Runway Lights for the Seat Belt

Twin-Turn Tool Provides Solution to Production Problem with a Double Turn

Ambient lighting has captured the car interior – and facilitated orientation for the passengers. There is no need for anyone to fumble for the seat belt buckle in the dark in the Audi A7, as an integrated light guide shows the way. Kunststoff Helmbrechts produces the 3-component part and also developed the tool concept. The trick: a so-called twin-turn tool which rotates on both sides. The company was awarded the GKV TecPart Innovation Prize for it at the K 2019.

No need to fiddle for the seat belt buckle anymore: an integrated light guide provides orientation for car passengers. Nonetheless, the production process proved to be quite a task (© KH)

The article itself does not appear to be spectacular: a ring-shaped light guide of PC lies between an inner contour with locking latches and a curved seat belt buckle cover on the outside, both made of black PC+ABS (**Fig. 1**). Nevertheless, when Kunststoff Helmbrechts (KH) received the request for the component, and prepared a production concept, it soon became clear they were dealing with a tool which the plastics company, with its own mold construction in Helmbrechts, Germany, had never built before. After all, no shadow was to be cast in the lighting area from the connecting bridges of the external materials.

A layperson might conclude that injecting black material from both sides of the light guide would suffice, and in doing so, form both the interior and exterior parts in just one process. However, physics thwarted this plan: to keep the area below the just 1.5 mm thick transparent section free (in order that the LED illumination might function here later), an appropriately thin, but 13 mm high contour would have had to be included in the tool. In the course of time, this would deform through the injection pressure of 1800 bar should the flow fronts not always enter simultaneously and with absolute precision. Since the geometry of the article could not be changed, the only possibility remaining was to create it as a 3-component part and then produce the individual components one by one.

A Small Rotary Plate on the Fixed Side

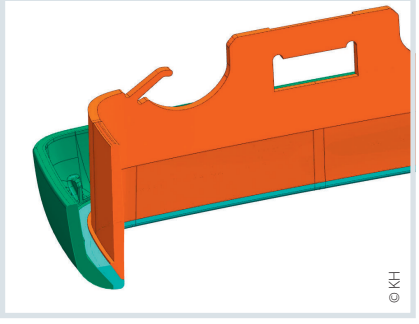
However, all the usual 3-component processes such as index or rotary-plate systems reached their limits with the seat belt buckle. So came the basic idea to install a normal size-reduced rotary plate in the nozzle side. At a team meeting, tool designer Bernd Müller casually said: "Let's just turn it around", and construction manager, Michael Klar, who is always enthused by unusual tool concepts, took on the challenge and developed a solution (**Fig. 2**). The result: a twin-turn tool which is partly movable on the usually fixed side (**Fig. 3**).

The following process now takes place on a 3-component machine with 1600 kN clamping force (type: Allrounder 520 S 3-K-1, manufacturer: Arburg GmbH + Co KG, Lossburg, Germany): the transparent polycarbonate (PC) flows into the contour of the small rotary plate forming the light guide, the tool opens and the rotary plate does a 180° turn (**Fig. 4**) so that the molded part ends up on the ejector side in station 2. Here the inner contour with assembly elements is formed from black PC+ABS. When the tool opens again the part is transferred to the movable side which makes a complete turn of 180° as well. Station 3 then forms the black part for the exterior seat belt cover on the nozzle side.

Once Michael Klar had thought through the concept, and was sure that it would function, the team got to work on the technical details. As the 27 mm thick hot runner nozzle runs through the center of the small rotary plate (diameter 300 mm), it heats it up substantially. The inserted ball bearing had, first of all, to cope with the around 280 °C. No regular supplier has this in stock. Ventilators for hardening ovens place similar demands, and one wholesaler even wanted to sell several hundred ball bearings. After some research work KH eventually found a manufacturer who actually delivered an individual item.

A further consideration applied to the motor which would drive the small rotary plate. For reasons of precision, a quill motor would have been the obvious choice; however its price of several thousand euros would have increased the tool costs too heavily. And so the decision to make utilize a cheaper hydraulic motor was taken and design inaccuracies would be balanced with a transmission.

Fig. 1. The inner contour and exterior cover of the light guide (in reality both black, in the graphic green and orange for better differentiation) cannot be formed in one process (© KH)



Absolute Uniform Illumination Necessary

For every illuminated design component, the surface finish plays a particularly important role. In the case of the light »

Fig. 2. Tool designer, Bernd Müller (left) and construction manager, Michael Klar: "Let's just turn it around" (© KH)

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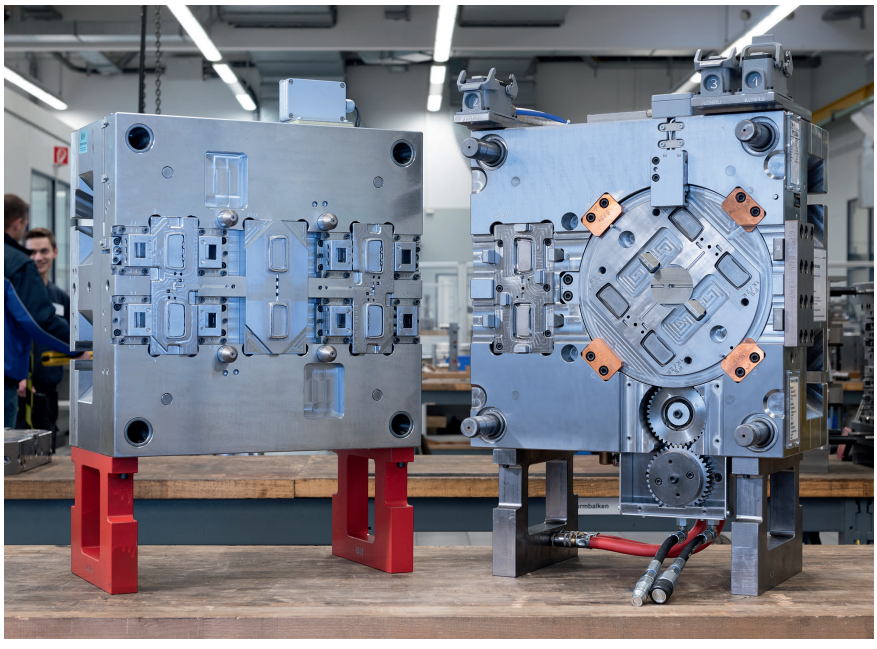

Fig. 3. Small rotary plate on the nozzle side: the twin-turn tool is also partly movable on the usually fixed side. The complete tool rotates on the ejector side (left) (© KH)

diffuser, no flow lines should be visible as the light – which, for reasons of security, is white and not colored – comes from one single LED positioned 7 cm below the diffuser. From here it must be able to spread out absolutely evenly. For this reason a relatively complex process takes place around the sprue.

To begin with, the melt distribution takes place in the classic sense from hot runner to cold runner and through a tunnel gate. After extraction, the gate is separated and milled off to improve the appearance while the filings are removed by suctioning to prevent any adhesion to the component. This subsequent finishing step only takes place once the seat belt buckle cover has been coated with a UV scratch-resistant paint. Firstly, this creates a more robust component, and secondly it prevents the tiniest particles finding their way under the hard coating.

The Scratch-Resistant Coating Does Not Tolerate any Cracks

The scratch-resistant coating itself proved to be a challenge for the project team. It required that the materials of the light guide (PC) and that of the cover (PC+ABS) combine completely with one another along the entire contour. Even micrometer-sized cracks would result in trapped solvents in the evaporation zone of the painting plant not escaping and forming bubbles during drying. After numerous injection molding trials and tool adjustments, KH optimized the thermal management in order to prevent this.

At first, an extremely hard and brittle paint system was specified by the OEM which could not balance the material hardness of the two components, PC and PC+ABS, well enough. In order to test existing paint systems and find one more suitable that would fulfil the requirements with regard to scratch resistance, the plastics specialists in Helmbrechts even developed the device for a belt tongue impact test. An SPS-controlled traction device guides the belt tongue upward and then lets it fall onto the belt buckle. In each case the angle is varied in order to create a realistic situation. Finally the decision was made for a more elastic paint system which provided very good results.

From the original A7 model, the illuminated seat belt buckle has expanded further and now belongs to the standard fittings of the A6 and Q models. In order to keep up with the increasing demand, the KH team has since built a further twin-turn tool. The concept of the two turning sides has proved to be a complete success.

Conclusion

The twin-turn tool is movable on both sides (partly) thus allowing component geometries to be produced that are not able to be produced with pure index or rotary-plate concepts. Technical challenges such as the melt flow through the smaller rotary plate were mastered with special components such as heat resistant ball bearings. ■

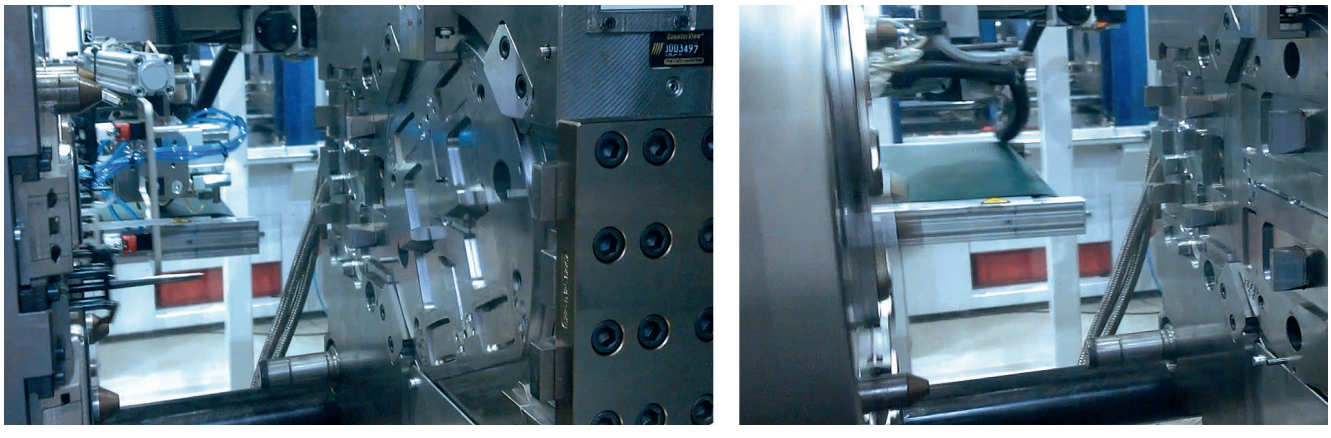

Fig. 4. The rotary plate does a 180° turn so that the freshly molded PC light guide ends up on the ejector side in station 2. There the inner contour with assembly elements is formed from black PC+ABS (© KH)