

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 - 3

Small batch production of plastic parts using “Space Puzzle Molding”™ (SPM)

SPM Technology is illustrated here, via three practical applications, to be an economical procedure for Prototypes and Small Series Batches.

by Wolfgang G. Trapp

Summary

Space Puzzle Molding™, the process originally developed for producing prototypes in low quantities (now alternatively termed SPM Technology), is no longer in its infancy. It is a leading rapid process designed to fulfil the requirement for individual sets of plastic parts for prototyping and ‘alpha build’ test, but in recent years it has, in parallel, made major inroads into small and medium batch production for many markets such as medical, electronic, instrumentation and in particular automotive. Three such examples of production components for typical automotive applications are given in this article.

The SPM Process

“Space Puzzle Molding™” (SPM Technology) has been elevated in status to a full production process partly on merit as the SPM tooling system has evolved naturally, and partly by changes in the market place, since shorter product life cycles, frequent product modifications, and the trend towards numerous product variants becoming known as ‘*Mass Customisation*’ requires ever smaller batch sizes of any particular design iteration. Space Puzzle Molding™, therefore, is becoming a significant supplier of production items directly to the vehicle manufacturers and to the Tier 1 players of the industry. Quantities of hundreds or, in specific cases, thousands of parts, are not uncommon. Unique in the World due to its patented and economic mould system, SPM Technology is the exclusive process created and perfected in Europe by protoform™ (K. Hofmann GmbH) in Fuerth, Germany.

At the start of a project the CAD department at protoform™ uses state-of-the-art software to tailor the customers' component data for injection mold processing. The same, uniquely designed, SPM injection mold, high-speed CNC machined in aluminium, is used for both prototype and production parts in the in-house injection molding shop. The whole production follows the "One-Stop" principle for the client, in that project handling is performed under single-source direction, whereby component supply includes such post operations as surface treatment and assembly.

Three Different Design Briefs

The three practical examples detailed below show how SPM-Technology is currently enabling efficient and economic part production, even in small batches and short series:

Brief 1 - A chrome frame made of ABS for covering printer and fax machine inside the rear centre console of the VW Phaeton

VW Individual GmbH, Wolfsburg, needed 3000 pieces of a filigree plastic part for the installation of a printer and a fax machine into the rear centre console of the deluxe Phaeton limousine. Small batch manufacturing did not justify making a normal injection mould. For this reason, VW contacted protoform™.

Having consulted several raw material producers, protoform™ selected the material (ABS, Novodur, manufactured by Lanxess AG, Leverkusen) and suggested using an electrolytic chromium plating-technology for the final finish.

The development and production order for small-batch manufacturing of the required parts placed with protoform™ specified the delivery of five initial samples to be produced according to the customer-specific VW test protocol. This required producing a thin-walled component of high quality, without flattened areas, material-dislocations and optical defects, but with a polished high-gloss surface. It was specified also that these components must be suitable for use in customer cars – if ordered as an optional feature.

The engineers at protoform™ designed an injection mould for the component, optimised according to plastic processing requirements. This mould compensated for the shrinkage parameters of the slender shape. For the small-batch mould, steel was selected for the tooling material rather than aluminium, in order to guarantee dimensional integrity and surface flatness of the component as well a stainless mirror-finish chromium surface. It was necessary to introduce minor design changes as the project progressed but this presented no problem. The SPM process makes tooling modifications a simple and straightforward operation. After finalising the parameters, protoform™ proceeded to manufacture the required 400 or so, chromium-plated parts, delivering them to the subcontractor, a system supplier and car refinement company in Cadolzburg, Bavaria.

Brief 2 - A two-part protecting cover of PC+ABS for the refrigerator control unit inside the VW Phaeton

The "Automobilmanufaktur Dresden" is the delivery address for a further plastic part for the Phaeton, Volkswagen's premium car, a two-part protective cover for the refrigeration unit. The component and hence also the mould had to undergo a design change during the manufacturing process. This is not unusual with new products where, despite careful work in the preceding stages such as simulation of the plastic injection process in virtual Mold Flow programs, the actuality of the final molding some times requires slight modifications. SPM moulds allow this to occur easily and at low cost. They can support necessary modifications and design revisions at any stage of the project. In this case the cost to the customer of the necessary alterations of some reinforcement ribs amounted to a mere 250 EUR.

In terms of product finishing to complete the component, the cover itself is made of PC+ABS (grade: Bayblend manufactured by Material Science AG, Leverkusen) with black basic colour. Subsequent flocking makes the component look like a dark grey carpet. Nominal batch size for this production run was 2000 items and approximately 1000 coverings have been manufactured and delivered to date since the project is currently on-going.

Brief 3 - Shock absorber components made of PA66-GF30 for the extended Far East Mercedes reproduction, the "New Chairman".

The "New Chairman" is an extended reproduction model of a Mercedes former E-class. It carries a number of highly technical, production parts made using protoformTM's "SPM-Technology".

This, South Korean, Mercedes copy coasts smoothly along the streets in the Far East as a stretched limousine, fitted with an electric-pneumatic shock absorption system provided by the Continental AG automotive Systems, Hannover Germany.

In the early stage, when the product was first launched onto the market, the plan was to make it a limited edition of 500 units. Parts of the shock absorbers in the New Chairman are a piston cover and a piston box, made of robust plastic, with integrated threads. Since both parts have functional safety implications, they have to fulfil stringent requirements in terms of precision, quality and stability.

They are made of a high-strength polyamide whose glass fibre content is 30 percent (PA66-GF30, Zytel manufactured by DuPont de Nemours GmbH, Bad Homburg). For this reason Continental Teves, Gifhorn, who received the parts, was a critical customer. On inspection and evaluation of early moldings, it was found necessary to modify the SPM moulds to increase roundness in certain areas. The pre-calculated and detailed filling simulation for this strong engineering plastic had not proved to be representative in practice. Gating was therefore changed as a result of, unusually high, local wall thickness values required of up to 12 millimetres. The unit weighs almost half a kilo of weight (496 grams) and the initial problem molding characteristics were overcome with a greater number of injection points, a change to mold-flow and a robust extrusion guide.

Each of these 'flight-critical' suspension components had its design changed repeatedly throughout this process. Having made the necessary changes, to accommodate the high-level of specification, the required quality level was achieved. The parts were released for installation after a 100 percent check and complete documentation. In the meantime, the production volume was extended. protoformTM's "SPM-Technology" delivered more than 2000 parts made from the prototype mould (instead of expected 500) to Continental Teves proving once again that the aluminium moulds have sufficient tool life to provide even greater quantities.

SPM Technology holds a unique place in the market

The still widespread belief that prototypes are fundamentally expensive, and suitable for only a few parts manufactured for evaluation, has to be revised as a result of SPM-Technology's entry into small batch production.

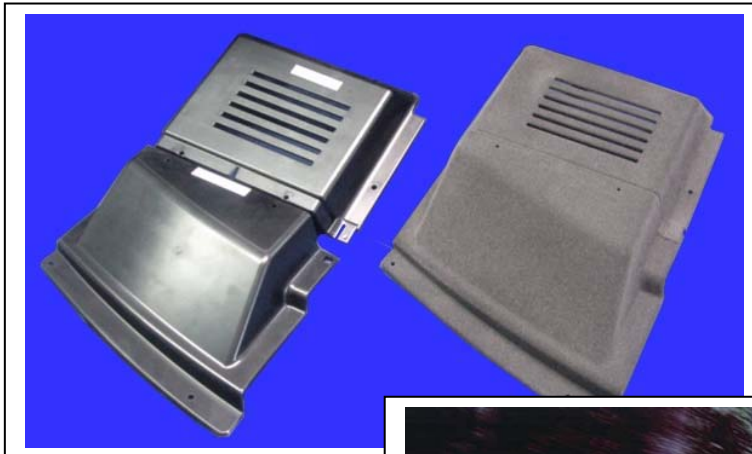
- ❖ The cost of moulds used by SPM is only half the price of full series production moulds.
- ❖ They available in half the time taken to make conventional moulds.
- ❖ Allowing that the price of the plastic-parts so produced can be typically five to ten times that of mass-produced items (this being entirely due to manual de-mold of SPM tooling, so saving the cost and complexity of automatic ejection) Nevertheless SPM-Technology from protoform™ makes overall economic sense for an increasing number of small-batch and continuous low to medium volume applications.
- ❖ Large-scale production continues to be reserved for the series mould of the traditional mould-maker and contract injection moulder.

The Author:

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Picture 1:

The two-part plastic covering for the refrigeration unit in the Volkswagen Phaeton (pictured also) (the ventilation slots are guides into the boot) is made in small-batch production using SPM-Technology from protoform™. The LH moldings are 'off-tool', the RH ones are surface treated to match the upholstery.



Picture 2:

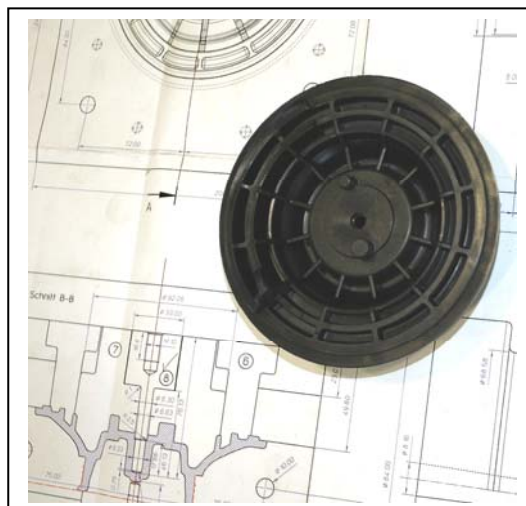
The "New Chairman" from South Korea coasts along the streets smoothly as a stretched limousine with pneumatic shock absorbers and plastic parts 'Made in Germany' using SPM-Technology from protoform™.



Picture 3:

The shock absorber parts have to meet strict requirements for precision, quality and strength. For this reason, they are of robust design and are made using SPM-Technology from protoform™.

(Some editors will only use one picture and will sub down the text hence reference repeated on each)



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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