Longer Term Investments

Automation and robotics

Chief Investment Office Americas, Wealth Management | 30 January 2018 5:02 pm GMT
Alexander Stiehler, CFA, Analyst; **Sundeep Gantori**, CFA, CAIA, Analyst; **Kevin Dennean**, Technology Equity Sector Strategist Americas, kevin.dennean@ubs.com

- We believe smart automation will power the fourth industrial revolution, combining the innovation in industrial and IT processes to drive global manufacturing productivity gains.
- As key automation end-markets bottomed last year and are growing again, we have raised our growth outlook for the automation market for the next three years. We believe cyclical and structural drivers support our theme.
- We expect mid-to-high single-digit growth rates on average in the longer term. Rising wages and challenging demographic changes will pressure costs of manufacturing firms, driving automation investments. Also, the increasing digitalization of automation equipment is a key driver of higher efficiency and therefore more automation investments.
- We suggest long-term investors add positions in this investment theme as key end-markets are nearing an inflection point after several years of below-average growth.
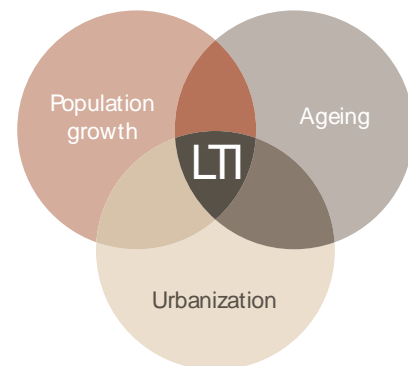
House view

The manufacturing industry has a history of being able to re-invent itself. Whether in the first industrial revolution of steam-generated power, or the next revolution supported by electric power, industry has found ways to boost productivity. Another industry revolution is now underway, which we believe will transform the future of manufacturing. It is powered by smart automation (SA) as Industry 4.0 rises in importance. SA 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 purely improving efficiency and accuracy. Automation is increasingly a tool for total operations and asset management.

This report discusses recent trends and the outlook for factory and process automation, industrial software and 3D printing, as well as commercial drones and artificial intelligence (AI). After several weak years of low investments, the global manufacturing sector recovered last year and we are confident that the outlook for the coming years is also promising.

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 segments offer high growth opportunities.

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, ageing, and increased urbanization create a variety of longer term investment opportunities.

- Investors willing to invest over multiple business cycles can benefit from potential mispricings created by the typically shorter term focus of stock markets.

Related Research
US equities: Update: Beneficiaries of transformational technologies, 21 September 2017

These changes should lead to: 1) long-term, above-average earnings growth; and 2) re-rating potential for industrial companies with automation software exposure. Both should result in superior performance compared to the broader equity market in the years to come.
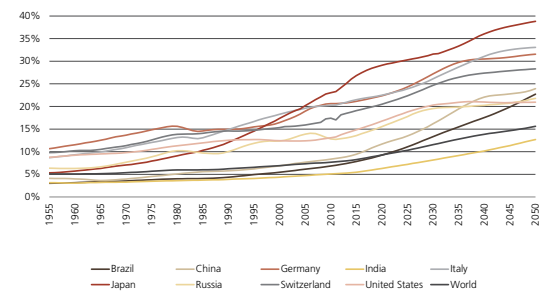
Growth drivers

Based on our market definition, the automation market currently has a size of USD 177.5bn (see Fig. 3). Driven by several structural drivers (which we will discuss in detail in this report), we expect the SA industry's average revenue to grow in the mid-to-high single digits. From an investment perspective, SA 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 in the next few years:

- We think emerging markets (EMs) are one of the most promising growth themes. In EMs, robotics usage is still far behind developed countries, but due to an aging population not only in developed countries (see Fig. 1), but also in EMs, the need to drive productivity gains, rising wages and the size of the manufacturing sector make it an attractive region for automation equipment. This is true particularly in China, where the mass reallocation of cheap labor from the agricultural sector to manufacturing is slowing.

- We expect the rising digitalization of the manufacturing sector (industrial software) to lead to a new wave of automation investments in developed countries. Compared to industries like office automation or healthcare, the use of software or IT penetration is still lower in the manufacturing automation world, but we have reached an inflection point, with software moving down to the factory floor, accelerating automation within manufacturing.

- In the past, new capacity expansion used to be the key driver for demand; but now, industry upgrade has become more important and will continue to be the predominant driver.

- In the future, 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 (see also our investment theme "Riding the wave of Internet of Things").
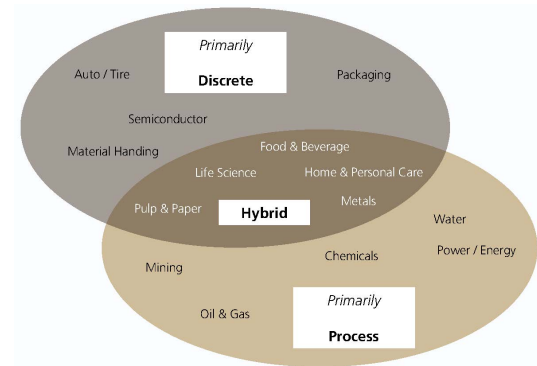
When people think about automation, most picture an industrial robot assembling a car. In reality, that is only one part of the entire automation value chain, which can broadly be split into several categories, with the most prominent ones being factory and process automation. Industrial software is becoming an increasingly important business driver in both segments. Factory (or discrete) automation generally describes assembling processes, such as

Fig. 1: Relative share of elderly people (aged 65 and over) growing in every country worldwide
Total % of population, 1955 – 2050E

Source: OECD, as of January 2018

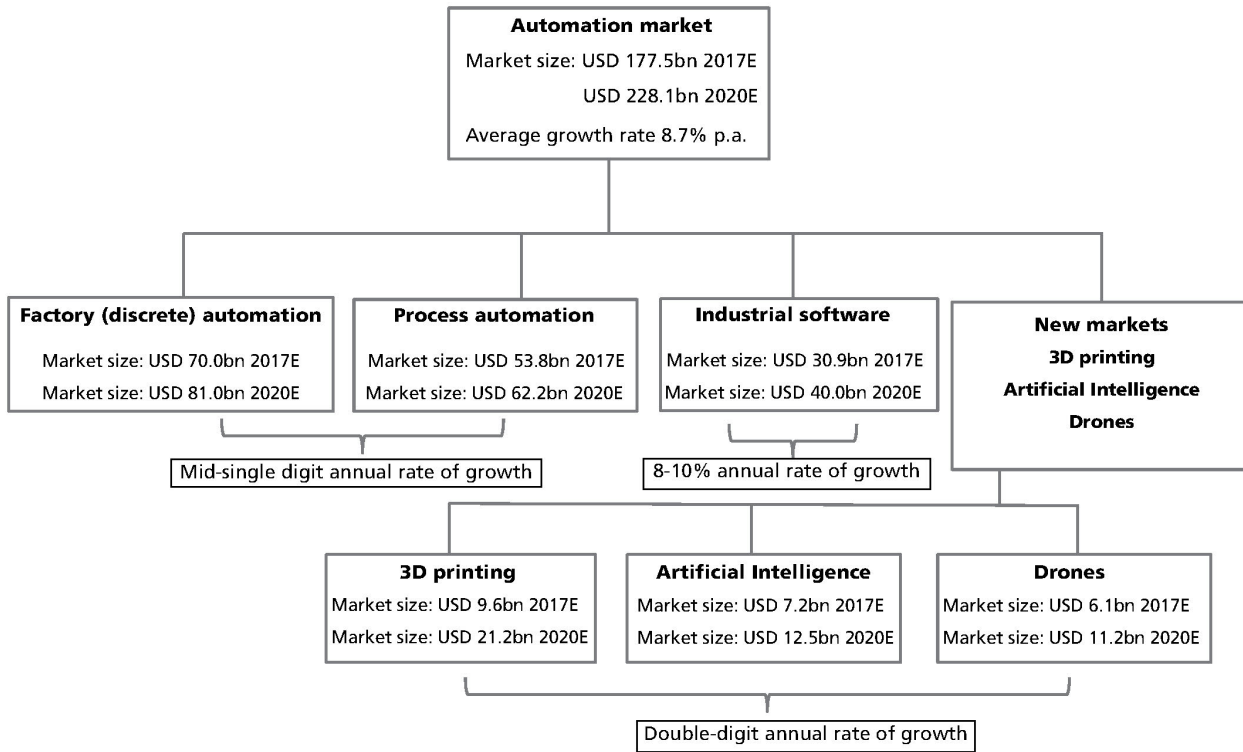**Fig. 2: Factory (discrete) vs. process automation**

Source: CLSA

our robot in the automotive industry, but also other automation processes in the general manufacturing industry, packaging and semi-conductors, to mention the most important ones. 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 and process automation, they clearly outperform the growth in the overall automation market (unfortunately, there are only a few and they are small listed pure-play companies).

We discuss all end-markets in more detail in this report. Our focus in the first section will be on the discrete and process automation industry as both end-markets are still most important for industrial automation companies. UBS estimates that the combined value is USD 124bn (2017E), with 44% attributable to process automation and 56% to discrete 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 177.5bn (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. Compared to our last estimate (January 2017), we have raised our growth forecast for the automation market due to three reasons: better growth in process automation (the market bottomed last year); continued growth in discrete automation, particularly due to strong demand from China; and higher estimates in the drone segment.

Fig. 3: Industrial software and new trends like 3D printing, artificial intelligence or drones drive industry growth

Automation market

Market size: USD 177.5bn 2017E

USD 228.1bn 2020E

Average growth rate 8.7% p.a.

Factory (discrete) automation	Process automation	Industrial software	New markets
Market size: USD 70.0bn 2017E	Market size: USD 53.8bn 2017E	Market size: USD 30.9bn 2017E	**3D printing**
Market size: USD 81.0bn 2020E	Market size: USD 62.2bn 2020E	Market size: USD 40.0bn 2020E	**Artificial Intelligence**
			Drones

Mid-single digit annual rate of growth

8-10% annual rate of growth

3D printing	Artificial Intelligence	Drones
Market size: USD 9.6bn 2017E	Market size: USD 7.2bn 2017E	Market size: USD 6.1bn 2017E
Market size: USD 21.2bn 2020E	Market size: USD 12.5bn 2020E	Market size: USD 11.2bn 2020E

Double-digit annual rate of growth

Source: Company data, UBS estimates, as of January 2018

Note: Our industrial software estimate includes only sales from software companies. Software sales from industrial companies like Siemens, ABB, Schneider Electric, etc. 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 auto-motive 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 more than half of the market (Siemens, ABB, Sch-neider Electric, Rockwell Automation, and Mitsubishi Electric; see Fig. 4).
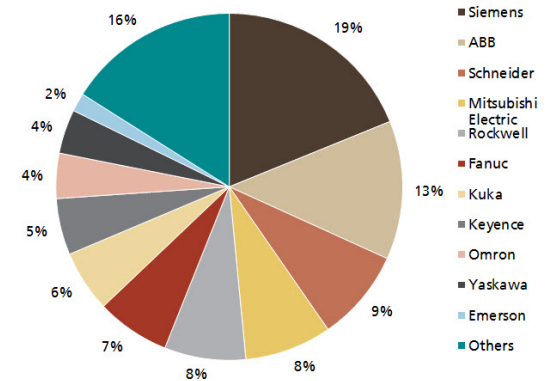
On average, the classic discrete automation market (ex-software) grew 3-4% p.a. between 2010 and 2017. Robot shipments outper-formed during this period (16% CAGR since 2010) due to strong demand in EMs, particularly in China. After a weaker period for automation equipment in 2015 and 2016, the global manufacturing sector improved again in 2017. We expect mid-single digit annual growth rates in the next three years for the overall discrete automation segment, slightly higher than historical growth levels.

We think the robotics sub-segment is still very exciting. The segment will still be the main growth engine. For 2018-2020, the International Federation of Robotics (IFR) expects 15% growth on average a year. Asia and Australia are expected to grow on average by 15% p.a., the Americas also by 15% p.a. and Europe by slightly less. On top of the software revolution, we see several additional drivers that should spur sustainable growth 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 is remains significant. In terms of robot density, China appears to be at a level comparable to Japan in the 1980s (see Fig. 5). There is still a gap compared to the global average, and nearly 90% compared to South Korea, the country with the highest robot density (see Fig. 6). Despite strong progress in the US - 189 robots per 10,000 employees in 2016 compared to 114 in 2009 - the country is still far behind Germany and Japan (both >300 robots). This shows the huge potential globally.

The IFR expects 210,000 robots to be installed in China alone by 2020 (total installation globally in 2017: 346,800), representing a global market share of 40% (expected total installation in 2020: 520,900). Other important markets are the US, Korea, Japan, Germany, Taiwan, Mexico, Italy and gradually also India (see Fig. 7).
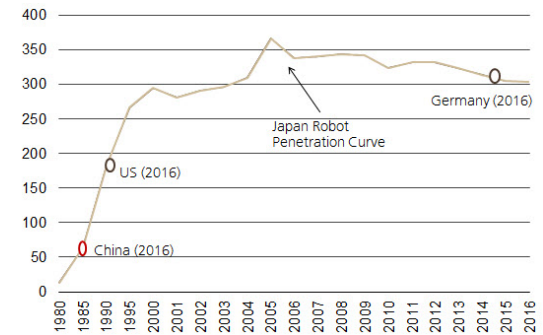
In the past, new capacity expansion used to be the key driver for demand, but now industry upgrade has become and will continue to be the predominant driver. Automation equipment is increasingly also used outside of the automotive industry, which provides a growth opportunity for automation equipment 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).

Fig. 4: Factory (discrete) automation market share
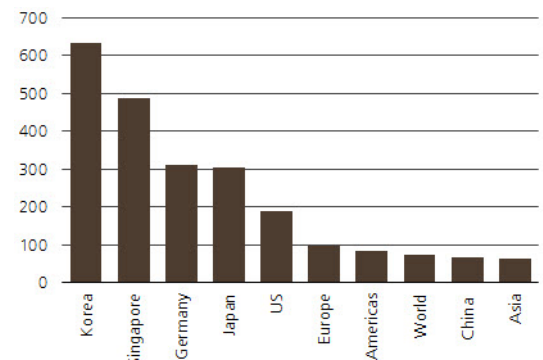Total USD 70bn in 2017E

Source: Company data, UBS estimates, as of January 2018

Fig. 5: Robot density in manufacturing industry by country, 2016
Robots per 10,000 employees

Source: IFR World Robotics (World Robotics Industrial Robots 2017)

Fig. 6: Robot density in manufacturing industry (all industries) by country/region, 2016
Robots per 10,000 employees

Source: IFR World Robotics (World Robotics Industrial Robots 2017)

Since 2000, wages in China have risen significantly above other markets (see Fig. 8), 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.

The market for robots is very concentrated; just four companies (Fanuc, ABB, Yaskawa and Kuka) control a major part of the global market and more than three-quarters of robots were sold in just five countries in 2017 (China, South Korea, Japan, the US and Germany).

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.
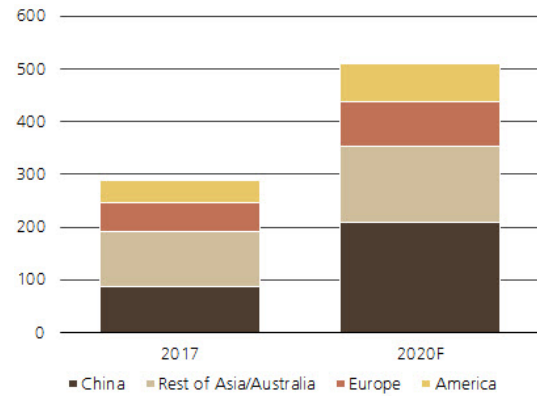
Without process automation systems, plant operators have to physically follow all parameters during the production process and afterwards assess the quality of the output. In addition, maintenance is not performed when necessary, but rather at regular intervals. Therefore, without automation equipment, 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 (see Fig. 9). Six companies have a combined market share of 78% (Siemens, Emerson, ABB, Yokogawa, Honeywell, and Schneider Electric).

The annual growth rate was on average 4% from 2006 to 2015, driven by a strong investment cycle 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.
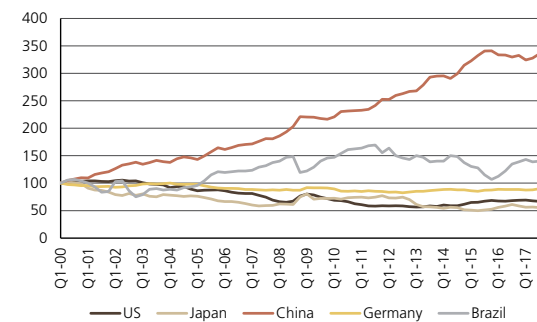
In 2015 and 2016, market conditions for process automation deteriorated significantly. The oil price collapse hurt process automation capital expenditures (capex). After bottoming in 2017, we expect growth till 2020, and similar to factory automation we expect mid-single digit annual growth off a lower base.

Fig. 7: China dominates global robot demand
Expected newly installed robots in 2017 vs. 2020

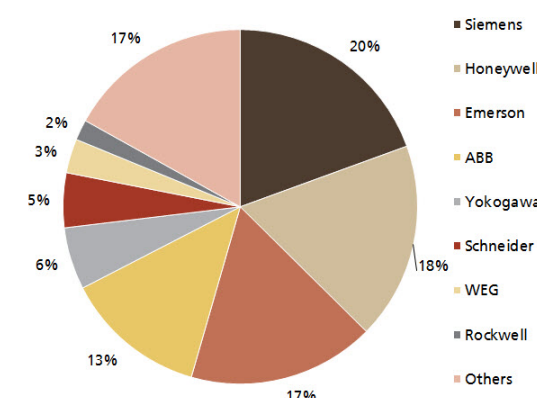Note: Others = reported and estimated sales which could not be specified by countries
Source: IFR World Robotics (World Robotics Industrial Robots 2017)

Fig. 8: Relative unit labor costs (indexed to 100 in the year 2000)

Source: Oxford Econ via Haver, UBS, as of 17 January 2018

Fig. 9: Process automation market share
Total USD 54bn in 2017E

Source: Company data, UBS estimates, as of January 2018
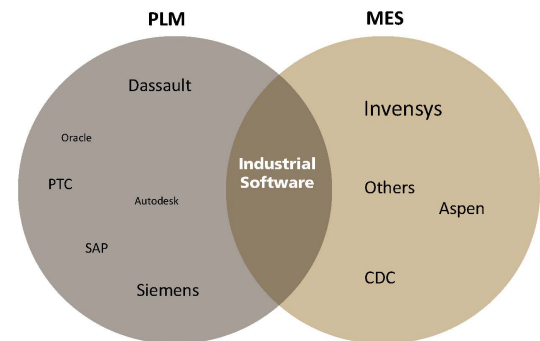
Industrial software

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 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) (see Fig. 10). 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. Key vendors in PLM include Dassault, Autodesk, PTC and Siemens; the top vendors in MES include Invensys, CDC Software and Aspen (see Fig. 10). 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 (see Fig. 11).

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.
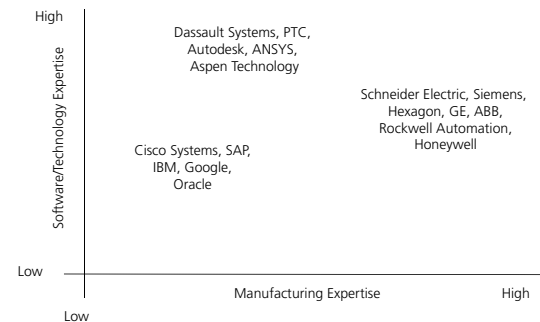
Fig. 10: Industrial software landscape

PLM=Product Life-cycle Management
MES=Manufacturing Execution System
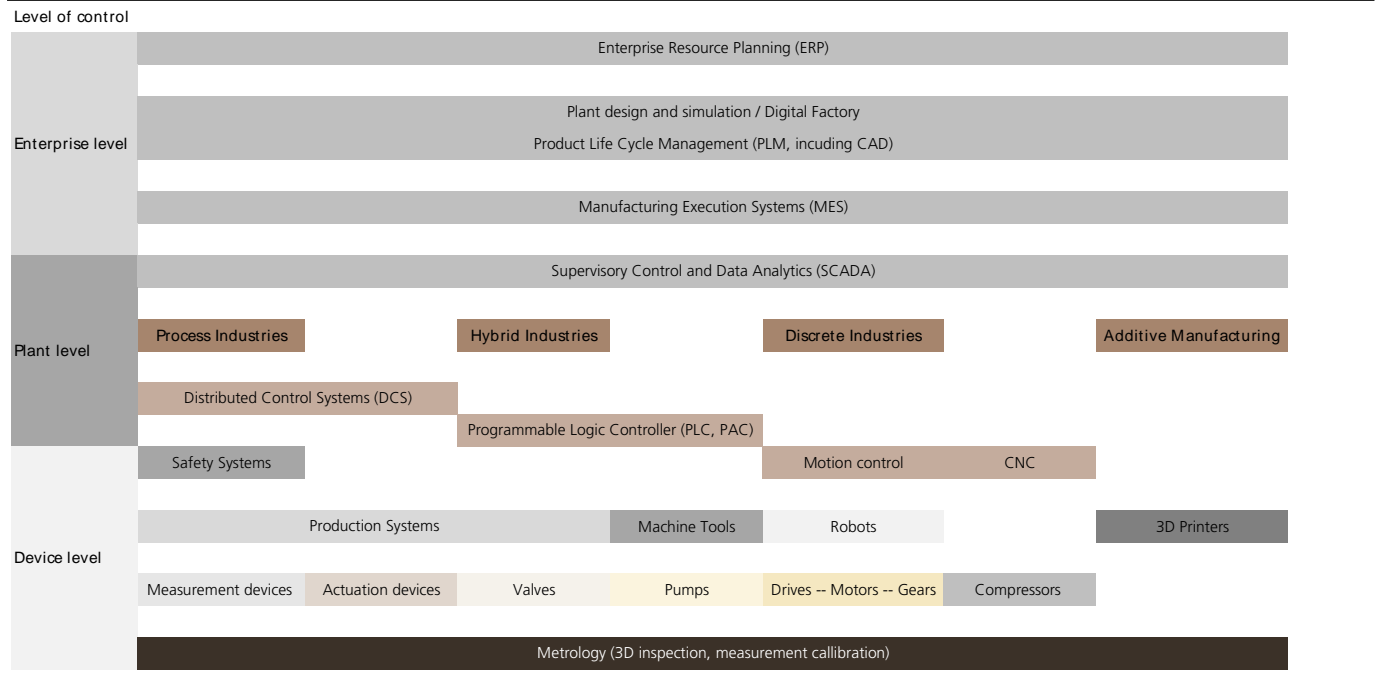Source: Company reports, UBS

Fig. 11: Comparison of software expertise vs. manufacturing
Mix of industrials and IT companies, mainly large caps

Source: Based on BofA Merrill Lynch Global Research, adjusted by UBS

Table 1: Overview of industrial software market

Level of control						
Enterprise level	Enterprise Resource Planning (ERP)					
	Plant design and simulation / Digital Factory					
	Product Life Cycle Management (PLM, incuding CAD)					
	Manufacturing Execution Systems (MES)					
Plant level	Supervisory Control and Data Analytics (SCADA)					
	Process Industries	Hybrid Industries		Discrete Industries		Additive Manufacturing
	Distributed Control Systems (DCS)					
		Programmable Logic Controller (PLC, PAC)				
	Safety Systems			Motion control	CNC	
Device level		Production Systems	Machine Tools	Robots		3D Printers
	Measurement devices	Actuation devices	Valves	Pumps	Drives -- Motors -- Gears	Compressors
	Metrology (3D inspection, measurement callibration)					

Source: J.P. Morgan

Implications for industrial companies

Today, industrial software accounts for up to one-third of automation sales for the companies we have highlighted in this report; software accounts for an estimated low-single digit of Fanuc's automation sales, mid-single digit for Rockwell Automation, low-double digit for Schneider Electric and ABB, and one-third for Siemens. However, the strong growth that we expect in this segment could make the difference over the next few cycles. Siemens, for instance, wants to double its number of software engineers by 2023 without making an acquisition (Source: Siemens). As mentioned earlier, we expect 8-10% annual growth in the industrial software segment over the next few years. The resulting impact on automation companies at a group level is additional growth of around 1-2ppt on top of the normal hardware growth (through-cycle roughly 4%).

Another point worth highlighting in this context is the higher operating margin level for industrial software sales. In 2016, average automation margins were 14-16% versus industrial software margins of more than 20%. Mentor Graphics' business, acquired by Siemens, achieved an 83% gross margin and a 15% operating margin in FY15. Taken together, higher growth combined with better margins in the software division could have a strong positive impact on valuations too. Fig. 12 shows the margin and growth differences of the most important European capital goods and software companies over the last 17 years. Pure-play companies in the software sector trade at a 40% premium to "normal" hardware automation stocks.

To better understand the opportunity, let's do a quick calculation using two theoretical companies: Company A has a growing industrial software part and Company B is only focused on hardware (see Table 2). Assuming all other characteristics are the same (cost of capital, leverage and asset intensity), automation Company A has a slightly higher margin than Company B (15% vs. 14%) due to better software margins and higher sales growth (5% vs. 4%).

The result is impressive, the multiples are much higher - Company A trades at an 18% P/E premium to Company B and has an higher implied equity value of 27%. This example shows the positive earnings and margin impact of software growth and the resulting re-rating potential for automation companies. We think that this opportunity is not yet reflected in share prices, and investors have the opportunity to benefit from this trend over the next few years.

Table 2: Example of impact on value depending on growth

	Company A	Company B
Sales	100	100
Sales growth	5%	4%
EBIT margin	15%	14%
Debt	20	20
Interest	3%	3%
Tax rate	30%	30%
Net income margin	10.1%	9.4%
NWC / sales	10%	10%
Fixed assets/sales	20%	20%
Long term growth	5%	4%
Risk free rate	2.50%	2.50%
Equity risk premium	6%	6%
Beta	1%	1%
Cost of equity	9.70%	9.70%
Net income	10.1	9.4
NWC	0.5	0.4
Capex-depreciation	1.0	0.8
Free cash flow	8.6	8.2
Value of equity (Gordon Growth)	183	144
EV	203	164
EV/sales	2x	1.6x
EV/EBIT	13.5x	11.7x
P/E	18.1x	15.3x

Note: NWC = Net Working Capital; EV = Enterprise Value
Source: J.P. Morgan, UBS

Remark: *The Gordon Growth Model is based on the assumption that the value of a company is worth the sum of all its discounted dividend payments. In this example, the value of equity is the discounted sum of free cash flows.*

Fig. 12: Software - growth opportunities & margin potential

Over the last 17 years, software sales grew 2x and the margin is more than 2x higher than in the capital goods sector (for comparison reasons, we used only European companies in both sectors) .

Big organic sales...   ...and margin gap

Note: rhs = right hand side

Source: Company data, Morgan Stanley, UBS, as of January 2018

New long-term trends

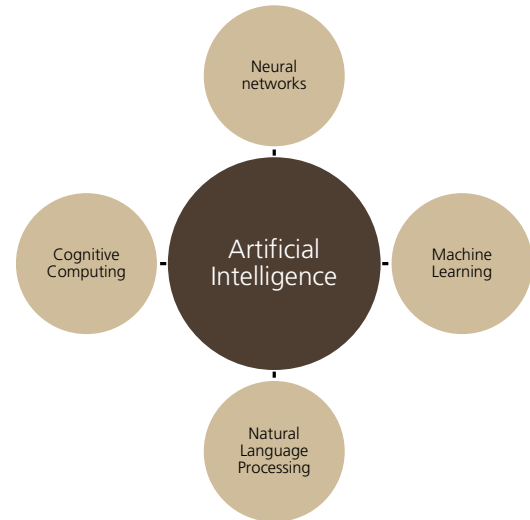**Artificial intelligence is at the center of the fourth industrial revolution**

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. 13).

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. 14): artificial narrow intelligence (ANI), artificial general intelligence (AGI) and artificial super intelligence (ASI). The use cases of AI are manifold as AI-based software will push the limits of automation. Like a brain, AI powers the traditional sources of automation and robotics and drives 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. 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 5bn in 2015 to USD 12.5bn by 2020, growing at an average 20% a year. While the 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 on the overall
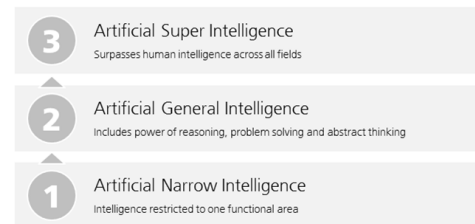
Fig. 13: Artificial intelligence is an umbrella term for many technologies

Source: UBS

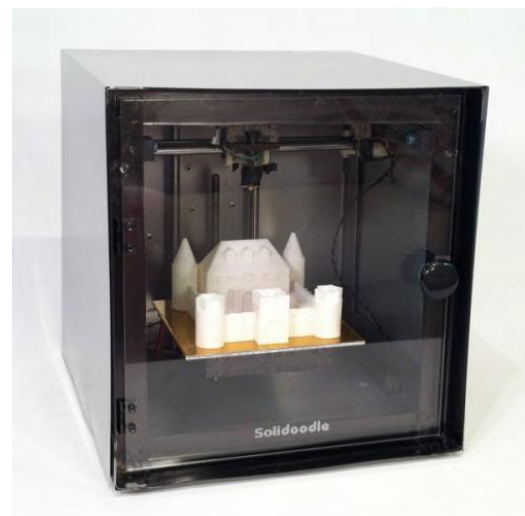**Fig. 14: Development of artificial intelligence**

Three stages of Artificial Intelligence

3 Artificial Super Intelligence
Surpasses human intelligence across all fields

2 Artificial General Intelligence
Includes power of reasoning, problem solving and abstract thinking

1 Artificial Narrow Intelligence
Intelligence restricted to one functional area

Source: UBS

Source: UBS

Fig. 15: 3D printer- from bytes to bits

Source: Solidoodle

size of the market. Furthermore, third-party software market growth rates should accelerate after 2020 as AI enters the second AGI 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. Wohlers Associates, a leading industry research firm in 3D printing, expects the industry's revenues to grow from around USD 9.6bn in 2017 to USD 21.2bn in 2020.

The rise of commercial drones

Drones, which were initially restricted to military use, 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.
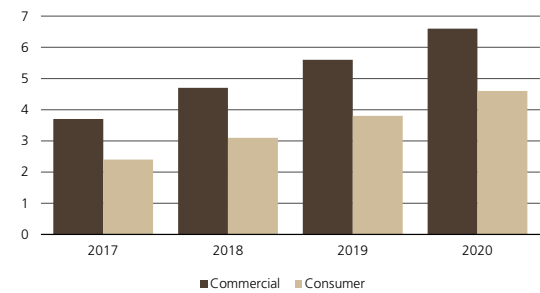
E-commerce and logistics companies are also beginning to experiment with drone technology, with Amazon, the global e-commerce leader, anticipating a future in which unmanned aircraft will exceed general air traffic, which currently totals 85,000 flights a day. Thanks to its autonomous features, drones 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. The global drone market, according to Gartner and Bloomberg Intelligence, is expected to grow from USD 6.1bn in 2017 to USD 11.2bn by 2020, with an average annual growth of 22%. 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.

Link to sustainable investing

We think that automation & robotics is part of the "energy efficiency" theme, which is a sustainability-themed investment. Energy efficient products and services help to significantly mitigate climate change through the reduction of greenhouse gas emissions. Energy demand

Fig. 16: Rising demand for drones (revenues in USD bn)

Source: Gartner, Bloomberg Intelligence, UBS

continues to rise, particularly in emerging markets. A growing population, continued urbanization and rising wealth levels contribute to this structural trend. Energy efficiency gains through more automation can help to alleviate scarcity in environmental resources. Given the relatively large size of the global manufacturing sector, an aging population and rising wages, there is potential for a sustained expansion in automation equipment. As a result, automation is becoming a key business factor for a growing number of companies. From an investment perspective, smart automation is one of the fastest growing segments in the broader industrial and IT sectors.

And as with all investment decisions, diversification and stock selection are important for success when investing through a cycle.

Link to impact investing and UN Sustainable Development Goals (SDGs)

Rapid increases in productivity, driven largely by automation, have been among the most powerful drivers of human development over the last few centuries. There are many reasons to be optimistic about the role of automation in helping achieve many of the UN's SDGs:

- There is significant scope in developing countries to increase productivity and economic output, contributing to progress on SDGs, including no poverty, zero hunger, good health and well-being, decent work and economic growth, and industry, innovation and infrastructure.
- Automation-driven reductions in the cost of manufactured products make technologies including solar and wind power systems, water filters, mobile phones and medical equipment cheaper and more available to low-income communities.
- Industrial software, precision machinery, ubiquitous sensors and advanced monitoring systems in manufacturing, mining and agriculture can increase resource efficiency and reduce water, energy and raw material usage. This positively impacts environmental SDGs like responsible consumption and production, climate action, life below water, and life on land.
- Artificial intelligence (AI) can improve health and well-being by promoting greater efficiency in existing healthcare systems, enabling self-monitoring and allowing for early diagnosis of medical conditions. Machine learning can further extend the availability of quality medical care to remote regions through automated diagnosis.
- Big data is increasingly being used to enhance decision-making in development efforts. Satellite imagery, combined with machine learning, can help map poverty more effectively and track illegal deforestation. Big data is also being used to improve efficiency in building and urban infrastructure design, smart power and water grids.

However, investors must also consider the potential SDG-related risks of automation. For example, automating low-skill and increasingly

middle-skill jobs could increase workforce polarization and lead to greater inequality, at least in the short term, as new economy returns accrue to those with capital and the highest skills. Also, increasing industrial production efficiency does not necessarily lead to greater resource efficiency as lower-cost goods can spur higher demand and increase overall resource consumption. Furthermore, as machine learning is increasingly used to evaluate access to credit, insurance and jobs, there is risk of AI replicating human biases and further exacerbating discriminatory social dynamics.

Automation's potential for social and environmental impact on multiple areas as outlined above, together with potentially higher growth and returns from disruptive technologies like AI, make it an attractive impact theme. Currently, few impact investing solutions focus exclusively on automation and robotics. Investors can access this theme through generalist private equity and venture funds as well as via direct investment opportunities, subject to eligibility, availability and ability to execute such investments. Artificial intelligence, in particular, is a current area of focus for venture capital, with over USD 5bn invested in 658 startups in 2016, according to CB Insights. When investing using non-impact-specific vehicles, impact investors must assess on their own whether individual investments meet impact criteria including intent, measurability, verification and additionality.

Andrew Lee, Head Impact Investing and Private Markets
James Gifford, Senior Impact Investing Strategist
Nicole Neghaiwi, Impact 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 177.5bn now. For the next few years, we have raised our market forecast for factory as well as process automation, which likely bottomed last year. 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 8-10%, with superior margins. Software is at the center of this revolution, but there is also tremendous demand for automation hardware, such as robots, from 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, we see two positives in this theme: strong earnings growth, and re-rating potential 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, a renewed weakness in oil prices could hinder petrochemical investments in process automation, and peaking automotive investments could hurt factory automation spending. And 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	CAGR	Compound annual growth rate
Capex	Capital expenditures	COM	Common shares
E	expected i.e. 2011E	EV	Enterprise value = market value of equity, preferred equity, outstanding net debt and minorities
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

Disclaimer

Research publications from Chief Investment Office Americas, Wealth Management, formerly known as CIO Wealth Management Research, are published by UBS Wealth Management and UBS Wealth Management Americas, Business Divisions of UBS AG or an affiliate thereof (collectively, UBS). In certain countries UBS AG is referred to as UBS SA. This publication is for your information only and is not intended as an offer, or a solicitation of an offer, to buy or sell any investment or other specific product. The analysis contained herein does not constitute a personal recommendation or take into account the particular investment objectives, investment strategies, financial situation and needs of any specific recipient. It is based on numerous assumptions. Different assumptions could result in materially different results. We recommend that you obtain financial and/or tax advice as to the implications (including tax) of investing in the manner described or in any of the products mentioned herein. Certain services and products are subject to legal restrictions and cannot be offered worldwide on an unrestricted basis and/or may not be eligible for sale to all investors. All information and opinions expressed in this document were obtained from sources believed to be reliable and in good faith, but no representation or warranty, express or implied, is made as to its accuracy or completeness (other than disclosures relating to UBS). All information and opinions as well as any prices indicated are current only as of the date of this report, and are subject to change without notice. Opinions expressed herein may differ or be contrary to those expressed by other business areas or divisions of UBS as a result of using different assumptions and/or criteria. At any time, investment decisions (including whether to buy, sell or hold securities) made by UBS and its employees may differ from or be contrary to the opinions expressed in UBS research publications. Some investments may not be readily realizable since the market in the securities is illiquid and therefore valuing the investment and identifying the risk to which you are exposed may be difficult to quantify. UBS relies on information barriers to control the flow of information contained in one or more areas within UBS, into other areas, units, divisions or affiliates of UBS. Futures and options trading is considered risky. Past performance of an investment is no guarantee for its future performance. Some investments may be subject to sudden and large falls in value and on realization you may receive back less than you invested or may be required to pay more. Changes in FX rates may have an adverse effect on the price, value or income of an investment. This report is for distribution only under such circumstances as may be permitted by applicable law.

Distributed to US persons by UBS Financial Services Inc. or UBS Securities LLC, subsidiaries of UBS AG. UBS Switzerland AG, UBS Deutschland AG, UBS Bank, S.A., UBS Brasil Administradora de Valores Mobiliarios Ltda, UBS Asesores Mexico, S.A. de C.V., UBS Securities Japan Co., Ltd, UBS Wealth Management Israel Ltd and UBS Menkul Degerler AS are affiliates of UBS AG. UBS Financial Services Incorporated of Puerto Rico is a subsidiary of UBS Financial Services Inc. UBS Financial Services Inc. accepts responsibility for the content of a report prepared by a non-US affiliate when it distributes reports to US persons. All transactions by a US person in the securities mentioned in this report should be effected through a US-registered broker dealer affiliated with UBS, and not through a non-US affiliate. The contents of this report have not been and will not be approved by any securities or investment authority in the United States or elsewhere. UBS Financial Services Inc. is not acting as a municipal advisor to any municipal entity or obligated person within the meaning of Section 15B of the Securities Exchange Act (the "Municipal Advisor Rule") and the opinions or views contained herein are not intended to be, and do not constitute, advice within the meaning of the Municipal Advisor Rule.

UBS specifically prohibits the redistribution or reproduction of this material in whole or in part without the prior written permission of UBS. UBS accepts no liability whatsoever for any redistribution of this document or its contents by third parties.

Version as per September 2017.

© UBS 2018. The key symbol and UBS are among the registered and unregistered trademarks of UBS. All rights reserved.