, the report revealed that overall environmental quality was diminishing and more needed to be done to reverse the decline. Some of the most telling trends are a 20 per cent rise in energy use over the last 11 years and a rapid increase in the number of endangered species in Silicon Valley's Santa Clara County.

Other coalitions, including the Bay Area Alliance for Sustainable Development (BAASD) also have urged integration of environmental, economic, housing, transportation and other related policies as necessary to maintain and improve the region's quality of life. BAASD is developing a set of indicators as part of its *Compact for a Sustainable Bay Area.*[92] Natural Resource Defense Council tracks five broad regional environmental health indicators that reveal mixed progress towards sustainability in the Bay Area. Per capita energy consumption is increasing which is exacerbating regional air quality problems. Although more wetlands are being protected or restored, the number of endangered species in the Bay Area is increasing.[93]

The SVEP report and similar efforts illustrate the importance of monitoring and information disclosure to environmental protection. Many of the trends indicate that in high growth areas such as Silicon Valley, factors such as population growth must be

accounted for in the design of effective policies. Increasing numbers of residents and workers put added strain on greenspace and water quality, and often negate gains in areas such as energy efficiency.

There is increasing movement towards an information-intensive, performance-based approach to environmental protection. The State of California is in the process of creating a set of statewide indicators that could inform a sustainability plan in the coming years. As the state and region attempt to tackle previously unregulated issues such as climate change and non-point water pollution, the role of the private sector will increase in importance. California high tech companies could be on the cutting edge, building on their policies of "beyond compliance" and publicly available environmental health and safety reports.

These companies, however, will need to do much more than they are currently doing to contribute to regional and global sustainability. "Beyond compliance" only refers to issues that are currently regulated such as point source air pollution. Key unregulated issues such as greenhouse gas emissions and local water use are often missing from company environmental strategies and reports. To their credit, many companies monitor these impacts. However, linkages between regional environmental health studies such as the one carried out by the SVEP and site-specific company environmental targets are almost entirely missing.

As companies attempt to improve their environmental policies, a crucial step will be the addition of site-specific information that includes overseas facilities. The inclusion of overseas information will enable those communities to apply the lessons of Silicon Valley as their own IT sectors grow, and to ensure that Silicon Valley is not simply exporting its most intractable problems elsewhere.

V. TOWARD CORPORATE ACCOUNTABILITY

The global IT industry faces serious ethical challenges and dilemmas. The dynamic worldwide growth of the industry and increasing use of IT products offer the potential of enormous economic, social and environmental benefits. Under a business-as-usual scenario, they also portend large social and environmental costs. Eliminating or reducing these costs will require a variety of mutually reinforcing initiatives from companies, governments and civil society groups.

Leading edge, multinational firms in the US, Europe and Japan have a special responsibility—and opportunity—to solve the dilemmas. Companies can direct research and development efforts towards to design more benign substitutes for toxic and hazardous materials, or to change basic engineering logic to eliminate them altogether. They can design products to be easily upgradeable and recyclable. They can embrace 'corporate social responsibility'as a fundamental part of corporate governance. And they can work with subsidiaries, suppliers, governments and community groups in developing countries to improve their performance and "CSR" capacities.

Defining new roles for government in strengthening corporate social responsibility is still largely uncharted territory. In the US high tech sector, a variety of government-industry "pilot projects" have explored new, performance-based approaches to regulation. These pilots, however, have not yet developed into programs with clear regulatory guidelines. American high tech companies have generally resisted both mandatory disclosure and community pressure for more voluntary disclosure. Lack of information makes it hard to evaluate the robustness and credibility of the commitments which companies *have* made to improve environmental management.

This section first surveys and evaluates voluntary initiatives underway in leading California-based high tech companies. It then examines the shortcomings of a "global best practice" approach to raising performance. Drawing from a report by industry analyst Jan Mazurek commissioned for this Project, it describes government-industry pilot projects that offer regulatory flexibility in exchange for better performance.[94] It concludes by pointing towards greater mandatory disclosure of environmental and social information as the cutting edge of a new approach to enhance corporate social responsibility through public accountability.

A. Voluntary Disclosure and Codes of Conduct

Most high tech companies have adopted codes of conduct for Environment, Health and Safety (EHS), including adherence to 'best practice' environmental management. IS0 14,001 certification is rapidly emerging as the industry's *de facto* standard for sound environmental management. ISO 14001 requires that a company develop an environmental management system (EMS) that includes environmental goals and objectives, internal auditing, and continuous improvement.

ISO certification, however, lacks two crucial elements: public disclosure of environmental performance statistics, and substantive performance standards. Without public disclosure, it is difficult or impossible to verify whether a company is truly improving its performance or not. Even companies that provide public information often use worldwide data, which can hide the poor performance of specific facilities.

As a universal application, ISO 14001 does not set substantive performance standards; it only suggests the *form* that environmental management must take. Thus, ISO 14001 at best clouds and at worst misleads external judgments of environmental quality. It enables companies to claim superior environmental performance without demonstrating real performance improvement.[95]

The credibility and robustness of the codes of conduct depend on four key factors:

- Specific targets for improvement and performance;
- Facility specific, as well as company-wide performance data;
- Comprehensive coverage of EHS aspects, including in supply chain management;
- Enforcement mechanisms, such as public disclosure and third-party verification.

Table 2 provides a survey of semiconductor and electronic component manufacturers based in California. Overall, three companies—Intel, Agilent, and Advanced Microdevices (AMD)—provide the most comprehensive and convincing information on their Environment Health and Safety (EHS) policies and goals (see Table 2). AMD is the only one to provide detailed site-specific statistics *and* company wide benchmarks for greenhouse gases as well as resource conservation. Intel provides such statistics but lacks complete information on company benchmarks and site-specific emissions and resource use. Agilent also provides detailed statistics and targets under the Global Reporting Initiative framework. However, the targets are not site-specific and targets are lacking for certain impacts such as water use.

AMD also describes the most systematic supply chain management program, though all the companies listed have at least a pledge to communicate EHS policies to suppliers and associates. Laggards in this category such as National Semiconductor and Solectron merely make a pledge and provide no information about how policies are enforced. Even at the best companies, practical integration of EHS personnel and priorities into procurement departments is just beginning

Greenhouse gas emissions policies reflect the widest range amongst the companies. All of the companies cite the EPA energy reduction partnership. In the case of National Semiconductor, this is the only information provided. The other semiconductor manufacturers such as Agilent and Intel have pledged a reduction of 10 per cent below 1995 levels by 2010. Advanced Microdevices has a 50 per cent reduction goal by 2010. None of the components manufacturers provide information about greenhouse gas emissions.

In terms of regulatory compliance, every company (except HP) states a commitment to meet or exceed existing regulations. Five out of eight companies state “best in class” as a company policy. In terms of product stewardship, all companies provide information on recycling and Energy Star progress as well as commitments to finding environmentally sound technologies. Very little is mentioned about such issues as lead free soldering. Agilent and HP are the only companies that state a policy of life cycle design. The pattern among laggards, notably National Semiconductor and Solectron, is to provide general policies on the hot button issues along with token statistics on such things as solid waste reduction and ISO 14001 certification.

Overall, the lack of company wide data and/or information about action and enforcement strategies make it difficult to evaluate both performance and commitment. Leaders provide substantial environmental performance information but lack comprehensive benchmarks and third party verification. In the middle are HP, Apple, and Seagate, who display a mixed bag of EHS commitment and performance. For example, while HP is a leader with its life cycle policy, it lags on requiring suppliers to meet EHS standards. Many companies advocate the use of “best management practices” but fail to explain how they are implemented. National Semiconductor, for example, has not updated its website in years.

Table 4
California Semiconductor and Component Manufacturers: Environmental Health and Safety Disclosure

Semiconductor Manufacturers	*Advanced Micro Devices*	*Agilent*	*Intel*	*National Semiconductor*
Greenhouse gas Policies	Site-specific statistics, : targets	Company-wide statistics targets under development	Company-wide statistics targets under development	Limited, out-dated statistics, targets under development
Supply chain Management	Risk-based, Supplier selection Process	Suppliers required to meet applicable EHS laws	Environmental content guidelines, supplier EHS report card	Seeks suppliers dedicated to EHS
Hazardous materials/product design	Advanced material review, Energy Star	Lifecycle design, remarketing	Lead reduction program, recycling; energy efficiency measures	Electronic Scrap Information data sheets for all products
Energy/water Conservation	Detailed statistics Targets	Detailed statistics, Energy targets, no water targets	Statistics, targets being developed	Limited, outdated statistics, no specific targets
Overseas disclosure	Site-specific	Company wide	Company wide	Minimal, out-dated
Verification of EHS performance	Third party audit	Internal audit	Internal audit	Internal audit
ISO 14001	All sites certified by 2001	Principle used in internal audits, all sites by 2003	Process in place for company wide compliance	Scotland Facility certified, no goals listed
Best Practice	Commitment in policy	Commitment in policy, uses GRI principles	Commitment in policy	Meet or exceed EHS regs

Component Manufacturers	*Apple*	*Hewlett-Packard*	*Seagate Technologies*	*Solectron*
Greenhouse gas Policies	No information	Company-wide statistics targets under development	No information or statistics	No information or statistics
Supply chain Management	Policy of encouragement, minimal info.	Encourages policy of continuous improvement	No information	No information
Hazardous materials/product design	Energy star, life cycle design, environmental data sheets	Energy star, life cycle design, Environmental data sheets	No information	No information
Energy/water Conservation	Limited information for products	Limited information for products, Statistics available for US facilities**,** targets under development	No information	Minimal information
Overseas disclosure	Limited site specific information, no statistics	Minimal information	No information	No information
Verification of EHS performance	Internal audits	Internal audits	Internal audits	Internal audits
IS0 14001	All sites certified	Company wide compliance	14 facilities certified	19 facilities certified
Best Practice	Commitment in policy	Comply with laws and company objectives	Best in class EHS policy	Meet or exceed EHS regs

In terms of workplace conditions and labor standards, every company has a long-term policy to eliminate workplace injuries and illnesses and comply with all existing laws and regulations. Some companies, such as Intel and Apple, pledge to go beyond existing laws if necessary. Most companies present steady declines in reportable incidents of injury and stress their commitment to educate workers about workplace safety. However, all the companies insist that their manufacturing processes present no risk.

Companies that do not rely on brand recognition are less likely to have stringent policies for their suppliers. For example, Solectron is a self-described "supply chain facilitator" that manufactures products for the biggest consumer electronics companies in the world. Solectron's EHS policies are not nearly as stringent as Agilent's. It is possible that the efficiency gains that drive Solectron's business depend on lower workplace standards in places like China and the flexibility of using "independent" contractors who are not subject to most workplace safety laws even in the US.

Even if a company is in compliance with local laws and has a modern environmental management system, problems may exist that will receive little public attention. For example, the only information on Seagate's website about its Thailand operations are a series of awards that include "Best EHS Committee" from the national government.

An earlier section of this chapter describes the deaths of several workers at a Seagate facility that happened in the early 1990s. Excessive lead and solvent exposure was suspected to be the cause. Following the event was a protracted struggle to improve occupational health and safety laws in Thailand. Because there is no union representation at Seagate's Thailand facilities, it has been a long and inconclusive fight with a government that seems to intentionally maintain low labor standards to attract foreign investment.

Overall, companies tout in their codes a high regard for worker safety in relation to accident and injury. However, there is substantial evidence—especially the reluctance to undertake health studies of worker exposure to toxics—that the industry has yet to come to terms with the "health" part of the EHS equation.

B. Company-Wide Standards: Is "Best Practice" Good Enough?

One way to improve the environmental and social performance of the global IT industry is for leading multinationals to embrace and disseminate "best practice" throughout their global operations. Most large high tech firms take a "no regrets" approach and adopt company-wide standards. For reasons of administrative convenience, training, and creation of a worldwide corporate culture, they generally aspire to implement the same standards in facilities around the world. Thus, even where local law is more permissive, Intel, for example, will use the tougher of California or Arizona air pollution standards in their overseas firms.[96] In other words, in the absence of international standards set by governments, companies adopt their own global standards.

Company-wide standards, however, can suffer in the implementation by overseas subsidiaries. Far from headquarters, subsidiary managers may be driven more by the pressure to perform financially than to uphold good environmental practice. Moreover, even if the same standards are scrupulously applied, the actual environmental and social impacts can be very different in developing countries than in the US.

The differences in context include lack local infrastructure, including emissions monitoring and waste management, as well as effective local enforcement. In our case studies, companies seeking responsible disposal options turned to local waste handlers, who promised to either dispose of the waste safely in country or re-export it to the company's home country. However, many developing countries have no adequate waste disposal facilities, and waste handlers may be unscrupulous.

Not all companies embrace global standards. Some follow local standards or, in the absence of standards, local practice. Even companies who generally claim to have company-wide global standards, however, do not apply them evenly to all environment management issues or in all countries. For example, the Silicon Valley Toxics Coalition has documented that US companies operating in Europe, where legislation on producer take-back is either in place or pending, have more and better take-back programs than they do in the US. In another example, companies do not provide information on toxic risks and pollutants, required in the US under the Toxic Release Inventory, about their overseas operations. In our case studies, the Material Safety Data Sheets required in the US were nowhere in evidence in plants producing for US firms.

Moreover, companies sometimes ignore international standards where they do exist. Long-standing International Labor Organization standards on occupational health and safety, including access to information on workplace risks, are rarely part of company codes of conduct. In our case studies, workers in overseas high tech plants remained largely ignorant about the chemicals in the workplace and their potential risks.

In some cases, global standards may provide inadequate or irrelevant guidance. . For example, ILO Conventions require businesses to respect freedom of association, but the application of this provision has been difficult in countries like Malaysia where gatherings of more than five people without state permission are banned. In effect, companies for the most part simply ignore the dilemma.

C. New Roles for Government: Planning and Benchmarking

The rapid growth of the IT industry in many countries, and its key role within national development strategies, creates a need for new planning and governance structures. A number of the studies noted the wide-ranging and unexpected nature of the environmental and social impacts of locating a burgeoning industry in previously undeveloped and underserved areas.

For example, in Bangalore, India, one of the high tech industry's major demands is for reliable energy. In order to meet the needs of the software and hardware industries, the

government has subsidized firms to buy their own generators while the public grid builds capacity. The generators run on diesel fuel, and their fumes greatly exacerbate local air pollution problems. Similarly, in Taiwan, demand for energy for the high tech industry has led to a massive dam-building program, with tragic effects on river health. These "second-order" effects need to be part of the environmental and social balance sheet for companies.

Even broader effects reveal a need for increased planning for the negative as well as positive effects of industry growth. Silicon Valley famously suffers from "livability" problems: gridlocked traffic, skyrocketing housing prices, and inadequate public services. Little replicas of the Silicon Valley model in high tech clusters around the world reproduce these problems. The public services crunch is often exacerbated because the underlying infrastructure is already deficient, and government is not up to the task of quick and dramatic improvement. In addition, high tech firms are exempted from many local taxes, often as part of the terms of establishment in export zones or industrial parks.

As countries (as well as states within the US) compete for high tech investments, plants obtain sizeable subsidies that shrink the public coffers, and skew decisions about location in environmentally problematic ways. Intel's decision to locate a large semiconductor plant, with its enormous water needs, in arid New Mexico, was largely a result of the tax breaks the state government offered the company. To attract an Intel wafer fabrication plant in the southern city Kiryat Gat, the Israeli government contributed about $600 million of an estimated $1.6 billion investment. [97] In February 2001, the government offered the company a subsidy of $440 million of a total $3.5 billion investment in another fab.[98] The Irish and Costa Rican governments have also exempted their Intel plants from one or more taxes. In India as well, land subsidies are provided to the IT industry in Karnataka and Andhra Pradesh state[99].

At the same time, many high tech companies have made significant contributions to community development in the countries where they operate. While companies may (and do) contribute generously to maintain the local firehouse or symphony, decision-making still shifts from the public to the private sphere. In countries where corruption is rampant and non-governmental groups tend to deliver services more efficiently, this shift may be positive. In other cases it leaves local authorities with few options but to acquiesce to company demands and let potential problems slide.

The ability of local authorities to adequately enforce the laws and protect community health and welfare also suffers where high tech facilities are insulated from application of these laws by concentration in industrial parks (also called industrial estates or export zones). These parks provide water, power, wastewater treatment, security and other services to IT firms. In principle, industrial parks can achieve economies of scale and uniform application of superior environmental, health and safety and labor standards. By creating a critical mass of companies in a given industrial sector, they can also create synergies and linkages that multiply the economic benefits of each firm. However, in practice they have been problematic.

First, these parks are removed from the jurisdiction of the local authorities, so that many laws either do not apply or are enforced directly by park administrators. These administrators are often either private or from export promotion bodies, with little interest or expertise in environmental or social regulations and clear incentives not to discourage potential tenants by overly onerous regulations. As expectations about environmental performance rise, industrial parks are insulated from local communities' increasing demands for performance.

Second, the parks obscure the individual responsibility of each firm for toxic or harmful discharges. In response to problems with water quality, for example, it is much more difficult to pinpoint the problematic discharger in an industrial park setting. The problem is exemplified by Hsinchu Science Industrial Park in Taiwan, where many IT firms share wastewater treatment and local authorities are unable to enforce most environmental laws within the park. In Thailand, administration of environmental laws within industrial estates was originally vested in the Industrial Estate Authority, but over time awareness of the potential conflict of interest involved resulted in the transfer of regulatory authority to the agency in charge of industry environmental compliance generally.

Third, competition among parks within a single country, or among countries, drives standards down. Global operating standards for industrial parks, appropriately enforced, would counter the downward pressure of competition.

Governance issues within the industry itself are also crucial. We have already noted the challenges posed by ever-more complex supply chains. Thus, a workable scheme to oversee and independently verify supplier environmental and social/labor rights performance is a first priority. This would include standardizing minimum supplier requirements, creating technical training and capacity-building resources for small and medium producers both in the US and abroad, and developing both periodic independent monitoring and complaint mechanisms that include significant participation from local and international NGOs. Only then will company reports of superior performance be credible to industry critics.

Another area of concern involves the dissonance between industry claims of social and environmental leadership and the actual positions taken by industry associations, especially in relation to public policy. The American Electronics Association's opposition to European take-back legislation—even as AEA members were touting their end-of-life programs--provides a striking example.[100] The industry's opposition to studies of long-term worker health, while at the same time insisting on the strength of their EHS programs, is another example. The long-term credibility of the industry will require a commitment at the very top of each company to make words and deeds correspond in both voluntary initiatives and public policy stands.

The industry will increasingly face scrutiny of its labor practices. Companies will be asked to put in place systems to manage labor and human rights issues which are as sophisticated as environment management systems. The primary focus of efforts to improve labor—and environmental--standards will be suppliers.

Even if all the links in the global supply chain follow the industry's "best practice," however, current problems involving toxic hazards and energy intensity cannot be eliminated without product redesign. It is unclear how much effort the industry is expending on the redesign that sustainable production will require. For example, nano-technologies or use of biologically based plastics may eliminate the need for metals and fossil fuel based plastics in high tech products. Dematerialization, long-term lease arrangements and other ways of lessening environmental impact are now possible.[101] While companies have toyed with these ideas, it is not clear they have backed them with solid research and development budgets.

Similarly, the industry will eventually have to confront its willingness to make long-term commitments to workers and to local communities, an issue obscured during the 1990s by the industry's phenomenal growth. The recent market volatility will test the industry's commitment to support the communities where it operates in the face of layoffs or slowdowns. As the value of stock options evaporates, long-suppressed issues of wages and overtime are likely to come to the fore.

D. From Pilots to Programs? New Approaches to Regulation

Developed in the 1970s, US federal and state laws set out a framework for regulation of solid and hazardous waste, emissions to air and water, and basic labor standards. Under this regime, the IT industry has reduced its air emissions and contributions to groundwater contamination. Some improvement—it is impossible to tell how much—is undoubtedly due to better process technologies. Some stems simply from changes in the quantity of output or location of manufacturing facilities.

Despite past improvements, the current regulatory framework is ill suited for further improving the environmental or social performance of IT firms. It employs uniform standards for an ever more highly differentiated group of processes and products. It has great difficulty keeping up with the economic restructuring and innovation that characterize the industry and virtually ignores problems related to the industry's increased outsourcing. And risk-based standard setting provides disincentives to chemical manufacturers to provide knowledge.[102]

The continual introduction of new substances, emerging greenhouse gas and energy issues, water use, livability and supply chain management concerns are all largely unregulated by current environmental laws. On the labor side, the current US legal framework provides a series of exemptions and gaps that make it largely irrelevant for many high tech workers. And in both the US and elsewhere, enforcement resources are scarce and cannot adequately police behavior, even in those cases where the legal framework is adequate.

Given these shortcomings, it is not surprising that policymakers, advocates and companies themselves have been experimenting with a "second generation" of environmental protection strategies which rely on facility- and company-wide management systems, combined with publicly set goals and reporting to the public of results. Based on

environmental management systems like EMAS or ISO 14001, they go further in setting substantive benchmarks and have been dubbed "EMS-plus" approaches.[103]

One set of US initiatives involves collecting and comparing the results of pilot projects throughout the country, including some large high tech firms, to see whether and how implementation of an EMS improves actual environmental performance. An EPA initiative called "National Environmental Performance Track" seeks to reward companies that combine implementation of an EMS with superior environmental performance, by providing a higher degree of regulatory flexibility and technical support.[104] A number of states have their own versions of performance track. It is not clear yet how much corporate support such "two-track" strategies will generate and, as importantly, whether government will have the oversight resources available to make them credible.

During the 1990s, a number of US "second generation" initiatives focused on the high tech sector. The Common Sense Initiative brought together stakeholders from industry, government, NGOs and local community groups to focus on improving performance and regulation in six industry sectors, including high tech.[105] The participants came up with an industry-specific set of performance metrics based on the information now required under different laws. They also agreed on a vision statement, which proposes that firms that seek substantial regulatory flexibility—a euphemism for relaxing some regulatory requirements—must demonstrate equally substantial improvements in environmental, health and safety performance beyond what is currently required.

Translating this vision into practice, however, foundered on problems of information: the initiative required non-industry participants to know as much about industry production processes and alternatives as did the industry. Another pilot initiative, Project XL, similarly foundered on disagreements about how to measure performance, from what baseline, as well as on coordination problems among public agencies. The challenge is to build on these efforts at the federal and state levels, while extending them to cover both manufacturers and suppliers based elsewhere. Simple adoption of an EMS, as the Taiwan case study shows, is not enough.

Mandatory Disclosure

The centerpiece of a new approach to regulating the high tech industry is to increase the quality and quantity of information gathered by companies and disclosed to regulators and the public. Disclosure of information on environmental risks and impacts, as well as worker health and safety and labor standards, would work in a myriad of ways to help raise performance. It would prod companies to create better information-gathering and monitoring systems, thus making its practices and impacts more transparent to itself. More information would allow companies to do better planning, including the allocation of research and development funds to improve environmental and social performance in ways that make the most financial sense for the company. It could help to spur efforts at product and process redesign.

Disclosure of information to regulators is crucial in developing integrated, regional sustainability approaches to environmental protection. In Silicon Valley, for example, the

way that companies manage toxic and hazardous materials is central to any attempt to set and achieve benchmarked improvements in environmental protection. State and local governments would not necessarily set specific emissions standards. Rather, they would set broad benchmarks, allowing individual companies flexibility in achieving them. A credible reporting process is key in making this flexible approach work. For communities, more information would help them apply external pressure in ways that are most effective in changing company practice. For investors and consumers, more information could strengthen the market impacts of ethical investing and green shopping.

Given the global nature of the industry, mandatory disclosure requirements should cover not only local but global operations and extend to supply chains. As intimated in an earlier section, the IT sector has made an enormous contribution to the social welfare of Silicon Valley and California in terms of jobs and an innovative, entrepreneurial culture that has become the envy of the world. The costs of IT-led growth—a legacy of toxic water contamination, a rapid influx of people which overloaded public infrastructure and created an acute housing shortage, the explosion of car use and traffic congestion, and shrinking natural space—remain to be grappled with. Given the political will, the region could mobilize its extensive capacities, including a vigorous civil society and many companies working to work towards sustainable communities, to face these issues.

In other parts of the world where these companies operate such as India and Taiwan, the story is not the same. Many of the same problems are emerging without the policies and organizations that are needed to address them. In many developing nations pursuing IT-led growth, worker safety and environmental quality are low priorities to the central government. The role of the company—and of their home governments—therefore increases in ensuring that worker, community and global environmental health does not suffer as a result of their business.

Endnotes

[1] The Basel Action Network and the Silicon Valley Toxics Coalition (2002), "Exporting Harm, The High Tech Trashing of Asia," February 25. Available at http://www.svtc.org/cleancc/index.html.
[2] San Jose Mercury (2000) "Pressure Tactics, Janitors Campaign Seeks to Shame Valley's Big Tech Firms," May 30; San Jose Mercury (1999), "Push Hard on Labor, Safety, Panel is Urged, Legislators Get Earful on Piecework, Temps," March 13; "Two Firms Sued over Overtime Piecework, Electronics Firms Gave Immigrants Inadequate Pay, Unsafe Work, Non-Profits Say," December 15; and "3 Fined in Probe of Piecework Inadequate Pay", December 14. See http://www.bayarea.com/mld/bayarea/archives.
[3] Friends of the Earth and other environmental groups promote binding global environmental, human rights, labor and accountability standards for multinational corporations. See http://www.foei.org/.
[4] Jan Mazurek, (2000) *From Pilots to Programs: Developing a California Environmental Policy Strategy for the Electronics and Computer Industry*, Novation Policy Group, Report to California Global Corporate Accountability Project, Berkeley, California, July, www.nautilus.org/cap/index.html
[5] Compiled from disaggregated industry data on US Bureau of Economic Analysis, http://www.bea.gov/bea/dn2/gpo.htm.
[6] Semiconductor Industry Association (2000) World Semiconductor Trade Statistics. Available at http://www.semichips.org.
[7] Green, Dan (2001), "EMS Industry 2000", *Circuits Assembly.*
[8] Ernst, Dieter (1997) " From Partial to Systemic Globalization: International Production Networks in the Electronics Industry," Berkeley Roundtable on the International Economy (BRIE) Discussion Paper, Berkeley, California, April 1.
[9] Ibid.
[10] Linden, Greg (1998) 'Building Production Networks in Central Europe: The Case of the Electronics Industry'. Berkeley Roundtable on the International Economy (BRIE) Discussion Paper. Berkeley, California, July.
[11] Chowdhury, Neel (2002) "The Tide Turns for Seagate Technology," *Far Eastern Economic Review*, May 2.
[12] New York Times (2001) "City Known for its Silk is Becoming a Center of High Technology in China , May 28.
[13] San Jose Mercury (1999) "Labor Practices to be Probed, State, US, To Look Into Home Assembly," July 1.
[14] As of December 2000. See "Know What You Own", a service of Calvert On Line, http://www.calvertgroup.org
[15] Calvert, "Socially Responsible High Tech Companies: Emerging Issues," http://www.calvertgroup.com/sri_821.html.
[16] See http://www.microsoft.com/presspass/features/2000/oct00/10-18digitaldivide.asp.
[17] As of April, 2002, Santa Clara County had 23 of California's 96 Superfund sites. All but 5 sites were connected directly or indirectly with the production of silicon chips or semiconductors. See http://www.epa.gov/superfund/sites/npl/ca.htm.
[18] Semiconductor Industry Association (http://www.semichips.org/abt_issues_environment.cfm). The phase-out of ODCs was mandated by international treaty and domestic law. Once regulation was imminent, the industry moved quickly, in advance of the regulatory deadlines.
[19] Mazurek, Jan (1999). *Making Microchips, Policy, Globalization, and Economic Restructuring in the Semiconductor Industry*, Cambridge, Massachusetts: MIT Press, p. 53.
[20] See discussion of the high tech sector by Innovest, an environmentally-oriented market analyst. Available at http://www.innovestgroup.com/ind_sec
[21] Silicon Valley Toxics Coalition: "Toxic Hot Spots," Interactive Map created by Clary Meuser Research Associates, http://www.svtc.org/ecomaps/svtc_maps.

[22] Chang, Shenglin, Taiwan Environmental Action Network, (2001) *A Study of the Environmental and Social Aspects of Taiwanese and US Companies in the Hsinchu Science-Based Industrial Park*, report to the California Global Corporate Accountability Project, April, available on http://www.nautilus.org/cap/.

[23] Gopalan, Radha, (2000) *A Study on the Performance of the Indian IT Sector*, report to the California Global Corporate Accountability Project, September, http://www.nautilus.org/cap/; International Institute for Environment and Development (2000), "Stimulating Sustainable Trade, Phase 2, Supply Chain Assessment Case Study of Electronics in India," November, draft, p. 35–41.

[24] Mazurek, Jan (2000), *op cit.* footnote 4.

[25] Gopalan, Radha (2000), *op cit.* footnote 23.

[26] Markoff, John (2002), 'Technology's Toxic Trash Is Sent to Poor Nations," New York Times, February 25.

[27] Environmental Protection Agency (2001) "Electronics: A New Opportunity for Waste Prevention, Reuse and Recycling," June, page 1. Available onhttp://www.epa.gov/epaoswer/osw/topics.htm.

[28] The Basel Action Network and Silicon Valley Toxics Coalition (2002), *o p cit*, footnote 1, page 4.

[29] Ibid.

[30] Environment News Service (2002) "EU Lawmakers Make Producers Responsible for Electroscrap," April, 10. See http://www.ens-news.com/ens/April2002/2002L-04-10.02.html.

[31] Hunter, R., and Lopez-Torres, M. (1999), "Legality Under International Trade Law of Draft Directive on Waste from Electrical and Electronic Equipment", American Electronics Association Europe, Brussels, 17 August.

[32] National Electronics Product Stewardship Initiative See http://www.nepsi.org.

[33] See US EPA's Design for Environment Printed Wiring Board Project, which completed a study in 2001 showing that alternatives to lead solder performed as well or better, at http://www.epa.gov/opptintr/dfe/projects/pwb, and the Global Environmental Coordination Initiative, which is also studying alternatives, at http://www.semi/org/web/wexpositions/nsf. See also company websites.

[34] Mazurek, Jan (1999), *op cit*, footnote 19, page 48.

[35] Interviews in Costa Rica and India with industry and government officials.

[36] Southwest Network for Environmental and Economic Justice and Campaign for Responsible Technology: (1997), *Sacred Waters: Life-Blood of Mother Earth*, p. 71.

[37] Intel (2000), Corporate Environment, Health and Safety Report,

[38] Lovins, Amory; Lovins, Hunter, (2001)'Natural Capitalism', Rocky Mountain Institute: Boulder Colorado, page 3.

[39] STMicroelectronics Annual Environment Report 2000 (*savings is based on per unit of production)

[40] Joseph Romm, (1999) "The Internet Economy and Global Warming," Center for Energy and Climate Solutions, December, http://www.cool-companies.org/energy/cecs.cfm.

[41] LaDou, Joseph (1986), 'Health Issues in the Microelectronic Industry,' *Journal of Occupational Health* 1: 1-11. See also Schenker MB, Gold EB, Beaumont JJ, Eskenazi B, Lasley BL, Hammond SK, McCurdy, SA, Samuels SJ, Saiki CL, Swan SH (1995) "Association of Spontaneous Abortion and Other Reproductive Effects With Work in the Semiconductor Industry," *American Journal of Industrial Medicine*, (6), pp. 639-660.

[42] Exposes of health risks in the high tech industry include Fisher, Jim (2001) 'Poison Valley', August, Salon.com (http://www.salon.com); Cook Christopher D and Thompson, A. Clay (2000) 'Silicon Hell', S. F. Bay Guardian, April 26-May 2, 34(30).

[43] LaDou, Joseph; Romm, Timothy (1998) "The International Electronics Industry", *International Journal of Occupational and Environmental Health*, Vol. 4 No 1, January-March (courtesy of www.svtc.org)

[44] Chen, Helen Y. (1997) "The Use of Lead in Printed Circuit Board Assembly: A Look at Exposures, Monitoring, and Hazard Communication." Energy and Resources Group, U.C. Berkeley, May.

[45] Ibid.

[46] Taipei Times (2001), "Former Employees of RCA Appealing to Lawmakers Over Cancer Compensation," July 20. Available on http://www.coolloud.org/coolindex.html.

[47] Fisher, Jim (2001) 'Poison Valley', August. Available at http://www.salon.com.
[48] Ibid
[49] The full study is available at http://www.hse.gov.uk/statistics/nsukrupt.pdf.
[50] Norr, Henry (2002), " Chip industry to consider health study," San Francisco Chronicle, March 20.
[51] San Jose Mercury News (2002), "Chip makers must do toxic chemical studies, not just consider them," Opinion, March 22.
[52] [52] E.g. Hossfeld, Karen (1999) "Why Aren't High tech Workers Organized?" in D. Cornford, ed., Working People of California (UC Press: Berkeley, CA); Rana, Shruti (2000) "Fulfilling Technology's Promise: Enforcing the Rights of Women Caught in the Global High Tech Underclass, *Berkeley Women's Law Journal*, 15, 272.
[53] Gopalan, Radha (2000), *op cit*, footnote 23.
[54] Roht-Arriaza, Naomi (2000). On site research in Costa Rica.
[55] Compa, Lance (2000) *Unfair Advantage: Workers Freedom of Association in the United States Under International Human Rights Standards*, Human Rights Watch, available on http://www.hrw.org/2000/Uslabor/USLBR008.htm.
[56] Jayadev, Raj (2001) "Winning and Losing Workplace Safety on Silicon Valley's Assembly Line," Pacific New Service, available on http://www.igc.org/svtc/listserv/letter81.htm.
[57] Rana, Shruti (2000), *op cit*, footnote 52.
[58] Hossfeld, Karen (1990) "'Their Logic Against Them': Contradictions in Sex, Race and Class in Silicon Valley," in Katherine Ward, ed. *Women Workers and Global Restructuring*, ILR Press.
[59] Ward, Jacob (1999) "Toward a more diverse high tech workforce," March 11, www.CNN.com.
[60] Holmes, Charles W (2000) "Minority Gap in High Tech," *The Arizona Republic*, July 23, www. Azcentral.com.
[61] Silicon Valley Toxics Coalition (2000), Clean Computer Report Card," http://www.svtc.org/cleancc/pubs/2000report.html.
[62] Copies of the full case studies are available on line at the Nautilus Institute for Security and Sustainable Development, http://www.nautilus.org/cap. Hard copies are available upon request from the Nautilus Institute, 125 University Ave, Berkeley CA 94710.
[63] A list of the organizations interviewed is provided in the full case study reports on http://www.nautilus.org/cap.
[64] Taipei Times (2001). "Former RCA Workers Protest Cancer Deaths," March 31.
[65] Between 1990 and 1994, IT companies only paid 1.4per cent of their sales profit to the Department of Finance, compared to 15per cent by the top 100 manufacturing industries, and 20per cent by small businesses.
[66] Chang, Shenglin, Taiwan Environmental Action Network, (2000), *op cit*, footnote 22, page 27.
[67] Chowdhury, Neel (2002). "The Tide Turns for Seagate Technology," *Far Eastern Economic Review*, May 2.
[68] Dr. Orapan recently received the American Public Health Association's "International Award of Occupational Health and Safety," Bangkok Post, October 18, 2001.
[69] Foran, Tira (2000) 'Corporate Social Responsible at Nine Multinational Electronic Firms in Thailand' Report to the California Global Corporate Accountability Project, http://www.nautilus.org/cap/ page 19.
[70] Ibid. Page 13.
[71] Gopalan, Radha (2000), *op cit.* footnote 23.
[72] Asian Development Bank, *Asian Development Outlook: 2001 Update, Malaysia*, http://www.adb.org/Documents/Books/ADO/2001/Update/mal_update.asp
[73] Wangel, Arne (2001), *Manufacturing Growth With Social Deficits, Environmental and Labor Issues in the High Tech Industry in Penang, Malaysia,* report to California Global Corporate Accountability Project, October, http://www.nautilus.org/cap/reports/index.html.
[74] Far Eastern Economic Review (2001), April 12.

[75] Lim, Hank (2002) "Investment and Development in Asia:: Debate Revisited," paper to the International Sustainable and Ethical Investment Rules Project, draft, April, Nautilus Institute for Security and Sustainable Development, Berkeley, California.
[76] Fold, N. & Wangel, A. (1997) The wage-labour nexus in Malaysia's industrial development., in Schmidt, Johannes D.; Hersh, Jacques & Fold, Niels (eds.) 1997. *Social Change in Southeast Asia.* Harlow: Addison Wesley Longman; and Fold, N. & Wangel, A. (1998). Sustained growth but non-sustainable urbanisation in Penang, Malaysia, *Third World Planning Review* 20:2 (May), 165-177.
[77] Arunasalam P. (2000) *The power of unions against companies that do not have a proper safety & health management system - the Malaysian experience.* Paper presented at the Theme Conference "The Impact of Globalization on Occupational Health, Safety and Environment" 6-7 December 2000, Asian Trade Union Institute for Occupational Health, Safety and Environment (OHSE), Bangkok, Thailand.
[78] Jomo K.S. and Lee Hwok Aun (2001) *Social impacts*. in: Jomo K.S. (ed.) 2001. *Malaysian Eclipse. Economic Crisis and Recovery*. London: Zed Books.
[79] Roht-Arriaza (2000), "Report of a Visit to Costa Rica," Nautilus Institute, unpublished, July.
[80] Sylvester, David , (2001) "High tech recession isn't built to last," www.siliconvalley.com, May 19.
[81] Miranda Ewell & K. Oahn Ha (1999) "High-Tech's Hidden Labor Outside the Eyes of the Law: Silicon Valley Companies Pay Asian Immigrants by the Piece to Assemble Parts at Home," *San Jose Mercury News*, June 27.
[82] K. Oanh Ha (2000) "Piecework Lawsuit Settled," *San Jose Mercury News,"* November 13.
[83] U.S. Code, volume 29, Annotated, section 213(17a).
[84] Cohen, Stephen; Fields, Gary (1998) "Social Capital and Social Gains, or Virtual Bowling in Silicon Valley," WP 132, Berekley Roundtable on the International Economy, Berkeley, California, September.
[85] Putnam, Robert (2001), *Bowling Alone, The Collapse and Revival of American Community,* Touchstone Books.
[86]Koch, Miller, Walesh and Brown (2001) "Building Community: Social Connections and Civic Involvement in Silicon Valley," Santa Clara University and Collaborative Economics, February 27.
[87] Silicon Valley Environmental Partnership, "Taking the Pulse of Silicon Valley's Environment, 1999 Environmental Index," http://www.www.mapcruzin.coom/svep.
[88].San Francisco Business Times (2001) "Bay Area Traffic Congestion Worsens," May 7.
[89] Garber, Andrew (2001), "Telecommuting Fails to Fulfill High Hopes," *Seattle Times*, September 1.
[90] Walesh, Kim and Henton, Doug (2001) 'The Creative Community: Leveraging Creativity and Cultural Participation for Silicon Valley's Economic and Civic Future," Collaborative Economics, February, http:www.coecon.con?publications.html.
[91] Silicon Valley Environmental Partnership (1999), "Taking the Pulse of Silicon Valley's Environment, 1999 Environmental Index," http://www.mapcruzin.com/svep/.
[92] See http://www.bayareaalliance.org/draftcompact.html
[93] See http://www.nrdc.org/greengate/about.html.
[94] Mazurek, Jan (2000), *op cit.*, footnote 4.
[95] See Morrison, Jason, Kao Cushing, Katherine, Day, Zoe and Speir, Jerry (2000), "Managing a Better Environment: Opportunities and Obstacles for ISO 14,001 in Public Policy and Commerce," Pacific Institute for Studies in Security and Sustainability , March, http://www.pacinst.org/environ.html.
[96] Roht-Arriaza, Naomi (2000), Interview with Intel EHS Personnel, San Jose, Costa Rica, July 6.
[97] EE Times (2000) "Intel Considers Israeli Expansion," May 3, http://www.eetimes.com/story/OEG20000503S0033.
[98] Semiconductor Business News (2001) "Israel ready to grant Intel subsidies for new wafer fab," http://www.siliconstrategies.com/story/OEG20010205S0045.
[99] Gopalan, Radha, (2000) *op cit*, footnote 23.
[100] Hunter, R., and Lopez-Torres, M. (1999), "Legality Under International Trade Law of Draft Directive on Waste from Electrical and Electronic Equipment", American Electronics Association Europe, Brussels, 17 August.
[101] See for example "Rolltronics Corporation Produces First Thin Film Transistor in Roll-to-Roll," October 21, 2001, http://www.rolltronics.com.

[102] Roe, David (2002), "Ready or Not: The Coming Wave of Toxic Chemicals," *Environmental Law Quarterly*, forthcoming, 29.3.
[103] See Maurek, Jan (2000) op cit. See also the work of the MultiState Working Group on ISO 14,000, which has been looking at the use of "EMS-plus" approaches in public policy. Available at http://www.iwrc.org/mswg.
[104] Environmental Protection Agency, http://www.epa.gov/performancetrack/.
[105] Mazurek, Jan (1999), *op cit.*, footnote 19, pages 151-165.