Introduction

How can the business identify and seize relevant technology at the height of its promise?
Make no mistake; in 2018 the CIO is a business partner. The pressure is on to move beyond supporting operations to become a driving force behind business growth. In the sea of emerging tech, you are the business’ navigator. Do you know where your business needs to go?

Let business outcomes be your compass.
A strategic direction is essential to making the right technological investments. Not every trend is worth pursuing, but missing the ones that are can be costly. An outcomes-focused approach gives you a framework to strategically evaluate emerging technology’s alignment with your business’ direction. Use a business-outcomes-centered outlook to effectively separate opportunities from distractions.

Go from browsing to doing.
Learn what is driving each trend and how it has evolved from previous years. Most importantly, use the business outcomes framework presented in this report to create the foundation for your adoption strategy. Determine which trends are worth your attention, chart an adoption course, and build a business case for your stakeholders.

A recent survey of over 20,000 IT and business executives concluded that innovation leadership is three times as important as it is perceived to be, in determining overall satisfaction with IT.

— Info-Tech Business Vision Survey
This year introduces **four key trends** that draw their impact from both technological innovation and an alignment with key **business outcomes**.

Each trend represents the convergence of several previously trending technologies to enable new advances that are greater than the sum of their parts. Assessing these transformative technologies with an eye to their ability to drive business outcomes reveals their unprecedented opportunities for business impact.

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In 2018, your priority is to drive business outcomes through emerging technology.

**2018 Trends**

Opportunities to Drive Business Outcomes

- Blockchain 2.0
- Digital Twin
- Robotics
- User-Facing AI

**2017 Trends**

Strategic Priorities

- Decentralized Making
- Everything-as-a-Platform
- Distributed Validation
- Automated Cognition
- Autonomous Machines
- Immersive UX
- The Digital Ecosystem
The boom of IoT and Industry 4.0 has created an abundance of data. So much so that an entire system can be characterized, and the collected data used to create a real-time, living model – its digital twin. The opportunities for decentralized monitoring and predictive analytics are truly extraordinary.

Increasing robotic sophistication is allowing machines to work with humans, but not replace them. Emerging opportunities to augment human performance means businesses can use technology to make the most of their human capital.

Communication barriers between humans and machines are coming down. Businesses can leverage this emerging connection to automate basic customer service tasks, improving experiences for customers and users alike.

The blockchain has outgrown bitcoin. Innovations are being developed to tailor distributed ledger technology to specific use cases outside of cryptocurrency, creating possibilities for scale, contract enforcement, and returning data ownership to the individual.
User-Facing AI

“27% of consumers weren’t sure if their last customer service interaction was with a human or a chatbot.”

— PwC, "Bot.Me: A revolutionary partnership"
Robotics

47% of jobs in the US could be replaced by robotics and other computerisation by 2034. 58% of CEOs intend to reduce headcount over the next 5 years as a result of robotics.

— PwC, "Pulse on robotics"
Digital Twin

Using digital twin technology to monitor and optimize wind turbine operation can boost energy production up to 20%, resulting in around $100 million in extra revenue over the life of a turbine.

— GE Renewable Energy, "A Breakdown of the Digital Wind Farm"
Blockchain 2.0

28% of CEOs in major US companies have spent $5 million or more in blockchain technology. An additional 25% of CEOs in major US companies expect to spent $5 million or more in blockchain technology in the coming calendar year.

— Deloitte US, "Blockchain survey 2017"
Five Key Business Outcomes

All of these trends have the potential to transform not just the bottom line, but the business itself, changing its internal processes and external positioning within industry and society.

Several axes have emerged along which this transformation can take place. These axes are represented by five key business outcomes.

1. Automation
   The ability to be lean through the replacement of aspects of human-based organizational processes and activities with technology.

2. Integration
   The ability of the technology in the trend to integrate with the technology of customers, partners, and suppliers.

3. Scale
   The ability for the product and/or service offering in the trend to quickly increase capacity.

4. Intelligence
   The ability for the trend technology to leverage organizational outputs to make processes smarter and more efficient.

5. Impact
   The ability of the trend to deliver a positive or negative social impact on user and customer experience.
Innovate Purposefully

What outcomes is your business hoping to achieve? Which trends have the most impact potential in these domains? Focus your efforts for the biggest return on investment.

Use outcomes-based thinking to zero-in on the trends that matter to your business. We scored each trend according to its potential for impact on each of the five key business outcomes. The resulting table should be your first strategic touchpoint.

Identify at a glance which trends are most relevant to your business’ current direction. Cut through the deluge of information and get to action sooner.
How to read this report

Get current information

Description:
• Each trend is introduced with a key point summary and statistic, highlighting its growth and impact.
✓ In 2018, technology is an opportunity to create lasting business impact.

Evolution:
• For each trend, we highlight the cutting edge of what is new for 2018.
✓ Technology doesn't stay still. Keep abreast of the latest developments to give yourself an edge in selecting the best tool for your purpose.

Evaluate strategically

Signals & Drivers:
• We analyze the driving forces behind each trend, and the way it is manifesting in different scenarios.
✓ Understand the technological and societal changes that are driving each trend to determine whether they are relevant to your business.

Business Outcomes:
• We present five key domains of business impact, and each trend's relevance to those domains.
✓ Viewing trends through an outcomes-focused lens allows you to align innovative initiatives with key business objectives.

Put theory into practice

Risk & Uncertainty:
• We list the key risks and critical unknowns that result from technological advancement.
✓ No matter your organization's risk tolerance, awareness of the risk is always the first step. Learn what questions you should be asking.

Case Study:
• Each trend is illustrated by a case study that examines how the trend was leveraged to achieve the desired business outcomes.
✓ Every organization will approach the business outcomes in its own way. What does success look like for your business?

Resources & Recommendations:
• We provide links to relevant Info-Tech resources for each trend.
✓ We are constantly growing our toolkit so that you can grow yours.


User-Facing AI

The disappearing user interface
What is user-facing AI?

Imagine if launching a video conference were as simple as saying, “Please call the main boardroom.” The call would then automatically be put through by a virtual assistant running a natural language processing algorithm.

Artificial intelligence (AI) in user-facing scenarios refers to the automation of user- or customer-facing tasks. The end goal is two-fold: to decrease the burden on human support service providers while increasing user satisfaction.

This development comes at the junction of two previous trends: automated cognition (intelligent systems) and immersive UX. It goes beyond previous thinking of simplifying user interfaces to removing them altogether. Intelligent machines are learning to live in our ecosystem and speak our language, sometimes literally. AI is also reaching us using digital tools we already have, as with chatbots interacting over Facebook messenger to book flights or doctor’s appointments.

This will impact customer satisfaction as well as user efficiency within the organization.

“75% of organizations using AI enhance customer satisfaction by more than 10%.”

— Capgemini Digital Transformation Institute, “Turning AI into concrete value: the successful implementers’ toolkit”
What’s new in 2018?

Previously, the focus surrounding human-computer interfaces was on digitizing the user’s environment, creating a more immersive experience using technology: “This new immersed individual [was] using technology in increasingly complex and different ways” (CIO Trend Report 2017).

In 2018, immersive technology becomes intelligent. Artificial intelligence, which has excelled in cognitive analytics on the back end, comes to the forefront of user experience. User-facing technology is beginning to anticipate our needs and adjust to them automatically. We begin to engage with technology in the same way we engage with humans – through speech and natural language. Rather than simplifying the user interface, 2018 seeks to remove it altogether.

Customers and users both benefit from this change, which results in greater customer satisfaction and user efficiency, translating directly to benefits for the business.

Estimated number of users of digital assistants worldwide

- Statista, “Digital Assistants - Always at Your Service”
“Worldwide AI revenue will grow from $643.7 million in 2016 to $36.8 billion by 2025.”

— Tractica, “Artificial Intelligence Revenue to Reach $36.8 Billion Worldwide by 2025”
Share of organizations implementing AI that observe more than 10 percentage point gain on the following benefits

- Reduced churn
- Reduced customer complaints
- Enhanced customer satisfaction

— Capgemini Digital Transformation Institute, “Turning AI into concrete value: the successful implementers’ toolkit”
What Is Driving This Trend?

Advances in natural language processing, machine learning, and increasing user adoption of technological communication channels set the stage for AI to take on user-facing roles effectively.

At the forefront of this trend are concepts such as augmented reality, the smart home or office and the concept of “zero-UI.” Zero-UI refers to a shift in thinking around human-technology interfaces. Computers will now adapt to human ways of communication through natural language processing, rather than relying on us to learn to engage with their interfaces. Even the least tech-savvy user is now able to command state-of-the-art technology.

The concept of human-in-the-loop – the idea that AI will augment human capabilities rather than replace them – is shaping the development of user-facing AI. AI roles are constrained to automating the simple and repetitive, enabling human agents to devote more attention to critical and complex tasks.
How does the trend score on the five key business outcomes?

To what extent does the trend allow the business to free up human capital through automation? Does it integrate with stakeholders’ existing technology? Is the technology able to quickly increase capacity? Can it learn from its own outputs? Will it deliver a strong social impact on user and customer experience?
Automation: Spot-on
Employing AI in user-facing scenarios has great potential for automating repetitive human resource intensive work, freeing up human capital for the highest value tasks.

Integration: High
The exponential adoption of user-facing AI results from its ability to make use of customers’ existing means of communication, like voice chat and popular instant messenger platforms. Businesses can leverage this to reach customers through familiar venues, removing a barrier to engagement with the business. Integration is further streamlined by AI’s ability to interface with both complex APIs and end-user tools, creating the potential for a seamless interface between systems and users.
How does the trend score on the five key business outcomes?

Scale: High
Personalization at scale – this is the promise of chatbots, virtual assistants and related user-facing AI technology. It allows the business to expand customer service without hiring more staff, and therefore plays an important supporting role in maintaining customer satisfaction as the business grows.
A word of caution: some customer support functions, especially if they form the core services of a business, are typically too complex to automate given the current state of AI. AI can’t replace your entire customer service team just yet.

Intelligence: Medium
Automating customer service tasks through AI allows for greater capabilities to both collect and use large amounts of user data to improve service delivery. Data quality is significantly impacted by removing human error in data handling, forming a solid foundation for analysis at scale through cognitive analytics.

Impact: Spot-on
Paradoxically, outsourcing tasks like call desk and appointment scheduling to an AI can create a more human experience for the end user. In many cases, these tasks have already been outsourced to less flexible technology, like call queue software. By bringing some of the human element back through human-like AI, you get the next best thing to actually putting more humans on the task, at a fraction of the cost. The result is greater user satisfaction, both through better outcomes (shorter hold times) and a more pleasant experience (more intuitive interface through voice, rather than pressing keys).
Risk Considerations

With AI’s ability to aggregate unprecedented amounts of user data, the need to protect data privacy grows ever greater. Risk further intensifies as communication shifts to commonly adopted platforms, such as instant message clients. Protections must be built in to ensure this new technology continues to comply with data privacy standards to maintain legal impunity and client trust.

In the case of interfacing with third-party platforms, it is critical to ensure the platform is capable of supporting the necessary levels of data protection for the type of data you are handling. This is especially true in fields such as healthcare, where communication over technological channels is often restricted to ensure confidentiality. As AI expands the range of platforms used for communication, platform creators and enterprise users alike will need to be judicious in selecting solutions capable of upholding appropriate data confidentiality standards.

Critical Uncertainties

The rapid development of AI and the speed of its adoption have created gaps in regulation surrounding data ownership. Although regulations are starting to emerge (e.g. GDPR), this space is still very much in flux, and legal provisions around data use will likely change over the next few years.

Concerns of job loss have been somewhat mitigated by the concept of human-in-the-loop. This is the idea that AI will augment, rather than replace, human performance in most cases. However, some concerns remain that the rate of change could still outstrip the pace of job market recovery. A definitive conclusion will likely only emerge in practice.
Case Study

Industry: Healthcare

Desired business outcomes: Social Impact, Scale

Situation

• Pre-procedure anxiety and stress are a major concern in healthcare settings, particularly in the case of pediatric hospitals.
• Hospitals provide a variety of stress management services to patients, ranging from books and educational videos, to personalized sessions with counselors and social workers.
• The client was a company in the entertainment industry who wanted to improve children’s hospital experiences using stress-reduction methods that would be easy to implement on a large scale.

Action

• The client created a virtual reality game to ease children’s stress when going into medical procedures. The game combines emerging VR technology with a smart stress-reduction algorithm. The game’s AI automatically adjusts gameplay to the child’s stress level, to ensure that at the end of play, stress levels are lower than at the start.
• The client engaged Info-Tech to develop a venture capital presentation for a go-to-market strategy, including selection of markets for initial entry.

Result

• Over the course of the week-long engagement, the client gained the ammunition necessary to put together a venture capital presentation for the healthcare market, as well as identify other markets for later expansion.
• The venture capital presentation was successful, securing an 8-figure amount and distribution partnerships.
• The project launch was a win, with adoption of the VR game complete or pending at over 20 hospitals.
Resources & Recommendations

Although tremendously exciting, the adoption of emerging technologies is also risky and uncertain. Info-Tech provides research and recommendations across industries to support a business-outcome-driven approach that ensures you get the value from your technology investments.

Recommendations

• Stay up to date regarding data privacy regulations in your sector. In addition to maintaining compliance within your organization, watch for changes in vendors’ service contracts regarding use and ownership of data.
• Consider the impact of automation on human performance and ensure any humans-in-the-loop maintain enough practice to keep their skills current.

Upcoming Research

• Implement AI Into Your Manufacturing Process

For Premium Members

• Learn why chatbots are a quick win in healthcare
• Strike the right balance of personalization with customer-facing AI
• Put a number on the business value of customer-facing applications
• Keep user data safe


Bibliography


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Robotics

Factory floor to the living room
What is robotics?

The goal of robotics is to create process-focused intelligent automation, incorporating artificial intelligence and machine learning algorithms. Robotics encompasses both robotic process automation (RPA), i.e. the automation of virtual or clerical processes using software “taskbots,” and robotic automation of physical tasks.

The aim is to replace humans in a variety of repetitive, rule-based, or dangerous tasks. These tasks can refer to business processes like employee onboarding or processing accounts payable, or physical tasks like lifting heavy loads, inventory management, or entering dangerous environments. Although the aim is to substitute human effort on a task level, at the job level the goal is more to augment human performance, a concept known as “human-in-the-loop.”

The intent is to make human workers more efficient, safer, and more engaged by automating part of the work. An example of this would be employing a machine-learning system, like Watson, to read radiological images and make recommendations to a human radiologist, who manually reviews complex cases and signs off on the final determination.

“We showed that currently demonstrated technologies could automate 45 percent of the activities people are paid to perform and that about 60 percent of all occupations could see 30 percent or more of their activities automated.”

What’s new in 2018?

Robotics is the convergence and evolution of two trends previously covered by Info-Tech: autonomous machines and automated cognition. Autonomous machines represent another industrial revolution, where humans can stop performing undesirable activities. Monotonous activities that require repetitive and extreme physical exertion can be done by robots. Automated cognition and RPA speak to an extension of the human mind. Ever increasing data sets require the outsourcing of certain computational processes to machines that can better respond to them.

Robots in 2018 are no longer machines that perform rote structured tasks or calculations – they are evolving to perform in dynamic environments. Robots are moving from working in isolation to working with humans. Robots are shifting from programmed to learned behavior through artificial intelligence (AI) and machine learning (ML).

In short, robots have crossed into the final frontier – our living rooms and our workplaces. Working, interacting, and living with robots has become all but an inevitability.

“If you look at the field of robotics today, you can say that robots have been in the deepest oceans, they’ve been to Mars, you know? They’ve been all these places, but now they’re just starting to come into your living. Your living room is the final frontier for robots.”

— Cynthia Breazeal, NOVA ScienceNOW documentary series on PBS
“The global market for RPA Software and Services is expected to grow to $1.2 billion by 2021 at a compound annual growth rate of 36%. The direct services market includes implementation and consulting services focused on building RPA capabilities within an organization.”

— Phil Fersht, “Enterprise Automation and AI will reach $10 billion in 2018 to engineer the OneOffice”
“RPA is a promising new development in business automation that offers a potential ROI of 30–200 percent—in the first year.”

— McKinsey & Company, “The next acronym you need to know about: RPA (robotic process automation)”
“3Gem Research ran a survey on 250 heads of department in the US and the UK, in various sectors such as business services, finance, banking and manufacturing. According to the respondents, ‘productivity and 24/7 availability ranked 1st and 2nd highest in terms of the benefits (62% and 61% respectively), followed by 58.4% of respondents agreeing ‘the end of repetitive work’ as a top benefit.”


What Is Driving This Trend?

Advances in artificial intelligence, machine learning, internet of things, sensors, and natural language processing are bringing robots into everyday life. Evolution in these different domains of technology has allowed robotics to become dynamic, human-facing, and economical.

Compounding these technological advances are the economic benefits that RPA can bring to organizations. Employees are faced with an abundance of data and increased complexity. Cost reduction, error avoidance, quality of work improvements, and time returned to employees are some of the most commonly cited reasons organizations are pursuing investments in RPA.
How does the trend score on the five key business outcomes?

To what extent does the trend allow the business to free up human capital through automation? Does it integrate with stakeholders’ existing technology? Is the technology able to quickly increase capacity? Can it learn from its own outputs? Will it deliver a strong social impact on user and customer experience?
How does the trend score on the five key business outcomes?

Automation: High
They key benefit of robotics is its ability to automate mundane tasks and move humans toward tasks that produce higher value. When line of business managers were asked to name the biggest benefits of robotics, 24/7 availability and increased productivity topped the list. Despite a high level of automation, the technology will not be ready to automate dynamic roles in the near future (CiGen RPA).

Integration: Medium
Robots are becoming more dynamic than ever before. Yet the ability for robots to interact with the machines of suppliers and consumers is still far away. There are issues with standardization because all systems involved in the process must be compatible. It goes beyond basic connectivity between systems, such as software, and it will take time for players along an industry vertical to align.
How does the trend score on the five key business outcomes?

Scale: Medium
We will see the mass proliferation of robots in every facet of life within the next 3 years. Cobots, robots that collaborate with humans to complete tasks, now sell for an average of $30,000. By 2020, that price will be $15,000, less than the price of most cars. The issue will not be supply, but rather demand, in that robots may not provide the exact fit organizations or customers are looking for (PwC, “Five ways robots are going mainstream”).

Intelligence: High
The technological advances that have brought robots into our everyday lives are a result of increasing robot intelligence. Machine learning and artificial intelligence are becoming more advanced each year, allowing an increased percentage of robots in the workforce to learn and improve from experience. This experience will likely still be confined to simple tasks in the near future.

Impact: Spot-on
There are great social implications for RPA. On one hand, the robots promise to liberate individuals from mundane tasks, so that they can focus on high-value, mentally stimulating activities. Robots can also cause great pain. In the near future, many human workers may be completely replaced by robots. It is predicted by 2025 that there will be 5.25 robots per 1,000 human workers. This will contribute to 3.4 million lost jobs (McRae).
Risk Considerations

Robots cannot easily adapt to small changes in a certain process. A change in a drop-down menu or the way data is entered can cause significant data corruption. At this point, the ability of a robot to recognize these small changes and make corresponding adjustments pales in comparison to that of a human. Changes to upstream and downstream steps in a process can easily disrupt a robot and result in heavy spending. For example, new regulations requiring minor changes to an application form could necessitate reconfiguration for all robots involved.

The scripts that program robots to perform a specific action should be treated like software code. Scripts should be designed using industry-standard methodologies that focus on reuse and abstractions. They should also be versioned and properly logged so that quality assurance processes can be executed against them. This will help organizations avoid the nightmare that may ensue if scripts are not designed for reuse and robots must be removed from business processes each time a small change is made to a process.

Critical Uncertainties

RPA implementation is nine times more expensive than the robots themselves. Uncertainties around enterprise architecture constraints and IT security concerns can easily drive costs up. We also don’t know how the current workforce will respond to an RPA implementation. If change management is conducted poorly, employees may get the sense that they are being replaced by robots (Deckard).
**Case Study**

**Industry:**
Professional Services

**Desired business outcomes:**
Automation

**Situation**

- Infosys BPM worked with a multinational corporation (MNC) to implement robotic process automation (RPA) in its human resources function.
- The HR function at the MNC handled a variety of responsibilities. Some of these included talent acquisition, talent administration, talent development, employee lifecycle management, employee experience, compensation, and benefits support.
- The client grew rapidly in recent years, and the HR function found it difficult to process an increasing volume of transactions. Processing these transactions demanded both speed to meet recipient demands and high attention to detail.

**Action**

- Infosys BPM was hired to assess opportunities for automation to improve the delivery of service for the HR function. Infosys studied each process and analyzed the steps in detail to determine the suitability of RPA. It categorized the level of RPA suitability into five groups: Very High, High, Medium, Low, and Nil.

- Suitability for RPA was determined by looking at processes by their volume, their average handling time, and risk of error. Infosys automated several processes identified during the analysis.

- An example of an automated process was the generation of offer letters for new employees. The process was a series of steps that had to be adhered to perfectly to ensure both accuracy and compliance to regulations. The process required 15 minutes per new employee because of the manual steps involved. The entire process was automated and processing time was reduced by 90% without compromising adherence to procedure and regulations.

**Result**

- When all the processes that were suitable for RPA were enhanced with automation, the HR function achieved significant monetary and time savings. There was a 70% reduction in manual effort, 55% average improvement in processing time, and $680,000 in net savings.

Source: Infosys BPM Case Studies
Resources & Recommendations

Although tremendously exciting, the adoption of emerging technologies is also risky and uncertain. Info-Tech provides research and recommendations across industries to support a business-outcome-driven approach that ensures you get the value from your technology investments.

Recommendations

- Change management must focus on the how RPA can enhance the work experience of current employees.
- Manage scripts for robots like software code. Use industry-standard methodologies that focus on reuse and abstractions.
- Map out processes that involve RPA and robots so that when changes are made to downstream or upstream steps, implications can be easily determined.

Upcoming Research

- Implement AI Into Your Manufacturing Process

For Premium Members

- Know why it is time for insurance to learn through direct adoption of autonomous machines
- Enable your manufacturing crystal ball to predict and prevent downtime in manufacturing robots
- Prepare your organization for the automation that is coming
- Learn about the benefits that chatbots can bring to banking
Bibliography


Digital Twin

A living model
What is a digital twin?

When an expensive component of a critical mechanical system fails, operations can be seriously impacted. Work stops, a replacement must be ordered, and a technician scheduled. If only you could know two weeks in advance when this critical part would fail. What if the part itself could tell you?

Digital twin refers to the creation of digital models of real-life objects using data from sensors on the objects themselves. More than a simulation, a digital twin is a living model. It allows the user to inspect an object or physical system remotely, or interact with it in a sandbox environment.

The digital twin comes as a natural extension of the Industry 4.0 movement, at the convergence of increased IoT adoption, better and cheaper sensors, and exponential growth in computing power. These advances have allowed simulations and physics models to move from the design phase to monitoring, and even to predictive analytics.

The digital twin removes reliance on physical proximity and introduces the possibility of predictive analytics through simulation. The applications span multiple industries, from optimizing transportation routes, to monitoring performance in manufacturing, to a surgeon digitally exploring a copy of a patient’s heart anatomy to prepare for the surgery.

“A digital twin is a living model that drives a business outcome, and this model gets real-time operational and environmental data and constantly updates itself.”

— Colin J. Parris, VP of GE Software Research, GE Global Research
What’s new in 2018?

The digital twin is a technology that has been slowly coming into influence in the world of IoT and the digitized factory. The idea is not new – at its most basic, a computer-aided design image used to produce a physical object can be called a digital twin. The idea driving a revolution, however, is the reversal of this data flow, from physical object back into the model, allowing the object to be monitored and interacted with in a sandbox environment.

At the cutting edge of digital twin is the move from monitoring to prediction and optimization. Growing computing power is allowing for sophisticated analytics and simulations to be performed, allowing businesses to predict failure events and schedule maintenance. These data persist beyond the lifetime of the physical object – to inform the design of the next generation.

A fleet of digital twins, operating in concert, allows for the benefits to extend to the system level. Businesses can not only predict and mitigate failure at the part level, but also optimize physical asset use and allocation so that the efficiency of the system as a whole is increased. System-level optimization will produce the biggest impact of this trend in the near future.

"It becomes a learning system. The more you relate past and present data and the more you analyze it, the more knowledge you have, and you can redeploy that. Even when you decommission a valuable asset, you have all the data and intelligence of its whole lifetime, which you can use to find patterns for the next generation you're designing."

— Dimitri Volkmann
“By 2020, 30% of G2000 companies will be using data from digital twins of IoT connected products and assets to improve product innovation success rates and organizational productivity, achieving gains of up to 25%.”

— Turner and MacGillivray, "IDC FutureScape: Worldwide IoT 2018 Predictions"
“Optimizing operations using a digital twin can increase the efficiency of a power plant by 1.5%. This, in turn, can lead to significant reductions in carbon dioxide emissions.”

— Aucotec, “How Digital Twinning Makes Plants More Productive and Efficient”
What Is Driving This Trend?

Digital twin is a consequence of exponential digitization in the Industry 4.0 movement. The proliferation of inexpensive sensors has enabled the capture of enormous amounts of data. Increasing computing power and growing adoption of cloud-based infrastructure has enabled us to work with these data sets effectively.

The economic power of digital twin is in its scale. Applying the optimization learned from one object to the entire fleet allows efficiency gains and cost savings to scale, resulting in large gains on the bottom line.

Increasing globalization of processes, from manufacturing to medicine, has created a need for decentralization and cloud-based accessibility. Digital twin fills this need by removing the reliance on physical proximity to the original physical object, enabling many functions to be performed remotely. A wealth of data combined with a sophisticated physics model of an object allows us to interact with the digital twin remotely, and ask questions with the same freedom we would if we had the object in hand.

“Last year, GE Renewable Energy signed a 5-year contract with two aging wind farms in Japan with the goal of boosting annual energy production by 2% and 5%. Even at 2%, the technology is expected to increase revenue by up to $650,000 over the life of the project.”

— Aucotec, “3 Industries Being Transformed by Digital Twins”
How does the trend score on the five key business outcomes?

To what extent does the trend allow the business to free up human capital through automation? Does it integrate with stakeholders’ existing technology? Is the technology able to quickly increase capacity? Can it learn from its own outputs? Will it deliver a strong social impact on user and customer experience?

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How does the trend score on the five key business outcomes?

Automation: Low
Digital twin can be used for automation, but in many cases, it should not be. Although it is possible to automate control of a physical part through its digital twin, currently this option demands tight control, certification, and risk assessments. In many cases, other technologies are able to perform automation better, at least at the current state of technological development.

Integration: Spot-on
The prevalence of multiple proprietary standards creates issues in the sharing and therefore interpretation of data. The digital twin has the potential to solve this by bringing data to a digital space in a workable format, and where access can be controlled through APIs. This impacts both analytical capabilities and the potential to integrate and share data across systems. Should a business export its data, the digital twin makes this a more valuable endeavor.
How does the trend score on the five key business outcomes?

Scale: High
The maximum potential of the digital twin is realized at scale. Lessons learned from one implementation can be applied to all objects of that type. When you move from optimizing individual components to optimizing systems, profit and savings become exponential, feeding into business growth. Decentralization, enabled by remote access to a digital twin, removes location-related constraints around staffing and access, facilitating business processes, and when interacting with a digital twin can replace a destructive interaction with its physical counterpart, resources are saved as well.

Intelligence: Spot-on
A digital twin captures the data produced in the course of regular operation with the goal of optimizing at the part and system levels. In a manufacturing context, this can be used to optimize the process itself. Currently, this is not automatic – a skilled person is still required to make the determination – but the versatility of a digital representation of an object and the ability to run simulations without altering the functionality of the real system make this person’s job much easier.

Impact: Medium
Digital twinning can render certain low-skill jobs redundant, and this effect on human capital must be considered in implementing the technology. However, the positive impact of improved operations on customers, e.g. increased efficiency in power generation, cannot be ignored.
**Risk Considerations**

Increasing integration of data carries many benefits but also renders the system more vulnerable to attack. This is a risk worth taking, in light of the benefits, but measures must be taken to mitigate the risks. Potential risks to be on guard against are:

- **Data theft** – digital twin data falling into the wrong hands.
- **Identity management** – pairing a physical object with another object’s digital twin, accidentally or maliciously.
- **Data spoofing** – malicious attack that creates false data.

The good news is that development of security protections has accompanied digital twin development. The digital ghost is a monitoring system with the sole purpose of detecting irregularities within a digital twin’s data, indicative of tampering. The digital twin’s sophistications come into play, as detection is done both on the basis of typical values and by calculating whether the observed values are possible given the physics of the system.

**Critical Uncertainties**

The amount of data captured by a digital twin creates tremendous value, but for whom? There are many stakeholders, from the original manufacturer of the part, to its current owners/operator, to the company contracted to service it. All these entities play some part in generating the data, and the coming years will see disputes over how data should be divided along this value chain.
**Case Study**

**Industry:** Aviation

**Desired business outcomes:** Intelligence, Scale

**Situation**
- Jet engines experience differential wear depending on factors such as weather, flight duration, locale, and even pilot flight style.
- Maintenance is costly, but so is unexpected failure and downtime. Optimization of engine use and service-window timing is essential to maximize ROI.
- Airlines are looking for a data-driven approach to optimize operations.

**Action**
- GE provides remote maintenance and diagnostic services for airlines through digital twin technology.
- By incorporating the wealth of data generated by each engine into its digital twin, it is possible to track real-time wear patterns, predict when failure will occur, and re-route the engine to a less taxing flight schedule to extend its service life before the maintenance window.
- GE builds a fleet of digital twins to correspond to the physical fleet of engines. This enables the use of predictive analytics and simulations on a system level to determine optimal flight distribution. The result is maximized efficiency not just for a given engine, but for the entire fleet.

**Result**
- Using a digital twin to detect anomalous functioning predicts potential failure 15-30 days in advance.
- Predictive analytics used to estimate the lifespan of parts saves $44 million in maintenance costs.
- $10 million in savings results from optimizing engine flight routes with respect to maintenance schedules and service locations.

Source: GE Predix Technology Brief
Resources & Recommendations

Although tremendously exciting, the adoption of emerging technologies is also risky and uncertain. Info-Tech provides research and recommendations across industries to support a business-outcome-driven approach that ensures you get the value from your technology investments.

Recommendations

- Even if you don’t know what you will do with the data, start capturing it from day one.
- Be aware that other stakeholders will be doing the same. Be on the lookout for data ownership and API clauses in contracts, and get ready to negotiate shared ownership and monetization.

For Premium Members

- Develop a culture of innovation in your organization
- Build a case for radical disruption in manufacturing
- Identify IoT quick wins to build a solid foundation for digital twinning
- Learn how IoT is laying the foundation of smart cities
- Use IoT to make chemicals manufacturing smarter


Bibliography


Blockchain 2.0
The technology beyond the cryptocurrency hype
What is blockchain 2.0?

Blockchain is a distributed computing principle that removes reliance on a single master copy of a digital record by keeping a "distributed ledger" – multiple duplications of a record, all stored on different devices.

This is a fundamental departure from traditional approaches that rely on keeping a single central master record and protecting it using restricted user permissions. It goes beyond cryptocurrency. The technology underlying it – blockchain – is what is truly valuable. Blockchain’s value is in its universality. It can be applied to almost any situation that calls for keeping a secure record. Examples include shipment tracking, recording asset ownership, and legal contracts.

Other capabilities beyond the distributed ledger are being explored and added to the blockchain universe. Smart contracts and proof of stake are the new frontier for blockchain. These innovations add new capabilities to blockchain technology and enhance the applicability of the distributed ledger.

“I’m reasonably confident... that the blockchain will change a great deal of financial practice and exchange 40 years from now. Blockchain and all that followed from it will figure more prominently in that story than will bitcoin.”

— Larry Summers, US Former Treasury Secretary (quoted in Guarda)
What’s new in 2018?

Previously, the focus of blockchain was its ability to provide distributed validation. The blockchain refers to a distributed ledger that augments dispersed consensus building. Consensus is built by sharing a transaction with a distributed network of computers that run algorithms independently to verify that the transaction has occurred. Once a transaction has been confirmed by the network, a “block” of data is added to the chain. After additional blocks are added, it becomes nearly impossible to change or remove.

Blockchain technology has evolved and experts are experimenting with additional applications to enhance its capabilities. Smart contracts and proof of stake, a new method to validate transactions on the blockchain, are two particularly exciting enhancements.

Experts are working to overcome challenges with scalability on blockchain network transactions. Smart contracts are contracts written in computer code that enable automatic execution of the contract once a set of conditions is met. Wide-scale implementation of smart contracts will allow for increased decentralization, lessen contract disputes, and enhance privacy (Gupta).

“42% of executives believe blockchain will disrupt their industry. 55% of executives say they will lose competitiveness if they do not adopt.”

— Deloitte US, “Blockchain survey 2017”
“The global blockchain market size is expected to grow to USD 7,683.7 million by 2022, at a Compound Annual Growth Rate (CAGR) of 79.6%.”

— Business Wire, ”Global Blockchain Market 2017-2022“

*These numbers represent the underlying technology that supports cryptocurrencies, blockchain. This does not include the value of cryptocurrencies.
“20 percent of central banks will be using Blockchain technology by 2019, and 40 percent will have active Blockchain applications within a decade.”

— Cambridge Centre for Alternative Finance, referenced in Buck
What Is Driving This Trend?

Proof of Stake

Proof of work (PoW) is the current method by which most public blockchains reward individuals for validating transactions and adding "blocks" to the blockchain. PoW involves solving a computational puzzle; the group (miner) that solves the puzzle first will receive the rewards. Mining requires a great deal of computing power, and as more miners try to solve the puzzle, electricity consumption increases.

Given that profitability is a function of the electricity cost, mining has ignited a race to secure the cheapest power possible. Some miners are cutting corners, resorting to low-cost coal or hydroelectric generators, and siphoning from power plants. A bitcoin mine has been reported to emit the same amount of carbon dioxide as a Boeing 747. Mining is becoming environmentally hazardous, and the rate of power consumption is growing unsustainable. As of December 2017, Bitcoin mining power consumption was equivalent to the power consumption of the country of Serbia (Irfan).

Proof of stake (PoS) is a new way to validate transactions on a public blockchain that will mitigate the adverse impacts of PoW. Miners will still exist, but will be limited to mining their "stake" in any transaction. For example, a miner owning 3% of bitcoins will only be able to receive 3% of the validation reward. This lessens competition for increasing computational power in the race to obtain a validation reward. Validation rewards will be spread across the different miners based on their "stake" (Momoh).

“As of November 2017, Bitcoin miners used 215 kilowatt hours to validate one transaction. The average American household consumes 901 kilowatt hours per month.”

— Malmo, “One Bitcoin Transaction Now Uses as Much Energy as Your House in a Week”
Smart Contracts

Smart contracts are contracts that can be executed automatically once certain conditions have been met, and they have the potential to deliver several key benefits.

Smart contracts facilitate the exchange of assets, including money, property, and shares, without the use of costly intermediaries. Each year, $150 billion US worth of crude oil transactions are disputed. Information is easily lost through processes that involve multiple parties, across great geographic distances, requiring the tracking of thousands of distinct assets (e.g. barrels of oil). Compare this to a smart contract that can be set up to transfer funds automatically upon receipt of the barrels of oil. The transaction can include tokens representing the underlying asset (e.g. a barrel of oil), issued by a trusted authority for the needs of the participating companies. The tokens would remain digitally attached to their underlying asset throughout the supply chain. Once the transaction is complete, the smart contract is triggered and tokens change hands (Cann).

Smart contracts protect a party’s anonymity, only revealing the information necessary to complete the transaction. In 2017, 55% of individuals surveyed stated that they declined to buy items online because of reservations about how third parties would use their identities. Likewise, 82% stated that they would not be comfortable with the sale of their data to third parties in exchange for speed, convenience, product range, home delivery, or pricing comparisons. Smart contracts can be coded to provide an avenue to share only the necessary information, alleviating consumer concerns (KPMG).

It is estimated “that by 2022, ratified unbundled (that is, defined impact) smart contracts will be in use by more than 25% of global organizations.”

— Panetta, “Why Blockchain’s Smart Contracts Aren’t Ready for the Business World”
How does the trend score on the five key business outcomes?

To what extent does the trend allow the business to free up human capital through automation? Does it integrate with stakeholders’ existing technology? Is the technology able to quickly increase capacity? Can it learn from its own outputs? Will it deliver a strong social impact on user and customer experience?
How does the trend score on the five key business outcomes?

Automation: High
Distributed ledger technology and smart contracts enable a level of automation in numerous industries and across numerous processes. These technologies enhance automation through the elimination of intermediaries and record disputes. Time is also saved from auditing records by the distributed ledger. Automation will be further enhanced when blockchain converges with other technologies such as AI, robotics, and internet of things.

Integration: Spot-on
Blockchain is best suited for organizations with complex value chains and multiple partners, and those wishing to improve data consistency. Blockchain’s major benefits integrate disparate systems and resources. By providing a distributed ledger, blockchain gives each partner in the chain access to an up-to-date copy of the data. Data will no longer go unverified across separate systems.
How does the trend score on the five key business outcomes?

Scale: Medium

Current blockchain technology providers and cryptocurrencies that leverage blockchain technology are not equal to the scalability of traditional providers. Bitcoin can provide 6 transactions per second, Ethereum can provide 20 transactions per second, and Visa can provide 1,667 transactions per second. There are blockchain networks with the same scalability as traditional providers, but each can only transact a specific process (Steemit).

Intelligence: Low

There are no current instances of blockchain technology leveraging past transactions to optimize future transactions without the assistance of human analysis. As applications of blockchain increase, this could be a field for future development.

Impact: Spot-on

At its core, blockchain provides a digital mechanism for transparently recording and viewing any transaction ever made on a ledger. It operates through a decentralized computing network with a record of transactions that cannot be hacked or altered. While the internet serves as an information exchange, blockchain offers a “value exchange.” The highest value will be achieved in parts of the world where trust of centralized institutions is low. Blockchain’s decentralization and immutability holds centralized institutions accountable for their records and enables people to exchange value without intermediaries.
Risk Considerations

Proof of Stake

While proof of stake (PoS) is a promising answer to the power consumption limits of proof of work, it is not without a downside. Perhaps most alarmingly, PoS creates a situation where the rich get richer.

PoS rests on the concept that each validating user will receive a reward equal to the amount of currency they have. If PoS were used by the bitcoin blockchain, an individual owning 3% of bitcoin would receive 3% of the reward. Each validator grows their share in the total pool of currency by the amount they currently own. This means that those who start with less currency will have a hard time catching up.

Critical Uncertainties

Proof of Stake

PoS could decimate the up-and-coming cryptocurrency mining industry, rendering mining rigs obsolete. Mining companies that have invested billions of dollars in this specialized hardware may not recover. This could lead to serious fluctuations in the pricing of cryptocurrencies, and in turn affect the economy as a whole.
Risk Considerations

Smart Contracts

Smart contracts that have been written flawlessly promise significant benefit, but the technology is immature. Smart contracts execute based on written code, and flaws in this code can be exploited with devastating financial repercussions for users. The fact that actions executed by the smart contract are immutable only compound these risks. The only proven way to alleviate the damage caused by these code flaws is to have the majority stakeholders in the blockchain network intervene. This was demonstrated with Ethereum’s DAO hack.

Critical Uncertainties

Smart Contracts

There is no means of ensuring that the code in smart contracts is flawless, and errors in even a single line of code can be disastrous. Reversal of damages caused by contracts is ad hoc, and at the discretion of the majority stakeholders in a public blockchain. Losses that result from contract code flaws should be treated as definite and irreversible.
Situation

- “The DAO” is the name of a particular DAO, conceived of and programmed by the team behind German start-up Slock.it – a company building “smart locks” that let people share their things (cars, boats, apartments) in a decentralized version of Airbnb.

- The DAO launched with a 28-day funding window. It became the largest crowdfunding in history, raising over $150 million. This was the equivalent of 12.7 million ether.

- During the crowdsale, several people expressed concerns that the code was vulnerable to attack (Siegel).

Action

- An attacker managed to drain more than 3.6 million ether into a “child DAO” that had the same structure as The DAO. The code of the smart contract itself is meant to be the ultimate arbiter of "the deal" it represents, and any flaws in the code can allow for funds to be stolen with the invested parties unable to do anything to stop the hackers.

- Two solutions were proposed to resolve the issue: One was a soft fork. This installs a “switch” in the basic Ethereum code that prevents the movement of any ether out of the DAO or its children. The second was a hard fork. It asked the miners to completely unwind the theft and return all ether to The DAO, where it could be redeemed by token holders automatically, thereby ending The DAO (Madeira).

Result

- The vast majority of people (89%) voted for the hard fork, and it was approved by Ether holders.

- The investors were only able to recover their funds with the cryptocurrency equivalent of a central bank bailout from the Ethereum Foundation. This attack demonstrates the serious nature of smart contract risks, and the cost required to respond to an attack.
Case Study (2/2)

Industry: Government

Desired business outcomes: Impact, Automation

Situation

• In 2007, Estonia experienced a cyberattack across most of the country’s critical government information technology infrastructure. The attack crippled dozens of government sites and jeopardized countless document records.

• At the time of attack, Estonia was one of the most "wired" countries in the world. The attack prompted Estonia to look for ways to prevent future attacks.

• A digital society is by its nature exposed to cyber-attacks. Since the 2007 attacks, Estonia has invested in blockchain technology to ensure government data integrity and protect it against threats (Davis).

Action

• The Estonian government partnered with Guardtime, a company specializing in blockchain for government security. The government deployed a blockchain called "KSI" through its networks.

• The Estonian government has worked with Guardtime to store and secure all of the country’s health records on the blockchain. Every update to healthcare records and every instance of access to healthcare records is now registered in the blockchain (Williams-Grut).

• Using blockchain, the Estonian government has created the Electronic Coordination System for Draft Legislation. Every law drafted since February 2003 has been uploaded onto the system. Readers can now view submitted legislation and see status and changes made to legislation in one location.

Result

• Healthcare records are stored on the blockchain, making it impossible for government, doctors, and hackers to change or tamper with a citizen’s record. Citizens can also sue if they discover their records have been accessed without a just reason.

• Blockchain technology contributed to Estonia achieving the record for second-fastest court proceedings in Europe. Interpreting laws is easier when the most up-to-date laws are accessible in one place, saving valuable time. Blockchain technology also helps ensure that involved parties can only access the information they are entitled to, and can validate who sees what information and when (e-Estonia).
Resources & Recommendations

Although tremendously exciting, the adoption of emerging technologies is also risky and uncertain. Info-Tech provides research and recommendations across industries to support a business-outcome-driven approach that ensures you get the value from your technology investments.

Recommendations

• Set up smart contracts in non-critical processes first or re-use existing smart contracts that have been tried and proven.
• Uncover what business processes in your organization may be automated with smart contracts. Focus on processes that require multiple parties.
• For organizations that leverage distributed applications, ICOs, or work with vendors building distributed applications on a public blockchain, keep an eye on the PoS shift. Any unforeseen issues that occur with the shift to PoS can impact vendors that work with these public blockchains. If your organization works with these vendors, this can impact your business.

For Premium Members

• Learn about blockchain basics and underpinning blockchain technology.
• Explore Blockchain: Foundational Technology of the Future to understand the disruptive nature of blockchain.
• Explore Blockchain in Oil and Gas
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Bibliography


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