Laboratorio di Tecnologie Biomediche

Indicazioni generali per la progettazione degli stampi

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Stampo

- Cavità che ricopia al negativo il pezzo che si desidera realizzare, nella quale si “cola” il materiale scelto per il pezzo, allo stato liquido
- A solidificazione avvenuta si estrae dalla forma
- Questo può essere direttamente il pezzo finito, oppure può richiedere successive lavorazioni, come nel caso dei metalli (greggio di fusione)

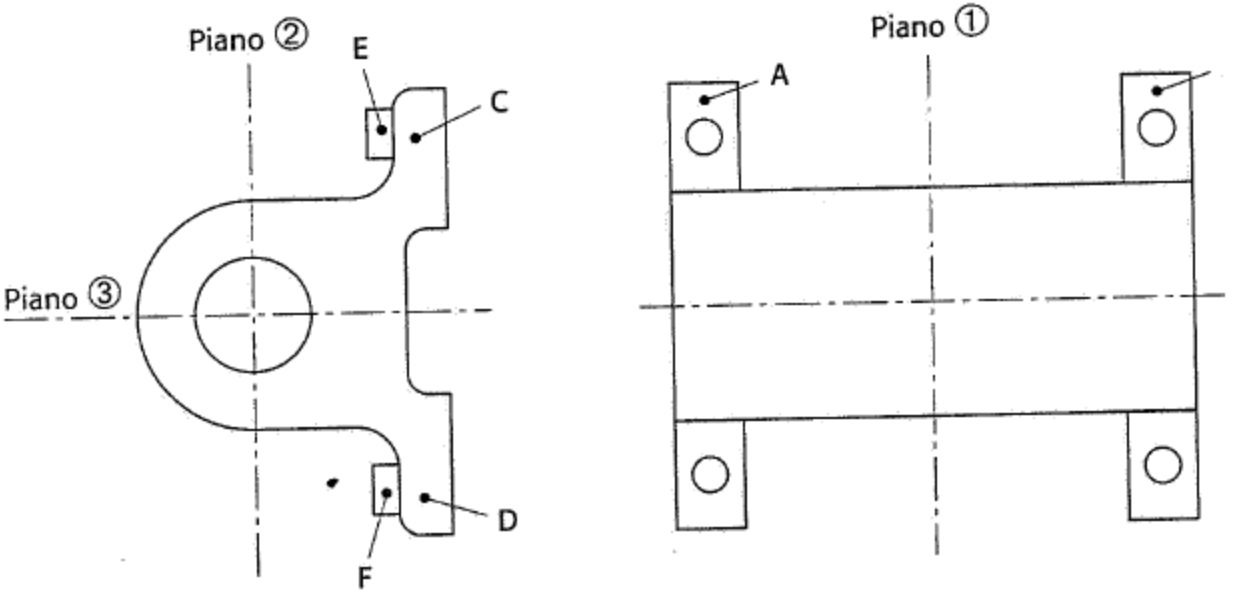
Estraibilità del pezzo

- Il pezzo deve poter essere estratto dallo stampo danneggiarlo o danneggiarsi
- Sottosquadro (o controsformo): parti del pezzo che impedirebbero l'estrazione
- Soluzione dei sottosquadri.

Soluzione dei sottosquadri

- Esistono infinite soluzioni, tante quanti sono i possibili sono i possibili piani di divisione di un modello
- Se non esiste questa soluzione, si può ricorrere a diversi metodi (con costi diversi)

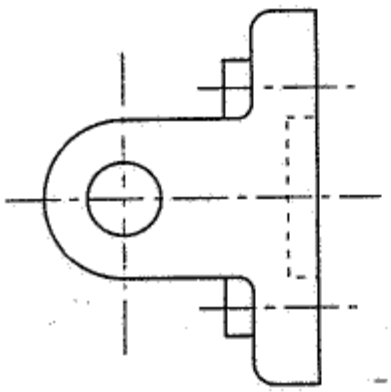
Soluzione dei sottosquadri

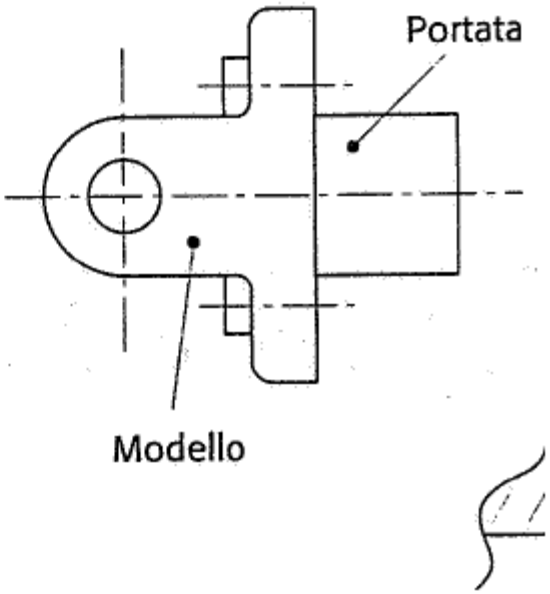


Soluzione dei sottosquadri

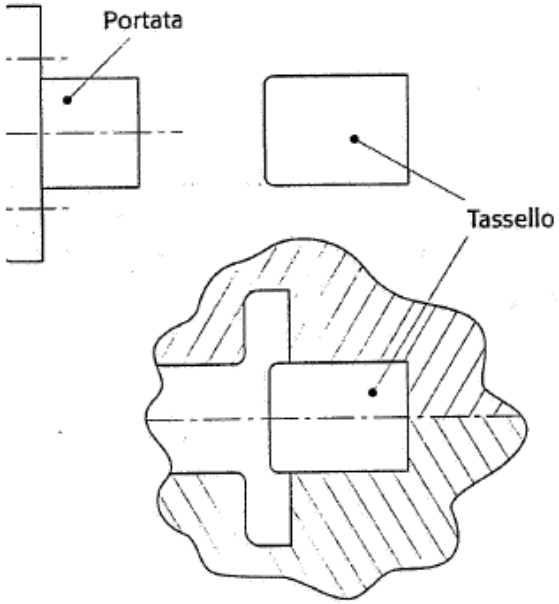
- Modifica del progetto
  - Attenzione alla modifica di spessore
  - Cavità di ritiro
- Uso di tesselli e di portate d’anima

Soluzione dei sottosquadri





Soluzione a: Formaggelle alla francese ed eliminazione parte tratteggiata

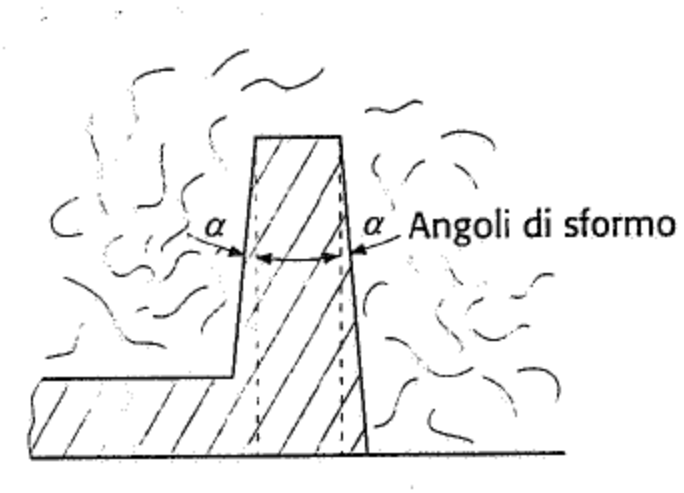


Soluzione b: Uso di tasselli

Angoli di sformo

- Sformatura: estrazione del modello dalla forma
- Eliminare o ridurre al minimo le superfici perpendicolari al piano i divisione
- Inclinare le superfici di un piccolo angolo (angolo di sformo), evitando così che nel movimento di estrazione del modello la superficie trascini via il materiale di formatura

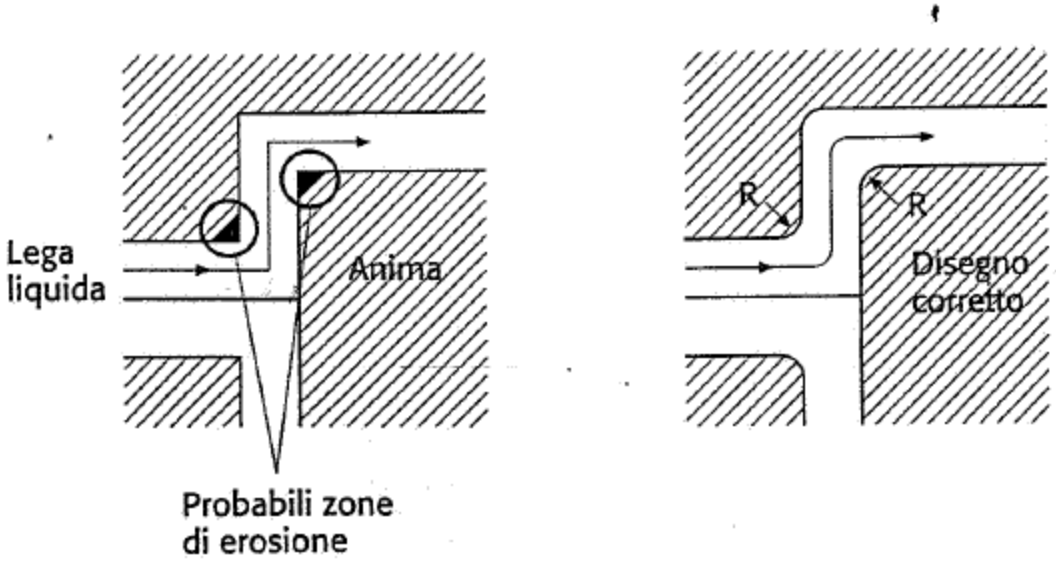
Angoli di sformo



Raccordi

- Gli spigoli vivi devono essere eliminati mediante raggi di raccordo
  - Non resisterebbero all'azione erosiva del fuso (inclusioni non metalliche nel getto)
  - Possible formazione di cristalli colonnari (punto di frattura, in caso di lavorazione di metalli)

Raccordi


Lega
liquida
Anima
Probabili zone
di erosione
R
R
Disegno
corretto

Fenomeno del ritiro

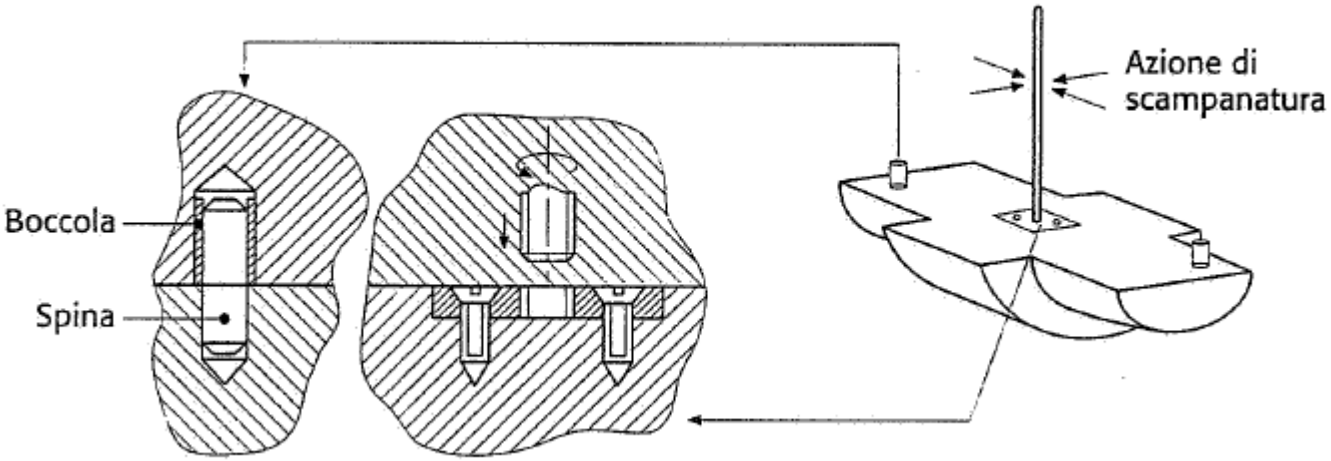
MATERIALI	RITIRO %(2)		
	Getti piccoli(1)	Getti medi(1)	Getti grandi(1)
Ghise grige	1	0,85	0,7
Ghise malleabili	1,4	1	0,75
Ghise legate	1,3	1,05	0,35
Acciaio	2	1,5	1,2
Alluminio e leghe	1,6	1,4	1,3
Bronzi	1,4	1,2	1,2
Ottoni	1,8	1,6	1,4
Leghe di magnesio	1,4	1,3	1,1

(1) I «getti piccoli» comprendono getti con una dimensione max < 500 mm; i «getti medi» comprendono getti con una dimensione massima compresa tra 500 e 1000 mm; i «getti grandi» comprendono getti con una dimensione massima < 1000 mm.

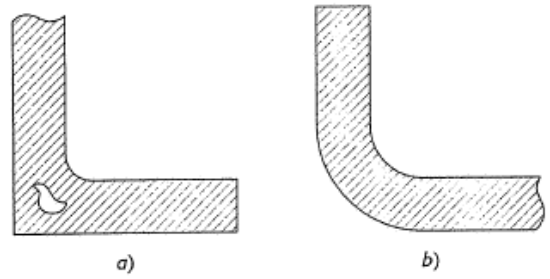
(2) Il ritiro delle cavità è in genere un po' minore (5–10%) rispetto a quello delle superfici esterne a causa della resistenza che oppongono le anime alla libera contrazione del metallo.

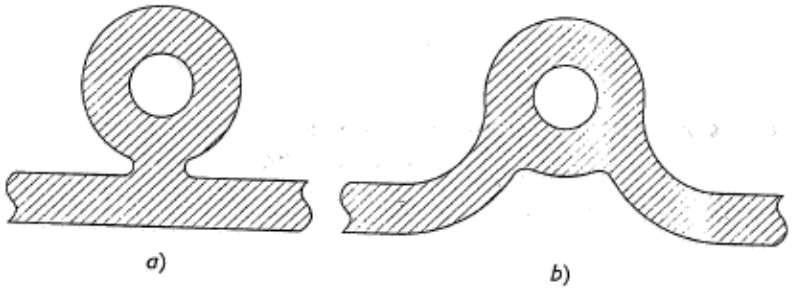
Caratteristiche costruttive

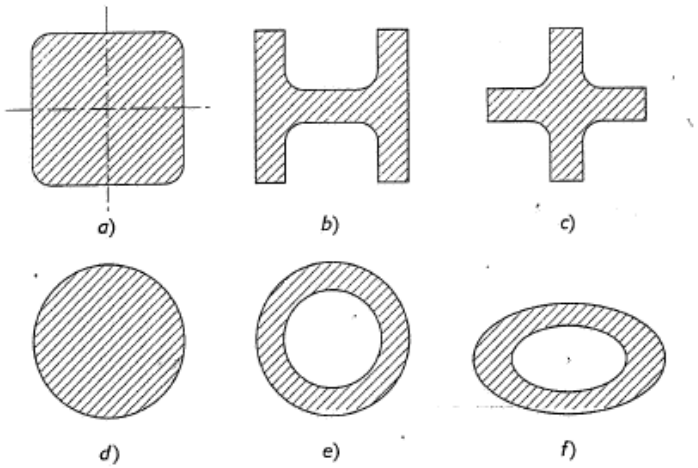
- Spine di riferimento

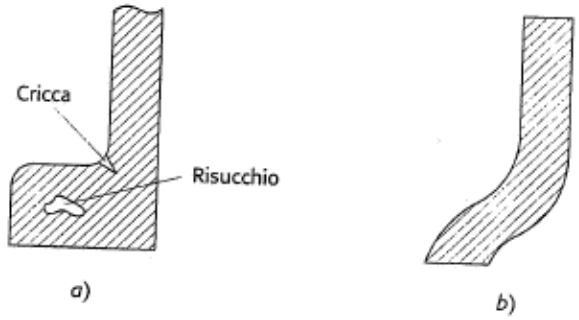


Esempi di riprogettazione di particolari

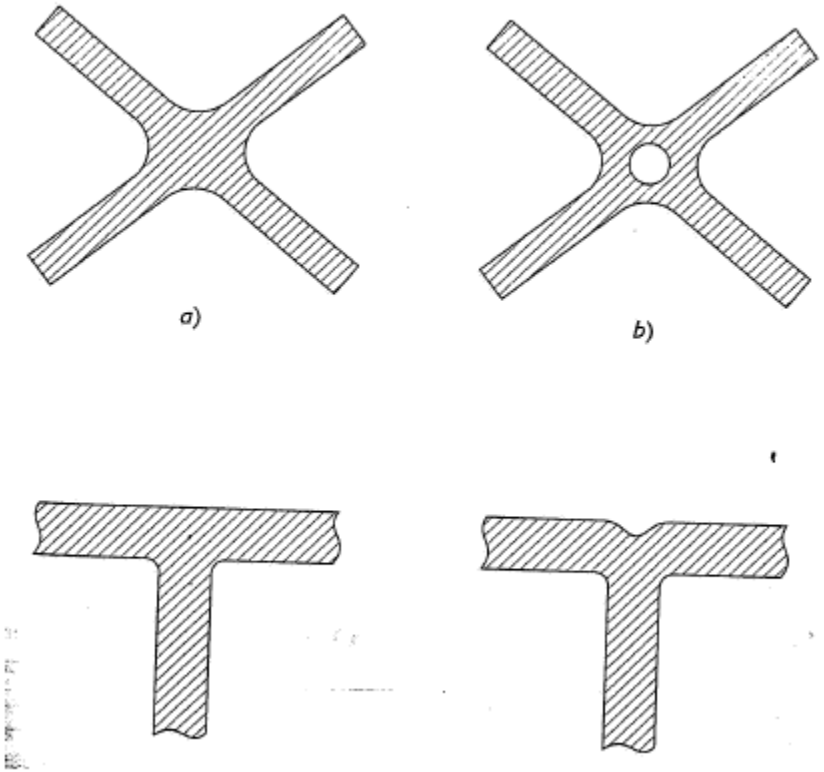




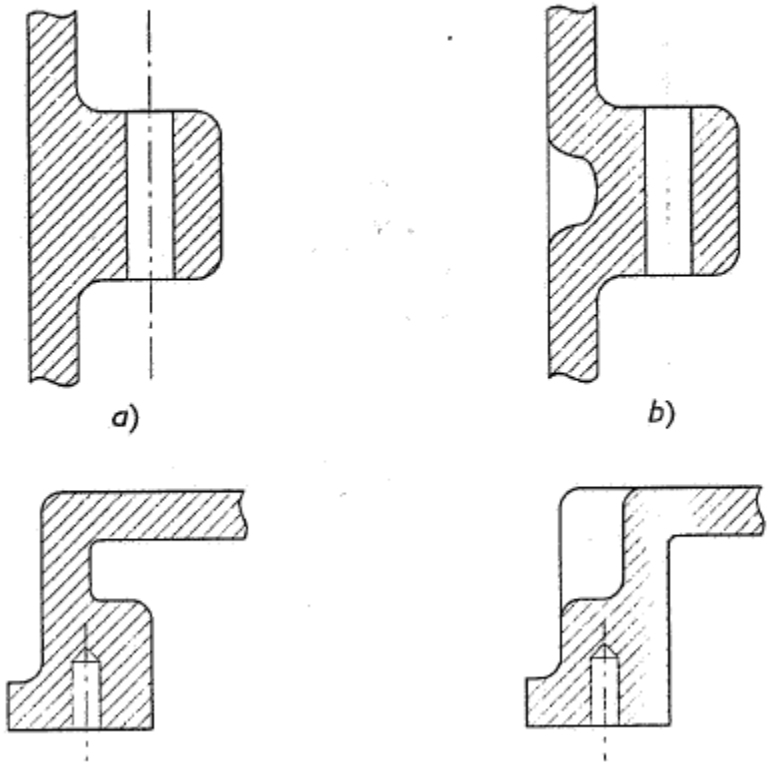




Esempi di riprogettazione di particolari



Esempi di riprogettazione di particolari

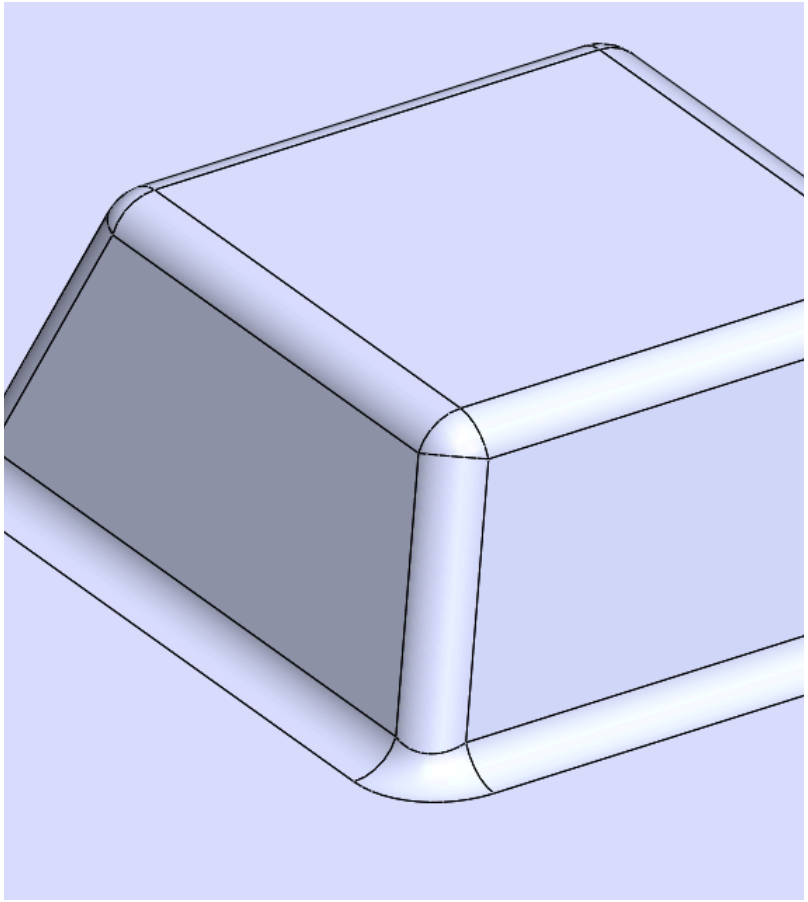


https://medium.com/jaycon-systems/engineering-guidelines-to-designing-plastic-parts-for-injection-molding-1c554a4545be

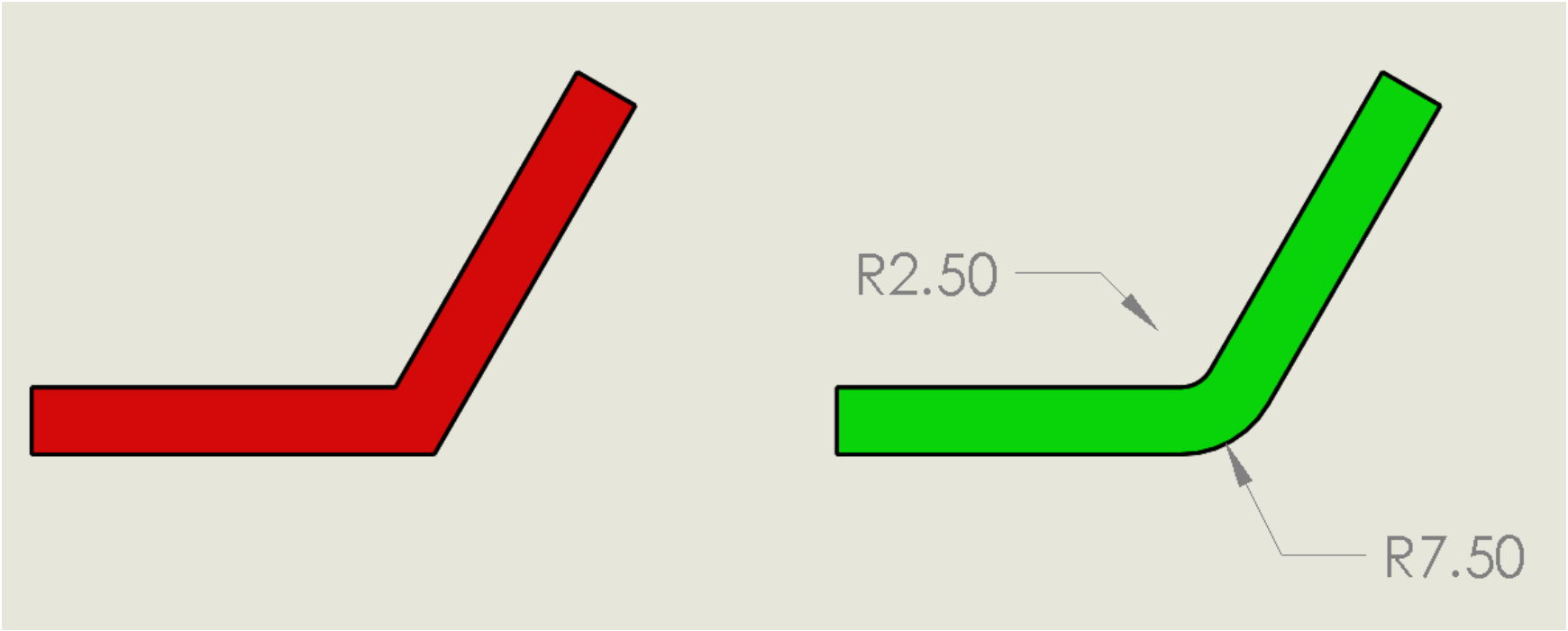
DETAILS FOR INJECTION MOULDING

Radiused Edges

- Having radiused edges and corners (both inside and outside) of a part is a multipurpose feature. This allows for better removal during part ejection, — in conjunction with drafted sides — and better material flow (more on this later). Most importantly, however, is that it will not only prevent excessive expenses when creating the mold, but it will prevent cracks from forming due to stress concentration.

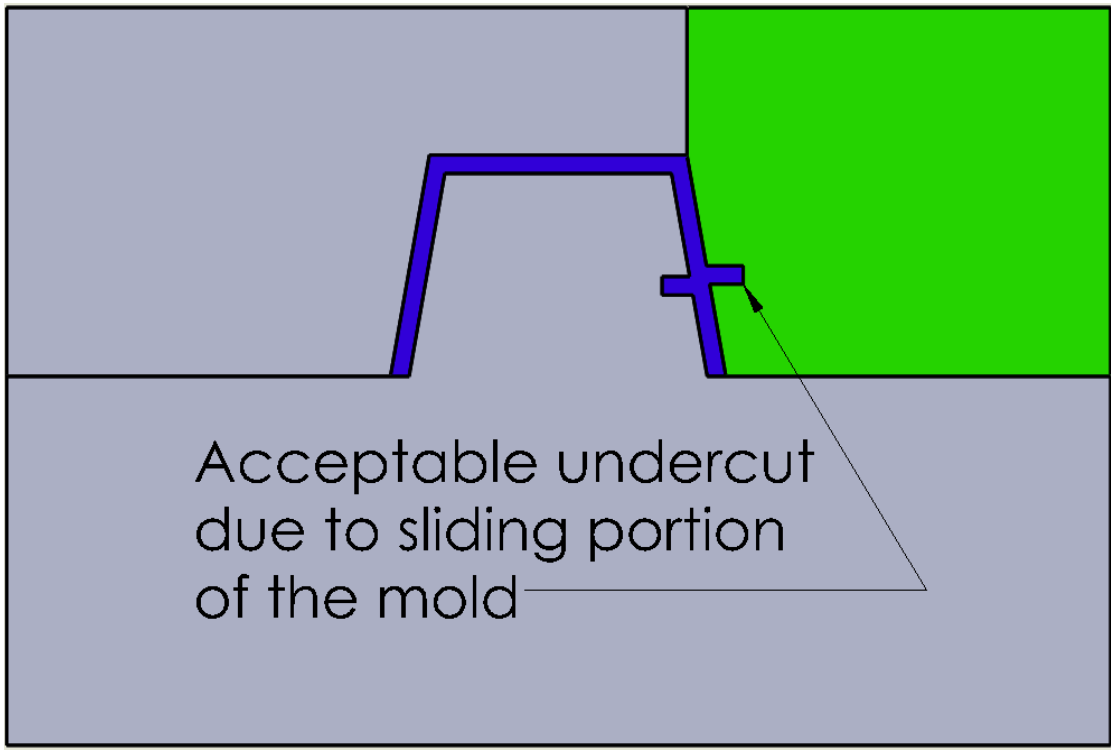


Keep in mind that radiused corners should maintain same wall thickness, which means that if inner r=½ thickness then outer R=3*½ thickness.



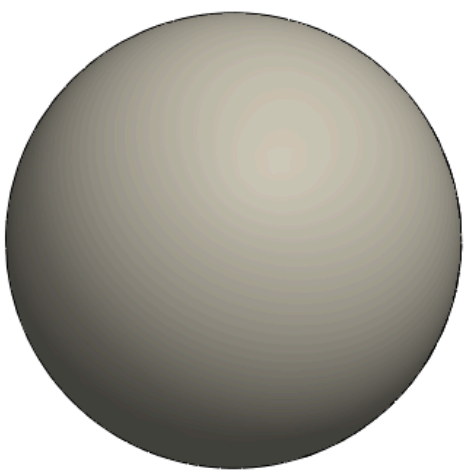
Undercuts

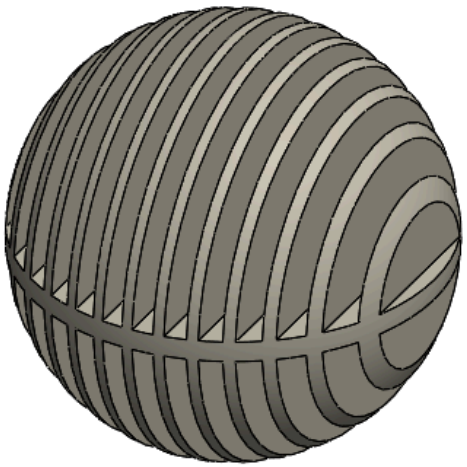
- Undercuts are items that interfere with the removal of either half of the mold.
- These are just as unacceptable, if not worse than a lack of a draft angle on the part.
- However, some undercuts are necessary and/or unavoidable. In those instances, necessary undercuts are produced by sliding/moving parts in the mold.



Solid vs Shell

- As the plastic cools in the mold, it also shrinks, which is a common characteristic for most materials.
- Making a component a shell versus a solid helps reduce the amount of shrinkage or warpage that happens during the cooling process. It also helps lowers the cost of material needed to be used in that part. There are numerous ways to shell a design, one example is shown on the sphere below.





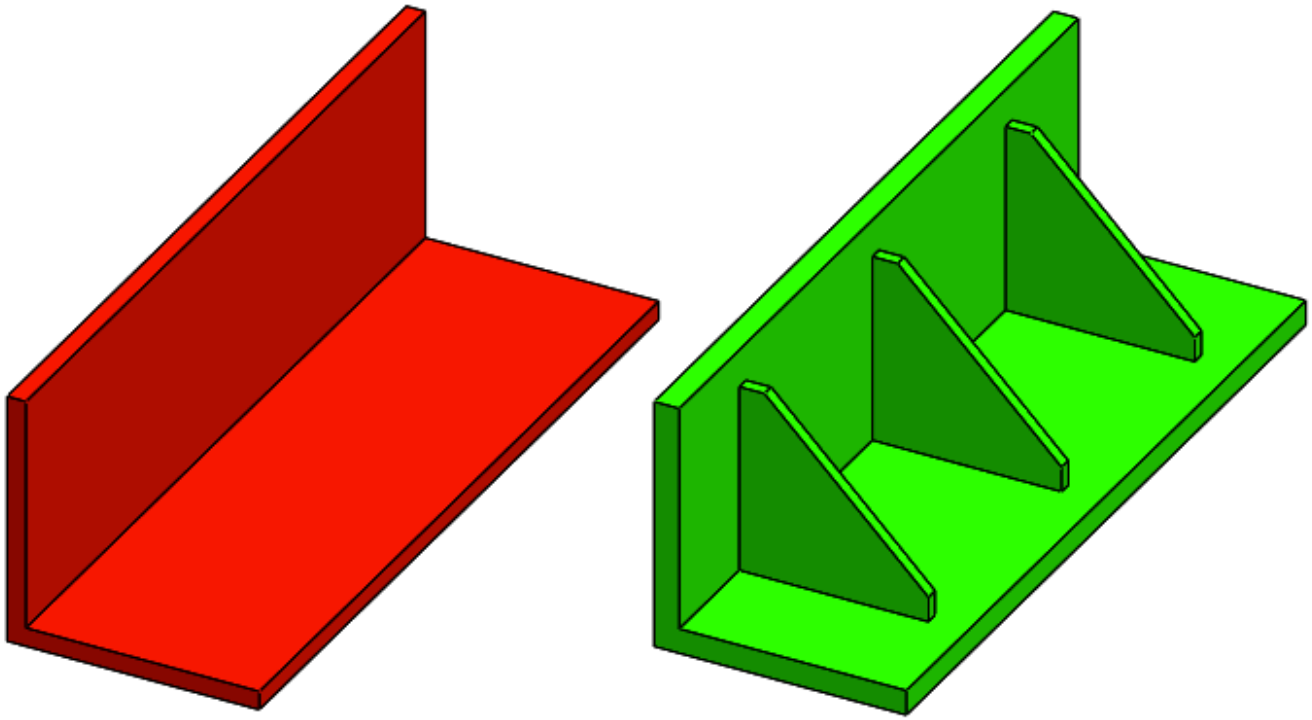
Support Ribs/ Gussets

- Support ribs/gussets are used to give a product's walls additional support. They are used mainly in two situations:
  1. where the part has 90-degree angled walls that meet, and
  2. where a part may be too long or large and the wall thickness leaves the part flimsy or weak.

- Support ribs tend to work best in the direction in which they are needed, such as running the length of a long section.
- When designing support ribs, it is important to consider draft angles and base thickness at no more than ⅔ the thickness of the wall it is attached to.

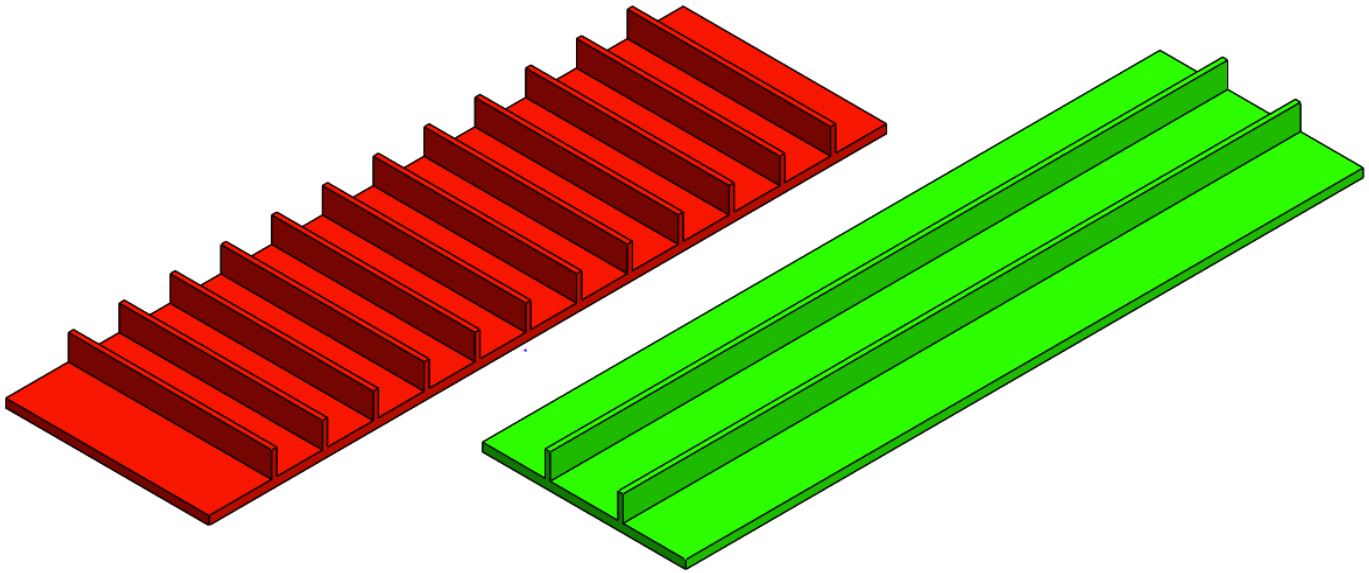
Support Ribs/ Gussets

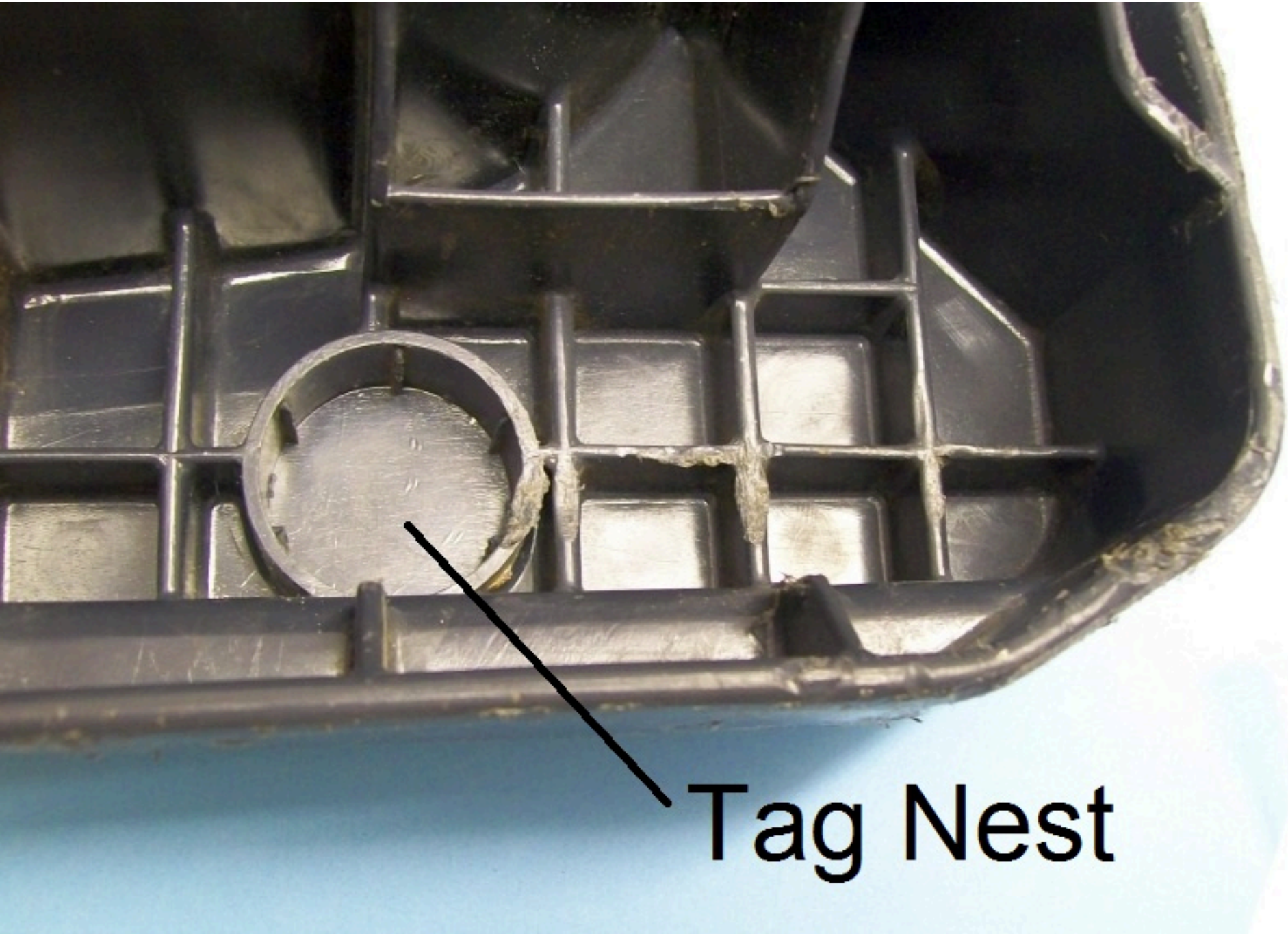
- Case 1



Support Ribs/ Gussets

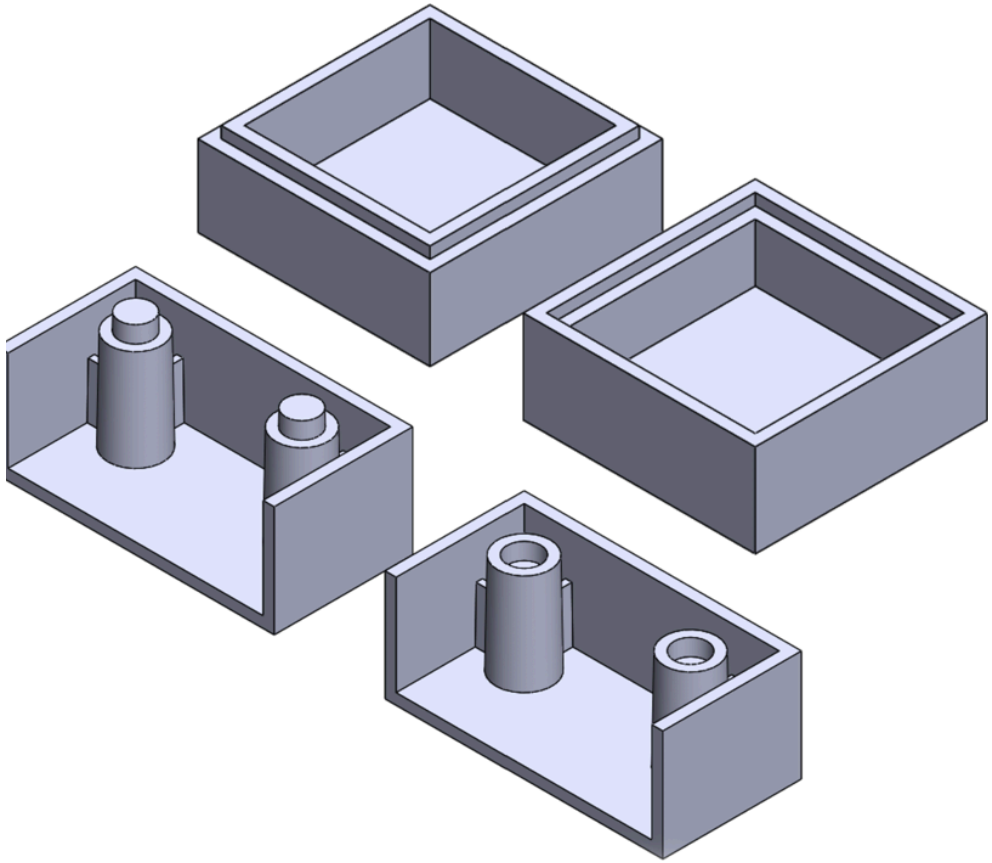
- Case 2




Tag Nest

Connecting Parts Together

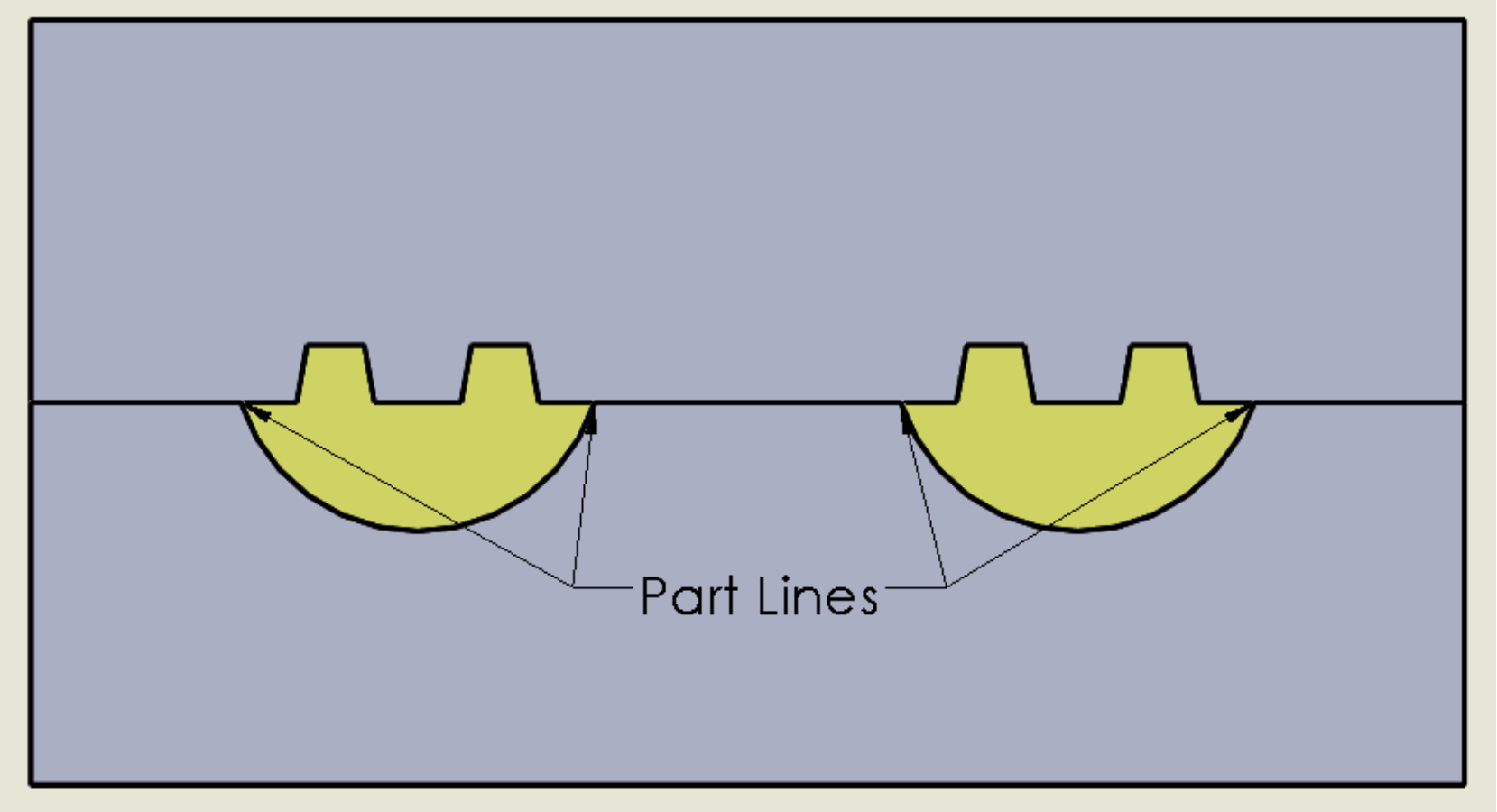
- Products are generally composed of two or more parts connected together. These parts can be connected with mounting bosses, snap hooks, screws, etc. A common way of uniting two parts is using screws through mounting bosses. Having lips/grooves where the parts touch is a common way to align parts together.



Part Line

- Part lines are where the two halves of the mold meet. This generally creates a physical line on a part that is both visible and noticeable to the touch.
- These lines, however, can be hidden or minimized when placed along edges of the part.

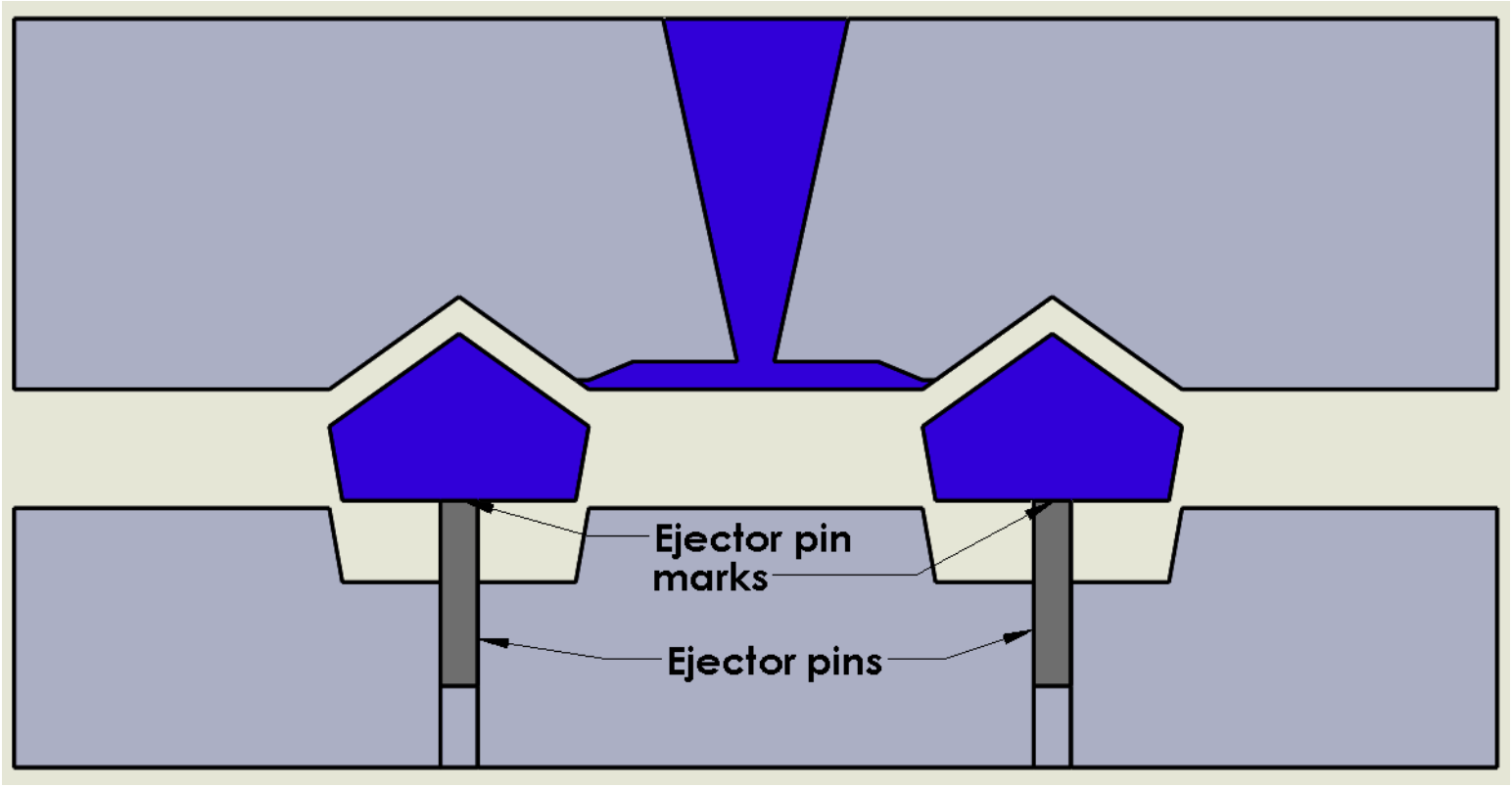
Part line



Ejector Pin Locations

- Ejector pins are what allow the part to be removed from the mold. These pins literally push the part out after the material has been injected into the mold and set. However, while pushing parts out, these pins leave marks on the part. These marks are generally not removable, so location is key to keep in mind when designing the part.

Gate Locations and Material Flow



Gate Locations and Material Flow

- Gates are where the molten plastic enters the cavity of the part in the mold. These gates, once the part cools, leave a mark/ indication of where the gate was, even when attempted to be removed by a post process. Gate location is sometimes determined by:
  - where it will be less noticeable;
  - where it will not interfere with the rest of the part;
  - how the plastic material will flow evenly through the part;
  - or a combination of all these.

Material and Thickness

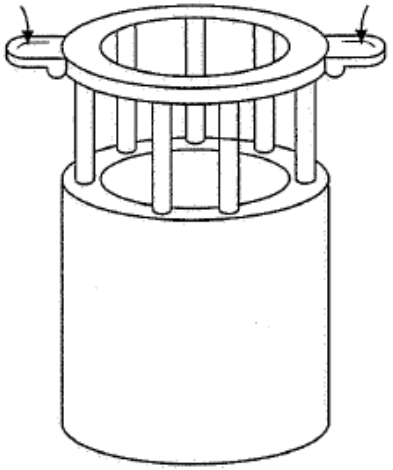
- Reccommended wall thinkness

Resin	*Inches*	*Millimeters*
ABS	0.045 – 0.140	1.143 - 3.556
Acetal	0.030 – 0.120	0.762 - 3.048
Acrylic	0.025 – 0.150	0.635 - 3.81
Liquid crystal polymer	0.030 – 0.120	0.762 - 3.048
Long-fiber reinforced plastics	0.075 – 1.000	1.905 - 25.4
Nylon	0.030 – 0.115	0.762 - 2.921
Polycarbonate	0.040 – 0.150	1.016 - 3.81
Polyester	0.025 – 0.125	0.635 - 3.175
Polyethylene	0.030 – 0.200	0.762 - 5.08
Polyphenylene sulfide	0.020 – 0.180	0.508 - 4.572
Polypropylene	0.025 – 0.150	0.635 - 3.81
Polystyrene	0.035 – 0.150	0.889 - 3.81
General rule of thumb	0.040–0.140	1.016 - 3.556

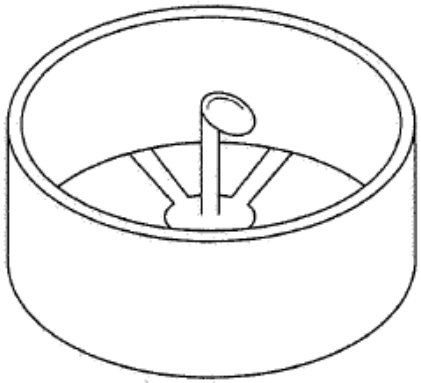
Sistema di colata (metalli)

- La forma deve essere riempita rapidamente, prima cioè che sia completata la solidificazione
- Occorre evitare forti velocità o turbolenze che potrebbero rovinare la forma e trascinare aria

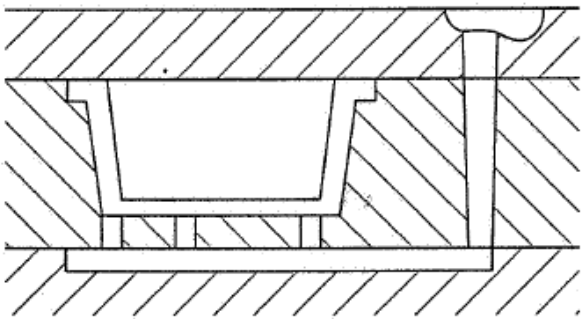
Sistema di colata (metalli)



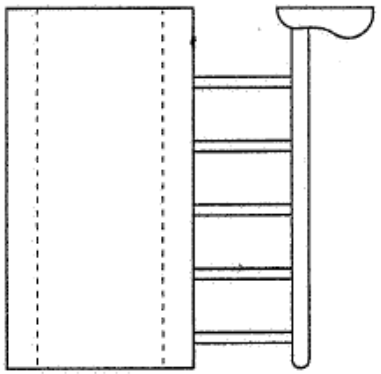
Colata dall'alto a pioggia



Dal basso a stella



Dal basso a sorgente



Colata a pettine