FOIA Number: 2008-1524-F

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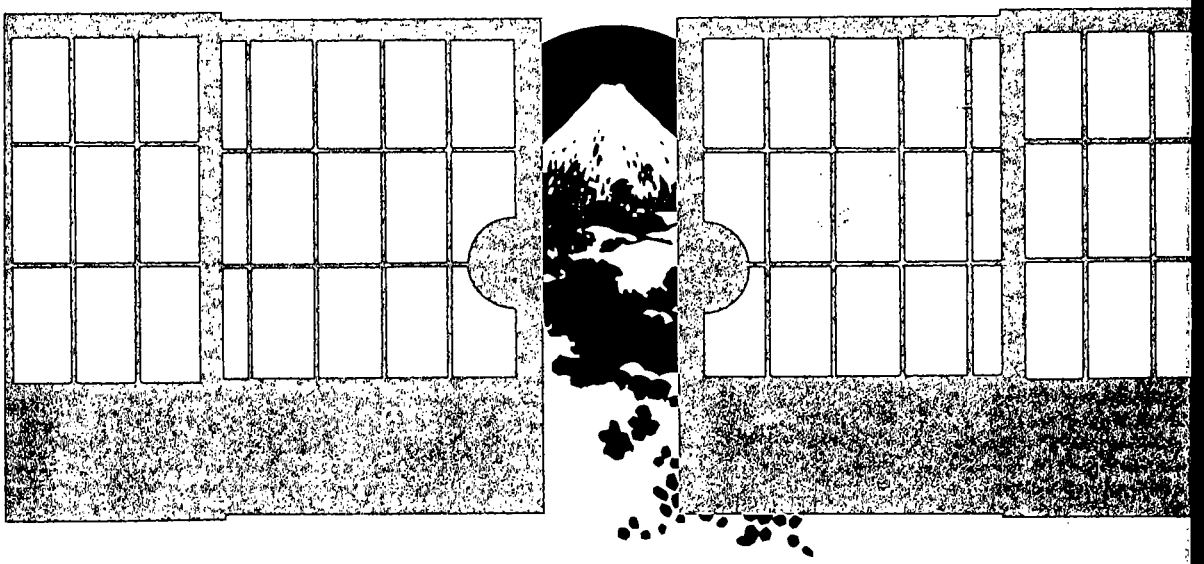
CRACKING THE JAPANESE MARKET

STRATEGIES FOR SUCCESS IN THE NEW GLOBAL ECONOMY



JAMES C. MORGAN &
J. JEFFREY MORGAN

MICRO TECH 2000 HIGHLIGHTS

By the year 2000, single semiconductor chips will contain over a billion transistors, and will be able to do more than many of today's complete computer systems. By the end of the decade, semiconductor technology will enable a new generation of products to improve communications, expand information services, raise the productivity of factories and provide near-instant access to knowledge archives around the world. Advanced semiconductor technology will not come without greatly increased costs, however. In ten years, factories capable of building the most advanced chips are expected to cost between $1.5 and $2 billion, and the development costs for the equipment and processes the factories use will cost additional billions of dollars. Only about ten of these advanced manufacturing lines will be required to satisfy the world's expanding demand for state-of-the-art semiconductors. Given the current geographic distribution of semiconductor market share, less than five of these factories are expected to be in the United States, including those owned by large captive chip producers.

The semiconductor industry is entering an era where no single company has the financial resources to develop all of the manufacturing processes and equipment, and build the factories needed to process chips at the end of the decade. Few companies will be able to capture enough of the world semiconductor market to afford even a single manufacturing facility for their own exclusive use. These enormous financial demands, coupled with major technical risks associated with developing the technology throughout the next ten years, will force a new culture of cooperation and sharing within the U.S. and the world semiconductor industry. Despite its history of independent, entrepreneurial firms and fierce competition, the U.S. semiconductor industry has begun to realize the importance of cooperation. The evidence can be seen in SEMATECH, the industry and government supported consortium to develop improved manufacturing technology, and in numerous technology development alliances that have been established on a worldwide basis over the past five years. These first steps are not adequate to meet the challenges of the next ten years, however.

Micro Tech 2000 Goals and Proposed Action Plan

The goal of the proposed Micro Tech 2000 initiative is ambitious—to assure U.S. preeminence in semiconductor markets by accelerating the pace of technology development through the year 2000. Successful completion of the technology roadmap would provide the U.S. industry with the manufacturing capability to produce chips with 0.15 μm features (normally associated with 4 Gbit DRAMs or 1 Gbit SRAMs) by the end of the decade—three years ahead of the pace predicted by past progress in semiconductor technology. Through this acceleration, the U.S. semiconductor industry could supply a broad mix of advanced chips to electronics systems makers to give them a distinct advantage in the world market.

To accomplish its goal, the Micro Tech 2000 initiative would have to accelerate all aspects of semiconductor technology, including manufacturing equipment, materials, computer aided design and simulation, economic modeling of manufacturing lines and markets, packaging, and testing. In order to be affordable, the program could not be financed with incremental spending. Instead, it would have to concentrate on coordinating and focusing the substantial resources that are already spent on semiconductor technology development by industry, government and academia. In order to convince prospective participants to share their human and financial resources, the initiative would have to design a program that provided real, measurable benefits throughout the next ten years.

Benefits of the Micro Tech 2000 Initiative

The ultimate benefit of the Micro Tech 2000 initiative would be to provide the foundation that will insure a growing, robust electronics industry in the United States. The electronics industry is already the largest employer in the Nation, and a continued prosperous industry will provide many opportunities for growth in the coming years. In addition, Micro Tech 2000 could provide a number of other important benefits to the Nation as it accomplishes its goals. A successful initiative would:

- Focus the numerous disjointed efforts to advance semiconductor technology that exist throughout the U.S. in industry, federal laboratories and agencies, and the universities.

- Reduce the risks facing smaller, independent firms as they try to keep pace with increasing development costs, and expanding technology options.

- Revitalization of the semiconductor materials and equipment industry through investments in advanced equipment design and materials development.

- Provide an opportunity for U.S. chip firms and electronics systems makers to regain international market share due to the earlier introduction of new generations of semiconductor technology.

Major Issues Identified at the Micro Tech 2000 Workshop

In order to accelerate the pace of semiconductor technology development, and to insure that it can be applied to high-volume manufacturing cost effectively, the semiconductor technology initiative will have to address many technical hurdles simultaneously . The ninety semiconductor industry experts who assembled for the Micro Tech 2000 workshop held in North Carolina in April began the process of identifying the most critical problems, and determining where additional efforts are needed. The group concluded that, while there are many unknowns and difficult problems to be solved, there are no fundamental obstacles that are likely to prevent the continued rapid pace of semiconductor technology advancement. In order to achieve engineering prototypes of a manufacturable 0.15 μm feature size process in the year 2000, the following issues must be addressed:

- An experimental lithography capability that can print features of 0.25 to 0.15 μm will be required in 1994, in sufficient volumes to allow process and manufacturing equipment development. This need may require new electron beam mask or direct wafer writing tools, or a capability in advanced phase-shift optical lithography. There are several competing lithography systems for volume manufacturing of semiconductor chips of the year 2000. Research and development for several alternatives will have to be supported for the next few years to determine which system is best suited for production.

- Semiconductor equipment and process developers will require a source of large diameter (300 mm) wafers by the middle of the decade. If the initiative is successful, wafer manufacturers will have to accelerate their own development schedules, but currently there are no U.S.-owned suppliers.

- The priority of advanced metrology will have to be increased. By the end of the decade, semiconductor manufacturing processes will require control at levels that we do not yet know how to measure. For example, ultra-clean manufacturing areas will require control of particles as small as 0.03 microns, yet, at present, we do not know how to measure or characterize these particles. Impurities in materials will also be hard to measure, with liquids requiring impurity levels at approximately 5 parts per trillion.

- The interaction of computer simulation with equipment and process development will be critical. Improved sensor technology for in-situ measurements and additional physically-based modeling is urgently required. Three dimensional models that take into account phyical effects that have previously been considered second-order must be developed to replace two dimensional models.

- A 1 Gbit SRAM will require a chip area of approximately 10 cm^2, even if each cell occupies only 0.5 μm^2. Logic devices of 5 – 7 cm^2 will incorporate a "system on a chip". These chip sizes will drive all features (and spaces) toward 0.1 to 0.12 μm, with tolerances of approximately 10 percent. In this technology, the finished feature sizes will be less than today's dimensional tolerances.

- Continuing trends toward increased process complexity will put increased emphasis on solving problems of multilayer structures (including interconnect and active devices), planarization (especially with high aspect ratio spaces, vias, and contacts), and the study of new materials. The increasing number of process steps and the expected 30 to 35 mask steps will also demand improved equipment throughput and reliability, as well as substantial defect density reductions.

- Greatly advanced computer integrated manufacturing will be essential to provide acceptable process margins. Real-time in-process controls will be necessary, since manufacturers will no longer be able to afford to wait until the end of the manufacturing cycle to measure results.

Next Steps

The Micro Tech 2000 workshop has provided the National Advisory Committee on Semiconductors with a draft report describing the major issues that will have to be addressed in order to make the U.S. semiconductor industry a world leader in advanced technology at the end of the decade. Over the next few months NACS will review the major findings of the the report and discuss its implications with the various stakeholders within the semiconductor industry, the government, and academia.