UBS

Longer Term Investments

Automation and robotics

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- We believe smart automation will continue to power the fourth industrial revolution, combining innovation in industrial and IT processes to drive global manufacturing productivity gains.
- We discuss the opportunities that digital twins—virtual representations of a product, production process, or performance—will bring in terms of flexibility to manufacture, time to market, and productivity improvements.
- We estimate the market size at USD 186bn in 2019 and expect mid-to-high single-digit growth rates on average in the longer term. Rising wages and challenging demographic changes will pressure the costs of manufacturing firms, driving automation investments. The increasing digitalization of automation equipment is also a key driver of higher efficiency and therefore more automation investment.
- We suggest long-term investors add positions in this investment theme to benefit from the structural growth opportunities in key end markets.

Our view

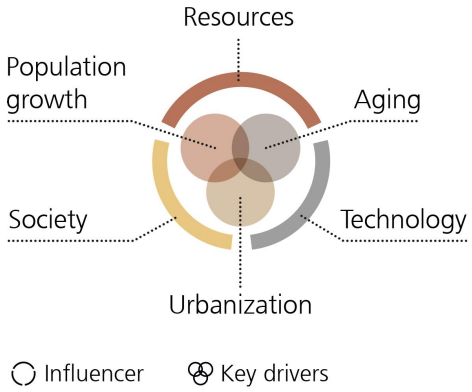
Industry 4.0, the Fourth Industrial Revolution, and smart manufacturing are terms that describe a new era of manufacturing characterized by increased connectivity and automation. The Industrial Internet of Things (IIoT), 5G, and industrial software all serve as key drivers of this transformation to smart manufacturing.

The term Industry 4.0 initially appeared in the opening speech at the Hannover Messe (one of the largest trade fairs worldwide) in 2011. In the speech, the CEO of the German Research Center for Artificial Intelligence, Professor Wolfgang Wahlster, used it to describe how high-wage countries could compete with cheaper global competition. He also mentioned that the internet will be the driving force behind this latest revolution and that the Internet of Things (IoT) creates a bridge between the virtual and the real worlds. We fully agree with this conclusion. In our view, smart automation combines the innovation power of industrial and IT processes to drive gains in global manufacturing productivity.

This report discusses recent trends and the long-term outlook for factory and process automation, industrial software, digital twins, and 3D printing, as well as commercial drones and artificial intelligence (AI). We believe automation companies can further outperform the recovery due to structural trends like demographic changes, rising labor costs in emerging markets, the drive for productivity gains, and rising digitalization. In particular, the industrial software and robotics

Introduction to the Longer Term Investments (LTI) series

- The Longer Term Investments (LTI) series contains thematic investment ideas based on long term structural developments.
- Secular trends such as population growth, aging, and increased urbanization create a variety of longer term investment opportunities.
- These investment opportunities are influenced by the interplay of technological advancement, resource scarcity, and the societal changes.
- Investors willing to invest over multiple business cycles can benefit from potential mispricings created by the typically shorter term focus of stock markets.



segments offer high growth opportunities. These changes should lead to: 1) long-term, above-average earnings growth; and 2) re-rating potential for industrial companies with automation software exposure.

Growth drivers

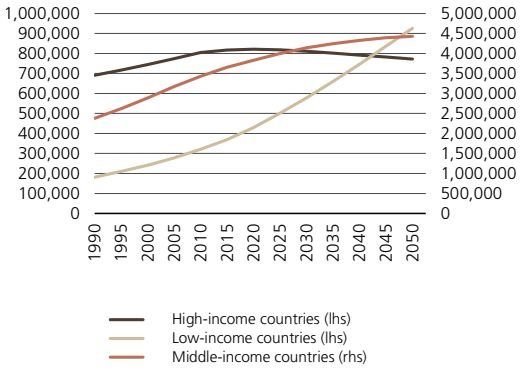
The manufacturing industry has a history of re-inventing itself. With steam power in the first industrial revolution, electricity in the second, and computing and automation in the third, industry has always found ways to boost productivity. Another industry revolution is now underway, which we believe will transform manufacturing. It's powered by smart automation as Industry 4.0 rises in importance. Smart automation combines the innovation power of industrial and IT processes to drive gains in global manufacturing productivity. Industrial software raises automation equipment to the next level from merely improving efficiency and accuracy. Automation is increasingly a tool for total operation and asset management. Based on our market definition, the automation market currently is currently worth USD 186bn (see Fig. 3). We expect the smart automation industry's average revenue to grow in the mid-to-high single digits, supported by several structural drivers (which we discuss in detail in this report). From an investment perspective, smart automation will likely be one of the fastest growing segments within the broader industrial and IT sectors over the next decade.

To understand the potential of the automation theme, it is important to identify secular trends that could lead to strong, sustainable growth over the next few years:

- We think emerging markets (EMs) are one of the most promising growth themes. In EMs, robotics use is still far behind developed countries, the need to drive productivity gains, rising wages and the size of the manufacturing sector. This is true particularly in China, where the mass reallocation of cheap labor from the agricultural sector to manufacturing is slowing.
- The aging population in both developed and emerging markets makes it also is an attractive region for automation equipment. More people both in high and in upper-middle income countries will retire in the next decade than will enter the workforce: working-age populations will peak in 2020 and 2025, respectively (see Fig. 1).
- We expect the rising digitalization of the manufacturing sector (industrial software) to lead to a new wave of automation investment in developed countries. The use of software or IT penetration is still lower in the manufacturing automation world than in offices or healthcare, but we have reached an inflection point, with software moving down to the factory floor.
- New capacity expansion used to be the key driver for demand but now industry upgrades have become more important and will continue to be the major driver.

Fig. 1: Demographic change: Shifting working age population

Size of population in ages 15-64, in thousands



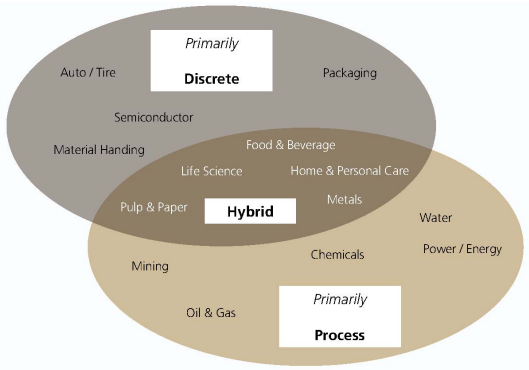
Source: United Nations, Department of Economic and Social Affairs, as of 29 October 2019

- Industrial software (smarter equipment) will increasingly also be a tool for asset optimization (remote monitoring, predictive maintenance).
- The so-called Industrial Internet of Things (IIoT) enables communication along the entire value chain, improving productivity through the use of big data. In our Executives and Entrepreneurs research series we did a deep dive on the Industrial Internet of Things and the implications for entrepreneurs, for more details please the report published on 2 October 2019 (*Industry 4.0 and the IIoT: Winners but also losers*).

When people think about automation, most picture an industrial robot assembling a car. In reality, that is only one part of the entire automation value chain, which can be split into several categories, with the most prominent being factory and process automation. Industrial software is becoming an increasingly important business driver in both segments. Factory (or discrete) automation generally describes assembling processes, such as automating robots in the automotive industry, but also other automation processes in the general manufacturing industry, packaging and semiconductors, among others. Process automation means continuous production processes that transform raw materials into final products (e.g. mixing of liquids in refining, or distribution of electricity). Typical process automation end-markets are the oil and gas industry, refining, chemicals or power generation. Between these two sectors are several hybrid markets that use both factory automation and process equipment. Fig. 2 summarizes all the different automation end-markets. Besides the traditional discrete and process automation market as well as the growing industrial software, we also count several new applications to the automation market like 3D printing, artificial intelligence and drones (see Fig. 3). Although the new markets are still relatively small compared to discrete, robotics, and process automation, they clearly outperform the growth in the overall automation market (unfortunately, there are only a few listed pure-play companies and they are small).

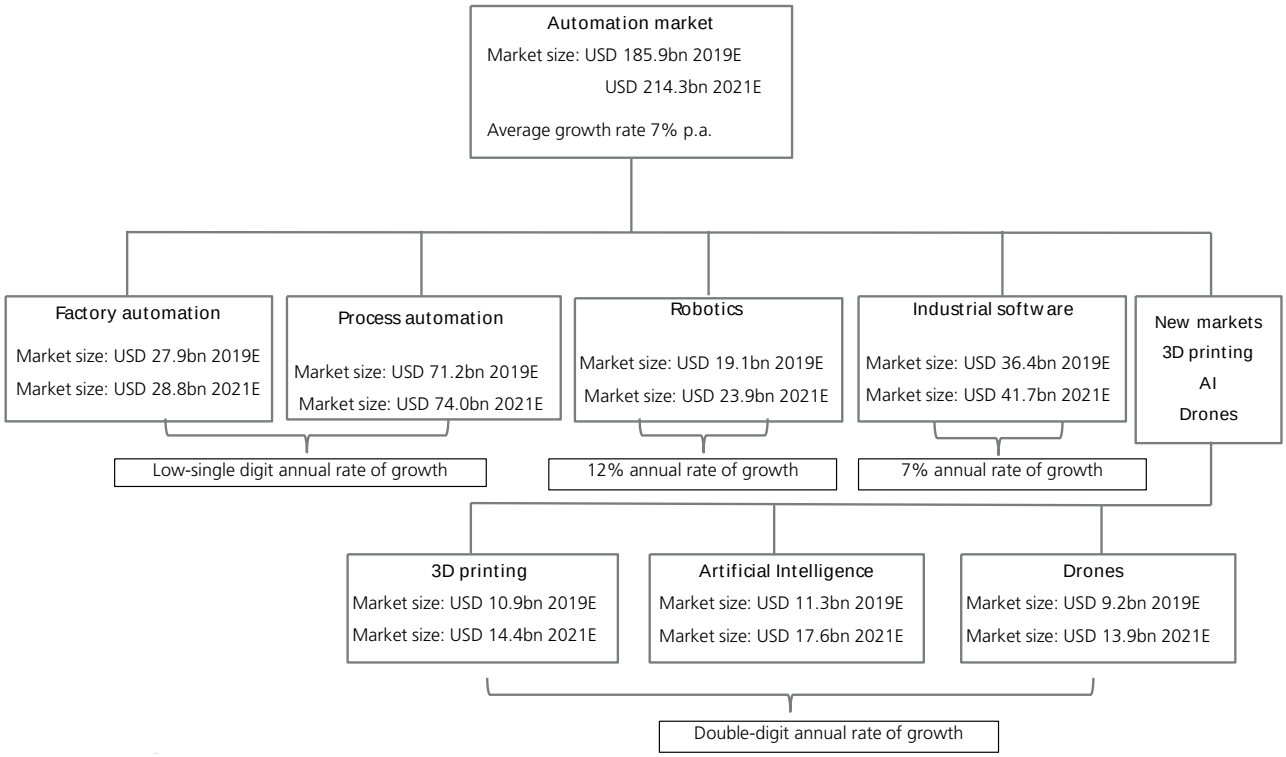
We discuss all end-markets in more detail in this report. Our focus in the first section will be on the discrete (factory), robotics, and process automation industry as all three end-markets are very important for industrial automation companies. UBS estimates that their combined value is USD 118bn (2019E), with 24% attributable to discrete automation, 16% to robotics, and 60% to process automation. If we include the emerging 3D printing market, artificial intelligence and drones plus revenues from pure-play automation software companies, then the total market volume amounts to some USD 186bn (see Fig. 3). To estimate the market size, we have used a bottom-up approach and aggregated automation sales of the most important market participants. Overall, the growth prospects are lower in our new forecast due to the weaker growth prospects across the traditional automation markets. We expect in weaker demand in particular from the automotive sector.

Fig. 2: Factory (discrete) vs. process automation



Source: CLSA

Fig. 3: All automation markets are expect to grow, but new markets such as 3D printing, AI and drones look set to take off.



Source: Company data, UBS estimates, as of February 2020

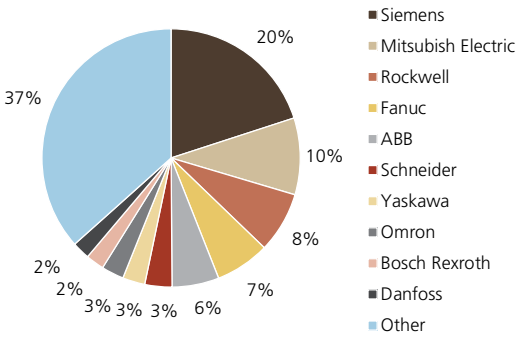
Note: Our industrial software estimate includes only sales from software companies. Software sales from industrial companies are included in either factory or process automation market due to limited access to detailed sales splits of industrial automation companies.

Factory (discrete) automation

The largest end-market in the factory automation market is the automotive industry; typical products are programmable logical controllers (PLCs), electric motors, sensors, robots and, of course, manufacturing software. The highly consolidated market is mainly controlled by European and Japanese companies and a few US vendors, with five players controlling half of the market. On average, the classic discrete automation market (ex-software and robotics) grew 3% p.a. between 2016 and 2019. For the next few years we expect only a low-single-digit growth rate due to weak demand from the automotive sector.

Robot shipments outperformed during this period (mid-teen p.a. since 2010) due to strong demand in EMs, particularly in China. We think the robotics sub-segment is still very exciting. The segment will still be the main growth engine. For 2020-2022, the International Federation of Robotics (IFR) expects 12% growth on average a year. The market is fairly consolidated with only four players dominating more than 50% of the market (see Fig. 5).

Fig. 4: Factory (discrete) automation market share
Total USD 28bn in 2019E (based on EURUSD exchange rate of 1.1)



Source: Company data, UBS estimates, as of February 2020

On top of the software revolution, we see several additional drivers that should spur sustainable growth for robots in the coming years. EMs account for roughly half of the global manufacturing output. However, robot penetration is much lower than in developed countries. Despite strong growth over recent years in China and other EMs, the potential remains significant. In terms of robot density, China appears to be at a level comparable to Japan in the mid-80s (see Fig. 6). There is still a gap compared to the leading manufacturing heavy industrialized countries (see Fig. 7). Despite strong progress in the US – 217 robots per 10,000 employees in 2018 compared to 114 in 2009 – the country is still far behind Germany and Japan (both >320 robots). This shows the huge potential globally.

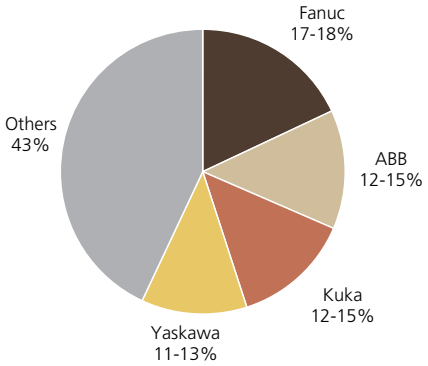
The IFR expects c420,000 new robots to be installed in Asia alone in the year 2022, representing a global market share of 72% (expected total installations globally in 2022: 583,520). The rest is mainly installed in Europe and the America, with a little rest in other regions (see fig. 8).

New capacity expansion used to be the key driver for demand, but industry upgrades will now be the predominant driver. Automation equipment is increasingly also used outside of the automotive industry, which provides a growth opportunity for automation equipment manufacturers. In particular, industry upgrades in the low-to-mid-end manufacturing sectors drive demand (rising labor costs, labor shortage, and an aging and better-educated population that doesn't want to work in factories). The long-term potential is shown in Fig. 7, which indicates how much more potential China has if it grows its robots density similar like developed countries. Its pure manufacturing size would make it a multi-million robots market in the future. Other EMs like India, Vietnam, or Thailand look also promising.

Since 2000, wages in China have risen significantly above other markets, and China's one-child policy triggered a decline in new labor supply and advanced the shift towards an aging population. While not every EM country is aging, with India as a case in point, the manufacturing-led economies like China, Korea and Taiwan clearly are. On top of this, rising education levels have resulted in a fewer workers willing to take lower-pay manufacturing jobs.

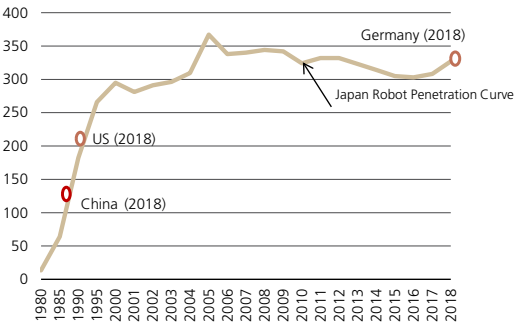
While the demographic challenge is a long-term issue, rising labor costs are an important short-term driver as higher wages shorten the payback period for robots. Other than the costs, efficiency is also much higher with robots; the best example is the automotive industry.

Fig. 5: Robots market share
Total USD 19bn in 2019E



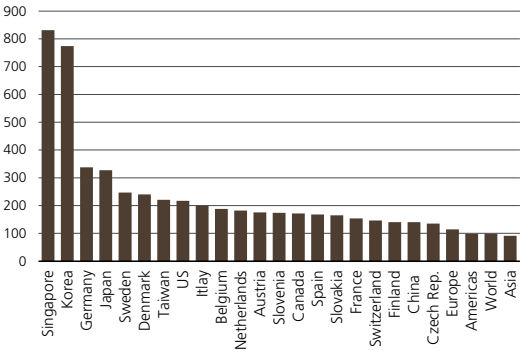
Source: Based on company data and 2018 Bernstein estimates, forecasted by UBS as of February 2020

Fig. 6: Robot density in manufacturing industry by country, 2018
Robots per 10,000 employees in the manufacturing sector



Source: IFR World Robotics (World Robotics Industrial Robots 2019), UBS

Fig. 7: Robot density in manufacturing industry (all industries) by country/region, 2018
Robots per 10,000 employees in the manufacturing sector



Source: IFR World Robotics (World Robotics Industrial Robots 2019)

Process automation

As mentioned earlier, process automation involves a continuous flow of raw materials (e.g. in the oil and gas or the chemical industries), where a high degree of measurement, timing and precision is important. The automation part is a kind of central computer that interacts with valves and sensors to run the process smoothly.

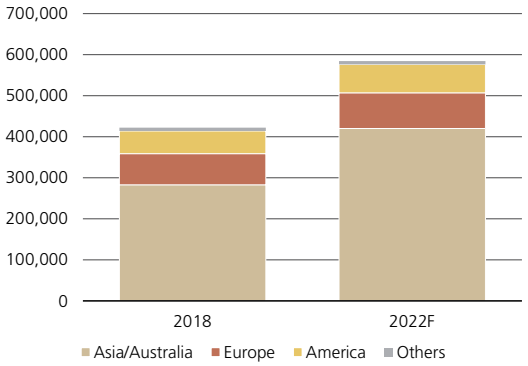
Without process automation systems, plant operators have to physically follow all parameters during the production process and afterwards assess the quality of the output. In addition, maintenance is not performed when necessary, but rather at regular intervals. Therefore, without automation equipment, it is much harder for plant operators to achieve best performance compared to an automated plant that has sensors and computers to analyze thousands of signals. Inefficiency in production processes and sub-optimal maintenance intervals make operations more costly.

Similar to factory automation, this market is also fairly consolidated. Ten companies have a combined market share of 66%.

In 2019, we estimate the total market size reached almost the level it had during the peak years in 2013/14 (USD 74.5bn in 2014, based on EURUSD exchange rate of 1.15). In 2015 and 2016, market conditions for process automation deteriorated significantly. The oil price collapse hurt process automation capital expenditure (capex). After bottoming in 2016/17 and decent growth in 2018/19 (around 4%) we expect -single-digit growth till 2021. We expect continued growth in the chemical and the oil and gas markets. The shale gas revolution in the US has triggered a wave of investments in both sectors, supporting process automation.

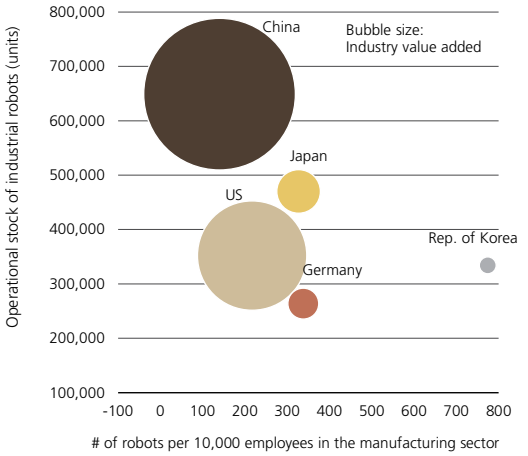
Last but not least, before we discuss the other automation end-markets in the overall distribution of market share, the top six names are 50/50 split between the US and Europe, followed by a few Japanese companies. Competition from emerging markets is not yet strong enough to make it into the top ten.

Fig. 8: Asia dominates global robot demand
Expected newly installed robot units in 2018 vs. 2022



Note: Others = reported and estimated sales which could not be specified by countries. Source: IFR World Robotics (World Robotics Industrial Robots 2019)

Fig. 9: China's long-term potential is huge
Operational stock of robots vs. Robots per 10,000 employees in the manufacturing sector



Source: IFR World Robotics (World Robotics Industrial Robots 2019), The World Bank: Industry (including construction), value added (current US$ 2010) - China, United States, Japan, Germany, Rep. of Korea, for the year 2017 (CC-BY 4.0 License), UBS

Industrial software

The growth outlook for industrial software remains solid as more companies leverage the benefits of digitalization in product manufacturing. The rising trend is more apparent as many manufacturing companies have started to carve out separate internal teams called "digital factories" to take advantage of software in manufacturing. Despite a mixed outlook for overall enterprise IT spending, the outlook for the software industry remains solid with mid-to-high single-digit growth in industrial software, which constitutes around 85% of the broader software industry.

The two major sub-industries within the industrial software segment include product life-cycle management (PLM) and manufacturing execution systems (MES). PLM is generally considered an enterprise level software system, whereas MES is a plant level system, the major difference being that PLM is used in development and corresponding production processes, while MES is used to optimize the production process. An example of PLM is a computer aided design (CAD) software program for designing products on the computer; an example of MES is operation management software. Increasingly, IT service companies like IBM and Accenture have begun investing more in the industrial software and services to take advantage of the industry's strong growth outlook.

Growth in industrial software will continue to depend on:

1. Solving design complexity: Industrial software helps manufacturing firms reduce design complexity, which is often a key bottleneck. For example, Renault's Formula One team leverages industrial software by using state-of-the-art simulation technologies for a broad range of applications including engine combustion, intake and exhaust, thermal cooling, batteries, electric motors, and turbochargers, thus enhancing its race competitiveness. Despite rising usage, we still expect significant growth potential for design-based software, particularly from EMs, given the low penetration.
2. Improved time-to-market: By solving design complexity and improving production efficiency through integrated tools, industrial software can significantly improve the time-to-market. In this regard, in addition to the advancement in 3D printing or additive manufacturing, drones are fast emerging as a key IT tool for the growth of industrial automation.

Digital twins

Digital twins are another major development trend in the industrial software segment. While the concept already exists in other industries, digital twins in manufacturing are at an inflection point and set for major uptake.

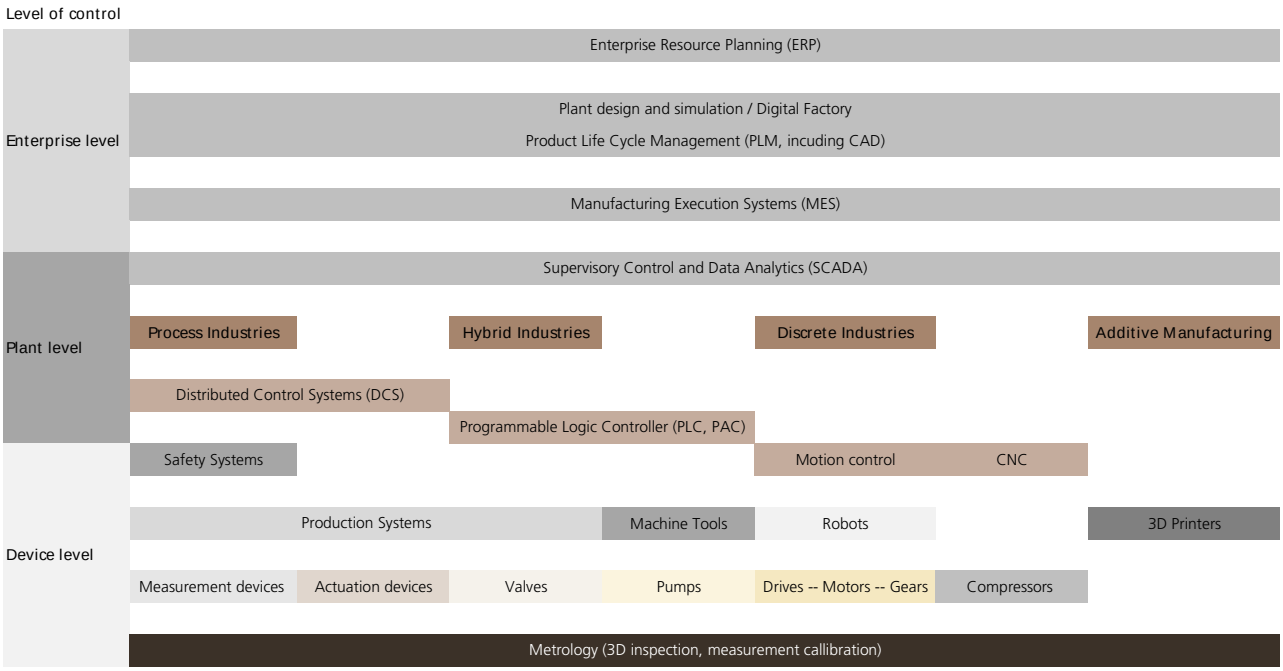
To put it simply, digital twins are like a digital replica, a representation of a manufacturing device or process aimed at optimizing the production environment. A digital twin model basically creates a thread using IoT sensors between the physical and digital world where digital twin is used to simulate the behavior of the product or process in a real-world environment. For example, technicians can use a digital twin to test a proposed fix before applying in the physical environment saving huge costs. Or a race car crew can use digital twins to identify a component that burns out most in a real race environment. Workers on an oil rig or in the wind turbine maintenance industry can monitor digital twins for defects rather than physically inspecting each and every time.

In summary, we believe digital twins will be center of manufacturing digitalization as they not only reduce significant costs but also drive optimized processes and improve time to market. While growth in developments is a low-hanging fruit, we see emerging markets as a huge growth driver for digital twins in the future.

Recommended reading

Executives & Entrepreneurs: Industry 4.0 and the IIoT: Winners but also losers, published on 2 October 2019.

Table 1: Overview of industrial software market



Source: J.P. Morgan

Implications for industrial companies - digital twins

The world market leader in industry automation, Siemens, defines a digital twin as a virtual representation of a product, production process, or performance. Modern factories no longer exist just in the physical world.

As the consumer industry experienced with the launch of smartphones, the industrials sector is undergoing a fundamental IoT driven structural change (see Box 1). Industrial equipment is becoming increasingly interconnected and linked, enabling people to collaborate better and enhancing productivity. Amid this digital transformation, companies will need to sense, analyze, and act based on data. So major industrial companies are in the process of expanding their software offerings or acquiring specialist IT companies that not only provide new product optimization opportunities for their customers but create new incremental revenue opportunities for themselves.

One key enabler of your digital twin is the IIoT, which describes a network of connected devices. Modern robots, warehouse equipment, and devices that automate refineries, heating and cooling systems in buildings, and even modern airplane engines all generate data. It enables the owner of the assets to operate them much more efficiently (see Fig. 10). IIoT technology and the related industrial software are also becoming a tool for asset optimization (cost savings) through remote monitoring and predictive maintenance. As the life-cycle maintenance cost of an aircraft engine, for example, is a multiple of its selling price, potential savings could be significant if one could predict unscheduled outages.

Buildings, too, benefit from this technology, through improved energy efficiency. They can be visualized before construction starts. Their owners, using this data, can optimize their energy supplies. Along with productivity and operational improvements, IIoT tech provides companies new revenue opportunities and realtime product support. The data collection during the life-cycle of products, buildings, and other applications delivers valuable insights about the parts that failed or weaknesses during periods of stress.

Siemens describes this approach as a closed cycle that links the entire value chain, from development and planning in the digital world to the real-world performance of the product.

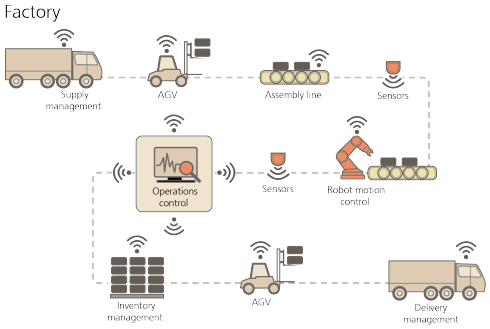
Based on our discussion with management teams from industrial companies and feedback from the Hanover trade fair in 2019, we believe that, for major industrial companies, digital twins will become a common tool. It offers such companies an opportunity for selling new digital services and interacting with their customers more often through continuous monitoring of the installed base.

The IIoT will be key to the success of the digital twin technology. It includes, among other applications, the use of sensor data, machine-to-machine communication, and big data technology (cloud-based platforms) to better monitor equipment and analyze data. Digital twins and IIoT technology eliminate inefficiencies and save time and money through better management of production processes and predictive maintenance.

Box 1: Description of the Internet of Things verus Industrial Internet of Things

The **Internet of Things (IoT)** refers to a network of connected, everyday devices that constantly send and receive data. A combination of connected chips (Bluetooth/WIFI or cellular) and sensors or lowpower processors linked to a remote hub is making regular objects like refrigerators, cars, and public lighting "intelligent."
The **Industrial Internet of Things (IIoT)** describes the Internet of Things in the manufacturing world. It includes, among other applications, the use of sensor data, machine-to-machine communication and big data technology (cloud-based platforms) to better monitor equipment and analyze data. IIoT technology optimizes inefficiencies and saves time and money through better management of the production process and predictive maintenance.

Fig. 10: Exemplary application areas of 5G in the factory of the future



Source: ZVEI

Note: AGV = automated guided vehicle

New technologies, in particular the coming 5G network, will accelerate adoption of the IIoT. 5G goes beyond the applications of 4G with its focus on machine-type communication. It will have 10 times more bandwidth than 4G. Even more important for industrial applications is its low latency, high reliability, and IoT connectivity. Latency defines reaction time: Low latency is a prerequisite for real-time applications. For LTE (4G) technology, latency is around 50 milliseconds (ms). It will drop in the 5G network to around 1ms (source: Deutsche Telekom). 5G reliability and availability is 99.999%, also an important feature. All these attributes will make it the standard wireless technology most companies use to communicate from the factory directly to the cloud. So 5G will be a pillar of smart manufacturing (Industry 4.0), improving efficiency, flexibility, and product diversity in the manufacturing process.

There are many use cases in which IIoT will play an important role. They include motion control systems and augmented reality (AR). While motion control devices need low latency rates and high reliability to control the moving and rotating parts, AR requires high data rates (see Fig. 11; source: ZVEI - 5G Alliance for Connected Industries and Automation).

IIoT development is still in its infancy. There are many IIoT players in this "proof-of-concept" period trying to create a new offering. They include traditional US and European software companies, as well as global industrial giants.

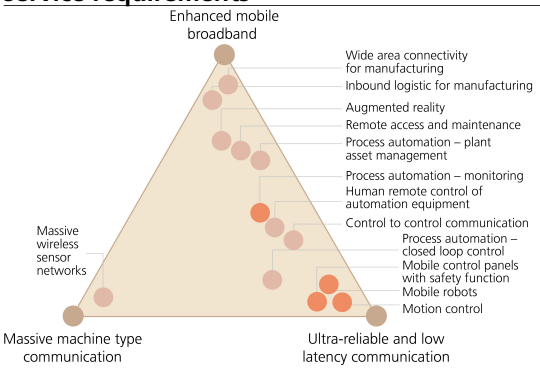
Although the landscape is fragmented, Siemens, with its MindSphere platform, is one of the market leaders among industrial companies. Behind MindSphere is an IoT application focused on product lifecycle management (PLM). It covers the entire value chain from development, prototyping, and production to the final end-customers and daily use.

Many traditional software companies leverage their existing technologies to service the industrial world. Some industrial companies use the basic architecture of the software players to build their platform in cooperation with them (e.g., Schneider and ABB have a partnership with Microsoft).

Microsoft has a leading IoT offering thanks to its dominant software position and solid cloud offering. For example, its IoT plug-and-play feature makes it easier for its SME clients (small and medium-sized enterprises), who don't have to write complex code to connect IoT devices through the cloud and speed up their time to market. China is more advanced in terms of IoT use as artificial intelligence (AI) meets IoT. Alibaba's ET City Brain is one example of IoT, cloud, and facial recognition technologies being used to solve traffic problems in cities like Hangzhou.

Which companies have the best offerings and will succeed are questions that cannot be answered yet, in our view. But it is important for industrial firms to use their installed based and the knowledge of their customers to compete against traditional software companies with deep knowledge in the software world.

Fig. 11: Overview of selected industrial use cases and arrangement according to their basic service requirements



Source: ZVEI

For more details about this topic, please read our Executives & Entrepreneurs publication 'Industry 4.0 and the IIoT: Winners but also losers' published on 2 October 2019.

New long-term trends

Artificial intelligence is at the center of the fourth industrial revolution

Artificial intelligence (AI), which we refer to as a set of tools and programs that makes software smarter in such a way that an outside observer thinks the output is generated by a human, is set to be a significant driver in the automation space as it will have far-reaching implications on many industries. In the most simplistic terms, AI leverages self-learning systems by using multiple tools like data mining, pattern recognition and natural language processing. It operates as a human would when conducting routine tasks such as common-sense reasoning, forming an opinion or social behavior. That said, AI is an umbrella term to cover a confluence of multiple technologies, such as machine learning, which includes deep learning, cognitive computing, natural language processing, neural networks, etc. (see Fig. 12).

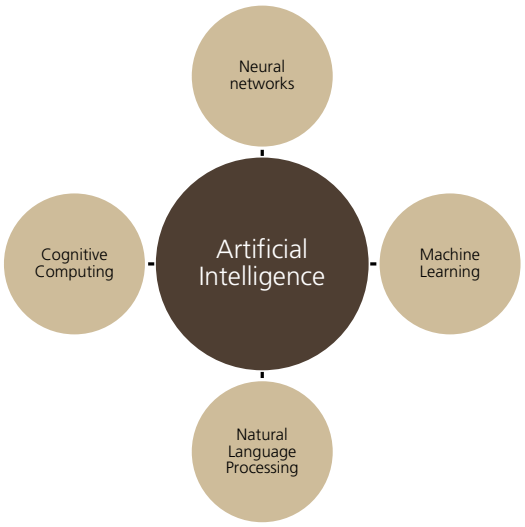
The main business advantages of AI over human intelligence are its high scalability, resulting in significant cost savings. Other benefits include AI's consistency and rule-based programs, which eventually reduce errors (both omission and commission), AI's longevity coupled with continuous improvements and its ability to document processes.

We believe AI can be divided broadly into three stages (see Fig. 13): artificial narrow intelligence (ANI), artificial general intelligence (AGI) and artificial super intelligence (ASI). The use cases for AI are diverse as AI-based software will push the limits of automation. Like a brain, AI powers the traditional sources of automation and robotics and drives the progress of sectors like autonomous vehicles and drones. But as a standalone industry, AI-based software can create significant business opportunities.

Some examples include virtual assistants or chatbots providing expert assistance, smart or robot advisors in the fields of finance, insurance, legal, media and journalism, and expert healthcare systems that provide medical diagnosis and assistance. Other benefits include significantly improving efficiencies in R&D projects by reducing time-to-market, optimizing transport and supply chain networks, and improving governance by better decision-making processes.

We are optimistic about the growth prospects of the AI industry. The exponential growth in computing power and the solid cloud and smart device ecosystem that are in place, coupled with favorable supply factors like low computing and storage costs, advanced algorithms and the increased availability of AI-based talent, are supportive factors.

Fig. 12: Artificial intelligence is an umbrella term for many technologies



Source: UBS

On the demand side, we believe corporations and governments are realizing the benefits of AI, resulting in increased attention and spending on AI projects. We expect AI-related software revenues to rise from USD 11.3 bn in 2019 to USD 17.6bn by 2021, growing at an average 25% a year. While this estimate looks very conservative, the size represents only the third-party AI software market, with significant spending both on infrastructure and on internal projects. As the industry matures, we should get a better idea of the overall size of the market. Furthermore, third-party software market growth rates should accelerate after 2020 as AI enters the second AGI (Artificial General Intelligence) stage, reaching a sweet spot with use cases and addressable market expanding sharply.

3D printing remains a long-term opportunity

Despite the recent mixed performance of 3D printing companies, we think that 3D printing holds promise in the long term. Beyond a few current applications, any dramatic benefits are only expected in the longer term. In the near term, rather than being applied to mass production, we see opportunities for 3D printers in businesses requiring rapid prototyping and high customization with small production quantities. Based on Bloomberg Intelligence, we expect the industry's revenues to grow from around USD 10.9bn in 2019 to around USD 14.4bn in 2021.

The rise of commercial drones

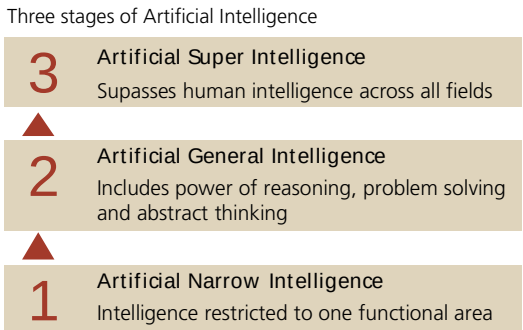
Drones, which were initially restricted to military use, have slowly expanded to personal use and are now literally taking off for commercial purposes. Also known as unmanned aerial vehicles (UAVs), drones are operated remotely or autonomously and generally carry a video camera to monitor flight. Although drones are still in their infancy, they are being used across industries like manufacturing, utilities, agriculture, movie and government organizations at a fraction of the cost of a manned aircraft.

E-commerce and logistics companies are also beginning to experiment with drone technology, with Amazon, the global e-commerce leader, anticipating a future in which unmanned aircraft will exceed general air traffic, which currently totals 85,000 flights a day. Thanks to its autonomous features, drones could be a new tool of industrial automation. For industrial companies, drones could prove handy for aerial inspection surveying, particularly in the oil, gas and mineral exploration and production industries, or for short cargo transport within the factory line, saving significant costs.

Agriculture is another promising industry where drones can be widely used – for e.g. to survey crops and spot irrigation problems. We expect the global drone market, based on input from Gartner and Bloomberg Intelligence, to grow from USD 9.2bn in 2019 to USD 13.9bn by 2021, with an average annual growth of more than 20% (see Fig. 15). The growth will not only be driven by consumer drones but also commercial drones as demand continues to be strong across industries.

Despite the advantages of the drone market, we believe safety and other regulatory issues need to be addressed before we can estimate the industry's growth rate. Many governments across the world are in the process of setting up regulations on safety and privacy.

Fig. 13: Development of artificial intelligence

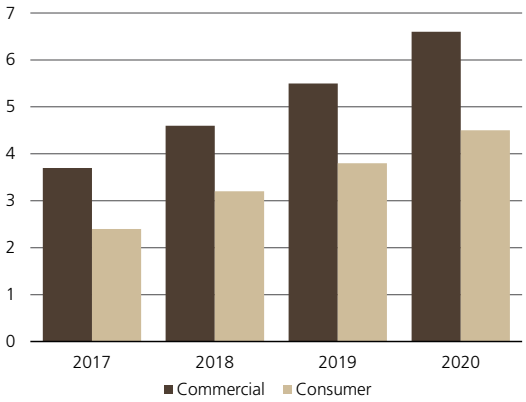


Source: UBS

Fig. 14: 3D printer- from bytes to bits

Source: Solidoodle

Fig. 15: Rising demand for drones (revenues in USD bn)



Source: Gartner, Bloomberg Intelligence, UBS

Link to sustainable investing

In our view automation and robotics can be considered a sustainable investing theme. It aligns with Sustainable Development Goal (SDG) 9 "Industry, Innovation and Infrastructure". SDG 9 aims at promoting inclusive and sustainable industrialization by 2030, upgrade infrastructure and retrofit industries to make them sustainable with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes. Industrial software, precision machinery, more sophisticated sensors and monitoring systems in manufacturing, mining and agriculture can increase resource efficiency and reduce water, energy and raw material use. For example, major industrial companies are using robots to aid them in their recycling processes by picking out reusable pieces for other products.

Artificial intelligence can advance work towards achieving the SDGs by generating data for more intelligent targeting of intervention, waste reduction, pollution and air quality monitoring. Jiang Kejun, one of the authors of the UN Intergovernmental Panel on Climate Change (IPCC) report said "this is more about technology than politics". Finally, artificial intelligence can trigger new applications that disrupt industries and professions, for example by promoting efficiency in existing healthcare systems by enabling self-monitoring and allowing early diagnosis of medical conditions. Machine learning can further extend the availability of quality medical care to remote regions through automated diagnosis.

Automation's potential contribution to the SDGs make it an attractive sustainability theme.

Rachel Whittaker, Sustainable Investing strategist

Melissa Spinoso, Sustainable Investing analyst

Conclusion

We think that the current industrial revolution will turn today's manufacturing into smart factories over the next decade. The smart automation industry's total annual revenues stand around USD 186bn now. In particular, the outlook for factory automation in China in the coming years is very promising. We believe that over the cycle the sector can grow by mid-to-high single digits, with industrial software, robots and the new trends discussed in the report the clear outperformers. We expect hardware companies with sizable software exposure to grow their automation business by mid-single digits and pure-play software companies by high-single to low-double digits.

Overall, we think that industrial software will be a growing differentiator for companies and investors. We expect the industrial software market to grow on average around 7%, with superior margins. Software is at the center of this revolution, but there is also tremendous demand for automation hardware, such as robots, from emerging markets (EMs) and several sectors which should lead to sustainable growth. One obvious example is the rising trend of multiple IT devices per individual (compared to just one PC in the past), coupled with shorter product cycles (six months to one year), that is leading to a surge in device manufacturing and increasing complexity. Against this backdrop, the rising trend of automation by IT vendors is evidence of the recent strong demand for industrial robots. Other supporting long-term drivers are demographic challenges in key countries like China and, in general, increasing wages in EMs.

In summary, this should lead to above average earnings growth for industrial companies with automation software exposure. We think investors have the opportunity to benefit from the automation and robotics trend over the next few years.

Risks

In the short-term weaker demand from the automotive sector and impact from the COVID-19 virus outbreak as well as a renewed weakness in the oil prices could hinder investments across the entire automation value chain. In the longer term, we see a global industrial recession as the main risk that could negatively impact automation investments.

Appendix

Terms and Abbreviations

Term / Abbreviation	Description / Definition	Term / Abbreviation	Description / Definition
2011E, 2012E, etc.	2011 estimate, 2012 estimate, etc.	A	actual i.e. 2010A
bn	Billion	Capex	Capital expenditures
COM	Common shares	E	expected i.e. 2011E
p.a.	Per annum (per year)	Shares o/s	Shares outstanding
UP	Underperform: The stock is expected to underperform the sector benchmark	CIO	UBS WM Chief Investment Office

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