

TECHNOLOGY

Chip Firms Face Technological Hurdles That May Curb Growth, Report Suggests

By DEAN TAKAHASHI
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SAN JOSE, Calif. — Makers of semiconductor chips face fundamental technological barriers that could test their ability to innovate and grow at historic rates, the

industry's trade association concludes in a 15-year forecast.

The Semiconductor Industry Association is issuing a 196-page technology "road map" today that predicts impressive improvements for the chips used in computers, consumer and communications devices. But keeping the \$150 billion-a-year industry humming may require companies and government to pour an additional \$1 billion dollars into basic research and development, said Owen Williams, a vice president at Motorola Inc. and chairman of the association's technology committee.

Drawing on contributions from more than 600 chip experts, the group found that innovation in the industry has accelerated since its last technology report in 1994. Companies are developing new chip generations every two years instead of every three. One consequence is that conventional manufacturing techniques may reach their limits faster than expected, said James Glaze, an SIA vice president.

For example, the report predicts that chip makers will exhaust conventional lithography, the process of printing circuit designs on silicon wafers, as early as 2006. Right now, the smallest features on chips that companies can efficiently create are 0.25 microns in width, or 1/400th as wide as a human hair. At the current rate of progress, the industry by 2006 will be approaching features that are 0.1 microns wide, beyond the reach of existing lithography tools.

'The Most Pressing Problem'

So far, there are four or five possible ways to make chips with such small features, but none of them is economical. "That is probably the most pressing problem facing us," Mr. Glaze said.

Chip makers have sailed past gloomy predictions before, finding new ways to extend the lives of conventional production processes and materials. This time, however, some researchers feel that the physics associated with ever-shrinking dimensions will require more radical solutions. In addition, any replacement technologies must not only work but be cost-effective; factory costs are already rising about 20% per year, posing a significant financial challenge to companies, Mr. Glaze said.

Factories that can produce 0.25-micron chips now cost \$2 billion, while the previous generation cost only \$1.3 billion. In five to 10 years, it's easy to envision \$4 billion factories, said Dan Hutcheson, president of VLSI Research, a market researcher in San Jose. Industry giants such as Intel Corp. can afford such huge sums, but the trend could pose hardships for smaller chip manufacturers in the U.S. and Asia.

The industry will have a tough time designing chips of the coming complexity, as well as testing them for defects. By 2012, a contaminant dust particle as small as 15 nanometers, or 1/700th the size of a human hair, could be enough to cripple a chip. Chip makers also will need to adopt new materials, the report found. International Business Machines Corp., for example, has proposed replacing aluminum with copper in chips to speed the flow of electrons through wiring.

Emphasizing Research

To deal with the research challenge, the chip industry has formed consortia to work on specific problems as well as contributed tens of millions of dollars for university research. The industry is still lobbying to get a greater share of federal research spending.

Despite the many challenges, SIA officials said they were optimistic that chip makers can find ways to stay on track with

Moore's Law, the observation by Intel Chairman Emeritus Gordon Moore that chip performance roughly doubles every 18 months while costs stay constant.

By 2012, the SIA's experts concluded, manufacturers should be able to put 1.4 billion transistors on a thumbnail-size microprocessor, which will operate at a speed of 2,700 megahertz. Memory chips will hold as much as 275 billion bits of data. By contrast, Intel's current Pentium II microprocessors have 7.5 million transistors and run at 300 megahertz, while the most popular memory chips only store about 16 million bits of data.

Rep of Corp. Motorola

Miss being obsolete

What are the implications of this??

Southeast Pursues Chip Makers

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period. So they are readying themselves to catch the wave.

"These plants are an order of magnitude greater than an auto plant," says Georgia's Mr. Todd. "I think everyone realizes our chance to become a part of this industry is now."

How intense could the competition get?

"A look at Delaware, on the far reaches of the region, could be a good indication. In the last six months, Delaware officials have raised \$500,000 in state and private money to pursue the industry."

One of the state's best sites, located in Middletown, has been zoned for semiconductor use only. Moreover, responding to the industry's complaints about the region's lack of a trained labor force, the state recently initiated a community college degree program in semiconductor fabrication, all without a single semiconductor plant in the state. State officials admit they are making a big wager they will land the industry.

"We are the only state in the country that has such a program but doesn't have a plant," says Mr. Riley, Delaware's chief recruiter. "We are determined to catch this wave."

Delaware