Integrated Solution for an Instrument Panel

**Process Chain.** Production of the instrument panel of the new Audi A4 necessitated combining numerous processing techniques into a highly complex production line. A concatenation of injection molding machine, rotary table foam installation and several assembly robots makes for a smooth process flow.

Translated from Kunststoffe 6/2010, pp. 42-45

Article as PDF-File at www.kunststoffe-international.com; Document Number: PET10422

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We were looking for a supplier who could cover the maximum possible number of manufacturing steps for the instrument panel of the new Audi, because of its high complexity and the interdependence of the individual steps,“ is how Anton Simon, plant manager of Peguform, an automotive 1-Tier-supplier in Neustadt, Germany, sums up the background to what in many ways is a special project. Ultimately, the company chose to partner with KraussMaffei Technologies GmbH, Munich, Germany, which now deploys its own solutions to cover a range of manufacturing steps, from injection molding via polyurethane processing through to automation. But that’s not all.

**Changing on the Fly**

In the difficult changeover phase, when Peguform had to seamlessly switch from producing the previous Audi A4 model (internal designation: B7) to the current model (B8), KraussMaffei provided a modern foaming installation on loan to help Peguform cope with the first prototypes of the new A4. Torben Englisch, head of industrial engineering at Peguform, describes just how quickly the changeover occurred: “Production commenced in week 36 of 2007, and then got into full swing from week 50 on. The B7 used to be produced on the old rotary table, while the B8 was made on the upright installation. We dismantled the old foamer/rotary table over Christmas and installed the new one, including flame-treatment unit, removal robots, and wet cell, and had it ready for operation in early 2008. It was then used to make the B8, while the upright installation produced the B7.” Over time, production numbers were reversed: the B8 was ramped up, and the B7 ramped down.

Peguform now produces 1,800 instrument panels a day, plus 7,000 bumper sys-
tems, 8,000 door panels and 7,000 rocker panels – every day. In general, production is back to normal levels. “We have weathered the crisis. We were back to operating at full capacity in May 2009 and have now abandoned short-time working,” says plant manager Simon.

Prime Example of a Complex Process Chain

The production line for the instrument panel, a prime example of a complex process chain, comprises a large number of coordinated individual steps, such as injection molding, flame treatment, foaming, cutting, milling and automation. “The Audi A4 instrument panel comes in two versions, namely left- and right-hand drive. In addition, there are three colors each. This yields a total of six variants,” says Englisch, before adding “Of course, there are a lot more left-hand-drive brackets to be made.” All the brackets are molded from continuous-strand reinforced polypropylene on MC 2300-19000 KraussMaffei machines. The entire mechanism for holding the airbag module and the air flow system required for protecting the airbag are integrated into the part by the injection molding stage.

When a molded bracket is removed, a camera system performs a 100 % visual safety inspection on it. It is then buffered for two hours on a conveyor line, whereupon a robot takes it and centers it for the next processing step – flame treatment.

The flame-treatment unit pivots into the processing station, and the three-station rotary table rotates further and the robot traverses a defined area. Flame treatment is essential for ensuring that the PU will adhere. However, adhesion is undesirable in some areas and so they are masked with stencils which have been designed to fit the contours. Torben Englisch explains: “Masking’s important for ensuring that whatever is cut out and milled later can be easily removed, that is, foam-free and flash-free.”

The flame treatment complete, the rotary table rotates further to the removal station. Waiting there is a handling robot that receives both the flame-treated part and later lifts the finished part from the foaming mold. Between these two steps, the KraussMaffei-built rotary table/foaming installation moves into the loading position.

Foaming on a Six-station Rotary Table

In a parallel rotary sintering process, PVC powder is sintered to form a slush-molded skin. The skin is fed to the rotary table/foaming installation by conveyor. At the operating stations of the rotary table, the skin is manually inserted into the lower half of the mold (Fig. 1). Before that, the gripper picks up the molded bracket fully automatically by the upper ram (Fig. 2). For foam application, the entire mold carrier pivots into a 30° oblique foam position.”This affords the best foam distribution and venting,” says the head of industrial engineering.

Then, before foaming begins, the carrier moves into the safety zone, where the airbag area of the slush-molded skin is blow-dried again to seal the already pre-
pared breaking point and keep out the polyurethane foam. Foaming commences on a six-station rotary table fitted with six electrical mold carriers capable of producing any combination of left- and right-hand-drive versions. When the reaction time has elapsed, the mold carrier opens in the removal position.

The robot fetches a new instrument panel bracket from the flame-treatment unit and places it on the upper ram, and the ejectors on the lower mold part are extended to allow the gripper to remove the finished part and place it on a conveyor belt with appropriately shaped receptacles. An employee then checks the surface of every finished, foamed part. It is subsequently manually fed to a Krauss-Maffei-supplied cutting center and automatically inserted into the cutting tool. This step features an integrated process buffer in which the part cools and postcures for 20 minutes.

A Cutting Tool Shaped Like a Hedgehog

In the next step, the part is placed on the presenting station of the cutting line. The cutting line is slightly uncoupled from the direct cycle sequence, that is, the operator does not have to insert the part in sync. A robot picks up the part and puts it into the cutting tool. There follows a complex cutting process that accounts for 85% of total cutting. Says Englisch: “The cutting tool has more than 22 slide tools and looks a bit like a hedgehog. The individual blades make cuts in different directions.” A second removal robot removes the cut bracket and places it in the holder of the milling cutter. Special attention is given to safe removal of the waste: cutting tool and installation are optimized accordingly to guarantee trouble-free series production.

Safety First

The cell contains an automatic changeover station for the milling cutters, with the tool length being measured after each cycle. “The airbag is a safety-critical part. If the milling cutter is shorter than the control expects, we assume a breakage has occurred,” explains the Peguform engineer. The defective bracket is then immediately changed and arrangements are automatically made for it to be destroyed. “That way, we prevent a bracket with any sort of defective cut in the airbag area from being shipped to the customer,” he says, describing the underlying safety thinking.

If the test instrument gives the green light, the mill holder is removed and the final machined part is presented to the removal robot, which places it on a conveyor belt. There, an operator removes the projecting skin pieces. This manual removal of residual foam harbors the problem that not only submersed cuts, but also oversize cuts are implemented – which is why masking is performed at the start of the process: if these areas had been flame-treated, the skin and foam would not detach from the bracket.
The next stop is the welding station, where the foamed bracket and two other injection molded parts – air duct and central part (Fig. 3) – are joined together. Each part variant passes through this installation. The front of the part is inserted into one of the six receptacles, and passes through four downstream welding stations to the removal station. Depending on which part arrives, defined feed units bearing sonotrodes extend forward. Welding is followed by automated removal. Again, the part is placed on a conveyor belt, and then fetched by an employee.

**100 Percent Checks to the Very Last Step**

The final process step involves two machines for attaching the fasteners (Fig. 4). KraussMaffei automated much of this line, too. The first machine attaches five hollow rivets and eleven large and eleven small snap nuts to the bracket. It consists of two robots, each of which attaches different fasteners. Parameters monitored here include the torque and fit of the individual fasteners.

Three clips, the frame of the center defroster, and the two side air vents and loudspeaker receptacles are assembled manually in the decorative trim area. They are then fastened in place with cutting nuts in the second machine (Fig. 5). This joining installation additionally attaches nine hexagonal bolts and twelve cutting nuts to the bracket. Furthermore, the holder for the electronic ignition lock and the combination panel brackets are bolted, as well as numerous gratings for the defroster and the speaker panels.

Peguform produces the large parts, and subcontracts the small parts, such as the defroster. The fasteners must be monitored meticulously for a perfect fit in order that the later modules may fit 100% – because the gap dimensions, which in the auto industry are considered a hallmark of quality, depend on it.

Finally, the combined panel bracket and instrument bracket are bolted together to form the complete instrument panel. Again, exact positioning is crucial so that the whole composite fits properly in the instrument panel and offers the occupants the usual quality appearance. For this reason, a 100% check is carried out again. The instrument panel is now finished and is placed manually in the shipping container for transport to Audi.

**Conclusion**

Production of the instrument panel for the new Audi A4 is a prime example of a partnership which pools the different competencies of the parties. Thus, KraussMaffei looked after the plant and process technology (injection molding, PU reaction technology, automation) and provided machines on loan during the transitional switchover phase of the models. Peguform, supported by its in-house center of competence (slush-molded skin, foaming, vehicle safety, airbag development), contributed its expertise as a systems supplier and, through delivering the project on time, including start-up, transition and roll-out planning, once again proved its reliability as a systems partner for the automotive industry.

**THE AUTHOR**

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Fig. 5. The assembly machines for the instrument panel of the Audi A4 at Peguform. This is where, inter alia, the receptacle for the ignition lock and the composite panel bracket are bolted together.

Fig. 6. The project managers worked closely together (from left to right): Torben Englisch (Peguform), Wolfgang Rössler, Michael Schulze (both KraussMaffei), Anton Simon (Peguform).

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