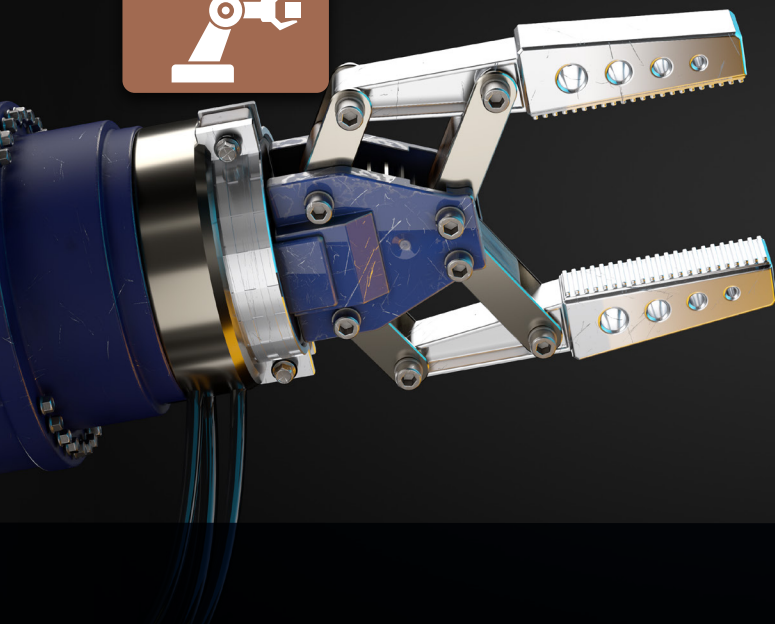




Whitepaper

Industrial



The Cobots are coming: How collaborative workflows will deliver flexible production of the future

Executive Summary

Collaborative robots (cobots) represent a rapidly emerging sub-sector of the industrial automation market, and are finding increasing application across various production industries. Characterised by an ability to work closely together with humans, the latest generation of cobots are safe, flexible, and user-friendly, providing companies of any size with a cost-effective means of adopting smart automation. This whitepaper looks at the growth of cobots, while outlining some of their key enabling technologies, such as controllers, arms, end effectors, sensors and drives. It also looks at the nature of the cobot supply base, identifying some of the key distributors of associated electronic components.





The rise of the robots is taking place within manufacturing facilities throughout the world. In an ever-growing range of sectors such as automotive, electronics, material handling, food and metal working, surging levels of investment in advanced automation result in smarter and more cost-effective ways of working, freeing up humans to perform more valuable tasks.

Traditionally, robots within manufacturing environments have been physically separated from employees – either behind safety cages in cells or on distinct production lines. But that is starting to change. A new breed of collaborative robots (cobots), which are designed to work hand-in-hand with humans for specific tasks, have started to come to the fore. These cobots are smaller and user-friendly than their fixed-position counterparts, opening up some exciting new applications in any manufacturing process.

Indeed, cobots represent by far the fastest growing sector of the industrial automation market, with stellar forward projections. A recent report from research specialists Markets and Markets suggests that sales of cobots will grow from \$710 million in 2018 to \$12 billion by 2025, at a staggering compound annual growth rate of more than 50% during the forecast period. This growth is attributed to a timely confluence of several factors, including the high return on investment and relatively low price of collaborative robots, which result in the growing adoption by small- and medium-sized enterprises. It is also supported by rising investments in automation by industries to support the evolution of Industry 4.0, improving human-machine interfaces, and increasing capability of artificial intelligence to imitate human behaviour, says Markets and Markets.

Benefits and applications

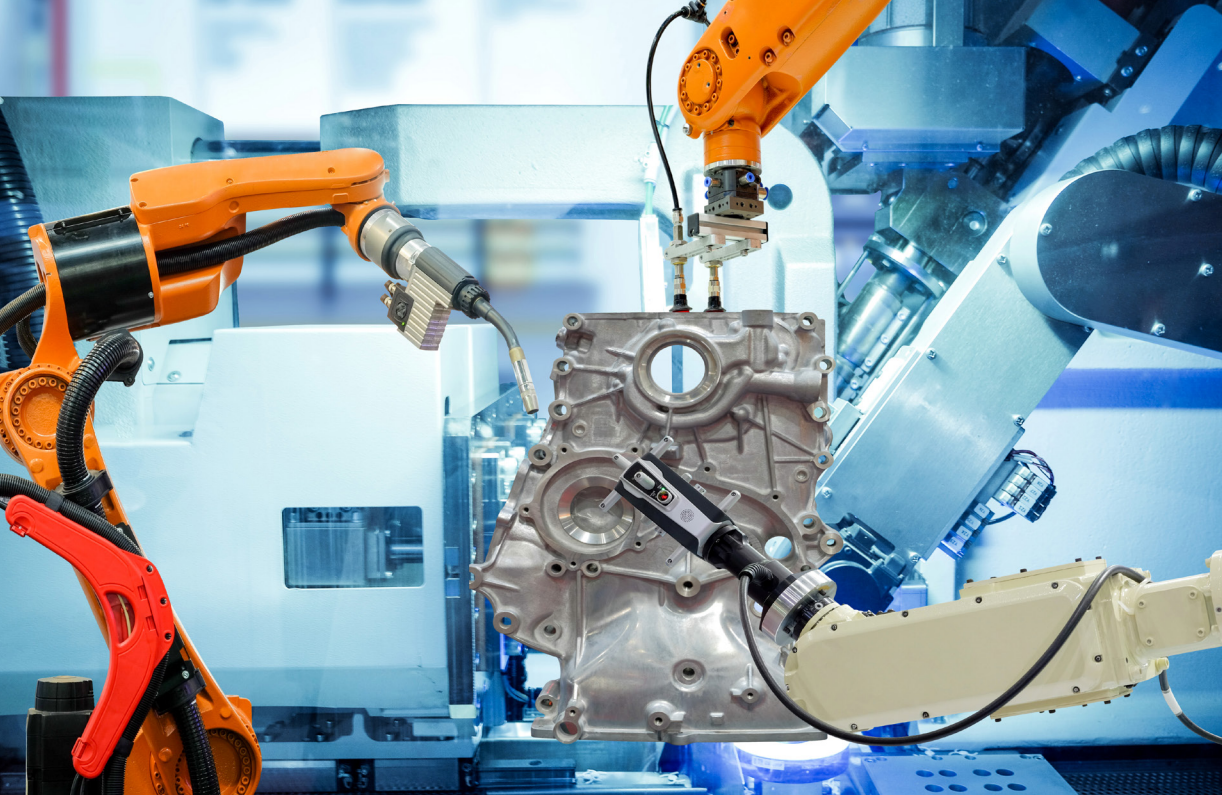
In terms of a commonly-used definition, cobots are described as robotic systems that are specifically designed for direct interaction with a human within a defined collaborative workspace. Within these shared environments, safety is obviously paramount. Cobots are therefore fitted with a suite of intelligent sensors which enable them to respond to human movement in a split second by reducing their speed and thus kinetic energy to an extent that prevents any form of injury. In short, when the person acts, the cobot reacts.

So, what are the primary benefits of cobots? Typically, traditional industrial robots have proved adept at performing simple, repetitive handling tasks. Humans, on the other hand, have unique thinking and response skills that enable them to understand and respond to any changes in tasks. By working hand-in-hand as a "team", humans and robots can greatly improve performance, as long as the work is optimally shared in a safe and efficient manner. That's where cobots start to find their place within manufacturing settings.

The use of such technology can therefore deliver some distinct advantages. Firstly, the removal of safety fences and cages is a huge space-saver on factory floors, encouraging far greater flexibility in terms of production line layouts by reducing the disruption to material flow. But it's not just about physical space-saving: Cobots can also transform the types of products that can be made. Whereas fixed position industrial robots are largely about consistency of quality and flow – replacing functions in which lesser-skilled people had to carry out repetitive, burdensome tasks – cobots are about working side-by-side with highly skilled people to create individualised products in an emerging trend commonly referred to as mass customization.

That could mean workers using the advanced capabilities of cobots to customise certain elements of car interiors, or to perform individual embellishment to high-spec watches and jewellery. Or it could mean adding new levels of authenticity to the packaging of premium craft beers and foods. Or cobots can help to perform risky tasks such as packing and unpacking boxes or cartons. It's only through man and machine working seamlessly together that manufacturers will be able to meet the rising expectation of an increasingly discerning customer base. It is about applying cobots as personal production tools that can be used by members of any workforce to apply creative skills more effectively, thus providing greater human value.

At an economic view, cobots can return their investment within a year at an entry level in a range of € 30k. . . €50k. Thus, they can become available also to SME where they can prove their benefits on a large scale.



Design considerations

In terms of design, there are major similarities between cobots and traditional industrial robotic arms, with both comprising a combination of controllers, arms, end effectors and drives to perform operational tasks. However, cobots are typically smaller and come with lower payloads, usually between 3 – 20kg. They are fitted with additional sensors and safety features including force feedback, vision and motion-detection sensors. The sensors are often installed beneath a padded 'skin' that is soft to touch, making them suitable for close operation with humans in what can be ergonomically-tight production environments.

The sensors enable the cobot to 'feel' external forces and, if the force is too high, to halt its movement. Passive compliance is produced through the use of mechanical components. So, if an external force is felt on a component such as a joint, this joint will submit itself to this force. In the case of a collision, the joint will move in the opposite direction or stop completely to avoid causing injury.

In parallel to the progression of cobot technology has been the development of safety standards to support their use. International Organization for Standardization ISO/TS 15066 provides technical specification for collaborative robot system safety, outlining four primary types of collaborative operation which ensure that cobots can be designed for safe use within manufacturing environments.

Firstly, there is power and force limitation, which allows the cobot to know how much power and force a person can withstand, and instantly cease activity if an obstacle is encountered. The energy of any collision is kept below maximum levels as defined by the ISO standard. Safety monitored stop, meanwhile, uses a suite of sensors to ensure that the cobot is aware of its human workers within the workspace, and if any body part gets too close, it will stop what it is doing. Effectively, either the robot system or the human operator moves, not both at the same time.

Then there is the use of speed and separation monitoring, which employs sensors to detect human immediacy and reduce operating. In such instance, says ISO, a minimum safety distance between the robot system and the person is maintained to avoid contact. The robot system then 'dances' with the worker, meaning that if the individual takes a step towards it, the robot system will move one step back. The ISO/TS 15066 technical specification offers detailed guidance on maximum allowed speeds and minimum separation distances for safe operation.

And finally, there is hand guiding, where human operators can program a cobot to learn new paths and positions by manually guiding the cobot arm. Hand-guiding cobots are particularly suited for use in delicate production line activities, and in other sectors such as healthcare where they can be used to carry out intricate surgical procedures such as needle insertion, drilling and stitching.

ISO/TS 15066 specifies wider safety requirements for cobots in industrial settings. This includes guidance on how to perform comprehensive risk assessments to assess not only the robot system itself, but also the environment in which it is placed, considering factors such as ergonomics which have a big impact on worker posture and comfort.

Expanding supply base

As the market for cobots has grown, and new applications have emerged, so the number of cobot suppliers has steadily increased. Initially, the market was dominated by a handful of global players including Universal Robots, Festo, ABB, Fanuc, and Kuka. However, over the past few years, other disruptive start-up companies were established, many of them start-ups from universities. Now, there are more than 30 sizeable companies active in the cobot market, and that number is expected to continue rising.

As a result, the increasingly fragmented nature of the cobot market is now supported by an ever-more diverse component supply chain, with electronics distributors offering a wide range of associated products including EMI/EMC/ESD passives, DC/DC power units, sensors, connectors and interconnects, sockets and wireless modules, to name but a few. At TTI Europe, for instance, this demand is being met through a range of product suppliers including Murata, TE Connectivity, TDK, Vishay, AVX and Amphenol, enabling cobot manufacturers of all sizes to design and build new models from the ground up, using latest technologies from these leading suppliers.

For instance, TTI's recently published Sensors Application Guide now features a specific section dedicated to robotics, cobots and factory automation. This includes details of products such as force sensors, which have been designed for sensing force in input devices and posture control in industrial equipment. The range uses MEMS technology to achieve the industry's smallest size, making it ideal for use in cobots. These sensors use the effect of piezo resistive bridge circuit formed on a silicon diaphragm, with the piezo resistance changed according to the strain by applying a force to the diaphragm. This yields high sensitivity and a good linearity, and the device can precisely detect micro forces less than 0.01N.

The guide also provides details of face recognition modules, which handle all the complexity of recognising faces, bodies and gestures, allowing a developer of cobots and other factory automation systems to read the data output and programme a response without the need to understand the algorithms or optical design.



What's next for cobots?

It's clear, then, that the market for cobots is developing at a rapid pace, with the number of manufacturers increasing and the component supply chain becoming ever-more established. Looking forward, it is likely to be small-to-medium sized businesses that continue to push the sector forward, with cobots providing relatively low-cost solutions that allow for a more customised manufacturing that is not restricted by factors such as volume levels or the kinds of products being created. New applications will continue to emerge, as companies exploit the opportunities of smarter working.

In short, the cobots are coming – and in the rapidly-developing world of fully collaborative manufacturing, it seems that humans will be marching with them too.



About TTI

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European Headquarters:

TTI, Inc.
Ganghoferstr. 34
82216 Maisach-Gernlinden
Germany
Tel.: +49 (0)8142 6680 – 0
Fax: +49 (0)8142 6680 – 490
Email: sales@de.ttiinc.com
www.ttieurope.com

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