The evolution of process automation

Moving beyond basic robotics to intelligent interactions

Executive Report

IBM Automation

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Automation in the digital enterprise

Automation has a long and storied history dating back more than 5,000 years.[1] Today, advancements in artificial intelligence (AI) are spawning a new phase of automation: intelligent automation. Intelligent automation is changing the way enterprises operate by using advances in technology to optimize processes, personalize customer experiences and enhance decision making. In this report, we reveal the steps pioneering organizations are taking toward intelligent automation, as well as the ways they balance the operational efficiencies gained with the changes for their workforce.

Introduction

Organizations around the globe are leveraging newly digitized enterprise processes and advances in technology to implement automation solutions capable of replicating human actions, eliminating routine tasks and thereby evolving employee tasks to a higher-value outcome.[2] Almost every organization – among the more than 3,000 we surveyed – is currently engaged in some level of intelligent business process automation; almost four out of ten are employing AI-based capabilities.

The evolution of task automation spans human history – from the Mayans automating water transportation via aqueducts to Adam Smith's example of automation's impact on hatpin makers to Henry Ford's automation of the mechanical assembly line.[3] The Digital Reinvention™ underway in most organizations, coupled with recent advances in technology, is ushering in a new age of automation: intelligent automation.

Throughout history, automation has represented an opportunity to create new value from the balance of the classic paradigm of people, process and technology. In the case of automating water transport, for example, technology (the aqueducts) enabled the process (water transport) supported by people (who built the aqueducts). This same balance ushered in the industrial age.

This paradigm shifted in the information age. Data-related tasks require people (on a keyboard) to enable processes (transactions or interactions) supported by technology (telephones, spreadsheets). Automation of data-driven enterprise tasks started in the 1960s with the introduction of enterprise resource planning systems and now has evolved to include robotic process automation (hence the term "bots").

More than 90%

of C-level executives report some level of intelligent automation already exists within their organizations.

More than 50%

of C-level executives using intelligent automation have identified key operational processes that can be augmented or automated using AI capabilities.

More than 90%

of C-level executives using intelligent automation say their organization performs above average in managing organizational change in response to emerging business trends.

But automation of tasks beyond simple "screen scraping" and data sorting has been stymied by data processing capabilities constrained to ingest only structured, standardized formats and enterprise operating processes that were non-digital or contained data deemed unreliable. The automation of tasks under these conditions still required human intervention to successfully complete an information-based process… until recently.

Intelligent automation is a new capability that enables processes to perform in ways that optimize the amount of human support needed. This shift – moving the burden of processes from humans to technology – has the potential to redesign the way work gets done within an enterprise. As increasingly more – and now, more complicated – tasks are performed by process automation, humans are free to engage in higher-value tasks.

The advent of high-density file systems, combined with recent advancements in algorithmic analysis and artificial intelligence tools, creates entirely new opportunities for the automation of data-driven tasks. Modernized data platforms are capable of processing massive volumes of multi-formatted data quickly and accurately across systems, interpreting anomalies, learning patterns and capturing vast quantities of hidden insights from recently digitized enterprise processes. With the infusion of artificial intelligence tools to process and analyze the data, the range of automation capabilities has rapidly expanded from the basic data movements of the 1960s to commanding advanced systems, some of which are capable of judgment-based actions and human-like interactions.
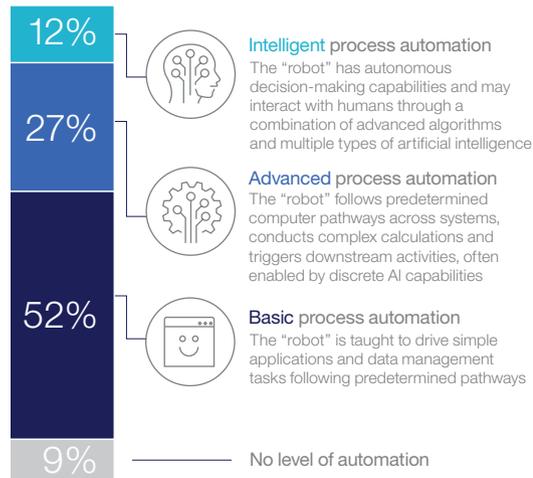
What is intelligent automation?

Intelligent automation incorporates recent advances in technology to manage and improve business processes automatically and continuously. Constituent components of intelligent automation include:

- *Artificial intelligence/machine learning* – The application of systems equipped with software that simulates human intelligence processes, including learning without explicit instructions

- *Natural language processing* – The ability to understand human speech as it is spoken

- *Robotics* – The use of robots that can act on Internet of Things (IoT) and other data to learn and make autonomous decisions

- *Predictive analytics* – The practice of predicting outcomes using statistical algorithms and machine learning.

For this report, we interviewed C-suite executives about their views on intelligent automation from a data-oriented perspective, including analysis of which business processes are most "automatable." For an operations-focused perspective on this topic, including where organizations are in their intelligent automation adoption journey, refer to our study "The human-machine interchange: How intelligent automation is changing the way businesses operate."[4]

Figure 1
Almost all organizations surveyed use at least one type of automation

12%	**Intelligent** process automation
	The "robot" has autonomous decision-making capabilities and may interact with humans through a combination of advanced algorithms and multiple types of artificial intelligence
27%	**Advanced** process automation
	The "robot" follows predetermined computer pathways across systems, conducts complex calculations and triggers downstream activities, often enabled by discrete AI capabilities
52%	**Basic** process automation
	The "robot" is taught to drive simple applications and data management tasks following predetermined pathways
9%	No level of automation

Source: IBM Institute for Business Value 2017 2Q C-suite research.

UBS, a global financial services company, recently explained its view on the progression of intelligent automation: "The availability of unprecedented amounts of data (much of it unstructured), the exponential increase in computer processing power, the declining price and growing convenience of data storage solutions, and recent advances in machine learning algorithms all provide a powerful toolset for making significant strides in intelligent automation."[5]

The ubiquity of data to manage business processes makes examining the use, behaviors and outcomes of intelligent automation more straightforward. We interviewed 3,069 C-level executives as part of the IBM Institute for Business Value 2017 2Q C-suite research, and 91 percent of them report some level of intelligent automation – ranging from transactional screen scraping to complex transactions to AI-enabled interactions – already exists within their organizations.[6] As such, almost every organization can be classified into one of three types of information automation users: Basic, Advanced or Intelligent. We use these category labels throughout the report to describe the type of data automation being discussed. For clarity, we are ignoring the 9 percent of organizations not using any automation and will refrain from commenting on them in this report (see Figure 1).

The technologies underpinning the evolution of data automation from data centers and ERP systems into complex enterprise operations are readily available. "Fetch and respond" chatbots, natural language processing and machine learning are quickly becoming common tools to tackle specific needs within business processes (see Figure 2).

Pioneers in technology-driven intelligent automation are taking strategic steps to balance the operational efficiencies gained with the evolutionary changes underway for their workforce. In this report, we examine the steps taken by these early adopters and provide guidance for those seeking to explore new opportunities with intelligent automation.

Figure 2

Technologies affiliated with AI underpin intelligent automation

Recommendation engines
Make tailored and personalized suggestions to a "market of one"

Natural language processing
Capabilities to understand and interact using human speech as it is spoken

Predictive analytics
Capabilities to anticipate outcomes based on collected knowledge

Machine learning systems
Ability to learn and improve without explicit instructions

Deep learning
Artificial neural network algorithms with ability to reason and remember

Image analysis
Ability to interpret visual images and conduct matching analysis

Automating efficiencies

"Optimizing business processes" is one of the top three ways most executives anticipate AI can help them compete within the next two to three years. The other top two AI impact areas – "personalize customer experiences" and "enhance forecasting and decision-making capabilities" – can, in many ways, only be achieved by using intelligent automation effectively.
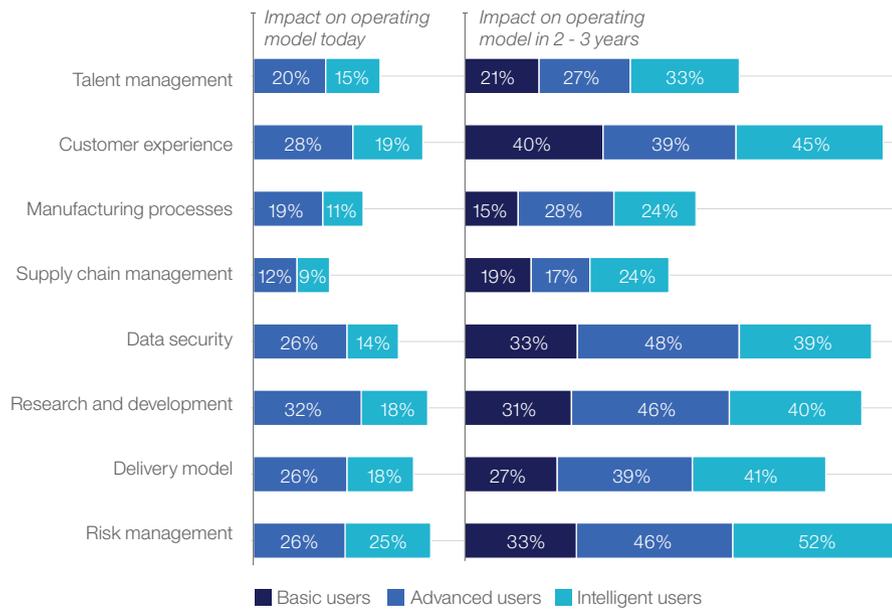
Early adopters of these new technology and AI-driven automation capabilities – Advanced and Intelligent users – already report achieving a significant impact from their use across a multitude of business functions. Even among Basic users only using non-modernized transactional automation today, anticipation is high that the infusions of these new technologies within enterprise processes will result in significant impacts within the next two to three years (see Figure 3).

It may seem counter-intuitive at first that more Advanced users report having experienced a significant impact from AI than Intelligent users implementing multifunction AI solutions. Executives were asked to rate the impact from the highest level of automation within their organization (based on complexity); our interpretation is the cutting-edge multifunctional AI systems of Intelligent users have less of a track record than the well-proven point solutions used by Advanced users. As we see, expectations even out over time.

The value of automation primarily comes from the efficiencies it creates. A Fortune 75 global consumer goods organization used advanced automation to resolve workflow problems (known as "trouble tickets") upward of 30 percent more quickly and improve employee productivity by upward of 50 percent.[7] And a global bank reduced its number of trouble tickets by up to 40 percent while increasing its employee satisfaction by more than 95 percent; it now plans to re-use the same technologies to support more than 25 corporate applications across various enterprise processes.

Figure 3

Current users of AI-driven automation capabilities report and expect a significant impact

Impact on operating model today / *Impact on operating model in 2 - 3 years*

Category	Today — Basic	Today — Advanced	Today — Intelligent	2-3 years — Basic	2-3 years — Advanced	2-3 years — Intelligent
Talent management		20%	15%	21%	27%	33%
Customer experience		28%	19%	40%	39%	45%
Manufacturing processes		19%	11%	15%	28%	24%
Supply chain management		12%	9%	19%	17%	24%
Data security		26%	14%	33%	48%	39%
Research and development		32%	18%	31%	46%	40%
Delivery model		26%	18%	27%	39%	41%
Risk management		26%	25%	33%	46%	52%

■ Basic users ■ Advanced users ■ Intelligent users

Source: IBM Institute for Business Value 2017 2Q C-suite research.

Simple automation of processes can eliminate errors, reduce biases and perform transactional work in a fraction of the time it takes humans. These basic technologies have demonstrated up to 75 percent cost savings on repetitive tasks compared to human performance, with 25 to 50 percent being the generally reported outcome.[8]

Adding AI to basic automation processes not only changes the speed at which work can get done, but changes the scale of work that can be managed. AI-driven processes can automatically scan millions of documents in a fraction of the time a human could – if they had a few hundred lifetimes – enabling processes as varied as legal contract reviews, medical treatment decisions, claims analysis and fraud management.[9] Intelligent automation systems can analyze data up to 25 times faster than the human brain, function around the clock every day of the week, and interact with employees and customers in natural language, all with incredible accuracy.[10]

A South American insurance company recently transformed its manual processes of reconciling incoming claims against each customer's policy coverage guidelines by creating an intelligent processing system using natural language processing. The system, capable of synthesizing thousands of pages of documents and spreadsheets, resulted in a more than 90 percent reduction in time required to process claims requiring agent intervention and netted more than USD 1 million in annual fraud reduction.[11] See Figure 4 for an example of how one insurance process changes with automation driven tasks.
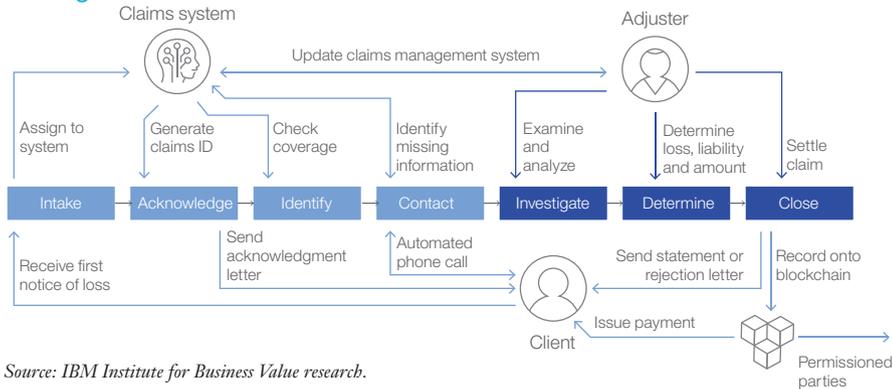
Figure 4

Many information-gathering tasks involved in managing a claim can be automated, allowing manpower to focus on investigation, determination and settlement tasks

Manual

Claims rep   Adjuster

Update claims management system

Intake	Acknowledge	Identify	Contact	Investigate	Determine	Close

Assign to claims rep   Generate claims ID   Check coverage   Identify missing information   Examine and analyze   Determine loss, liability and amount   Settle claim

Receive first notice of loss   Send acknowledgment letter   Phone call   Send payment or rejection letter

Client

Intelligent

Claims system   Adjuster

Update claims management system

Intake	Acknowledge	Identify	Contact	Investigate	Determine	Close

Assign to system   Generate claims ID   Check coverage   Identify missing information   Examine and analyze   Determine loss, liability and amount   Settle claim

Receive first notice of loss   Send acknowledgment letter   Automated phone call   Send statement or rejection letter   Record onto blockchain

Client   Issue payment   Permissioned parties

Source: IBM Institute for Business Value research.

Operational processes managed using AI – whether instance-specific or aggregated into intelligent systems – bring "smarts" to the activities automated, amplified by the transparency and inexhaustibility of automation. For example, one European electricity supplier has seen an estimated savings of EUR 6 million after only the first 8 of 50 planned bots – mostly customer service chatbots – went operational and anticipates double-digit percentage cost savings over the course of the implementation.[12] Automation also creates the ability to flexibly and variably scale enterprise operations based on seasonal demands or surge promotions.

The use of AI-driven automation is in its early days, but like most technologies, it will continue to evolve. Organizations today are primarily using natural language translation, unstructured data recognition, "fetch-and-respond" interactive agents and complex algorithmic (step-by-step) actions to automate processes that reduce or eliminate the need for human intervention. Next-gen intelligent capabilities include systems that can remember (creating the ability to automate future robot configurations, for example) and reason (enabling tasks like predictive and probabilistic processing), two capabilities that combined create a system that can learn and interact.

What to automate

Hundreds of thousands of discrete tasks make up the thousands of activities that drive the hundreds of processes within a digital enterprise; each individual task is an automation opportunity. For executives, just where to begin is the most immediate question.

Developing an automation strategy in advance enables organizations to optimize investments by striking a balance between the difficulty of automating a task with its potential increase in efficiency. One out of two executives using Intelligent automation have identified the key processes within their organization that can be augmented or automated using AI capabilities compared to one-in-four Advanced users and one-in-seven Basic users.

Analyzing work activities is the most accurate way to assess the potential for automation. The American Productivity and Quality Center (APQC) publishes a list of almost 1,100 cross-industry activities that compose 300 core enterprise processes. These processes are further organized into 70 process groups and 13 high-level process categories. Using this framework, we examined the average effort needed for each activity – the 1,100 level – to identify the most "automatable" enterprise activities (see Figure 5).[13]

We found that the most automatable business process categories have the most transactional work, such as tasks that support managing financial resources, managing customer services and delivering physical products. The least automatable process categories tend to be the most strategic and judgement oriented, involving activities like developing vision and strategy and managing external relationships.

Figure 5

Using the APQC Process Classification Framework, we identified the most and least automatable processes within core cross-industry business processes

Most automatable process groups	Score
Process accounts payable and expenses	62
Process payroll	56
Perform global trade services	53
Perform revenue accounting	52
Manage customer service contracts	52
Manage product recalls and audits	52
Evaluate customer service and satisfaction	50
Produce, manufacture and deliver product	50
Manage logistics and warehousing	48
Reward and retain employees	47

Least automatable process groups	Score
Dispose of assets	15
Deploy information technologysolutions	15
Develop knowledge management capabilities	16
Deliver/support information technology services	16
Manage employee relations	17
Manage business resiliency	17
Develop customer service strategy	18
Generate and define new product/service ideas	18
Redeploy and retire employees	19
Establish service delivery governance strategies	19

Source: IBM Institute for Business Value research using the American Productivity and Quality Center (APQC) Process Classification Framework.

Figure 6

The level of automation needed for any given process varies by the nature of the process tasks

Level of automation	Nature of the process
Intelligent	**Interactive** · Unpredictable pattern with known set of desired outcomes · Any data format · Variable and unpredictable outcomes
Advanced	**Knowledge based** · Recurring, high-volume tasks, variable actions · Unstructured and structured data · Predefined outcomes
Basic	**Rule based** · Repetitive tasks, simple actions · Structured data sources · Transactional outcomes
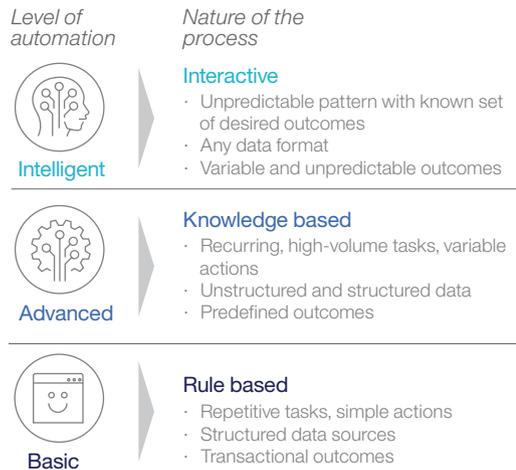
Source: IBM Institute for Business Value research.

Industry-specific automation falls outside this framework. These predominantly point-solution uses of AI-driven automation tend to perform algorithmic tasks at speeds that exceed a reasonable level of human capacity to achieve. (See sidebar on page 13: *Banking on efficiency and accuracy*.)

The level of automation needed for any given process varies by the nature of the process tasks. Basic automation is good for rules-based, repetitive tasks with well-structured activities, clearly defined rules taken from well-structured data sources, and systems that result in visible and measurable outcomes. Ideally, a good candidate is a high-volume, high-cycle-time process with high visibility as a current bottleneck or pain point that is initiated by a digital trigger and supported by digital data (see Figure 6).

A German financial services provider realized a 60 to 80 percent time efficiency gain and up to a 20 percent tangible short-term cost reduction after automating only the first of ten planned processes. After realizing a return on its investment in less than 12 months, the company plans to automate more back-office processes such as form creation, name changes, prefilling data, updating statuses and triggering investigations.[14]

Advanced automation is needed as tasks become more complicated. AI solutions are used to automate tasks that are based on a combination of unstructured and structured data, often with activities involving multiple systems or massive quantities of data. Activities within these processes often draw upon vast knowledge databases, but each action taken is predicated on specific data and predefined outcomes. Ideal processes for advanced automation are also those that fluctuate in demand as automation can scale to accommodate what would otherwise cause staffing variability.

Banking on efficiency and accuracy

In 2014, a multinational Japan-based bank released a new product that helps investors establish tax-exempt trusts for qualified education funds, making it easier for them to pass along an inheritance to children and grandchildren. The product met with unexpected success, exceeding JPY 500 billion in assets and establishing the bank as a market leader.

These growing volumes started to put a strain on internal processes. The bank employed close to 300 examiners to verify qualified educational expenses, but with 1.4 million transactions annually at 45 minutes per transaction, this manual review process was untenable and holding the company back.

To address the shortfall, the company found that automation could supplement human judgment of whether a given expense qualifies for tax exemption – using keyword extraction to check the claim for required elements, compare it against regulations and customer agreements, and cross-reference it with past evaluations. Combined with optical character recognition capabilities, the solution translates images of printed and handwritten text into structured and unstructured data, including information from receipts and claim forms, while the solution's machine learning algorithms become increasingly accurate as more cases are added to the corpus.

Using advanced and intelligent automation capabilities, the client shortened evaluation time by 60 percent, from 45 minutes to 18, by minimizing errors and rework. With the dramatic increase in efficiency, the bank expects to reduce costs by JPY 130 million within two years of implementation. Given the projected growth in transactions, the company expects to save a total of JPY 730 million over five years. In addition, the bank aims to increase customer satisfaction by accelerating claim approval processes and strengthen its brand and market leadership as an educational trust fund provider.

Adding advanced automation capabilities to data security systems in the form of machine learning is quickly becoming standard practice as organizations face millions of cyber threats a day.[15] And given its programmable, rules-driven nature, automation at any level can accommodate geographic data storage requirements and consistently apply rules for fiscal requirements.

Intelligent automation can be used to augment or "autonomize" enterprise processes that require context and choice yet occur in unpredictable patterns. To augment, multiple AI-driven capabilities can work in concert to do the mundane parts of a task while a human completes the task. Alternatively, automation can be used to work through all the steps within a process, including taking variable actions, and complete the task on a human's behalf.

Process automation is not – yet – a drag-and-drop activity. Once executives identify which process areas are best suited for automation, the next step is to reimagine the process from end to end across the ecosystem. Too often, as processes became digitized and partner networks became interconnected, each new component was just bolted onto or sliced into the existing processes. Dropping bots into a poorly designed, under-optimized (sometimes newly digitized) process undermines the ability to create value. Automation creates an opportunity to rethink the way work gets done.

Rebalancing the workload

Automation throughout history has been an opportunity to create new value from the balance of the classic paradigm of people, process and technology. The impetus is not necessarily to replace people, but to transform the work that humans do and create new ways of working. The creation of a twenty-first century digital workforce must be balanced with recognition of its impact on the human workforce already in place.

Newly digitized enterprise processes are not islands of technology; core operational processes today – and in the future – require an interplay between humans and the data being processed. A digital workforce – created by the automata (or groups of task automation routines) running various operational processes – is ideally suited to handle tasks that either happen too fast for humans to respond or too often to be worth human time to complete. The human workforce recaptures time to do what it's best suited to do: think strategically, act creatively and interact humanely.

One-third of executives using intelligent automation tell us they expect to redeploy some employees to more value-added activities by using AI capabilities. This is the case for financial services firm UBS. According to an article on the company's website, "… intelligent automation will, above all, allow us to free people from routine work and so empower them to concentrate on more creative, value-added services. The overall benefits to the economy from such enhancements could be large, as could the benefits in terms of enjoyment of work and quality of life."[16]

One labor-intensive, cost-laden area of generally mundane tasks within most organizations is application management. Companies can spend large portions of their IT staff and budgets simply maintaining business process applications – the essential but low-value work of keeping the lights on, ensuring databases have capacity, keeping servers up, and making sure applications are available to business users and customers. It's currently a highly manual process of monitoring dense reams of data, making it highly error prone, as well.

Figure 7

Few executives feel they have the necessary data science, machine learning and other AI/cognitive talent on staff today

*Percent agree their organization **does not** have the necessary data science, machine learning and other AI/cognitive skills*

90%
Basic
process
automation

89%
Advanced
process
automation

75%
Intelligent
process
automation
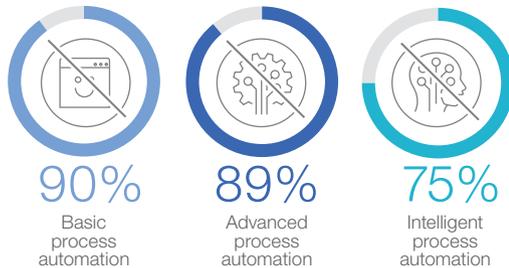
Source: IBM Institute for Business Value 2017 2Q C-suite research.

The use of basic robotic automation to monitor and maintain business applications is maturing quickly. By integrating AI-driven capabilities, organizations can evolve automation solutions beyond simple report generation and pattern recognition to ones that trigger actions to remediate, thereby creating self-healing systems. (See sidebar: *The age of the self-healing system*.)

Responding to this type of workforce transformation, especially on the potential scale of enterprise operations, requires an equal cultural transformation.[17] Ninety percent of Intelligent users report their organizations have been successful at major change management in the past compared to less than half of Advanced users and about one-third of Basic users.

Just like the hatpin makers and carriage builders displaced by earlier technological advances, so too will some existing jobs be revamped as digital labor assumes tasks previously completed by humans. Unfortunately, our research finds that only 20 percent of executives surveyed have yet to establish plans to retrain or reskill their workforce.

About one-in-three executives surveyed – regardless of automation level – agree their organization will need to create net new roles specifically to use or support AI technologies within the organization. And most executives admit they currently do not have the talent needed to support AI capabilities, such as data scientists and those with machine learning skills, and will need to either hire or train for those skills (see Figure 7).

Experience indicates executives must overtly consider and explicitly address the workforce balance implications automation brings with it. The need for strong change management in data and analytics efforts has been well documented, and we foresee an even greater need here.

The age of the self-healing system

Using AI-driven automation, one pharmaceutical company is using automation to solve enterprise application problems before they become incidents. As one of the world's largest drug distribution providers, the company processed millions of orders per day at a pace well beyond human capacity, making system availability critical to success.

Yet ensuring availability of business-critical processes was a cumbersome activity, dependent on hundreds of repetitive, manual tasks that consumed a large portion of IT staff time. These tasks included daily monitoring of servers, services and disk space, with rules-based remediation activities when capacity was low and daily verification and reconciliation of a large legacy ERP system to ensure that deliveries shipped were also invoiced. Recurring issues within the application suite were impacting the company's end customers: While support staff worked to fix problems in the application, trucks were kept waiting at warehouses for the information they needed to make deliveries.

By automating enterprise application monitoring activities, the company dramatically reduced the need for manual intervention. The team began by analyzing recurring issues, targeting automation of the fixes for the most common causes. Now, automated bots perform scheduled monitoring and remediation and then verify shipments against invoices each day. If an issue occurs, a fix is automatically deployed – meaning support staff members only need to step in for exceptional cases. Most of the time, the system runs on autopilot, meaning trucks leave on schedule and customers receive orders on time.

Automation has enabled the organization to redirect around 1,100 man-hours each month – or over 13,000 hours per year – toward new project initiatives. This allowed the team to build and develop valuable project design skills in lieu of "running the system." Users and clients also benefit from improved system reliability and availability.

The automation journey

About the research methodology
The IBM Institute for Business Value, in cooperation with Oxford Economics, interviewed 3,069 C-suite executives from 91 countries and 20 industries worldwide. Information was collected through a combination of 2,491 live phone interviews and 578 face-to-face meetings conducted from April 1 to June 30, 2017. Respondents were a balanced mix of six C-suite roles: CEO, CMO, CFO, COO, CIO and CHRO.

Automation is a journey, and executives would be wise to think strategically and programmatically about how they move forward. As we noted, almost every organization is already part of this evolution in intelligent automation; while most are still using basic robots, we find leading-edge organizations are now creating intelligent interactions.

Decades of experience with lower-level automation, data and analytics, and point-solution use of AI come together when organizations begin to think about an intelligent enterprise. While automation capabilities created often build upon one another, we find that most organizations have skipped one or more earlier steps, regardless of their current capabilities; the path forward often requires a few steps back to make the longer trek easier.

We identified three key steps to creating an intelligent enterprise enabled by automated processes, which are enabled by technology and supported by people: Think big, start small and work differently.

Think big: Create an automation foundation
Taking a strategic approach to automation enables an enterprise to use its resources wisely and optimize the return on its investment. A strategic approach also includes being prepared and transparent regarding the impact automation will have on the existing workforce.

- Appoint a cross-business and IT executive team with project prioritization, budget and resource allocation, and metrics monitoring and management.
- Prioritize intelligent automation opportunities based on efficiency gains, but ensure strategy addresses talent management and knowledge retention.
- Communicate early and often so employees are comfortable with the new ways of working.

Start small: Streamline expansion with an automation command center

An automation command center provides structure and governance to the development and use of information automation assets. This is a key success factor since most organizations have thousands of potentially automatable process tasks to consider, convert and manage.

- Task an enterprise unit to manage the project pipeline, ramp-up deployment and measure benefits.
- Co-locate teams performing robot "build" capabilities and other services to optimize knowledge reuse within the organization.
- Maintain a catalogue of task automation programs to enable reuse and, eventually, automate the task of building new robots.

Work differently: Optimize digital processes and rebalance the workload

Automating tasks within an inefficient process results in an underperforming asset. Rethinking the way work gets done in the digital age requires an information platform designed for adaptability, flexibility and scalability.

- Reengineer processes to optimize the balance of the human and digital workforces.
- Iteratively evaluate automated tasks and activities for opportunities to redesign processes using AI capabilities.
- Enable the digital transformation of the enterprise using automation platforms and programs.

A new phase in automation has indeed arrived. And while only time will reveal tomorrow's leaders, we believe organizations that invest in intelligent automation today will be well positioned for success in the new era.

For more information

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"Cognitive Catalysts: Reinventing enterprises and experiences with artificial intelligence." IBM Institute for Business Value. September 2017. ibm.com/services/studies/csuite/ai/

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17   Based on prior IBM Institute for Value analytics research and IBM case studies.