ENVIRONMENTALLY CONSCIOUS TECHNOLOGIES

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INTRODUCTION

The global concern over environmental and health issues has resulted in a "Pull" from consumers for "GREEN" technology and products and a "Push" from regulatory agencies both at the national and international level. This will increasingly affect the computer industry by impacting the manufacturing and design of products, their technology development, and marketing *strategies*[1,2]. This drive to reduce pollution and toxic waste has resulted in burgeoning laws and regulations[3], labelling requirements, and product "take back" programs, all of which affect every step in the life cycle of computer products and may affect the competitiveness of the electronics industry by increasing costs and imposing international trade barriers. The following activities are now in progress.

- ISO and IEC (International Electrotechnical Commission) Guides for standards writers are in preparation so that future standards will incorporate environmentally desirable attributes. The IEC Guide, to be published this year, is specific to the electronics industry and makes recommendations on environmentally desirable design features.
- ISO 14000 standards are in preparation that are analagous to ISO 9000 standards in requirements and burden. They are expected to create shared environmental expectations among firms engaged in international trade.
- Environmental Labelling Standards are under development in ISO, Germany, and the European Union. Under the Blue Angel program, Germany is in the final stages of its labelling standard for computer workstations. ISO is beginning to elaborate environmental labelling standards, targeted for 1996, that are expected to have a broad impact on national labelling programs as well as on the use of environmental criteria in international trade.

The electronics industry, while not the worst contributor to hazardous waste, must respond to this push from regulatory pressure and pull from consumer desire for "green" products. This results in two major trends. First, there is a shift from "end-of-pipe" solutions such as waste disposal and remediation[4] to new emphasis on "design for the environment" where the focus will be to reduce/eliminate toxic hazards in our products and manufacturing facilities; reuse parts and materials and recycle electronic parts to address the concerns of diminishing landfills and buried waste hazards. In Germany this year, personal computers were among the most voluminous returns (33M lbs. in 1995- 5-10% of potential) , and IBM took back 27M lbs. of equipment In the US and Europe, color displays must be buried in hazardous waste landfill. This drives the need to develop environmentally conscious technologies, and it is estimated that the world market for these technologies will double to $300B over the next decade[5]. To address these needs there is increasing focus world-wide on research and development in the area of environmental technology in academia, and industrial research and national laboratories. In the United States there is $\simeq$ $5B environment related government R&D funding fragmented among 13 different agencies with little cohesive strategy. The National Laboratories, have redirected $\simeq$25% of their budgets to address these issues and consortia such as in 1993 Sematech and MCC both had dedicated funding for environmental research. U.S. industries are increasing research activities, but are acting individually rather than cooperatively. Academia is quickly responding with new programs and research in the environmental area.

As opposed to the fragmented U.S. environmental efforts, the European community is fostering a cooperative approach between industry and government. In 1993, EUREKA, a multi-industry/government R&D program had 21 members, 117 environmental projects, and a $1.2B budget. The United Kingdom, through its Center for the Exploitation of Science and Technology (CEST) has formed a working group to study the recycling options for used electronic equipment.

Japan is also aggressively pursuing opportunities in environmental technology and R&D in this area is supported by major companies and MITI. Japan's leading environmental institution, established in 1990 with a budget of $128M , is the Research Institute of Innovative Technology of the Earth (RITE). Hitachi Research Laboratories, Sony, and Sanyo have all focused activities in "Green Centers." This year $160M was dedicated to support the adaptation of Japanese technology to Asian markets. Also, adaptation of new technologies is encouraged by providing a 6% tax exemption for environmentally associated R&D., and low interest loans.

The computer industry has increased their activities in R&D to address the environmental challenges of the future, and this paper will present some on-going activities at IBM.

R&D INITIATIVES

Many computer companies, including Hewlett-Packard, DEC, Sun, Motorola, AT&T, Siemans, Xerox and Hughes have environmental initiatives which provide guidance, support R & D, and assure compliance. As a high volume electronics manufacturer, IBM produces as much as 1B lbs/yr of hardware. In 1991, IBM initiated a corporate function to provide world-wide guidance on environmental regulations, health and safety product requirements, and information on technology development to the manufacturing units, which are increasing their emphasis on developing products with environmental attributes. In 1993, IBM eliminated glycol ether solvents, found to be teratogens, from all manufacturing sites, and all CFC's. Converting CFC usage to water based solutions, resulted in a cost savings of $3M at one site alone. Last year IBM established a business to dismantle, salvage, and reutilize IBM, as well as non-IBM parts. There are increasing efforts in the manufacturing of computer products to optimize/eliminate the solvents and gases used in manufacturing that are ozone depleting, lead to global warming, are health hazards in manufacturing processes or contribute to the toxic waste stream. There is also a need to to conserve resources such as the amount of water used in the manufacturing of silicon chips. Also, the need to reduce energy consumption in the operation and manufacturing of our products has resulted in extensive activity to develop energy-efficient low-power products. There are efforts to utilize recycled/renewable resources in our products, and increasing efforts to design for ease of disassembly to enable the recovery and recycling of value-add products. This places an increasing demand for information technology to access databases for life cycle analysis, optimize design choices, manage process chemicals, and track compliance to regulations.

Printed wiring boards shown in Fig. 1, are currently a $25B world-wide industry. They are produced in high volume and are in all electronic products ranging from electronic appliances and games, to computers, automotive and aerospace applications. In the fabrication of printed wiring boards (PWB's) high volumes of solvents are required and 1MegW heat and 220KW of electrical power is consumed. They also utilize high volumes of oil-based resins, and require lead solder to assemble chip components on the circuit boards. While the electronic industry is not a high lead user, it still consumes 50M lbs. of lead/yr. Also printed wiring boards are not recycled because the removal of soldered subassemblies is costly and advanced chip designs require new printed wiring boards to be competitive. These boards are incinerated using high cost scrubbers, and the residual ash (30% by weight of the PWB) must be buried in hazardous waste landfill due to lead content. This presentation will describe new research efforts to address these concerns, and emphasize the importance of joint efforts between government, industry and academia to meet the challenges and opportunities presented by increasing world-wide environmental concerns.

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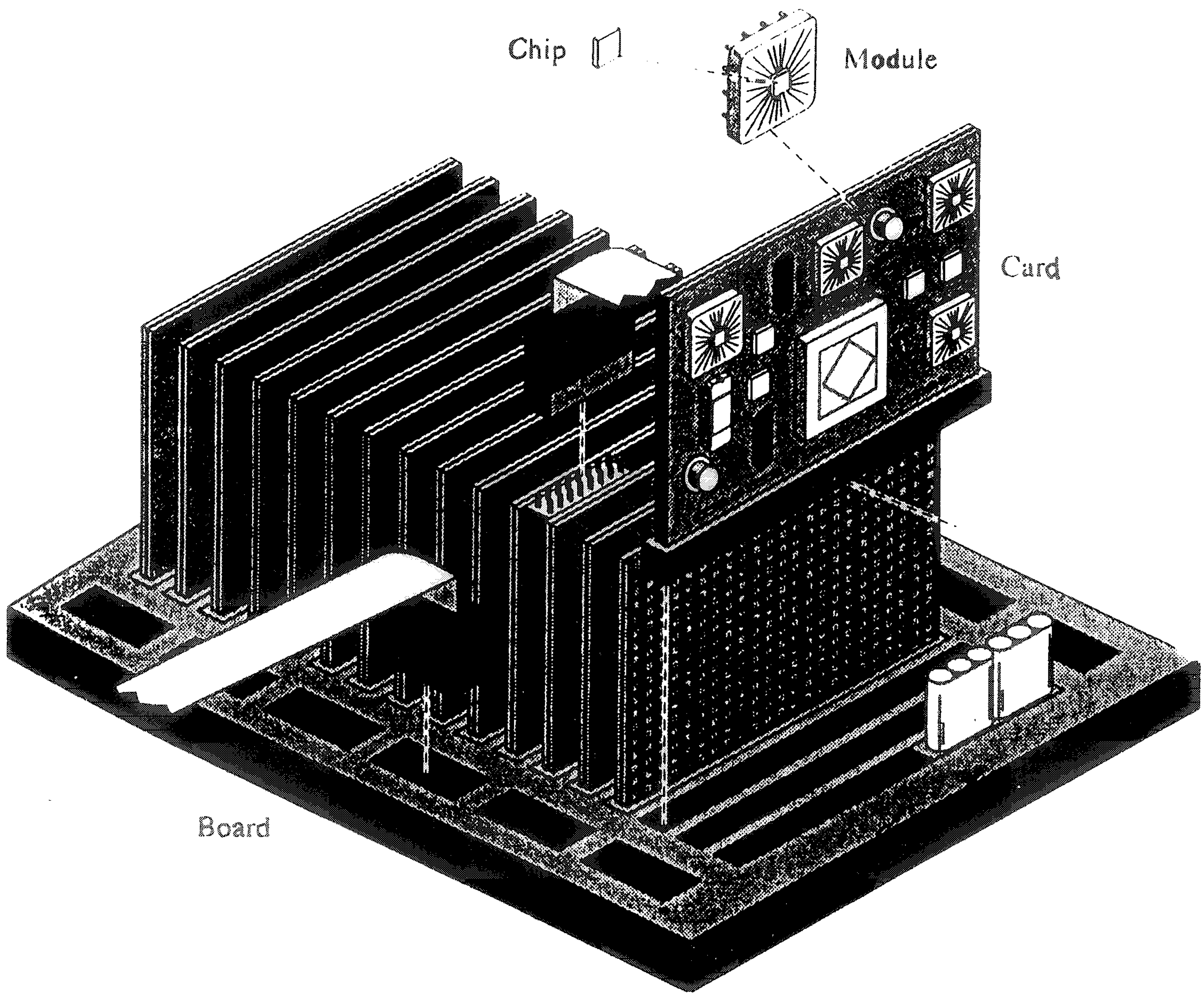

FIGURE 1