New perspectives on robots in mechanical engineering

Barriers at the control level must be removed. Industrial robots open up a great deal of interesting perspectives on mechanical engineering. However, robots must fit smoothly into the automation architecture, a fact which estabilished robotics suppliers are beginning to recognize. Andrea Barbolini, responsible for robotics at Schneider Electric, talks about the current trends and what it means to integrate robots into machines.

How do you see the robotics market at the moment?

Robotics is currently experiencing incredible growth. The number of units installed worldwide is increasing by double digits every year. Looking at figures from the International Federation of Robotics (IFR), there has been an increase of between 14% and 15% annually since 2013. This tremendous is expected to should last until at least 2019, and it is happening worldwide: China stands out purely because of its size – it is the largest single market for robotics.

Which are the technical trends to watch?

The market is diversifying. As well as classic industrial robots, a new segment of "service robots" is establishing itself. A significant boom is expected to take place in this segment, though of course service robots have very different applications from industrial robots.

Collaborative robots are also a new trend. Lightweight robots are gaining a particular foothold here, as their lower weight and generally slower movement makes them less dangerous for human use. But lightweight robots are not generally competing with industrial robots, in which highly-accurate positioning and/or higher speeds are more important.

Which construction materials do you see in the future of robotics?

That depends on the kinematics, the intended application and the weights involved. As a general rule: the lighter the construction, the higher the dynamics. Despite the material's outstanding properties, I am wary of carbon fiber, particularly for applications in the food, pharmaceutical, and cosmetics industries. If an arm gets broken in a crash or another sort of accident, the whole area becomes contaminated with fibers. This would involve a massive clean-up operation. Arms can also be found which are made out of stainless steel panels. Personally, I see these as the better option.

Crashes happen very rarely. Do they justify the heavy steel construction?

For one thing, crashes are not the only disadvantage to carbon fiber: industry-standard detergents make the surface of carbon fiber brittle, increasing the likelihood that fibers will be released. And for another thing – when constructed in the right way, stainless steel arms are just as rigid and not significantly heavier than their carbon fiber equivalent.

Industry 4.0 and IoT are the trending topics of our time. Will they also affect robotics, in your opinion?

Absolutely: For us, robotics is a key component of the "smart machine" – the mostly autonomous, networked unit integrated into an automated, flexibly adjustable production process. It also integrates with Internet-based concepts of production control. Robots, at least as far as Schneider Electric is concerned, work as an integral part of a production process or even as a directly integrated component of machine concepts. They automate processes to the extent that, ideally, they would function without operator input. Robots pick, position, sort, and mix products. In the best case scenario, they would do so completely automatically and could be changed over at the push of a button. In many cases, robotics has become a key function where machining, processing, packing, and handling steps are integrated into a complete process.

This isn't entirely new!

No, but the advantages of robotics are demonstrated especially well when processes have to be adjusted flexibly to changing circumstances. Robots offer a lot more freedom than classic machinery. This is particularly important when changing to fit new situations. Changing process parameters requires no manual intervention as long as the whole tool doesn't have to be changed, and even that can be automated.

Therefore, in many cases, robotics is a crucial component of the dream of fully-automated, artificially-intelligent production, as in Industry 4.0. What's more, robots are generally equipped with relatively complex sensors or coupled to vision systems. This means robots or robot cells can obtain valuable data for overall analysis and statistical solutions.

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Do robots need any further development before they are “Industry 4.0-ready?”

That depends on expectations.
Current robots are fundamentally ready for Industry 4.0. However robots, like any other machine, will have to become more communicative in the future: Preventive maintenance, status information, exceptional situations, diagnostics – all of this will lead to increased integration of sensors in robots, with a greater variety of diagnostic concepts than those we are used to today.

Proprietary control concepts are common in robotics. Do these meet the requirements of the smart machine you imagine?

This question can be answered with a definite “no.” There are a variety of reasons for this: As a rule, robots are integral components of processes that are automated by conventional control systems. If a machine or another type of complete system is changed over to a different format or product, the robot integrated in the process also needs information flexibly in order to adjust to the changed parameters.

This is only really possible when the robot controller, including the positioning, is an integrated part of the machine program. By contrast, a proprietary controller means there will be a machine program and a completely separate robot program. Of course both controllers can be connected via interfaces, but generally speaking a portion of the flexibility gained by the robot is lost in this separation.

Apart from that, the command exchange interface presents a barrier to the availability of other data: isolated concepts for operating/ visualizing, functional safety, diagnostics, image data – all of this becomes much less accessible.

What solutions do you see?

We migrated to standard solutions for motion control over nine years ago: We’ve integrated complex functions into IEC 61131-3-compliant, parameterizable modules. These can be embedded into normal IEC programs. This means robots are advancing to relatively complex multi-axle servo systems.

With such deep integration into the machine program, the robot is able to comply with a change in parameters – for example a change of dimensions in a top-loading packaging machine – without restrictions. By doing so, you unlock all the advantages of an integrated control solution for visualization, diagnostics, exception handling, and even data generation within the framework of IoT-based solutions.

"Particularly in terms of integrating robotics into machines, I can only recommend finding out exactly what support is available on the software side."

Robotics require more processing power than normal motion applications – is that a problem?

I can only speak for us – PacDrive 3 is our standard motion control solution. It offers scalable controller performance for between two and 130 servo axes moving in synchronization, which communicate with the controller via Sercos using a cycle time of between one and four milliseconds. Using an IEC 61131-3-compliant program, the controllers calculate all of the position values for the movement of one or more robots.

Of course, normal servo axes cannot compare with robot axes in terms of processor load. But four to five axes per robot and up to 10 robots in a picker line – we can manage that without a problem. And we also control the rest of the machine’s servo axes, including belts and typical PLC functions.

How can modular approaches work with this concept?

With modular or decentralized approaches, we control robots individually using a "simple" controller for six synchronous axes per robot cell. That is sufficient for example for a Delta 3 robot with an additional rotation axis as well as feed-in and feed-out – ideal for controlling modular robot cells. Machine and robot controllers can then be synchronized just as quickly using controller-to-controller communication via Sercos, as is the case within the controllers' own Sercos systems.

So this approach only works for your own range of robot kinematics?

That is not correct, because many of our customers construct their own, highly application-specific robot kinematics. At first glance, these often don't even look like robots. But as long as our servo motors and servo drives are used, we are still in our control environment and all of the associated advantages remain available.

And for us, robotics is not just reduced to a hardware portfolio: we also offer robotics for software functionality, consisting of libraries with fully pre-programmed robot functionalities and generic transformations for all current kinematic types with up to five axes.

But that won't work when integrating products from classic robot specialists, right?

Manufacturers of classic industrial robots have certainly recognized the need for robotics to integrate more deeply in the environment of machine applications. For example, Stäubli offers the uniVAL PLC and uniVAL Drive interfaces. These work both with our control environment, as well as with that of Schneider Electric's competitors. A year ago, KUKA presented a software library through which their robots could be controlled directly by classic automation control systems.

So can machine builders integrate more products from classic robot specialists into their machines now too?

At the moment that will only work with a few pioneers in this area. Secondly, there are significant qualitative differences concerning integration at the program level: There is a distinction between complete and partial integration of robotics into the control solution of a machine. The Stäubli uniVAL plc interface allows partial integration.

The company has developed function blocks which can control the robot's operation using their machine controllers. Path planning for the movement of robot axes continues to run on the Stäubli CS 8C robot controller. The Kuka solution, with the mxAutomation interface, is similar.

What about complete integration?

Here I can only refer to the Stäubli solution. With this, the robot(s) can be completely integrated into the machine program via the uniVAL drive interface. The CS8C robot controller, as a part of Sercos communication, then emulates the right number of servo drives depending on the number of robot axes.

The machine controller – a motion controller – then calculates the position values of the robot's path for these drives. The second option: closer collaboration means that for at least part of the Stäubli portfolio, there is the option of operating robots with our servo drives.

Then we would have a "full-blooded" motion control-based solution, including all the advantages of an integrated automation solution. When integrating by emulating a servo system or another device, who provides the tools to program path planning?

Are there library functions available for this?

This is exactly what a machine builder should consider before deciding which route to take. When integrating a robot into a machine purely for control, this does not happen. What can help me generate robot movements, what will I get from my automation partner? Nothing at all, perhaps at least a library with the relatively simple robotic function blocks defined by PLCopen?

Or maybe a library with ready-made software components for complete motion sequences, belt tracking, intelligent acceleration limits, motion functions with and without blending, camera integration and lots more? That is the key difference: How high qualit a robotic solution can be implemented in the machine's program, and how difficult will it be? I recommend asking that very question!

Andrea Barbolini joined Schneider Electric in 1995 as CEO of ELAU ITALIA Srl. He has a degree in engineering from the University of Bologna in Italy and has a vast amount of experience in the packaging industry, earned in collaboration with important Italian machine builders. After overseeing the integration of ELAU into Schneider Electric, he's currently Vice-President Solutions Management and responsible for Solutions and Applications.

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