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21st CENTURY THEMES

Automation and robotics

Successive advances in technology are making the economics of automation and robotics increasingly compelling for many companies in a growing number of industries. While the displacement of jobs by robots may raise some concerns, we believe that companies, investors and society will be net long-term beneficiaries of the increasing adoption of automation and robots.

This Perspective outlines some of the key structural trends that should continue to drive the growth of automation and robotics and looks at some of the potential ways that investors can gain exposure to these trends.

“Our intuition about the future is linear. But the reality of information technology is exponential, and that makes a profound difference. If I take 30 steps linearly, I get to 30. If I take 30 steps exponentially I get to a billion.”

Ray Kurzweil (author, scientist, inventor, futurist, director for engineering at Google)

Automation – the use of automatic equipment in manufacturing and other processes – has been around for decades, since at least the 1950s in the case of automobile production. Over time, technological advances have enabled increasingly sophisticated automation, with machines that can not only do the same thing over and over again but in increasingly intelligent ways, giving rise to the concept of robots. Sometimes attempts are made to make a strict definitional distinction between automation and robots, based, for example, on criteria such as multi-functionality, re-programmability and reactivity to external stimuli. In our view however, relying on rigid distinctions can miss the big-picture argument that automation and robotics are essentially on the same continuum of ‘robotic automation’, which is our preferred terminology.

AT A GLANCE

- The economics of robotic automation is improving for many firms thanks to the three key drivers of: better technology, worsening demographics and developments in China.
- While some jobs losses will be inevitable, we think the long-term collective benefits of robotics adoption should exceed the costs.
- Over the near term, industrial automation will continue to offer the most viable investment opportunities.
- However, in the longer run, improving technology should enable more professional service robots that can interact and work better with humans.
- We think that among the sectors that will stand to benefit the most from this will be: e-commerce and logistics, healthcare, defence, mining and agriculture.

World annual supply of industrial robots by region 2009–2013

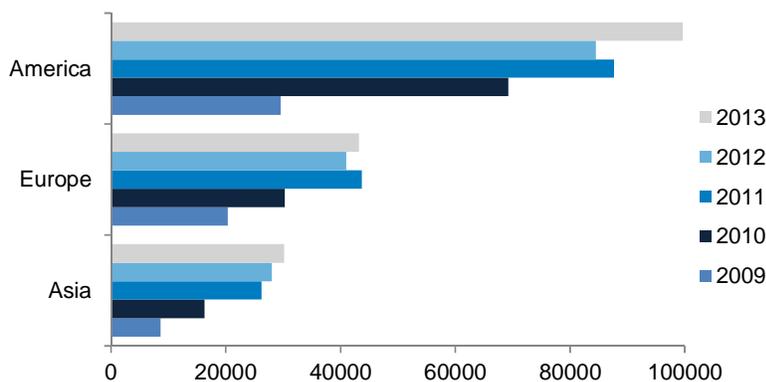


Chart 1. Source: International Federation of Robotics, June 2014.

As the chart above shows, robotic automation in the industrial/manufacturing sphere has enjoyed very strong growth in the last decade, with a record high 179,000 industrial robots installed in 2013, representing a 12% increase on the previous year and nearly double the number of a decade earlier. We think the strong growth rate in industrial robotic automation is likely to be sustained in coming years owing to improving economic viability and a number of supportive thematic drivers.



FUNCTIONAL BENEFITS OF ROBOTIC AUTOMATION

As the diagram below summarises, robotic automation offers an array of benefits for firms. Broadly speaking, robots offer the potential to produce goods more quickly, more cheaply, more safely, with less errors and downtime and to a higher specification (quality) compared to human operation. In theory, these benefits can translate into either lower operating costs and/or higher selling prices (if quality is improved), which in turn should result in higher profit margins.

Key functional benefits of robotic automation

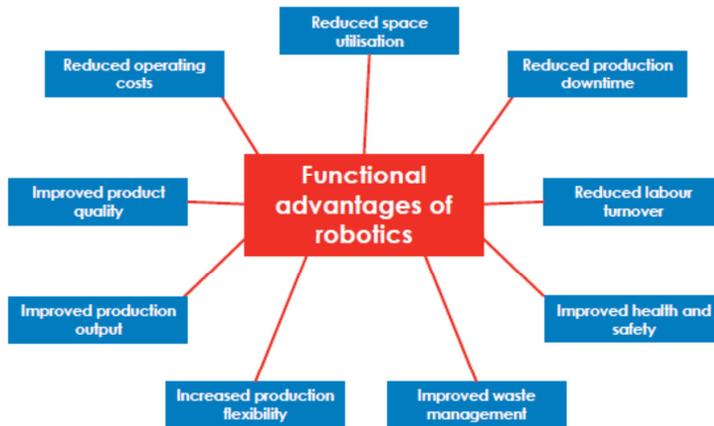


Chart 2. Source: FIL July 2013.

IMPROVING ECONOMICS OF ROBOTIC AUTOMATION

While robotic automation can offer the multitude of functional improvements highlighted above, for any firm, the key decision will always depend on cost-benefit analysis. In particular, in a business setting, the choice will be between more labour or more capital (in this case robots). While labour has less upfront costs, it tends to have significantly greater ongoing costs. On the other hand, capital tends to have higher upfront costs but much lower ongoing costs. Clearly, the higher the relative cost of labour, the more attractive capital investments should become.

The key point to note is that while the cost of labour nearly always increases over time, the costs of many robotic solutions are very likely to decline over time owing to improving technology. For example, in computing, Moore's law states that the number transistors in an integrated circuit doubles every two years – from a consumer perspective, we see this reflected in high-spec and expensive computers becoming significantly cheaper over time. We think similar non-linear dynamics should apply in many areas of robotic automation, thereby making them more viable economic solutions for a greater number of companies over time.

KEY THEMATIC DRIVERS OF ROBOTICS GROWTH

We think the growth in robotic automation adoption should also be supported by the three key thematic factors of technology, demographics and China.

Technology – as noted above, rapid, frequently non-linear technological progress is probably the single most critical key driver of robotics adoption. As technology improves, functionality will improve and the cost of robotic automation should decline, making it more economically feasible for firms not just in the industrial sphere but also well beyond. Aside from improvements in areas such as processor speed and sensors, we think three technological developments should be especially significant for the robotics industry:

- 1) **Uniform messaging systems** – notably the free-to-use, open source, Robot Operating System, developed by the Open Source Robotics Foundation is a key development. In short, this software system enables different areas of robotic expertise to work and mesh with each other, significantly lessening a key practical barrier to progress.

“Today, robotics development has assumed a core place in the industrial development thinking of far-sighted, household-name companies. For example, Caterpillar plans to develop fully autonomous heavy robots by 2021. Such a broadening of the theme should result in a rapid rise in the number of applications for which robotics will be specifically designed. In turn this will prompt competitors to out-design these robots with newer versions, giving rise to a virtuous circle of mainstream industrial innovation.”

Christopher Moore , Portfolio Manager, Global Equities

- 2) Advances in **3-D printing** – this makes it easier and quicker for new robotics concepts to move from the design phase to the prototype and production stages.
- 3) Developments in **cloud computing** – this essentially expands robotic capabilities by conveniently and cheaply boosting information access capabilities.

Demographics – As life expectancy improves and societies age, the ratio of economically active people to inactive people looks certain to continue falling in many countries. With fewer workers becoming available to effectively support older generations, there will be a growing need for improved productivity – the increasing deployment of robotic automation offers one obvious way of addressing this problem.

China – As China's economy has been developing, a clear resulting trend has been strong wage inflation. While in a sense this serves policy efforts to lessen export dependence and boost domestic consumption, the steady erosion of China's long-held labour-cost advantage, coupled with ever rising quality expectations are among the key challenges for many Chinese firms.

Rising unit labour costs in China

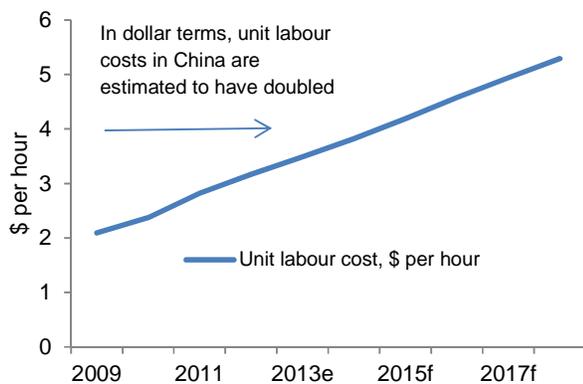


Chart 3. Source: Economist Intelligence Unit, June 2014

Robots stock: China v Japan

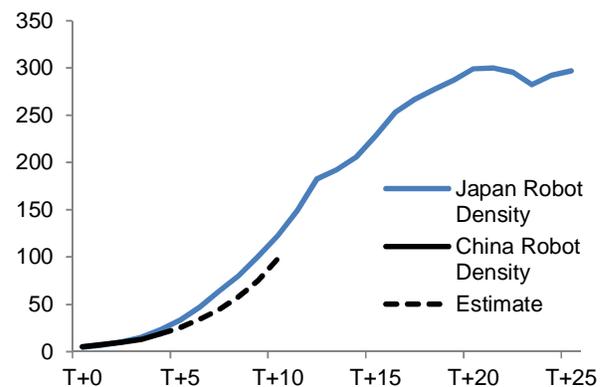


Chart 4. Source: 'Global Industrial Automation', Credit Suisse, Aug. 2012

An ideal way for China to both move up the value-added scale and to tackle declining manufacturing competitiveness due to rising wages is via the increasing adoption of robotic automation. Indeed, significant steps in this direction are already being taken, with industrial robot sales in China doubling in 2013 to 36,000 units in 2013. Despite this, China's robot density (the number of robots per 10,000 of the population) of about 20 is still a small fraction of the leading countries such as Japan, Germany and South Korea, where densities range from 270 to 400. According to the International Federation of Robotics (IFR), around one million new robots will need to be activated in China over the 'next few years' for China to catch up to these countries.

RISE OF THE MACHINES – A CAUSE FOR SOCIETAL CONCERN?

Perhaps the most controversial aspect of increasing robotic automation is the displacement of human labour. As robots become more effective, more economic and more ubiquitous, it is likely that they will displace a growing number of jobs thereby creating unease in some circles and perhaps drawing unhelpful policy responses.

However, while some short-term labour market dislocations could be unavoidable, we think the collective long-term gains from robotic proliferation should outweigh the losses. This should be especially so if combined with better access to education and skills development. On the product level, increased robotics should ultimately deliver better quality and cheaper products that help to raise overall living standards. At the firm level, reduced costs and increased profits can free up capital to invest into other areas that should lead to new job creation and increased innovation. With industry revenues expected to double by 2020¹, it is apparent that the robotics industry itself should continue to create more jobs. Finally, it should also be noted that since the industrial revolution, history is replete with examples of the global workforce responding effectively and creatively to the emergence of new labour-displacing technologies.

“Although many industrial end-markets in China will grow at a much slower pace from here, automation will very likely be an exception. Labour in China is a key driver with wage inflation here to stay, owing to dwindling rural labour supply and more challenging demographics. The experience of other East Asian economies that have industrialised also points to increased automation penetration in China from very low levels.”

Mark Wilson, Industrials Analyst

NON-INDUSTRIAL ROBOTS

Robotic automation is already widely deployed in a number of industrial sectors, with the automotive and electronic manufacturers being by far the biggest users. However, there has been much less non-industrial deployment to-date. A key reason for this is that industrial environments tend to be highly structured with relatively manageable technological requirements – indeed according to a recent CLSA report authored by Henrik Christensen of Georgia Tech,² as much as ‘90% of today’s industrial robots lack the dynamic sensing, control, decision processing, mobility manipulation and human interaction capabilities required to do more than blindly execute pre-programmed instructions in well-structured relatively static environments’. Moreover, since areas such as automobile production and electronics are typically engaged in mass manufacturing, it can often be economically viable to create the kinds of structured environments to suit the robotic technologies available.

However, with technology typically progressing in a non-linear fashion and with rapid progress in areas such as dynamic sensing, human interaction and artificial intelligence, the widespread expansion of robotics into non-industrial sectors can only be a matter of time. Indeed, an increasingly widely used term for more autonomous, more intelligent and therefore more ‘human inter-actable’ types of robots, is ‘service’ or ‘professional service’ robots. For the time being, this area of robotics remains fairly niche and relatively non-investible as indicated by IFR data, which shows that total sales of professional service robots amounted to USD3.4bn in 2012, while sales of consumer-orientated ‘personal service’ robots (such as autonomous vacuum cleaners and lawnmowers) were only USD1.2bn. This compares to the USD25bn market³ for industrial robots, including related software, peripherals and system engineering.

“As I look at the trends that are now starting to converge, I can envision a future in which robotic devices will become a nearly ubiquitous part of our daily lives ...”

‘A robot in every home’,
Scientific American, Bill Gates,
January 2007

Professional service robots – top utilising sectors by units sold in 2012

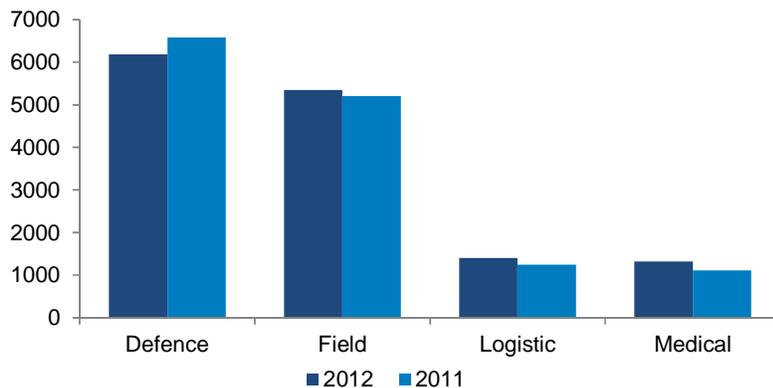


Chart 5. Source: International Federation of Robotics, June 2014

NEXT-GENERATION SERVICE ROBOTS

While current sales of service robots are low compared to industrial robots, in the medium-to-long term, this is likely to be an area where some of the most impressive technological breakthroughs and innovations will take place. Moreover, as service robots become more sophisticated, the boundaries could blur with the potential for successful service robotic forms to cross over into the industrial sphere, in the form of industrial robot ‘assistants’, for example. In our view, among the most promising sectors for service robot development are:

E-commerce/logistics – With more and more shopping being done online, e-commerce is a powerful theme that continues to shake up the retail sector. Among the central attractions of e-commerce is cost efficiency. By cutting out the need for expensive shop floors, e-retailers can offer more competitive deals to customers. A focus on cutting costs and dealing in potentially large volumes tends to make e-retailers more motivated to automate.

With timeliness and convenience being further key attractions of internet shopping, many of the leading players have been investing growing sums in efforts to make their supply chains leaner, including most notably by utilising robotic automation in giant warehousing

facilities. Indeed, by becoming very adept in this area, many larger e-commerce companies are extracting more value by squeezing out the need for third-party logistics; to the extent that some companies are starting to resemble logistics companies.

Healthcare – in the economically and socially vital area of healthcare, robots have great potential to improve outcomes by enabling new medical procedures and by providing assistance to the elderly. In the field of surgery, for example, robots in combination with the latest imaging technology have the potential to conduct operations more precisely and at lower cost. To illustrate the potential value, in the US market alone, if robots undertook just 10% of all surgical procedures, this could create a saving of USD6bn.²

Defence – in terms of national defence, for countries like the US, it is becoming increasingly apparent that many of the biggest operational risks are connected to the asymmetric means being deployed by the opposition. One effective way to minimise the asymmetric advantage of the enemy is via increased use of robotic technology. A good example of this is the thousands of the unmanned tele-operated ground vehicles that have been used extensively in Iraq and Afghanistan in order to successfully defuse improvised explosive devices (IEDs). More recently, the US army has been able to claim some very big successes from its unmanned aerial drone programmes in places like Pakistan and Yemen.

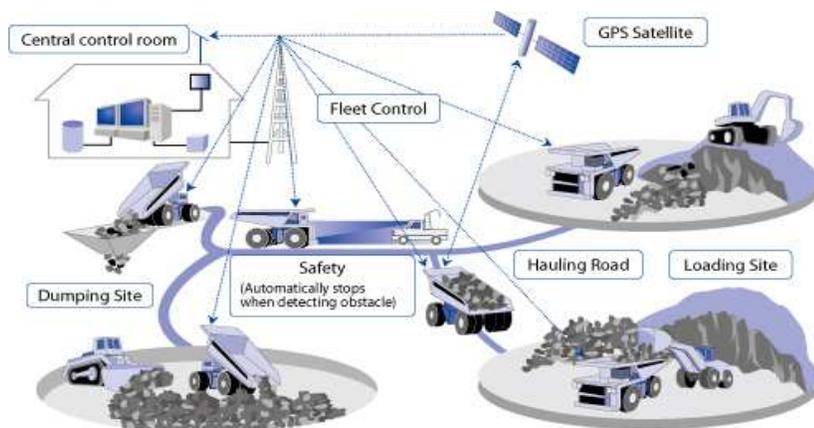
In 2013, the US army also initiated its Tactical Assault Light Operator Suit project – an ‘Iron Man’ robotic ‘exoskeleton’ designed to augment soldiers’ battlefield capability. Already significant military investment in these types of technologies is very likely to grow in the future and developments in this space could quite conceivably have multiple crossover benefits in the civilian sphere.

Mining – Mining is becoming technically more difficult owing to declining output grades and the growing need to operate in ever more challenging environments where extraction costs and safety risks are higher. In this context, the increasing integration and automation of mining operations offers a potentially very good solution that can simultaneously boost extraction intensity, improve safety and speed up the supply chain. For example, resource giant Rio Tinto’s ‘Mine of the Future Programme’ is seeking to automate as many mining operations as possible, with engineers managing the whole process remotely in centralised control centres, with automated production drills and with driverless trucks and trains used to transport output within and across facilities.

“E-commerce companies have been early adopters of robotics. Amazon is a good example of how technology companies are thinking ahead of the curve. For example, in 2012, it acquired Kiva Systems, a robotics company that makes hardware and software for material handling and warehouse automation. With the adoption of advanced robotics systems, Amazon will continue to drive efficiency in its fulfilment system, thereby strengthening its competitive advantage over traditional retailers.”

Hyun Ho Sohn , Portfolio Manager, Global Equities

How an Autonomous Haulage System works



Source: Komatsu. (Note Rio Tinto deploys Komatsu’s ‘Autonomous Haulage System’ as part of its ‘Mine of the Future’ programme).

Agriculture – One of the central challenges of the modern world is producing enough food to feed the world’s rapidly expanding population. Despite typically consisting of highly structured environments (which we know have been a key driver of automation in industrial sectors) and increasing mechanisation, the take-up of sophisticated automation techniques in farming has been surprisingly low to date. However, with demands for productivity growing and technology improving in areas such as satellite navigation and climatic sensors, we think this is very likely to change in the future. For example, farmers in more advanced agricultural and high production volume nations, such as the US and

Australia, are already experimenting with more autonomous systems in various areas, including aerial drones for watering and spraying pesticide and self-driving tractors for planting and harvesting.

FINDING THE WINNERS – STOCK EXAMPLES

In terms of locating the companies that can benefit from the structural growth in robotic automation, while service robots offer huge long-term potential, the most readily available investments today are still largely to be found in the industrial sector. In particular, within industrial robotic automation, it is possible to make a broad distinction between the large global industrial conglomerates for which automation/robotics is part of a broader suite of business areas and more focused 'pure-play' industrial robotics solution providers. Beyond this, it is also helpful to construct a third class of less directly exposed companies which do not fall into either of the other two main industrial classes.

Industrial conglomerates – In the industrial conglomerate space, among the companies which we rate most highly on an integrated basis and which we think also provide decent levels of industrial automation/robotics exposure are France's **Schneider Electric**, Switzerland's **ABB**, Germany's **Siemens** and **GE** in the US.

Industrial automation pure plays – In terms of automation pure plays, among the likely long-term winners are Japan's **Fanuc**, and **Yasakawa Electric**, Germany's **Kuka** and **Rockwell Automation** in the US. While sharing various positive characteristics, these companies also have some unique features which can give them an edge in particular areas. In Rockwell's case, for example, there has been a big focus on extracting value from all the data collected from industrial automation installations, thereby enabling improved real-time diagnostics, maintenance and remote monitoring.

Other robotic plays – In the 'other' robotic class there is a more diffuse range of companies which provide more indirect sources of exposure to the robotic automation theme. For example, as one of the world's leading electronic connector manufacturers, US-based **TE Connectivity**, should benefit from the growth in robotic automation because many industrial installations will rely on its connectors.

In a class all on its own meanwhile, **Google** merits a special mention. Although its main revenue source is clearly the world's leading search engine, the company has been a notably prolific investor in start-up robotics companies, with at least eight such investments in 2013 alone. Google's new robotics division, which supervises all these acquisitions, is headed by Andy Rubin, a noted robotics enthusiast and the developer of Google's mobile phone operating system which he named 'Android'. Considering also its outstanding track record in innovation, combined with the massive resources and expertise at its disposal, Google's robotics programme looks well placed to deliver what could be some of the most spectacular robotics breakthroughs over the next few years.

CONCLUSION

Driven by the key thematic factors of improving technology, demographics and developments in China, the economics of robotic automation is rapidly improving for a growing number of companies and across more industries and sectors. In the near term however, we think most of the viable investment opportunities will continue to be found in the industrial sector where robotic automation is already well established. Looking further ahead, over the medium-to-long term, continuing advances in technology should enable more autonomous, more intelligent and therefore more 'human inter-actable' forms of robots, which should spur rapid growth in 'professional service robots'. In our view, among the sectors that could benefit the most in the future from developments in this space are the e-commerce, healthcare, defence, mining and agriculture sectors.

In terms of social impact, it seems plausible that increasing cross-industry robotics adoption will result in some short-term labour market dislocations, but we think the long-term collective benefits in areas such as cheaper and better-quality products and innovation, should ultimately outweigh the losses.

"As one of a handful of global automation companies, and the only US-listed pure-play, Rockwell is well placed to take advantage of the long-term automation trend."

Peter Kaye, Portfolio Manager, US Equities

"With improving technology and mounting demographic challenges, I have no doubt that robotic solutions will proliferate. As investors, we can try to pick the specific industry winners or we can try to find those companies that provide the key components that support the wider industry. Generally, I tend prefer the latter approach, for example by investing in companies such as TE-Connectivity one of the world's leading electronic connector manufacturers."

Aditya Khowala, Portfolio Manager, US Equities

REFERENCES

¹ FIL estimate based on total robotics (industrial + service) market value of \$28.4bn in 2012 and assuming a compound annual growth rate of 9%.

² 'Electric sheep – dreaming of a robot society' – a CLSA report authored by Dr Henrik Christensen, KUKA Chair of Robotics and distinguished professor of computing, Georgia Tech, February 2014.

³ International Federation of Robotics (2012 estimate).

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