The Economist Intelligence Unit

A report from The Economist Intelligence Unit

Ascending cloud

The adoption of cloud computing in five industries

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Contents

Introduction

Cloud computing has clearly become a driving force in the information technology world. Over 90% of global enterprises report using cloud as part of their business.[1] With over $33 billion in projected 2015 spend, cloud is now the largest category in IT infrastructure budgets.[2]

But every industry has its unique technology dynamics. Therefore, to understand the future of cloud computing you need to understand its dynamics in key industries.

In September-October 2015, The Economist Intelligence Unit, sponsored by VMware, asked a panel of 360 senior executives and thought leaders their views on the future of cloud computing. These were decision-makers—all directors or above, including half from the C-Suite or board of directors of their companies or non-profit organisations and approximately one-third with an IT background. Collectively they present a strong global perspective, and were drawn equally from developed and developing nations.

Finally, these respondents were equally representative of five key industries—financial services, retailing, healthcare, education and manufacturing—that are being impacted by cloud. Questions that required deeper industry expertise were directed to sub-panels of experts from each industry.

In this report, we will first present some brief observations on the role of cloud across these verticals. The focus will be on the pace of cloud adoption and its subsequent impact on key sectors within each industry.

In addition, our research showed that manufacturing plays a special role in global development—and so the report will take a deeper dive into that unique sector. In doing so, the report will highlight digital trends that have a broader impact as cloud moves from the digital to the "cyber-physical".

For reports on the impact of cloud on **healthcare** and **education**, please click on these links. ■

1 RightScale *State of the Cloud Report, 2015*

2 IDC, *World IT Infrastructure Spending Forecast, 2015*

Cloud computing—what does it mean for key industries?

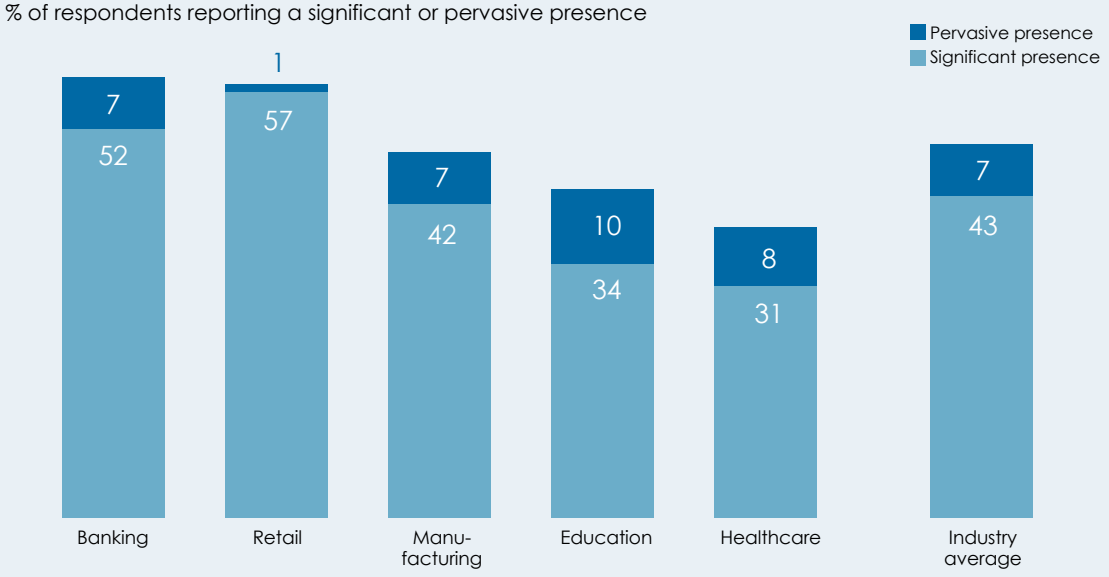
There is certainly a great deal of dialogue about the growth of cloud—but where does it actually stand? We asked each industry sub-panel to assess the current presence in their own industry.

The first observation is significant differences in the rate of cloud adoption. The first movers appear to be those that can generate a digital "pure play" side-by-side with the legacy industry—for example, digital banking emerging from branch networks, or e-commerce competing with high street retailers and shopping centres.

Manufacturing, as we shall see, presents a more complex problem—the integration of cloud into physical structures such as factories, machines and assembly lines. Finally, as discussed in our review of these industries, adoption in Education and Healthcare is slowed by regulatory constraints and less intense competitive environments.

The second observation is that, as far as cloud has come, it has a long way to go. "Pervasive presence"—ready access and widespread deployment—averages out to only 7% across industries. The following industry analysis illustrates just how that rate of growth is expected to be.

How would you characterise the current presence of cloud in the following industries?
% of respondents reporting a significant or pervasive presence



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

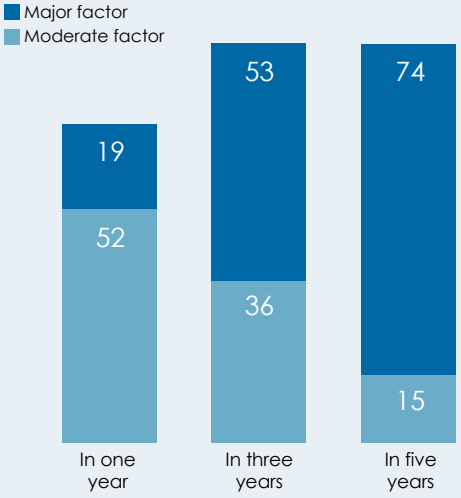
Banking—disruption of a legacy business

Two trends are driving cloud adoption in banking. The first is the adoption of cloud for back-office and selected customer operations by traditional banking institutions. The second is Fintech—digital insurgents who are regularly using cloud-based services to compete in key banking products.

According to our banking sub-panel, these forces will drive a rapid rate of adoption—almost three out of four predict cloud will be a major factor in banking in five years. Analysis of banking products and new markets shows a more nuanced picture of cloud coexisting with non-cloud systems. This may indicate the growth of cloud alongside existing legacy systems, coupled with concerns about security.

Future cloud penetration of the banking industry

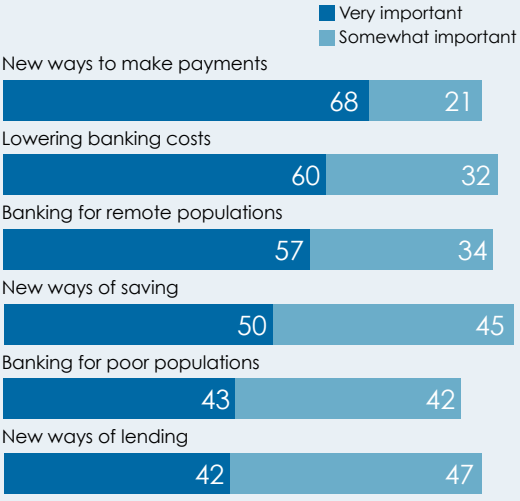
% saying cloud will be a moderate or major factor



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

How important is cloud in supporting sectors of the banking industry?

% saying cloud will be somewhat or very important



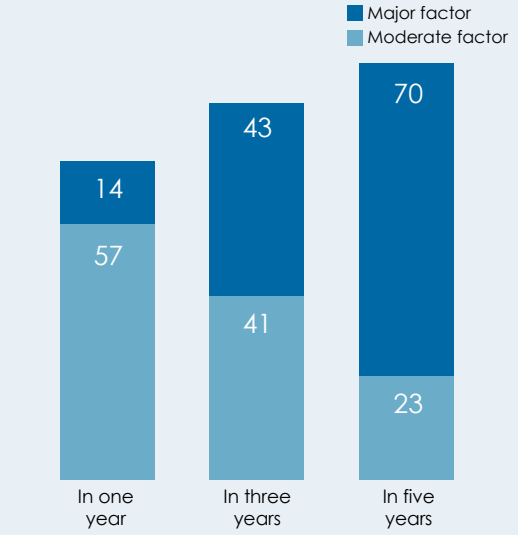
Source: EIU Survey "Cloud Computing and Economic Development", October 2015

Retail—the growth of parallel businesses

Our retail experts predict a similar pattern of cloud penetration in the retail business. From a relatively modest base, the expectation is that cloud will grow five-fold as a major factor in retailing.

One of the impacts of cloud appears to be making retailing more consumer-friendly, as a technology being used to increase access, lower prices and reducing costs for the customer. Another result appears to be enabling the growth of new products and the start of new businesses—indicating cloud's place as a central technology of e-commerce.

Future cloud penetration of the retail industry
% saying cloud will be a moderate or major factor



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

How important is cloud in supporting sectors of the retail industry?
% saying cloud will be somewhat or very important

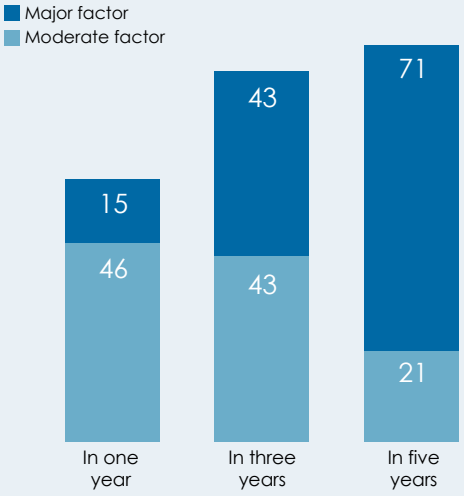
Source: EIU Survey "Cloud Computing and Economic Development", October 2015

The rise of digital manufacturing

As noted before, manufacturing appears to have something of a late start in cloud. One reason is that unlike digital "pure plays" such as financial services, manufacturing requires embedding of cloud into physical equipment—for example sensors into a machine tool, or GPS-markers into an order of parts.

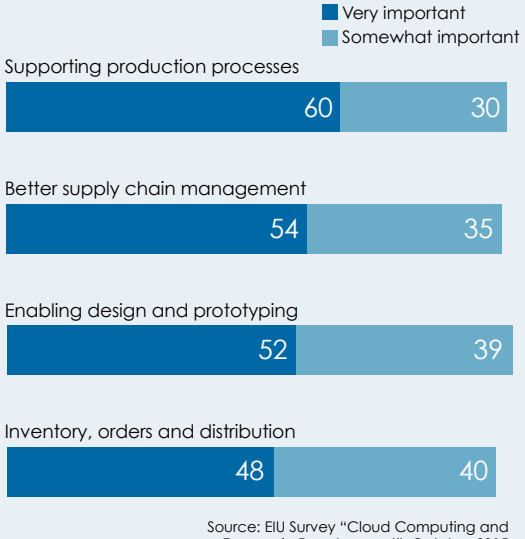
However, with extensive investment in the internet of things by manufacturers (which is largely cloud dependent), cloud penetration is expected to increase significantly and rapidly. Cloud is also expected to play a significant role in every step of the manufacturing process (from supplier to customer)—more detail in the analysis that follows.

Future cloud penetration of the manufacturing industry
% saying cloud will be a moderate or major factor



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

How important is cloud in supporting sectors of the manufacturing industry?
% saying cloud will be somewhat or very important



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

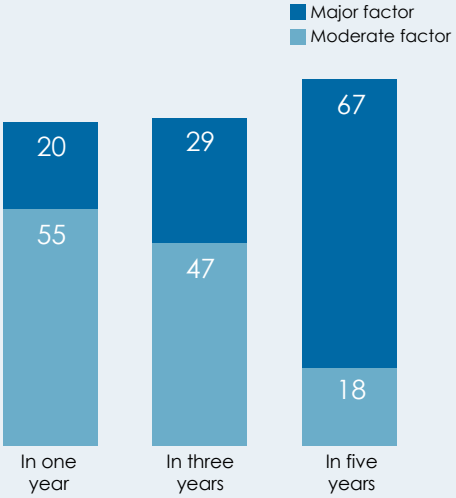
Cloud, technology and education

Education shows a somewhat slower adoption rate than other industries. Possible reasons include a less competitive environment and traditionally slower rates of technology adoption by government.[3]

But after much initial hype, online education has also suffered a series of disappointments as "MOOCs" (massive open online courses) found that large numbers of enrolled students did not pursue their studies. Nonetheless, adoption looks set to pick up speed in the 3-5 year timeframe, and cloud looks set to impact the entire spectrum of education.

Future cloud penetration of the education industry

% saying cloud will be a moderate or major factor



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

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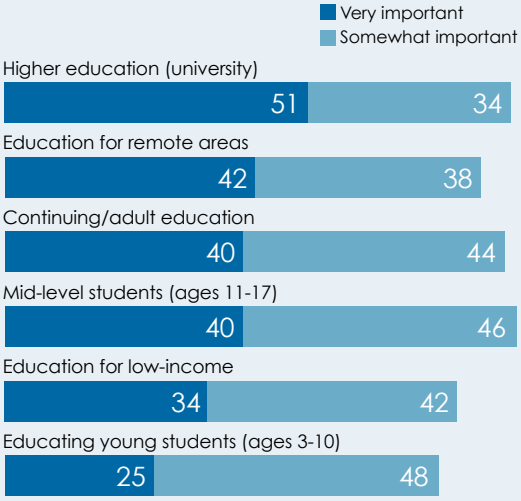
% saying cloud will be somewhat or very important



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

3 Information Week, *Public Sector Slow to Adopt Cloud Computing*, June 2012

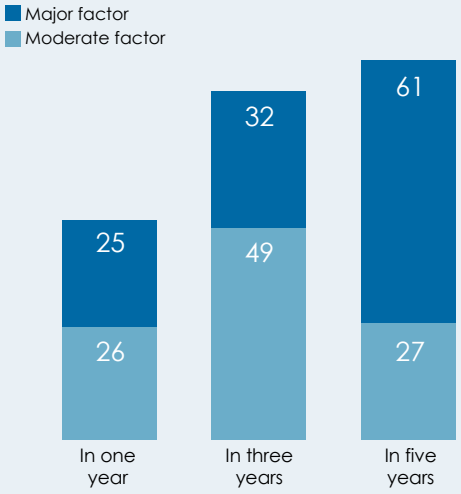
Cloud and healthcare—changing the relationship between patient and doctor

As in all of the industries analysed, cloud is expected to grow to become a major factor in delivering services. One area that the research indicates cloud will have an impact on is the actual delivery of health services—and the doctor-patient relationship.

Specifically, cloud is geared to support remote diagnostics and treatment—helping to empower the patient with knowledge of their own condition. It may also support the extensive data requirements of preventative care, supporting a long-term industry goal of holistic medicine.

Future cloud penetration of the healthcare industry

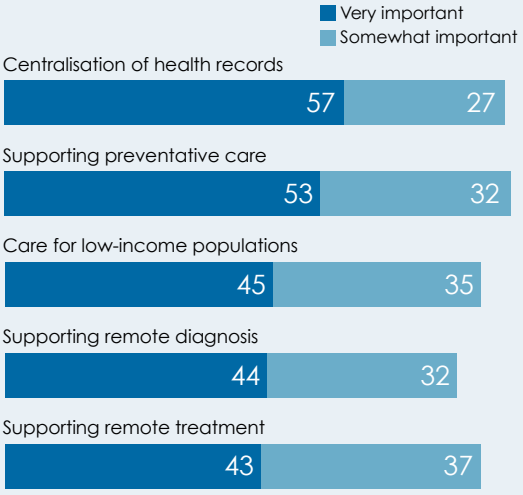
% saying cloud will be a moderate or major factor



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

How important is cloud in supporting sectors of the healthcare industry?

% saying cloud will be somewhat or very important



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

Manufacturing—a special case of cloud adoption

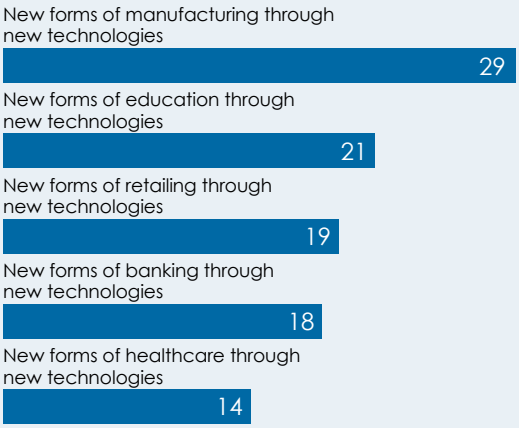
Different industries can be expected to make different contributions to economic growth. The EIU therefore asked our panel which sector—irrespective of its penetration by cloud—will have the greatest impact on economic prosperity. By a clear majority the panel identified manufacturing as the leading driver of economic growth.

Why is manufacturing so important to economic growth? An obvious reason is its sheer scale—manufacturing currently employs one in eight of all workers around the globe, and accounts for 16% of global GNP. Any changes in this massive sector cannot help but impact the larger economy.

Manufacturing also makes a disproportionate contribution to R&D and innovation. It is responsible for 20% of global innovation, and funds 77% of global research and development. Given the above, it is no surprise that manufacturing accounts for 37% of increases in global productivity.[4] This briefing will therefore focus on the impact of cloud on the key manufacturing sector.

Which sectors will drive economic growth?

Which of the following do you feel will have the greatest impact on your country's overall economic prosperity in the next three years?
(% respondents)



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

4 McKinsey, *Manufacturing the future*, November 2012

Enter cloud computing—the rise of digital manufacturing

Cloud has a relatively small current presence in manufacturing—only 7% of respondents believe that cloud has a pervasive presence in the industry. Accordingly, it lags behind more readily digitised industries such as banking and retailing, while leading traditionally slow-moving, regulated industries such as education and healthcare.

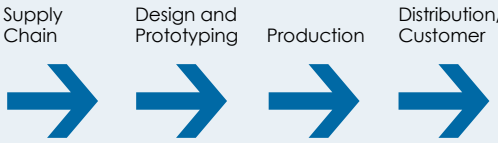
The primary obstacle is the physical element of digital manufacturing. Creating cloud applications in banking and other services, for example, is a relatively simple matter of proper coding. But embedding cloud into a factory requires the design of new sensors, ensuring common standards across machines, communications protocols—and a host of other "cyber-physical" challenges to be met.

That said, firms are currently investing billions to overcome these hurdles. Indeed, our survey panel expects an extremely rapid penetration of cloud into manufacturing—with over 90% projecting cloud will be a significant factor in only three years' time. Moreover, this high adoption rate is expected for all major manufacturing regions across the globe.

Interviews with experts in cloud computing support these findings. "The first initiatives we've seen around cloud and manufacturing were very much driven by a single dimension in terms of value creation and that was cost" says Ralf Dreischmeier, global leader, Technology Advantage Practice at the Boston Consulting Group. "Looking at the value of cloud today we hear more about agility, quality and innovation. I think that the more sophisticated parts of the business, like design and R&D, are much more likely now to adopt cloud because those benefits are there. This is a very clear trend that we have observed."

In sum, cloud-based manufacturing is starting from a low base, but is expected to be widely deployed in a few short years. When "digital manufacturing" arises, what will its benefits and challenges be?

The manufacturing value chain



Cloud and the value chain of manufacturing

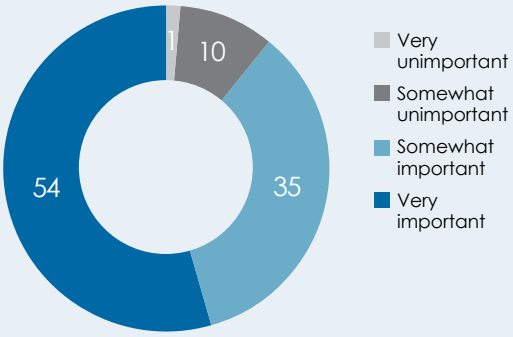
Manufacturing can be understood as a linear progression—supply chain, design, production and the shipment to customers. The impact of cloud is best understood as a transformation of each of these steps.

i. Cloud and the manufacturing supply chain

A modern television is built from 2,000 components, a car from 30,000 and an Airbus A380 from over 4 million. These raw materials and parts must flow in from thousands of locations to arrive across the globe on-time, on-spec and in-budget.

This complex chain requires huge scalability, access by multiple devices with different operating systems and the ability to manage large pools of data, all done cost-effectively—it is difficult to imagine building this outside of a cloud network.

What will be the importance of cloud in manufacturing **supply chain** in one year's time?
(% respondents)



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

For example, cloud-based solutions allow the dissemination of designs, specifications and contract terms to thousands of suppliers instantaneously.

When coupled with radio-frequency identification (RFID), cloud enables inbound parts to be tracked by multiple devices across the globe. Finally, cloud provides the scalable computing power and software-as-a-service applications that enables a procurement officer to closely manage delivery, inventory and pricing.

But this effect goes beyond simply tracking parts:

1. *Cloud can reduce supply chain costs*: The ability to source qualified bids from more suppliers can increase competition, driving down the cost of goods sold.
2. *Cloud can connect, expand and diffuse the global base of suppliers*: There is a reason why parts manufacturers are clustered around Detroit, Wolfsburg and Nagoya—their automotive customers want to be sure of close collaboration and no shipping problems. Cloud, by providing connectivity to inventory counts and shipments, can enable original equipment manufacturers to reach out to more distant, smaller-scale suppliers with confidence.
3. *Cloud supports partnerships between customers and suppliers*: An attribute of ubiquitous cloud is that it supports collaboration on a global scale—in design, in testing and in quality assurance. This can insert a new agility into supply chain relationships—where parts are co-designed and tested for quality.

In the longer term, these attributes can force a radical revision of the global supply chain. Suppliers can become more dispersed, more cost-competitive and compete based on their ability to collaborate with their manufacturing customers.

Joseph Salvo, manager, Complex Systems Engineering at GE Global Research, sees this trend as a broad social force. "As we connect the machines of the world to the people of the world in the industrial sector, the free flow of data and the free flow of information is going to be the force of democratisation," he says. "That increases GDP more than anything else. It's the ability to get access to ideas and knowledge. That's what transforms society and culture and leads to a better living standard for the average person."

ii. Cloud and design and prototyping

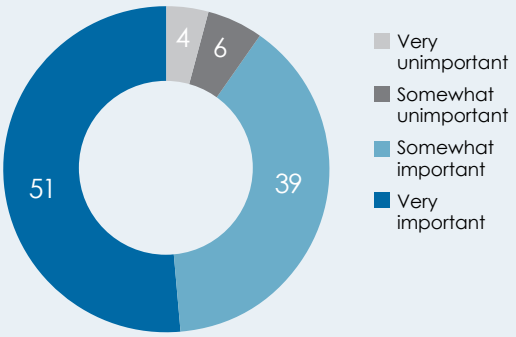
Traditional manufacturing design has been driven by a painful iterative process—design, test, fail, redesign, test, fail, redesign, etc. Cloud-based design and its cousin, 3D printing, will likely enable manufacturers to shorten or even bypass this painful process.

Cloud computing provides the immense data capacity and virtualised computing power that enables dynamic, digitally-based design. Imagine a working hologram of a part that can be constantly refined for wind shear, heat expansion, conductivity, fit with adjacent parts, component cost and a dozen other variables. Pre-modelling of these and other properties can allow the cloud-enabled designer to accelerate the product into the prototyping stage for physical testing.

This cloud-driven flexibility in design and prototyping will likely result in:

1. *Reducing costs*: Traditional manufacturing

What will be the importance of cloud in manufacturing **design and prototyping** in one year's time?
(% respondents)



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

design requires extensive rework, engineering time and production resources. Cloud based can certainly reduce costs associated to those.

2. *Accelerating time to market*: It takes only a half day to assemble a car, but it takes seven years to design a new one. Dynamic design and testing of parts can take years off of this cycle.
3. *Increasing customisation of manufactured products*: Flexibility in the design phase will enable manufacturers to "design on spec"—creating products that fit the individual needs of the customer. Similarly, a change in a component's design can be rapidly disseminated to thousands of suppliers, enabling them to retool and bring their product into specification with the new design.

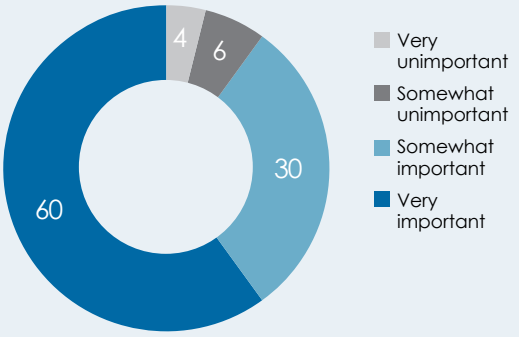
As usual, the unforeseen benefits of technology may be most interesting. The greatest impact of digital design may be in the intangible field of innovation—where a late-night engineer has the freedom to tinker, test and experiment rapidly at low cost. In this sense the greatest impact of cloud on design may well be the innovative development of unforeseen products.

"We have definitely seen that cloud allows you to realise simplification and productivity improvement where you didn't expect it," Mr Dreischmeier says. "In discussions with clients we started off saying that the cloud is a more efficient way to store your data, so you save IT operating costs. The discussion we're having now is that it enables highly distributed technical data to come together in one place where it can be accessed by next-generation devices. So with all these additional benefits now coming through, cost saving is still a lever, but now there are other levers that are becoming more and more important."

iii. Cloud and the production process

The production process describes the physical creation of the products—the measuring, cutting, stamping, welding, assembly and testing of the finished product—be it a child's toy, a smart phone, or the airframe of a commercial airliner.

What will be the importance of cloud in manufacturing **production** in one year's time?
(% respondents)



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

Cloud is the network platform for the internet of things (IoT)—which includes the embedding of sensors into the assembly lines, machine tools, factory controls and quality testing monitors of the "smart factory". Cloud can provide the computational glue that enables data to be collected and analysed to support the IoT. This will likely result in the following developments in the production process:

1. *Cost reduction through operating efficiencies*: For example, equipment-based sensors will tell a central dashboard when the machine needs maintenance, is operating at sub-performance, or is about to fail. By alerting the operator to the need for preventive maintenance, these cloud-based reports can optimise the unit's performance, and prevent the breakdowns that result in the dreaded "shutting down the line."
2. *Boosting manufacturing flexibility*: Traditionally, a washing machine factory did just that—it was only capable of manufacturing washing machines. But cloud can enable factories to become "programmable"—enabling a rapid re-setting of production lines for new products, or customised versions for current ones.
3. *Greener manufacturing*: A simple manufacturing maxim is that greater manufacturing efficiencies mean lower fuel

consumption. For example, cloud–based building controls can regulate power (typically the second-highest operating costs for manufacturers) to when and where it is needed. Furthermore, sensors can be used to track sub-performance operations and their impact on CO_2 emissions.

Salvo points out that cost is not the only driver of greener manufacturing: "Why now is there this big push for sustainability and environmental consciousness?" he asks. "Once you go back to a local production paradigm, you want to be able to site your production anywhere the customers are. If you are going to do that you have to build trust and creditability with the customers so your systems must be transparent. And they have to be sustainable."

A sadder consequence to cloud based-manufacturing may be the further decline in skilled manufacturing jobs. Cloud computing can provide the digital backbone that supports robotics and automated assembly. These technology-intensive solutions will continue the displacement of skilled blue collar workers with highly-paid but much fewer digital specialists.

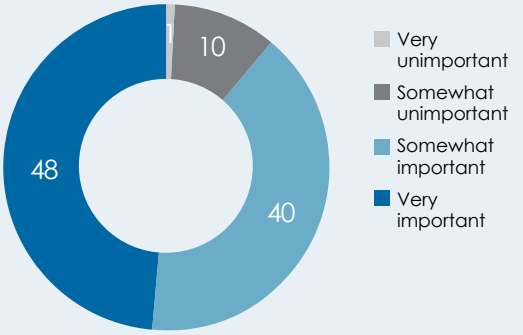
iv. Cloud and the manufacturing customer

The traditional manufacturer-customer relationship has been: 1) A product is sold to the customer and then 2) The supplier disappears until a new product is to be sold. Cloud has the potential to revolutionise this arm's length relationship.

Just as cloud enables upstream collaboration with suppliers, it can support downstream collaboration with customers. The ability to flexibly source parts, to dynamically design products and to switch out one production run for another will create a new test of competitiveness—how closely you can collaborate with your customer.

Now, when you buy a car, you pick out whatever is in the showroom. In the near future, it may be possible to order the "configured car" with your choice of engine size, transmission, interior colour and number of cup holders. The successful manufacturer won't just make the best product—they will make the best product for each customer.

What will be the importance of cloud in manufacturing **distribution and customer relationships** in one year's time?
(% respondents)



Source: EIU Survey "Cloud Computing and Economic Development", October 2015

Cloud's impact on customers won't just be in the relationship. It could also be in the product itself.

"Now the secret is who can innovate into that vast market and find the market niches that they can outperform and create the value," Mr Salvo says. "It's going to be more about creating value stories for the individual customers and creating those network relationships versus brute force competition against the guy next door. That is a mind shift that I see happening, although it's going to take some time."

Manufactured products are increasingly carrying a digital capability—be it smart clothing, telematics in a truck, or fuel sensors in a jet engine—that have the potential to restructure the customer relationship.

Take for example a commercial heating, ventilation and air conditioning (HVAC) manufacturer. Five years ago, they might sell a $5 million unit to a building manager and—unless it failed—not see them again for the life of the unit. Now that HVAC system is equipped with temperature, humidity, fuel consumption, maintenance, performance and other sensors. This cloud based system enables the manager, among other things, to monitor and purchase

utility power at its lowest rates (eg in the middle of the night).

The result is that the manufacturer is no longer a supplier, but has become an energy manager for the building. Instead of selling a product, the HVAC manufacturer leases it, and earns revenue on joint energy savings. This collaborative, cloud-enabled relationship can be found in consumer wearables (Fitbit), building controls (Siemens), or air turbines (General Electric).

The challenges to digital manufacturing

Cloud-based manufacturing will open up a brave new world—but not all of it will be simple or easy. Front and centre is the risk that challenges the deployment of cloud and other technologies in all industries—cyber-risk, or increased vulnerability to cyber-attack and digital espionage.

The historical manufacturing plant was a pretty autonomous facility—no digital connectivity at all was the ultimate firewall. But by embedding sensors in machines, storing digital designs and creating a smart factory network, the digital manufacturer assumes a new vulnerability to cyber-attack.

Embedding proprietary designs into digitised workflows allows them to be more easily penetrated and stolen. A cyber-savvy competitor could conceivably tap into reporting applications and get a clear picture of your manufacturing methods, cost position and new product line. A really unscrupulous competitor or cyber-terrorist could make data disappear, or reset a manufacturing line to come to a grinding (that is literally grinding) halt. As in all emerging technology, cyber-risk emerges as the most serious challenge.

Another challenge is that, at present, there are no commonly-accepted standards that enable seamless connections from machine-to-machine, manufacturer to supplier, or manufacturer to customer. We are only just beginning to see software that is capable of handling the massive data deluge of digital manufacturing. Digital manufacturing has many technical hurdles to leap before it delivers on the many promises being made.

Dreischmeier points out that regulations concerning access to data can also be an obstacle to cloud adoption in some industries. "When we talk about manufacturing, clearly it's pretty diverse," he says, "it goes from aerospace to drugs to automobiles. Adoption rates can be significantly influenced by regulatory requirements that ultimately influence a company's philosophy around security and risk. Regulations do limit what companies can and can't do quite a lot."

The final challenge is a human one. The digitisation of the manufacturing line (including the installation of robotics) will clearly disrupt the blue-collar workforce that has built the modern world. At best, it will force a wrenching reset in the skills needed in manufacturing—a wrenching evolution that will leave many traditional blue collar workers behind. At worst, the digitisation of manufacturing will drive to a net loss in highly-paid manufacturing positions, increasing income inequality and concentration of wealth.

Cloud computing—the long view

Major technology transformation seems to follow three waves of adoption. The first is cost reduction. The second is doing-what-you-are-doing-now-but doing-it-better. The third is the most fascinating—the creation of unforeseen, wholly new opportunities that no one planned for or expected.

What is happening to manufacturing's suppliers can be applied to the suppliers of any industry. Transparency in digital bidding may drive down supplier costs. Advanced digital design will shorten and cheapen the iterative cycle of almost any product's design. The digital factory may operate more efficiently, with less down time and using less energy.

In a million little ways, digitisation can make many industries more efficient and flexible. Supplier collaboration can be enhanced. Design changes will come faster. Production lines can be reconfigured and switched out faster. A key outcome will be a speeding up of the creation cycle, including the iterative process of design/test based on changing customer demands.

Even experts in the field are amazed at the potential for sweeping change. "Every day I can hardly wait to get up to work in this space," says Mr Salvo. "This is a once in a lifetime moment in history where we are literally connecting all the machines and minds of the world and we are going to improve our environment and our ability to deliver value to everyone that's connected to the network. It's just totally exciting and transformational in my opinion." ■

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