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GLOBALIZATION

Immune from offshoring

DIGITAL CIRCUITS ARE ON OR OFF; `ANALOG DEALS WITH THE GRAY'

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Bryan Legates belongs to a breed of techie increasingly in demand in today's global economy. The 36-year-old engineer at Linear Technology of Milpitas is an analog chip designer in an industry dominated by digital engineers.

Analog engineers do the old-fashioned, almost artistic work of putting real-world information, such as sound, voltage or temperature, into digital form -- the zeroes and ones that computers recognize.

With digital engineers outnumbering analog ones by an estimated 200-to-1, one headhunter has even said recruiting analog engineers is like using a pig to sniff out truffles in the forest.

When Legates or his colleagues at Linear publish a technical paper, even in the company newsletter, they get calls from headhunters. ``As soon as your name is in one of those, they will start calling,'' Legates said.

Globalization and the rise of a tech economy worldwide often lead to images of Silicon Valley engineers and software developers being outsourced or offshored. But the analog engineer, long in high demand, is enjoying even more of a heyday as the world goes digital. They're largely immune from offshoring.

Global use of products such as cell phones, digital cameras, digital music players and satellite radios continues to grow. And more content, such as music, video and data, are being digitized to run on such devices. In order for digital devices to operate, they need chips that can take signals from the real world -- such as sound, power and temperature -- and compress them into a format that can be understood by a computer as zeros and ones.

So the demand for many types of analog chips in the $32 billion-a-year analog market continues to grow. So does demand for these specialized designers.

``Consumers from Shanghai to Chicago now have cell phones on their belts and wires dangling from their ears,'' said Dave Bell, president and chief technology officer of Linear. Last year, Linear, which spun out of National Semiconductor more than 20 years ago, had the highest gross profit margins of any public company in Silicon Valley.

``The digital revolution speaks to the ability to store and render our physical world in a digital representation. In digital, you are trying to differentiate between zero and one,'' said Dennis Monticelli, a fellow at National in Santa Clara, one of the top three analog chip companies.

Digital circuits in chips are either on or off, zeros or ones, while analog deals with the continuous waves and the imprecise realm of real-world signals. ``Analog deals with the gray,'' Monticelli said.

Analog chips have a few hundred transistors vs. millions in digital chips, but because they are dealing with so many imprecise elements, the analog layouts need to be checked by hand. The chips also need to be tested by hand, because there are not nearly as many software design tools or test and simulation tools for analog chips as for digital ones.

Generation to generation

Analog chip design is highly collaborative -- passed down from generation to generation, like artisans learning from master tradesmen.

The collaborative nature of analog design makes it an unlikely field to be outsourced anytime soon to new engineering centers in India or China.

Recently, at Linear in Milpitas, a group of more than a dozen semiconductor engineers stood around a large conference table, scrutinizing a massive sheet of paper with the layout of a chip being developed for LCD TVs -- a bit like artists looking at a canvas.

The brightly colored design showing circuitry grids and their connections took up the entire table. As they walked around

it, some made notations on the paper with black markers. The discussion was animated, with ideas, suggestions and debates going back and forth.

Legates, a boyish-looking design manager with dirty blond hair and a slightly stocky build, gave his input to the chip's principal designer, Mike Negrete, 24.

The interaction between the more experienced and the less experienced is key in developing analog design skills. ``That room is where the real magic happens,'' Legates said.

Legates, like many other analog engineers, has artistic interests. He used to draw. His father is a carpenter and both love to build things. Like many of the engineers at Linear, Legates bought his own equipment for his workbench, which contains old oscilloscopes, probes and other equipment, to test his circuits. The workbench looks like it is from the 1950s, with equipment he found in garage sales, flea markets or on eBay.

``That's where the fun is -- using a lot of old technology to do some really cool stuff,'' he said.

Legates first became interested in analog as a freshman in college, when a friend who was an aspiring analog engineer showed him contraptions he had built for his dorm room, including a light meter that synchronized with music playing on his stereo.

After getting a bachelor's degree in electrical engineering at North Carolina State University in Raleigh, Legates went on to Georgia Institute of Technology, one of a small number of universities in the U.S. with an analog circuit design curriculum. There, he earned his master's in electrical engineering with a focus on analog. He got a job in Silicon Valley at National Semiconductor after graduating.

Like a doctor's residency

Analog engineers describe their apprenticeship much like the residency that doctors go through at a hospital. Because there are few automated tools in the field, they learn how to do chip layouts from being mentored and hearing the stories, tricks and mistakes of others.

Joy Taylor, 26, an applications engineer at National and a rare woman in the analog field, takes courses at National's own university and constantly learns from her mentors. She joined the company after graduating from San Jose State University with a bachelor's in electrical engineering.

``In the past three years, my learning curve has grown exponentially,'' Taylor said. She tests circuits, writes data sheets and interacts with customers. She works on chips for portable products, such as a chip that regulates the back-light on a cell phone.

Much of the classroom education takes place in the United States, at schools such as Stanford University, the University of California-Berkeley, Georgia Tech, Massachusetts Institute of Technology and a few others. Students in other countries who are serious about analog design typically come to the United States for advanced degrees and usually end up working here, said Bruce Wooley, a professor and chairman of the Electrical Engineering department at Stanford.

Many companies, such as Texas Instruments, the leader in the field, and others like National, Analog Devices, Maxim and Linear, sponsor programs at universities, and then recruit heavily from that pack of engineers.

But it can be hard to encourage engineers to study analog design. The lure of big company names like Intel for chip designers or Google for software developers can make the notion of designing voltage regulators or power amplification chips sound mundane to students.

Along with the limited talent issue, executives said another barrier to entering into this market is the fact that all the analog companies manufacture their own chips. Their plants that fabricate chips don't cost as much as the multi-billion factories that Intel has for microprocessors.

Most observers don't see major competition from overseas on the horizon for the U.S. analog industry. ``In the U.S. and Silicon Valley, we can continue to compete in analog for sure,'' said Jack Gifford, the founder and chief executive of Maxim. ``We will continue to compete as long as immigrants can continue to come to this country. But if people chose not to be here, you could have these learning centers here move.''

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