Project Breakthrough

Disruptive Technology Executive Briefs

NEXT GENERATION ROBOTICS

Going beyond the factory floor

Robotics is a familiar technology for the vast majority of people but their perception of its applications and capabilities vary greatly. In its simplest form, a robot is a machine that performs an action (or series of actions) that include movement, based on instructions provided by either an operator or a piece of software.

Recently, the variety and range of applications for next-generation robotics have increased dramatically. These include those working with humans (sometimes called co-bots), interacting with humans (such as educational robots), assisting humans (surgical robots, exoskeletons), or adapting and integrating into human-made environments. We now see uses for robots across industrial manufacturing, the home and the battlefield.

The technology

New sensors (such as cameras, distance, force and proximity sensors) now enable robots to recognise and respond to their environment. The robots can also use software and algorithms (including artificial intelligence) to interpret the data collected and to control their movement. That movement is then enabled through actuators such as wheels, grippers and robotic arms.

The potential

Robots traditionally performed repetitive, pre-programmed movements in a structured environment using simple controls. Now there is an increasing need for them to adapt to less structured and more complex, changing environments. The new generation of robot designs make it easier and safer for humans to interact and work with them in these conditions, with the potential to bring dramatic changes to the world of work.

The barriers

Automating more and more tasks using industrial robots can improve efficiency and lower production costs but are also able to reduce the number of human operators required. There are also safety and privacy concerns, with connected robots having the potential to be hacked and used to gather data or perform dangerous actions. Public perception of these factors will also be a key factor in the rate and level of uptake of this technology.

United Nations Global Compact

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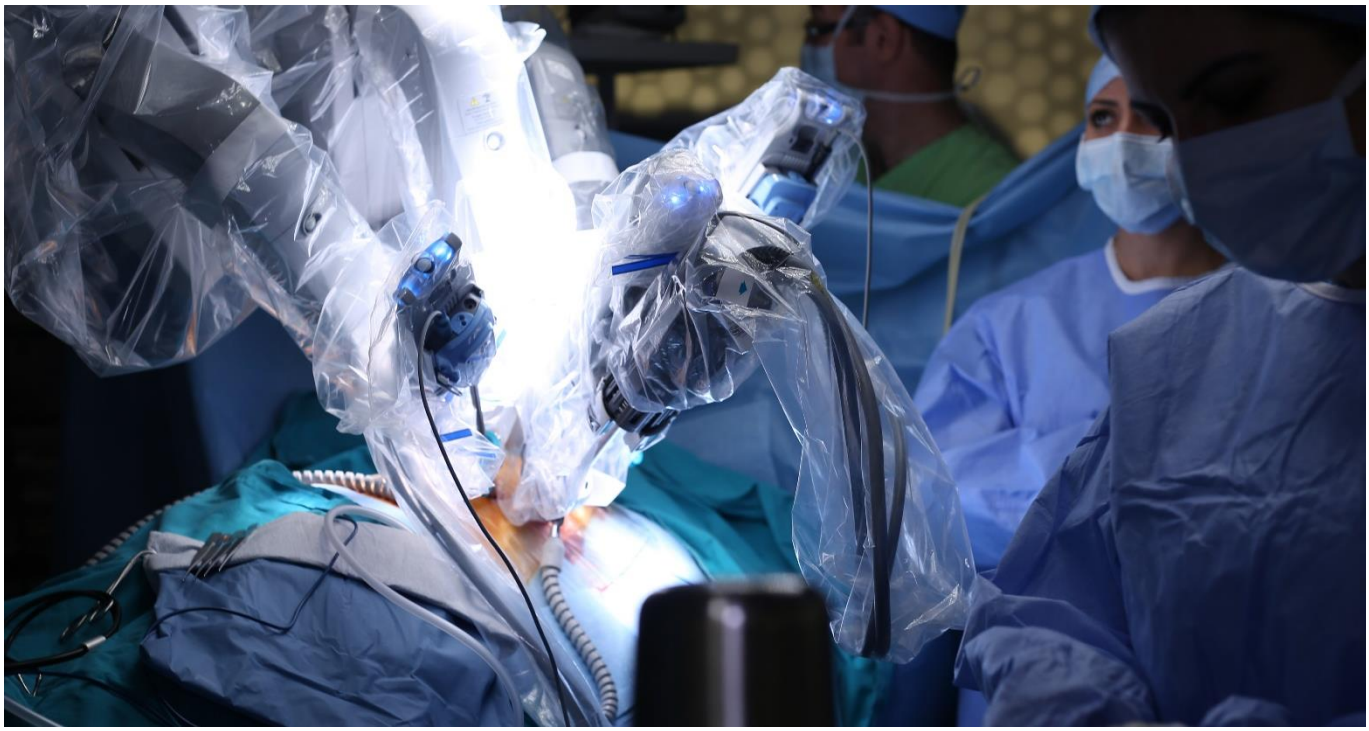
Some Example Applications...



Hospital robots

Robots have an increasing presence in healthcare, such as surgical robots like Da Vinci or support robots used to deliver medical supplies around a hospital when needed. In addition, robots are also performing more routine tasks such as acting as guides, helping patients and visitors navigate large hospital estates, and freeing up valuable capacity for trained professionals.

Exoskeletons

The Phoenix exoskeleton has enabled people paralysed from the waist down to walk again. With the cost and weight of these systems reducing, we are likely to see exoskeletons increasingly used to both enable mobility and support work-based activities.

Manufacturing reinvented

Rethink Robotics have introduced the Baxter robot that is designed to work on a production line alongside humans. Human operators can re-program Baxter by moving its arms into desired configurations, much like teaching a child. Using such robots can reduce equipment costs for factories by allowing human-robot collaboration and minimising the changes needed to acquire and install the robot, as well as the costs associated with learning to operate and re-configure it.

Key Numbers

$82.7 bn

Estimated market size in 2020

Source: Allied Market Research

20,000+

Patent applications filed annually

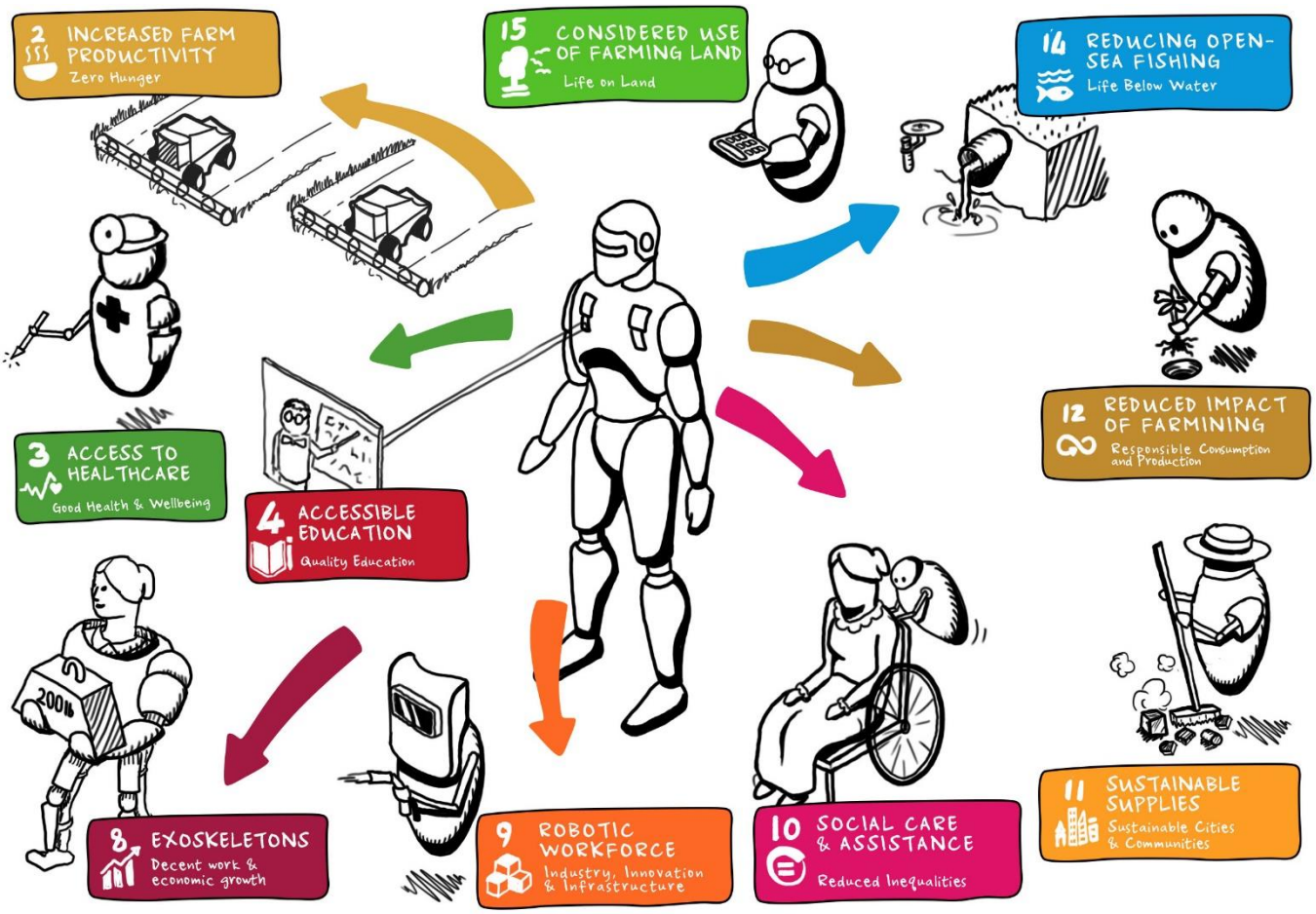
Source: Patsnap Insights

$188 bn

Estimated spending in 2020

Source: Statista

Advancing the Sustainable Development Goals (SDGs)



Next generation robotics have the potential to advance many of the SDGs. Below are some examples of areas of application across a wide variety of sectors.

SDG 2 Zero hunger

- Monitor fields, identify and remove weeds, and eventually eliminate the need for herbicides, making agriculture more cost-effective and sustainable.
- Improve farm productivity in areas where urbanisation has resulted in a reduction in the available workforce in rural areas.

SDG 3 Good health and well being

- Make high quality care and access to expert doctors a right for all, by using healthcare robots in remote or underprivileged locations. Assisted by next-generation robotics, procedures could be undertaken by less experienced staff, allowing individuals in remote or under-served locations to receive the same quality of care as those in major hospitals.
- Avoid injuries by automating tasks that are dangerous or harmful for humans to perform. Robots are already used in construction, search and rescue, ordnance disposal, mining and waste disposal, to avoid exposing human operators to dangerous, harmful or hazardous environments.
- Improve the quality of life of people with limited mobility through exoskeletons, to help with everything from picking up objects to walking. This type of robotics can also reduce secondary complications resulting from immobility, such as muscle wastage and sores.

SDG 4 Quality education

- Make education more accessible, even in remote locations where specialised teaching would be too expensive, or where trained educationalists are not available, or are in short supply.
- Provide specialist help for children with learning difficulties or autism through high quality, tailored educational tools which can adjust to individual difficulties and match learning style. Allow human specialists to reach a larger number of children with a range of learning difficulties.

SDG 8 Decent work and economic growth

- Transfer simple, repetitive tasks to robots, freeing up people to focus on more value-adding activities while increasing quality and safety. Jobs will become less dangerous, less repetitive and less physically demanding. Exoskeletons will open up highly physical roles to a wider workforce and reduce the likelihood of injury.

- Change the make-up of the workforce and nature of employment. As more tasks are automated, demand for manual labour will decrease, but demand for highly skilled engineering, programming roles and less specialised robot operators and maintainers will increase. The net effect on the overall number of jobs will become clear over time – it is likely to be uneven across geographies, as regions with better education and training gain at the expense of other areas as already observed in the decline of manufacturing locations across the world.

SDG 9 Partnerships for the goals

- Improve efficiency and effectiveness of production, whether it be in time, money or natural resources. Next generation robots can integrate into the production ecosystem smoothly and compared to full automation, offer valuable flexibility at a lower cost, requiring fewer changes to current operations while increasing flexibility, reducing human idle time and minimising cost.
- Allow less developed countries to automate at a lower cost, by reducing the costs of training and by acquiring and maintaining equipment. This can contribute to increased economic independence and enable countries to develop their own manufacturing base rather than relying on imports.
- Lower significantly the costs of customised products. Production line machines that are easy to reconfigure and re-program by non-experts, with reduced training time and investment requirements, will make mass-customisation feasible.

SDG 10 Reduced inequality

- Provide access to help and assistance for those who currently do not have it.

SDG 11 Sustainable cities and communities

- Enable more sustainable production and supply of services.

SDG 12 Responsible consumption and production

- Allow better monitoring of environmental impacts of farming operations and reduce the use of excess water as well as enable more efficient waste disposal, herbicide and fertiliser development.

SDG 14 Life below water

- Provide data relevant to pollution monitoring and support marine management through unmanned underwater vehicles.

SDG 15 Life on land

- Provide support in management of land and ecosystems.

Potential Negative Impacts and Barriers

There are fears about the potential for robots to replace humans, creating mass unemployment. It will be vital to address these concerns if they are to be widely accepted.

Human interaction and employment

Some of the earliest debates around next-generation robotics have been focused on the human labour that it replaces and the lack of human interaction it can cause. This will need careful management by all those involved in the roll out and implementation of this technology, tailored to the individual regions it affects to minimise short term impacts. In the longer term, the advent of next generation technologies is also going to bring with it a range of new industries and job creation, which, if managed correctly, has the potential to off set much of these impacts.

Ethical considerations

There are many ethical considerations when introducing robots into environments where they can make decisions that affect human lives, such as the use of autonomous robots in the military or robotic surgeons. Legislation to address these issues will need to be introduced and this is likely to be an area of extensive debate at both national and international levels over the next few years.

Public perception

Education to improve public understanding and perception of robots will be essential to ensure their smooth adoption in environments such as schools and hospitals, and to explain the capabilities and limitations of robot platforms.

Security

Cyber security is another important consideration, as more autonomous robots operate in safety-critical environments. There is a risk that someone could take control of the robot and do significant harm, undermining the public perception that robotics is a beneficial technology.

Technical Considerations

Basic tasks that we take for granted, such as climbing stairs or acting on variable instructions pose significant technical challenges which we will need to be overcome for robotics to reach its true potential.

Learning to get better

The learning algorithms that allow robots to seamlessly integrate into the environment present numerous computer vision and control challenges that are still being addressed. These will need to improve in both performance and cost to support their wider use.

Infrastructure

Information and infrastructure is currently tailored to human needs, with information presented in a human friendly format whereas robots need to be able to translate it to a robot friendly format.

The dalek conundrum

Robots will need to be able to operate in environments designed for humans including stairs, doors and lifts, presenting further mechanical and motion control challenges.

Dealing with surprises

Real world environments can be unpredictable and constantly changing. Anticipating all possible variations in real world environments is very challenging and until robots can learn to do so reliably, their applications will be constrained.

Trust and communication

Designing user interfaces that are intuitive for humans to use and facilitate human-robot interaction can be a challenge. Trusting them too much or too little can also present difficulties and mean that their interfaces are used ineffectively or not at all.

Dexterity

Manual dexterity needs to be improved to allow robots to handle delicate materials and different geometrical shapes.

Enabling New Business Models

Robotics has already revolutionised the world once. It is going to do it again.

Robots working closely alongside humans as an integrated part of the workforce will impact most, if not all, sectors of industry. They could potentially be used anywhere where physical tasks are performed, or where there is interaction with humans, in both developed and developing economies. In the same way as artificial intelligence will help humans and support the achievement of intellectual tasks, exoskeleton robots will enable humans to do more physical tasks.

Robots will allow services to be delivered in new and different ways to customers, products to be tailored to individual needs and to develop propositions to meet currently unmet customer requirements. Businesses will be able to operate faster, cheaper and more flexibly, with humans and robots working alongside each other. The flexibility of robots working with humans will reduce some barriers to entry and the ability to work across distances will allow businesses to serve locations that were previously uneconomical.

The impact will be felt on both mainstream businesses and how they operate, as well as creating opportunities for small-scale start-ups, and possibly as part of the tools that individuals own and bring to work to perform their jobs.

Robots will enable a number of the disruptive business model levers identified on the Project Breakthrough website. Specifically:

A more personalised product or service

Robots working with humans will make it easier to tailor and adapt products and interactions to individual consumers, and increase the geographical reach of experts.

A closed-loop process

Robots can reduce waste in the production-to-consumption process through better production techniques and control, and recovery and reuse of components and materials at the end of their life.

An agile and adaptive organisation

The combination of robots working with humans may offer greater flexibility than full automation. Entire product generations of robots can be updated remotely and instantly, rather than needing to be serviced or returned to the manufacturer.

More Examples...

Robokind are producing robots to help educate children with different needs and treat autism

https://www.theguardian.com/lifeandstyle/2015/feb/01/how-robots-helping-children-with-autism

Autonomous robot surgeon pits its skills against a human

http://spectrum.ieee.org/the-human-os/robotics/medical-robots/autonomous-robot-surgeon-bests-human-surgeons-in-world-first

Aviva looks to reskill staff if jobs are at risk of being done by robots

http://www.insurancebusinessmag.com/uk/news/breaking-news/aviva-asks-16000-staff-if-their-jobs-can-be-done-by-robots-61106.aspx

United Nations Global Compact

The United Nations Global Compact is a call to companies everywhere to align their operations and strategies with ten universally accepted principles in the areas of human rights, labour, environment and anti-corruption, and to take action in support of UN goals and issues embodied in the Sustainable Development Goals.

The UN Global Compact is a leadership platform for the development, implementation and disclosure of responsible corporate practices. It is the largest corporate sustainability initiative in the world, with more than 9,000 companies and 3,000 non-business signatories globally.

Project Breakthrough

Project Breakthrough is a collaboration between UN Global Compact, Volans and partners that spotlights the best thinking in sustainable innovation. It showcases innovators across mainstream companies and next generation entrepreneurs who are developing solutions with the potential to achieve exponential impact. It features analysis and resources designed to help leaders understand the new business models and technologies that will be crucial in achieving the SDGs, catalysing action amongst today's businesses to meet the needs of tomorrow's world.

The Disruptive Technology Executive Briefs are produced in collaboration with PA Consulting Group, combining cross sector technology, innovation and business design expertise. The briefs are intended as an easy to digest introduction to disruptive technologies, to help organisations understand how they could advance the Sustainable Development Goals and business performance. These overviews explore key features, examples of applications, potential positive and negative impacts, and how they may enable the new business models.

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