strategy+business

**ISSUE 86** SPRING 2017

# The Thought Leader Interview: Bill Ruh

During the next few years, says GE Digital's leader, the Industrial Internet will turn every company into a digitally empowered enterprise.

BY ART KLEINER AND JOHN SVIOKLA

**REPRINT** 17111

# The Thought Leader Interview: Bill Ruh

During the next few years, says GE Digital's leader, the Industrial Internet will turn every company into a digitally empowered enterprise.

BY ART KLEINER AND JOHN SVIOKLA

Photograph by Matthew Septimus

According to Bill Ruh, the underpinnings of our industrial society will be profoundly changed by 2020. Every form of large-scale machinery will be suffused with sensors and software controls, all more and more interoperable. Increasing productivity, raising profits, eliminating waste, ensuring environmental quality, and improving manufacturing processes will all be automated activities, functions of a kind of ghost in the machine. There will be at least 1 billion more digital electric power meters than there were in 2015; more than 100 million lightbulbs will be connected to the Internet, turned on and off by sensor or smartphone; and machines produced by just one company, GE, will generate a million terabytes of data per day, much of it in the form of operational statistics that adjust machines to make them more efficient every day they are in use.

Whereas Northwestern University economist Robert Gordon argues that productivity growth is fated for a permanent slowdown, and MIT's Erik Brynjolfsson expects automation to erode employment even if productivity recovers, Ruh sees himself as a productivity activist. He is building the software and hardware platforms that will take industrial technologies into a new, prosperous stage of development.

GE, of course, has been at the forefront of technological change since it was created in 1892 through the merger of Thomas Edison's and Charles Coffin's electric companies, supported by financier J.P. Morgan. After embracing financial-services and media businesses in the 1980s and 1990s under CEO Jack Welch, and then retreating from them after Jeffrey Immelt took over in 2001, the company has gradually reshaped its identity around the industrial platforms it maintains as a maker of turbines, jet engines, power systems, and healthcare equipment. Because platforms of this sort are rapidly evolving to incorporate sensors, data analytics, and Internet connections, GE is redefining itself as a producer of software-driven offerings — or, as Immelt puts it, "a top 10 software company by 2020."

Ruh was hired in 2011 to oversee GE's digital strategy. As chief digital officer for GE, he was in charge of embedding software-oriented technologies and practices throughout the company's operations and product lines. (Before 2011, he had been vice president at Cisco Systems, in charge of advanced services and solutions.) Although he has never been the company's chief information officer (that role is currently held by Jim Fowler), he works with the IT departments, strategists, and senior leaders throughout GE to reinvent the company's technological practices from the inside out.

In September 2015, Ruh's purview expanded when he also became the head of GE Digital, a new division that, like Amazon's cloud services, is building a business for customers from the capabilities originally reserved for GE itself. The endeavor is focused on what GE calls the "Industrial Internet" — the tight integration of the physical and digital worlds, enabled by embedded computer intelligence, connected devices (as in the Internet of Things), and sophisticated data analytics. GE Digital now includes the company's software development services, its industrial security business, and Predix — an operating system and platform for industrial applications. (GE Digital has also launched an Industrial Internet alliance with this magazine's publisher, PwC; see www.pwc.com/gedigital for more information.)

**"In the industrial company of the future, there won't be a separate IT department. Top leaders will understand digital innovation."**

Ruh sat down with *strategy+business* at his office in San Ramon, Calif., just outside Silicon Valley. The conversation covered not just the lessons emerging from GE's own businesses, but the productivity and progress available as the "big iron" of industrial technology shifts to "big electron."

**S+B: What was the origin of GE Digital?**

**RUH:** It started with our interest in increasing our customers' productivity through the equipment and services we sell them. Up through around 2010, most companies enjoyed a relatively high rate of productivity growth. This meant that their top-line versus bottom-line ratios were increasing at 4 percent per year on average. Then, in 2011, that productivity growth rate dropped. You could attribute this to slowing GDP growth and higher oil prices, but perhaps the biggest factor was the decline of process innovation. It could no longer generate the major productivity gains that it once did.

We asked ourselves: Where will the next great leap come from, to again provide productivity gains in industrial firms? The answer was digital technology — specifically, analytics. We live in a data-rich world. If we can organize that data effectively and look for patterns of behavior that an unaided human being couldn't see, we could drive productivity gains that couldn't be had before.

However, that means you can't keep IT separate from the rest of the

**Art Kleiner**
*kleiner_art@strategy-business.com*
is editor-in-chief of *strategy+business.*

**John Sviokla**
*john.sviokla@pwc.com*
is a principal with PwC US and its marketing leader. He is the coauthor of *The Self-Made Billionaire Effect: How Extreme Producers Create Massive Value* (with Mitch Cohen; Portfolio, 2014).

business. The days when you could say, "Here's my tech guy, go talk to him," are over. In the industrial company of the future, there won't be a separate IT department. Top leaders will understand digital innovation in the same way they understand finance and accounting today. They will design digital technology into their products and their practices. This is a profound change from where we were even five years ago — in the kinds of leaders we have, their backgrounds and training, and how they look at themselves, their people, and their products.

**S+B: Are you talking just about GE, or about a broader group of businesses?**

**RUH:** It's broad. It reflects the nature of competition today. The consumer-facing industries, for example, are being completely remade by startups with deep digital talent. The startups can rethink the taxi, hotel, or music business at a faster rate than the traditionalists who have zero digital background. The traditional companies can only compete by embedding digital inside everything they do.

**S+B: What does that competition look like?**

**RUH:** Take Uber or Lyft. Conventional taxi firms could have invented the same technology. You would think they would do it better, because they own the asset — the automobiles. But owning an asset in itself isn't enough. You have to figure out how to get more productivity out of it than anyone else can. That's what the ride-sharing services did; they got more productivity out of the cars and drivers. If you're an asset-rich company, like a taxicab firm, or GE for that matter, then shame on you if you can't provide the greatest productivity for that asset.

Sooner or later, someone will figure out how to make power plants more productive using software. It ought to be the industrial firms that own the plants, because they understand the operations better. But some other type of company might beat them to it.

**S+B: Have any examples of digital productivity particularly impressed you?**

**RUH:** In 2013, we launched a digital analytics capability called PowerUp for wind energy. By optimizing each blade for the wind it was receiving, the software could get 5 percent more electricity out of a wind turbine. That's profound, because 5 percent more electricity generated equals 20 percent more profit for the wind farm owner. And it's been improved further — to 20 percent more electricity, with the same hardware.

Similarly, for a North American railroad, we enabled a one mile per hour average increase in locomotive performance. For the railroad, that was equal to US$200 million in added profit each year. You can use similar analytics to boost fuel productivity for an airline or a power utility; this is game-changing for them.

In general, if we can obtain operating information from industrial assets, develop analytics based on our knowledge of how these assets perform, and provide insight on the fly, we think we can get productivity growth in the industrial world back to 4 percent. Maybe higher, because technology like this can get more out of the industrial asset base than anybody ever has.

**S+B: Do you see this as a one-time leap, or are you creating a platform for ongoing productivity gains?**

**RUH:** This is a great question to think about, and it's not fully answerable today. Fifteen years ago, many IT professionals thought, "If we had a good ERP application, we'd be done. Our businesses are perfect." Then came smartphones.

We're going to end up in an industrial world where nothing ever breaks, because it's fixed first; where no individual in an industrial setting is put in harm's way; and where the efficiency of resources is close to perfect. That won't happen all at once; we'll see a 30-year progression through little apps that, when strung together, optimize the three vectors of growth, safety, and efficiency, in ways we hadn't thought about before.

In a sense, this is the digitization of everything that people like [quality pioneer] W. Edwards Deming talked about: the use of better management systems to build quality and productivity into products. Except now, in addition to training people to continuously improve systems, we're building continuous improvement into the technology.

We're also going to change the way we design products. When a product is used, operational data will go right back to engineering and R&D. The engineers will change products at a faster rate because their designs will go right into manufacturing. With additive manufacturing [3D printers and digital fabrication], we'll be able to enhance products at rates we couldn't before. Those are foundational changes.

"We're going to end up in an industrial world where nothing ever breaks, because it's fixed first."

**S+B: Is that the rationale behind Predix?**

**RUH:** It is. We think of the Predix platform as an ecosystem where everyone can develop B2B apps for the Industrial Internet market. And of course, we're in the early stages — similar to where Amazon Web Services was in 2007, driving the consumer Internet, or where Salesforce.com was in pioneering software-as-a-service in the early 2000s. We're early on in rethinking this industrial world and trying to bring it to a new place.

**S+B: How do you expect to do this?**

**RUH:** We are following the example of the consumer Internet. There's a lot to learn there. The consumer Internet has foundationally changed daily life; it has made people much more productive as individuals. It has done this, in part, by having a great user experience evolve from day-to-day practices. It does this with data analytics–based modeling, which simulates interactions among elements of a computer system — for instance, in a search engine.

The Industrial Internet has an additional core approach that doesn't exist in the consumer world. It is the idea of physics-based modeling. All assets — buildings, vehicles, fleets, even financial assets — have physical properties. Physics-based modeling simulates the behavior of plants, generators, engines, and other tangible assets. The Industrial Internet, or Industry 4.0, as some call it, is powered by data analytics–based and physics-based models coming together.

Data analytics–based modeling allows you to look at patterns of behavior and act on them earlier than you would otherwise. For example, it can recognize when there is a high probability that a part is going to break. A machine may be within its operational parameters but the coupling of two or three indicators — one type of vibration along with a particular type of stress or environmental condition — suggests that it could break earlier than you might expect. Analyzing the past allows you to predict future behavior.

Physics-based modeling gives you options for that future. Having discerned, through analytics, that the machine may be vulnerable, you now have choices. Should you take it out of service now to fix it? Or could you put it into maintenance that is already scheduled for later that night? With a cloud-based, physics-based model, you can run a million scenarios simultaneously and pick one that is optimized for what you're trying to accomplish. When you combine analytic processes and physics-based modeling, you can have that happen automatically. That's a feature of the Industrial Internet that usually doesn't appear on the consumer side.

**S+B: Except when my car tells me I have 104 miles to go before I run out of gas, based on its estimates of my mileage and gasoline supply. That's analytics-based modeling, isn't it?**

**RUH:** Yes, but I'd take the example a step further. When an electronic automobile dashboard tells you to replace your oil at 6,000 miles, that is done with basic analytics-based modeling. Based on analysis of past performance, it picks an oil replacement schedule that is best for the average person.

The problem is that everybody drives differently. Some conservative drivers could wait 10,000 miles to replace their oil, and that delay would make the asset more efficient. Others probably should replace it at 3,000 miles. And if you operate in a very hot, harsh environment, that plays into it as well. The decision about when to change your oil should not be based on averages. You want to use physics-based modeling to figure out the optimal schedule for you.

This is exactly how we maintain jet aircraft engines. Not every jet aircraft engine needs to operate on a fixed schedule. In fact, we now tailor the maintenance process to every engine, using physics-based modeling. Engines that operate in a hot, harsh, dusty Middle East environment are maintained differently than those in colder climates.

With the combination of analytics-based and physics-based modeling, we can predict a problem before it occurs and allow you to maintain it at the optimal rate and cost. This is becoming a killer application for the industrial world. For example, if I can anticipate that a pipeline oil leak or jet engine malfunction is likely, I can fix the prob-

## "I can make every process more efficient in its use of resources. I'm adjusting the control systems in real time to match the environment."

lem before it occurs. I still can't predict a nail puncturing a tire, but I can predict a blowout related to ongoing stress on the tire.

I can also make every process more efficient in its use of resources, as PowerUp does with wind turbines. This is groundbreaking: I'm constantly adjusting the control systems in real time to match the system's environment at that exact moment.

Again, this cannot be accomplished just from the IT department. The digital experts who work there have a role to play, but not in isolation. They have to be close to the business, and business leaders need more digital acumen. When those two ways of thinking are combined, magic occurs.

**S+B:** What specific skills do IT people need to operate this way?

**RUH:** In the traditional industrial world, the IT function has focused on infrastructure. Put in a network, build a data center, set up an ERP system. We have been oriented toward transactions. This doesn't require business leaders to have much digital insight. They can say to their IT staff, "Automate this for me."

That's going to change. Industrial firms will have to develop the orientation to user experience that you see on the consumer Internet, or at Google and Apple. Business intelligence [the analysis of your own business processes and those of competitors] will have to move forward from being just a reporting capability to having hard-core data analytics that help you continuously improve systems and practices. And we'll have to change from an on-premises ERP approach to a mobile-friendly, cloud-based world, giving people access to business systems through smartphone apps.

When you look at these capabilities in combination, you see that they require a new set of skills and practices. Silicon Valley–style skills — like agile software development, user experience design, and deep machine learning — are not common in traditional industrial firms. The mechanical and electrical engineers who manage the IT functions at many companies are great at physics-based modeling, but less great at, say, artificial intelligence. They also use legacy development tools that are not necessarily in tune with where the cloud-based mobile world is going.

So a retooling of technological skills and practices often has to take place. At GE, we are going through that retooling now. It doesn't mean getting rid of all the capabilities we have, because we're still working with ERPs and other legacy systems. But we have to balance that old talent with new, and make both groups work together in an integrated whole.

**S+B:** What are you discovering about recruiting, developing, and managing this new talent?

**RUH:** In the beginning, many GE people were skeptical. Why would talented people come here instead of to a startup? Everybody wants to work in a startup, right? And there was some truth to that.

But young people are coming to work for us for two reasons. They want to work on the most advanced technology in the world, and that's often the technology of industrial systems. And they want to have a mission in life. Their greatest ambition is to work on something that's important. For us, that mission is the Industrial Internet. We're making rail travel safer when we design software into locomotives; we're helping healthcare deliver when we build new CT scanners. It's a great story to be able to tell their grandparents — that they have an effect on transportation and healthcare. It can be easier to explain than gaming and social networking, and they can take pride in the fact that they're changing the world. That's why the Industrial Internet of Things is the next big thing.

**S+B:** **How do you design an Industrial Internet project?**

**RUH:** The cornerstone is always the same, whether it is a thermostat or a jet aircraft engine. You have to have some form of connectivity. You will have to collect performance data. You'll need both analytics- and physics-based modeling — not just to analyze the data, but to deliver it to a machine to improve its performance, or to a person to improve the performance of the system.

You'll also need to secure your assets against cyber-attack. When a thermostat doesn't work, it's a nuisance. When an electric grid goes down because of a cyber-attack, you can lose society. For reliability's sake, not everything can run in the cloud. A significant amount of processing must take place close to the activity. We're going to see an enormous amount of computer processing take place right next to industrial activity, so that there isn't concern about being disconnected. Every power plant will become a big data center that generates electricity. Every locomotive will be a data center on wheels.

**S+B:** **How do you navigate the regulatory issues?**

**RUH:** There are complicated relationships with national governments. They don't want to see industrial data leave their boundaries. This has huge implications. Many multinational companies have cloud-based activities around the world, in Saudi Arabia, China, and the European Union. We will probably see the separation of data and processing; technology may be managed by a global infrastructure while countries retain sovereignty over their management of data.

> "Our company and many others are bringing manufacturing jobs back to the United States."

This won't work for the consumer Internet. Data and processing are tightly coupled and you lose the necessary economies of scale if you try to put a data center and cloud in every country. I think the regulators will recognize this and demand that local data be protected while companies retain the advantages of global operations. This affects the design of systems like Predix.

GE operates in more than 170 countries, and we understand all of their regulatory environments. That is why the power utility industry, for example, is so diverse; conditions are very different in, say, the United States versus Brazil versus Dubai versus Thailand.

At the same time, the regulatory environment itself will be fundamentally affected by the emerging approach to data. When there is an increase in the amount and accuracy of insight into operations, regulators can report out more completely and still reduce the cost of oversight. Security will be increasingly important. Protecting an operational technology is a totally different game from protecting an information system. We will see new types of cybersecurity emerge as a result, to protect large installations like power plants and railroads.

**S+B:** **Of course, you're not the only company building a platform for the Industrial Internet. Siemens is doing the same, and others will undoubtedly follow. As these platforms connect together, how do you distinguish GE from the competition?**

**RUH:** In the next decade, success will be based on driving productivity. Whoever can pump a barrel of oil at the lowest cost, or use less fuel to fly an airplane, or gain more energy out of a turbine will have the competitive advantage. I think manufacturers everywhere will rethink their operations costs. Going to a low-wage country will no longer be productive; instead, the answer will be putting manufacturing close to your customers, to reduce the cost of transportation, and investing in technology. As additive manufacturing advances, you'll be able to invest your capital costs with greater confidence, because your digital infrastructure will allow you to be more flexible. The platforms that provide better productivity will thrive. For example, the winning agricultural equipment companies will be those that make farmers most productive. Gradually, companies will compete less on productivity and more on their distinctive approach to analytics.

**S+B: As the Industrial Internet rolls out, how do you think it will affect jobs and economic growth?**

**RUH:** Automation is at the center. One class of jobs will be displaced; that's the nature of manufacturing technology. Our company and many others are bringing manufacturing jobs back to the United States. But the new plants are much more efficient than they were, say, 20 years ago. So the jobs are different and require a different skill set. In the early part of the 20th century, a lot of people were employed taking care of horses and cleaning up after them. Those jobs went away with the automobile, but other jobs came in. I think this will happen again; it's not going to be as dire as the negativity suggests.

It's still hard to predict what new jobs will come in this time, and in what numbers. But there is a growing need for data science and world-class programming capabilities. The technical skill requirements will go up, even for people without college degrees. People will have to know how to handle automated machinery and work effectively with robots. Companies will have to get really good at managing and training the technological workforce through this transition.

**S+B: How does this transition fit with the overall GE story?**

**RUH:** I have the title of chief digital officer, but the real chief digital officer is CEO Jeff Immelt. The core leadership team members at GE — including Immelt, chief financial officer Jeff Bornstein, and chief marketing officer Beth Comstock — are digital leaders. They have deep technological backgrounds that they've developed over a number of years that allow them to understand and make decisions in a way I couldn't have imagined before I joined. They place a value on learning and extending your own capability that extends through the company.

As we've moved toward the Industrial Internet, we realized that we didn't have enough data scientists on staff. We have gone from about 20,000 professionals in this area three years ago to about 28,000 today. But we didn't bring in new talent to displace our existing workforce. We need to blend the old skills and new skills into an integrated whole. If you can't bring your physics modeling people together with your data modeling people, you don't get the full value of your workforce.

We're about halfway through the integration of these skills. It involves shifting our leadership training so that digital is an important part of every program. We don't expect everybody to be fluent in Python [a popular and influential programming language], but we do expect them to understand what Python is, what other technologies we're using, why they're important, and how the technology affects their business.

We are also in the process of rethinking the role of IT in a company like GE — including the CIO's job, the organizational structure of the IT department, and the titles and capabilities of the staff. We still have to run networks, create data centers, and provide ERP. But how does all of that combine with the new deep analytics and insight that will drive our business? How do these new software capabilities connect with our machines, repair shops, services, and manufacturing facilities? How does it all affect our product portfolio? We've grown our annual digital revenues from virtually nothing to more than $6 billion across the company. That's a substantive change that has affected everything we do.

Jeff Immelt says that we're on step 15 of a 50-step journey. At any given point, you can see three or four steps ahead in enough detail that you're confident of what you're doing. You can plan out 10 steps, and you can articulate where you want to be at step 50. But you can't jump from step three to step 45 in one leap. You've got to know what you can accomplish in the near term that will produce results that give you confidence and allow you to see how to change your journey to get to your end result in the right way.

> "How do these new software capabilities connect with our machines, repair shops, services, and manufacturing facilities?"

**S+B: What does all of this mean to you personally?**

**RUH:** I'm like most of the people we're hiring: We want to work on the best technology, and to feel like we're on a mission. I'm driven by the idea of working on foundational changes. I've been watching the Internet of Things [IoT] movement for a decade, and I took that mission as my own: to drive a new platform architecture that leads to renaissance-like effects, with higher productivity, zero unplanned downtime, greater safety, and a more livable world. I realized that to take hold, the IoT would have to shift from a technology sale — where people buy it as the next stage of IT — to an outcome sale, where people buy it for productivity and expanded opportunities.

When I was approached by GE's executive recruiters, it made sense to join. I could see that GE was the kind of company that, with the right investment and leadership, could take this movement forward. Hokey as it sounds, I believe we are on the verge of the next industrial revolution. And what better way to spend the last 10 years of your career than helping that change take place? +

Reprint No. 17111

**strategy+business** magazine
is published by certain member firms
of the PwC network.
To subscribe, visit strategy-business.com
or call 1-855-869-4862.

- strategy-business.com
- facebook.com/strategybusiness
- linkedin.com/company/strategy-business
- twitter.com/stratandbiz



pwc | strategy&