

Efficiency up, Cycle Times down

Total Integration of Industrial Robots Including Injection Molding Machines

Process integration and the corresponding automation solutions are important keys to better quality and lower piece costs. However, both trends tend to complicate the processes and lead to several control systems that have to communicate with each other in real time. Overall efficiency cannot be improved further unless peripheral controls are entirely integrated in molding machine control. Large multi-axis industrial robots used in conjunction with injection molding machines with high clamping forces are no longer an exception from the rule.



Entirely integrated: An Engel duo combi M injection molding machine produced decor elements for an automobile interior at the 2015 Fakuma. An Engel easix industrial robot performed the handling of real wood veneers and the finished parts (figure: Engel)

Totally integrated system solutions from a single source are enjoying increasing global demand, since they not only speed up commissioning by reducing the effort required to coordinate such projects, but also because they offer advantages in terms of process technology. For instance, at Fakuma 2015, an application by Engel Austria GmbH of Schwert-

berg, Austria, could demonstrate a 10% reduction in removal time over an incompletely integrated solution.

In this case, decor elements with real wood veneer (**Title figure**) were produced on a large machine (type: Engel duo 650 combi M) by what is called the "Clearmelt process". A completely integrated multi-axis robot (type: Engel easix) placed the

wood insert in the mold, removed the finished parts and laid them on a conveyor belt. This was the first time Engel demonstrated its large new robot at a trade fair. Its 3,900 mm reach and its 240 kg load capacity in the standard version widen the application range of Engel multi-axis machines. Even injection molding machines with clamping forces of up



Fig. 1. Viper linear robots as well as easix multi-axis robots are integral elements in the Engel CC300 injection molding machine control. Hand-held terminals are available for stand-alone operation (figure: Engel)

to 55,000 kN used, for example, in the production of 1,000 liter garbage bins can be automated together with multi-axis robots in an integrated solution.

Subsequent to the exhibition, the production cell including the injection molding machine, robots and technology package were shipped to HIB Trim Part Solutions in Bruchsal, Germany, an affiliate of NBHX Trim GmbH. The world's first highly automated production line for "Clearmelt parts" will be placed in operation there shortly.

Engel spotted the trend to customized system solutions early and oriented their own development away from that of a builder of injection molding machines and towards system expertise, instead. Their own robotics program is an important building block in this strategy. As early as 1980, Engel began with the development and construction of linear robots and integrated them into molding machine control. Since 2011, Engel has also offered the easix series of completely integrated multi-axis robots. The smaller models available right from the start are based on a technology platform from Stäubli Robotics; for its new, larger models, Engel has been able to secure Kuka as a further partner.

Thanks to close cooperation with the system partners, Engel has access to intensive research and development by the manufacturers of industrial robots. In order to adapt automation individually to

the specific requirements of particular applications, Engel combines its partners' know-how with its own knowledge of the industry, thereby accessing a complete range of products. This includes the multi-axis industrial robots of the types Engel viper linear, e-pic pick-and-place, easix, as well as special automation solutions. As general contractor, the company moreover integrates robots and additional periphery components from third suppliers in its overall concept.

Simple Control for Complex Processes

The advantage of an integrated Engel solution comes from the fact that the injection molding machine and the robots share the same control and thus possess a parts data bank. The performance characteristics of a linear robot are also available to multi-axis robots. Complete integration is the prerequisite for simple and intuitive operator guidance. Since the control of Engel robots is configured as a subsystem of the CC300 Engel injection molding machine control [1], the operator does not have to be trained for different operating logics, but can also operate the robot using the familiar commands for the injection molding machine (Fig. 1).

The additional robot motion commands fit seamlessly into the graphical user interface of the machine control system. Then it no longer makes a difference to the control, whether it calls the three

linear axes and up to three rotational axes of the linear robot, or if it calls the many rotary and linear axes of the industrial robots. Even when additional peripherals, such as test equipment, magazines, supply units, laser cells or infrared ovens are integrated, the CC300 controller functions the same way as an overall control. The consequences thereof are clearly simplified control and control loops. No additional PLCs (programmable logic controls) are required, since the total system is operated at all times exclusively via the Engel control.

In order to enable rapid parameterization even in highly complex overall systems, the CC300 offers various flowcharts, from the simple selection of ready-made standard processes, to the object-oriented graphical creation of sequences known in connection with linear robots (Fig. 2). This includes, among others, manual mode, message and actual value displays, closing security and working space, as well as the use of standard and user masks for pre-programmed robot operations. An additional advantage is offered by an exit strategy in the form of a pre-programmed home run from any position. This function alone ensures that the industrial robot can be operated reliably and safely without in-depth training.

The teach skills for linear robots are sufficient to parameterize a multi-axis robot, as well. By contrast, the syntax-based code of the conventional multi-axis »



Fig. 2. Complete control integration enables simple parameterization and operation of the easix multi-axis robot. The Engel solution enables object oriented graphical representation of flow sequences even for complex production processes. Teach skills for the viper linear robot are all that is needed (figure: Engel)

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robots on the market requires thoroughgoing familiarity with the program code of the particular robot manufacturer. Just as easily, several robots can be combined with one injection molding machine. There are no limitations, even where program positions, speeds, types of motion, safe path planning and the teaching of free shapes are involved.

Additional added value is offered by solutions that include an image processing system for simple presence tests prior and subsequent to the process and including robot guidance using the 2½D method. This provides the injection molder with a single point of operation for the entire production cell even for complex automation tasks. He can also switch back and forth between languag-

es. Besides all European languages, the standard Engel solution includes the prominent Asian languages. Thanks to this wide range of features, the machine operator can handle many tasks by himself that used to require calling in a programmer. This increases production cell availability and production flexibility.

Zero Time Removal for Faster Processes

An essential advantage of this depth of integration is the fact that the robot does not communicate with the injection molding machine, but, being an integral part of the system, accesses the same data base. Precisely this characteristic holds the key to optimizing production

efficiency, since injection molding machines and robots can coordinate their motion sequence and control loops with each other automatically.

Whereas robots in incompletely integrated solutions cannot be released until the mold is entirely open and the machine has communicated this condition to the robot, the robot in the Engel solution can start entering during the opening motion of the movable platen. So-called zero time removal shortens handling and eliminates the time required by conventional communication interfaces between machine and robot.

Fieldbus communication enables the motions of the injection molding machine, mold and robot to be synchronized without additional equipment. Even for complex processing sequences, this takes place within the CC300 environment via the molding machine display. The definition of blocked spaces is standard in the integrated solution. Blocked spaces are graphically visualized in the control. The operator not only sees where they are located over the entire range of travel, but also recognizes which blocked spaces are active, or, for example, have been violated by a manual motion.

If the molding machine, robots and additional peripheral equipment stem from the same source, Engel, as system supplier, assumes the CE certification of the entire system. The large new easix KR



Fig. 3. The stand-alone version of the multi-axis robot – as here at Weidplas in Treuen, Germany – makes it possible for production operations to work with an integrated solution and a uniform operating logic via the injection molding process (figure: Weidplas)

robots have been type-tested by the TÜV (German Technical Inspection Association).

The Level of Automation Rises Further

Since Engel introduced its easix robots, more than 150 multi-axis units of this type have been installed, 80 having been sold within the last twelve months alone. These figures reflect the general trend to a higher level of automation and to single

point of operation in injection molding. Europe and America are currently the strongest growth drivers.

Multi-axis robots with complete integration continue to arouse the interest of processors, since they can flexibly support additional working steps, such as quality control or assembly tasks, in addition to the injection molding process. Even without an Engel injection molding machine, the stand-alone version with and without a Euromap 67 interface enables all production processes to be performed by integrated automation and a uniform HMI (**Fig. 3**).

Outlook

With its high system competence, Engel can offer powerful, multi-functional and easy-to-operate automation solutions. In order to adapt these so as to maximize efficiency in particular applications, the company continues to expand its product range. Thus the Engel easix series has now been expanded to include a Scara version. Due to their high rate of picks per minute and comparatively low investment costs, these four-axis robots offer advantages for pick-and-place tasks, grip arm fitting or conveyor tracking (**Fig. 4**). For this latest expansion of its product range, Engel is cooperating with Stäubli Robotics; the first such easix four-axis robots have already been installed. ■



Fig. 4. Engel has expanded its easix series further with Scara robots. They are utilized for fast pick-and-place tasks, such as the efficient full equipping of grips or buffer adapters (figure: Engel)