An Alternative Modular Manufacturing Concept

Sprueless Single-Cavity Injection Molding. Shorter product lifecycles are in many cases reducing the number of parts that are produced in one mold. Seasonal and cyclical fluctuations further reinforce the pressure for flexibility in production. In response, an SME injection molding machine manufacturer has expanded its manufacturing concept into a fully integrated production system.

In rank and file: the Boy XS, seen here in production by Playmobil, has a footprint of only 0.8 m² (photo: geobra Brandstätter)

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In the past, production transfer to low-wage countries often went hand in hand with the deployment of larger machines and molds with more cavities. This increased the production volumes of injection molded parts for a particular production site. A contrary development has been the increasing trends towards individualizing the products and shortening product lifecycles. In many cases, this reduced the number of parts produced in one mold. Seasonal and cyclical fluctuations further reinforce the demand for maximum flexibility in injection molding.

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From the Injection Molding Machine to the Fully Integrated Production System

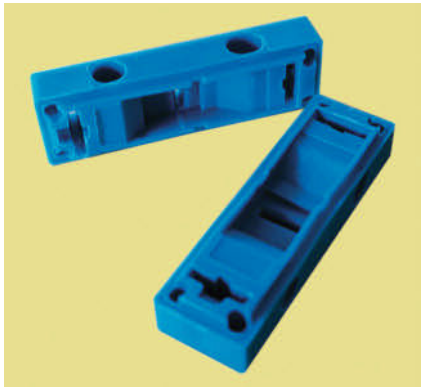
The worst-case scenario in this context was the 2008/2009 global economic crisis. Manufacturing volumes had to be drastically reduced very rapidly. Highly specialized, expensive plants were shut down often for weeks or months, while fixed costs, such as depreciation, interest payments and occupancy expenses, continued. Retooling for different projects often failed because of the complexity of the systems.

The upswing in 2010 started just as abruptly. These results tested the flexibility of the injection molding companies. The idle plants had to be rapidly ramped up to full capacity again; however the highly qualified personnel were often not available as they had left the company. Clouds are already appearing again on the global economic horizon; there is talk of a lapse back into recession. In this environment, Dr. Boy GmbH & Co. KG revised its manufacturing concept and developed a manufacturing system predominantly suited for the production of small plastic parts.

At the core of this concept is the Boy XS automatic injection molding machine, which was presented in 2009. Its compact size requires a footprint of only 0.8 m^2. A special machine nozzle system permits sprueless manufacturing of parts with low shot weight in single-cavity molds. Simultaneously, a mold concept was developed that forms the basis of the easy and rapid conversion to new products. This concept has many advantages, some of which are not immediately obvious and often cannot be quantified. They include economic and logistical criteria and technical aspects.

Lower Capital Commitment – Lower Risk

Immediately after the part design has been decided, a cavity can be introduced into the mold plate without complicated mold technology. This part insert can then be used in a carrier mold directly for the production of prototype parts and



The manufacturing concept was developed especially for small parts such as this cover for a microswitch

subsequently for mass production. The prototype mold thus becomes the first production mold. Since only small steel blocks need to be machined, the lead time for the molds is reduced. In the example in which the product is successful on the market (this stage is often reached at a very early stage because of the short lead time), so production can be adapted to demand. A manufacturer can quickly and easily satisfy increasing demand by multiplying this plant concept.

The use of small universal machines with simple and inexpensive molds permits rapid adjustment to current demand. In the case of a successful product a company can use its increasing income to procure new production systems to meet demand. With falling sales, individual plants can be used for new projects. Thus, it is only necessary to make, and sustain, that capital investment that is required to meet current demand. Sudden increases in capital outlay, with the risk of a bad investment, are thereby eliminated.

Minimized Set-up Times

With this modular manufacturing concept, all parts can be produced according to the current distribution demand. The only variable is the number of machines that are running a particular part. In the case of large machines with multi-cavity molds, the order-related retooling of the machine from one part to the next often involves an undesirable intermittent overproduction. The complicated procedures also affect the material and color exchange at the injection molding side.

The rapid exchange from one order to the next is supported by a cassette mold system. This mold consists of a basic frame into which a two-part mold platen insert is mounted. An integrated ejector pack automatically couples with the machine-side ejector. The mold inserts allow even complex part geometries to be implemented. Slides and core pullers can be machined into the inserts. Minimum material outlay and ease of handling of the small, standardized mold inserts permit low mold costs for new parts, since each machine only requires one mold base.

Access is facilitated by the machine construction with two diagonally offset tie bars

The mold inserts, together with the associated ejector system, can be exchanged very rapidly. The ergonomic construction of the XS series from Boy, with two diagonal tie bars, simplifies this operation. The operator can access the mold without being hindered by the tie bars. Moreover, material exchange with the small plasticizing units takes place very rapidly. Since the nozzle can be simply lifted off the mold, it is unnecessary to clean the hot runners in the sprueless system. The next order can thus start within a few minutes.

The user-friendly Procan Alpha control with full-touch display helps to minimize set-up times here. Setting data sets can be rapidly changed from machine to machine via the USB interface, provided they have not already been loaded via the LAN interface. When uploading the setting data set, the operator obtains detailed information on the new part via a text, with images or drawings, assigned to the mold.

Just-in-Time Production and Reducing Inventory

By varying the number of systems used for an order, it is possible to manufacture precisely to the demand volume. Part inventories can be reduced to a minimum. In addition, products can be produced simultaneously in customized modifications, e. g. with different engravings or in different colors or materials.

The modular manufacturing concept permits improved fine control over the output quantity. The concept also permits reliable delivery, especially with just-in-time production. If a large machine with a multi-cavity mold fails, production comes to halt. If production is distributed between a large number of small machines with simple capacity, the other machines can continue to produce the part in the event one or more machines fail.

If possible, all parts should be produced continually. In this case, parts inventories, and associated capital, can be reduced. The risk of stocking and disposing of unsaleable products is reduced to a minimum. Expensive warehouse space can be converted into profitable production areas and in-house logistics can be considerably reduced. In the event of in-house or inter-company production transfer, it is easier to transport small machines than the large, heavy, complicated production systems.

Reducing Cycle Time and Assuring Quality

Plant wide implementation of the sprueless single-cavity injection molding throughout is a way of achieving shorter cycle times, because the sprue, which is often the thickest walled component in injection molding, is eliminated. Optimized cooling of the molded parts permits extremely short cycle times, and the single-cavity concept does not require compromises to be made in the configuration of multiple cavities. Furthermore, with small machines, faster movements, together with reduced opening strokes, →

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Parts such as these toy figures can be manufactured in many different variations in rapid succession

can be obtained. A number of small automated systems can achieve higher productivity compared to a unit with a large number of cavities.

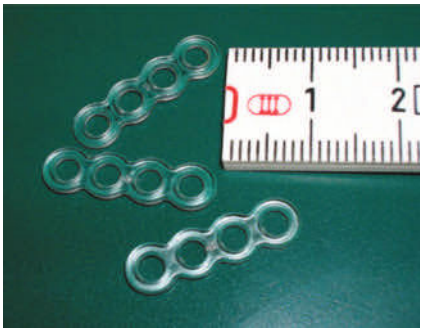
A complex manufacturing system with many cavities is more sensitive and carries a higher quality risk. With multi-cavity molds, it is a difficult undertaking to quickly identify one or more defective cavities as soon as some individual batches contain rejects. With small systems, the expensive secondary work of sorting out the unacceptable parts is completely eliminated.

Small plasticizing units that operate in the optimum range permit defects to be identified sensitively and alarm signals to be given as required. This reduces the probability of supplying unidentified unacceptable parts, or incorporating them into the end product. At the same time, sensitive plastics can be processed more gently due to reduced residence times in the manufacturing process. Thus, unique and inherent material properties benefit the parts to the full extent. Large plasticizing units in which the material resides for a long time in the screw space have clear disadvantages compared to those of small machines. This is particularly true for the production of micro and small parts with a low shot weight. Precise dosing with small plasticizing units is more efficient.

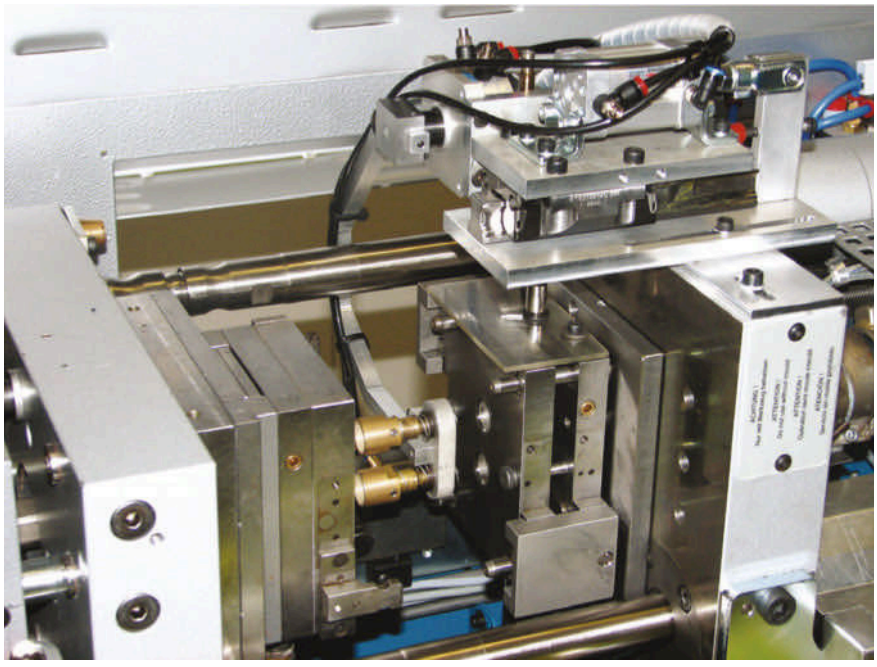
Sprueless without Hot Runners and Automation without Obstacles

The sprueless system with a special machine nozzle offers the advantages of a heated nozzle without the need to accept its disadvantages for material exchange and cleaning. There is no need for an additional control point for the hot runner.

Precise metering is essential for the production of microparts. The barely 2 mm-diameter gear wheel weighs only 1 mg



Mini-osteosynthesis plate: the concept is also promising for the medical sector



Automation equipment can be compactly stowed beneath the protective safety gate

The single part drops out of the machine, and only that polymer that is sold as a finished part is processed.

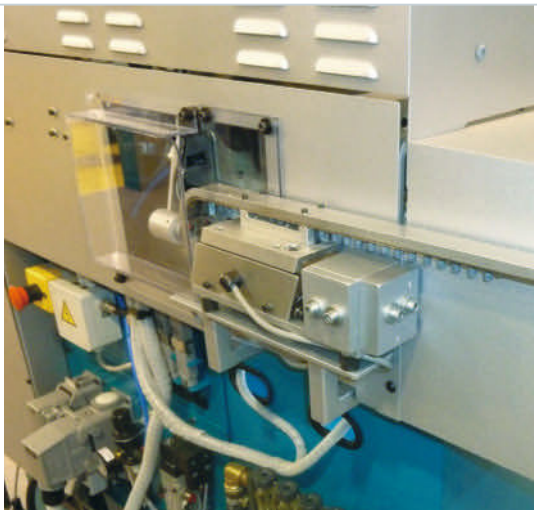
The avoidance of sprue waste offers a huge savings potential. The sprue waste can often be greater than the total weight of the product. It is often overlooked that the large proportion of the throughput determines the production costs of the plant in the same ratio.

While the part is sold for a profit after production, the sprue continues to add to production costs. The handling of sprues by sprue pickers, grinders and mixing valves results in additional costs, handling overheads and sources of defects. In addition, not all the regrind can be re-used or must be used for lower-quality products or disposed of.

The fact that the parts handling can concentrate on an individual part without sprue simplifies the automation processes taking place downstream of the injection molding process. For example, the parts can be decorated with downstream processes. Two-platen systems and the diagonal arrangement of the tie-bars on the Boy XS machines provide good accessibility and permit the use of simple and lightweight handling systems, which are considerably more inexpensive and functionally reliable than the complex systems that are usually used with multi-cavity molds. This results in rapid and precise movements, and therefore shorter cycle times. The automation steps that normally take place downstream of the injection molding process may be performed entirely on the machine, including the packaging of parts ready for shipment. No intermediate handling or transportation to the next processing station is generally required.

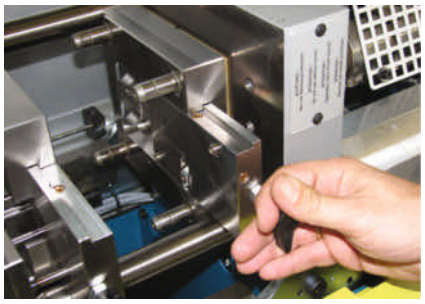
Summary

With the development of the Boy XS and the underlying manufacturing concept, Boy has thoroughly succeeded in re-



Two examples of lean automation: A small swivel-arm handling unit, which is integrated beneath the safety gate of the Boy XS (left) to save space, and a servoelectric linear robot on a Boy XS V automatic insert molding machine (right) pick up inserts from a positioning unit, place them in the mold and remove the finished parts

sponding to future challenges for greater flexibility. What has not yet been mentioned, but should not be neglected, is that in the operation of a large number of identical machines, it is economically advisable to stock spare parts – especially in the lower price range. As a result, downtimes are minimized in the event of a machine failure.



The cassette mold makes child's play of changing the part insert (photos except title photo: Dr. Boy)

To assess the efficiency of this concept, all the factors relevant to the decision for a specific case must be considered, and entered into a comparison. Of course, the single-cavity concept is less advantageous if volumes are high enough that a multi-cavity plant is working to capacity around the year, and retooling work is therefore not required. The concept also assumes a high degree of automation so that in countries with low wage costs its efficiency advantages are less important. ■

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