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Thought Leader: Erik Brynjolfsson
by Art Kleiner

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Photograph by Reed Young

The Thought Leader Interview: Erik Brynjolfsson

MIT's theorist of productivity draws a link between innovation in management practice and ongoing prosperity.

The question of productivity growth couldn't be more relevant in the aftermath of the economic crisis of 2008–09. High productivity — the ability of large companies, small entrepreneurs, and government to accomplish more with less — has always tracked closely with strong economic growth. And high levels of productivity will probably be needed to solve other problems facing business and society: urbanization, ecological change, global competitiveness, and health care and education costs.

But the dynamics of productivity growth have always been a bit mysterious. In the U.S., for instance, productivity grew rapidly from 1948 to 1973 (about 2 percent per year), slowed to 1 percent between 1973 and the early 1990s, and then accelerated again, reaching 3 percent per year in the early 2000s. Then, in 2009, it soared: The U.S. Bureau of Labor Statistics estimated in September that American productivity in nonfarm businesses had risen 6.7 percent during the previous 12 months. Later estimates were even higher — as much as 9.5 percent for the third quarter of 2009. Could this foreshadow a

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robust recovery, in the United States or everywhere?

For answers to that question, *strategy+business* turned to Erik Brynjolfsson, the Schussel Family Professor at the Massachusetts Institute of Technology's Sloan School of Management. Brynjolfsson is one of the leading economists tackling the dynamics of productivity, and he was one of the first to research the impact of information technology on it. Now he has taken a further step into studying the root cause of this economic engine. In *Wired for Innovation: How Information Technology Is Reshaping the Economy* (MIT Press, 2009), Brynjolfsson and coauthor Adam Saunders (a professor at the Wharton School of the University of Pennsylvania) argue that productivity growth is driven primarily by organizational capital: improved management practices and operational processes.

If Brynjolfsson and Saunders are correct, it would bring a pragmatic perspective to a field that often seems biased by ideology. Several years ago, for instance, a McKinsey & Company report declared emphatically that the root cause of productivity growth was laissez-faire governance; the less reg-

ulation, the more productive the economy. Others have linked productivity gains to farsighted central planning, like that of some giant companies or of the Chinese government, and still others to information technology on its own. Brynjolfsson is well positioned to explore these issues as head of the MIT Center for Digital Business, a seedbed of research on the information economy. (Among those associated with the center are *Predictably Irrational* author Dan Ariely, *The Future of Work* author Thomas W. Malone, "trust-based marketing" innovator Glen Urban, and *s+b* contributing editor Michael Schrage.) In a variety of projects, Brynjolfsson and his fellow researchers have been developing the concept of a "digital organization," one that mixes IT innovation with management effectiveness and thus (according to Brynjolfsson) will tend to lead its industry in productivity growth — and in quality, convenience, customer service, and profitability.

In September, *s+b* met with Brynjolfsson in his office on the MIT Sloan campus in Cambridge, Mass. We discussed productivity, the digital organization, information technology, and the remarkable

and discomfiting future to which these trends may lead.

S+B: Since the Great Recession began, productivity numbers have risen dramatically. Is that signal as positive as it seems to be?

BRYNJOLFSSON: By mid-2009, we already knew that the growth of GDP would be positive, or at least flat. But employment continued to fall. So by just doing the arithmetic, dividing output by employment, we knew in advance that there would be a big productivity number. This was triggered by the recession, but it was not a sudden reversal. It was part of a longer pattern we've seen with the recent wave of so-called jobless recoveries. Companies have discovered that they can produce a lot of output without needing as many people.

Many of those gains could be traced to investments made between 2000 and 2009, but the gains weren't harvested until companies laid people off. For a lot of knowledge work, it may have been hard for managers to perceive whether all the workers they had were necessary. And even if they perceived during the boom years that they didn't need as many people, political and cul-

“IT itself isn’t enough. Companies that have made the highest gains in productivity have also improved the quality of their work processes.”

tural factors may have made it hard to lay people off. There was thus a potential productivity gain, but it didn’t show up in the statistics or the bottom line.

Then the financial crisis forced the top management to say, “OK, we need to let go X percent of the labor force.” And now that the crisis has peaked, companies may realize that they don’t necessarily need to hire those people back.

We may not get the employment bounce-back that we had in 1982 or after earlier recessions. Many of the laid-off workers will not be hired back into the same jobs when the economy recovers. Those spots on the assembly line or behind the desk are gone forever, made superfluous by technology-enabled restructuring. Instead, people will need to find new jobs, in new companies and even new industries. That takes people a lot longer to sort out than simply going back to business as usual; hence, we can expect longer periods of unemployment.

S+B: And the reason for all this is information technology?

BRYNJOLFSSON: Part of it. But IT in itself isn’t enough. The companies

that have made the highest gains in productivity have also improved the quality of their work and management processes. They have what we now call organizational capital.

S+B: What is that?

BRYNJOLFSSON: It’s a kind of intangible asset. In many ways, organizational capital behaves mathematically just like other assets. By convention, an asset is something that creates a stream of value over time. Money spent on value that is realized within a year — for instance, labor and rental costs — is considered an expense. But if it’s spent on something that continues to create value for more than a year — like equipment, machinery, and buildings — it’s considered investment in an asset.

Now we’ve found that the same is true of investments in management processes and practices, including inventory management systems, value chains, accounting methods, and many others. Investing in these kinds of processes and practices can be very costly. You see companies spending a lot of time and effort to optimize the way that they work. But they build up a stream of value that lasts a long

time. If you measure those costs and the value that comes from the new practices, you can use those figures as inputs to a productivity equation. Then you see how they are correlated with outputs, including goods, services, and revenues.

You can also enter the value of these organizational practices into market value equations, which define a firm as equal to the sum of the values of all the assets it owns. Statistically, we’ve found that for every dollar of real estate, plant, or ordinary equipment that a company owns, on average, the company realizes one more dollar of market value. Organizational practices add to that amount significantly. In fact, in a typical company, for every dollar of technology assets, we found that there’s about US\$10 worth of computer-enabled organizational capital. Another way to put it is: The value of computer-enabled intangible assets in the U.S. economy is about \$2 trillion.

S+B: How do you measure the costs and value of management practices?

BRYNJOLFSSON: We’re just beginning to learn how to do it, and we still don’t know completely. One of

the ironies of the information age is that information work is less visible than manufacturing or agriculture. We have fewer ways of tracking it than we have ways of tracking the number of tons of steel being produced, or cars coming off the assembly line. Labor in traditional manufacturing is very visible by comparison. So you can be taken by surprise when great waves of change strike the body of information technology work.

But that doesn't mean that it's inherently less visible. If we want to really see the value of our organizational capital, then we have to change our metrics. The amount of energy and materials that Microsoft or Google uses is obviously not zero, but it's not nearly as intensive as it would be in a steel mill or automobile company. Their success is all due to human input. The only related metric that most companies use so far is employee head count, but that's not sufficient.

Our group at MIT, the Center for Digital Business, has been looking at e-mail traffic and other types of electronic communication. Lately we've been using sociometric badges [badges that track people's movements around offices] and tele-

phone traffic. We have also worked with Alex Pentland at the MIT Media Lab, tracking call center employees. [See "The Science of Subtle Signals," by Mark Buchanan, *s+b*, Autumn 2007.] You can get incredibly detailed information this way about where people are spending their time and what they're doing. Most companies don't make much use of that information, and there are privacy issues and a lot of other things that have to be navigated. But I could imagine that over time — five, 10, or 15 years from now — we will have excruciatingly detailed data about information workers that will make what we knew about physical work seem crude by comparison.

This kind of measurement is like the microscope when it was first used. Before that, people didn't know about individual blood cells. And from that invention came germ theory, which completely changed medicine. Something similar will probably happen in economics. Right now, most economists treat companies as a black box. Inputs go in, outputs come out, and some mathematical production function happens in the middle that's highly abstract. But we can make this kind

of economic theory much more fine-grained in the near future.

S+B: Certainly, any experienced executive knows that the quality of management matters enormously.

BRYNJOLFSSON: But it has been underappreciated. And only now is the link between management quality and economic growth becoming apparent. The studies that we've done, and that others have done, consistently show that when you have a lot of organizational capital, combined with IT in place, you can get a productivity boost. As more of the economy gravitates to services and information work, I think that component of success will increase.

From Taylor to Cisco

S+B: In defining the value of organizational capital, how do you differentiate among management practices? Aren't some more valuable than others?

BRYNJOLFSSON: We interviewed a bunch of firms, starting in the early 2000s. And we learned a great deal from Cisco Systems Inc. in particular. We wrote a case study about their management approach, based on conversations with their

employees, including their director of culture; the fact that they have created such a position is interesting in itself. [See “Networked at Cisco,” by Stephanie Woerner with George Herman, 2001, MIT Sloan School of Management Center for eBusiness, Case Study No. 1.] They carried a card they called the culture badge, about the size of a credit card, that listed 11 principles. Some of the principles correlated statistically with higher productivity: for example, open communication, empowerment, maintaining a quality team, and stretch goals. Others turned out to be more particular to Cisco and might not apply as strongly elsewhere: for example, dedication to customer success (meaning close collaboration with their business-to-business customers), “no technology religion,” frugality, and seizing opportunities during market transitions. About once every few years they might update or modify one or two of the principles, but basically the principles have held steady for the life of the company.

Based in part on the Cisco example, we wrote up a set of questions that we could ask in interviews at other companies. We also drew on the work of other researchers: Paul Osterman, an MIT professor who has conducted studies on high-performance work practices, and Tom Kochan, who codirects MIT’s Institute for Work and Employment Research. We used those questions as the basis for a set of about 450 interviews, at a variety of firms, that

lasted about 20 minutes each.

And then we let the data speak, to see whether these practices were correlated with higher performance and greater use of information technology. One cluster of seven management practices kept appearing in the most productive IT-intensive companies, and we started calling this combination of practices the “digital organization.”

S+B: By this you don’t just mean an organization using a lot of digital technology and IT?

BRYNJOLFSSON: Right. Of the seven management practices, only the first involved the use of digital processes instead of analog — for instance, tracking financial results through company-wide computer systems, rather than using paper systems. Open information access, in which even frontline employees have access to information from outside their departments, was another one. A third was empowering employees and decentralizing authority. For example, Cisco uses an IT system to delegate decision rights when someone goes on vacation or is out of the office. The other practices were using performance-based incentives, investing in corporate culture (as with Cisco’s badges), putting more effort into recruiting great people, and investing in human capital with, for instance, excellent training programs.

We found that companies that combined the seven management practices of the digital organization with IT were much more produc-

tive — they achieved better results with less investment — than firms that had either the digital organization without IT or IT without the digital organization.

S+B: How do the metrics for organizational practices fit together? For example, does lean production have a different impact on productivity than, say, team-building or diversity-related practices?

BRYNJOLFSSON: In measuring organizational practices, we asked people at the firms we chose a few dozen specific questions — for example, about their companies' use of incentive pay, the responsibilities for choosing work methods, and the investments in training per employee. We found that all of these metrics are correlated with one another, and we can create a single aggregate variable, which we call organizational capital. Every firm has a rating. To simplify our econometric analysis, we normalized all the ratings so that the average firm had a score of 0 and two-thirds of the firms had a score between -1 and +1: in other words, one standard deviation from the mean.

We haven't yet made the survey results public. We have considered

creating a website where people can answer the questions, see how their company compares to others, and add their answers to our database. But to be accurate about any company, it would have to include a number of perspectives: at least one person each from the human resources and IT departments, and enough people overall to compensate for the distortion of each person's limited perspective.

One framework I've found very useful for thinking about this is the concept of complementarities. It's the idea that two practices are more valuable together than separately: doing more of one increases the returns from doing more of the other. [Stanford University economists] Paul Milgrom and John Roberts have pushed the work on this forward. This principle traditionally has been applied to two technologies improving the impact of each other. But it can also be effectively applied to work practices. That's what our research on the digital organization is all about: understanding which management practices best complement today's technology, as well as the technologies that are just emerging.

And a lot more is known about

the technological side than the management side. When engineers design bridges, they've got software tools that allow them to visualize exactly where the stresses will be and how to put the beams together. When you design an organizational process, it's much more abstract; there are fewer tools to help you visualize what you're doing, and the effects are much more uncertain. (At MIT, we developed our own tool, called the matrix of change, to help with this process.)

The science of management and economics lags way behind physical engineering, and we should be focusing more of our innovation resources on the former. That's where the real payoffs will be in the coming decade. In fact, I believe that if something catastrophic happened and all computer technology froze for the next decade, we would still continue to see a tremendous amount of business innovation just trying to catch up with the technology that already exists.

S+B: In the most successful companies you've studied, which type of innovation comes first? Does new IT lead to better management — or does more creative management

“GDP misses some of the most important chunks of the economy; Wikipedia, Google, and Facebook aren’t priced in these equations.”

make it easier for IT innovation to take hold?

BRYNJOLFSSON: In the short run, better management practices come first, and information technology adapts to them. We found that the demand for IT was higher in firms that already had some of these practices in place, and they benefited disproportionately.

But management practices also evolve to keep up with technology — just over a much longer sweep of time. I have a book called *Scientific Management*, a collection of articles edited by Clarence Bertrand Thompson, published in 1914. The authors include Frederick Taylor and other early management experts, describing the optimal work practices of the early 1900s. The book’s ambitiously named First Law of Scientific Management says that “the worker must never need to stop and think.”

You could see how that might make sense at the time, but it’s 180 degrees from what we teach today. And the book contains many other similarly outdated principles. Never cross-train your workers, hold very high levels of inventory to make sure you never run out, and so on. We’re both laughing, even as I men-

tion them. But in fairness, I’m sure they were very successful practices. Henry Ford built a tremendously successful company and industry, and so did many other companies, by emulating those principles.

S+B: And they made Taylor into the first modern management guru.

BRYNJOLFSSON: Exactly. It was very costly to invent and create these principles. Taylor conducted all those time and motion studies, and his methods created value for many, many years. I don’t think those principles were innately wrong or right. Rather, they were well matched to the situation of that era, including the relatively inflexible machinery and the workforce skills of the time.

Back then, for instance, there was no information about what customers really wanted. Henry Ford famously offered his cars in any color, “as long as it was black.” That was because he had no way of communicating with his dealers and knowing about demand, and he couldn’t suddenly shift his assembly lines to paint different colors on every car. It was either black or out of his cost range.

But now you can get real-time information on sales trends and

have that information disaggregated by different geographies and demographic groups, and you can adjust your factories accordingly. Given today’s technology, a different set of principles makes sense. And because technology and management practices evolve together, productivity keeps growing.

Measuring Economic Health

S+B: Is productivity growth a reliable metric with which to measure society’s ability to provide the good life?

BRYNJOLFSSON: Yes and no. On one hand, productivity correlates well with standard of living. If it grows at about 1 percent per year, then it takes about 70 years for living standards to double. If productivity grows at, say, 4 percent per year, it takes only 17 years for living standards to double, and after 70 years they would be 16 times higher than at the 1 percent rate. That’s a big difference. Look at recent history. The difference between 1 or 2 percent, like the U.S. had in the 1970s, and 4 percent, as we’ve had recently, can have a huge impact when compounded over time.

On the other hand, an accurate

measure of productivity depends on having meaningful measures of output and input. And it's difficult to capture the true factors affecting quality of life. This doesn't just relate to productivity. Gross domestic product, for example, which simply adds up what is sold each year, misses some of the most important chunks of the economy. For example, Wikipedia, Google, Facebook, and even the value of a lot of health treatments aren't priced in these equations. If Wikipedia is available free and a bound set of *Encyclopedia Britannica* costs, say, \$1,000, when someone switches from *Britannica* to Wikipedia the GDP goes down. Yet, in practice, the value received by the consumer goes up; Wikipedia has much more comprehensive coverage. GDP gives us misleading statistics.

A good supplementary metric for measuring the level of economic growth is consumer surplus. This is the difference between what consumers are willing to pay for an item or service versus the market price they actually have to pay. For example, if I would be willing to pay \$10 a month for access to Wikipedia, but I pay zero, then I get \$10 a month of consumer surplus from it. Other people might be willing to pay only a dollar or a penny, and others would be willing to pay more. If you could average them all, then you would get the total value of how much everyone would be willing to pay, over the price they all had to pay, and that's the total consumer surplus from that product or

service. All together, there are trillions of dollars of consumer surplus in our society created by new goods and services.

S+B: But how can you measure what people are willing to pay for every product? You can survey them, but wouldn't the answers be suspect?

BRYNJOLFSSON: Sure, there are issues to resolve in measuring consumer surplus; we would need to triangulate it from a number of different directions. But you can estimate it with available data. In fact, some companies are doing that. They try different prices for different subgroups, using coupons or offer letters, or auction sites like Priceline. You can plot out every point on a demand curve, to see how the popularity changes as prices go up or down. By extrapolating between the points that you measure, you can make some reasonable assumptions about the upper and lower bounds on the consumer surplus for a given product.

And this is the data that we must consider when we want to understand how well an economy is functioning, because the consumer surplus indicates the opportunities for new directions and growth.

S+B: So if there were an overall consumer surplus in products and services — including such expensive domains as housing, health care, and university education — then that would be a reliable indicator of a healthy economy?

BRYNJOLFSSON: Viewed broadly, what we really want to know is the change in consumer surplus over time. Is it moving in a positive or a negative direction? If we're getting more goods that add to our consumer surplus, that's a good thing. If we continue to have high consumer surplus but it's shrinking each year, perhaps from greater pollution or traffic congestion, then even though it's still a positive number, the decline is a bad thing.

And we also have to factor in other issues, like people's expectations. In housing prices, for instance, there are factors related to both supply and demand. Part of the price reflects the value that people place on living in San Francisco or New York or Boston, where they are willing to pay a premium. Other places carry lower expectations, and those are reflected in the housing prices. Some of the value in a premium location ends up being captured by the landowners or the

“Part of the problem of income inequality may be due to the combination of IT and management practice.”

housing owners, who, when they sell, can charge more, and raise price expectations even more. Those factors are reflected in metrics like the GDP, but the consumer surplus is more likely to tell you how the overall economic quality of life in a country is going to change.

S+B: Given the continued evolution of both technology and management practice, what do you see as you look forward? Will the productivity spike last a while?

BRYNJOLFFSSON: Well, these estimates always get revised in hindsight, sometimes pretty significantly. It could be revised up or down. So I would hesitate to ascribe a lot of significance to any particular number in the short run. But over time, the growth in productivity is significant. It reflects growing output without growing labor input. As a general trend, we will probably have a continuation — and even acceleration — of this jobless recovery phenomenon. And this is possible because of the business process changes that companies have put in place.

It's also possible that the productivity growth spurt could be short-lived. The last period of high productivity growth, between 2000

and 2004, followed a period of very intensive IT investment and business process change. People used the Y2K conversion as a catalyst: “Rather than spending a lot of time fixing our computers, let's just overhaul the whole system now, and since we're getting rid of all our old COBOL anyway, we may as well put in a new CRM [customer relationship management] function.” There was actually too much IT investment. They overshot. But nonetheless there were a lot of productivity gains harvested.

This time around, investment in IT over the past five or six years has been relatively tepid, and so there may be less harvesting of technological impact available now. On the other hand, there may be a productivity boom coming in IT itself. “Cloud computing” is shorthand for the Internet becoming an enterprise computing vehicle, and we don't know how big the effects will be.

The other cause for concern about the economy is the distribution of benefits from this (or any) productivity boom. I don't know that there's anything in pure economics that says you couldn't have a sustainable society with just a few wealthy people and the rest being

have-nots. It may not be fair. It may not be the kind of society we want to live in. And Bill Gates won't consume as much food and clothing as his money would buy if it were distributed evenly. But he might spend more on jets and safaris, and it might not slow down economic growth that much.

In fact, part of the problem of income inequality may be due to the combination of IT and management practice we've been talking about. Some of our research suggests that global connectedness and IT power can create a kind of superstar effect, where it amplifies the creative and managerial talents of a few people. That can tend to concentrate wealth in not just the top 1 percent of the economy but the top 0.1 percent or less. Whether that issue gets addressed without undercutting productivity growth depends not just on innovation in the management sphere and technology, but also on our choices as a society and how policymakers implement those choices. +

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