Cheil Industries Inc.

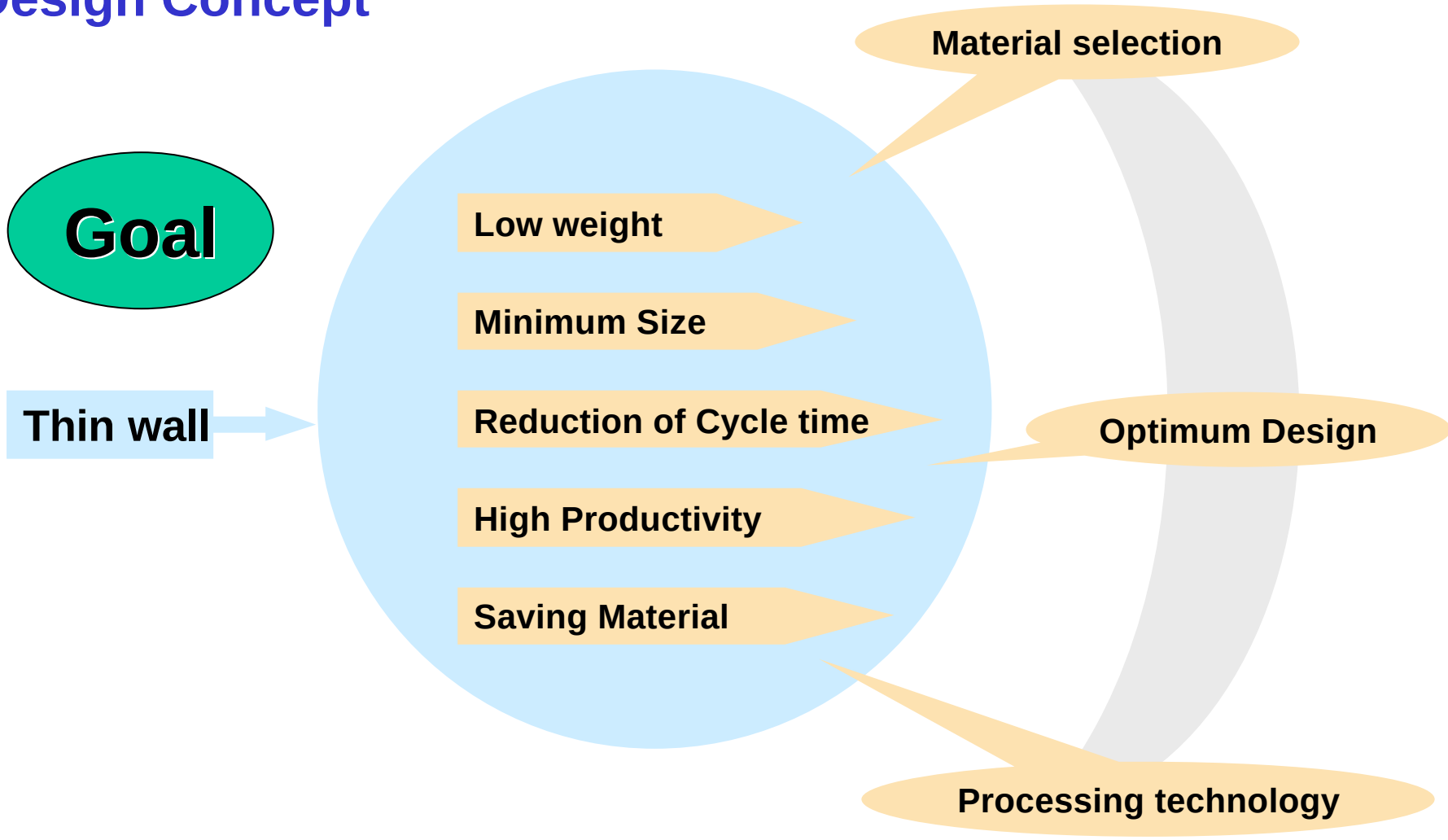
Design Guide

SAMSUNG

Design Guide for

Thin Wall Product

Design Concept



Material selection

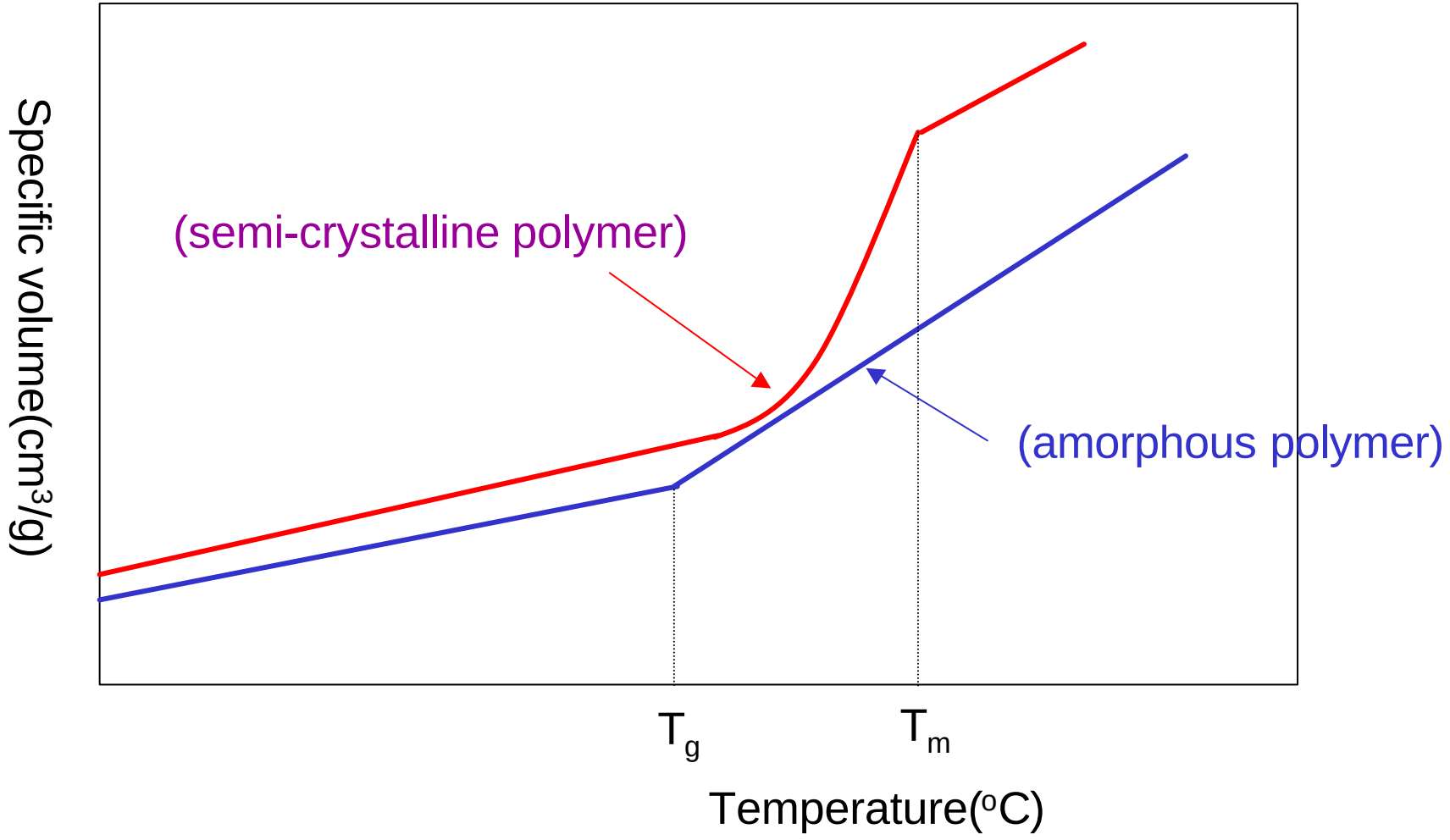
Requirement

100:1 ~ 150:1 ≥200:1

High Flow Length	**Resin Flow length: Spiral Flow(L/T)**
High Impact Strength	**Notch Izod Impact Test, Low Temperature Impact Test**
Good Appearance	**Low Gloss, UV Resistance: deltaE 1~2**
Stiffness	**Neat engineering Plastics: Flexural Modulus- 2,000MPa** **Reinforced plastics : Flexural Modulus- 3,500~ 14,000MPa**
Heat Resistance	**UL Relative Thermal Index(RTI): 70 ~ 95°C**
Mechanical Integrity	**Design for assembly : Snap fit, Small Screw, Ultrasonic Welding**
Flame Resistance	**Mobile Phone : UL HB, Portable PC: UL94 V-0~V-1**

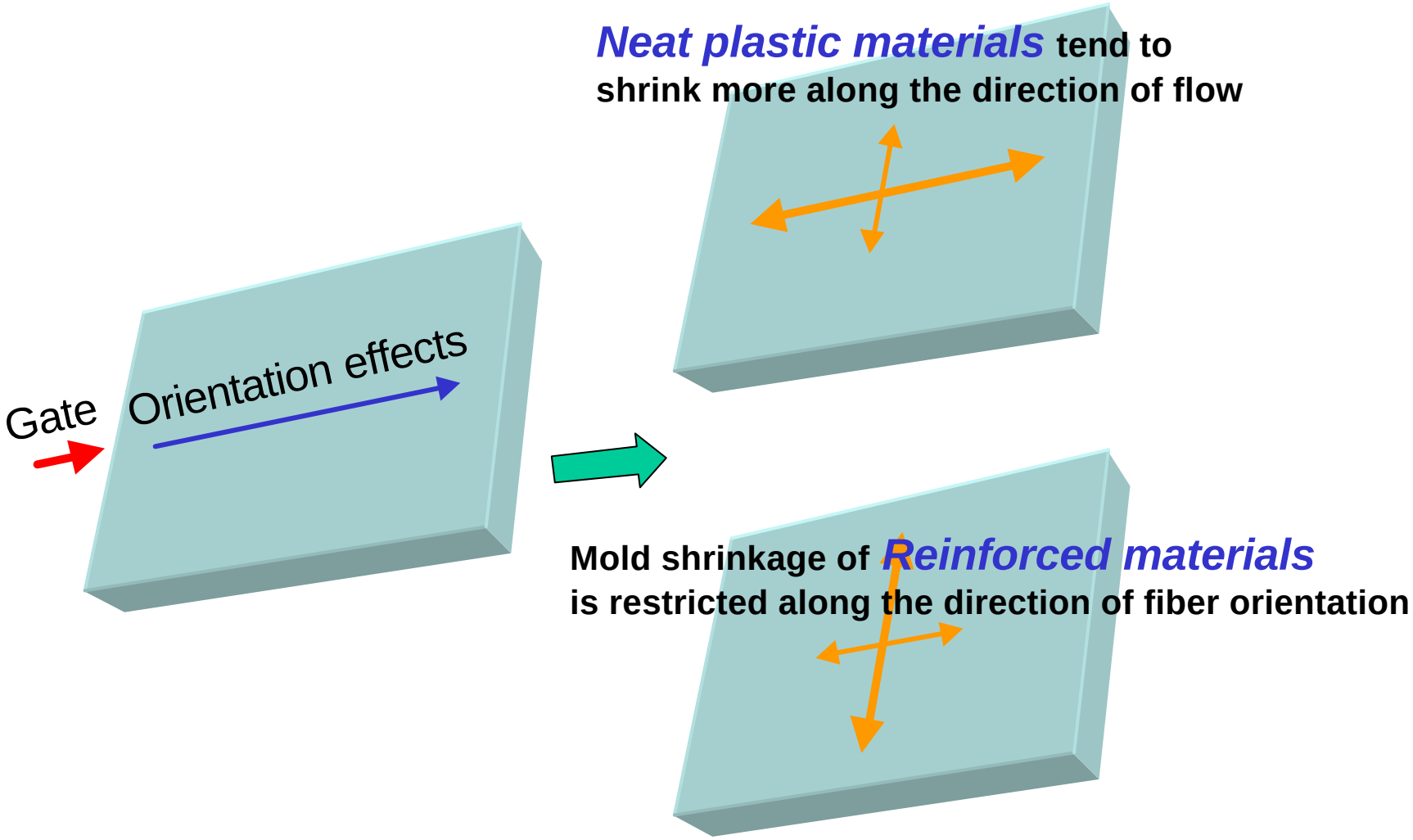
Shrinkage

Amorphous vs. semi-crystalline



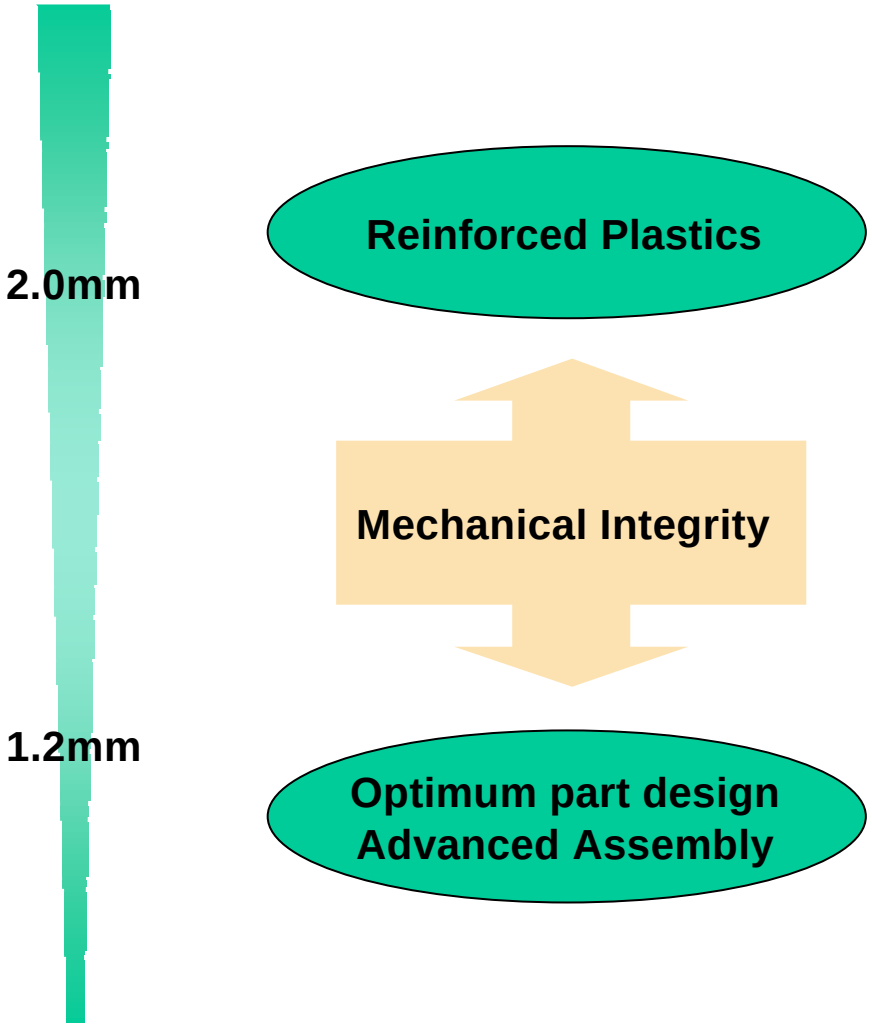
Shrinkage

Neat plastic materials **tend to shrink more along the direction of flow**



Mold shrinkage of *Reinforced materials* is restricted along the direction of fiber orientation

Mechanical Integrity



Larger & thick wall part

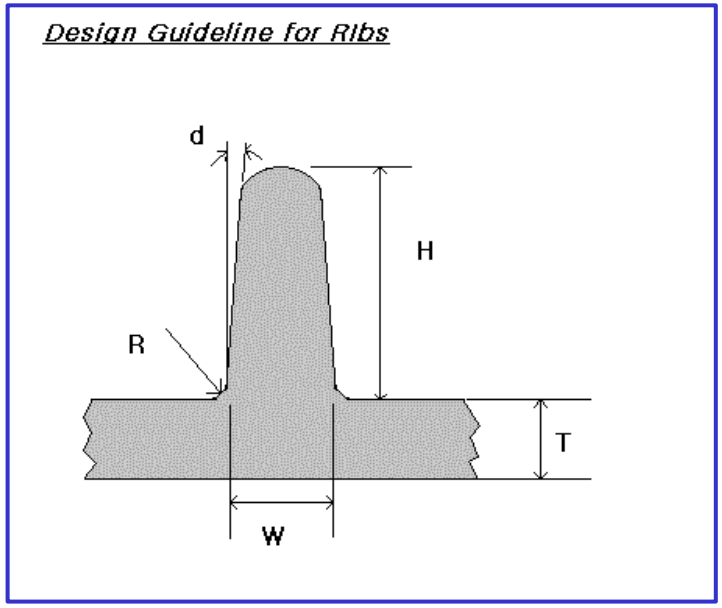
Smaller & Thin wall part
- optimize part geometry
- use proper assembly technique

Ribs

W ≤ 0.6T
d ≥ 0.25°

W ≤ T
d ≥ 0.5°

Wall Thickness of Rib, Boss, Gusset in thin wall part may be same as part thickness because of low possibility of sink or void.



Guidelines for Rib dimensions:

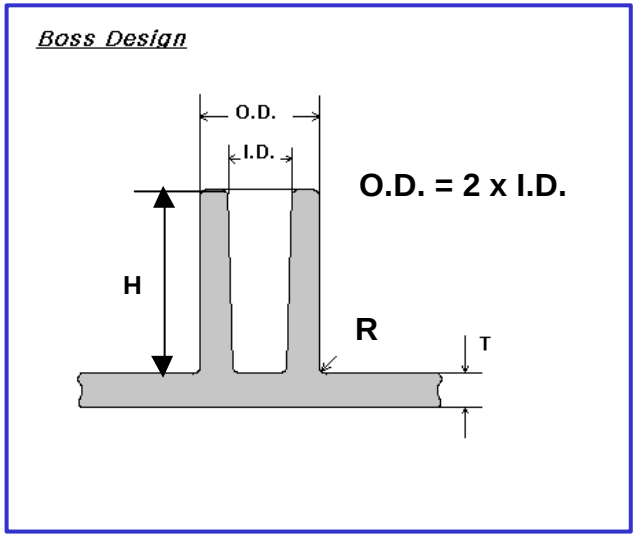
Components wall thickness:T
Draft per side(d):0.5° ~1.5°
Rib height(H):less than 5T(typically 2.5T~3T)
Rib spacing(on center):more than (2T~3T)
Base radius(R):0.25T~0.40T
Rib thickness(W):0.4T~0.8T
(less than 0.5T for PC/ABS,0.5T~0.7T for ABS)

Bosses

W ≤ 0.6T
d ≥ 0.25°

W ≤ T
d ≥ 0.5°

A boss with outside diameter which is two times the inside diameter is sufficiently strong



Guidelines for Boss dimensions:

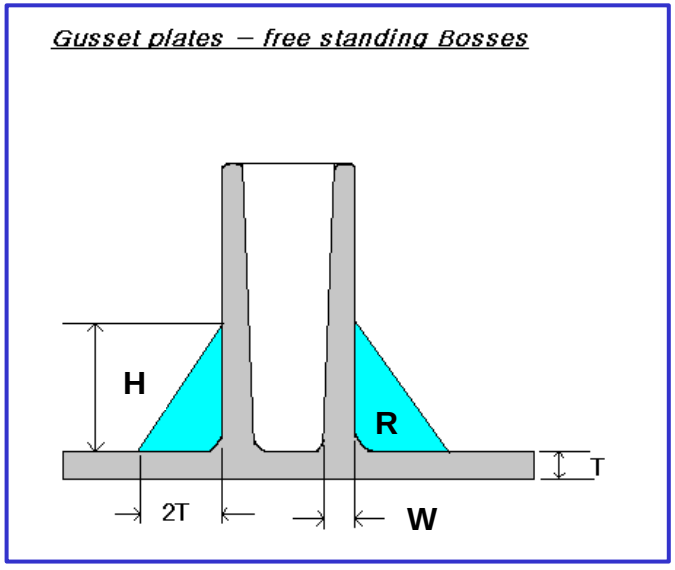
Components wall thickness:T
Draft per side(d):0.5° ~1.5°
Boss height(H):less than 5T(typically 2.5T~3T)
Base radius(R):0.25T~0.40T
Boss thickness(W):0.4T~0.8T

Gussets

W ≤ 0.6T
d ≥ 0.25°

W ≤ T
d ≥ 0.5°

Gussets are another form of ribbing that can be used to reinforce a side wall of a part or boss



Guidelines for Gusset dimensions:

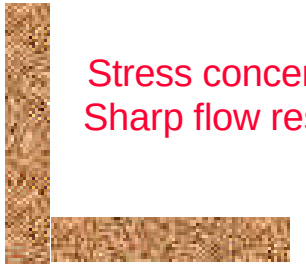
Components wall thickness:T
Draft per side(d):0.5° ~1.5°
Gusset height(H):less than 5T(typically 2.5T~3T)
Base radius(R):0.25T~0.40T
Gusset thickness(W):0.4T~0.8T

Corner

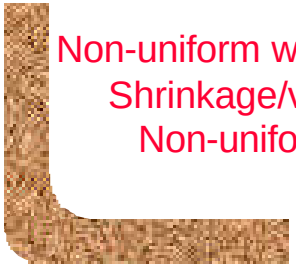
Good design

- Generous radius
- Uniform wall thickness
- Smooth flow transition

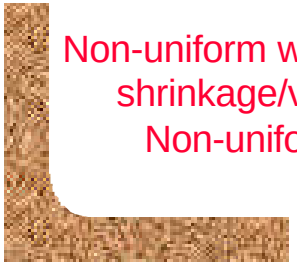
Incorrect design



Stress concentration
Sharp flow restriction



Non-uniform wall thickness
Shrinkage/void/sinks
Non-uniform flow

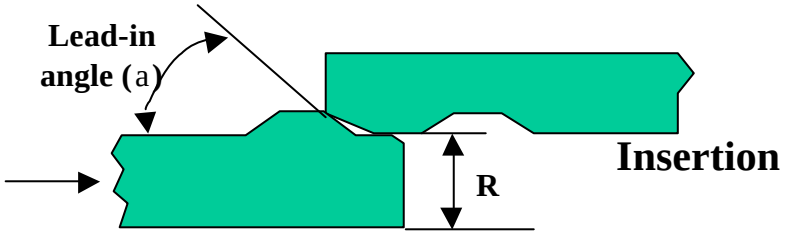


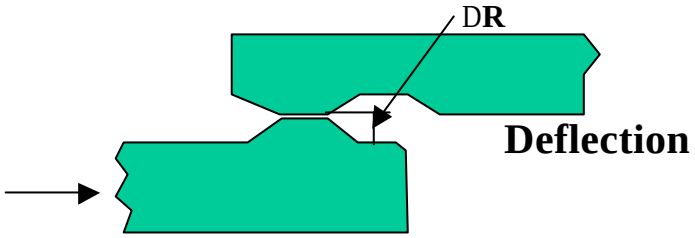
Non-uniform wall thickness
shrinkage/void/sinks
Non-uniform flow

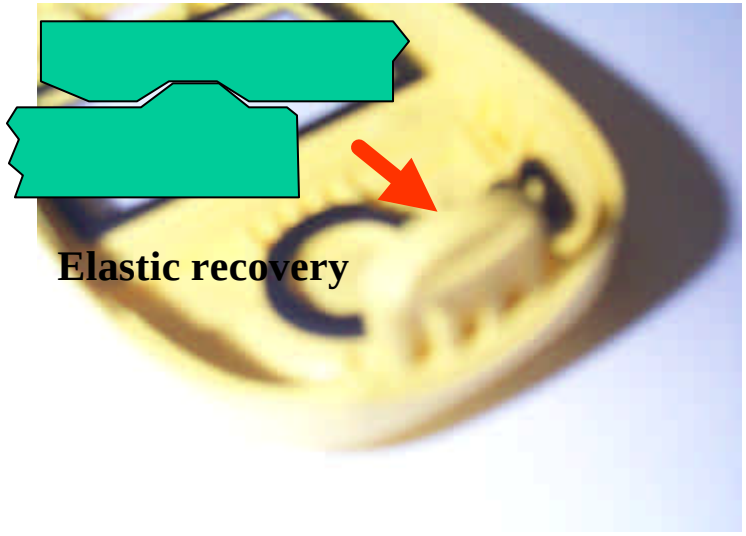
Design for Assembly

Snap Fit Joint assembly

satisfy both Design for assembly and Design for disassembly





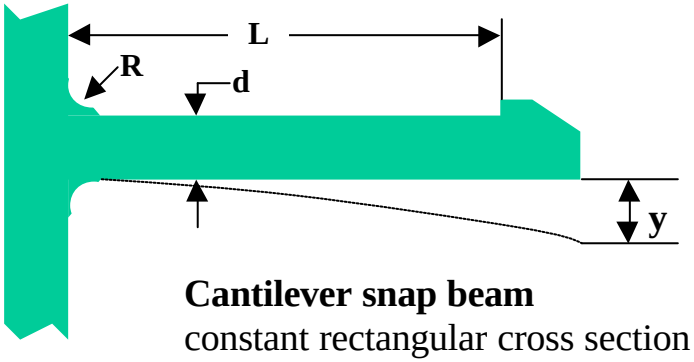


Simple & Most versatile means of plastic product assembly

Design for Assembly

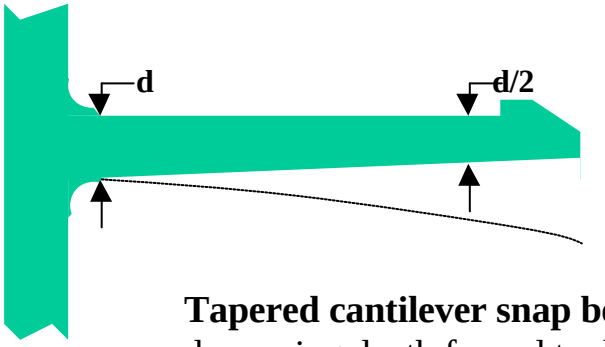
Snap Fit Joint assembly

e = maximum tensile strain



Cantilever snap beam
constant rectangular cross section

$$y = 0.67\ e\ L^2/d$$



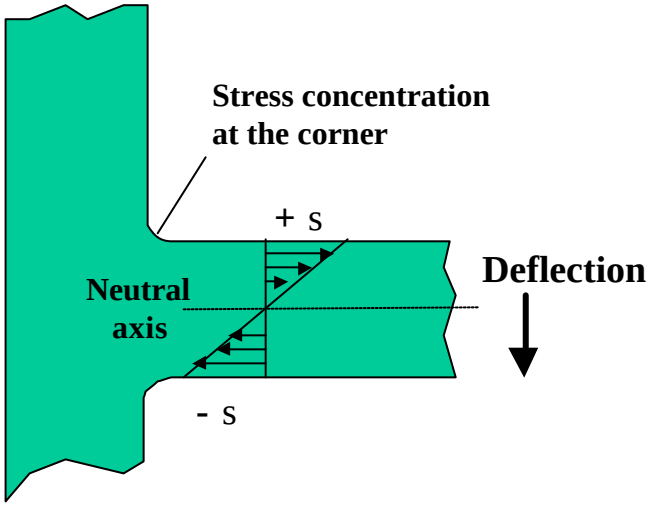
Tapered cantilever snap beam
decreasing depth from d to d/2

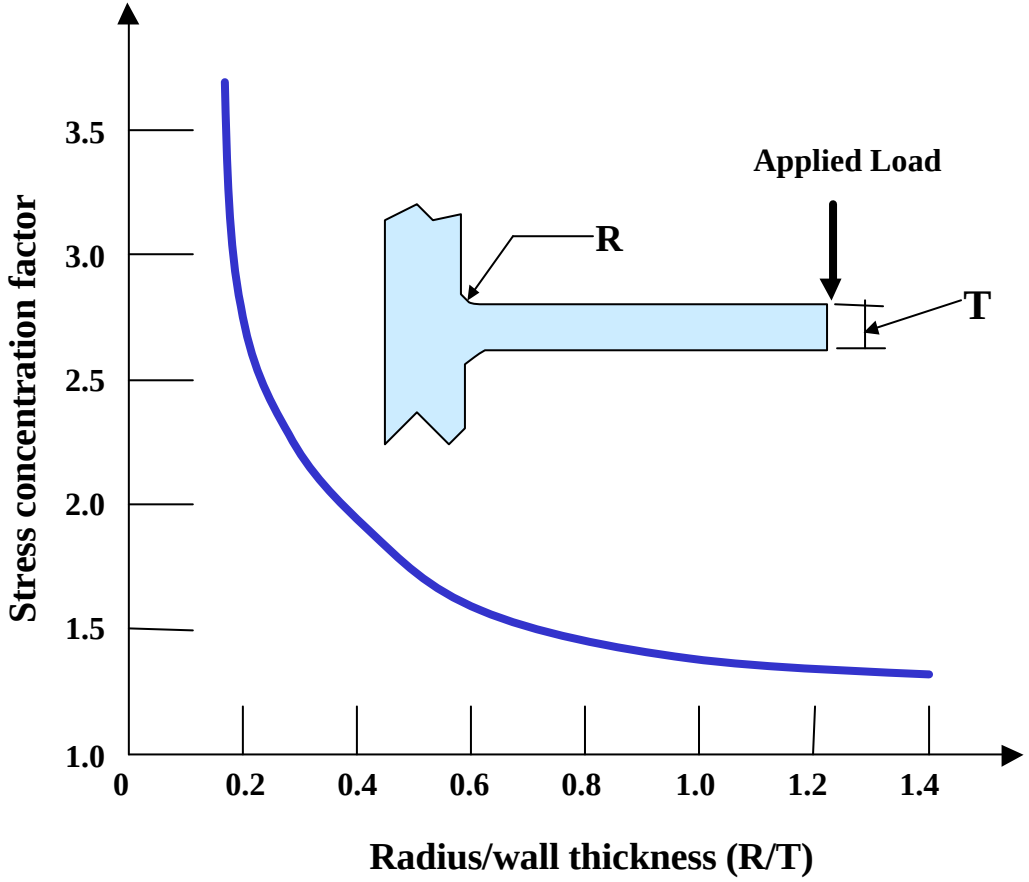
$$y = 1.1\ e\ L^2/d$$

Permissible deflection for the tapered beam is about 60% greater than that of the constant cross section of rectangular beam

Design for Assembly

Snap Fit Joint assembly





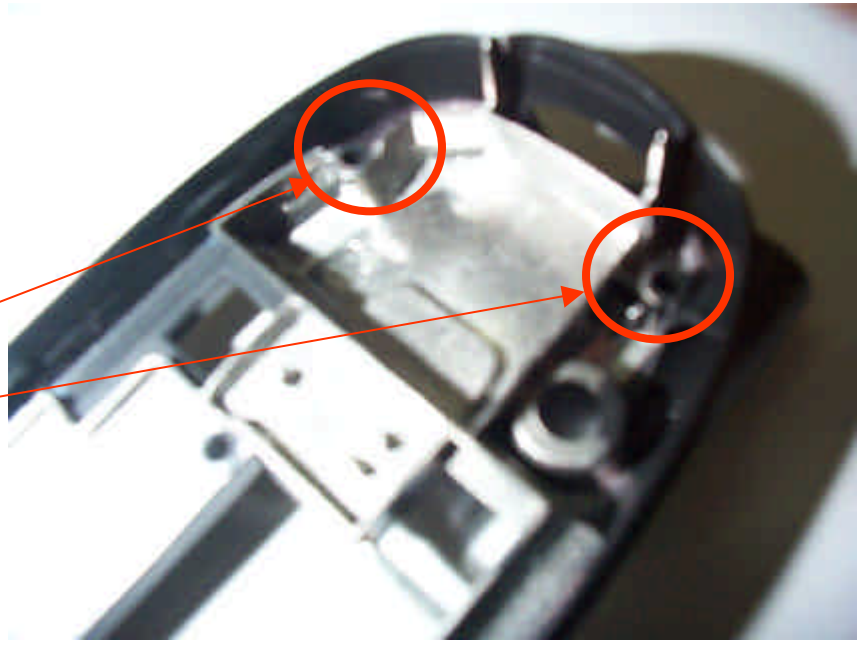
Stress concentration factors show that larger radius values tend to reduce the stress concentration and mold filling orientation related problems, however, excessive radii can lead to complications due to sinks, voids, shrinkage stress.

Design for Assembly

Mechanical fastener - Screw

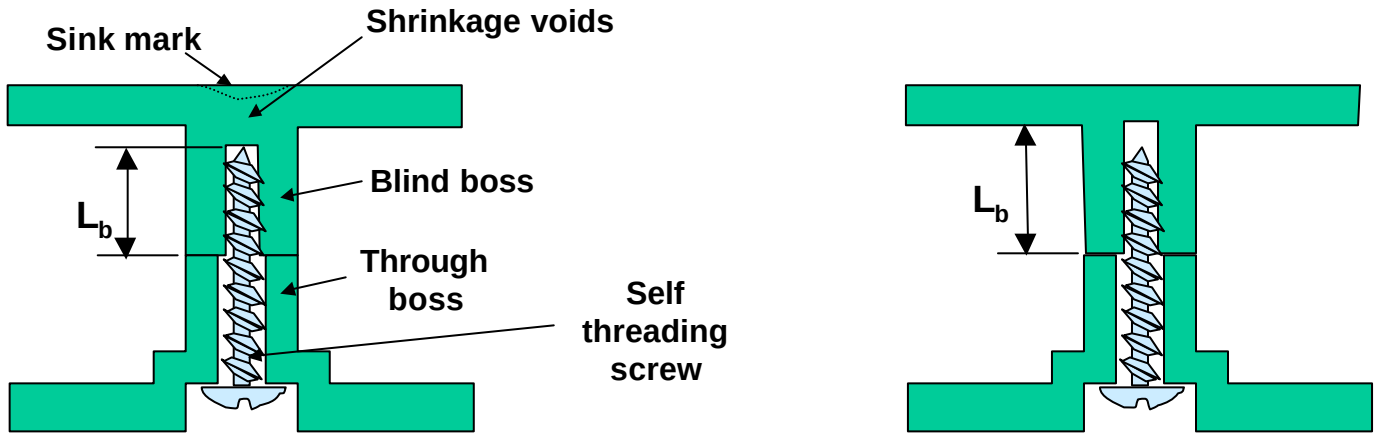
Screws provide a simple, fast, and effective method of joining similar or dissimilar materials

- **Machine screws (I.e. nuts and bolts)**
- **Machine screws with a threaded metal inserts or molded threads**
- **Self threading screws**



Design for Assembly

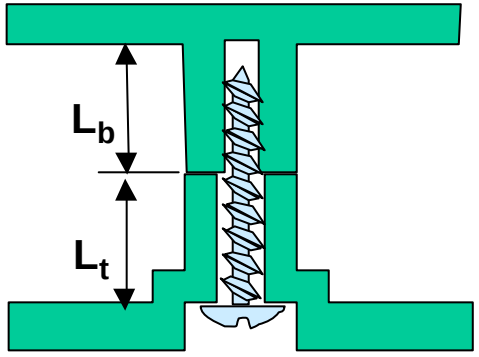
Self threading screw

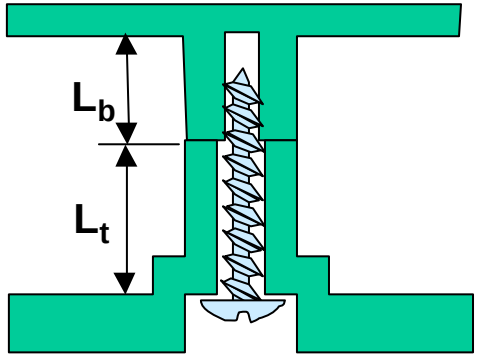


The core pins that are used to form the holes in blind bosses should be extended as much as possible to core out excessive material.

Design for Assembly

Self threading screw





L_b=length of hole in the blind boss

L_t= length of hole in the through boss

The blind boss core pin length is reduced to minimize the molding problems associated with long, cantilever core pins

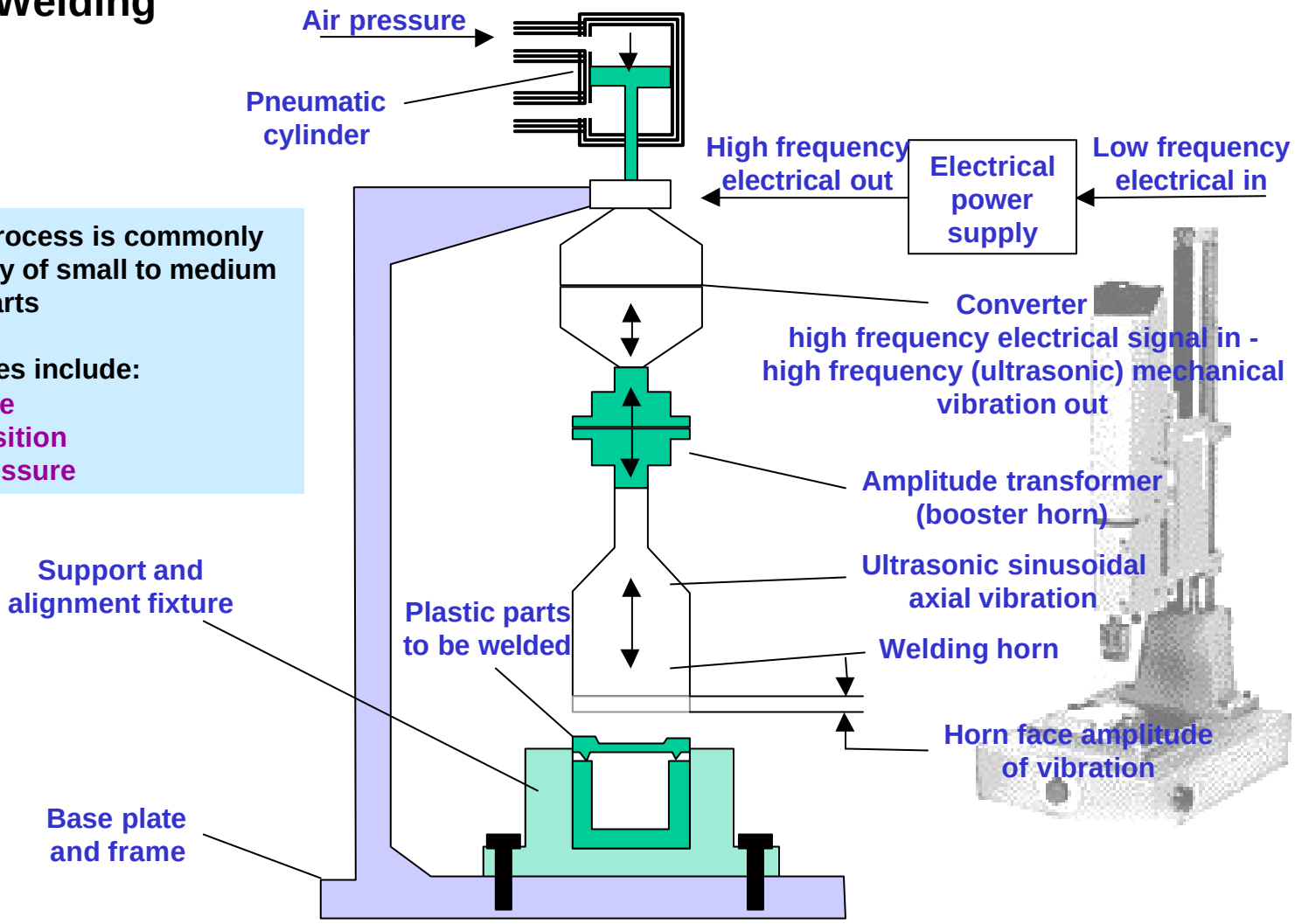
Design for Assembly

Ultrasonic Welding

Ultrasonic welding process is commonly used for the assembly of small to medium size thermoplastic parts

weld process variables include:

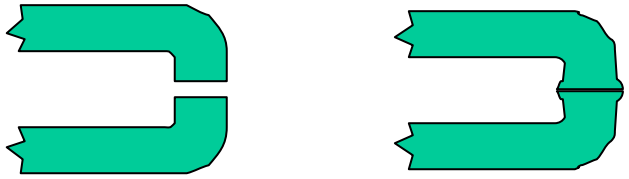
- weld time
- horn position
- weld pressure



Design for Assembly

Ultrasonic Welding

Butt joint



- Poor but joint design
- Excessive weld time
- Excessive weld energy
- Exuding melt results in a visual defect

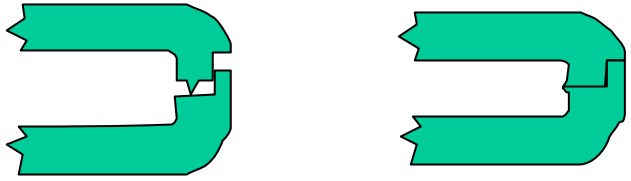
Butt joint with energy director

- Improved butt joint design
- Reduced weld time
- Reduced weld energy
- Exuding flash (visible)

Flash trap added

- Flash trap added
- Reduction in weld area
- Exuding melt does not result in a visual defect

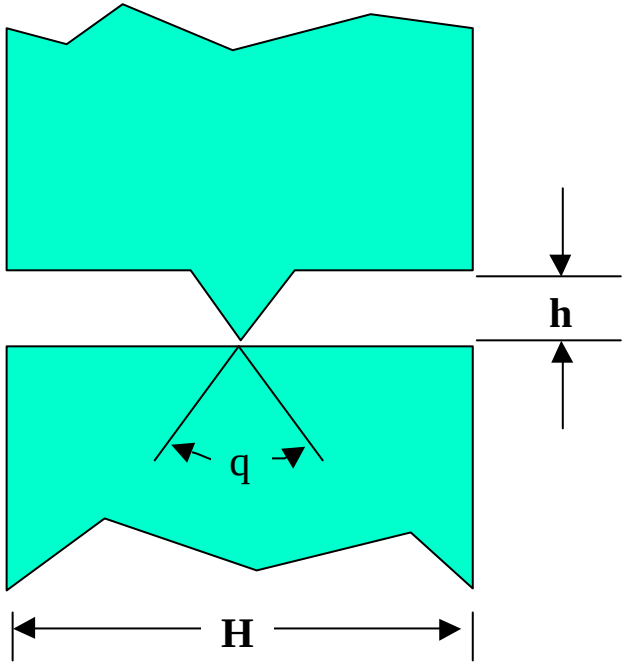
Step joint



- Step joint design
- Improved shear resistance
- Exuding melt does not result in a visual defect
- Assists in locating parts

Design for Assembly

Ultrasonic Welding



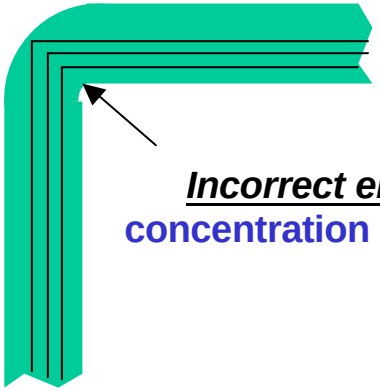
Typical energy director dimensions(millimeters)

	Amorphous polymer		Semi-crystalline polymer	
Dim.	Small part	Large part	Small part	Large part
h	0.3 - 0.4	0.5 - 0.6	0.5 - 0.7	0.7 - 1.0
q	60º to 90º		90º	

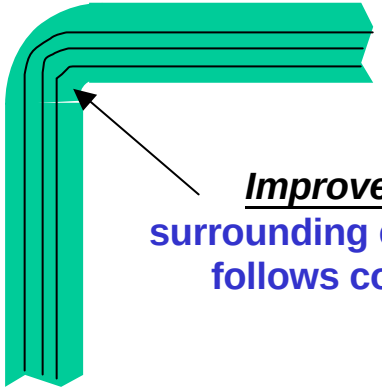
Design for Assembly

Ultrasonic Welding

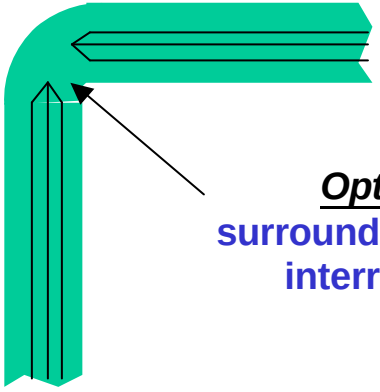
Butt joint energy director: corner consideration



Incorrect energy director design:
concentration of weld material at corner



Improved design:
surrounding energy director follows corner radius



Optional design:
surrounding energy director interrupted at corner

Design for Assembly

Ultrasonic Welding

General Guidelines on the Compatibility of Various Thermoplastics for Ultrasonic Assembly

Material	Notation	Complete compatibility	Partial compatibility
ABS	A	A,B,D	T
PC/ABS alloy	B	A,B,K	D
Acetal	C	C	---
Acrylic	D	A,D	B,E,J,K,T
Acrylic Multipolymer	E	E	A,D,Q,T
Cellulosics	F	F	---
Fluoropolymer	G	G	---
Nylon	H	H	---
Polyphenylene oxide	I	I,Q	D,K,T
Polyamide-imide	J	J	---
PC	K	B,K	D,I,R
Polyester	L	L	---
Polyethylene	M	M	---
Polymethylpentane	N	N	---
Polyphenylene sulfide	O	O	---
PP	P	P	---
PS	Q	I,Q	E,T
Polysulfone	R	R	K
PVC	S	S	---
SAN	T	T	A,D,E,I,Q

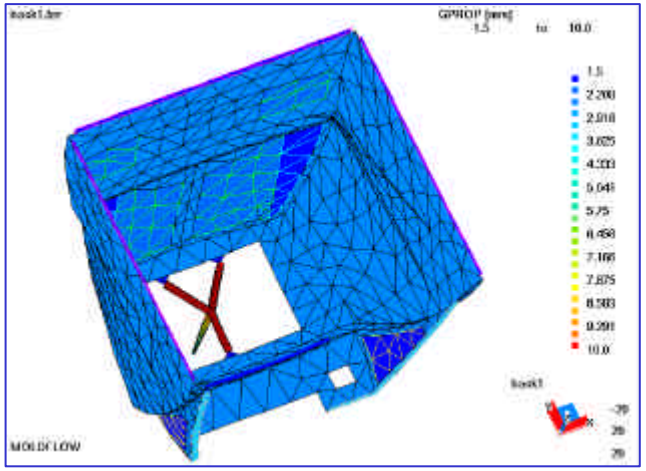
Processing Guide

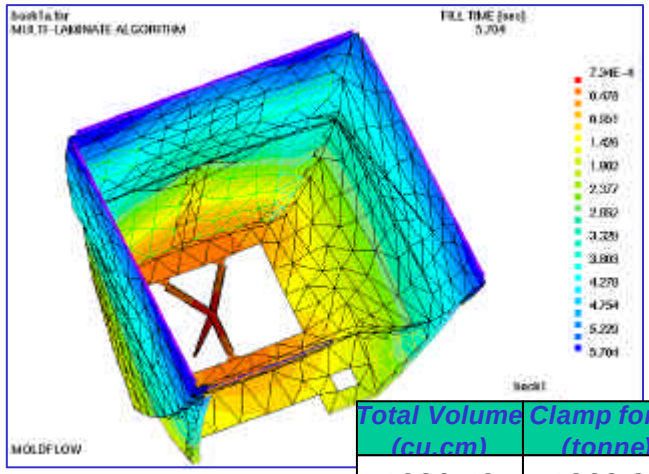
Injection Time	**> 2.0 sec**	**0.6 ~ 2.0 sec**	**< 0.5sec**
Cycle Time	**40 ~ 60 sec**	**20 ~ 40 sec**	**6 ~ 20 sec**
Pre-drying of Resin	**Dryer (dew point : -29 ~ -40 ºC)**		
Mold Tooling	**Complete Gas vent** **Many larger eject pin** **Use Sleeve or Blade type eject Pin** **Use Non-looping Cooling line** **Use Support pillar** **Strong & Thick mold structure**		

Mold Filling Analysis (CAE)

Example : 17” Monitor Rear cabinet

STAREX ABS VE-0856

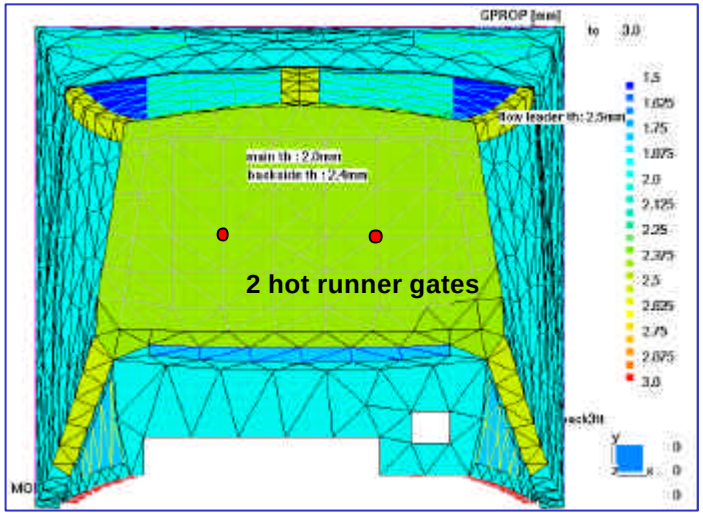


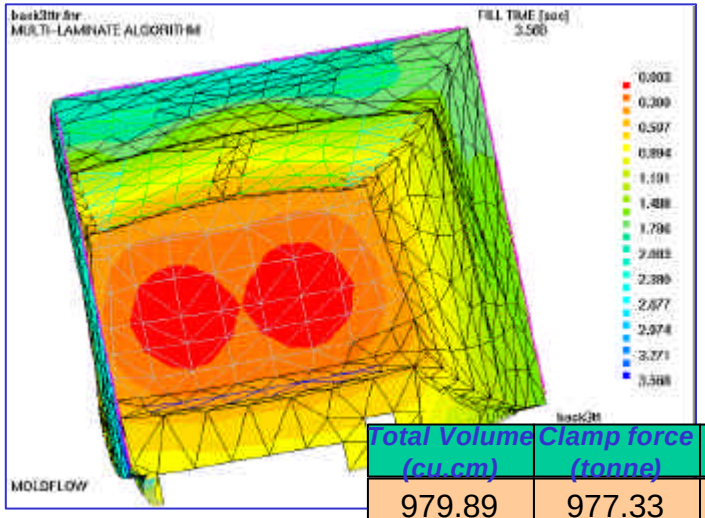


Original design

- 2.5mm standard thickness
- High Clamp force
- High Inj pressure

Total Volume (cu.cm)	Clamp force (tonne)	Clamp force at 95% fill	Inj. Pressure (Mpa)
1086.49	1268.35	750.54	134.4





Thin Wall design

- 2.0mm standard thickness
- Install Flow leader
- Balanced Flow pattern
- Higher Injection Speed
- Low Clamp force
- Low Inj pressure
- Save materials

Total Volume (cu.cm)	Clamp force (tonne)	Clamp force at 95% fill	Inj. Pressure (Mpa)
979.89	977.33	766.25	77.41

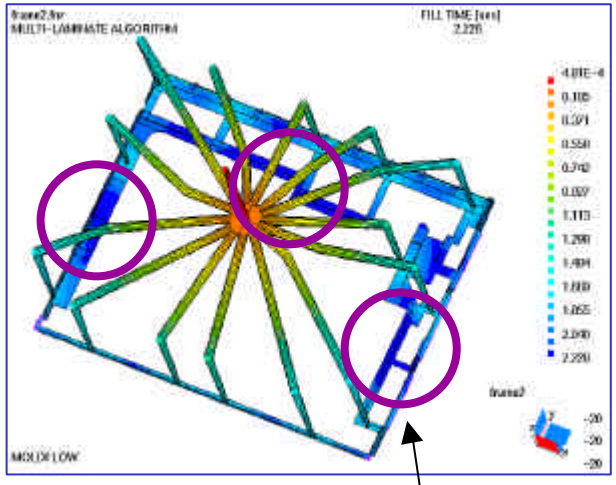
Mold Filling Analysis (CAE)

Example : TFTLCD Mold frame

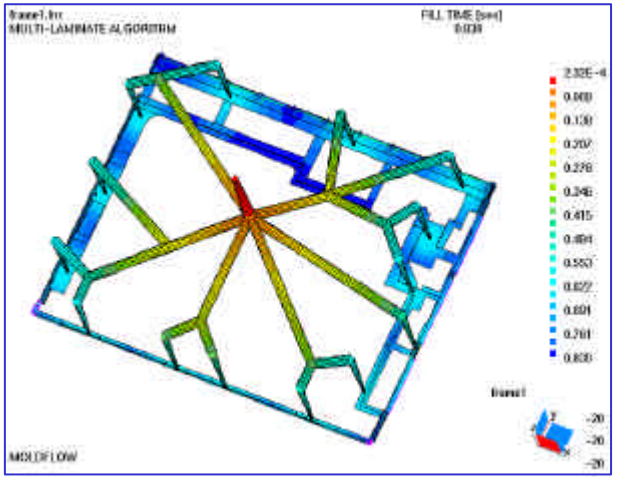
STAROY PC LB-1020W

- Most of TFTLCD mold frame have severe change of thickness in cavity and the basic thickness is very thin (0.5mm ~ 1.0mm). Therefore, surely the check of flow pattern with CAE simulation is needed to prevent short shot or severe weld line.

Non-Uniform Flow



Uniform balanced Flow



Because of hesitation of fill at the circle areas, There is a very strong possibility that short shot or severe weld line is generated at the circle area.