WHITE PAPER

Expanding horizons - why teaching automation is key to shaping tomorrow's workforce

Contents

Introduction – getting ready for a changing world

The future of work is changing. Throughout every corner of society, developments in technology are resulting in wide sweeping changes in our lives and careers, from the way we carry out tasks through to the way we communicate and relate to one another. The transformations that took place during the pandemic, where workplaces became virtual and e-commerce accelerated to meet wide-ranging consumer demands, have set a new paradigm for the future where technology is set to play an even bigger role.

Similarly, the lessons learned from the pandemic, coupled with the growing impacts of a global labour shortage, fractured supply chains and geopolitical instability, are set to see an increase in the rollout of automated technologies in everything from factories and warehouses through to new environments including restaurants and shops, as business owners take steps to ensure they can continue to operate when workers are not readily available.

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By 2025, technology will create at least 12 million more jobs than it displaces. It will be the job of education to help prepare the workforces needed to help fill them.

This future represents a brave new world for employment. Many traditional roles will cease to exist, new roles will be created, and new ways will be found to utilize existing workers. Training will also need to be available to help people to adapt and update their skillsets to enable them to work with automated technologies. Not surprisingly, many of those most likely to be affected by the rise of automation are worried about losing their jobs – in a 2017 survey by PricewaterhouseCoopers, 37 percent of respondents expressed concern about losing their roles to automation[1].

With many of the roles, skills, and job titles of tomorrow not even existing yet, the ability to stay one step ahead will mean adapting and learning to work with new technologies. Reassuringly, the World Economic Forum estimates that by 2025, technology will create at least 12 million more jobs than it displaces[2]. It will be the job of education to help prepare the workforces needed to help fill them.

To do so, education will need to become a lifelong process, acquiring basic skills and understanding during the first years of school that will then be sharpened and refined as people move through the educational system and into the world of work. It will also require people to learn to work together more closely than ever, combining their personal skills and intelligence with the technologies available to collaborate in new ways.

We believe the best way to encourage this culture of lifelong learning and openness to new technologies is to put in place the measures needed to instil it from the earliest possible stage. In this white paper, we will look at the impact of automation on the future of work, and the measures that can be taken to ensure that the workforces of tomorrow are as prepared as possible for the changes this will entail.

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Access to lifelong education is key to ensuring people have the skills to use new technologies.

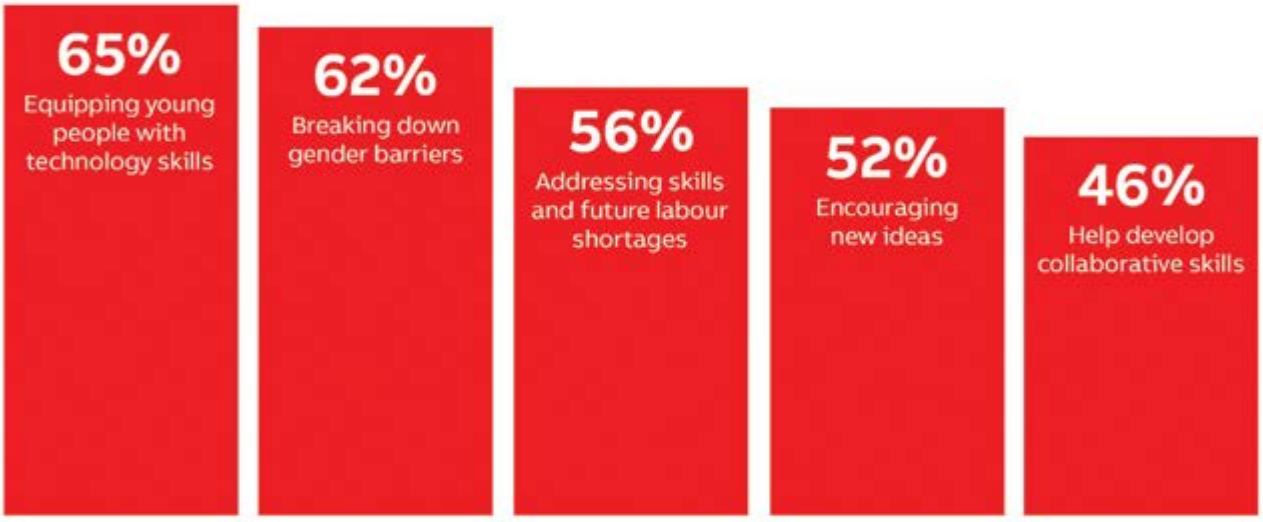
Global education establishments need to use robots to help young people thrive in the workplaces of tomorrow

In a recent **ABB global survey of 2,301 global education providers,** only **1 in 4** currently use robots as part of their teaching programme. ABB will address this with cutting-edge automation solutions that will enable future employees to succeed in the workplaces of the future.

80%

Educational institutions worldwide believe robots will shape the future of employment in the next 10 years

Main benefits of using robots in education



What key skills are being taught with robots?

Programming skills
ABB's **RobotStudio®** offline programming tool and **Wizard Easy software** are helping students learn skills.

Collaboration skills
As robotics and automation are more widely adopted, the ability for people across different disciplines to work together will become increasingly important.

New production techniques
New robot technologies are helping students to understand how robotic automation can be deployed across different sectors.

Research and problem-solving
Students are learning how the latest robots and software developments can be used in a wider range of applications.

What will the factories of the future look like – and what will this mean for employment?

The growing role of automation and artificial intelligence technologies is already starting to see change at all levels in the workplace. On the factory floor and in the warehouse, robots are increasingly either taking over or assisting with an expanding range of tasks. As they do so, the nature of people's jobs is changing, removing and redefining some tasks and responsibilities and creating others that did not previously exist.

As this happens, it presents both opportunities and challenges for employers and employees alike. For employers, robots present the opportunity to improve productivity and competitiveness by enabling faster, more flexible production with less waste through greater levels of accuracy and consistency. However, to do so, they will need to ensure that workers have the skills and knowledge to program, operate and maintain the robots and any other automated equipment. Moreover, they will also need to ensure that other workers displaced by the technologies are given other roles to perform.

For both the current and future generations of employees, the opportunity is to release themselves from arduous, repetitive, and tedious tasks to work on higher level tasks that make better use of their intelligence and abilities. This could potentially include everything from programming and support through to working in other roles and other departments. The challenge is to ensure that they are prepared for these changes and have both the motivation and the ability to access the necessary education and training required.

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The arrival of robots and automation is changing the skillsets needed for careers in manufacturing.

Megatrends affecting the future of work

Digitization

Technology is steadily changing the way that work is carried out. The increased use of digital technologies during the pandemic especially has transformed the relationship between workers and technology, whether as a means of communication with colleagues or for remotely interacting with product equipment and processes. As such, people have become better equipped to cope with many of the changes associated with digitization of the workplace, acquiring new skills that have helped them to interact more easily with new technologies.

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"While American manufacturers will need to fill 3.5 million manufacturing jobs by 2025, around 2 million will remain unfilled as people opt to find jobs in other sectors."

As well as answering the challenges posed by the pandemic, technology is also increasingly helping to address the growing skills gap across a wide range of industries – from retail through to manufacturing – that is seeing a rising number of roles going unfilled. A 2018 research study by Deloitte and the Manufacturing Institute estimated that while American manufacturers will need to fill 3.5 million manufacturing jobs by 2025, around 2 million will remain unfilled as people opt to find jobs in other sectors[3]. As many of these jobs will be critical to the country's industrial performance, these roles will need to be filled in some way. The growing capability of robotic automation means that many of these roles are increasingly taken up by robots, with industrial robot orders in North America hitting a new record in 2021 with 39,708 units ordered.

CASE STUDY

How Illinois State University is using ABB robots to help bridge the US manufacturing skills gap

The impact of a growing shortage of labor on US manufacturing has seen a sharp rise in the nation's adoption of robots. According to figures from the Association for Advancing Automation, a record 39,708 robots were sold in the U.S. in 2021, with non-automotive companies in sectors such as metals, food and beverage, plastics and rubber and others accounting for 58 percent of the total demand. In many cases, these companies are using robots to handle jobs that are dirty dangerous, dull, and hard to fill due to the lack of skilled labor.

As the number of robots being deployed has grown, so too has the demand for engineers and qualified technicians who can program, operate, and maintain them.

Addressing this need is the goal of the Department of Technology at Illinois State University (ISU), which trains students to program and operate industrial robots in preparation for careers in industry.

"One trend that I think we're seeing clearly is an increased demand for our graduates, said Dr. Kevin Devine, College of Applied Science and Technology Professor, Department of Technology, ISU. "The industry is clamoring right now for qualified people and we're having a lot of trouble meeting that need."

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ISU's fully-equipped robot laboratory provides students with first hand experience of programming and using robotic technology.

ISU's investment in robotics has proven to support student innovation, creativity, and technical advancements. Their program has attracted students from around the world and re-invigorated the classroom experience through their ABB supported robot lab and offline programming tools.

The lab features an array of ABB robots and software to provide students with the experience and knowledge of industry 4.0 and smart manufacturing technologies.

"We give our lab the feeling of a training environment to resemble the workplace," said Professor Jeritt Williams, Department of Technology at ISU. "We have a work cell with authentic equipment, materials, and real-world situations that they'll be using in their careers."

One of the tools available is ABB's RobotStudio® offline programming software, which enables different robotic solutions to be created and simulated in a virtual environment before applying them in the real world. ABB offers up to 100 licenses free of charge to universities and colleges.

"The RobotStudio software product is a powerful learning tool that ABB provides at no cost to educational institutions that use their robots," said Dr. Devine. "The graphics programming capabilities of RobotStudio are fantastic. I have my students create and program their robot work cell in a virtual space using RobotStudio which they can then download and run-on real robots."

Training for educators

The key to the effectiveness of the teaching program is ABB's Software, Maintenance, and Robotics Training (SMART) certification program for STEM. This program certifies educators to effectively implement, teach, and certify their students on ABB's curriculum.

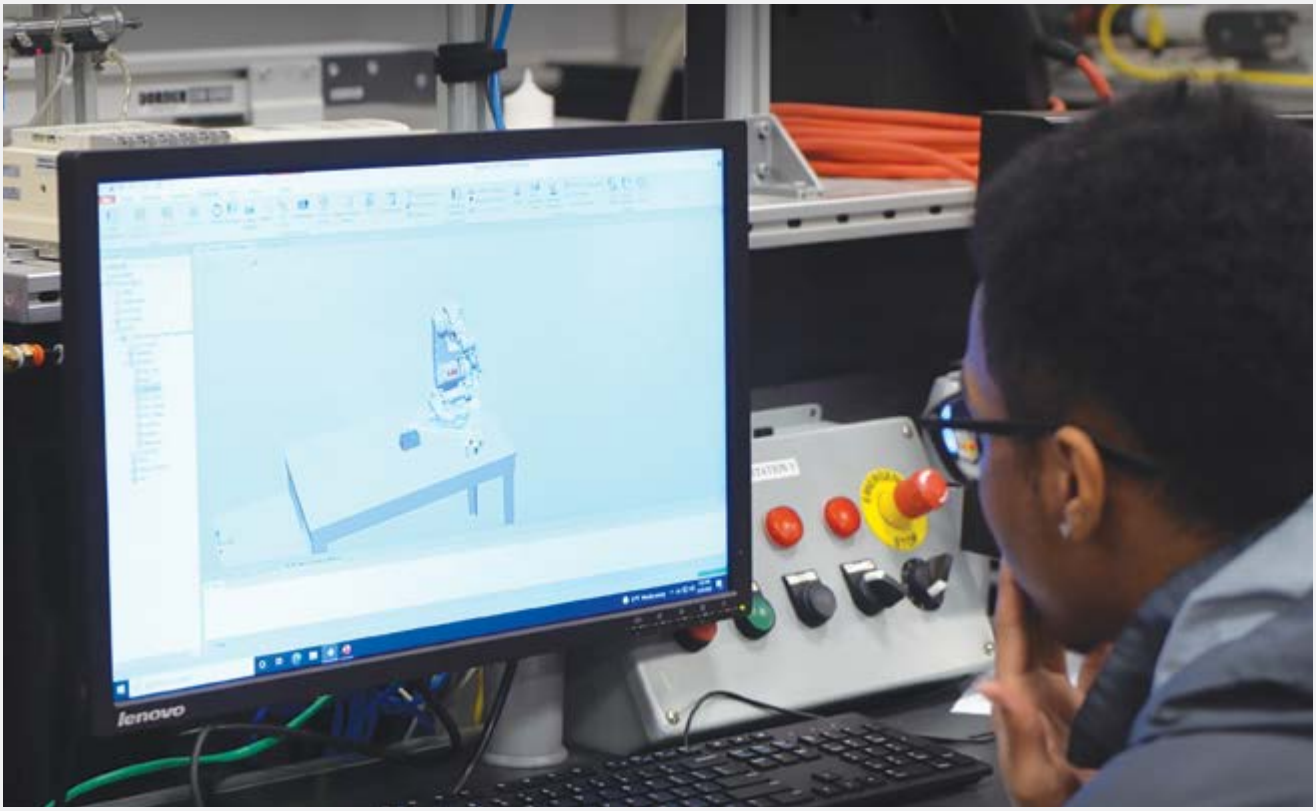
The program guides educators through the tool with hands-on examples and interactive labs that boost student engagement and success. The SMART certification program enables ISU's staff to access ongoing training and help enhance their own knowledge.

"I have been impressed with the quality of the technical support and training provided by ABB," said Dr Devine. "I have attended three training classes conducted by ABB and learned a great deal in each class. "If I have questions about anything, technical support personnel are glad to help."

A valuable partnership

The partnership between ISU and ABB has been invaluable in helping to prepare students to be able to hit the ground running by equipping them with the robotics skills that companies are looking for.

Says Dr Device: "ABB does not simply sell robots. They are active participants in a mutually beneficial relationship that we value deeply at ISU."



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ABB's RobotStudio® offline programming software is used as a teaching tool, enabling students to model, simulate and refine solutions in a virtual environment before testing them on a physical robot.

This same pattern is also evident in other countries worldwide as companies struggle to tackle their own domestic skills shortages. A December 2021 report by the International Federation of Robotics highlights the accelerated growth in the take-up of robots for industrial applications, with a near doubling in the global robot density figure from 66 robots per 10,000 workers in 2015 to 126 workers per 10,000 workers in 2020[4].

It is also important to recognize that the arrival of disruptive innovations – technologies that displace established approaches or solutions – are creating new opportunities for employment too. One example is the development of 3D-printers. Increasingly capable of creating an expanding range of objects, 3D-printers, including those using robots, are being deployed in a growing range of applications in industries ranging from retail through to architecture and construction. For prospective workers, learning how to use these systems presents opportunities to learn a raft of new skills, from programming through to the business skills needed to market and sell the resulting products.

Roles associated with 3D-printing are just one of a brace of potential career opportunities that will be enabled by technology. In its report '21 jobs of the future. A guide to getting – and staying – employed over the next 10 years'[5] by multinational information technology services and consulting company Cognizant predicts a variety of potential roles that will come about because of technology, both in manufacturing and business and across wider society. Similarly, the World Economic Forum's 2020 paper on the 'The Future of Jobs'[6] envisages 10 key roles that are emerging as the result of developments in technology and automation, including jobs such as AI and Machine Learning Specialists and Process Automation Specialists.

The deployment of robots on factory floors has also been proven to provide opportunities for existing workers to upgrade their skills, enabling them to move from mundane roles such as machine loading and unloading to more rewarding positions involving programming, supervising or maintaining robotic equipment.

The introduction of Autonomous Mobile Robots (AMRs) into manufacturing and distribution applications, for example, is releasing workers from transporting parts and products between stations, enabling them to be redeployed to other higher value tasks, including programming and servicing the robots.

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Robots are creating new opportunities for employment by releasing workers from heavy, mundane, or potentially dangerous tasks.

Below is a list of roles from own experience that we see either being generated or having the potential to be created in the future as robots and automation become more deeply embedded throughout industry:

- Robot applications engineer
- Robot maintenance engineer
- Programmer
- Diagnostic data analyst
- Robot skills trainer
- AI / machine learning integrator / analyst
- Automation / production planner / enabler
- Automation commodity specialist /Automation procurement engineer
- Automation simulation (digital twin) engineer/ programmer
- Automation Safety & Risk Assessment engineer
- Automation operator
- Robotics AR & VR engineer
- Smart Factory designer/engineer
- Business process automation programmer
- Robotics UX engineer
- Automation Economist

In each case, we believe that there will remain a central role for human workers in helping to optimize automated technologies, either directly by ensuring that they are working at maximum effectiveness, or indirectly, by managing, working with, and training others to help them collaborate with those technologies.

The rise of AI

As automated technologies are introduced, the nature of jobs is also changing. The introduction of AI technologies especially is already having an impact, with certain tasks being allocated to automated technologies as organisations seek new ways to boost productivity and efficiency and improve the levels of service offered to customers.

In its report 'Will robots really steal our jobs? An international analysis of the potential long-term impact of automation'[7], PricewaterhouseCoopers identifies three overlapping waves of artificial intelligence technologies that will affect jobs in the coming decades, with some roles already starting to be affected.

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"A successful skillset in the future will be defined by an individual's ability to get the most out of AI, learning how and where to use it to make themselves more efficient."

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Italian manufacturer, Anodica, uses ABB's YuMi cobots to handle complex and repetitive production tasks, releasing workers for more interesting roles including supervising and programming the robots.

These waves are defined as:

Algorithm wave – consisting of algorithms being used to automate mathematical calculations and increasingly sophisticated computational tasks, including machine learning, this wave is already seeing certain roles that were previously handled by humans being taken over by technology instead. While most of the impact is currently focused in industries such as finance, the growing capabilities of machine learning algorithms are also starting to see the technology also being rolled out by some manufacturing companies as well for areas such as diagnostics, maintenance and supply chain optimization.

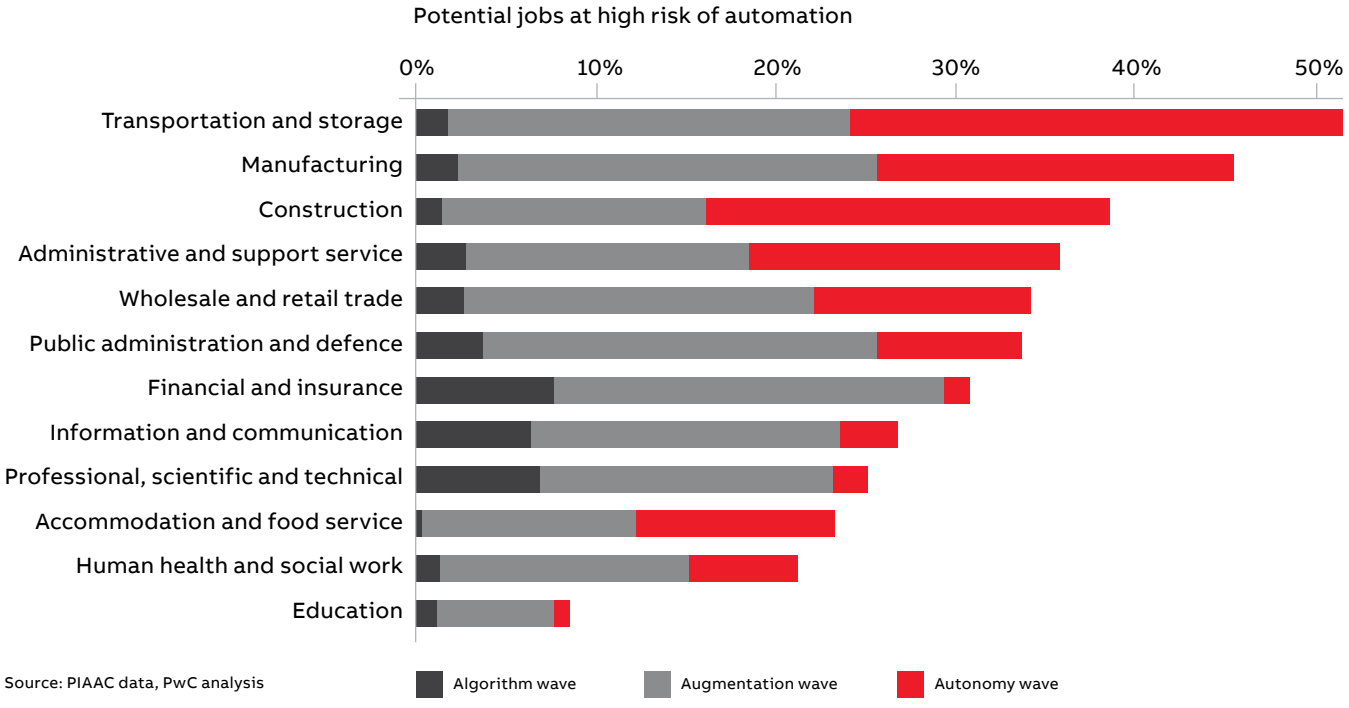
Augmentation wave – consisting of technologies that are deployed to help augment the capabilities of human workers, the augmentation wave is projected to have the biggest impact on jobs, with automation being used to carry out many key tasks that have previously been performed using manual labor. In many cases, such as roles involving repetitive, tedious or dangerous work such as heavy lifting, using automation to take over these tasks will help to improve job quality. This augmentation is already taking place, with collaborative robots such as ABB's YuMi® and GoFa™ cobots that can be deployed safely alongside workers already being used to assist workers on production lines in industries including electronics, plastics and logistics.

Autonomy wave – in this wave, developments in AI will see automation extending beyond routine tasks to include those also involving physical labor and dexterity. It will also see technology being used to assist in problem solving, enabling machines to respond to problems by using real-time inputs to develop suitable solutions.

As can be seen from the above graph, the effects of the augmentation and autonomy waves will especially be felt most keenly by the transportation and storage, manufacturing and construction industries. Currently largely characterized by routine and physical tasks, these industries lend themselves well to greater automation. By comparison, those roles involving greater levels of interpersonal skills as well as higher levels of literacy are less at risk.

The cumulative effect of automation on employment is likely to see a redefinition of roles, with employers demanding a new range of skills. A successful skillset in the future will be defined by an individual's ability to get the most out of AI, learning how and where to use it to make themselves more efficient. It will also rely on the ability to work with others to use the technology to help solve problems and find new ways of applying it to challenges.

The composition of jobs in areas where automation is used is also likely to see a radical transformation as the requirement for physical labor is replaced with the automated solutions to handle manual tasks. Automating certain tasks – such as machine loading and unloading, for example, can release operatives to perform other duties, including machine supervision or robot programming, that may not previously have been part of their job description. Similarly, for warehouse operatives, the use of automated technologies to handle many of the physical tasks that used to be associated with their role, such as sorting, picking and lifting has enabled them to handle other tasks such as inventory management and machine supervision.



Source: PIAAC data, PwC analysis

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Potential rates of job automation by industry across waves.

Consumer trends

Meeting the demands of today's consumers for faster delivery and greater choice, including a rising demand for personalization, is requiring manufacturers to adopt the latest flexible production technologies and manufacturing and order management systems to keep pace. Meeting the challenges entailed in keeping customers happy calls for production systems that can react and adapt quickly to changing requirements. To enable this, production and distribution lines need to be increasingly joined up, connecting automation to factory and warehouse management systems to enable the collection and utilization of data at every step.

Factors such as the acceleration in e-commerce and rise in alternative channels to market such as omnichannel distribution and flexible order fulfilment, coupled with a need for companies to improve their resilience against future pandemic-level shocks, is seeing an increase in the deployment of automation throughout the manufacturing and logistics sectors.

Contrary to the prevailing narrative that robots are a threat to jobs, evidence from industry shows that companies are increasingly looking to use automation such as cobots to help them augment the performance of their workers.

Figures from the International Federation of Robotics' (IFR) World Robotics report for 2020, show that sales of collaborative robots have increased year on year between 2017 and 2019[8]. This trend is further supported by predictions from Fortune Business Insights, which projects a compound annual growth rate (CAGR) of 42 percent in the adoption of collaborative robots between 2020 and 2028[9] as companies look for ways to use technology to enhance worker performance.

The growing adoption of robots and other automated technologies enabling human-machine collaboration will increase worker exposure to automation, making it crucial for future workers to possess the skills needed to work with and alongside them.

Skills shortages

Globally, the manufacturing sector is facing a rising skills shortage that could pose a threat to both economic competitiveness and standard of living in countries around the world. A combination of factors, including an aging demographic and a reduced desire amongst younger people to work in manufacturing and engineering positions is leaving many economies exposed to growing problems when it comes to filling key roles.

The scale of this problem is growing annually, especially as experienced or older workers either leave the industry or retire quicker than they can be replaced. According to an estimate from the World Economic Forum in its report 'The Future of Manufacturing – Opportunities to drive economic growth'[10] upward of 10 million positions are currently unfilled in the global manufacturing sector, with skilled engineers being particularly hard to find.

One example demonstrating the impact of skills shortages is the global shortage of welders, which has made it increasingly difficult for manufacturers to achieve the levels of quality and output they need to satisfy demand. According to labor market data specialist Emsi, the US will need over 375,000 welding professionals by 2023 to fill available job openings[11]. In Australia, the problems of filling welding positions is being further complicated by an aging workforce, with around 30 percent of the country's welders being aged over 45[12].

To help fill this gap between the number of welders needed and the total number of qualified welders available, companies are increasingly turning to automation for a solution. Interestingly, while many are reporting benefits ranging from improved quality through to increased production output, they are also finding that the complexity of the robots requires them to employ skilled operators who possess both in-depth knowledge of welding and the ability to program, operate and maintain the robots.

Tackling negative perceptions

Another factor that has affected the supply of labor in the manufacturing and engineering sector is poor image and a lack of awareness of the career opportunities that industrial companies can offer. Negative and outdated perceptions about the sector are resulting in tech-savvy youngsters missing out on the exciting technologies that are increasingly being deployed in industrial applications ranging from smart sensors and mobile robots through to intelligent production management systems.

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"We see involvement in schools, colleges, and universities as a vital tool in helping to show young people what modern manufacturing is all about."

Stefan Drakensjö, ABB

Part of the reason for this is a lack of exposure to industry in educational institutions, especially at school and college level. A 2020 report by the Organization for Economic Cooperation and Development (OECD)[13] revealed that many young people are growing up unaware of the career possibilities offered by technology. Covering the career aspirations of 15-year-olds in 41 countries worldwide, the report found that nearly half were narrowing their choice to just 10 professions, covering traditional roles such as lawyers, business managers, police officers and teachers.

The findings also identified that students in countries with strong vocational training programmes for teenagers tended to have a better appreciation of the possibilities of manufacturing as a career.

“We see involvement in schools, colleges, and universities as a vital tool in helping to show young people what modern manufacturing is all about,” says Stefan Drakensjö, VP Global Marketing & Sales, General Industry at ABB Robotics and Discrete Automation. “Allowing young people to experience robots first hand really helps to change perceptions of the role our technology plays in today’s factories. It also helps them to realize that robotic automation is not just about the physical robots used for applications like machine tending or welding, but also the software such as RobotStudio that makes them work.

This can really help in communicating the ‘cool factor’ and show that many of the technology skills they already possess from activities such as gaming and using smart devices are also being used in factories.”

Near- and Re-shoring

A variety of factors are challenging previously established global manufacturing and supply chains. A survey of 1,610 executives from US and European companies carried out by ABB in mid-2022 revealed that the Covid-19 pandemic, geopolitical disputes, trade issues, labor shortages and raw material shortages have all had an impact in convincing companies to rethink their global operations.

Consequently, 73 percent of the companies that responded to the survey are looking for ways to bring production closer to home, either nearshoring – shifting production from one foreign location to one closer to home – or reshoring, returning production from another country to their home territory as a way of improving supply chain resilience. The survey results show an acceleration of plans to shift operations, supporting the findings of a 2022 BCI Global study revealing that 60 percent of U.S. and European businesses plan to re-shore operations in the next three years[14].

In many cases, problems with finding skilled labor have led to companies identifying automation as a key component of their relocated manufacturing and logistics lines, with 38 percent investing in automating their manufacturing lines and 48 percent investing in automating their logistics operations. While this helps to address immediate labor shortages, it also raises further challenges with finding expert staff needed to support the automated technologies, providing a further justification for equipping both existing and future workers with automation and robotics skills.

Uncertainty

Whether in manufacturing, distribution or retail, these are uncertain times for businesses. The collective impact of factors such as the COVID-19 pandemic, trade disputes, component shortages, geopolitical instability, and the transition to electric vehicles in the automotive industry to meet government deadlines for the end of combustion engine vehicle sales, is increasingly leading companies to find ways to make their operations more resilient against unexpected events.

This realization of the need to become more resilient is seeing a rise in investment in automated technologies in the manufacturing and logistics sectors. In both sectors, the inherent flexibility of robots is seeing them being adopted in a growing range of applications as a way of helping to protect against events such as sudden surges in orders or the need to switch between different product ranges or models at short notice.

A good example of the need to adapt to market uncertainties is the automotive industry. By 2035 EVs will outsell combustion engine vehicles . For automotive manufacturing, that means wholesale changes to long-established methods and technologies – probably, the greatest change since the automated production line. Due to this rapid increase, OEMs need a diversified battery sourcing strategy to maintain a flexible and robust battery supply chain to meet demand.

Environment / sustainability

Rising public awareness of the impact of manufacturing on the environment, both during the production of goods and at the end of their life, is seeing companies looking for new ways to use technology to make their operations more sustainable and driving new business models and innovations that use technology to minimize waste through recycling and recovery.

This drive to greater sustainability is seeing companies looking to robotic automation as part of the solution. The inherent flexibility of robots, coupled with greater levels of accuracy and consistency, makes them an ideal way of reducing waste during production, ensuring that goods are produced right first time with no need for reprocessing.

There are various examples of initiatives where robotic automation is being used to help produce goods more sustainably.

Robotic 3D printing, for example, is enabling new techniques to be used in construction applications, providing a sustainable solution that enables complex shapes to be produced in-situ, reducing energy consumption compared to conventional manufacturing processes where materials and /or structures have to be pre-fabricated. A major benefit of 3D printing is the ability to recover and reuse potentially harmful or environmentally unfriendly by-products from other industries, as building materials. Fly ash and slag from the coal industry and steel industries, glass and plastic are examples of materials that can be used for 3D printing. Where recycled glass is used, it can also be used as part of cement mixes as a substitute for construction sand, which is facing a growing shortage.

> "We are keen to show tomorrow's workers how robots can play a major role in transforming manufacturing and to teach them the skills and expertise they will need to thrive in the workplaces of tomorrow."
>
> **Benoit Gerber, ABB**

Robotic 3D printing can also be used as a solution or recycling other forms of waste. Environmental organization and global network, Parley for the Oceans, is using an ABB robot as part of a 3D printing solution that enables recovered ocean plastic to be used as a feedstock for producing new plastic products. The company's aim is to use the technology to empower local communities across the globe, giving them the tools to turn local plastic pollution into business opportunities and useful objects.

These and other applications, such as electronics waste recovery using AI-enabled robots, present exciting new opportunities for job creation in the circular economy. Projections by the independent think tank and charity the Green Alliance estimate that around 450,000 new jobs could be created in the UK alone[15] through the formation of new circular industries involving remanufacturing – returning goods to their original condition or better – and recycling. Filling these and other similar 'green' roles that could entail the use of automated technology in areas such as vertical farming, renewable energy, green construction and sustainable fashion is a good example of the type of skills that will be needed in the economies of the future.

CASE STUDY

Learning to make a sustainable difference

An ABB robot is playing a key role in an educational project to find new ways of minimizing the environmental impact of manufactured goods once they reach the end of their life. As part of an academic study into the potential for automated disassembly, the robot is helping to demonstrate a new concept that could transform the way that future products are designed, made, and recycled.

Max Ashford is a British student at the École Cantonale d'Art de Lausanne (ECAL), a university of art and design based in Renens in Switzerland. Believing that there is a better way to sustainably manufacture products, Max created a study entitled RUEI_01, or 'Robotic Unmanufacturing Embedded Information', involving the creation of a concept training shoe that could be easily disassembled by a robot, with its component parts being sorted into readily recoverable fractions for recycling.

Robotic de-manufacturing

Having approached ABB during the research phase of his project, Max was provided with a single arm collaborative YuMi® robot, together with the software needed to program it.

"We are keen to show tomorrow's workers how robots can play a major role in transforming manufacturing and to teach them the skills and expertise they will need to thrive in the workplaces of tomorrow," says Benoit Gerber, Collaborative Robot Specialist at ABB. "With its emphasis on sustainability, Max's project also ties in with our aim of helping manufacturing companies to find ways to use technology to make both their production processes and their products more sustainable."

By demonstrating how products can be designed with recycling in mind from the outset, the RUEI_01 project presents new opportunities for manufacturers to minimize their environmental impact by both reducing waste and enabling the recovery of high-quality materials that can be used to produce future products.

> "ABB's Wizard Easy Programming software was great for a first-time user like myself who had never programmed a robot before."
>
> **Max Ashford, student**

Starting with scanning the QR code, the robot begins dismantling the shoe, removing and separating the individual parts and placing them into dedicated boxes ready for recycling. Once the process is completed, the boxes containing the various parts of the shoe can be taken away, with the components ready for recycling.

To carry out the operations needed to dismantle the shoe, the single-arm YuMi is equipped with various tools, including a special gripper for scanning the QR code and lifting the shoe, and a cutting tool for severing the cords. With its compact design, and extensive safety features, including the padded robot arm and emergency stop capabilities that can bring it to a halt in microseconds, YuMi is an ideal learning tool that can be safely deployed in a teaching environment.

YuMi's simplicity was also a major benefit. As well as lead-through programming, which allows users to program the robot by physically manipulating the arm into the required positions, YuMi uses ABB's Wizard Easy Programming software, which uses simple graphical blocks representing different commands to create a robot program.

"ABB's Wizard Easy Programming software was great for a first-time user like myself who had never programmed a robot before," says Max. "Instead of having to learn programming code, I was able to program the robot by dragging and dropping the relevant command blocks into place."

To help test that the solution would work, Max also used ABB's RobotStudio offline programming tool. Used by ABB's customers across a wide variety of industries, RobotStudio enables virtual models of complete robotic installations to be created, tested and refined in a virtual environment to ensure they will work in a real-life production scenario.

"ABB's RobotStudio software was also very useful in helping to create the final program needed to instruct the robot," adds Max. "With help from Benoit Gerber at ABB, and by watching the range of YouTube tutorials that are available for single-arm YuMi and RobotStudio, I was able to learn how to use the software to find ways to maximise the performance of the robot and ensure that it would dis-assemble the shoe in the right way."

The next step

The exciting potential of the RUEI_01 concept has already been recognised. As well as winning ECAL's BCV Award and the Eyes on Talent Award, RUEI_01 also achieved a national runners-up position in the prestigious James Dyson Award, an international design competition created to celebrate, encourage and inspire the next generation of design engineers. In addition, Max was also invited to be a speaker at the 2021 Dutch Design Week, explaining how the RUEI_01 concept could help to shape the future of manufacturing.

In the long-term, Max would like to see his idea being incorporated into the manufacturing processes of the world's leading sports shoe brands.

"Every year, 23 billion pair of shoes are made worldwide, with around 300 million being thrown away in the same period," concludes Max. "Ideas such as the RUEI_01 concept could make a massive contribution to reducing the amount of waste that this produces, helping manufacturers to improve their sustainability and providing a ready supply of high-quality material that they could reuse to manufacture future products."

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Developed as part of a university project, the RUE_01 project shows how robotic automation could help sports shoe manufacturers to improve the lifelong sustainability of their products.

Why do we need to be teaching automation skills?

One of the key issues in the automation of the workplace has been the rapid pace of technological development. While developments in areas such as AI and data analysis, vision, sensing and remote communications have opened new possibilities, the pace of their introduction has not been matched by provision of the skills and training needed to use them. Consequently, many of the concerns that surround the jobs of tomorrow are caused by a current inability to imagine what they may look like, rather than a discontinued need for human labor.

Bridging this imagination gap requires a new generation of tech-savvy employees who can master the technologies and find new ways to work with them. For both current and future workers, the challenge is to ensure that their skillsets are complementary to automated technologies, allowing them to use the technologies to find ways to make themselves more productive.

Studies by organizations such as PricewaterhouseCoopers (PwC) already highlight an acceptance amongst workers that they will need to upgrade their skills. In a 2018 global survey of 10,029 people from a range of countries including China, Germany, India and the UK, 74 percent of respondents said they were ready to either learn new skills or completely retrain to remain employable[16].

While this is encouraging, the true enabler of change will be to ensure that future employees are as prepared as possible by the time they arrive at the workplace. As such, educational institutions, from schools through to colleges and universities have a crucial role to play in helping to teach the skills that will be needed for people to succeed in an automated workplace.

By exposing young people both to the technologies and problem-solving approaches they will need to use in their future working lives, these institutions present a fertile environment for planting the seeds of an automated future.

A chance to close the gender divide

Although the global ratio of men to women is roughly equal, the manufacturing sector has traditionally been heavily male-dominated, with women still significantly under-represented in the global manufacturing and engineering workforce.

One reason for this could be that many manufacturing roles have traditionally involved physical tasks that have been better suited to men.

However, as these physical roles increasingly become automated, and manufacturing becomes more about problem solving and collaboration, we believe that robots especially will help to open new opportunities for greater gender diversity.

Our recent survey of 2,301 people in education supports this, with 62 percent of respondents agreeing that robotics and automation education could help to improve the gender balance in manufacturing industries.

Ultimately creating a more diverse and gender-balanced environment means introducing robots and automation into schools at the earliest opportunity and encouraging children to engage both with these technologies and with one another. In this way, the two most important skills needed to get the most from robots – technical skills and the collaborative inter-personal skills needed for problem-solving – can become second nature. Introduction of the technology at an early age as a way of encouraging inclusivity and problem-solving may also be instrumental in helping to shape attitudes away from gender-reinforced stereotypes.

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Robotic automation offers a great way of breaking down gender and diversity barriers.

Who needs to be included?

In the future, workers in everything from from offices through to factory floors, warehouses and beyond, will be increasingly expected to be able to work with technologies that enable the collection and processing of big data that can be used for a variety of purposes such as real time analytics, machine learning / AI and simulation tools such as digital twinning.

For industry, the challenge will be to recruit sufficient workers with the skills needed to make this happen and ensure that there will be a ready stream of future employees who can add value by finding new ways to apply automated technologies such as AI and robots.

All of this will require a new approach to education, entailing close cooperation between policy makers, industry, and the academic community to create more diverse models of training and education, including a reshaped, technology-led curriculum, apprenticeships and vocational training.

In the following section, we look at some of the key parties that will need to be involved in making change happen.

Schools, Colleges and Universities

Young people today are increasingly becoming true digital natives, with many brought up in environments where they are surrounded by screens and smart technologies. With advances in simplified interfaces and the creation of a growing range of engaging age specific content, children are quickly mastering technology from a very young age.

By providing an environment where the skills needed to maximize the possibilities of new technologies can be developed and nurtured, educational institutions can help to prepare young people for the world of work, equipping them with the important technological, problem solving and interpersonal skills that will be needed to succeed in an automated workplace.

There is already a high awareness amongst educational institutions of the potential impact of robots and automation on employment. Our recent global survey of 2,301 contacts in educational institutions including schools, colleges, vocational schools, universities and adult education providers reveals that 80 percent believe that robots and automation will increasingly shape the future of employment in the next 10 years.

Robots and automation will increasingly shape the future of employment in the next 10 years:	
Strongly agree	30.2%
Agree	50.1%
Neither agree nor disagree	15.7%
Disagree	2.7%
Strongly disagree	1.3%
NET: Agree	**80.3%**
NET: Disagree	4.0%
Total	**100.0%**

There is also overwhelming agreement of the need to include the teaching of robotic and automation skills in educational institutions, with 76.1 percent of respondents rating it as either very important or important.

What is your view of the need to teach robotic / automation skills?	
Very important	30.9%
Important	45.1%
Don’t see it as a priority	23.9%
NET: Important	**76.1%**
Total	**100.0%**

When asked about the benefits they thought it could bring, 65.8 percent rated equipping young people with the technology skills they will need for future employment as the top justification for introducing robotic technology into classrooms.

What do you see as the main benefits of using robots in education? (multiple choice)	
Equipping young people with technology skills for future employment	**65.8%**
Teaching collaborative skills	35.3%
Breaking down gender barriers	19.0%
Addressing skills shortages in industry	28.5%
Tackling future labour shortages in industry	27.1%
Improving environmental performance by developing new sustainable production techniques	28.3%
Encouraging new ideas / approaches	52.3%
Other -please specify	0.6%
Don’t see any benefits	6.4%

From grassroots to graduation

Iolanda Leite is an Associate Professor at the Division of Robotics, Perception and Learning at KTH Royal Institute of Technology. Specialising in human-robot interaction, her field of study has included looking at ways to encourage interaction between children and robots and the benefits that robotic technology can deliver as part of the educational process.

“Engaging children with technology at an early age can be key in helping to shape their attitudes to learning. As they have no preconceptions or outside influences, they see technology such as robots as exciting and something to be embraced,” says Leite. “The tangibility of robots and the variety of options available, from educational robots through to tools such as LEGO® Mindstorms®, provide the ability for children to explore different options that can help to stimulate their natural curiosity and allow them to develop critical problem-solving skills through play and experimentation. The skills that they develop through this interaction can then be carried with them throughout their educational career.”

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“Engaging children with technology at an early age can be key in helping to shape their attitudes to learning.”

Iolanda Leite, Associate Professor, KTH Royal Institute of Technology

She also sees robots as a learning delivery tool that can be used to augment lesson delivery in classrooms, both as a means of engagement with students and as a way of assessing student performance and progress.

“Our research in the use of robots in classrooms highlights the value of using robots as personalized companions for students that can be used to deliver a tailored learning experience for their exact needs. The robot should be able to collect data about its interaction with the student and report it back to the teacher to enable them to assess performance and provide further adaptive exercises designed to the student’s needs.”

“A good example of how robots can be used to deliver personalized learning is a joint application carried out by KTH and various learning providers where robots were used to communicate with newly arrived immigrant children, speaking to them in their own languages to encourage social interaction and engagement with learning.”

Building the foundational skills for using and interacting with robots in early years learning can be valuable for students as they progress to further or higher education. Worldwide, there is an expanding range of colleges and universities that have either created robot-specific courses or are using robots as part of their learning delivery.

Ruhr-Universität Bochum is just one of many global examples of a university that is offering courses in robotic automation, teaching students the skills needed to program and use robots in different applications. Previously responsible for product management and technology at ABB Robotics until 2009, Professor Bernd Kuhlenkötter teaches courses on industrial robotics, covering all aspects from the basics of how a robot works through to complex programming skills needed for specific industrial applications. The courses are typically four to five years in length and are attended by students aged 18 to 19 years old who join straight from school or college. While some may have had prior experience of learning with robots, most will never have encountered an industrial robot before, so the course starts with a universal lecture covering the basics of robotics, followed by specific workshops dedicated to different areas of robot programming and operation.

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Teaching children how to use technology at an early age can be key in developing skills such as problem-solving and teamwork that will be a core part of working in the factories of the future.

Throughout the course, students can use a full range of tools to help them learn, including industrial robots from ABB and ABB's RobotStudio® offline programming software that can be used to program, test and simulate the operation of a robot or robot cell in a real-life working environment.

"Giving students access to the same equipment they would use in a real manufacturing or other environment is a vital part of the learning process," says Professor Kuhlenkötter. "Many industrial applications are complex and require a full understanding of how technologies such as robots can be applied in production processes. By acquainting students with the real technologies used in the real world, we can help to ensure that they will have the necessary skills that potential employers are already demanding."

Professor Kuhlenkötter also sees the use of the robots as a two-way learning process that can be as valuable for course instructors as it is for students.

"The great thing about teaching robotics at university is that you have a lot of young people who are very interested in robots and want to know how and where they can be used," says Professor Kuhlenkötter. "They often have great ideas for using robots that challenge the established ways that things have typically been done, which can often help us on the teaching staff to generate new ideas and create new project challenges for students."

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"The best way of changing perceptions of manufacturing and engineering is to get children interested as early as possible."

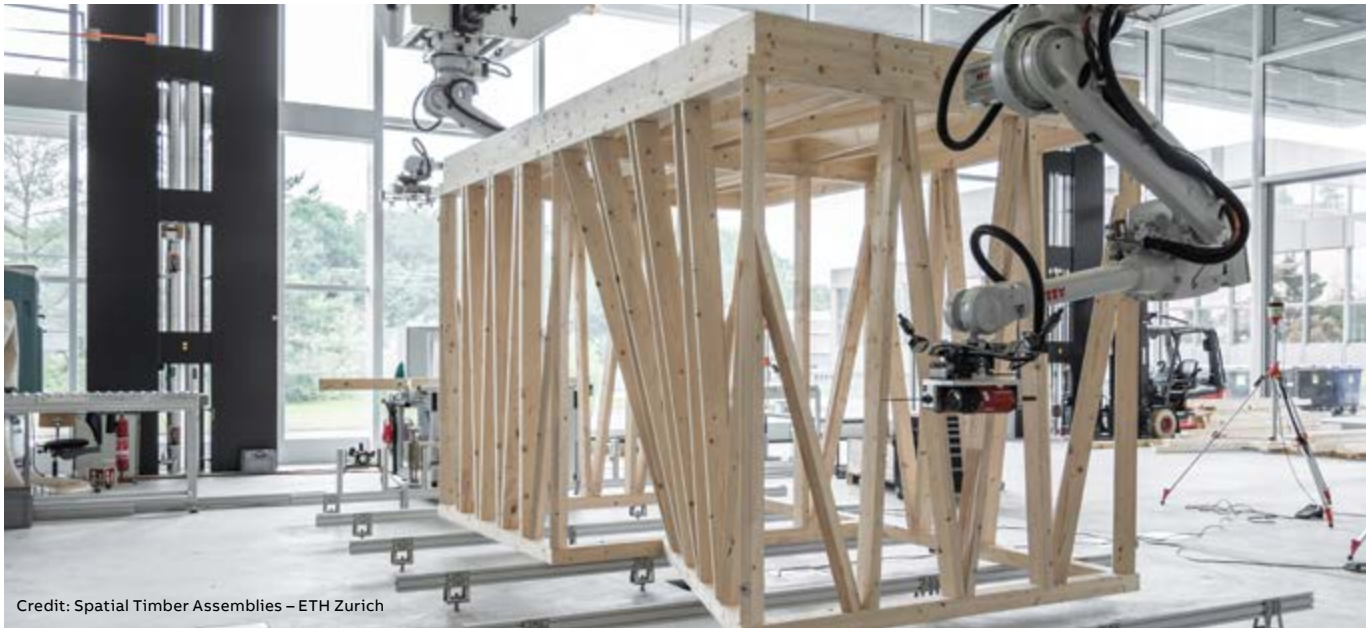
Bernd Kuhlenkötter, Professor, Ruhr- Universität Bochum

The expertise and resources residing in universities can also help to make them highly effective partners for other parts of the educational value chain. Many universities, including Ruhr-Universität Bochum, KTH in Sweden and Norway's Stavanger University which also has a partnership with ABB, operate outreach programs for schools to help engage younger students and show teachers how robots can be incorporated into lessons.

"The best way of changing perceptions of manufacturing and engineering is to get children interested as early as possible," says Professor Kuhlenkötter. "One way that we do this is to run experience days every semester where we invite children aged 8 to 10 to interact with robots through techniques such as challenges and games. This can be really beneficial in helping to spark interest and also support schools that may be unable to incorporate robots into their own teaching programs."

The formation of commercial partnerships between universities and industry can also offer opportunities for students to be involved in solving real-world production problems. ETH Zurich (Swiss Federal Institute of Technology), for example, works extensively with the construction industry to find new ways of using automated technologies, including ABB robots and software, to develop new sustainable building techniques.

In the UK, the Universities of Birmingham and Loughborough worked in partnership with the Manufacturing Technology Center, and independent research and technology organization, to develop a new containerized manufacturing concept called 'Factory in a Box' (FIAB)[17]. Featuring fully-automated production cells housed in a shipping container, the concept offers new possibilities for introducing the next generation of manufacturing techniques for small to medium sized manufacturing companies.



Credit: Spatial Timber Assemblies – ETH Zurich

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Swiss university ETH Zurich works in partnership with ABB to develop new automated solutions for the construction industry. Using ABB robots and software, students can learn how to apply automation to new building techniques such as 3D printing and modular fabrication.

Government

Ensuring that future workers are prepared for an automated future means putting in place frameworks that will deliver equal access to the training and education needed. As the main body that shapes, funds and implements education policies, government has a major role to play in facilitating these frameworks.

The Organization for Economic Cooperation and Development's (OECD) 2019 Skills Outlook study[18] highlighted that the countries that were best able to meet the implications of technological change were those with populations with higher levels of skills achieved through education and training.

The ability to achieve these skills is linked to several factors. Firstly, there needs to be structures in place that enable easy and equal access to lifelong learning, involving the provision of training at every level, from schools, colleges and universities through to the workplace.

Training materials and courses should also be open to anyone in any location to enable people in remote areas to enjoy the same levels of access to learning as those in towns and cities.

The skills taught also need to be relevant to the needs of industry, either directly or providing the basics needed for people to be able to quickly and effectively master new technologies and transfer this learning between jobs.

Different governments and governmental organizations worldwide are already rolling out initiatives aimed at helping people to adapt to the digital age. One example is the European Union's Digital Action Plan[19], which seeks to create the necessary frameworks for teaching digital technologies in schools and other educational institutions to enable a culture of lifelong learning.

Where schools are concerned, education curriculums need to be reimagined to reflect and cater for the needs of modern manufacturing, where students are taught about new technologies and are given opportunities to use them in solving real-world problems. In an article titled 'What kind of education do we need in the future?'[20], the World Economic Forum quotes research from multinational information technology company Infosys covering the views of 9,000 16-28 year olds worldwide, with almost half of those surveyed saying that their education did not prepare them for their working life. The article emphasizes the need for this to be addressed by ensuring that curriculums put technology and digitalization at the forefront of modern education.

Manufacturers

Partnerships between manufacturing companies and educational institutions have been demonstrated to deliver value in helping to deliver contextual learning that can help students to acquire the skills needed for careers in industry. In the UK, for example, various businesses have become involved in the delivery of industry-specific teaching through the creation of University Technical Colleges (UTCs), enabling students to get directly involved in solving typical engineering problems.

For students, such partnerships help to provide contextual learning that shows the real application of technical, language and numeracy skills, and give an insight into the career options available in modern manufacturing and the routes available to achieve them, such as apprenticeships. For manufacturers, there is the opportunity to use their participation to train students on both the technical and softer skills such as problem solving, teamwork and interpersonal communication that they look for in potential candidates.

As more manufacturers adopt automated technologies into their processes, such partnerships will become an important way of exposing students to the career possibilities available and the skills they need to acquire to achieve them.

Partnerships between education and industry can also play a key role in providing teachers, tutors and lecturers with the knowledge and context needed to deliver relevant and high-quality instruction to students, especially when it comes to the use of new production technologies. In a global survey carried out by ABB in April 2022 of 2,301 representatives from educational institutions in seven countries, 47 percent of respondents highlighted the need for assistance with teaching instructors and teachers as a key requirement when teaching robotics skills.

What do you expect from a robot supplier when it comes to assisting with teaching robotics skills? (multiple choice)	
Assistance with purchasing / discounted pricing	32.0%
Assistance with learning support (i.e. course materials, etc)	49.0%
Assistance with teaching instructors / teachers	**47.1%**
Compact installation options	17.0%
Providing easy to use software	48.6%
Providing safety systems / expertise	29.3%
Recognised certification (i.e. qualification)	20.6%
Education-specific offering	44.8%
Assistance with servicing / maintaining the robots	30.2%
Other - please specify	2.0%

Automation suppliers

As the developers and suppliers of the automated technologies that will transform the workplace, automation equipment suppliers, including ourselves, have a responsibility to make sure our products deliver the widest benefits to society. This includes providing training and support at every level, from schools, colleges and universities through to on-the-job-training to provide both future and current workers with the right skillsets that will help them to work with automated and digital technologies.

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"The ability to work directly with ABB is a real plus for students. For a robotics student there is no better experience than being able to study in a company that develops, builds, and supports robots for real-world applications."

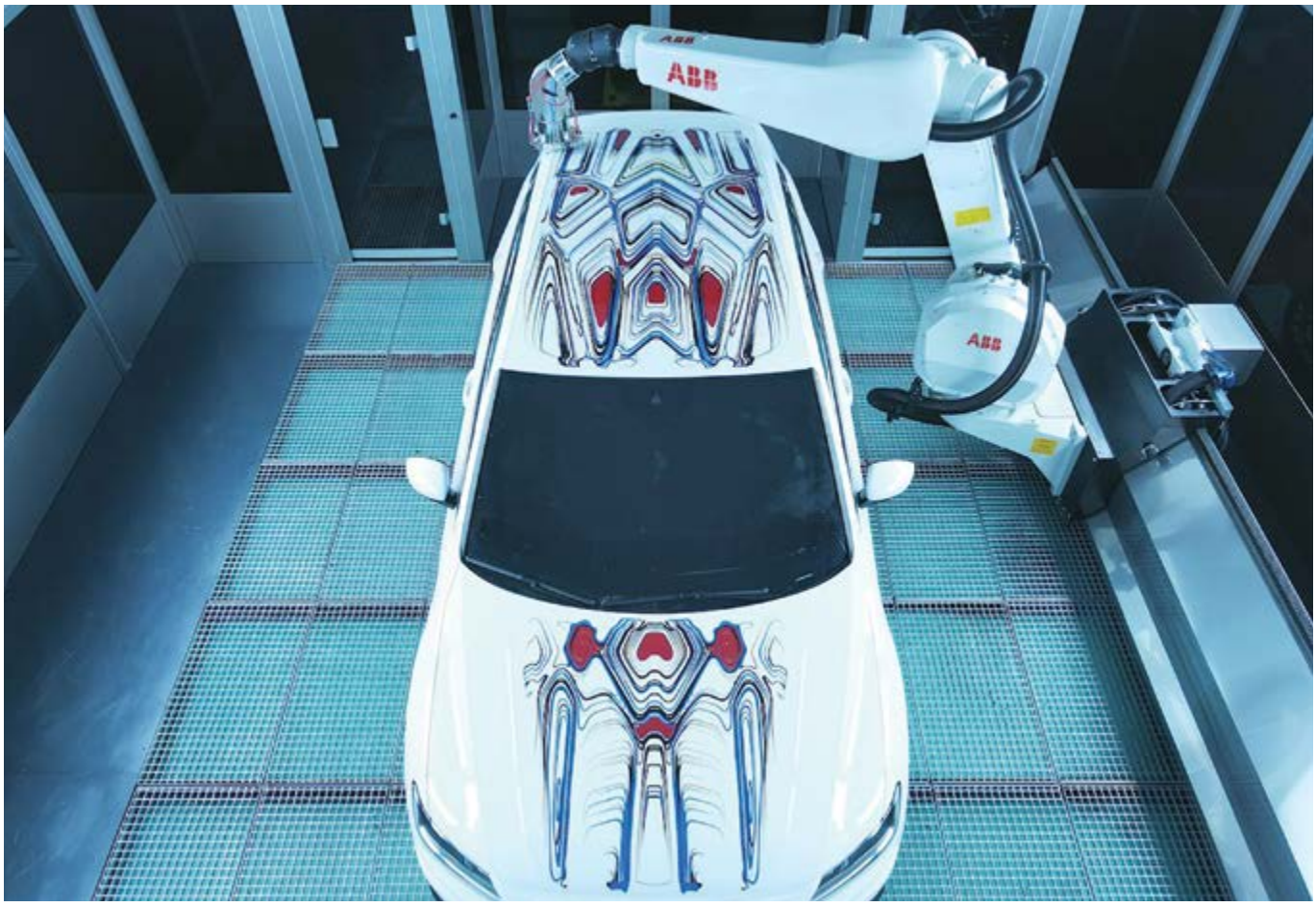
Morten Mossige, ABB

One example of how we are doing this is our involvement with the University of Stavanger in Norway. With the assistance of ABB Senior Principal Engineer Morten Mossige, who also holds an associate professorship at the University, Bachelor and Masters students are able to work at ABB's premises and have access to resources including our robots and software such as RobotStudio to help them in their studies. Students are given projects to work on, with the focus being to develop tools that enable people to work with robots.

To broaden access, we also offer the ability for students to study remotely, using our RobotStudio software as a learning tool that they can use to develop solutions which can then be sent as files to Morten and his team for assessment.

Now in its tenth year, this arrangement has been mutually beneficial for both the university and ABB, as Morten explains:

"The ability to work directly with ABB is a real plus for students. As the saying goes, 'experience is a great teacher', and for a robotics student there is no better experience than being able to study in a company that develops, builds, and supports robots for real-world applications. For ABB, the arrangement has also been a great way of identifying some real 'diamond' candidates who we have subsequently recruited onto our team."



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ABB's ground-breaking PixelPaint robot was developed with the help of a University of Stavanger student who was recruited by ABB (©Illusor Design).

CASE STUDY

Partnership with ABB helps Guangzhou Light Industry Vocational School to prepare students for an automated future

Founded in 1958, the Guangzhou Light Industry Vocational School is the region's only public secondary vocational school that focuses on the major of intelligent manufacturing. In 2011, as part of China's drive to develop the skills and technology needed for a robotic manufacturing future, the school launched a robotics major, with around 300 students recruited annually.

Starting with its first ABB robot in 2012, the school now has a total of 29 sets of ABB industrial robots jointly designed and developed in partnership with ABB. As well as providing the robots, ABB has also been actively involved in providing teacher training and supporting materials for the school's Application of Electromechanical Technology and Application of Industrial Robot Technology courses.

High-quality teaching aids supports hands-on courses

The courses are taught at the Industrial Robot Application-Oriented Talent Training Center, which features dedicated areas for hands-on practice and simulation using a variety of ABB robots. Each year, ABB Robotics provides teachers with targeted technical training, and the school with teaching and learning materials, including textbooks, courseware, and online courses to help students achieve a solid grasp of conceptual knowledge of using and applying robots through systematic learning.

Using the robots, students learn how to apply and integrate robots in different applications including palletizing, chip decomposition, welding, painting, and deburring. To help them fully understand the roles they are likely to perform in employment, students are also encouraged to roleplay real-world positions such as industrial robot assistants, debuggers, production line maintainers and project managers. Higher-level tasks allow students to adapt in advance to the transitioning from student, to apprentice, and gradually, to employee.

Students can also use the center's simulation area to learn how to use ABB's RobotStudio offline programming software tool. Using RobotStudio, students can code instructions and accurately simulate and calculate robot movements in an offline environment. In class, teachers encourage students to code instructions creatively from a professional perspective and maximize the performance of the robot.

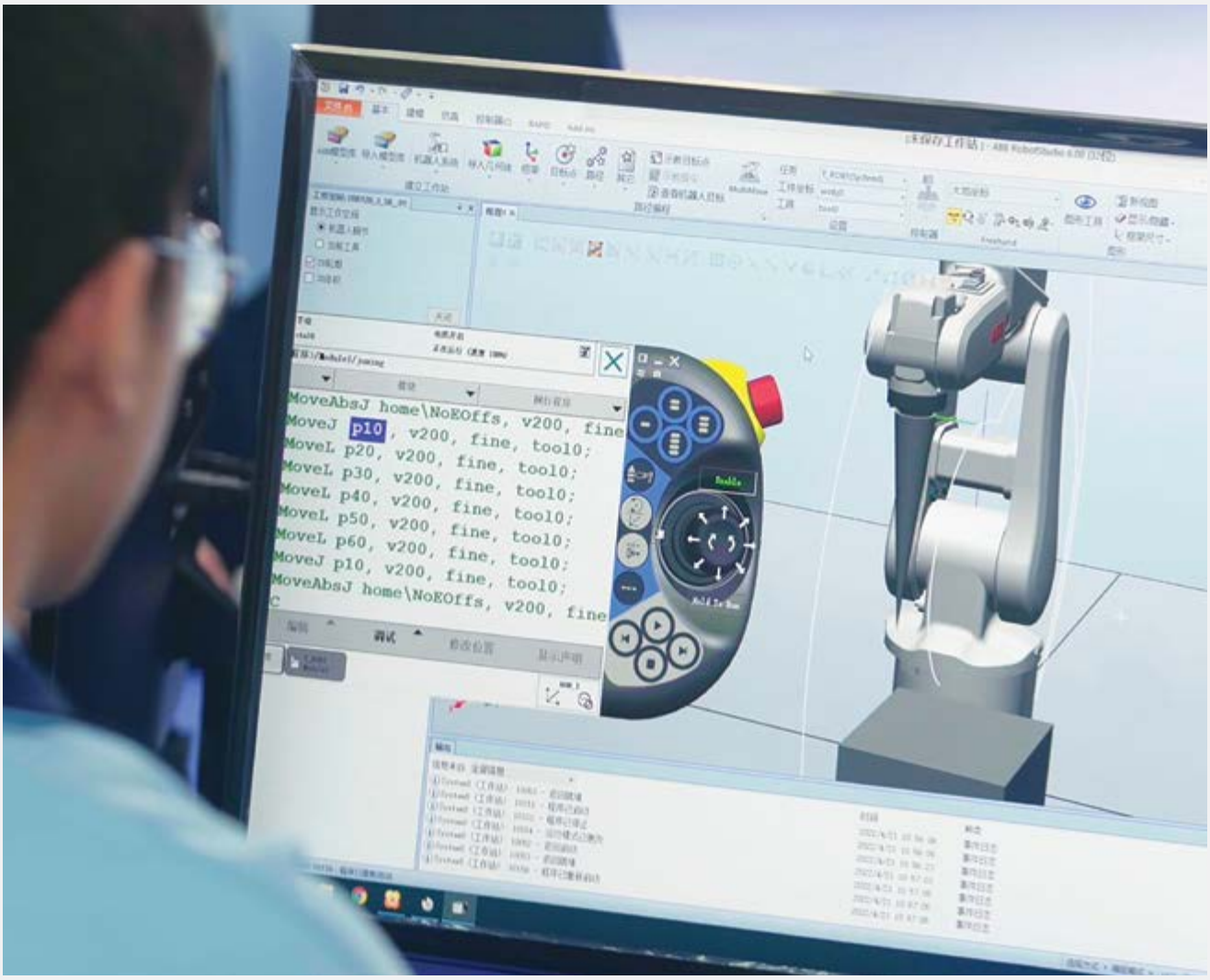
China's Guangzhou Light Industry Vocational School has been teaching robots and automation as a core part of its curriculum since 2011, with many students graduating into careers including manufacturing and robot production.

Competition platform unlocks students' potential
Another bonus for the school of working with ABB has been the opportunity to compete in the ABB Cup Innovation Contest. Held annually in China, the competition has added a robot group, which helps students majoring in robotics verify their learning outcomes and inspires students to explore innovative application scenarios and the benefits of robots in manufacturing and human life. Last year, two students from Guangzhou Light Industry Vocational School won first prize in the contest for their project, which involved designing a GoFa robotic waste sorting system together with the graphical instructions to go with it using ABB's RobotStudio offline programming software tool.

Opening opportunities for rewarding careers
Many students who have taken the courses since they were introduced in 2011 have found them invaluable in shaping their future studies and careers. Of the 700 robotics graduates who have passed through Guangzhou Light Industry Vocational School since the course started in 2011, 70 percent have pursued higher education, with many pursuing careers in industrial robot production, integration, and application businesses in the Guangdong-Hong Kong-Macao Greater Bay Area.

A valuable partnership
Cai Jifeng regards the partnership with ABB as a key part of the school's success in teaching its students to such a high standard.

"Our ability to provide high-quality education is inseparable from the complete set of teacher training, teaching materials, teaching aids and student development platform provided by ABB Robotics. We will continue to maintain a long-term close cooperative relationship with ABB which will enable us to go further and explore the possibilities around the latest robotic technologies and their potential application in intelligent factories, intelligent production lines and intelligent control professional groups, enabling us to provide professional, rigorous and lively education in robotics to our students."



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Teaching tools include ABB's RobotStudio® offline programming software, enabling students to build and test robot operating programs.

Adoption of robots in education – a global picture

To help ascertain the level of adoption of robots in educational institutions and gauge perceptions around the benefits and potential pain points surrounding the teaching of robotics and automation skills, ABB surveyed 2,301 representatives from schools, colleges, universities and adult education providers. To provide a global comparison, the survey covered a range of countries, including China, France, Germany, Italy, North America, South Korea, Sweden and the UK.

Number of individuals surveyed in each country:

Country	Count
UK	426
Sweden	111
South Korea	224
North America	422
Italy	223
Germany	254
France	254
China	387
Total	**2301**

Institutions covered by the survey:
To reflect the differing natures of educational institutions and the purposes they serve, the survey covered a range of different educational facilities, comprised as below. It should also be noted that, whilst differing types of institutions were surveyed, schools accounted for the majority of respondents:

Sector	Count
School	1628
College	89
Vocational school/Technical college	155
University	300
Adult education	129
Consultant	35
Total	**2301**

The survey revealed a number of key findings, which are covered below:

1. The majority of all education professionals agree that robots and automation will increasingly shape the future of employment

Of the 2,301 people surveyed, 1,848 responded that they agree to at least some extent with the statement "Robots and automation will increasingly shape the future of employment in the next 10 years", amounting to 80.3 percent of respondents. This was broadly reflected across all countries surveyed, however the sentiment was expressed by over 90 percent of those in China:

To what extent do you agree with the statement:
"Robots and automation will increasingly shape the future of employment in the next 10 years"?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	NET Agree
GLOBAL TOPLINE	30%	50%	16%	3%	1%	80%
UK	22%	51%	18%	6%	3%	73%
Sweden	30%	45%	23%	2%	1%	75%
South Korea	24%	53%	21%	3%	-	77%
North America	29%	50%	19%	1%	2%	79%
Italy	31%	53%	13%	1%	1%	84%
Germany	28%	55%	13%	3%	0.4%	83%
France	30%	49%	16%	3%	2%	79%
China	46%	44%	8%	1%	0.3%	90%

It should be noted that percentages in the table above have been rounded where appropriate. Furthermore, a "NET Agree" percentage does not necessarily imply an inverse NET Disagree percentage, as many respondents indicated that they neither agreed nor disagreed with the statement.

It is reasonable to conclude from the survey data that most respondents see robots as the future of employment, with very little disagreement. Even in the UK, where the lowest level of respondents think that robotics will shape the immediate future of employment, only 9 percent actively disagreed with the statement. In all other countries surveyed, the percentage of those disagreeing was negligible, although it should be noted that a not insignificant proportion, particularly in Sweden and South Korea, did not an express an opinion either way.

Respondents displayed similar attitudes when asked the question "What is your view of the need to teach robotic and automation skills?", where globally 76% of those surveyed agreed that it was important to some extent. Drilling down on this question by country, the major statistical outliers were the UK and North America, where around a third of education professionals did not see teaching robotics as a priority. Conversely, in China, Italy and South Korea, around 85 percent of respondents agreed that it was important or very important.

These results could arguably be attributed to a range of cultural factors. Uptake of robotics and automation in industry in countries such as China and South Korea already vastly outstrips their use in the UK and North America, and so an interpretation of these findings could be that countries that already have a widespread installed base of robotics are more likely to be exposed to their benefits, and thus more likely to advocate for their adoption in education to prepare future generations for roles involving robotics and automation within the workforce. This presents something of a "Catch-22" situation, whereby robots are required in the workforce to encourage their adoption within education, yet education is required to increase adoption in the workplace.

The countries with the most positive attitudes towards educational robotics appear to be those that have already achieved a critical mass of acceptance of robots in the workplace. Whilst attitudes are shifting in nearly all countries towards more positive perceptions of robots and their value as a collaborative, productive and/or educational tool, the rate at which this is occurring appears to vary from country to country.

2. Collaboration, sustainability, and equipping people with the skills to thrive in the workforce of the future, are seen as the main benefits of adopting robotics in education

66 percent of educational professionals believe that equipping young people with technology skills for future employment is the main value driver behind using robots in education. Notably, this is lower than the proportion from any country indicating that robots will shape employment over the next 10 years. Equipping young people entering the workforce with the technical skills required to program, operate and maintain robots is essential as industry and society transition to a future in which robots are an increasing part of everyday life.

What do you see as the main benefits of using robots in education?	
Equipping young people with technology skills for future employment	66%
Teaching collaborative skills	35%
Breaking down gender barriers	19%
Addressing skills shortages in industry	29%
Tackling future labor shortages in industry	27%
Improving environmental performance by developing new sustainable production techniques	28%
Encouraging new ideas & approaches	52%
Other	1%
Do not see any benefits	6%

However, a similarly instructive finding could be the value that respondents placed on the value of soft skills in the workplace of the future, as well as the benefits of robotics not just for productivity, but for improving quality of life for wider society. 52 percent of those surveyed said that using robots in education is useful for encouraging new ideas and approaches, while 35 percent indicated that it could be beneficial for teaching collaborative skills.

As the modern workplace changes, employers are increasingly looking beyond merely technical skills, and seeking workers with problem-solving and critical thinking abilities, and those who can work effectively as part of a team. As robots increasingly take on the menial, repetitive tasks that would previously have been carried out by humans, the role that humans can play in a productive workplace is set to evolve. Having workers with the ability to interpret data and generate insight, carry out supervisory duties, and use their creativity and intuition to solve problems and develop innovative new solutions, will be key in creating an agile, efficient, and effective workforce. Traditionally, employers placed a far higher value on technical skills, whereas today's worker is increasingly being encouraged to think for themselves and be able to adapt rapidly to change.

—
Developing soft skills such as collaboration and problem-solving will be increasingly important in helping to get the most from automated technologies.

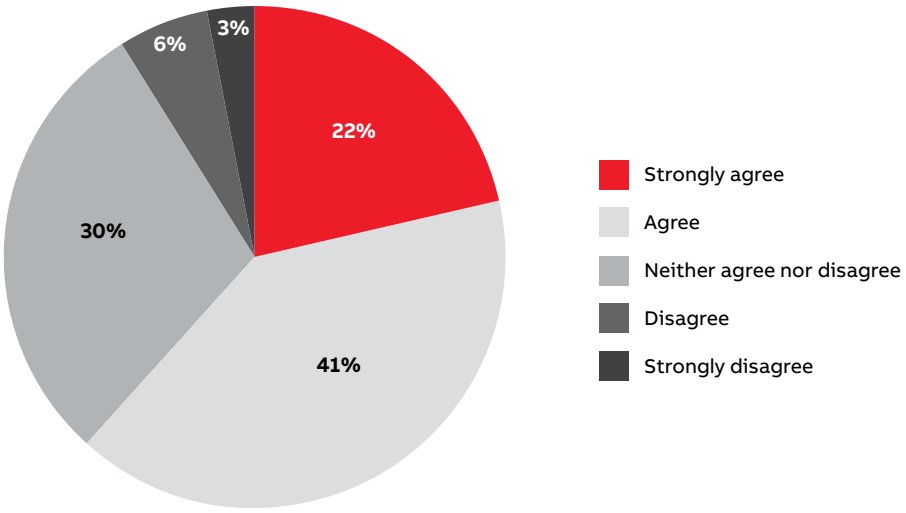
As well as soft skills, respondents also noted the supplementary benefits of using robots in education, namely in improving environmental performance by developing new sustainable production techniques. With 28 percent of respondents listing this as a priority, this seemingly makes it every bit as important as addressing skills (29%) and labor (27%) shortages in industry in the future.

Breaking down gender barriers was listed noted as a benefit by 19 percent of those surveyed, reflecting changing attitudes towards gender equality, and a view that robots can play an important role in levelling the field, however France (10%) and South Korea (11%) were notable outliers compared to other nations in placing less emphasis on this particular benefit. When asked specifically the extent to which they agree with the statement "Robotics and automation education could help to improve the gender balance in manufacturing industries", respondents broadly agreed, with only a minority in a small number of countries expressing dissent for this view:

To what extent do you agree with the statement:
"Robotics and automation education could help to improve the gender balance in manufacturing industries"?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	NET Agree
GLOBAL TOPLINE	22%	41%	30%	6%	3%	62%
UK	13%	42%	32%	10%	3%	55%
Sweden	27%	39%	32%	3%	-	66%
South Korea	21%	48%	28%	2%	1%	70%
North America	20%	35%	36%	5%	3%	55%
Italy	22%	40%	32%	4%	2%	63%
Germany	17%	35%	32%	10%	6%	52%
France	19%	38%	34%	6%	3%	57%
China	37%	46%	15%	1%	1%	83%

Robotics and automation education could help to improve the gender balance in manufacturing industries?



3. In many countries, adoption of robots in education has been relatively slow

Just 28 percent of all respondents indicated that they currently use robots as part of their teaching plans.

Do you currently use robots as part of your teaching programmes?	
Yes	28%
No	72%

However, a significant statistical outlier in the data was China, where 58 percent responded positively, followed by Sweden with 38 percent. Other countries generally ranged from 15 percent to 30 percent.

% of those responding "Yes" to the question "Do you currently use robots as part of your teaching programmes?"	
GLOBAL TOPLINE	28%
UK	22%
Sweden	38%
South Korea	21%
North America	15%
Italy	29%
Germany	17%
France	26%
China	58%

An interesting anomaly here is the inverse correlation between attitudes towards robotics in certain countries, and their actual investment in education as evidenced within the survey responses. According to the IFR, South Korea is the second most automated country in the world (in terms of robot density, i.e. number of operational robots relative to the number of workers)[21], while Italy, Germany, USA and Sweden are in the top 10, and yet these countries are comparatively behind others surveyed when it comes to robots in education. Sweden meanwhile is also in the top 10, and has a commensurate placing for robots in education, while China is outside the top 10 on robot density, and yet was by far the leading country surveyed on this metric.

Of those surveyed, 67 percent used 1-5 robots as part of their teaching programmes globally, although in Italy this figure reaches 86 percent. Only South Korea uses 16 or more robots in more than 10 percent of its educational institutions.

Of those that do use robots in their teaching programmes, most reported that they exclusively use educational robots, China, 65 percent of institutions surveyed indicated they had some sort of partnership with local manufacturers or robot suppliers. This could indicate that across most of the countries surveyed, there is untapped potential for manufacturers and robotics specialists to provide financial and vocational assistance in this area.

An average of 36 percent across all countries indicated that they worked in partnership with other educational institutions as opposed to industry or robot suppliers. In Sweden, 23 percent reported that they had acquired their robots without the influence of external investment, government initiative, or industrial partnership. This is far higher than any other country surveyed.

The way in which robots are used in education is largely consistent from country to country, although in Sweden there is a significant focus on teaching programming skills (91%), while in China robots are used to teach programming skills (71%), teach new production techniques (61%), and to teach teamwork skills (54%). In both countries this suggests a concerted effort from educational facilities to implement robotics into the curriculum, perhaps on a more vocational basis compared to other countries.

How are you using the robots? (Multiple answers may apply)	
To teach programming skills	71%
To teach new production techniques	39%
To teach teamwork skills	42%
As a research tool	26%
Other	2%

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Teaching robot programming skills is a key focus for many educational institutions.

4. Lack of funding is the most cited barrier against increased adoption of robotics in education, while many institutions report a lack of awareness and insufficient training, time, and provision within the existing curriculum

By far the biggest barrier against the adoption of robotics in education is a lack of funding. Robots can represent a significant investment for educational institutions, and require maintenance and training of staff, as well as development of specific courses to ensure that the robots are utilized to their full potential. Most of the concerns expressed were logistical (e.g. lack of funding, insufficient teaching resources) as opposed to ideological (e.g. maintenance, safety).

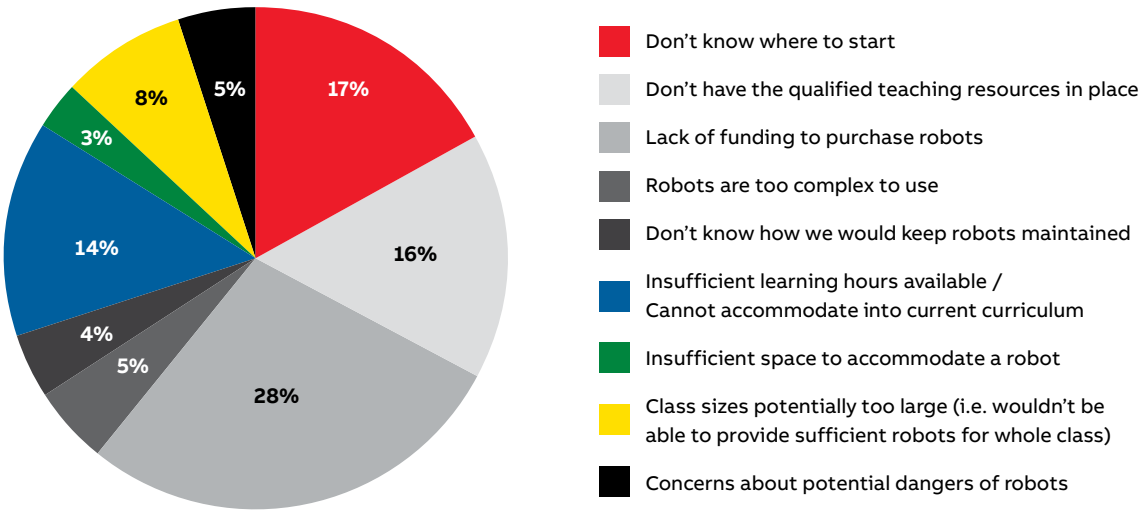
If you are not using robots as part of your teaching programme, why not?	
Don't know where to start	17%
Don't have the qualified teaching resources in place	16%
Lack of funding to purchase robots	28%
Robots are too complex to use	5%
Don't know how we would keep robots maintained	4%
Insufficient learning hours available / Cannot accommodate into current curriculum	14%
Insufficient space to accommodate a robot	3%
Class sizes potentially too large (i.e. wouldn't be able to provide sufficient robots for whole class)	8%
Concerns about potential dangers of robots	5%

However, drilling down into the responses by country reveals some interesting findings. In both the UK (26%) and North America (27%), a large proportion of respondents indicated that they simply don't know where to start with robotics, yet these same regions (12% and 10% respectively) were not nearly as concerned with the availability of teaching resources compared to other countries. In South Korea (28%) and France (23%) this appeared to be of particular concern.

Very few respondents were worried about maintenance or space requirements, although class sizes were identified as a notable barrier in Sweden, Italy and France. In Italy and Germany in particular, respondents suggested that there was insufficient latitude within the curriculum to incorporate robots effectively.

Lack of funding was consistently the top issue across all countries with the exception of South Korea, where lack of teaching resources appeared to be the biggest concern. In the UK and North America, there is clearly appetite for increased usage of robotics in the classroom, however the fact that many education professionals simply don't know where to start should trigger a discussion in these countries as to how robotics is approached on the curriculum in a way that engages not just students, but teachers also.

If you are not using robots as part of your teaching programme, why not?



5. There are many regional variances in attitudes towards robotics from country to country

UK overview
Only **21%** of educational institutions surveyed in the UK currently use robotics as part of their teaching programs. Of these, **63%** possess 1-5 robots, while **29%** have 6-10. The majority of these robots are educational, with only **3%** of institutions using industrial robots exclusively.
In the UK, robots are largely used to teach programming skills, with **70%** of robots used for this. **42%** of robots are used to teach teamwork skills, while **32%** use them as a research tool, and **28%** are used to teach new production techniques.
Attitudes towards using robotics in education are more mixed in the UK compared to other countries, with only **66%** indicating that it is either important or very important to teach robotic skills.
Conversely, there is a general acceptance that robots in education are important to equip young people with the right skills for the future of work, with **73%** sharing this view. Robots in the UK are seen more as a teaching aid rather than a vocational skill in its own right, with **37%** used to teach collaborative skills, and **54%** used to encourage new ideas and approaches.
The reason given by the **29%** of respondents for not using robotics more in education is a lack of funding, although **26%** suggested that they simply don't know where to start.
Only **4%** of those surveyed reported having a partnership with any robot supplier, with **35%** of robots acquired via other educational institutions. When asked what support they would like in a partnership from a robotics supplier, **56%** would like to see the provision of easy-to-use software, while **49%** would like education-specific offering, as well as direct assistance with learning support and provision of teacher training.

Sweden overview
In Sweden **38%** of educational institutions already use robotic automation in education; a much higher figure than other comparable countries.
Of those that use robotics as part of their training programs, **67%** possess 1-5 robots, while **24%** have 6-10. **10%** of institutions surveyed use 11-15 robots.
The vast majority of these robots are educational robots, while **7%** of institutions also use industrial robots for teaching.
Robots are used by **90%** of institutions for teaching programmable skills, although **19%** are also used for teaching teamwork skills, and **14%** for teaching new production techniques.
78% of respondents see the need to teach robotic and automation skills as important, with **57%** citing the need to equip young people with technology skills for future employment as the main driver.
37% of robots used in Swedish education are sourced through partnerships with other institutions, while **23%** obtain their robots with no outside influence.
The main barrier against the incorporation of robots into educational institutions in Sweden is a lack of funding, with **30%** citing this as a major concern. However, **75%** agree that robots and automation will increasingly shape the future of employment.
When partnering with robotics suppliers, **42%** of respondents would like assistant with learning support, while **38%** want an education-specific offering.

South Korea overview
Despite the use of robots being widespread in manufacturing, only **21%** of South Korean respondents reported that they currently use robots as part of their teaching programs.
10% of these institutions use 16 or more robots for teaching, although **63%** have between 1 and 5 robots. **85%** of these are educational robots with **4%** industrial, while **10%** use a combination of both.
Robots are primarily used to teach programmable skills, at **58%**, while **40%** are used as a research tool.
85% consider robotics and automation skills to be important in education, with **41%** seeing the main benefit to be equipping young people for the workforce. **40%** also consider them beneficial for encouraging new ideas and creative problem-solving.
In South Korea, one of the main barriers preventing widespread adoption of robotics in education is a lack of teaching resource, with **28%** indicating that they don't have the requisite teaching qualifications on their staff.

North America overview
Only **15%** of educational institutions in North America currently use robots as part of their teaching programs. Of these, **67%** use between 1 and 5 robots, with **81%** educational, and **18%** using a mix of educational and industrial robots.
73% of the robots used in educational settings in North America are with the aim of teaching new programming skills, while **57%** are used to promote teamwork skills.
Robotics are not considered as high an educational priority in North America compared to other countries, with **31%** not seeing it as a priority at all.
74% consider one of the main benefits of robots in education is to equip young people with skills for the workforce, while **79%** agree that robots and automation will be increasingly important in the future of employment.
34% of respondents consider a lack of funding as the main barrier to accessing robots, while **27%** don't know where to start when including robots in educational settings.
34% would like to see assistance with purchasing and discounted pricing from robotics suppliers, although this is not the most common expectation, with **50%** hoping for specific course materials and software.

Italy overview
29% of Italian educational institutions use robotics in the classroom to some extent. The vast majority of these have only a small number of robots, with **86%** possessing between 1 and 5. **39%** of these robots have been sourced through collaboration with other educational institutions.
Many of these robots are used to teach programming skills, with **61%** of respondents reporting this to be the case.
Robotics skills is seen to be a priority in Italy, with **84%** considering it to be important, and **73%** citing the reason for this as to equip young people with skills for the future workforce.
In terms of what they want to see from robotics suppliers, **57%** expect better assistance with teaching of staff, while **53%** would like more learning support such as course materials. The main reason why robots are not widely used is due to a lack of funding for purchasing them, with **33%** citing this as a reason.
Robotics and automation are widely seen to be the future of work in Italy, with **84%** agreeing with this sentiment.

Germany overview

Despite having invested extensively in industrial automation, the use of robots in education is not particularly widespread, with only **17%** of educational institutions having access to them. **24%** of institutions instead use either industrial robots or a combination of industrial and educational robots.

Robots are used by **67%** primarily to teach programming skills, while **41%** also use them both to teach new production techniques, and to teach teamwork skills.

Robots are generally viewed favourably within education in Germany, with **76%** seeing the need to teach skills in this area as a priority, and **60%** viewing this as a necessity to equip young people with skills for the future.

Many German educators source their robots from other educational institutions, with **44%** reporting this to be the case. In terms of what more they want to see from robotics suppliers, there is a relatively broad spectrum, with respondents variously wanting assistance with learning support (**49%**), expertise and safety systems (**35%**), education-specific offering (**49%**), and assistance with maintenance (**36%**).

Robots are widely seen as the future of industry in Germany, with **83%** agreeing with this sentiment. By far the biggest barrier to entry for educational institutions is a lack of funding to purchase robots, with **31%** reporting this to be the case.

France overview

Only **26%** of French educational institutions use robots as part of their teaching, with the majority (**77%**) using between 1-5. Most of these robots (**86%**) are educational robots.

The main objective among French educators that do use robots is to teach programming skills, with **76%** considering this to be the case. However, **30%** do not see the teaching of robotics skills as a priority at all.

67% of respondents say that the main benefit of using robots in education is to equip young people with technology skills for future employment, with **79%** agreeing that robots and automation will shape the future of employment in the next 10 years.

The main priorities for robotics suppliers according to educational institutions in France are to provide assistance with teaching staff (**52%**), and assistance with course materials (**47%**).

23% of respondents report that they lack the qualified teaching resources to teach robotics effectively, while **21%** say that they lack the funding to purchase robots.

China overview

58% of Chinese educational institutions currently use robots as part of their teaching programmes, by far the highest of any country surveyed.

Of these institutions, **64%** have between 1 and 5 robots, **26%** use between 6 and 10, while **10%** have 11 or more. **69%** of these are educational robots, while **29%** use a combination of educational and industrial robots.

Robots are primarily used to teach programming skills (**71%**), teach new production techniques (**61%**), and teach teamwork skills (**54%**).

87% of Chinese educators see the need to teach robotics and automation as important, with **53%** of these describing it as very important. The main reason given is to equip young people with skills for the future workforce; a view shared by **71%** of respondents.

Unlike many other countries, robotics suppliers and local manufacturers play a key role in the use of educational robots, with **91%** of institutions gaining access to robots in this way. **46%** also utilize other educational institutions.

Among the priorities for what they want to see from robotics suppliers, **56%** would like assistance with teaching instructors, **55%** would like assistance with course materials, **56%** want easy-to-use software, and **51%** want education-specific offering.

90% of Chinese educators share the view that robots and automation will shape the future of employment in the coming years, however **27%** report a lack of funding as their main concern in acquiring or gaining access to robots.

How is ABB helping to shape future workforces?

Partnerships

ABB's extensive experience and portfolio of robotic solutions makes us well-placed to help assist educational institutions with the products support and training needed to incorporate robots into learning programs.

We have already built an extensive network of partnerships with universities worldwide, providing the equipment and support needed to teach robotic and automation skills. In many cases, these partnerships are enabling institutions to engage in the research and development of automated solutions for deployment in real applications, such as construction, providing added potential employment opportunities for students.

We are also working with a growing number of schools and colleges in various countries to ensure that students can learn the fundamental basics of robot programming and operation. For example, we have helped schools and higher education institutes in Italy to introduce new courses to their curriculum to teach 16- to 18-year-olds the key principles and operation of robotics and cobots. Equipped with these skills, students at the schools can either prepare themselves for a career in industry or further study at university.

CASE STUDY

How ABB robots are helping to educate the next generation of young Italian engineers

Schools and higher education institutes in Italy have introduced new courses to their curriculum to help train young engineers in the key principles and operation of robotics and cobots. Developed in collaboration with ABB, the courses have been developed in response to a call from the Italian government for more STEM teaching, and to help prepare students from 16 to 18 years old for the world of modern industry.

The north-east of Italy has strong industrial connections, with many small and international companies operating nearby. As such, the area is an excellent catchment area for new employees entering industry, with many students going on to work in the region, helping the local economy. The schools are allowed by the MIUR (Minister of Education in Italy) to develop and tailor specific courses to suit the needs both of students and of local industry. More than 100 secondary schools in Italy are supported by ABB to conduct courses in robotics, with the aim of equipping young people with the skills they will need to operate effectively within an increasingly digitalized, automated industrial workplace.

> "The programming skills developed in our courses are directly applicable to industrial environments, making our students well prepared to enter the world of work."
>
> **Eugenio Berti, ITT Marconi**

The ITT G. Marconi of Rovereto secondary school uses an ABB dual-arm YuMi collaborative robot and a IRB 120 small industrial robot to help teach students the fundamentals of robotic automation. Using the robots, students can get hands on with the hardware and learn how to carry out programming using ABB's RobotStudio software and RAPID programming, enabling them to acquire valuable skills that can be used in the real world of employment.

The compact design of both robots, coupled with YuMi's ability to work safely alongside people without the need for additional safety measures such as fencing, are key benefits for the school.

According to Eugenio Berti, a teacher at ITT Marconi, the YuMi in particular, provides compelling opportunities for developing practical skills with the latest generation of industrial robots and cobots: “We toured a local leading manufacturer of eyewear that was using YuMi robots and saw that the robot had huge potential as an educational tool. Students are fascinated by YuMi and feel compelled to challenge themselves to find out what it can do. Part of the challenge is in synchronizing the device’s two arms, but the programming skills developed in our courses are directly applicable to industrial environments, making our students well prepared to enter the world of work.”

For a final exam project at ITT Marconi last year, students had to integrate a complex project, ultimately using the robot to construct a small torch from assorted components. Students had to combine several aspects of robotics engineering, from web design and communication through to communication and programming the robot’s movement. All students passed the exam and are now undertaking university courses in the field of electronic engineering.

Eugenio adds that sometimes the students surprise him with their innate knowledge: “In the last few years we’ve seen an increase in the number of students taking the course, and the new generation coming through are digital native users. When you give them a tool like the FlexPendant HMI, they already have a rough idea of how to use it. ABB has been enormously supportive throughout the development of these courses, and along with their technical support have made significant contributions to the educational content of the course, even coming to the school to offer courses and train teachers. They also created an online platform with lots of helpful materials like video lessons and exercises, as well as the textbooks. I can think of no other brand which would have committed to the project in this way.”

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Teaching both male and female students, ITT Marconi’s courses are helping to bridge the engineering gender gap.

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ABB’s YuMi® is one of two robots that are used for teaching the fundamentals of robotic automation to students at the ITT G. Marconi of Rovereto secondary school.

Textbooks and qualifications
To help further support schools, ABB has also created two textbooks which can be used to instruct and teach students, one aimed at beginners and the other at advanced users. Based on the courses typically offered to industrial companies through ABB’s robot training program, the textbooks provide information and exercises that can be used by students to develop their skills in robot programming and operation.

To enable students to demonstrate their competence, ABB also helps to manage exam days and issues certificates of competence upon completion of courses, after which students can decide whether to continue with their studies at higher technical institutes (ITS) or universities or pursue internships and employment.

Marta Castagna, School Director at the Zaccagna Galilei Institute in Carrara, has seen the benefits of giving students a certified robotics qualification: “This experience is fundamental for the connection between the world of school and the world of work, and we have also developed evening classes for adults to re-skill for the modern economy. Our agreement with ABB means that students receive a certificate of competence on robot programming, which they can take to any employer to prove they have the skills to make an effective contribution in the workplace. Many of our students have found high quality employment as a result.”

Apprenticeships

ABB apprenticeships offer an exciting and rewarding opportunity for gaining first-hand experience in applying our portfolio of automation technologies in industrial applications. Running for three years, our robotics apprenticeships teach the full range of skills needed to program, operate and maintain the latest generation of robots. In many cases, apprentices will be offered the opportunity of a permanent position once they have completed their apprenticeship.

CASE STUDY

From apprentice to ABB engineer

Louis Novakovic is one of several ABB robotics engineers based at Milton Keynes. After completing an apprenticeship at ABB Robotics UK, Louis now works with cutting edge robot technologies, including YuMi, ABB's innovative dual arm collaborative robot.

With his role including bringing YuMi to companies that have never used robots before, Louis is a great example of the new generation of young tech-savvy graduates that just need the support of an apprenticeship in a technical company to inspire their future in the world of STEM.

How did you become interested in robot engineering?
I was studying for an IT course at college that covered areas such as programming, web design and games. When the course finished, I looked around at what I could do next. I knew I didn't want a job that involved just sitting in front of a computer all day, so when I saw some robotics apprenticeships on the government apprentice web site, I knew this could be the perfect fit for me. It involved several aspects, including programming and both mechanical and electrical engineering, so it would have a lot of variety.

I went for a first interview at ABB, where I was given an overview of the company and a tour of the Milton Keynes site to see what the robotics team did. A second interview was more of a one-on-one about me and later that day I got a call to say I had got the apprenticeship.

What form did your apprenticeship take?
It was a four-year program, with the first year spent entirely at college. The remaining years I did one to two days at college with the rest of the week at work. I achieved several qualifications and did some separate courses in areas such as networking to help prepare me to work in a company such as ABB where meeting end customers, members of the press, public and even government officials can be a daily occurrence.

What does your current work involve?
Most of my time is spent working with YuMi, ABB's new collaborative robot that works alongside people on assembly tasks. This is very exciting because it's a new way of thinking about robots. Instead of working behind a cage or screen to separate people and the robot, YuMi works on the assembly line right next to human workers, helping them assemble products and inspect finished articles. It's also different in that it's aimed at companies which have most likely never used robots before, including smart phone and tablet manufacturers.

With YuMi, I have a lot of interaction with customers. We will visit their premises to see how they work and look at the products they want to build. I will program a YuMi to assemble these products so we can conduct a trial of the application and demonstrate this to the customer.

I am also involved with support and training, teaching the customer's staff about how to build their products with YuMi. It's been really enjoyable so far. Although there's a steep learning curve, it's good because I am learning a lot in a short space of time.

How would you describe an engineer's role to a young person interested in the career?
I would say that engineering and how engineers work has changed a lot over the last few years. It's much more to do with programming and automation than the traditional, 'getting your hands dirty' sort of image that a lot of people have.

Many young people are used to using electronic devices and the idea of programming machines in some form, so today's engineering could fit in well with the experience they already have.

We held a STEM session recently for a local school. We taught them how to program robots and it was amazing how well they got on with it – they picked it up instantly.

Technology

We're providing students at all levels with access to the technologies and software that they'll find in the workplaces of the future.

Robots

Our extensive portfolio enables us to offer a wide choice of robots for education applications. Our offering extends from cobots and small industrial robots for use in classrooms through to larger options that can be used in laboratory or research facilities. For institutions that are either taking their first steps in teaching robotics and automation or have limited installation space available, our YuMi® and GoFa™ cobots and IRB 120 small industrial robot offer an ideal solution.

With extensive built-in safety features, ABB's single and dual-arm YuMi cobots and the recently launched GoFa can be used without the need for safety fencing, enabling students to work with them directly.

Software

ABB offers various software packages that can be used to help teach the skills needed to program and operate its robots.

RobotStudio®

ABB's RobotStudio® offline programming software is widely used by industrial operators to program, simulate and refine robotic installations in a virtual environment. By enabling users to create and test different configurations without having to disturb their factory, warehouse or other operations, RobotStudio has been proven to significantly reduce the time, cost and disruption of installing robots.

With the ability to be used with or without a physical robot, RobotStudio offers an attractive teaching tool for schools, colleges and universities. Institutions can benefit from up to 50 floating licenses, which can be provided to students as a learning tool. Using the software, students can develop working virtual models of anything from a single robot through to a complex multi-robot cell, which can then be used either to program a physical robot in the classroom or sent to a teacher or lecturer as a packaged file for assessment.

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"ABB's RobotStudio software was essential as a learning tool. It enabled me to remotely test algorithms and communication interfaces that I had developed, which enabled me to progress my education without requiring daily in-person access to a robot."

Daniel Schillhammer, UAS Technikum Wien Masters Student

As such, the software is ideal for situations where students are unable to access a physical robot or for situations where learning needs to be carried out remotely.

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With no need for safety fencing, ABB's GoFa™ cobot quite literally enables students to gain hands-on experience of programming and operating robots.

CASE STUDY

Offline remote programming software enables students to advance the science of robotics

ABB's RobotStudio offline programming and simulation software has earned a reputation as a leading tool enabling companies across a range of sectors to plan and execute robotic installations. For students at Austria's UAS Technikum Wien, the software also played a valuable alternative to classroom-based teaching during lockdowns caused by the COVID-19 pandemic.

At the University of Applied Sciences (UAS) at Technikum Wien there is a state-of-the-art robotics laboratory, equipped with a range of ABB robotic solutions including collaborative and industrial robots and a variety of software programming suites. The Robotics Lab enables students to learn the science of robotic mechanics, electronics, sensors, processors and actuators needed for a productive career in robotics and mechatronics. With local support from ABB, the Robotics Lab provides university level instruction to advance the development of industrial robots for practical tasks in the present, and experimental applications in the future.

No one could have predicted that the realities of remote learning would be put to the test by the restrictions imposed by the global pandemic, which was challenging for students and instructors alike. The benefits to be gained from hands-on development, testing and learning were going to be challenging to achieve with little or no physical access to the robots in the lab.

According to UAS Masters student Daniel Schillhammer, "I graduated from high school with almost no technical background, but I knew that my passion for technology would be best served by pursuing higher education in mechatronics and automation systems, specifically how they apply to classic mobile and industrial robots, as well as cobots.

"Before the pandemic happened, I hadn't envisaged that the majority of my learning experience would end up being delivered remotely."

A major part of the Robotics Lab installation is the support provided by RobotStudio, ABB's simulation and offline robotics programming software designed to not only apply actual tasks and processes to physically active robots, but importantly in this case remotely simulate and test new programming techniques without compromising ongoing live production. This meant that despite the lack of physical access – often for extended periods of time - a comprehensive program of educational training, programming and optimization experiences could be achieved entirely offline.

ABB's RobotStudio® programming software proved an invaluable remote learning tool for students during the COVID-19 pandemic.

According to Schillhammer, "ABB's RobotStudio was essential as a learning tool. It enabled me to remotely test algorithms and communication interfaces that I had developed, which enabled me to progress my education without requiring daily in-person access to a robot.

"And because the RobotStudio software is so comprehensive, I could be confident that what I had developed offline was going to work. It was greatly satisfying that when I was able to test with a physical robot what I had created in a simulated environment, it worked precisely as I anticipated. Remote learning had its drawbacks, but RobotStudio was not one of them. Quite the opposite. The detailed, in-depth experience was invaluable."

Support from ABB

Although the students' lecturers are the first line of support, ABB Austria is nearby and can help with more in-depth robotics theories and experiments. However, because the RobotStudio software is so intuitive it enabled students like Schillhammer to resolve everyday issues as well.

"It's important that young people learn robotics because the field offers exceptional opportunities for people who can program, operate or work alongside them," Schillhammer concluded. "It's exciting that with the help of UAS and ABB, students and academics alike are gaining world-class experience. The potential for innovation, productivity and, ultimately, satisfying employment is huge."

Wizard Easy Programming

Available for ABB's cobots including the single arm YuMi®, GoFa™ and SWIFTI™ and the IRB 1100 industrial robot, Wizard Easy Programming offers an ideal way for first time users to get to grips with the basics of setting up and programming a robot.

Featuring a graphical interface, Wizard Easy Programming enables users to select and arrange pre-programmed function blocks to create robot operating programs. With no need to learn or understand programming code, the software allows first time users to program collaborative and industrial robots within minutes without specialized training.

As such, it provides an ideal route for younger students especially to get their first experience of programming and operating a robot.

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ABB's Wizard easy programming software is an ideal learning tool for those with little or no prior experience of robots.

AR Viewer

Available for use on the latest generation of smart mobile phones and tablets (from iPhone 6s, iPad Pro or onwards and Android 7.0 onwards with ARCore support), the RobotStudio® AR Viewer app provides a new and exciting way for students to view and test any virtual models created in RobotStudio in a real-life environment.

The app can be used to test any model created in RobotStudio, enabling users to get an idea of the size and scale of a robot or robot cell. Using Augmented Reality (AR) technology, the app overlays the modelled solution into the real-life environment, with the ability to scale it to full size and rotate it through a variety of angles to achieve the best result.

"The AR Viewer app tool helps students to understand things better when developing a solution – it could also be used to demonstrate incorrect or inefficient set-ups using the tool rather than the physical robot."

The benefits of the AR Viewer extend to being able to watch the model in action. A timeline feature makes it possible to check the cycle time and go quickly to a certain point in time in the animation, enabling users to find ways of enhancing performance or pinpointing a potential issue.

Available free of charge, the app provides a low cost, safe and easy way of visualizing an installation that can be used by individuals or groups, with none of the potential concerns over complexity, hygiene or nausea that can occur with VR-based alternatives.

As a freely accessible tool, the AR Viewer is an ideal teaching tool that gives students a real idea of how robots can be integrated into factory or other environments.

CASE STUDY

Augmented Reality helps students see the future of robot programming

Students at UAS Technikum Wien in Vienna are seeing the future of robot interaction, using the latest ABB Augmented Reality (AR) technology, RobotStudio AR Viewer, to learn more about designing and developing robot installations.

Using RobotStudio AR Viewer, which can be downloaded as a free app onto smart phones and tablets, students can see how a robot will interact with its environment in the real world. The technology helps them learn about robot motion, giving them a better understanding of degrees of freedom and multi-axis configurations.

A better view of robot installations
The RobotStudio AR Viewer app can be used to test any model created in ABB's RobotStudio offline programming and simulation software tool, giving users an idea of the size and scale of a robot or robot cell. It also shows them how the robot could be wdeployed in a factory to work with any existing production equipment. The app overlays the modelled solution into the real-life production environment. Users can scale it to full size and rotate it through several angles to see the installation from all sides and ensure they have the correct layout and that the robot movements do not conflict with existing facilities.

Students are introduced to the technology and allowed to use it on their own to give them their first insights into what AR is and what it can do, as well as how to use it with RobotStudio to gain more experience of techniques such as path programming.

"The ABB RobotStudio AR Viewer is a really good learning tool for students, allowing them to understand 3D movement and the six degrees of freedom using Augmented Reality robot applications. The most promising aspect is that it is really intuitive and pretty easy to use. There is some learning required, particularly on RobotStudio as students need to learn the basics but it is quite straightforward," says Horst Orsolits, Head of Competence Center Virtual Technologies and Sensor Systems at UAS Technikum Wien. "RobotStudio is good, but the app gives a more immersive idea of what the installation and program would look like."

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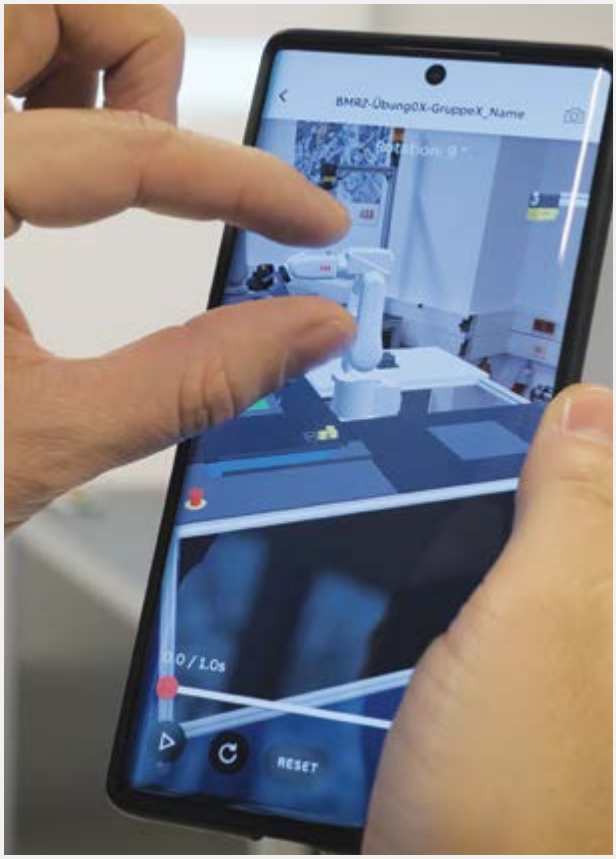
"The ABB RobotStudio AR Viewer is a really good learning tool for students, allowing them to understand 3D movement and the six degrees of freedom using Augmented Reality robot applications."

Horst Orsolits, UAS Technikum Wien



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Using ABB's AR Viewer software, students can see how their robot models would operate in a real-life environment.

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Horst Orsolits at Technikum Wien uses the AR Viewer for teaching students how automated production lines work.

Virtual working gives real benefits
One of the major attractions of AR Viewer, particularly for student use, is that there is a low entry barrier, as it is free and easy to use. With no complicated tools, manuals or tutorials necessary, all that's required is a short explanation on how to export the model from RobotStudio and how to transfer it to the app and smart device.

"The tool helps students to understand things better when developing a solution – it could also be used to demonstrate incorrect or inefficient set-ups using the tool rather than the physical robot," says Orsolits.

Meeting future needs
Orsolits sees the next step as being able to superimpose the AR onto an existing robot station. "We would like to make it possible for students to record what they program and then superimpose the AR robot model on to actual robot cells, so they can see how robot will move on the physical work object."

Cooperation with industry would also be a useful way of giving students a wider perspective. "For larger set-ups, we plan to cooperate with industry partners who could use the RobotStudio AR Viewer app to explain how a production line works, both in terms of robots and other equipment and also where problems or issues may occur."

AR is already catching the interest of commercial users as a training and communications tool. "Some production facilities have a strong emphasis on using AR to familiarize people or transfer new information to colleagues - the 3D experience makes it easier to deliver core information and enable visualization."

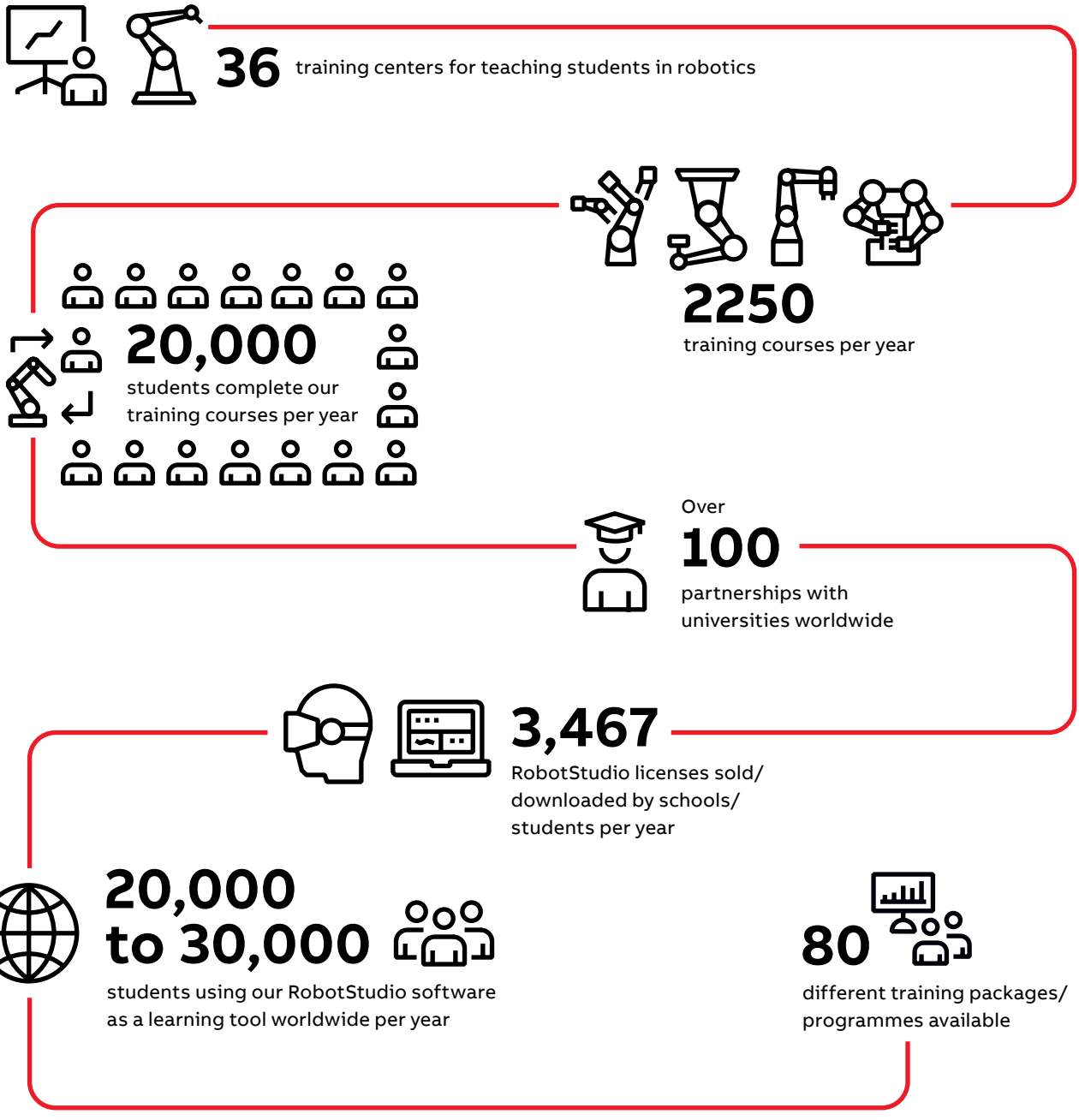
The technology is also showing promise in conventional teaching. "We are starting a research project to integrate VR and AR into classrooms, as well as measuring student and lecturer acceptance and the benefits they experience and we will be doing something similar for RobotStudio AR Viewer," adds Orsolits.

Education packages

Our educational packages, combines a robot, controller, programming software and training materials, plus training for teachers to enable them to run their own courses on robotic automation. The packages enable schools, colleges and universities to purchase a complete robot package at an affordable cost for hands-on teaching of programming and operational concepts in the classroom and lab. Utilizing the same technology used in a wide range of industrial applications, ABB's educational package gives students the opportunity to learn the skills needed to effectively manage modern robotic manufacturing systems. The package includes ABB's compact IRB 120, the IRC5 Compact Controller; and 50 licenses for ABB's RobotStudio simulation and offline programming software. Additional software functions are also available if required, offering advanced programming functions such as force control, collision detection and multitasking.

Training for teachers

Instructors at schools are certified to teach courses after they have completed the required steps for certification. Our ABB Robotics instructors are able to certify teachers and professors to teach classes even if they start the process with little or no robotic experience. They will learn robotics from the ground up through the completion of our customized training course and hands on training. After the instructors have completed the training, they are required to pass a certification exam, and will be provided with course outlines and materials. The certification timeline can be flexible based on the instructor's schedule.



Conclusion – creating prospects with automation

As highlighted in this document, while automation is undoubtedly a game-changer for employment, it is by no means the end of it. While the use of automated technologies such as robots will end some roles, especially those involving physical exertion and routine, repetitive tasks, it will also create new, more rewarding ones that will fill their place.

As new developments take place in areas such as vision, force sensing and collaboration, new opportunities will be created for working with robots, offering innovative ways of solving production problems and opening potential avenues for the formation of industries and new types of companies specializing in areas such as sustainable manufacturing and personalized artisan-level products.

Ultimately, the future of work will be what we make of it. To help ensure that the transition to an automated future is as painless as possible, it is important that actions are taken sooner rather than later to ensure that tomorrow's workers especially will be equipped with the skills they need to prosper.

Education can and must play a major role in helping to create the workforces of tomorrow. To achieve this, all parties involved, from educational institutions through to potential employers, must work together to ensure access to lifelong learning that will help workers to adapt to change throughout their careers.

For educational institutions and other key stakeholders including governments and manufacturing companies, working with companies like ABB will help to provide the technology and support, including providing training for instructors, that can help to ensure that young people are as fully equipped as possible to turn the challenges of automated workplaces into opportunities to thrive.

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Teaching the skills needed for the factories of the future will be key in turning the challenges of an automated workplace into opportunities to thrive.


ABB

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