

**SPACE PUZZLE MOLDING™**  
 Economic + Rapid Tooling System For 'Class A' Injection Molded Parts  
 Prototype + Early Batches + Medium Volume Series Production  
 All Molding Materials and Technologies Compatible  
 SPM™ is IDEAL for complex moldings

SPM™ uniquely from  
**protoform™**  
 of Bavaria

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## PROFESSIONAL ARTICLE 03/2006 - 1

### BENDING THE RULES WITH SPACE PUZZLE MOLDING™

The Space Puzzle Molding™ (SPM) technique, patented and operated by Bavarian based company protoform™, is used regularly in the prototyping and production of early-series plastic components for the automotive and other industries. All grades of injection molding materials can be processed. Inserts, outserts, co-injection and gas-assisted methods can also be accommodated appropriate to the designer's specification.

In this automotive application the unusual technical achievement made was the result of an idea introduced by protoform™'s technical staff when cooperating with designers from Mitsubishi.

Working to a brief from automotive component specialist Dr Schneider, the task was to find an economical solution to a composite application for a directional ventilator molding destined for one of the Smart range of vehicles.

The design dictated that the main body of the housing should be in PP/PE TV20, a hard durable plastic suitable for both the ventilator vanes and the swivel mechanism, but that the interface between the moving part and the rear housing should be an inner band of a softer grade of plastic to act as a bearing surface

and partial seal. The material chosen for this was TPE Santoprene (shown white in the product photo) which has a lower melt temperature than the PP/PE.

Tradition, and also advice from the materials experts, suggested that the only feasible route would be to inject the harder material first and to do this would mean creating a cavity into which the softer material to be injected later. This method would necessitate creating a collapsible core for the centre of the tool, a simple and inexpensive exercise for the SPM Space Puzzle tooling, but considerable more expensive for the production tool. With economy in mind for both prototyping and later production it was agreed to try an unconventional approach.

Space Puzzle Molding™ tools are renowned for their flexibility and the creation of two sets of 'horse-shoe' forms to create the outer surfaces of the component enabled the softer, lower melting point Santoprene (shown red in the CAD view) to be injected first. It was not necessary to create a whole new separate tool to complete the product since the Space Puzzle technique of assembling the tooling into a common support bolster allows for such switch operations to be readily accomplished.

The first matching 'horse-shoes' were then replaced by the larger ones illustrated in the CAD tooling image, leaving the first moulding in situ, and the higher temperature material injected. It was anticipated that there would be a small degree of melt at the interface of the two materials but, as predicted, the working surface of the Santoprene remained perfectly formed and entirely functional.

Sean Halstead of protoform™ explains:

“It was of critical importance that the inner functional face of the Santoprene, which has an injection temperature of 220 degrees C, did not reach deformation temperature. As a quick test we applied a strip of TPE Santoprene, of the same thickness as that in the design, to a heat source corresponding the injection temperature of 250 degrees C for the PP/PE. We then measured the temperature on what would be the inner face.

We established that with the 1 second of injection time needed, the deformation temperature was not reached. We also optimized the design of the TPE part to reduce the possibility of heating due to friction.

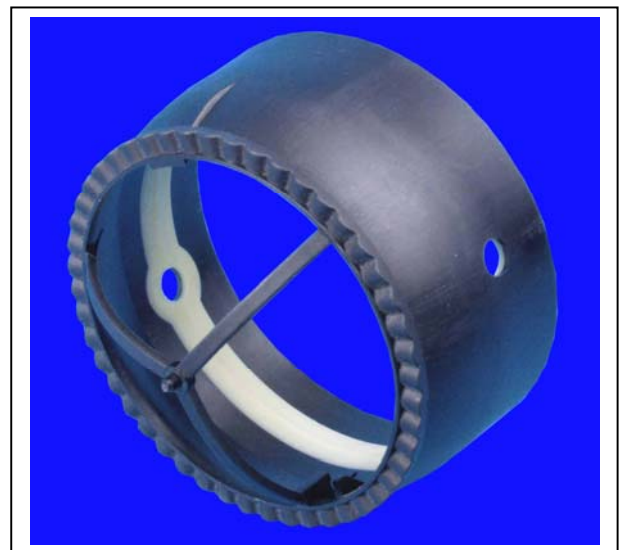
The idea worked beautifully in practice and we were able to run series production of identical mouldings for prototypes in production intent materials.

It was bending the rules a little but it achieved the desired result. The economy of this approach was appreciated by the client and the technique was reflected onwards into production.”

**Pictures:**

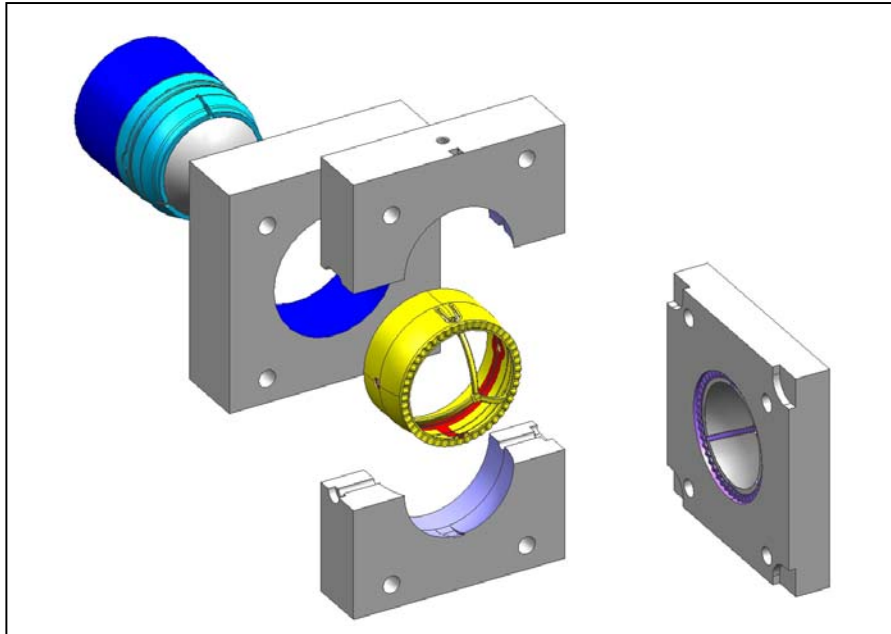
**Picture 1A/B**

Component showing softer insert in white  
Also finished assembly



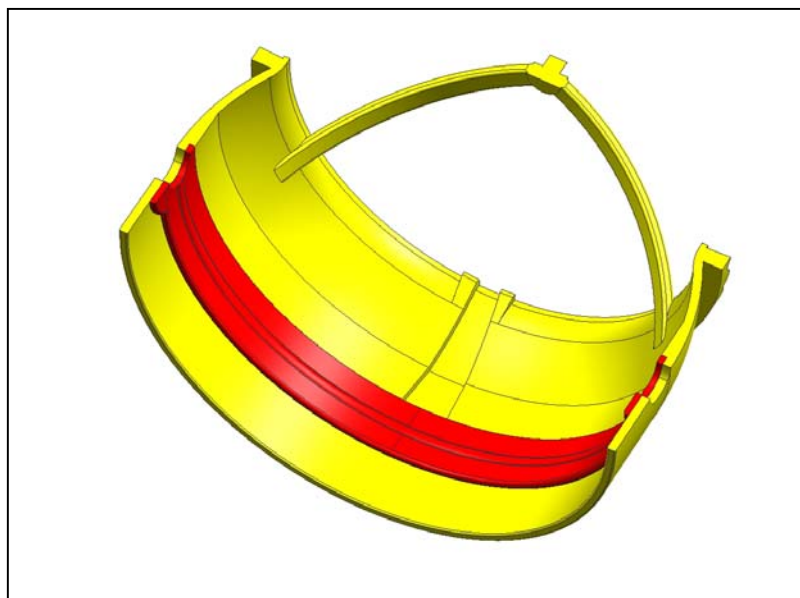
**Picture 2**

Space Puzzle Molding™ (SPM) Tooling in CAD



**Picture 3**

Cutaway in CAD



Procedure in Brief for information or reproduction supplementary to articles:

The SPM method, Space Puzzle Molding™, is a hybrid technique of joint Rapid Tooling and Rapid Prototyping technologies, and provides low-cost, simplified moulding tools made of aluminium, using state-of-the-art CAD software and high speed CNC machining methods, working from client's CAD data. With these moulds, one can call off both prototypes and batches of plastic parts in production intent materials.

Moldings so produced are Class A, quality perfect and series identical. They are manufactured to exacting standards using semi-automated methods on standard injection molding machines.

Space Puzzle Molds comprise individual pieces like parts of a puzzle precisely interfaced and secured to the injection machine in a unique patented device which is product-envelope categorised common to many sets of molds.

The SPM process is Ideal for complex parts. New iterations / Design variants can be readily introduced by changing the individual inserts and elements that make up the tooling.

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