accenture

IT'S LEARNING.
JUST NOT AS
WE KNOW IT.

**How to accelerate skills acquisition
in the age of intelligent technologies**

G20
Young Entrepreneurs'
Alliance

CONTENTS

PIERRE NANTERME

Chairman & CEO, Accenture

The issue at hand is one I take very seriously: Employers face a global skills crisis that could hold back the economic promise of intelligent technologies. Well beyond today's talent shortages, digital innovations will continually and rapidly alter the demand for skills in the future. Incremental changes to our education and corporate learning systems will not be sufficient.

In response to this crisis, business leaders must completely rethink how to prepare their workforces, from anticipating the skills their organizations will need, to how they will help people learn and apply new skills throughout their careers. For leaders looking to drive growth in an incredibly competitive and rapidly changing business environment, investing in people is both responsible and cost effective.

The good news is that skills development is, itself, undergoing rapid advances. This report examines the potential of new learning opportunities and offers recommendations for businesses, entrepreneurs and policy makers.

Among the recommendations, we call for teaching approaches that encourage individuals to develop a range of both technical and innately human skills, like empathy and critical thinking. We advocate a greater commitment to experience-based skills development, like on-the-job learning and apprenticeships. And we describe how engaging

and adaptive techniques can support more personalized, lifelong learning—especially in older workers and those in low-skill roles, who are often excluded from education and skills programs.

As a professional services company, Accenture's people make the difference in driving innovation and delivering high-quality services to clients. Indeed, we are tackling skills challenges head on. We have invested in large-scale skill building that leverages the latest advances in learning sciences, digital applications and experiential techniques. These help our people develop diverse talents—combining creativity, analytical and digital skills. In the communities where we work, we are extending apprenticeship programs to facilitate youth on-the-job learning. We are also supporting disadvantaged people as part of our Skills to Succeed program, which is on target to equip more than three million people with the skills needed to get a job or to build a business.

We are proud to once again support the B20 as it shapes the education and skills agenda. We are pleased as well to collaborate with the G20 Young Entrepreneurs Alliance (G20 YEA) to offer fresh insights and recommendations for policy makers working hand-in-hand with organizations. We hope our unique analysis, combined with our own experience of reimagining skills development, will help businesses and policy makers take the necessary steps forward.

BRUNO SANGUINETTI

Chair, G20 YEA Argentina

Call it the skills paradox: Small businesses and fast-growing enterprises are drivers of the technology innovations and digital business models that are reshaping our world. But as these technologies disrupt the nature of work, smaller businesses are often the least able to reskill their own people.

The sheer scale and complexity of continuously reskilling workers can overwhelm organizations that lack the capacity to invest in training. According to the OECD, workers in small and medium sized enterprises (SMEs) are 50 percent less engaged in training programs than those at larger organizations.[i]

As the G20 YEA puts the skills agenda at the forefront of discussions at the G20 and B20 meetings that culminate in Argentina this year, it is time for entrepreneurs to take advantage of new learning techniques and approaches that will help create an adaptable future workforce more cost effectively than ever before.

The growing demand for new approaches to learning also presents small enterprises with tremendous opportunities for disruptive growth in the fast-changing education and training sectors. Whether they offer technology or learning innovations to larger organizations and educational institutions, the most imaginative entrepreneurs must be on the lookout.

We are delighted to have worked with Accenture to scope the impact of the digital revolution on skills and jobs and to demonstrate how experiential learning can be a catalyst for addressing the skills challenge for large and small businesses alike.

We trust that this report will help policy makers and leaders of educational institutions put in place the investments, incentives and infrastructure that will transform the way we teach and learn.
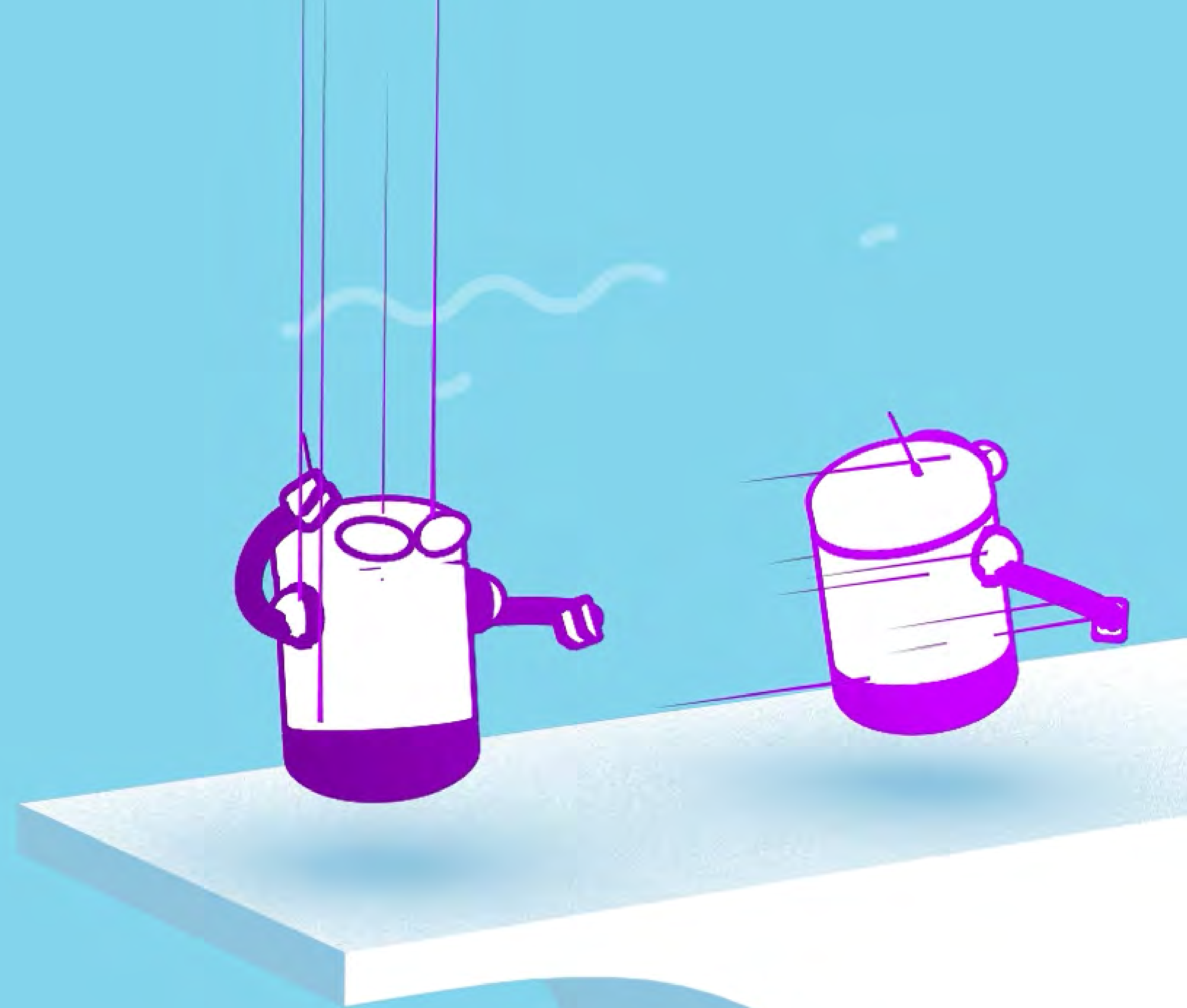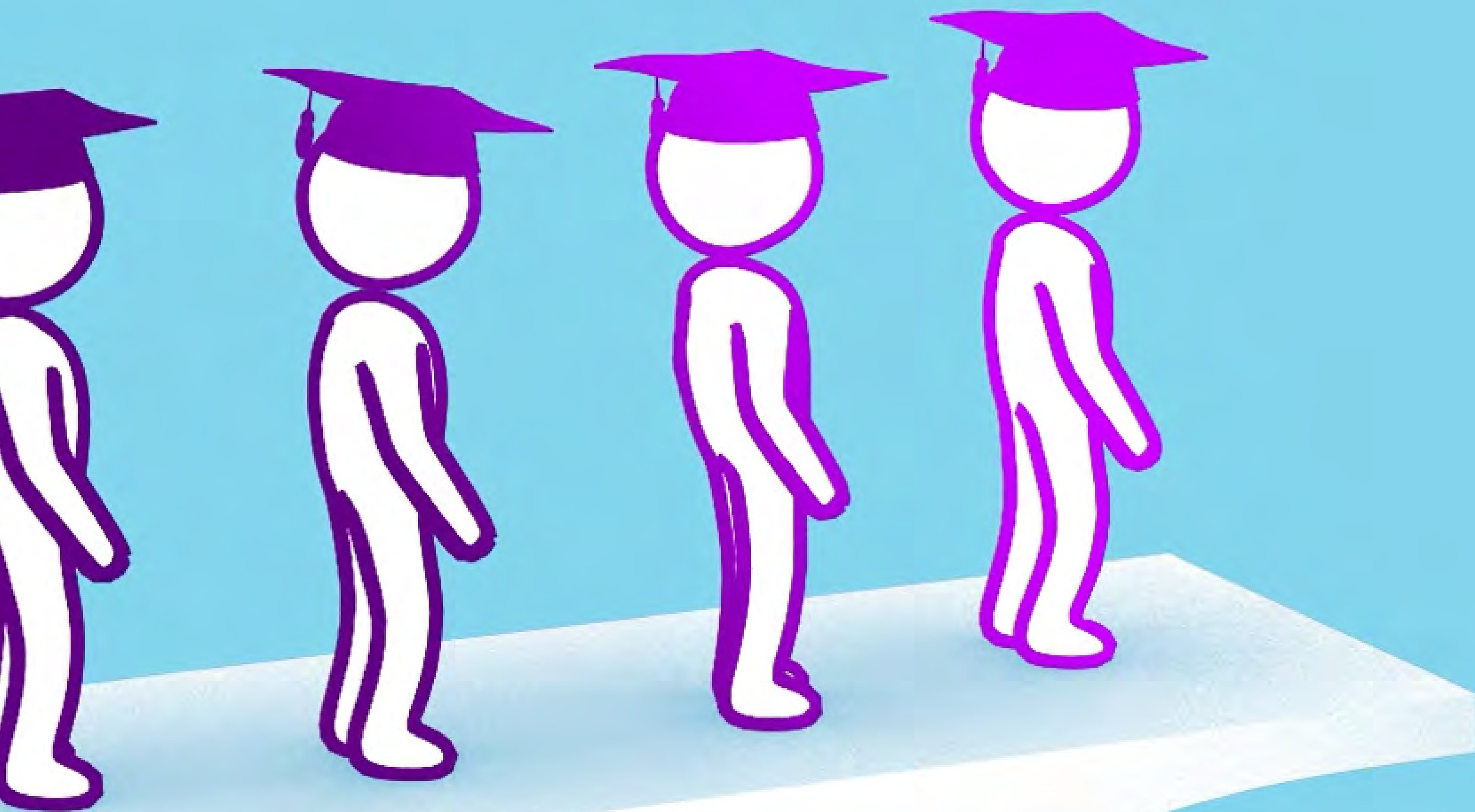
"The future of work will be a race between education and technology."

Mauricio Macri,
President of Argentina,
host of the G20 2018.

THE RACE IS ON

It's a race between education and technologies. Blockchain, AI and advanced biosciences promise new efficiencies and growth opportunities at a time when leading economies are struggling with weak productivity gains and, in some cases, slow GDP growth. But it's easier said than done.

Industrial age education and training systems put these economic opportunities at risk. If skill-building doesn't catch up with the rate of technological progress, the G20 economies could lose up to US$11.5 trillion in cumulative GDP growth in the next ten years. That's equivalent to losing more than an entire percentage point from the average annual growth rate every year over that period.

For this report, we look through the lens of the future worker – from the shop floor to the boardroom, from the shop front to the back office – and we identify their evolving skills demand. We analyze the changing importance of skills to different roles and the impact of intelligent technologies.

Contrary to conventional wisdom, this is not about technological skills. It is about cultivating the full range of skills, from the creative to the complex cognitive capabilities that the future workforce will need.

Our diagnosis: Current education and corporate learning systems are not equipped to address the coming revolution in skills demand. The challenge is especially urgent for roles that are more vulnerable to dislocation through intelligent automation. The impact is uneven across economies and industries, demanding targeted interventions.

Our proposed solutions: Learning with experiential techniques, shifting the focus from institutions to individuals and empowering the most vulnerable people to learn.

Advances in the science of learning, paired with new technologies, allow pioneering businesses to offer new approaches to learning. The challenge? Accelerating their adoption across all organizations, large and small, and throughout education systems in the G20 economies.

STAYING STILL IS NOT AN OPTION

The cost of inaction is staggering. Over the next decade, the 14 G20 countries in our analysis could miss out on as much as US$11.5 trillion of cumulative growth promised by intelligent technologies – if they can't meet future skills demand. That equates to forgoing more than an entire percentage point from their annual average GDP growth rate every year.

The impact will differ by country and by industry, depending on how labor is distributed across different roles. China, for example, could forgo up to 1.7 percentage points from its annual growth rate; Mexico and South Africa 1.8 percentage points. Economies with a stronger skills base may be better prepared, but could still lose big, as much as US$975 billion in the United States and US$264 billion in Germany over the coming 10 years. Beyond the economic impact, the risk includes greater rates of unemployment and intensified income inequality. (See Figure 1. For more details see Appendix 3: Technical Annex: Skills Crisis: Measuring the Growth at Risk.)

FIGURE 1: POTENTIAL COST OF THE SKILLS CRISIS

Cumulative GDP growth at risk*, 2018-2028

Billion US$ (in log scale)

Figures in white – absolute values at risk, US$ billion
Figures in blue – Additional average GDP growth at risk every year, % points of GDP growth at risk every year

Country	Value	% pts
Australia	$113 bn	0.5 %pts
Canada	$119 bn	0.4 %pts
Argentina	$131 bn	1.5 %pts
South Africa	$152 bn	1.8 %pts
Italy	$173 bn	0.6 %pts
France	$182 bn	0.5 %pts
UK	$185 bn	0.5 %pts
Germany	$264 bn	0.5 %pts
Mexico	$513 bn	1.8 %pts
Japan	$544 bn	0.6 %pts
Brazil	$781 bn	1.7 %pts
US	$975 bn	0.4 %pts
India	$1,970 bn	2.3 %pts
China	$5,447 bn	1.7 %pts
Total	**US$11.5 trn**	**1.1 %pts.**

Note: * Scenario assumes investments in intelligent technologies per worker in each country reach current US investment levels in traditional technologies per worker. More details on calculation and further scenarios can be found in Appendix 3, Technical Annex.

"We should be talking more about learning than about education. Education is about processes and top-down transmission of knowledge. Learning is a much wider concept. A lot of learning goes on in non-educational contexts, and today we have a very large and increasing number of learning opportunities."

Cristóbal Cobo, Director, Center for Research, Ceibal Foundation (Uruguay) and Research Associate, Oxford Internet Institute, University of Oxford (UK).

INTELLIGENT TECHNOLOGIES WILL RECONFIGURE ROLES

To some, the solution is simple: Train more engineers, raise the number of creative designers, produce more data analysts. But creating larger cohorts with specialist skills is not the answer.

It's equally naïve to assume that intelligent technologies will simply eliminate some jobs and create new ones. In fact, the biggest effect will be a reconfiguration of positions, as tasks evolve and worker capabilities are augmented by machines.

Instead of asking which jobs will prevail, we should instead ask how roles will be redefined and in what ways tasks will be affected by intelligent technologies. For example, as nurses utilize intelligent systems to manage paperwork responsibilities, more of their time will be freed up for patient care. This shift implies that certain skills, like empathy and communication, will rise in importance while others, like administrative skills, will decline. Industrial engineers are already called upon more frequently to use their communications skills to collaborate with and

report to senior management, but are less likely to need logistical skills, much of which can now be undertaken with the help of intelligent software.

A ground-level analysis of skills related to future roles is the crux of our research. Drawing on US data on skills and tasks, we identified the skills workers actually apply as they perform daily tasks. We empirically grouped tasks and skills that tend to be used together to create 10 distinct role clusters (see Figure 2. For more details see Appendix 3, Technical Annex: Defining and Deriving Role Clusters). We then determined whether intelligent technologies augment or automate specific work tasks, and worked with labor force data from across 14 G20 countries to paint a detailed picture of how intelligent technologies could scramble future skills demand.

Our role cluster analysis allows organizations to understand more accurately how roles will increase and diminish in demand, helping them design more precise lifelong learning strategies, take advantage of opportunities and minimize risks. Our approach helps leaders answer the following questions:

- Which skills tend to be utilized together in different roles?

- How is skills demand evolving and where will the gaps be?

- Which roles are most likely to be augmented and automated by intelligent technologies?

- How will intelligent technologies change skill and labor demand in different industries and economies?

WHAT HAVE YOU BEEN DOING AT WORK?

Our analysis reveals how tasks have shifted between 2008 and 2017. Consider the Physical Services cluster: Retail cashiers used to stock shelves and price items each day, but now do so little more than weekly. Addressing customer queries – which used to be a once-a-day task – is now an hourly one, at least.

By comparison, maintenance engineers in our Technical Equipment Maintenance role cluster had to calibrate equipment more than once a week ten years ago. Today, they do so twice per month, and collaborate with colleagues to install complex equipment daily, instead of monthly.
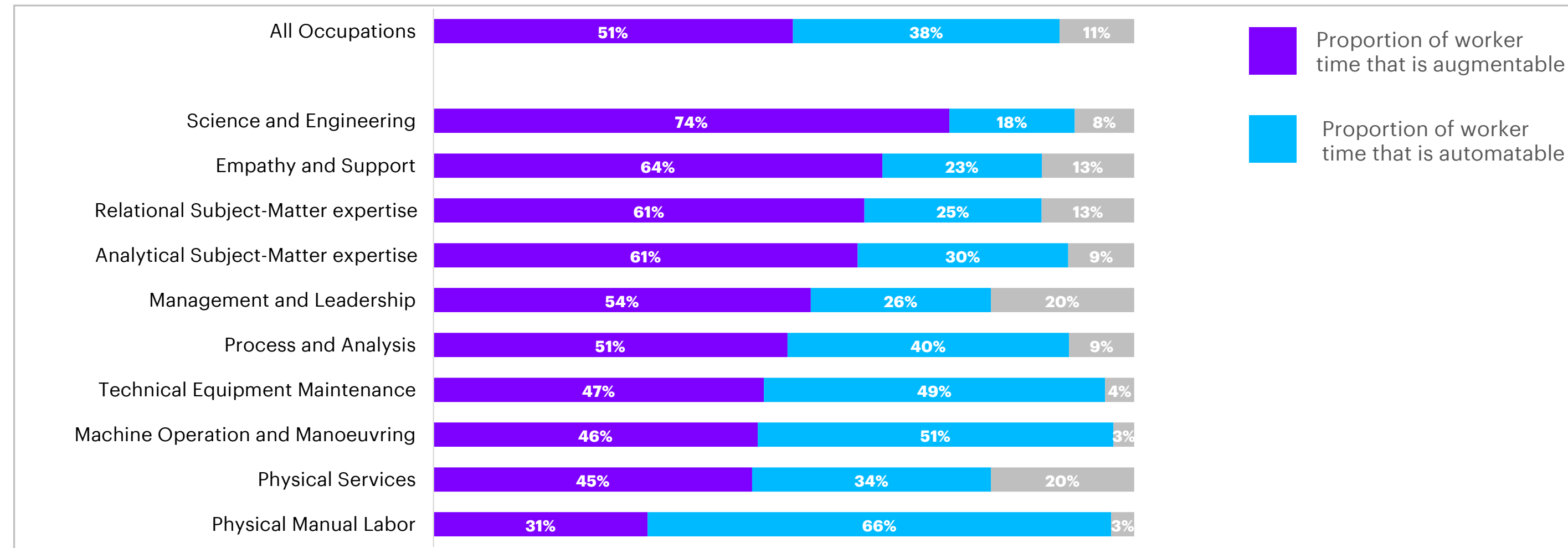
FIGURE 2: ROLE CLUSTERS OFFER A UNIQUE LENS ON EVOLVING WORK PATTERNS

Accenture's 10 role clusters are derived from the empirical clustering of work tasks that tend to be performed together and skillsets that tend to be utilized together. Therefore, workers within each role cluster will be impacted by intelligent technologies in similar ways.

ROLE CLUSTER	TYPICAL ACTIVITIES	ILLUSTRATIVE OCCUPATIONS	ILLUSTRATIVE TASK EVOLUTION
1 MANAGEMENT & LEADERSHIP	Supervises and takes decisions	Corporate managers and education administrators	Marketing managers handle data and take decisions based on social media and web metrics
2 EMPATHY & SUPPORT	Provides expert support and guidance	Psychiatrists and nurses	Nurses can focus on more patient care rather than administration and form filling
3 SCIENCE & ENGINEERING	Conducts deep, technical analyzes	Chemical engineers and computer programmers	Researchers focus on sharing, explaining and applying their work, rather than being trapped in labs
4 PROCESS & ANALYSIS	Processes and analyzes information	Auditors and clerks	Accountants can ensure quality control rather than crunch data
5 ANALYTICAL SUBJECT-MATTER EXPERTISE	Examines and applies experience of complex systems	Air traffic controllers and forensic science technicians	Information security analysts can widen and deepen searches, supported by AI-powered simulations
6 RELATIONAL SUBJECT-MATTER EXPERTISE	Applies expertise in environments that demand human interaction	Medical team workers and interpreters	Ambulance dispatchers can focus on accurate assessment and support, rather than logistical details
7 TECHNICAL EQUIPMENT MAINTENANCE	Installs and maintains equipment and machinery	Mechanics and maintenance workers	Machinery mechanics work with data to predict failure and perform preventative repairs
8 MACHINE OPERATION & MANOEUVRING	Operates machinery and drives vehicles	Truck drivers and crane operators	Tractor operators can ensure data-guided, accurate and tailored treatment of crops, whilst "driving"
9 PHYSICAL MANUAL LABOR	Performs strenuous physical tasks in specific environments	Construction and landscaping workers	Construction workers reduce re-work as technology predicts the location and nature of physical obstacles
10 PHYSICAL SERVICES	Performs services that demand physical activity	Hair dressers and cooks	Transport attendants can focus on customer needs and service rather than technical tasks

FIGURE 3: PERCENTAGE OF WORKER TIME POTENTIALLY AUGMENTED / AUTOMATED BY INTELLIGENT TECHNOLOGIES

Occupation	Augmentable	Automatable	Neither
All Occupations	51%	38%	11%
Science and Engineering	74%	18%	8%
Empathy and Support	64%	23%	13%
Relational Subject-Matter expertise	61%	25%	13%
Analytical Subject-Matter expertise	61%	30%	9%
Management and Leadership	54%	26%	20%
Process and Analysis	51%	40%	9%
Technical Equipment Maintenance	47%	49%	4%
Machine Operation and Manoeuvring	46%	51%	3%
Physical Services	45%	34%	20%
Physical Manual Labor	31%	66%	3%

Proportion of worker time that is augmentable

Proportion of worker time that is automatable

Note: simple average across occupations
Source: Accenture analysis of national labor force data

WHICH ROLES ARE MOST PRONE TO AUGMENTATION AND AUTOMATION?

In *Human + Machine,* Accenture's Paul Daugherty and James H. Wilson have shown that as people collaborate with intelligent machines, there will be a significant opportunity to augment human capabilities and elevate the work people do.[ii] In the analysis for this report, we reveal that a significant portion of worker time (90 percent on average, across roles) will potentially be affected by intelligent technologies, either through augmentation or automation (see Figure 3).

A little more than half of work time in the 14 economies we have analyzed can be potentially augmented. Thirty-eight percent has the potential to be automated. However, the distribution of potentially automatable and augmentable work is disproportionately skewed to some role clusters and to those economies where those role clusters comprise a greater share of the workforce. As a result, some economies will be more exposed to the negative consequences of automation than others. The overall predominance of augmentation opportunities makes the vulnerability of roles like Physical Manual Labor and Machine Operation and Manoeuvring all the more starker.

Workers are performing interactive and collaborative tasks more frequently, and repetitive ones less frequently.

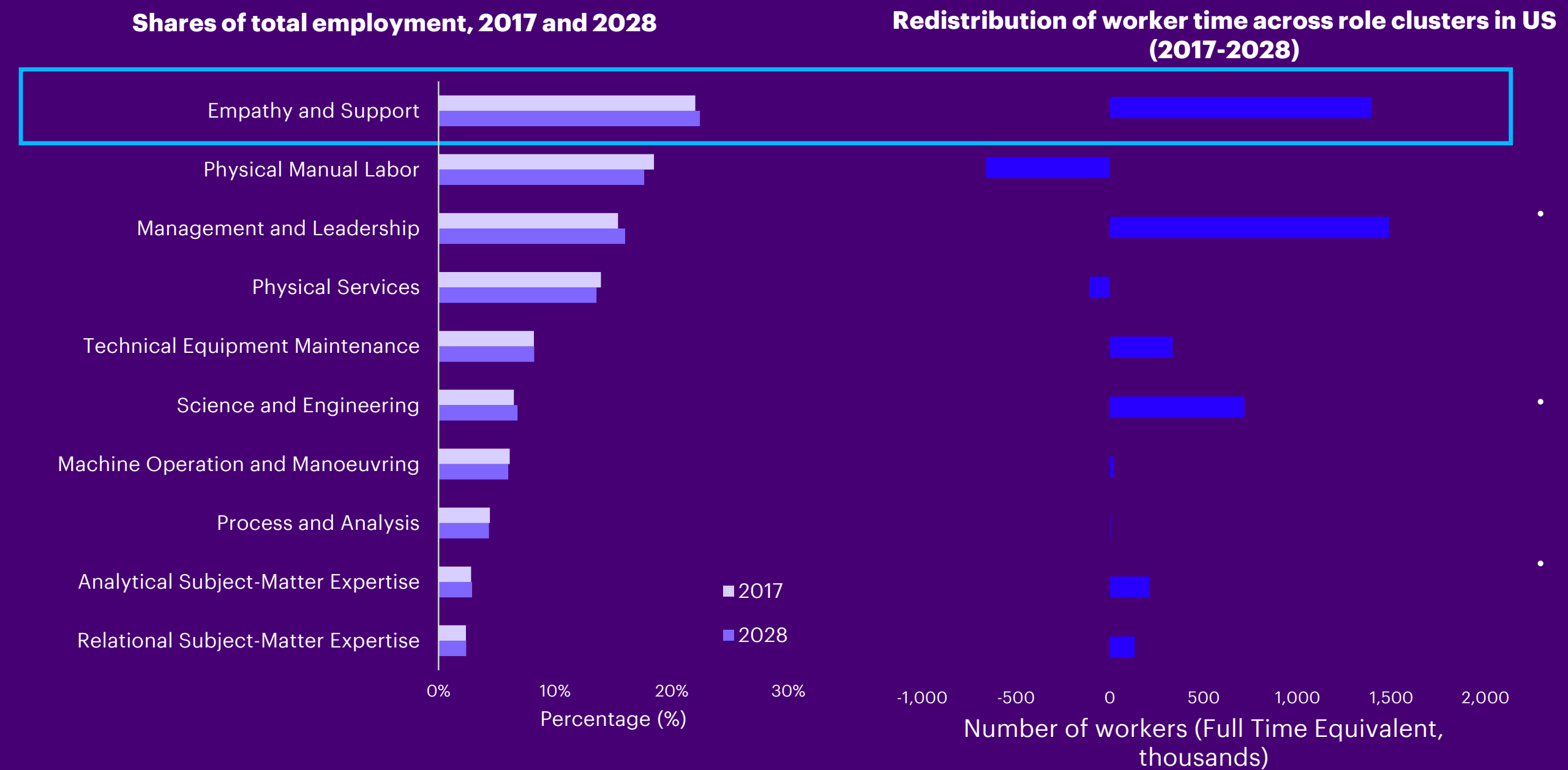## HOW CAN G20 NATIONS IDENTIFY OPPORTUNITIES AND RISKS?

In the US, Empathy and Support workers (such as nurses and psychiatrists) represent the largest single share of employment in the entire economy. Our research highlights that these roles are highly augmentable (see Figure 3). Specifically, we find that 64 percent of their work time could be potentially augmented, and that 14 percent might be augmented already in the next ten years. As this happens, and as the US working-age population grows, we can expect these roles to see a major increase in demand for labor, as much as 1.4 million workers (see Figure 4).

Supporting the transition of these workers to the skills demands of the future workplace will be a significant driver of productivity and growth gains in the US. With the right skilling investments, the prize is there for the taking.

In contrast, China possesses the largest workforce in the Physical Manual Labor cluster, which is particularly vulnerable to automation. Although China will continue to employ vast numbers of people in Physical Manual Labor jobs, our model points to a potential redistribution of 63 million workers away from these roles over the next 10 years, which will leave many workers in need of new skills (see Figure 5). Anticipation of future skill gaps allows for planning and intervention.

FIGURE 4: REDISTRIBUTION OF WORK ROLES IN THE UNITED STATES, 2017-2028

Empathy and Support roles represent the largest share of employment in the US and will also require a major increase in workers over the next 10 years.
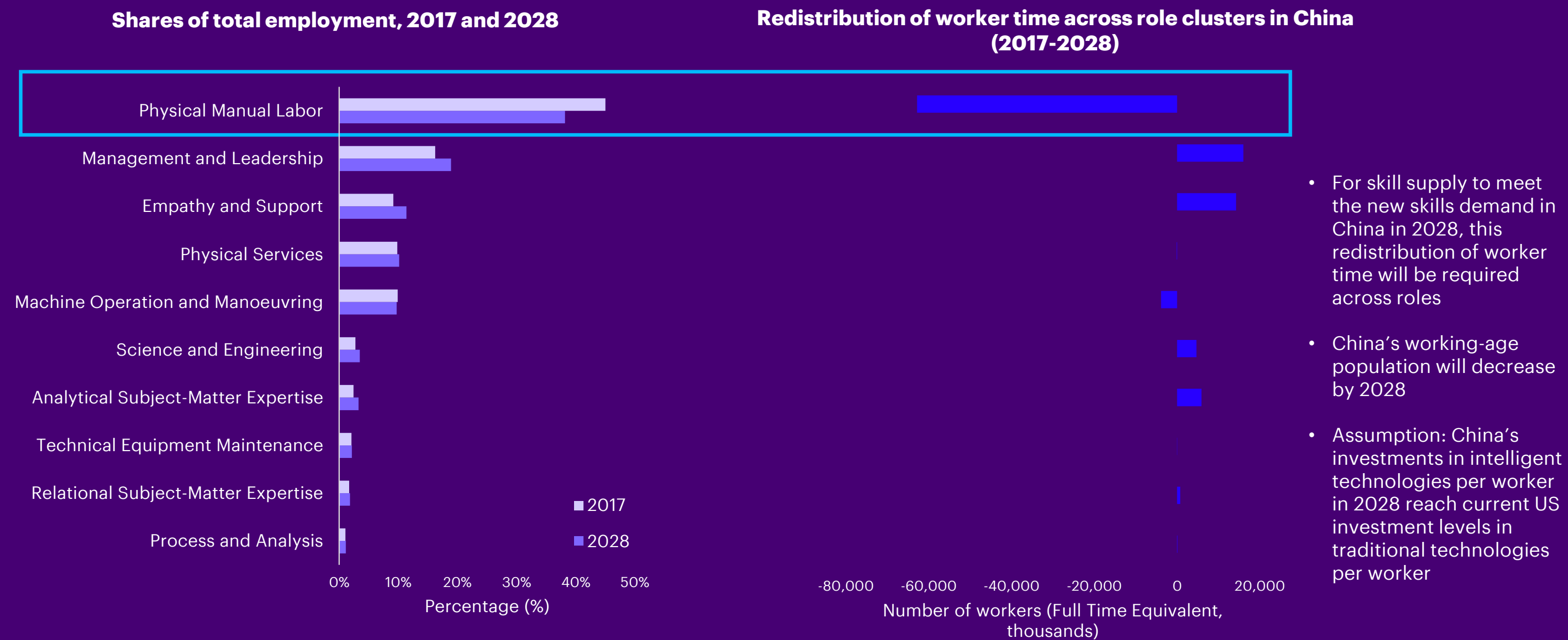

Shares of total employment, 2017 and 2028

Redistribution of worker time across role clusters in US (2017-2028)

Empathy and Support
Physical Manual Labor
Management and Leadership
Physical Services
Technical Equipment Maintenance
Science and Engineering
Machine Operation and Manoeuvring
Process and Analysis
Analytical Subject-Matter Expertise
Relational Subject-Matter Expertise

2017
2028

0%   10%   20%   30%
Percentage (%)

-1,000 -500   0   500 1,000 1,500 2,000
Number of workers (Full Time Equivalent, thousands)

• For skill supply to meet the new skills demand in the US in 2028, this redistribution of worker time will be required across roles

• US working-age population will increase by 2028, resulting in greater demand for almost every role

• Assumption: Investments in intelligent technologies per worker in 2028 reach current investment levels in traditional technologies per worker

Source: Accenture analysis of national labor force data

FIGURE 5: REDISTRIBUTION OF WORK ROLES IN CHINA, 2017-2028

Physical Manual Labor represents the largest share of employment in China. By 2028, demand will decrease, but it will remain the dominant form of employment.

Shares of total employment, 2017 and 2028

Redistribution of worker time across role clusters in China (2017-2028)

- Physical Manual Labor
- Management and Leadership
- Empathy and Support
- Physical Services
- Machine Operation and Manoeuvring
- Science and Engineering
- Analytical Subject-Matter Expertise
- Technical Equipment Maintenance
- Relational Subject-Matter Expertise
- Process and Analysis

■ 2017
■ 2028

Percentage (%)

Number of workers (Full Time Equivalent, thousands)

- For skill supply to meet the new skills demand in China in 2028, this redistribution of worker time will be required across roles

- China's working-age population will decrease by 2028

- Assumption: China's investments in intelligent technologies per worker in 2028 reach current US investment levels in traditional technologies per worker

Source: Accenture analysis of national labor force data

"Technology like AI puts a premium on human skills like empathy, creativity and critical thinking. But unless we analyze the everyday activities of workers on the ground, it's hard to understand precisely how needs will evolve and where to take action."

Robert Seamans,
Associate Professor of Management and Organizations at New York University's Stern School of Business.

INTELLIGENT TECHNOLOGIES ARE SUBVERTING THE SKILLS MIX

The nature of work is evolving quickly, and will only accelerate as humans and machines increasingly collaborate with each other. We have seen how roles and tasks will change, but which skills will increase in importance?

Our analysis reveals that for almost every single role, a combination of Complex Reasoning, Creativity, Socio-emotional Intelligence and Sensory Perception skills (see Figure 6) is increasingly relevant.

It's a finding that raises a daunting challenge: today's education and training systems are ill-equipped to build these skills. By their nature, these skills are acquired through practice and experience, often over long periods of time. They are not inculcated in the classroom, lecture hall or library.

Moreover, role clusters that use these experience-dependent skills more intensively, such as "Management and Leadership" and "Emotional and Support," are precisely the roles that will grow in prominence and labor demand, worldwide, as intelligent systems spread.

In the meantime, skills gaps are widening and institutions are not equipped to cope. How can we start teaching these skillsets? How can we adapt learning systems to meet evolving skills demand? And how can we reach out to workers who are most in need of skills training, and help them learn, quickly?

> **"We still talk about a knowledge economy, but the reality is that the world is moving beyond it. What we have now is an innovation economy. Knowledge has been commoditized. There is no longer a competitive advantage in simply knowing more than other people, because Google knows everything. What the world cares about is not how much you know, but what you can do with it."**

Tony Wagner,
Senior Research Fellow, Learning Policy Institute.

FIGURE 6: THE RISING IMPORTANCE OF NEW SKILLSETS

The skillsets that are increasingly important across every role are acquired through practice and experience, not in classrooms.

Importance: ● High (purple)   ● Medium (blue)   ● Low (grey)

	Complex Reasoning		Creativity		Socio-emotional Intelligence		Sensory Perception	
	Importance in 2017	Change since 2004	Importance in 2017	Change since 2004	Importance in 2017	Change since 2004	Importance in 2017	Change since 2004
MANAGEMENT & LEADERSHIP	High	▲	High	▲	High	▲	Low	▲
EMPATHY & SUPPORT	Medium	▲	High	▲	High	▲	Low	▲
SCIENCE & ENGINEERING	High	▲	High	▲	Medium	▲	Low	▲
ANALYTICAL SUBJECT-MATTER EXPERTISE	Medium	▲	High	▲	High	▼	Low	▲
RELATIONAL SUBJECT-MATTER EXPERTISE	Medium	▲	High	▲	High	▲	Low	▲
PROCESS & ANALYSIS	Medium	▲	High	▲	High	▲	Low	▲
PHYSICAL SERVICES	Low	▲	Low	▲	High	▲	Low	▲
TECHNICAL EQUIPMENT MAINTENANCE	Medium	▲	Medium	▲	Low	▲	High	▲
MACHINE OPERATION & MANOEUVRING	Medium	▲	Low	▲	Low	▲	High	▲
PHYSICAL MANUAL LABOR	Low	▲	Low	▲	Low	▲	Medium	▲

Note:
- Complex Reasoning includes critical thinking, deductive reasoning, active learning and a set of higher-order cognitive capabilities.
- Socio-emotional Intelligence involves active listening, social perceptiveness, persuasion, negotiation and service orientation.
- Sensory Perception incorporates a wide range of sensory capabilities that have been stimulated through our increasingly intimate relationship with digital technologies.

Source: Accenture analysis of data from The Occupational Information Network (O*NET) of the US Department of Labor

SOLVING THE SKILLS CRISIS IN THREE STEPS

STEP ONE:

SPEED UP EXPERIENTIAL LEARNING

Thanks to advances in neuroscience and technology, the development of experiential learning techniques have progressed significantly in recent years. These techniques are about learning through hands-on application, rather than absorbing knowledge by listening or reading.

In late 2015, The Dartmouth Center for the Advancement of Learning conducted a review of research on the known outcomes of experiential learning. The very skills that are growing in demand according to our analysis (complex reasoning, critical thinking, creativity and socio-emotional intelligence) are the ones best acquired through experiential learning techniques.[iv]

THE POWER OF LEARNING BY DOING

Experiential learning captures our attention because it is immersive and hands-on. Learners are active participants, not passive recipients of knowledge. Progressive schools use project-based and team-based learning to engage children. In some countries, apprenticeship schemes offer deep experiential learning to large sections of young workers. In corporate settings, experiential techniques range from design thinking in the boardroom to simulation training tools for more technical roles.

A growing body of research in neuroscience and the behavioral sciences confirms how these techniques lead to faster and deeper learning. A 2015 study at the University of Chicago used brain scans to show that hands-on learning activates sensory and motor-related areas of the brain. Students who learned this way – experiencing a science concept by doing experiments, for example – understood more and scored better on tests.[iv]

The US National Training Laboratory found that retention rates for training through Virtual Reality (a tool for highly experiential forms of learning) are 75 percent, far above the 10 percent for reading-based learning and the five percent for lecture-style learning.[v]

Paul Zak, a neuroeconomics professor, co-founded Immersion Neuroscience, which developed a wearable sensor that tracks production of the hormone oxytocin, the neurochemical associated with empathy and human connection. Working with CaseWorx, a video training company, Immersion Neuroscience has shown that watching a video of a case study, rather than reading it, improved knowledge recall by 97 percent.

When learning is active and "effortful," the brain forms new connections more easily, according to Washington University professors of psychology and brain sciences, Henry Roediger and Mark McDaniel. They also found that students learn more when they are forced to solve a problem rather than being taught the solution. Making and correcting mistakes also improves skills retention.[vi]

These approaches are especially well-suited to adults. As brain plasticity decreases over time, retaining information through listening and reading becomes more difficult. The overarching consensus is that incorporating these experiential techniques into skilling programs will yield the best results.

TECHNOLOGY PUSHES THE BOUNDARIES OF EXPERIENCE

For decades, aircraft pilots have benefited from experiential simulation training, which lets them practice dangerous and stressful situations in safety. Today, new technologies are making these experience-based solutions more engaging, personalized, accessible and relevant to future work.

Virtual Reality is the most attention-grabbing experiential tool. It offers the closest experience to reality. Use cases range from collaborative hands-on learning about rare diseases among physicians to preparing for hazardous scenarios on an oil rig. The advent of 5G networks will mark a crucial milestone in making these solutions more accessible and effective, and advances in areas like haptic technologies and holograms are pushing the boundaries of extended reality even further.

Other technology advances accelerate and enhance experiential learning. Artificial Intelligence (AI), for instance, enables the personalization of learning, improving relevance and heightening the impact for each individual. According to Area9 Learning, which specializes in adaptive learning, 70 percent of US training content is forgotten in 24 hours. The company uses AI to understand what the learner is doing and to adapt the lessons and activities in response – suggesting additional drills to improve mastery of a specific skill, for example. Area9 says that its adaptive learning system not only improves knowledge retention, but also cuts training time by 50 percent.[vii] A similar approach is taken by

> **"Technology is a natural ally for experiential learning. It offers people ways to really experience what they are supposed to be learning about, but in a safe and controlled environment. This affords unique opportunities."**
>
> Manolis Mavrikis,
> Director of the Education and Technology MA,
> University College London (UCL).

Solving the Skills Crisis in Three Steps

InsideBoard, a change management platform provider (see Appendix 2: Technologies in Action).

The data-driven nature of new technologies also helps to measure performance objectively. Michael Casale, Chief Science Officer at STRIVR, an immersive learning and training company, says, "A primary benefit of virtual reality is that it enables us to capture people's moment-to-moment reactions and behaviors in real time. These behaviors, typically never captured objectively and systematically until now, give us great insight into individuals. By applying AI algorithms to that data, we can learn about what VR designs are most effective and how immersive experiences can be improved on an individual level. Ultimately, this allows us to develop the most impactful training experiences in order to achieve the desired behavior change in the real world."
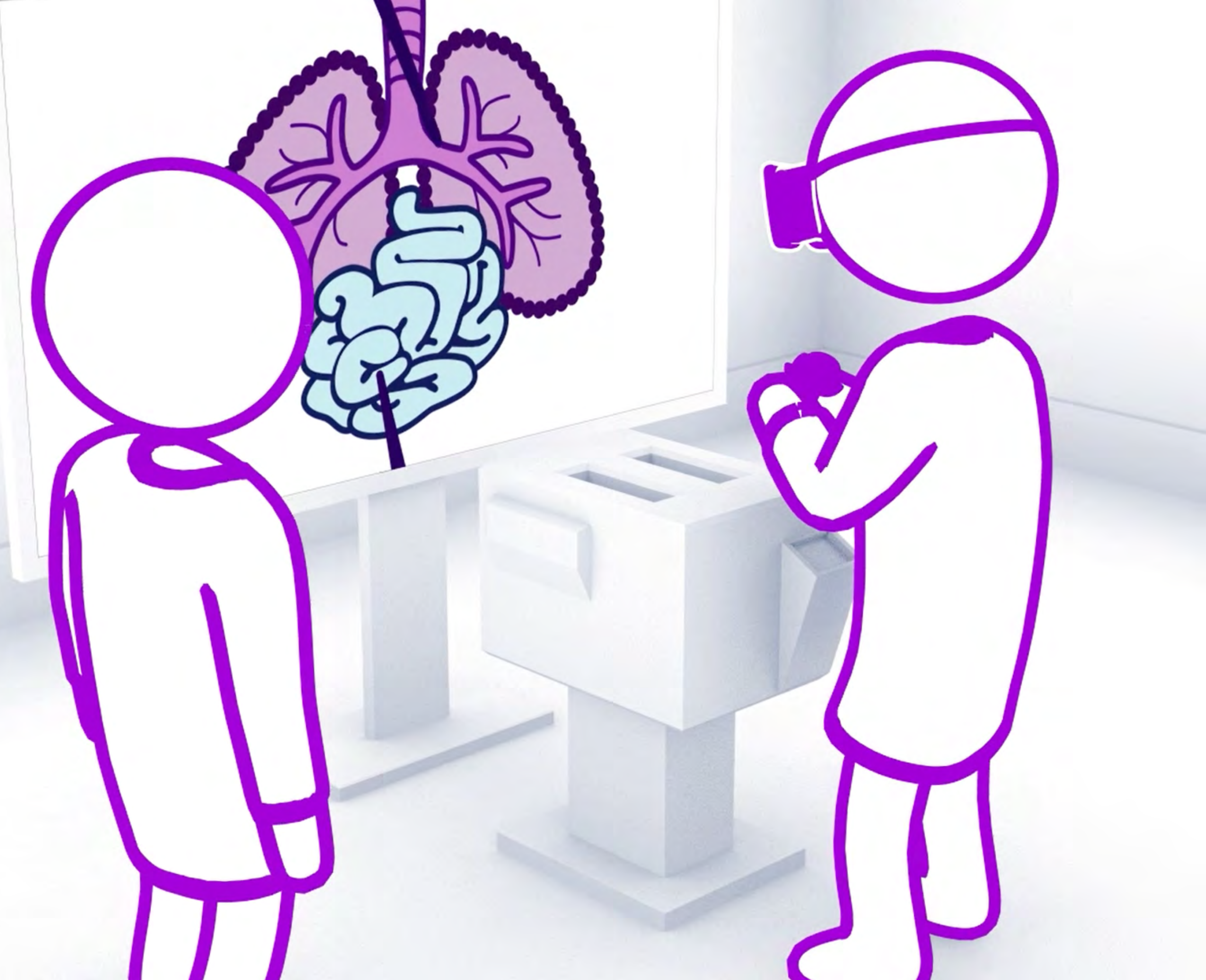
APPRENTICESHIPS: AS EXPERIENTIAL AS LEARNING CAN GET

No other learning technique is closer to "real work" than apprenticeships. The nature of an apprenticeship ensures that participants practice the full range of skills that a job demands. The chance to build these skills and gain familiarity with the world of work while continuing studies is highly attractive.

"When someone enters the work environment, they do not necessarily understand the importance of working in a team and do not appreciate the elements of being service-oriented," says Shea Gopaul, Founder and Executive Director of the Global Apprenticeships Network (GAN). "However, after completing their apprenticeship, young people are better prepared, more confident and ready to take on the tasks required for a job."

Thanks to an apprenticeship culture built up over more than a century, Switzerland's Vocational Education and Training (VET) initiative is a gold standard, covering two-thirds of students graduating from compulsory education and keeping youth unemployment rates extremely low. But this admirable kind of success is challenging to replicate. According to the OECD, uptake levels reach 34 and 32 percent in Germany and Austria, respectively, while countries as diverse as Japan, Spain, Italy, Korea and the US struggle to get
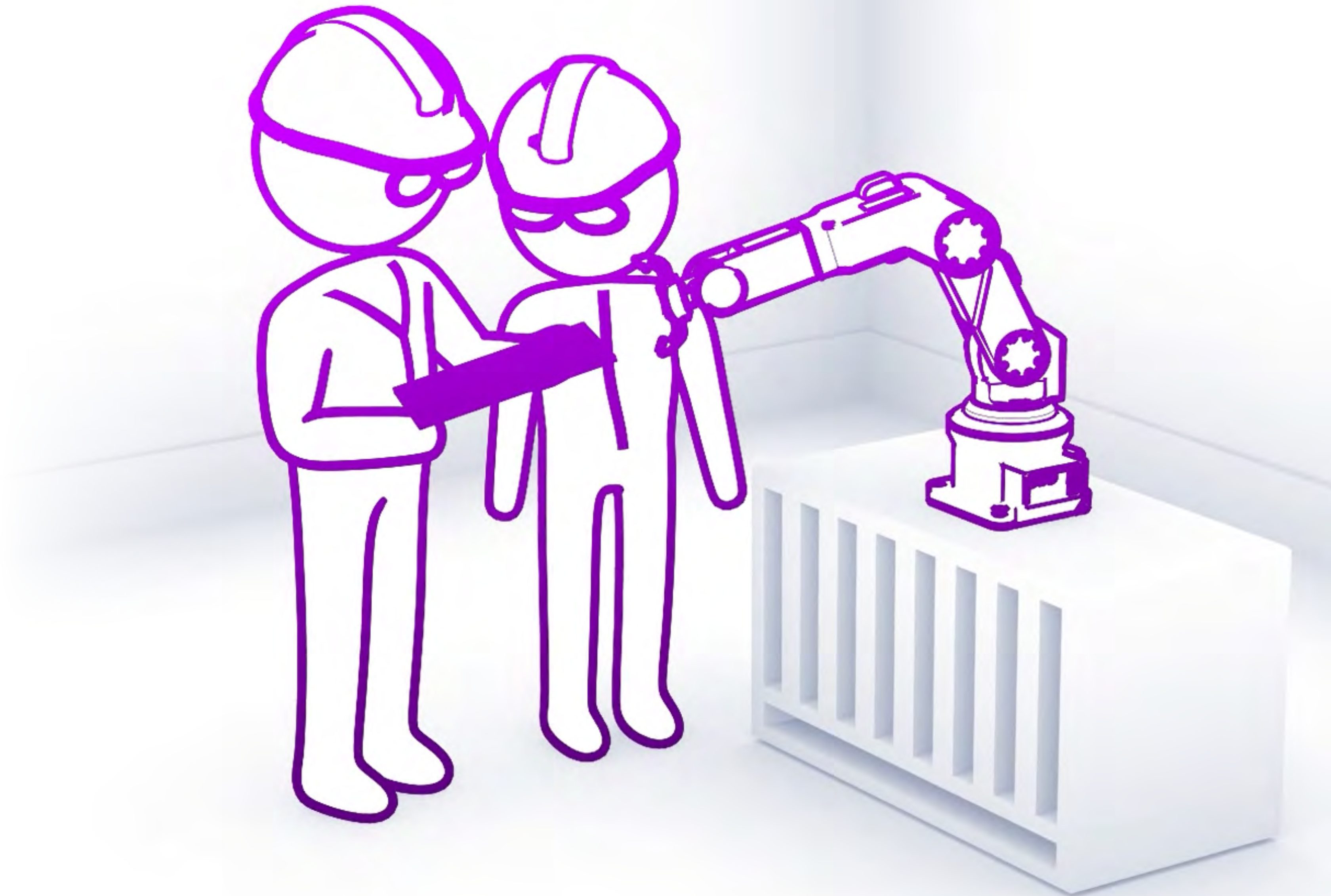
On-the-Job Learning at Walmart

With a shifting retail environment and 1.4 million employees in the US (and nearly another million around the world), Walmart may have one of the United States' greatest skilling challenges. The Walmart Training Academies, which give two to six weeks of hands-on learning with classroom and sales floor experience, are a key component. "On-the-job training allows for a more intense learning experience and keeps the skills of our workforce adapting to new realities," says Dan Bryant, Senior Vice President of Global Public Policy and Government Affairs.

The company has a complete suite of learning options that range from high-school completion programs to associate's and bachelor's degrees costing just US$1 a day. The concept of job-relevant skills development, though, is a core priority. Academies, which are located within stores, keep learners connected to customers and real work experiences. And by investing in associates' development, the programs boost engagement and retention rates. "An added bonus of our on-the-job training," adds Bryant, "is that it gives our employees the chance to earn college credits as they upskill and re-skill. This allows the 7,500 associates who graduate each week to keep better track of their progress and feel proud of what they've achieved, a goal we aim to complement with micro-credentialing."

apprenticeship initiatives off the ground, with participation at less than two percent.[viii]

Obstacles are manifold. In some countries, businesses, labor organizations and governments may agree on the importance of apprenticeships but disagree over how to pay for them. In others, young people and their families still see apprenticeships as a lesser kind of education compared with, for instance, university studies. In reality, these options do not have to be mutually exclusive.

Despite the challenges, there are signs that momentum for apprenticeships is building. Earlier this year the French Government announced a plan to make apprenticeships more attractive. It will seek to increase the monthly pay for apprentices and publish information about the success of each program in leading to jobs. It also wants to increase the maximum age of participants from 26 to 30, and to give businesses and unions, rather than civil servants, the task of defining the qualifications required for vocational training programs. [ix]

In the meantime, Accenture continues to work with GAN and to support the adaptation of the Swiss VET model around the world. [x]

STEP TWO:

SHIFT FOCUS FROM INSTITUTIONS TO INDIVIDUALS

Most of us recognize the value of a broad variety of skills across the workforce. But there needs to be a greater emphasis on broadening the variety of skills *within* each worker.

The most useful and relevant blend of skills for each person will continuingly shift and become more complex. For example, our analysis shows that highly analytical Science & Engineering roles increasingly require creativity and socio-emotional intelligence (see Figure 7). Research scientists, who used to spend most of their time in their labs, communicating via technical papers, are now regularly called upon to interact, present and share their insights with non-technical audiences. At the same time, what have traditionally been considered "creative" roles—in marketing, for example—require more analytical skills such as interpreting social media data and examining web performance trends. It is important, therefore, to cultivate these evolving combinations of skills within each individual.

RE-THINKING TARGETS AND MEASURES

Today's education and learning systems do not usually address the needs of individual learners. They measure and incentivize the macro-level output of their institutions. For instance, setting targets for more "STEM" skills has meant tracking the number of engineering graduates; the demand for more creativity is now turning attention to the number of Arts and Humanities graduates.

These measurements miss the point. Our demand for more creativity doesn't necessarily mean we need more ballerinas and sculptors, it means that each of us must be more creative in our daily activities. A more learner-centered approach would be to design metrics and incentives that encourage the blending of skills in each person.

Educators should begin encouraging a better-rounded set of skills from elementary school. The UK, which is strong in the creative industries, is currently hosting heated debates over whether initiatives to improve STEM skills

and bring more rigor to tests have compromised efforts to encourage creativity, through classes like drama, music and art. Many schools across the G20 do not expose children to these skills at all.

Deeply entrenched practices, bureaucratic systems and simplistic terminology complicate the task of institutional reform. Current approaches create costly misconceptions. For example, "softer" skills are seen as nebulous and impossible to measure and assess. But techniques like the

FIGURE 7: CHANGE IN IMPORTANCE OF SKILLS FOR SCIENCE AND ENGINEERING ROLES (2004-2017)

Science and engineering roles already require greater creativity and socio-emotional intelligence.
This trend will accelerate with human-machine collaboration.
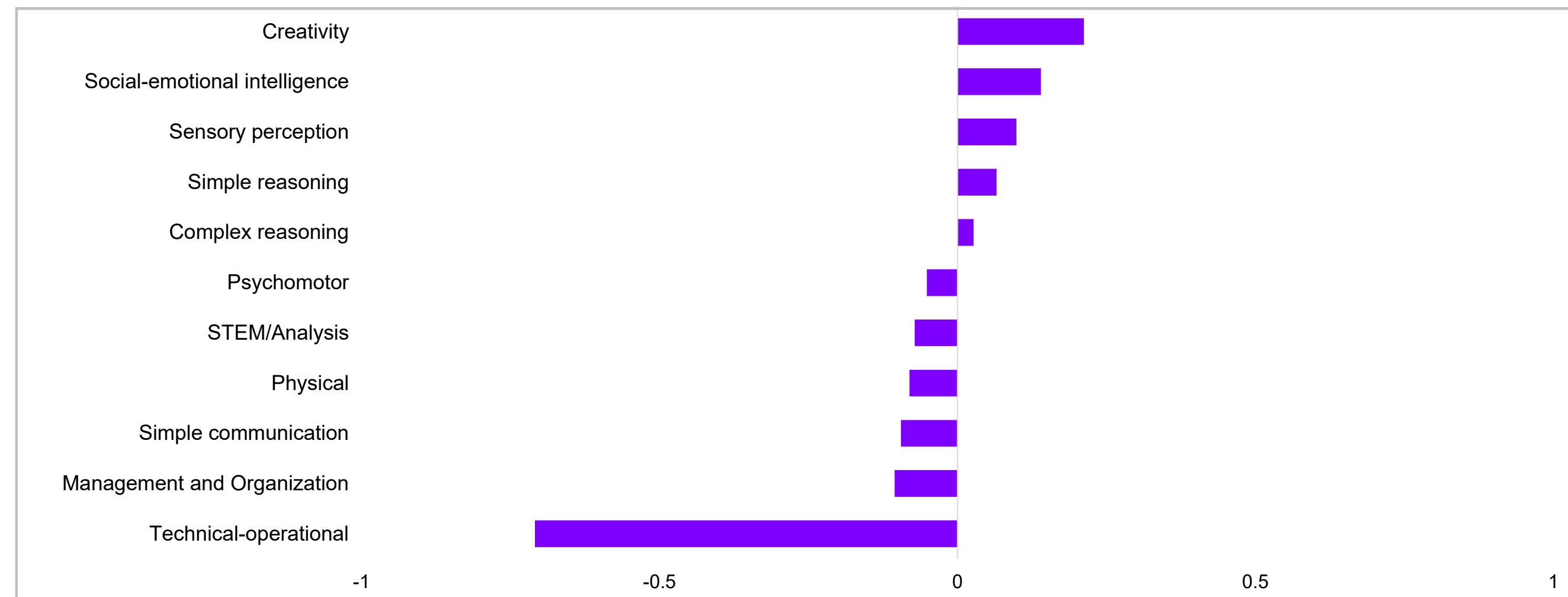
Scale based on US Department of Labor (O*Net) measure of skill importance, 1-5 scale
Source: Accenture analysis of data from The Occupational Information (O*Net) from the US Department of Labor

A Blend of Skills for Naval Officers

The US Navy teaches a wide range of cognitive and non-cognitive skills to its young officers. Working with the University of Southern California, the US Navy prepares its junior leaders with interpersonal and social skills training before they are put into positions of responsibility, in or out of combat. The Immersive Naval Officer Training System (INOTS) involves virtual reality and classroom response technology. It provides a safe space in which officers can learn to handle not just technical issues, but the interpersonal skills required to handle sensitive or challenging situations. INOTS has trained over 15,000 sailors since 2012.[xi]

Torrance Test for Creative Thinking have been around since the 1960s, while Montessori schools have been offering and assessing child-centered approaches for more than a hundred years.

Another damaging misunderstanding is the way the term "STEM" is commonly used to refer to all analytical and complex cognitive skills. In reality, truly analytical STEM-related skills like mathematical reasoning, science and programming are only of high importance to Science & Engineering roles, and are decreasing in importance for many other roles (see Figure 8). Not everybody wants to be a mathematician or scientist, but each person needs to build complex reasoning and high-order cognitive capabilities. The teaching of these skills should not be restricted to STEM subjects.

Universities should make greater efforts to encourage cross-fertilization of ideas and multi-disciplinary learning opportunities. Lifelong learning, both inside and outside companies, should encompass a broader range of skills, especially for roles that do not currently utilize much complex reasoning, creativity and socio-emotional intelligence skills.

FIGURE 8: THE CHANGING IMPORTANCE OF STEM/ANALYSIS AND COMPLEX REASONING SKILLS

STEM skills are important for some people, but every worker needs to get better at complex reasoning.

Importance:	STEM / Analysis		Complex Reasoning	
● High ● Medium ● Low	Importance in 2017	Change since 2004	Importance in 2017	Change since 2004
MANAGEMENT & LEADERSHIP	● Medium	▼	● High	▲
EMPATHY & SUPPORT	● Medium	▼	● Medium	▲
SCIENCE & ENGINEERING	● High	▲	● Medium	▲
ANALYTICAL SUBJECT-MATTER EXPERTISE	● Medium	▼	● High	▲
RELATIONAL SUBJECT-MATTER EXPERTISE	● Low	▼	● Medium	▲
PROCESS & ANALYSIS	● Medium	▲	● Medium	▲
PHYSICAL SERVICES	● Low	▼	● Low	▲
TECHNICAL EQUIPMENT MAINTENANCE	● Medium	▲	● Medium	▲
MACHINE OPERATION & MANOEUVRING	● Low	▲	● Medium	▲
PHYSICAL MANUAL LABOR	● Medium	▼	● Low	▲

Note: Complex Reasoning includes critical thinking, deductive reasoning, active learning and a set of higher-order cognitive capabilities.

Source: Accenture analysis of data from The Occupational Information Network (O*NET) of the US Department of Labor.
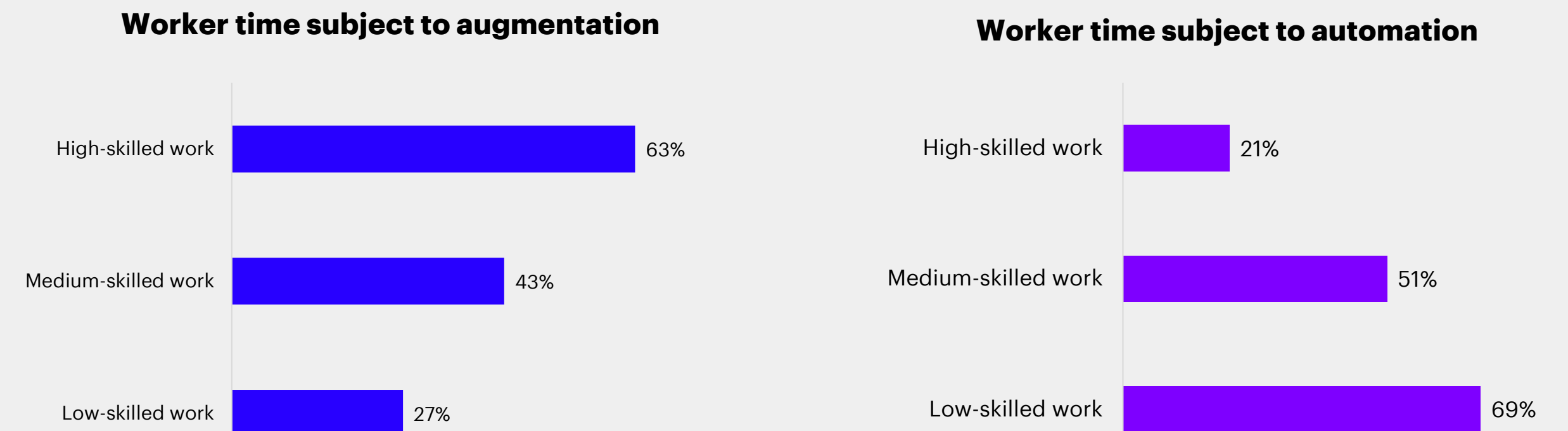
Coorpacademy, a Switzerland- and France-based provider of training solutions realized the need to help clients lead and communicate more effectively in the world of new technologies. The firm has introduced a blockchain course that is focused less on technology and more on helping managers create a culture that will ease collaboration with blockchain experts as this technology increasingly plays a role in business.

STEP THREE:

EMPOWER VULNERABLE LEARNERS

Education and corporate lifelong learning systems must be accessible to all in order to truly close the skills gap. Workers who are vulnerable to disruption from technological change must be identified for targeted interventions. Our analysis confirms that lower-skilled work is more susceptible to automation (see Figure 9). Workers in these roles also require the broadest range of skill building, but tend to participate less in training, compounding their disadvantage.

FIGURE 9: THE IMPACT OF INTELLIGENT TECHNOLOGIES ON WORKERS, BY SKILL LEVEL*

Worker time subject to augmentation

High-skilled work	63%
Medium-skilled work	43%
Low-skilled work	27%

Worker time subject to automation

High-skilled work	21%
Medium-skilled work	51%
Low-skilled work	69%

*The ILO measures skill level by considering one or more of: i) the nature of the work performed; ii) the level of formal education; and iii) the amount of informal on-the-job training and /or previous experience.
Source: Accenture analysis of national labor force data

The OECD finds that poorer, less educated and less digitally-literate adults face significant informational and motivational barriers.[xii] The European Commission notes that only 4.4 percent of the 66 million adults with at-best lower secondary education attainment participated in adult learning in 2015.[xiii] A Pew study in the US reinforces the finding: 57 percent of adults with secondary schooling or less identified themselves as lifelong learners, compared with 81 percent who had completed tertiary education.[xiv]

Businesses and governments must act deliberately to make sure the lifelong learning revolution we're striving for does not deepen economic and social inequalities.

Another group worthy of targeted interventions is the older workforce. Older workers tend to participate less in training, due to a mixture of their own reticence and a corporate bias toward investing more in youth skills development. As populations age, equipping seniors with the skills they need to stay productive will become a priority.

Workers in Small and Medium Sized Enterprises (SMEs) also have less access to corporate learning. The OECD finds that workers in SMEs engage in half the amount of training activities than workers in larger firms. [xv]

The access issue is exacerbated by the poor quality of adult training. The World Bank's Draft World Development Report 2019 underlines how adult learning programs consistently fall short of their intended impact. "Adult literacy programs often improve word recognition but fail to improve actual reading comprehension…Entrepreneurship programs often improve business knowledge but not income or employment…Vocational training for the unemployed often improves short-run earnings but does not always increase long-run employment."[xvi] It is rare to find systems that truly cater for the needs and challenges of vulnerable adults.

PROVIDE LEARNING GUIDANCE AND FLEXIBLE ACCESS TO TRAINING

"Empowering individuals to drive their own learning journey is great in theory," says Kathleen Mullaney, VP of Careers at Udacity, a leading Ed Tech provider, "but, a big lesson for us was that learners also want and need guidance." The company provides menus of options and suggests pathways towards actual jobs. "Self-driven learning is a difficult thing, so we try to facilitate that connection to a person's next role."

Innovative Skills Funding Models

Governments are finding innovative ways to incentivize latent learners. Beginning in 2019, active workers in France will be granted up to €500 per year for a "personal training account," with a lifetime ceiling of €5,000 (€800 and €8,000 for those with low qualification levels) to spend on the courses of their choice. People will use a smartphone app to register and pay for courses and to certify their qualifications. It is part of the country's efforts to prepare itself for the "global battle for skills," as Labor Minister Muriel Pénicaud has defined it. [xvii, xviii] Singapore began a similar initiative in 2016. SkillsFuture Credit initially offers the equivalent of US$370 to all citizens of 25 years and older. Topped up over the years, it pays for government-approved courses. A related program offers workshops and other resources to help people develop their own career and skills plans. [xix]

Lifelong learning programs must be flexible enough to accommodate busy adults with many responsibilities at work and beyond. Like some others in the new digital learning market, Udacity's model focuses on short, "stackable" courses; specifically, nanodegree programs.

Modular approaches also open up new and sometimes unexpected learning paths. "Our Self-Driving Car Engineer Nanodegree program turned out to be wildly popular," says Mullaney, "and it actually led to many people wanting to find out more and explore more foundational skills in areas like artificial intelligence."

The scale of the adult learning challenge is especially significant in emerging economies. "There are several million workers in Indonesia lacking proper qualifications," says Novistiar Rustandi, Co-Founder and CEO of Haruka Edu. "Many of them would like to go back to study and

earn a degree. But this is only possible if education is both affordable and flexible." His firm blends online learning with in-person lectures at university campuses. "Our students need flexibility to choose their own learning paths based on their skills. This is especially important for people who are already working. We use a variety of content, learning approaches and platforms, so that everyone can have a study experience that addresses their needs."

Lifelong learning starts early. School systems should be designed to ignite passion for lifelong learning. If more children are encouraged to develop a growth mindset, one that strives for resilience and learns from failure, more workers of the future will be able to adapt to change and seek out better opportunities.

Providing career pathways for disadvantaged people

As part of its Digital Skills agenda in the UK, Accenture offers online courses to anyone looking to gain skills to thrive in the digital economy, especially those not in education, employment or training. Previous Accenture research shows that digital literacy helps those excluded from the labor market gain a foothold. The mobile-based learning approach provides a range of bite-sized digital training modules and enables interaction between students and Accenture experts through a social learning platform. [xx]

Accenture is also running pilots in the US and the UK to help young people overcome the uncertainty of career transitions. The pilots will involve interactive tools that help people identify their inner strengths and skills and find appropriate work. The company is also working with Youth Business International in the US, applying AI and analytics to help connect budding entrepreneurs with the skills, training and mentoring they need to achieve their goals. The system, which has attracted 3,500 entrepreneurs and volunteers since 2017, provides virtual and in-person mentors and a network of helpers. [xxi]

These initiatives are part of Accenture's global Skills to Succeed program that has equipped 2.2 million people with the skills to get a job or build a business, and that aims to reach a total of 3 million by 2020.

ARE YOU READY TO TRANSFORM LEARNING IN YOUR ORGANIZATION?

Are You Ready to Transform Learning in Your Organization?

Our analysis reveals the extent to which intelligent technologies will change the demand for skills. The impact will vary between job roles and national economies. Whether work is automated or augmented, the need for urgent skill building and new approaches to learning is clear. But some groups of workers, sectors and countries will be in need of pressing and targeted interventions. Business leaders should ask themselves the following questions to stimulate boardroom preparations and constructive action:

1

Speed up Experiential Learning: Multiply the impact of your lifelong learning investments.

Is your organization experimenting with experiential learning techniques? Are your learning and recruitment systems ready to participate in apprenticeships or on-the-job training initiatives? Are you applying design thinking or simulation tools to improve decision-making and learning? Have you identified partners that can apply new technologies to personalize training and create immersive learning experiences?

2

Shift Focus from Institutions to Individuals: Stimulate your people to expand their horizons.

Has your organization assessed the evolving blend of skillsets that your key workforce groups need to acquire? Can your learning systems and metrics adapt to develop a broader range of skills within individuals?

3

Empower Vulnerable Learners: Act responsibly to support your people.

Has your organization assessed which workers are most exposed to automation? Have you identified how their talents can be redeployed to new areas of value? Are your skill building systems set up to support older workers and the lower-educated with lifelong learning programs suited to their particular capacities?

APPENDICES

CREATING AN AGENDA FOR CHANGE

The variety of skilling priorities and interventions detailed in this report require concerted effort from business leaders and policymakers. In many cases, they will have to work together to make progress. This report has focused on three areas of action. But these actions will have a greater chance of succeeding if stakeholders collaborate to provide the underlying conditions necessary for changes to take root. We see the following steps as accelerators that will help ensure that our future workforce is prepared to thrive in the next era of technological progress.

NO MORE GUESSWORK: SHARE DATA TO IMPROVE WORKFORCE PLANNING

The bigger the datasets, the better the insights. To devise more relevant skills strategies, business and government must collaborate to apply advanced big data and analytics solutions to track labor market and skills dynamics more accurately. The following key steps will accelerate progress:

- **Harmonize official labor data** across G20 national institutions to improve forecasting.

- **Open up datasets** to external organizations to stimulate innovative approaches from experts and academics, such as combining national statistics with real-time hiring data to generate more granular and accurate insights.

- **Share successes and leading practices** in work and workforce planning to help establish industry guidelines and standards.

New skilling at speed and scale

Accenture has developed a framework to develop new skills in its own people at speed and scale. It has applied neuroscience research to design a range of experience-based learning methods that are offered at various stages of the skilling process. The framework helped the company train 150,000 people in New IT in its first 18 months, through a mix of immersive and classroom training, combined with fieldwork.

NO MORE REGURGITATION: EXPERIMENT WITH EXPERIENTIAL LEARNING

Experiential learning is especially well-suited to the skills challenges presented by intelligent technologies. Key actions to accelerate adoption include:

- **Design experience into lifelong learning programs.** Benefit from advances in neuroscience and the deeper, faster, more personalized learning brought by new technologies like VR and AI.

- **Build or Buy.** Consider the balance between in-house learning, using experiential techniques, and partnering with specialist providers of experience-centered, tech-driven courses.

- **Embed experiential learning into everyday work.** From design thinking and simulation tools that can improve decision-making, to on-the-job learning and apprenticeships that can reinforce recruitment and retention models, experiential techniques can improve ongoing business performance.

NO MORE OUT-OF-DATE LEARNING: DISRUPT THE EDUCATION AND LEARNING SECTOR

Our analysis shows that the education industry holds the greatest opportunity for intelligent systems to augment the work of its professionals. Entrepreneurs must exploit digital transformation to creatively disrupt the education and learning sector in key areas:

- **Skills matching platforms.** There is strong demand for user-friendly platforms to match workers with jobs and learning opportunities.

- **Digital-based learning solutions**, particularly to provide more experiential and personalized approaches.

- **Spotting new market opportunities** in areas such as teacher training, skills proficiency testing, monetizing workforce data and consulting on education transformation.

NO MORE TWEAKING: REINVENT TOMORROW'S LEARNING INFRASTRUCTURE

Governments must improve the enabling environment that will allow education and corporate learning initiatives to thrive in the next technological era. Policymakers should share their experiences across countries and invest in pilots to explore new opportunities. Key accelerators include:

- **Upgrade teacher training.** Teachers must be prepared to teach and assess students in new skills like complex reasoning, socio-emotional intelligence and creativity. This includes more project-based learning, active learning, collaborative learning and instilling a growth mindset in students.

- **Fast-track next generation technologies.** Support the adoption of new innovations – for example, 5G networks and advances in headset-based and haptic technologies – to transform experiential learning opportunities.

Transparency opens up opportunities in Colorado

The Markle foundation has partnered with Microsoft, LinkedIn, the state of Colorado and local partners to build an initiative called Skillful. Skillful uses data and technology tools to offer a transparent view of skills demand and supply, allowing job seekers better access to jobs and skill development, employers better access to the skilled talent they need to grow and educators the information to target relevant skill-building[xxii]

- **Explore more innovative funding models for lifelong learning.** Follow the example of Germany, Austria and Switzerland in making lifelong learning accessible to all through apprenticeships. Supplement with personalized learning funding schemes, such as the initiative launched in Singapore (see Innovative Skills Funding Models box on page 26). Experiment with new infrastructures such as blockchain that can provide secure, transparent, decentralized funding models for lifelong learning.

TECHNOLOGIES IN ACTION

VIRTUAL REALITY

Virtual reality (VR) immerses users in a new world via special 3D headsets. It lets educators create inexpensive experiential learning opportunities that boost engagement and improve outcomes. VR can be an especially powerful tool for developing quintessentially human skills, such as empathy.[xxiii]

IN PRACTICE

United Rentals, a US company that rents construction equipment to job sites, developed a platform with VR-training firm STRIVR that allows staff to gain job site experience without leaving the classroom. This initiative led to a 40 percent reduction in training time. [xxiv]

AUGMENTED REALITY

Augmented Reality (AR) blends the digital and physical worlds, using smartphones or other devices to overlay information, graphics and sounds on the real world. People can see data as they work, facilitating on-the-job learning. They can also view and interact "naturally" with objects or people outside the classroom.

IN PRACTICE

The UN Industrial Development Organization (UNIDO), the Swedish International Development Cooperation Agency (Sida) and Volvo have a training academy for heavy-duty commercial vehicles outside Addis Ababa, Ethiopia. The training center partnered with California-based firm EON Reality to provide a gamified AR experience that teaches diesel engine maintenance to employees, many of whom come from poor, rural communities. Learners experience the subject matter directly and no longer have to overcome literacy and language barriers.[xxv]

ARTIFICIAL INTELLIGENCE (AI)

AI includes technologies such as machine learning, natural language processing and computer vision. AI can offer insights, guidance and feedback based on the vast amounts of data it analyzes, allowing users to personalize their learning. Chatbots, for example, can be always-available subject-matter experts. AI can automate processes for educators and design better courses through algorithm-generated recommendations. It can also uncover new insights from big data by, for example, combining aggregate macro and regional data with data about individuals.

IN PRACTICE

InsideBoard, based in the USA and France, is a global AI-driven change management platform that gauges individual and collective usage, generates personalized "Call-to-Action" notifications, and recommends "the right action at the right time" for each person. Its gamification engine makes change fun and engaging. The platform improves learning efficiency and reduces its costs by up to 33 percent.[xxvi]

NEXT-GENERATION DIGITAL LEARNING PLATFORMS

These go beyond "traditional" Massive Open Online Courses (MOOCs) that often have completion rates below five percent.[xxvii] They build on the digital format with videos, animations and activities. They also accommodate schedules and learning styles.

IN PRACTICE

Udacity (US) and Coorpacademy (Switzerland and France) offer next-generation online learning programs for corporate employees. One common feature: learners participate in an activity every few minutes, rather than listening to long lectures or explanations. HarukaEdu, based in Indonesia, offers the same content in audio, text and video so people can select their preferred format. It also organizes offline meetings between lecturers and learners to preserve the human element of the learning process.[xxviii]

THE BLOCKCHAIN

The blockchain is a way of storing data in a distributed ledger that allows multiple stakeholders to confidently and securely share access to the same information. It can improve the transparency and efficiency of systems that support education and lifelong learning. For example, the blockchain can be used to issue fraud-proof certificates which all employers will be able to accept, even across borders. Blockchain also offers important opportunities for transparent education funding models, a particularly attractive application for countries whose systems suffer from inefficiencies and corruption.

IN PRACTICE

Spain-based startup Tutellus uses blockchain-based tokens so that both teachers and students can earn from learning experiences. Teachers receive a share of the fee students pay, as well as an amount of tokens dependent on how much time students invest in their courses. Students can earn tokens – which can be traded outside the platform – by helping other students or passing exams. [xxix]

TECHNICAL ANNEX

1. SKILLS CRISIS: MEASURING THE GROWTH AT RISK

Many have talked about the growth boost that new technologies will generate, but few have attempted to understand how that growth could be imperilled by not addressing the skills crisis.

1 DEMAND: Our approach begins by understanding how intelligent technologies will affect specific work tasks and skills needs through automation and augmentation effects.

2 SUPPLY: Next, we look at the supply of skills: Whether technologies can produce value added growth depends on the capacity of labor supply to deliver the new labor demand.

RIGID TALENT SUPPLY
At one extreme, we assume that labor markets are entirely unable to adapt skills profiles to meet the changing skills needs.
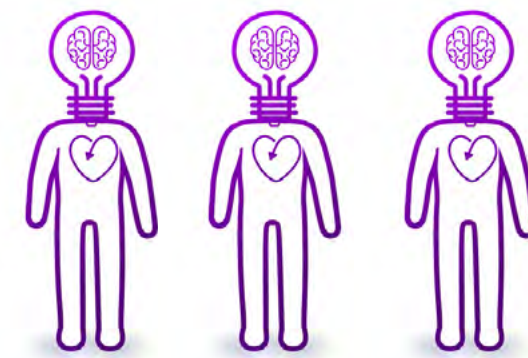
TALENT SUPPLY ACCOMMODATES
At the other extreme, we assume that labor markets fully accommodate the new skills needs.

Additional Notes

STEP 1: In order to calculate the shift in labor demand, the following elements were required:

- Data from the Occupational Information Network (O*NET) of the US Department of Labor and from the International Labour Organization (ILO), were used to calculate the total time worked by workers in each country and each industry, based on the task frequency of 330+ work activities for 900+ occupations derived from O*NET.

- Technology experts tagged each of these tasks according to how intelligent technologies would impact the task through augmentation and automation.

- The total potential time susceptible to automation and augmentation was computed for different occupations, based on the frequency with which they perform the analyzed work tasks.

- Time savings and productivity gains were measured, depending on assumptions about investment levels in intelligent technologies. Assumptions about the relationship between time savings and technology investment were based on regression analysis performed on a panel of 14,000 global companies.

- It was assumed that labor supply matches labor demand at the average unemployment rate of the past 5 years.

3

We then model GDP growth (2018-2028) under the two supply assumptions, allowing us to measure the gap between them as the GDP that is at stake if skilling needs are unmet.
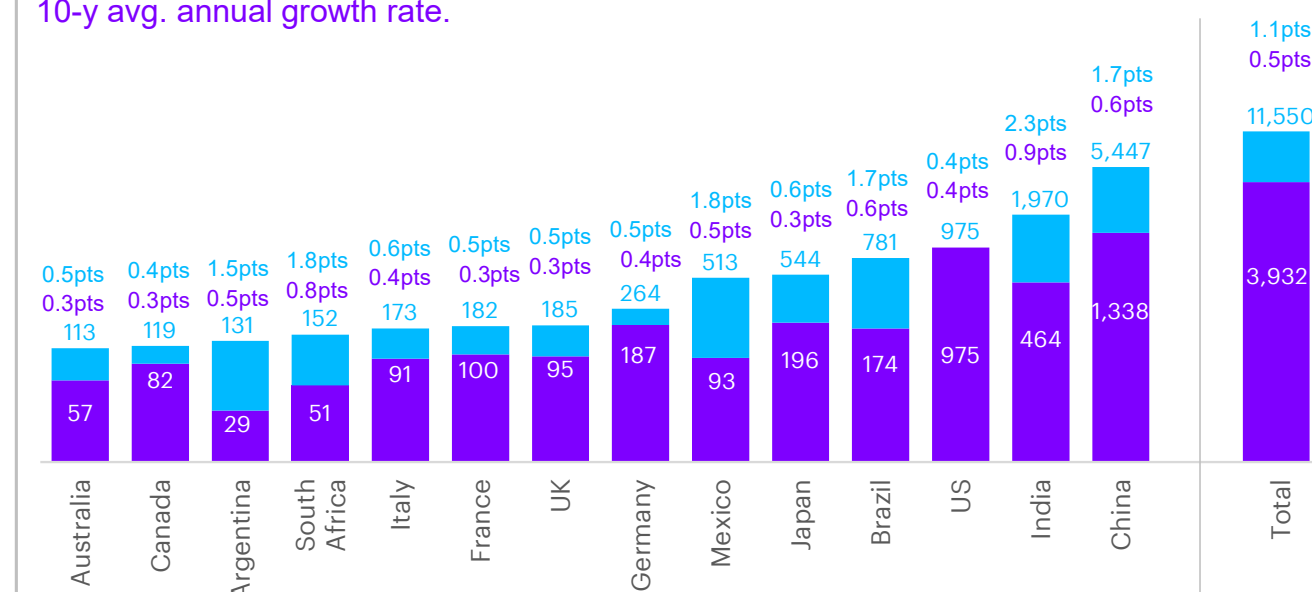
The difference between the two GDP growth figures measures the total potential "Forgone Growth Premium."*

US$46trn

US$35trn

Supply Accomodates   **Rigid Supply**

Forgone Growth Premium
US$11.5 trillion

*Cumulative figure for 2018-2028 across 14 G20 countries analyzed. Note: This growth is in addition to baseline economic growth, unrelated to intelligent technologies.
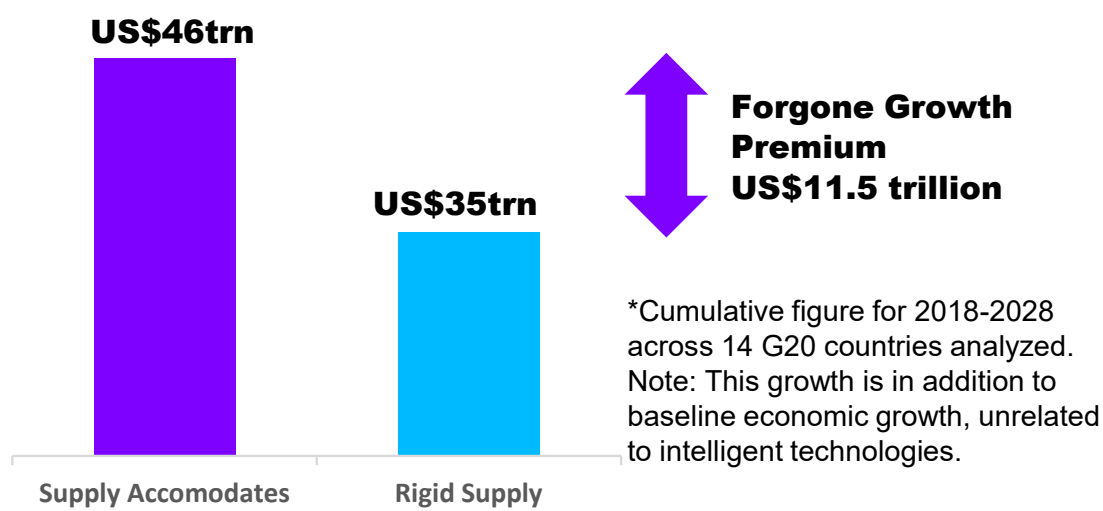
4

Finally, we present the potential Forgone Growth Premium under two different scenarios about investment in intelligent technologies. We illustrate the range of value at risk in each of the 14 countries analyzed.

Potential Forgone Growth Premium.
Cumulative 2018-2028, US$ bn, log scale and %pts deducted from 10-y avg. annual growth rate.

Country	Scenario 1 pts	Scenario 2 pts	Value
Australia	0.3pts	0.5pts	113 / 57
Canada	0.3pts	0.4pts	119 / 82
Argentina	0.5pts	1.5pts	131 / 29
South Africa	0.8pts	1.8pts	152 / 51
Italy	0.4pts	0.6pts	173 / 91
France	0.3pts	0.5pts	182 / 100
UK	0.3pts	0.5pts	185 / 95
Germany	0.4pts	0.5pts	264 / 187
Mexico	0.5pts	1.8pts	513 / 93
Japan	0.3pts	0.6pts	544 / 196
Brazil	0.6pts	1.7pts	781 / 174
US	0.4pts	0.4pts	975 / 975
India	0.9pts	2.3pts	1,970 / 464
China	0.6pts	1.7pts	5,447 / 1,338
Total	0.5pts	1.1pts	11,550 / 3,932

Scenario 1: Investments in intelligent technologies per worker in each country reach the country's current investment levels in traditional technologies per worker.

Scenario 2: Investments in intelligent technologies per worker in each country reach current US investment levels in traditional technologies per worker.

Additional Notes

STEP 2: In order to calculate employment supply in 2028, the following elements were required:

• Population projections from the UN for the age range 15-64 (moderate growth scenario).

• Labor participation rates from the ILO for the same age range (average of the last five years available).

• Unemployment rates from the ILO for the same age range (average of the last five years available).

STEP 3: In order to calculate the GDP growth figures, the following elements were required:

• Baseline labor productivity growth by industry and country was sourced from Oxford Economics.

• Value added growth in the baseline scenario is the result of multiplying labor productivity by employment levels in 2028.

STEP 4: In order to calculate the different technology investment scenarios, the following elements were required:

• Investment levels for traditional ICT and intelligent technologies at the country level and industry level were calculated based on data sourced from IDC.

• Investment in intelligent technologies is comprised of spending on Cognitive Technologies, Analytics and Robotics.
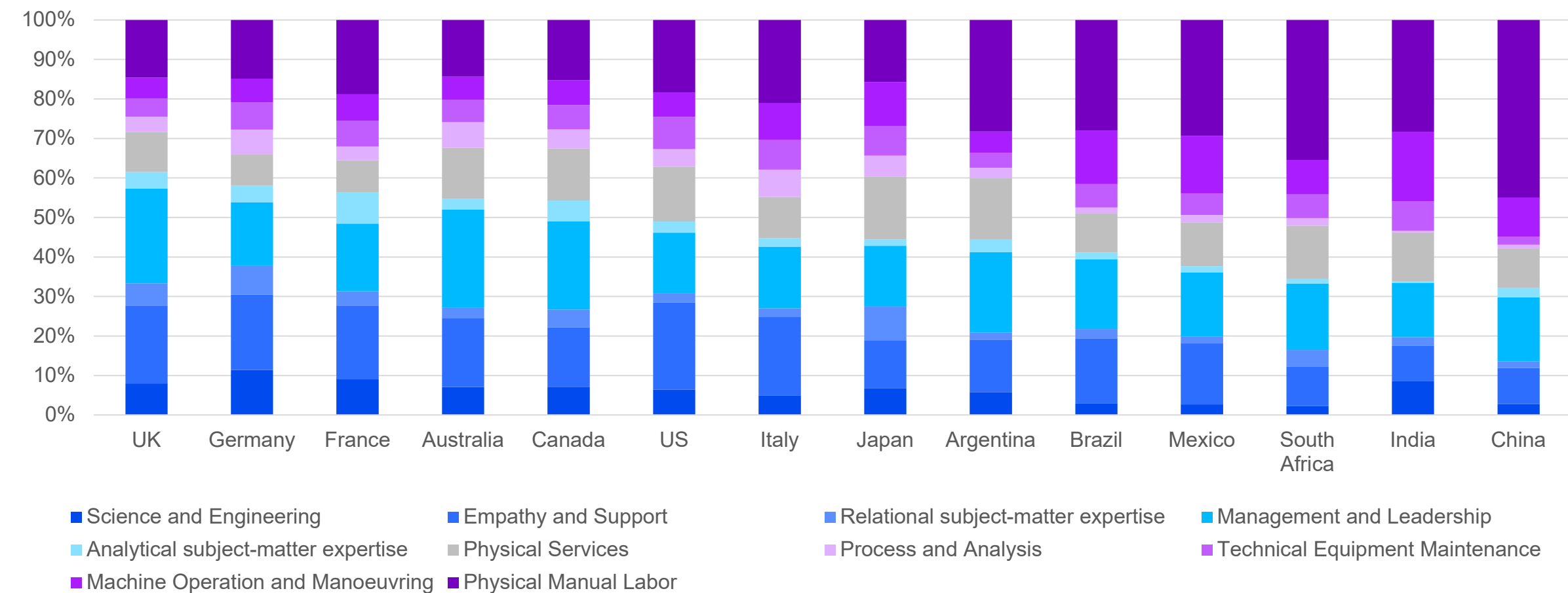
2. DEFINING AND DERIVING ROLE CLUSTERS

The objective of this modelling exercise is to create empirically-derived groupings of roles and occupations that utilize similar skills and perform similar tasks in their work. In doing so, workers within each cluster can be expected to be affected in similar ways as intelligent technologies take hold in the workplace. The main steps of analysis were as follows:

• Statistical clustering techniques (principal component factor analysis) were employed to analyze the skills, abilities and work activities in O*NET's database (derived from 974 representative occupations in the US). This activity generated six distinct factors for skills and abilities, and five distinct factors for work activities.

• The importance of each of these factors was used to tag occupations into six groups for skills/abilities and five groups for work activities.

• The groups were cross-referenced against one another to identify the combinations (clusters) that grouped at least 35 percent of workers within a skill/ability group. The result was 10 such groups, which represent our 10 Role Clusters.

• The 10 Role Clusters (see Figure 10) were used to categorize the workforce composition of 14 G20 countries. This was done through the creation of conversion tables that matched each national occupation code to US occupation codes. US employment figures were sourced from the Bureau of Labor Statistics (www.bls.gov/oes). Employment

FIGURE 10: DISTRIBUTION OF EMPLOYMENT BY ROLE CLUSTER

Share of total country's employment in roles

DISTRIBUTION OF EMPLOYMENT BY JOB ROLE

■ Science and Engineering   ■ Empathy and Support   ■ Relational subject-matter expertise   ■ Management and Leadership
■ Analytical subject-matter expertise   ■ Physical Services   ■ Process and Analysis   ■ Technical Equipment Maintenance
■ Machine Operation and Manoeuvring   ■ Physical Manual Labor

at the occupation/industry level for each other country was sourced from national household surveys and other national statistical sources.

• Under the assumption that the same occupation utilizes similar skills and performs similar tasks across countries, the categorization of occupations within the US Role Clusters were then applied to the other countries.

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