Does Moore's Law Still Hold Up?

By Jeff Dorsch

Moore's Law shows up in countless PowerPoint presentations by corporate marketing departments, and it is cited endlessly in news articles and features on the chip business, but is it still relevant or has it turned
into technical lip service?

Moore's Law is less of a law than an observation on semiconductor technology. It was first laid out in an article for Electronics magazine in 1965. Its central point – that the number of transistors on an integrated circuit would double, on average, about every 12 months – was initially predicted to hold true for the next decade, through 1975. Gordon Moore's now-famous postulation has endured for 36 years, outlasting Electronics magazine itself.

Moore's Law is widely respected, sure. But is it used as a significant metric for strategic business plans? Is anyone building their new company around it?

"Moore's Law is self-perpetuating," says Daniel Grupp, manager of advanced device development at Acorn Technologies and a visiting scholar at Stanford University's Center for Integrated Systems. "It is relevant, and continues to be, because the whole cycle of design, development, manufacture, distribution and sales is known to be sustainable if we follow Moore's Law.

"If we beat Moore's Law, the market cannot absorb the new products, and engineers lose their jobs. If we slip behind Moore's Law, there is nothing to buy, and the distribution chain withers. For example, in planning the development strategy at Acorn Technologies, we carefully track Moore's Law to time the introduction of our devices."

Thirty-six years ago, Grupp states, "Moore's Law was merely an observation. Now, we in the industry enforce the law. It has become a business dictum."

He adds, "Moore's Law will continue beyond our lifetimes into the new millennium."

Joe G. Xi, vice president of products and marketing at Plato Design Systems, says, "Moore's Law is still in effect. If you are a leading-edge semiconductor company, you definitely have to observe Moore's Law – not Moore's Law per se, but the migration of the process technologies."

The dictum of 2x transistors every 18 months (as the amended Moore's Law has it) "may not be as accurate (now) as it was five or six years ago," Xi adds. "Does the product that

people develop reflect whether they have considered Moore's Law? Usually, they have not."

Analog IC companies are the ones that must answer more directly to Moore's Law, according to Xi.

"In general, Moore's Law is still correct," he concludes.

Jodi Shelton, executive director of the Fabless Semiconductor Association, says, "Moore's Law ends up being pretty accurate. Look how quickly we've moved from 0.18-micron (device features) to 0.13 micron; it's amazing."

Prem Jain, chief technology officer for Cynergy System Design (formerly CAE Plus), says, "Historically, IC design time has not been the bottleneck in the semiconductor industry; the electronic industry growth rate has been primarily driven by the rate of advances in manufacturing capabilities. The EDA industry has provided the tools to improve the design productivity, but the advances in EDA technology have been lagging behind, at least by a factor of two, the growth rate predicted by Moore's Law.

"This lack of design productivity improvements has now come to the level that Dataquest predicts that semiconductor industry growth rate will be primarily driven by IC design productivity. Dataquest predicts that if the system-level design tools are not in the mainstream by 2004, which is highly unlikely, then the chip industry cannot take advantage of the available transistor capacity. Even if the manufacturing processes follow Moore's Law, the consumers will not see the same growth rate in the electronic systems as seen in last three decades."

Tygo Ebenhahn, a young design engineer two years out of college, says his EE professors never mentioned Moore's Law. "I learned about Moore's Law when I was doing a paper on Intel in a writing class," he reports.

While asserting that Moore's Law is still relevant today, Ebenhahn says, "Moore's Law does not directly drive chip design. An IC group will most likely not consider Moore's Law when designing a chip because they are limited by today's technologies. They can't design with a process that doesn't exist yet. So on one hand you could try to make the argument that Moore's Law is not relevant when you are looking at a single chip."

On the other hand, Ebenhahn adds, "Moore's Law does come into play with forecasts or at anytime someone is thinking about their particular device in the future. If a new process to develop smaller ICs (is) developed every 18 months, it is not hard to see your current design as being obsolete in three years. So, Moore's Law does very much affect design cycles.

“As soon as a company puts out a product, they turn right around and start to redesign partially to take advantage of new technologies. Sometimes there are instances where something isn't feasible today, but it could be down the road, if Moore's Law continues to be upheld. The smaller processes help to make advances not only in the CPU world, (but also) portable, low-power products like cell phones, digital cameras, etc. This allows constant turnovers and the ability for the electronics
industry to put out an upgraded product every year. It is definitely is the interest of the electronics industry to make sure Moore's Law remains unbroken.”

Robert O’Dell, vice president of marketing at Wintegra, observes, “What drives Moore’s Law is the ability of the fabs to product silicon that is smaller.” Suppliers of wafer fabrication equipment, he notes, “plan on Moore’s Law; they are producing equipment and solving physics problems.”

Still, he adds, “I always wonder if it’s a self-fulfilling prophecy.”

Moore’s Law is relevant and important these days, according to the marketing executive; “it anchors what’s given in a period of time,” he says.

The number of transistors on a given IC may be doubling every 12-18 months, but there are other considerations that are leaving Moore’s Law behind, O’Dell states. Communications bandwidths, especially in the optical component space, “can’t wait around for Moore’s Law,” he notes. “No one has built an all-optical switch that works. Something has to give; you have to put more silicon down.”

At the same time, “I/O is not scaling as fast as Moore’s Law,” O’Dell says.

There are those who are skeptics, or even cynics, on the continued viability of Moore’s Law. Ted Mittelstaedt, a columnist for Computer Bits magazine, wrote in 1999: “Gordon Moore, one of Intel's founders, formulated a ‘law’ that states that semiconductor device complexity doubles approximately every 18 months. Unfortunately, this caught the public's fancy and has been repeated by just about every dumb fool that has had anything to say about it.

“Largely forgotten is that Moore, in an attempt to keep his ‘law’ effective, formulated Moore's Second Law, which says that facility costs increase on a semi-log scale. In other words, every additional doubling of device complexity increases manufacturing costs exponentially. Ultimately, the cost to obtain the next doubling is larger than the entire wealth of the planet, and that next step is economically impossible. Of course, economics aside, there is a practical limit somewhere: It'll be a while before we can build entire CPU chips that are a tenth the size an atom.

“We are already beginning to see the failure of Moore's Law with processor clock speed. Faster clocks add a level of difficulty to CPU design; you have to consider the effects of clock propagation through the CPU. Clock lag effects become serious for large and complex CPUs running at high clock speeds. Every increase in CPU speed has come as a

smaller and smaller percentage of the total. If the semiconductor industry were still doubling CPU clock speed with every design iteration, then we would have gone from 100 to 200 to 400MHz, and the next doubling should be 800MHz, and after that, 1.6GHz. Instead, CPU clock speed increases past 200Mhz have been made in smaller and smaller increments."

According to Ron Gyurcsik, group director for the Datacom IC strategic business group at Tality, the design-services subsidiary of Cadence Design Systems, Moore's Second Law is more relevant these days than Moore's First Law. Chip design is "more cost-driven than anything," he says.

"The two (laws) work together," Gyurcsik adds. "The cost emphasis drives us to Moore's Law. Cost (is) the way the industry has been driven for a long time."

Increasing design complexity is a factor inhibiting the inexorable progress of Moore's Law. "At 0.13 micron, 90 percent of the transistors – excluding memory – come from some form of IP, internal or third-party," notes Gyurcsik. Chip designs are incorporating "much larger blocks of IP, especially in wireless and communications," he adds.

Will Moore's Law stumble into irrelevance soon? Recent advances in manufacturing technology, especially the extreme ultraviolet lithography programs spearheaded by Intel and other chipmakers in cooperation with the U.S. Department of Energy's national laboratories, suggest that the Intel co-founder's dictum still has life in it. How well the industry can do on the design side remains to be seen.

Jeff Dorsch is a freelance writer. Reach him at JeffDorsch@aol.com.