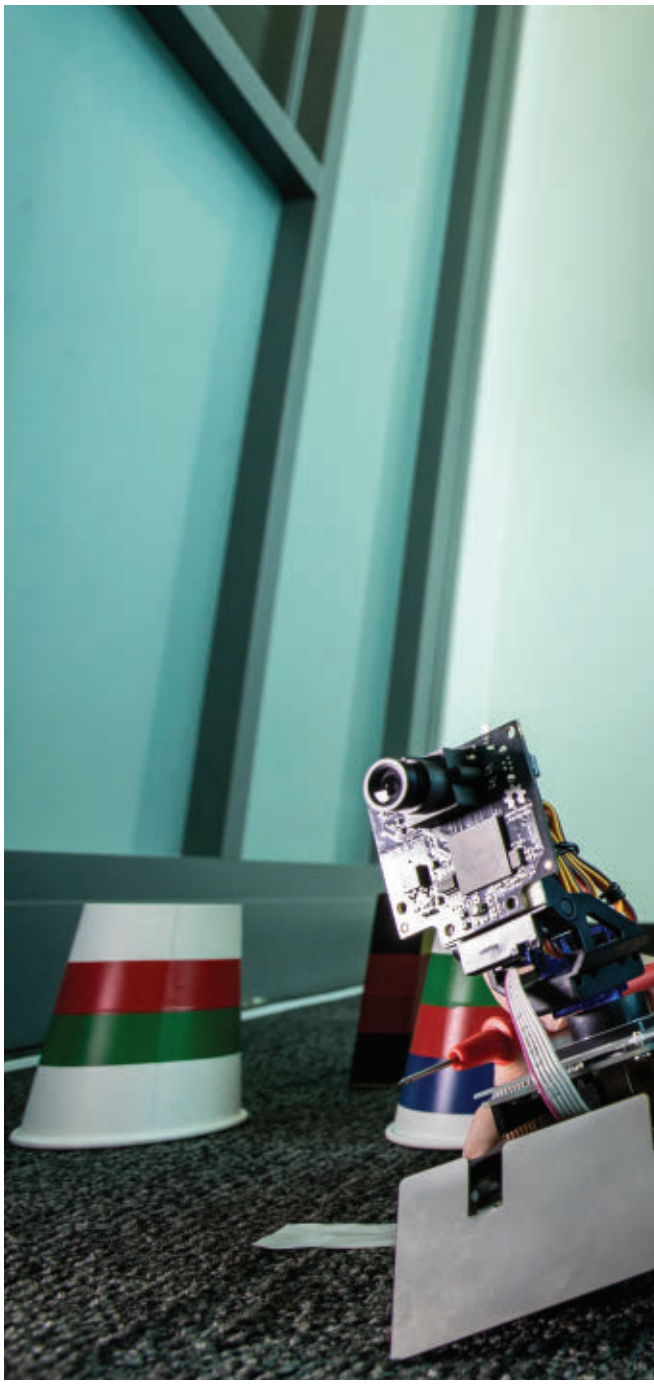
F30

Does Silicon Valley Have Enough Mech

The internet of things promises a world of digitally connected physical objects. But do tech firms have enough mechanical engineering talent to make it happen?

By Kayt Sukel



For those with the right skills, Silicon Valley has developed a system that can catapult the career of a couch-surfing coder to new heights, making him or her wealthy and perhaps even nerd-famous in the process. The model is simple: invest in startups with a handful of employees, avoid physical assets, and sell their final code across the internet. While many firms fail, others, like Google, Facebook, and Netflix, have changed their industries—and our lives—forever.

It's hard to disagree with renowned Silicon Valley entrepreneur Marc Andreessen, whose oft-cited 2011 *Wall Street Journal* essay argued that software is eating the world. Nor is it hard to miss how Silicon Valley's economic model offers few opportunities for mechanical engineers, the people trained to design physical machines and their components.

Until now.

A new digital revolution is upon us. In fact, Andreessen, Nostradamus-like fashion, foretold it. In the same essay that explained how software was eating conventional entertainment and retail alive, he predicted that it would start consuming the physical world. Now, seven years later, the most stubbornly physical of industry verticals—think agriculture, manufacturing, and construction—are getting their own virtual makeover through the internet of things (IoT).

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Frederick Fourie of Microsoft combines programming, internet of things sensors, and mechanical parts to build a robot at a hackathon.
Photo: Microsoft

IoT, at its simplest, is not so much a technology as a model of connection. It makes it possible for just about any physical device—from a car or HVAC system to warehouse shelves or sensors—to connect to the internet and other devices. This makes it possible for users to remotely unlock the front door or collect critical data from a wind farm.

"IoT is not some technology fad," said Alfonso Velosa, an IoT analyst at the tech consulting firm Gartner. It goes beyond using a smartphone app to control the thermostat or dim the lights. Today, emerging networks of connected things are also becoming more important in industries ranging from healthcare to logistics.

"We are now seeing business leaders, across the world, wanting to implement IoT projects so they can make business transformations or get the data they need to make better business decisions," he said. "The conversation over the last few years has gone from, 'What is IoT?' to 'How can I make this work for my business?' "

In fact, Gartner estimates that the world will be home to over 26 billion connected devices in the next few years. The emerging rule of thumb is, anything that can be connected, will be connected. And as those connections grow richer, they promise to upend human and corporate behavior in ways that are every bit as surprising as the changes caused by the internet and smartphone technology.

As this revolution unfolds, it raises some very important questions. If the IoT seeks to control physical things that require an understanding of engineering principles—force, stress, and thermodynamics, for example—how will that change the role of mechanical engineers? And does Silicon Valley have enough skilled MEs to keep up with the IoT boom?

The Right Stuff, the Right Skills

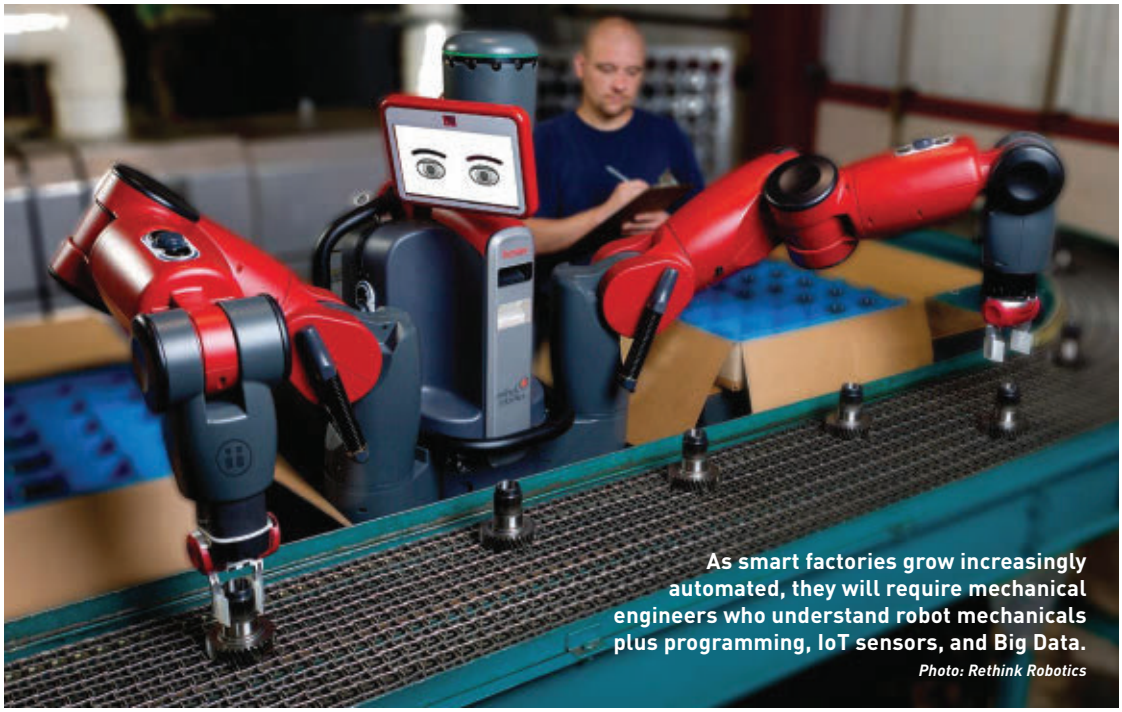
Companies will need employees who successfully straddle the line between information technology (IT) and engineering skills, said Ram Ramasamy, consulting manager for digital industrials at consultant Frost & Sullivan. He expects IoT demand to rise 11 to 14 percent annually over the next five years.

"We are going to see a convergence of sensors, assets, algorithms, cloud, and information and data needs," Ramasamy said. Hence, someone who has experience with industrial assets and mechanical engineering as well as IT skills will be the most sought after.

"There is a supply-demand issue right now. For so long, the world has had a single stream focus. You were either IT or operational technology (OT). We're now at a juncture where IT/OT convergence is driving change in skill set requirements. Companies want people who can do both," he said.

Those people are not easy to find. IT managers are reporting that hiring has gotten harder over the past year, said Rich Pearson, a senior vice president of marketing for UpWork, a global platform that helps businesses find freelance talent. While technical positions are always hard

Smart homes connect many devices that were once exclusively mechanical, such as HVAC, fans, appliances, power systems, and even window shades to the internet.



As smart factories grow increasingly automated, they will require mechanical engineers who understand robot mechanicals plus programming, IoT sensors, and Big Data.
Photo: Rethink Robotics

to fill, those that require IoT skills are especially difficult.

When Pearson ticks off employer needs, they include the usual computer science/IT skills, such as machine learning, web programming, and geographic information systems. Yet, they also include such mechanical engineering standbys as AutoCAD and Arduino software and hardware used to sense and control physical objects.

"We track the demand for different skills and, from an IoT perspective, we're trying to find freelancers as fast as we can to fill these jobs," Pearson said. "As long as the business world and the distribution models for products continue to evolve as quickly as they have done, we're going to see continued demand for engineers."

Those mechanical engineers, however, will have to bring something a little more than just traditional skills to the table, said William Oget, vice president of engineering for Prodea, a global IoT services operator.

"We're at the point where almost everyone needs some kind of understanding of software engineering," Oget said. "Perhaps everyone is a bit of an overstatement—but it's a must for engineers. Today, if you have a blind spot around IoT, if you have a blind spot around the cloud, if you have a blind spot around coding or data, you will be at a disadvantage especially since the efforts of mechanical engineers and software engineers will need to dovetail throughout the timeline of any IoT project."

Clearly, Silicon Valley needs a different type of mechanical engineer, one who is fluent in forces, thermodynamics, and process control—and also data science, informatics, and some basic IoT application programming.

"I call this new generation of engineers, 'digital engineers,' " Ramasamy said. "Codification of processes to make IoT faster, smarter, and simpler will be their defining role in the industries of the future."

Building Tomorrow's Engineer

Are today's mechanical engineering students learning the skills they need in order to become tomorrow's digital engineers? They should be, said Jonathan Cagan, co-director of Carnegie Mellon University's Integrated Innovation Institute in Pittsburgh. To compete for a job in the future, MEs must broaden their idea of what a mechanical engineer does.

Every engineer needs a basic set of IoT skills, and not just to send the right data to the internet, Cagan argued. They need to understand how accessing IoT data after it is processed will change how we design and build mechanical

Silicon Valley is looking at hackathons for engineers who understand how to build mechanical devices that work in an interconnected IoT world.

products to interact with one another and with humans.

"Today's mechanical engineer needs to understand how to design these things, and also how connectivity works, the advantages of connectivity, and how things need to function in a collaborative system," Cagan said.

Most university mechanical engineering programs require at least some basic programming. Yet Anthony Rueda, who is pursuing a master's degree in mechanical engineering at Carnegie Mellon after graduating with a B.A. in electrical and computer engineering, wonders if it is enough.

"The integration between mechanical engineering and computer science is at the forefront of Silicon Valley, no doubt," Rueda said. "And that may be why you don't see many mechanical engineers finding jobs there. There aren't enough mechanical engineers with a strong enough programming background."

Paul Steif, associate head of the mechanical engineering department at Carnegie Mellon, said the department is always adding courses to reflect new workplace demands, and to fill in perceived gaps in their students' education. They have already added some IoT courses.

"Last year, for example, we added a course in the internet of robotic things," Steif said. "We recognize there is opportunity here—a new area where students want to gain skills—and we are trying to meet that opportunity. We are definitely seeing that the whole connection between electronics, mechanical engineering, and computational processing is becoming more and more central to today's work. Being able to integrate the mechanical side—the actuators, sensors, and old-fashioned mechanical things—with the processing and computation is becoming more and more important."

IoT knowledge is also working its ways into traditional courses as well. At the University of California, Berkeley, in the heart of Silicon Valley, mechanical engineering professor Francesco Borrelli has been modifying his process control class to fit today's requirements.

"I can't teach the same class I taught five years ago," Borrelli said. "The field of IoT is evolving—but there is definitely a kind of skill profile that IoT companies are looking for.

"Mechanical engineers who work in this area will have to be comfortable with some programming. They will have to analyze and work with data. And, you know, not everything that is connected should be connected. Since it's the engineers that understand the mechanical design, they need to be able to help make a use case of why something should even be on the internet in the first place."

Borrelli's point on the field's rapid evolution

is important. While most experts agree that IoT will be increasingly important in the future, it has not quite reached the anticipated feeding frenzy status. One reason, Gartner's Velosa said, is because companies are having such difficulty finding the right people to staff current projects. He expects that 75 percent of IoT projects will take up to twice as long as planned through 2018.

That skills shortage is a global problem, Velosa said. "I see more capabilities in North America because educational institutions are now realizing the importance of IoT. Yet IoT is not about some abstracted model of a physical asset. You have to understand the physical asset—how it works and how it is used. High levels of abstraction can only take you so far. We need more people who can work in that physical space."

Prodea's Oget, whose firm recently acquired another IoT company, agrees. So where is he looking for more mechanical engineers?

"Anywhere we can find them," he joked.

"The top universities are mostly great," Oget said. "But I'd love to see more flexible, innovative programs where there are partnerships between universities and companies and students are working on IoT internships and bringing that knowledge back to the classroom," he said.

Prodea, like many other companies, still recruits engineers through job sites and at job fairs and technical opportunity conferences at the top universities. It fills immediate needs through freelancer work platforms.

Until the market fully matures, and companies know exactly what skills they will need from tomorrow's mechanical engineers, Oget has a piece of unorthodox advice: participate in hackathons.

Hackathons are sprint-like design events where computer geeks collaborate intensively to create usable—and perhaps even commercially viable—software. Once the sole province of computer science majors, hackathons now embrace autonomous robots, smart homes and cities, driverless cars, and other IoT standbys.

These festivals provide many opportunities for mechanical engineers to show off their practical IoT skills. They are a boon for students just entering the job market, and also established engineers who are looking to expand and showcase their IoT capabilities.

"Go to these kind of events, show your skills, have fun, meet people," Oget said. "Go to an accelerator, to a crowd-funding meet-up, to places where new ideas and start-ups are discussed. You may discover a company that would have never been able to explain why they need you and your skills, but will realize they need you once they see you in action."

Those companies are surfing the IoT wave. After decades of ignoring hardware, Silicon Valley is rediscovering its physical assets. It may not know exactly what skills it needs now or will need in the future as IoT evolves, but it is ready to start talking to mechanical engineers.

"It's clear that Silicon Valley does not have enough mechanical engineers," Velosa said. "It does not have enough people who understand how these interconnected physical things work in the real world.

"Right now, we are at the beginning of what will be a ten- or twenty-year journey. We barely understand how these things that we are connecting work, how or why or where they should connect to one another, how we can or should use the data we collect from them. But we are learning as we go.

"There are a broad range of challenges. But within those challenges, there are also a huge set of opportunities, not just for mechanical engineers but for the other professional fields that can help us address them," Velosa said. **ME**

KAYT SUKEL is the author of *The Art of Risk* and covers science and technology from outside Houston.

It took engineers and computer scientists to design NASA's virtual reality glasses.
Photo: NASA