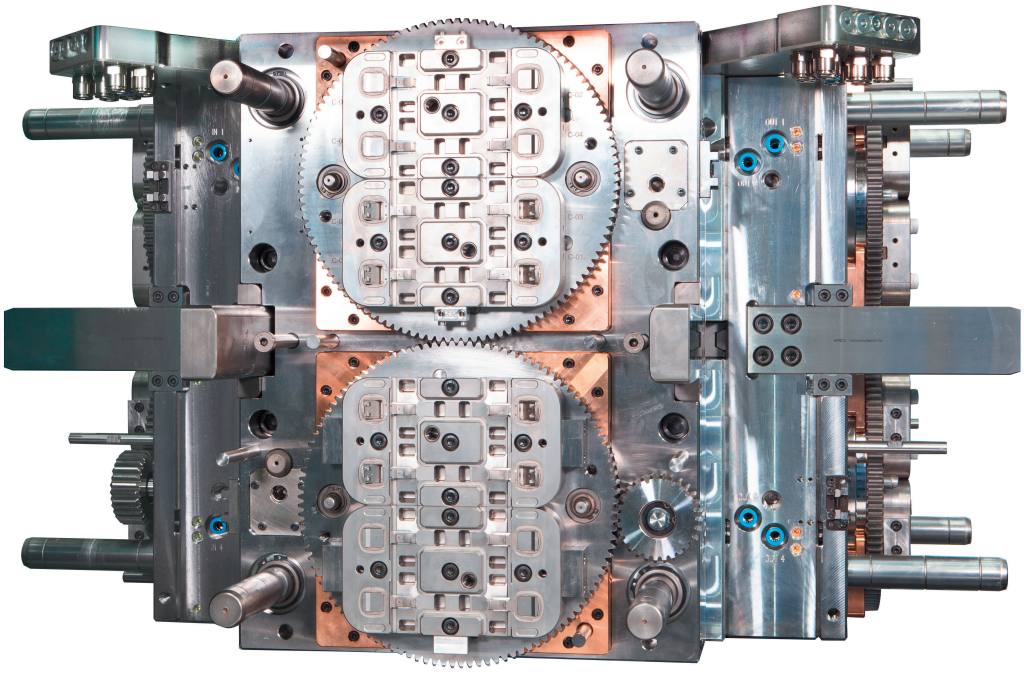
Multicomponent Cube Molds

Turning out 3-Component Parts under Torque

Functional integration instead of downstream assembly: moldmaker Foboha presented a sophisticated patented mold technology at K 2022 that could transform the market for disposable beverage containers in the next few years. The company is remaining tight-lipped about its current pilot project. This article describes the underlying Citi technology, which features a cube mold with integrated turning inserts. The new process saves production space, energy and cycle time.



The sprockets of the circular Citi tool elements interlock with each other and provide the vertical rotation. The entire cube then rotates horizontally.

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Citi stands for "Cube Inclusive Turning Inserts," a patented technology especially applicable for 2-component articles where a second material is required on both sides of the basic body, such as toothbrushes with soft components on the handle.

In this case, it is a 3-component part, where a frame of polypropylene (PP) is injected first, followed by sealing on both sides of thermoplastic elastomers (TPE) and a moving element of polyoxymethylene (POM).

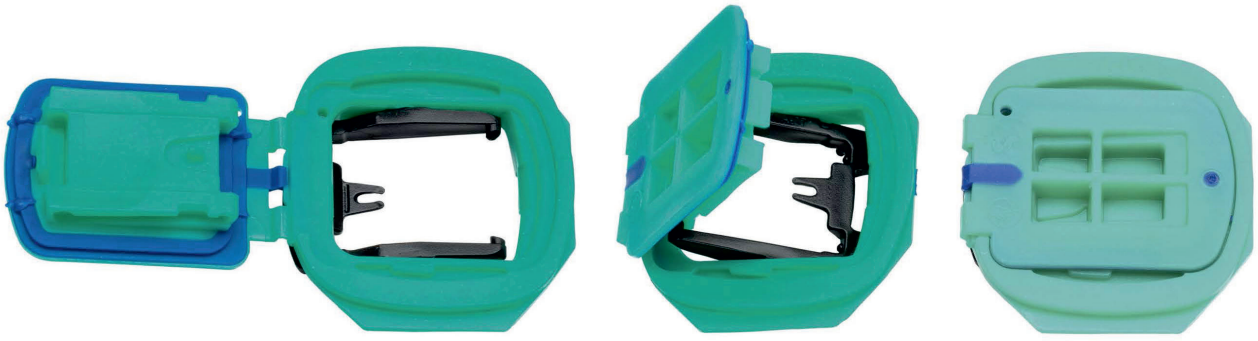
While this concept is possible today, the costs for multiple presses and automation are considerably higher than having the full functionality integrated directly into one mold. Citi saves product costs, production space, energy, and assembly time. The assembly time is approximately 30 % lower than with assembly downstream of injection molding.

Simultaneous Processes on Four Sides of the Cube

The multi-turn mold, whose technology was developed by long-time Foboha General Manager Rainer Armbruster, runs on an Arburg Allrounder Cube 1800. On each side of the cube (600 x 600 x 696 mm), there are two circular Citi elements arranged one above the other, with their gear rims interlocking and each having eight cavities.

The process works with impressive efficiency: on the moving mold side, PP is injected into the upper row of cavities of each of the two circular Citi elements. This creates a total of eight frames as pre-molded parts. The cube then rotates horizontally by 90°, so the mold side with the pre-molded parts faces outward. Then the two Citi elements rotate 180° vertically around their own axis, positioning the frames in the bottom row of cavities.

The next time the mold is opened, the cube is rotated 90° again, and the frames land on the fixed side of the machine. Components two and three follow – first is the TPE gasket, which is needed on both sides of the frame. »



3-component part: first, the green frame is made of PP. This is followed by the blue TPE seal. Finally, the black lever made of POM is injection molded. It is attached to the frame by means of the pin and bush principle but remains movable. © Foboha

The TPE melt reaches the back of the frame through a small opening and quickly injects the POM. The result is the second component in the form of a lever, which is attached to the frame using the pin-and-bush principle, yet it must remain movable to function. The mobility is maintained because the "cold turning technique" prevents the frame of PP and the functional element of POM from connecting.

Once the TPE and POM have been injected and cooled, the mold opens again, and the cube rotates 90° to its final position. A robot removes the finished part, and an end-of-arm tool folds the lever (which has been facing up) flat onto the frame, finalizing the assembly.

Compact Hot Runner in the Tightest of Spaces

Since the entire product is only a few centimeters, the space for the connection on the fixed mold side was extremely tight and posed a challenge for the hot runner. The team from project partner and Foboha sister company, Thermoplay, developed a compact hot runner concept for Citi technology in which a total of 16 nozzles can be accommodated next to each other, with a nozzle diameter of 18 mm and a length of almost 200 mm.

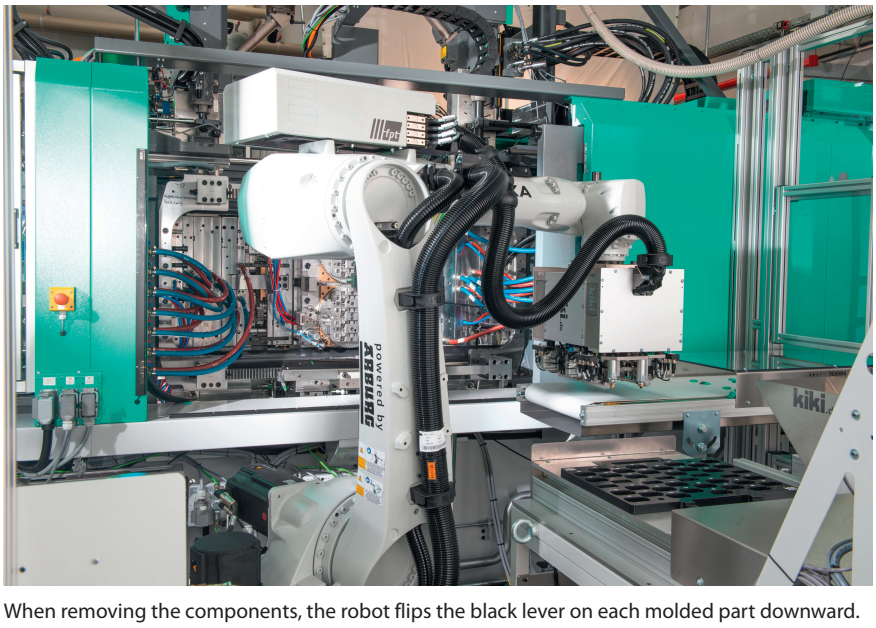
The melt is fed into three flow channel levels, which means that the TPE nozzles dip through the higher POM manifold level. The manifold consists of four diffusion-welded plates with milled flow channels that supply smooth deflections and low shear rates. The flow channels were designed in terms of their diameter and geometry to minimize the residence time of the small volumes of POM and TPE and to keep the pressure drop low. POM is a challenging material that degrades easily, so the design guarantees excellent balancing behavior for all three plastics. Rheological optimization also factored in the balancing of a possible series mold comprising 48 + 48 + 48 cavities.

The homogeneous temperature distribution is supported by a nozzle head (carrier ring) perfected using the finite element method, which minimizes contact points with the mold. Consequently, energy loss through heat transfer to the mold can be reduced by 50 % – a powerful argument in the current energy discussion. Another unique feature on the carrier ring is the "Leak Stop" function, which prevents over-molding from being left in the nozzle in the "worst case" scenario, causing leakage into the mold.

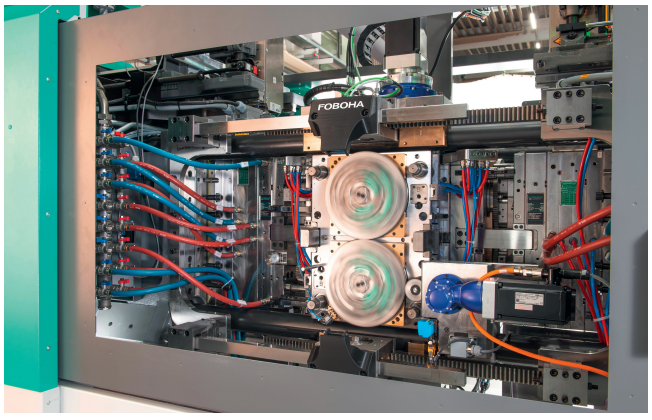
For this technology to work, engineers had to optimize for other factors, such as the "torque" of the Citi elements. Since it takes place at the free station outside of the mold – i.e., not in the direction of the machine axis – a separate patent pending adaptive drive unit was engineered. A servo motor with gearing now engages the pinions of the Citi elements and sets them in motion.

High-Speed Cameras for Inline Quality Assurance

A "vision system" consisting of two high-speed cameras with image matching was installed to ensure the system's fully autonomous production operation. After the first 90° rotation of the mold, a visual



When removing the components, the robot flips the black lever on each molded part downward. © Foboha



Rotate and turn in all directions: the vertically rotating tool inserts are a special feature of Citi technology. © Foboha

inspection is performed in the first injection station on the moving mold side. The next production steps are initiated when the cavity is confirmed to be filled. If the cameras show an alert, the press stops automatically to avoid damaging the mold.

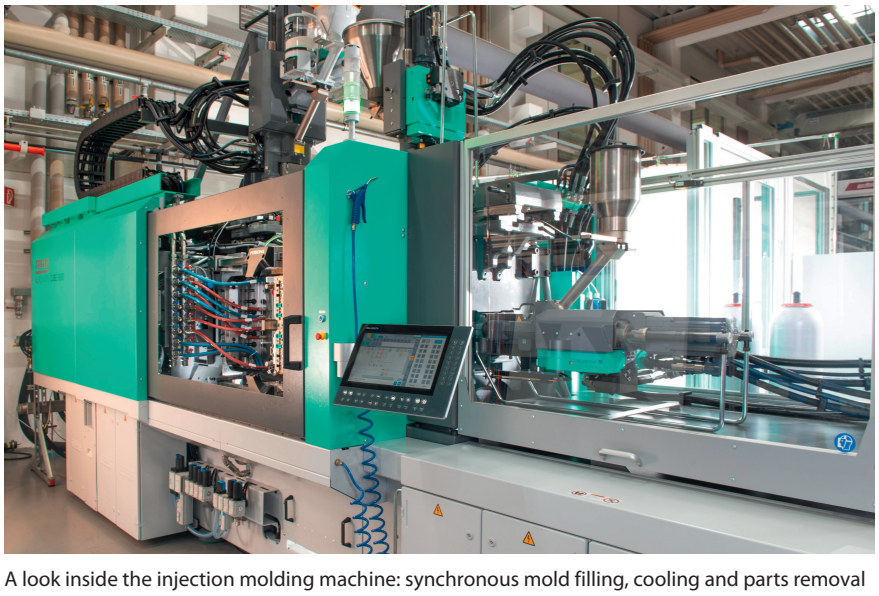
The mold without a hot runner consists of hundreds of individual parts, most of which had to be manufactured to the smallest possible tolerance range (4 to 6 µm) and are 100 % interchangeable due to the delicate geometries.

Initiative Project for Packaging Applications

The 8 + 8 + 8-cavity mold (i.e., eight cavities and three components) marks a pilot project for Foboha, followed by molds up to 48 cavities. At the K show, Citi was running at the Arburg booth, and the project team acquired knowledge through its continuous operation, which contributed to further optimization. The plan is to produce a pilot series that customers can use to check market opportunities and acquire projects.

Citi technology uses the cube's rotation on the horizontal plane and provides vertical rotation on the cube. Simultaneous injection operations on two sides of the cube, extraction on the third side, and assembly within the mold further increase the efficiency principle of "typical" cube applications, saving production space, energy, cycle, and assembly time.

Foboha's Citi project also led to new insights that Barnes' Molding Solutions network plans to apply to product developments in the future. The focus will be on homogeneous wall temperature, even faster cycle times, and good gate quality – especially for packaging applications. ■



A look inside the injection molding machine: synchronous mold filling, cooling and parts removal was demonstrated on an Arburg Allrounder Cube 1800 at K. © Foboha

Info

Text

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Barnes Group

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