MIM Part Design Guide

ALFA MIMtech

metal injection moulding technologies

www.mimtech-alfa.com

This document lays out the general design rules that must be followed when offering MIM as a technological alternative for the manufacturing of metal parts.

MIM process can be an attractive option for the following kinds of parts:

-Large series of small precision cast parts (which are already a complex challenge in precision casting).

-Samall parts that require various and complex machining operations.

-Parts created by the pressing-sintering process that then require secondary operations (machining, shaping) or improved mechanical properties.

-Plastic or light alloy injected parts that require superior mechanical resistance - Parts which, due to their geometrical complexity, are created by welding or riveting different components together.

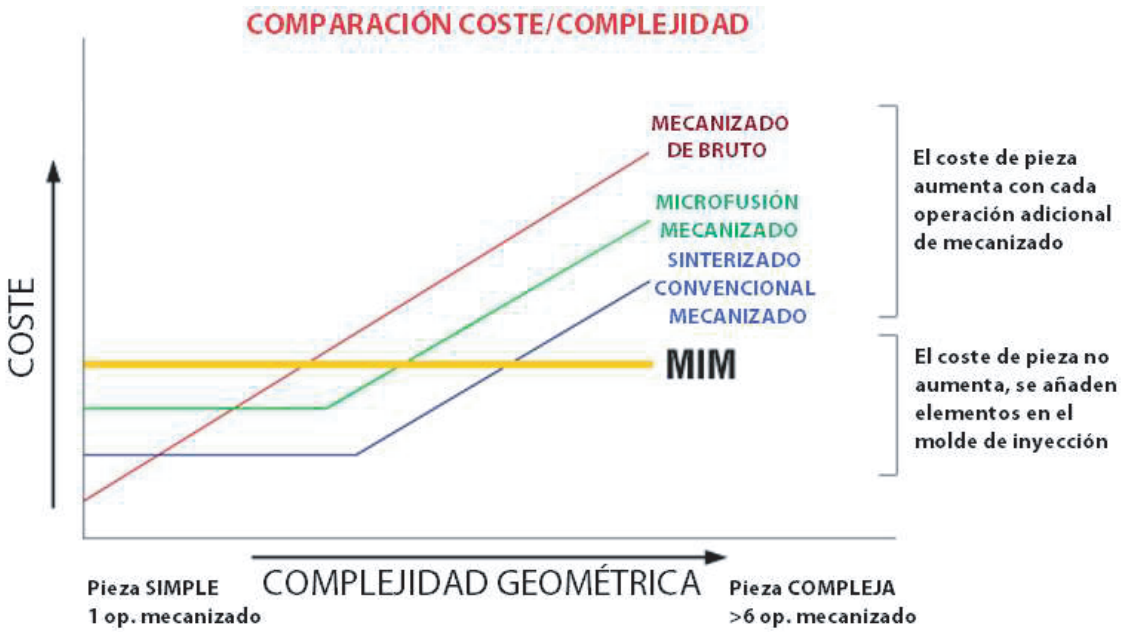
As a summary, the characteristics of an ideal MIM part are the following:

-Weight: few grammes (between 0.5 and 25 grammes). -Geometry: highly complex.

-Series: as large as possible (minimum 5000-10000 parts, with practically no upper limit).

-Mechanical characteristics: superior.

Given the complexity of the production process for the raw material to be injected in MIM, its cost is relatively high, which has a major bearing on the final price of the product. The part should therefore preferably be small, while parts weighing more than 100 grammes may be injected when the complexity of their geometry means that MIM is the most cost-effective technology. The following graph shows the economic advantage of MIM with relation to the geometrical complexity of the part to be manufactured.



Another advantage of MIM technology is the high versatility of design that it can offer. In this respect it is considered to be on a part with plastic injection, combined with the excellent mechanical properties of metals. This is the main reason why its use covers an infinite range of sectors such as automotive, aerospace and defence, mobile phones, medical, electronics, electricity, industrial tools, pharmaceuticals, etc.

MIM also enables several different parts that make up a set to be joined together in a single part, thanks to a design that covers the functions to be carried out by the assembly.

When designing a MIM part, it is advisable to take into account the limitations and possibilities the technology can offer. The process consists of three main stages, during which the material changes state until it acquires the structure and characteristics of the metal part. The tension exerted on the material during the injection process, together with the effect of gravity, as well as the decrease in size that occurs during the sintering process, are all factors that may lead to the deformation of the part if they are not taken into account in the design stage. The following recommendations must be adhered to:

- **Weight** minimum and maximum: 0.5-150 grammes.

- **Profile thickness:** 0.4-10 mm (thicknesses above 6 mm not recommended) ▪ Maintain a uniformity of thickness in the entire part.
▪ Avoid areas with an accumulation of material.
▪ Where uniform thickness is not possible, the transition between the changes in thickness must be gradual.

- The part must be supported during the process. The part should have a flat base to ensure stability.

▪ When the part cannot be given a flat surface, an injected or manufactured part can be used for support.

-The shape of the part is obtained by injecting the raw material into the mould, and the characteristics inherent in this process must be taken into consideration.

▪ An injection point is needed, and the mark is always visible on the part. ▪ It is necessary to extract the part from the mould, generally by means of mobile ejectors, the marks of which will be visible on the part.
▪For extraction, it is necessary to provide the walls parallel to the direction of extraction with draft angles
▪The mould must open for the part to be extracted, and in the opening area a visible parting line will be left on the part.

-The transition between the different planes should be designed in such a way that it facilitates the flow of the injected material. Sudden changes should be avoided, smoothing the transition by using rounding radii, eliminating any sharp internal edges.

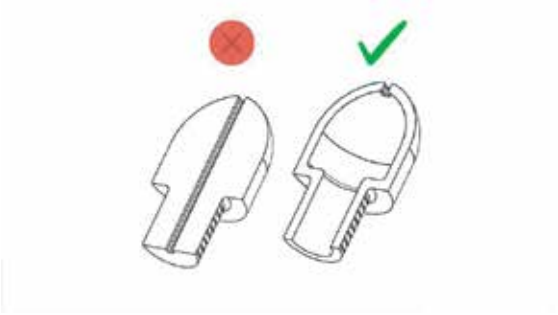
-It is permitted to maintain sharp external edges (rounded r<0,1mm)

-Markings, identification, tracking daters, knurling or aesthetic patterns are possible, with their inclusion in the injection mould

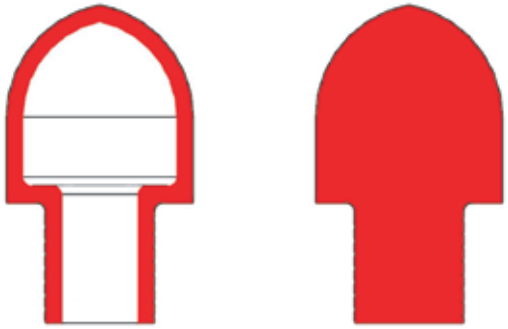
-It is possible to produce different versions or variants of the same part, by using interchangeable inserts in the matrix of the mould

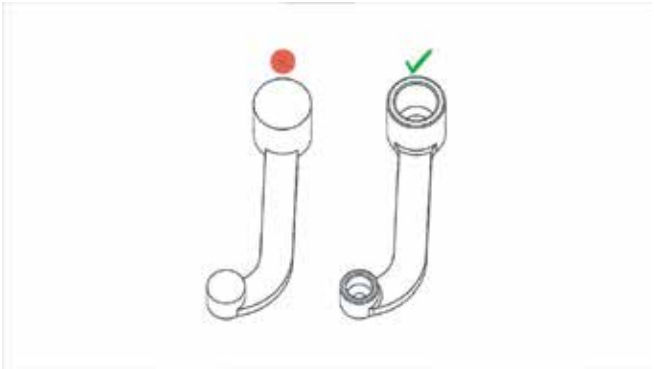
-Strengthen thin perpendicular walls with reinforcement ribs. This will prevent angular deformation, maintaining the required degree of perpendicularity.

WALL THICKNESS



- Uniform wall thickness
- Gradual transition of changes in thickness
- Minimum thickness: 0.4 mm
- Maximum thickness: 6 mm

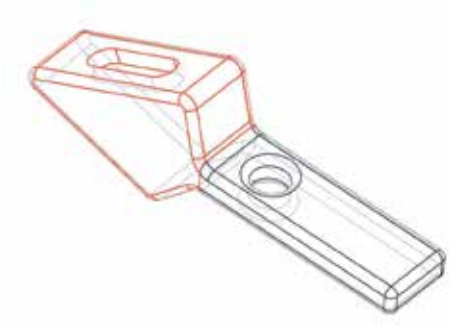


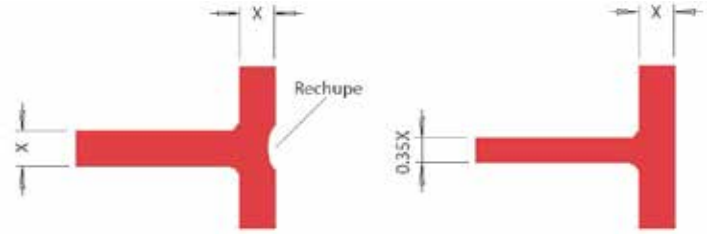


AVOID AREAS WITH ACCUMULATION OF MATERIAL

In areas where there is an accumulation of mass, in which the thickness of the part is more than 4-5mm, it is difficult to achieve the required compacting during the injection process and this can lead to defects as the part cools down.

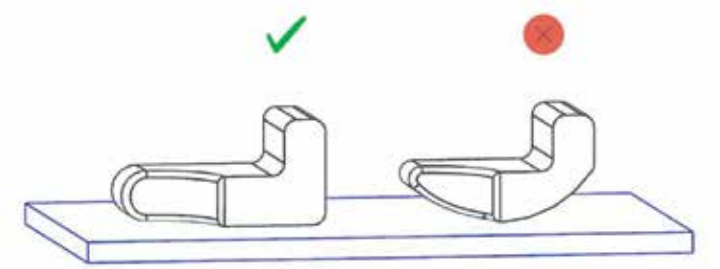
Superficially, this can result in the partial sinking of the external surface, a defect known as sink mark, and can also create cavities or hollow areas, known as spans or internal voids.



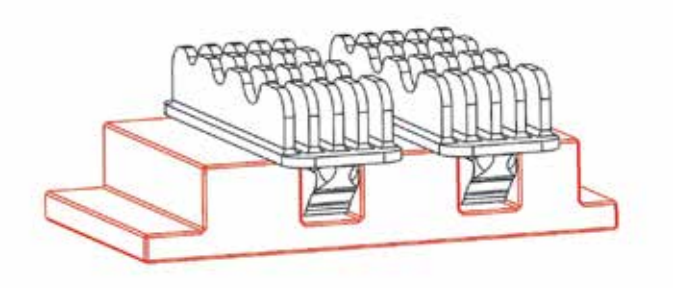


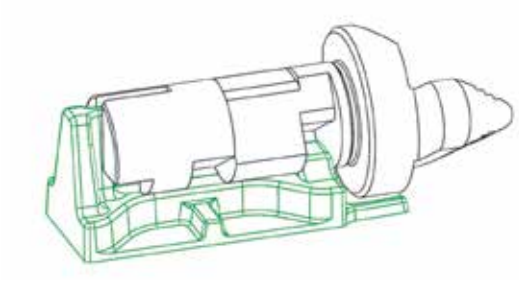
POSITIONING OF THE PART IN THE PROCESS

Ideally the part should be able to rest on a flat surface, avoiding areas without support so as to prevent deformation during the manufacturing process.



Preferable flat support surface

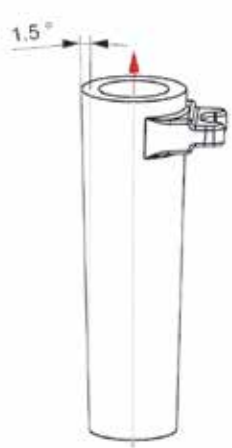




If the shape of the part makes it impossible to provide a support surface, the part can rest on another part that acts as a support

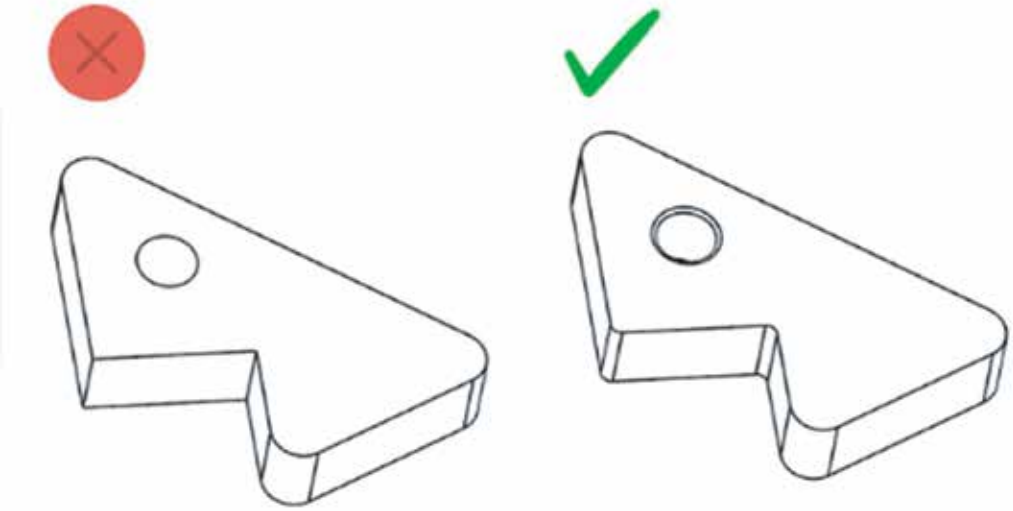
DRAFT ANGLE

Apply draft angles of 1° to 5° on the surfaces perpendicular to the parting line of the mould to facilitate the extraction of the part.



AVOID SHARP EDGES

Avoid sharp connecting edges between the surfaces of the part, that will cause turbulence in the flow during injection, leading to cracks and defects that harm the mechanical resistance of the product.

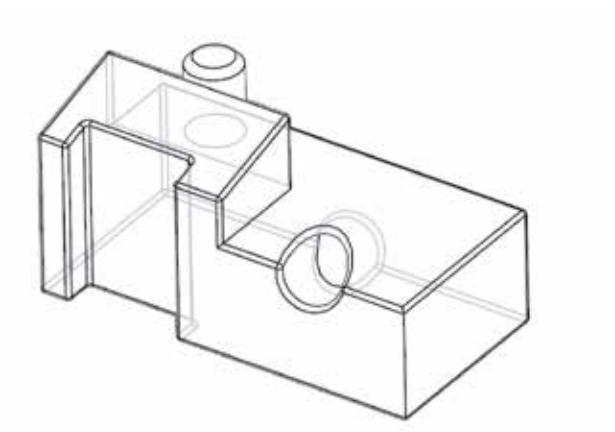


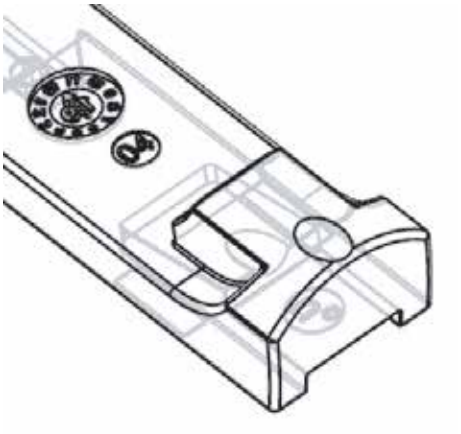
HOLES, CLEARANCES, GROOVES

MIM makes it possible to create holes and grooves in the different draft angles, using mechanical systems activated when the mould opens, or hydraulic or pneumatic systems activated before extraction.

Interconnected holes can also be made. In these cases, the fit between the surfaces of the cores that shape them must be extremely accurate to avoid mismatches and burrs.

Another option is to make grooves or internal cuts, provided they can be released from the mould during the injection process.



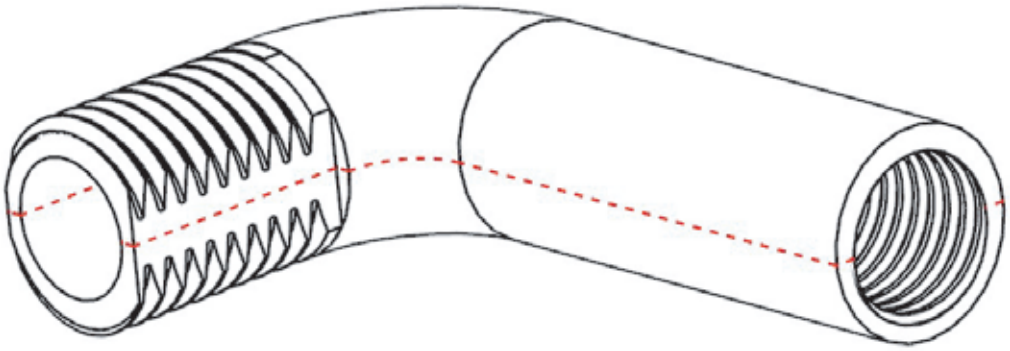


THREADS

Both internal and external threads can be created.

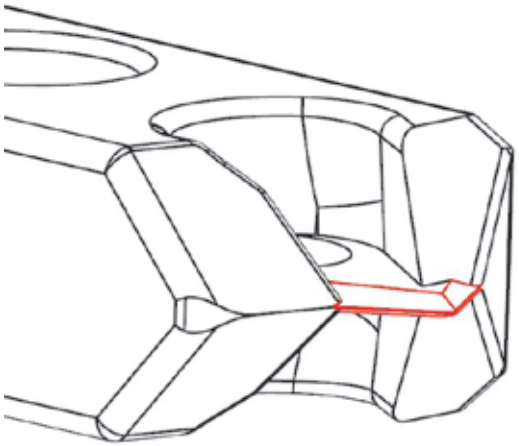
External threads are easier to produce. The mark of the mould parting line remains on the thread; it is therefore advisable to apply a flat face on either side of the threaded surface in order to avoid problems in the functioning of the thread.

The presence of internal holes involves a more complex mould design. Considerably more complex mould release systems are required to extract the part (zip, hydraulic, electric or pneumatic actuators).



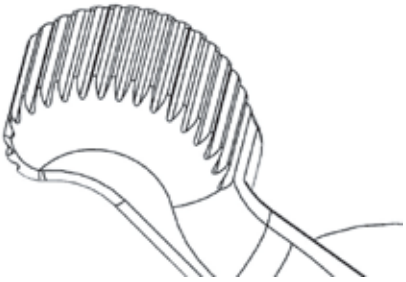
SHARP CUTTING EDGES

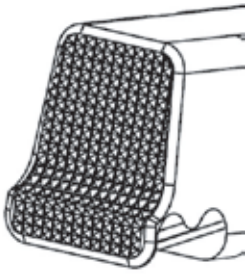
It is possible to produce parts that have non-rounded external edges, creating sharp cutting edges.

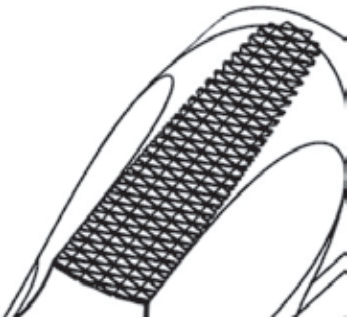


MARKING-TEXT-KNURLING

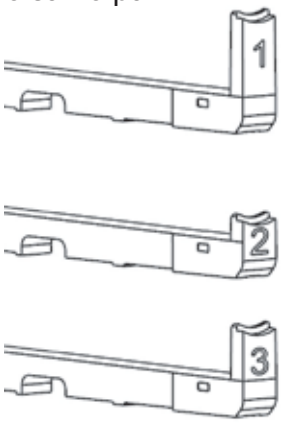
MIM parts can be designed with knurled and textured surfaces, marked with identifying symbols or to facilitate traceability.







The use of interchangeable inserts in the mould makes it possible to produce different models and variants of the same part.



MARKING-TEXT-KNURLING

In shapes where there are perpendicular surfaces, it is advisable to join them with reinforcement ribs to ensure perpendicularity between the walls, thus increasing the mechanical resistance of the part without the need to increase its mass.