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Machining Cell for Injection Moulded Plastic Containers

The introduction of a manufacturing cell equipped with a milling and drilling robot at a plastic container manufacturer´s shows that this solution is superior to the original process in which the parts were conveyed to a milling machine. Only the robot cell can work with an identical cycle to the injection moulding machine and thus guarantee a constant, high product quality.

When it comes to expertise in static and dynamic storage systems, this is the preserve of Bito-Lagertechnik, Meisenheim/Germany. Bito has earned itself a global reputation as a specialist for all-in solutions for shelving systems with automatic picking. The company produces plastic containers and trays for these systems which have been developed in-house. These containers fulfil special requirements:

- a stiff double base keeps deflection to a minimum under high loads
- the base is flat and very smooth to ensure that automatic conveyance gives rise to only a low level of noise
- containers with a perforated base are supplied for warehouses with sprinkler systems to BG 4.3 / VdS; this ensures that
- fire-fighting water can drain off downwards in the event of an emergency - safety aspect 1 - rather than remaining in the containers and increasing the weight higher up, which is not permitted - safety aspect 2.

Achieving a container design that is suitably tailored to the plastic requires ribbing on the outside of the base in order to provide extra stiffness. A smooth base plate is then affixed to these ribs by means of vibration welding, giving a particularly rigid honeycomb sandwich systems.
Die Fertigung bei Bito läuft kontinuierlich im Drei-Schicht-Betrieb.

Awaiting Shrinkage Prior to Welding

A number of logistics problem have to be solved before these containers can be produced in a cost-efficient manner. The injection moulding machine produces containers with a base of 600 mm x 400 mm and a height of 320 mm in a 40 s cycle, for instance. Before the base is welded on, these containers must be stored for 24 hours in a dry location, until the moulding shrinkage is virtually complete. Containers of this size thus require some 200 m3 storage space to be available, through the nature of the process, while bigger containers require correspondingly more space. As a result, production is run continuously at Bito, i. e. the containers are injection moulded in three shifts and, after the shrinkage process has been completed in the intermediate store, the base plate is welded on, observing the "first-in-first-out" principle.

On account of the shrinkage process, the base plate has to be 3 mm wider and 3 mm longer than would actually be necessary to cover the ribs on the base. Once welding is complete, any plastic protruding is milled off along the contour. At the same time, an inclined run-up edge is applied by milling a bevel. This facilitates transport on the conveyor section.

While the container is clamped in place, the holes will be drilled where these are required (12 holes with a diameter of 10 mm for the case referred to). These must be precisely aligned with the holes that have already been moulded in the container. Only in this way con it be ensured that the hole edge formed in the injection mould, which is also welded, will effectively seal the hollow-chamber profile of the twin base when the container is subsequently cleaned.

Finally, the containers are ionised so that they attract as little dust as possible during transport to the end customer. They are identified by barcode labels that are attached to all their sides, stacked on pallets, and have shrink film applied to them ready for dispatch. All these process steps have to be synchronised with the injection moulding cycle. Only in this way is it possible to ensure a constantly high quality of production in just a small production space.

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The Robot as the Centrepiece of the Manufacturing Cell

So far, the containers have been machined with a CNC milling machine incorporating an automatic tool changing facility. This solution is only suitable to a limited extent for a continuous process, however. For big containers, and where holes have to be drilled in addition to the milling work, the fabrication sequence of the milling machine takes more time then the injection moulding cycle. This gives rise to a discontinuous production process, necessitating a high intermediate storage volume and leading to a lower quality in some cases. Since batches of parts have to be machined, the individual containers will have been in intermediate storage for different periods of time and will thus have shrunk to differing extents.

To overcome these limitations, the new concept includes a robot manufacturing cell, set up by REMAK Maschinenbau GmbH, Reinheim/Germany. The centrepiece of this cell is a KR 60-3 HA articulated arm robot (manufacturer: KUKA Roboter GmbH, Augsburg/Germany). This is mounted, along with a rotary table, on a solid base plate which is a feature of all REMAK machining cells. The plate conducts the force between the robot and the work table. At the same time, it serves as a central means of transport and as a basis for aligning the manufacturing cell. The system can thus be erected, started up and optimised on-site within a very short time.

REMAK´s software engineers have considerably simplified the operation and programming of the KUKA robot through a newly-developed user interface. An extra control panel for path correction has been specially developed for this particular application. The structural configuration of the pivoting machining head, with the milling unit and drill drive, permits particularly simple programming for the different manufacturing tasks, since the TCP (Tool Centre Point) is identical for both tools.

The cell is loaded and unloaded independently of the machining operation. After the container or tray has been removed from the welding machine, the vibration welding machine operator places it on an inclined unit outside the manufacturing cell. This holds the part by means of suction and centres it. The unit is mounted together with another unit on the rotary table, which is half inside and half outside the manufacturing cell. A co rotating protective element in the centre of the table serves as the safety closure for the manufacturing cell.

Once loading is complete, the operator moves out of the space in front of the workplace, which is monitored by means of o photoelectric beam, and confirms that loading is finished by pressing a button on the control panel. In the course of this operation, the robot mills and drills a moulded part on the rotary table in the cell. After this, it moves with the drilling head into a cleaning and checking station in which any chips adhering to the drill are wiped off, and the drilling head is checked to ensure it is complete. At the same time, the robot´s control system issues the command for the table to be rotated. The part that has just been machined is thus transported to the outside, while the newly introduced part is conveyed to the inside. The robot starts work again while, outside, the operator checks the finished part and brushes off any chips adhering to it.

Machining tolerances can occur on the milling edges an account of the process - either during injection moulding and/or as a result of different storage times (despite the live storage system). The operator can reduce the severity of these deviations in a simple manner, without needing to intervene in the process cycle, by pressing plus/minus buttons on a control panel. If milling residue remains on one edge, for example, the operator can improve the milling results by pressing the minus button allocated to this milling edge and thus have the milling dimension for this edge, parallel to the base surface of the container, shifted to "minus" (= smaller base dimension) in increments of 0.1 mm. The path correction is stored in the robot´s memory and applied for all subsequent containers machined until such time as the correction is changed or cancelled. The control panel incorporates illuminated buttons showing where the current path is in relation to the programmed reference path (marked by "0").

Moving the milling edge does not affect the programmed drilling grid. Tolerances in the injection moulded part are accepted as a slight displacement of the drilled hole in relation to the injection moulded hole. If the tested parts is found to be good, the operator will forward the container for the automatic elimination of any static charge. The unit to take the article is then empty and can be reloaded.

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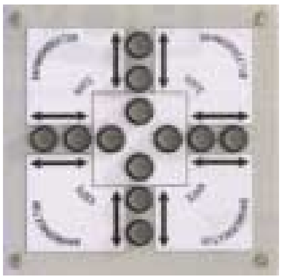

Pictures: REMAK Maschinenbau GmbH

Continuous, Cycled Process

Although cutting speeds and hence the milling and drilling times are comparable in both cases, only the robot manufacturing cell can work to the same cycle as the injection moulding machine, making it far superior to the milling machine. The reason for this is that the loading and unloading operations take place independently of the machining operation in time terms. The robots starts automatically. The milling head and drilling heads are not changed but simply realigned. Both run continuously with an infinitely variable speed (maximum 15 000 r. p. m.). The head that is not engaged runs along too, so that the tools do not need to be slowed down and then accelerated again. The robot can perform a fast traverse over 3D paths and mill or drill on an alternating basis where required, if the geometric configuration makes this worthwhile.

A further advantage of the robot cell is its big working area. The cell can handle parts with a base of up to 900 x 750 mm. It is even possible for the container walls to be laterally machined, where required.

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