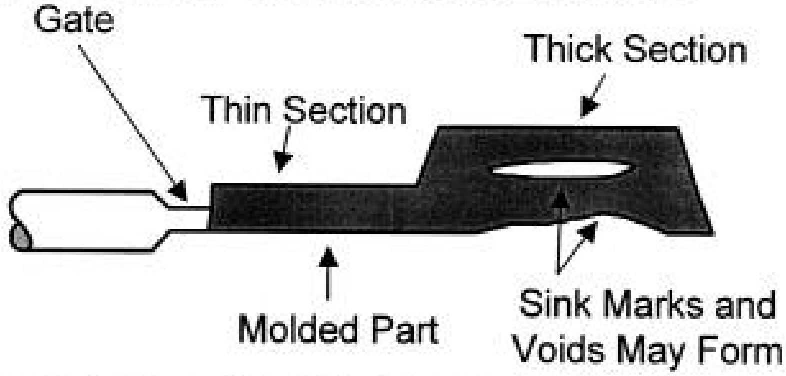
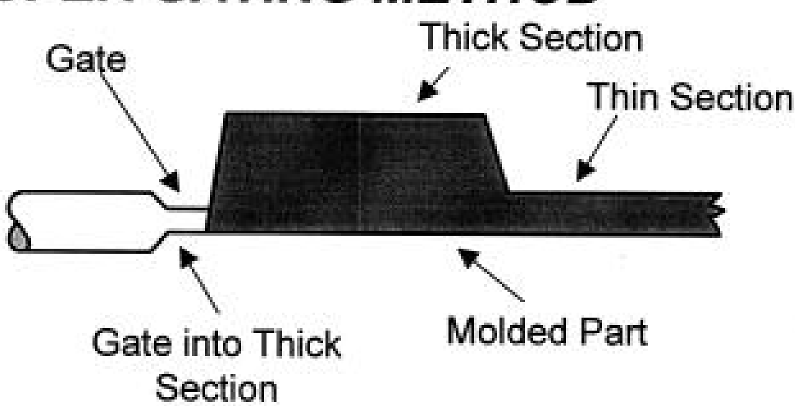
CONTENTS: PART DESIGN

GATE LOCATION

IMPROPER GATING METHOD



PROPER GATING METHOD

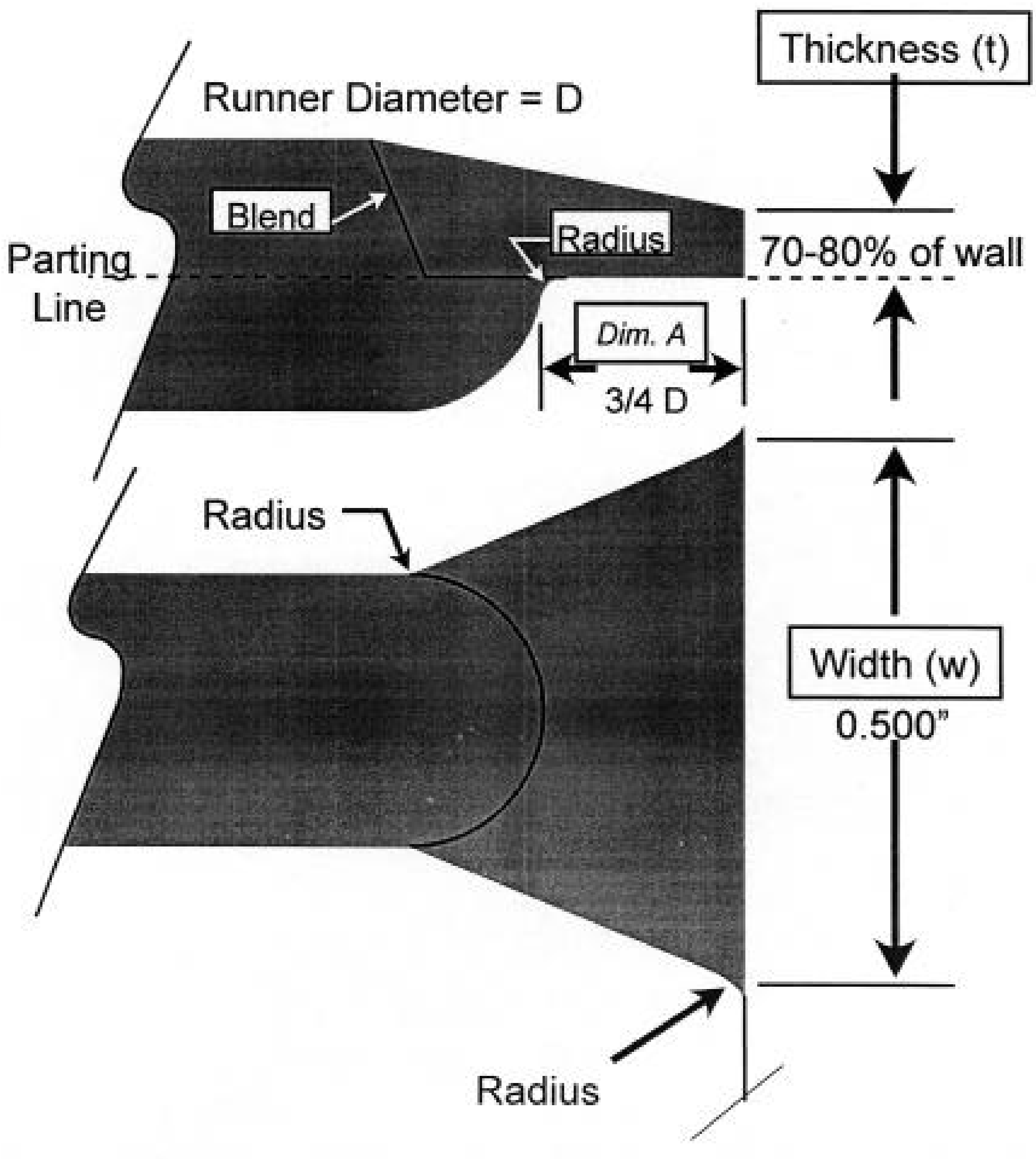


NOTES

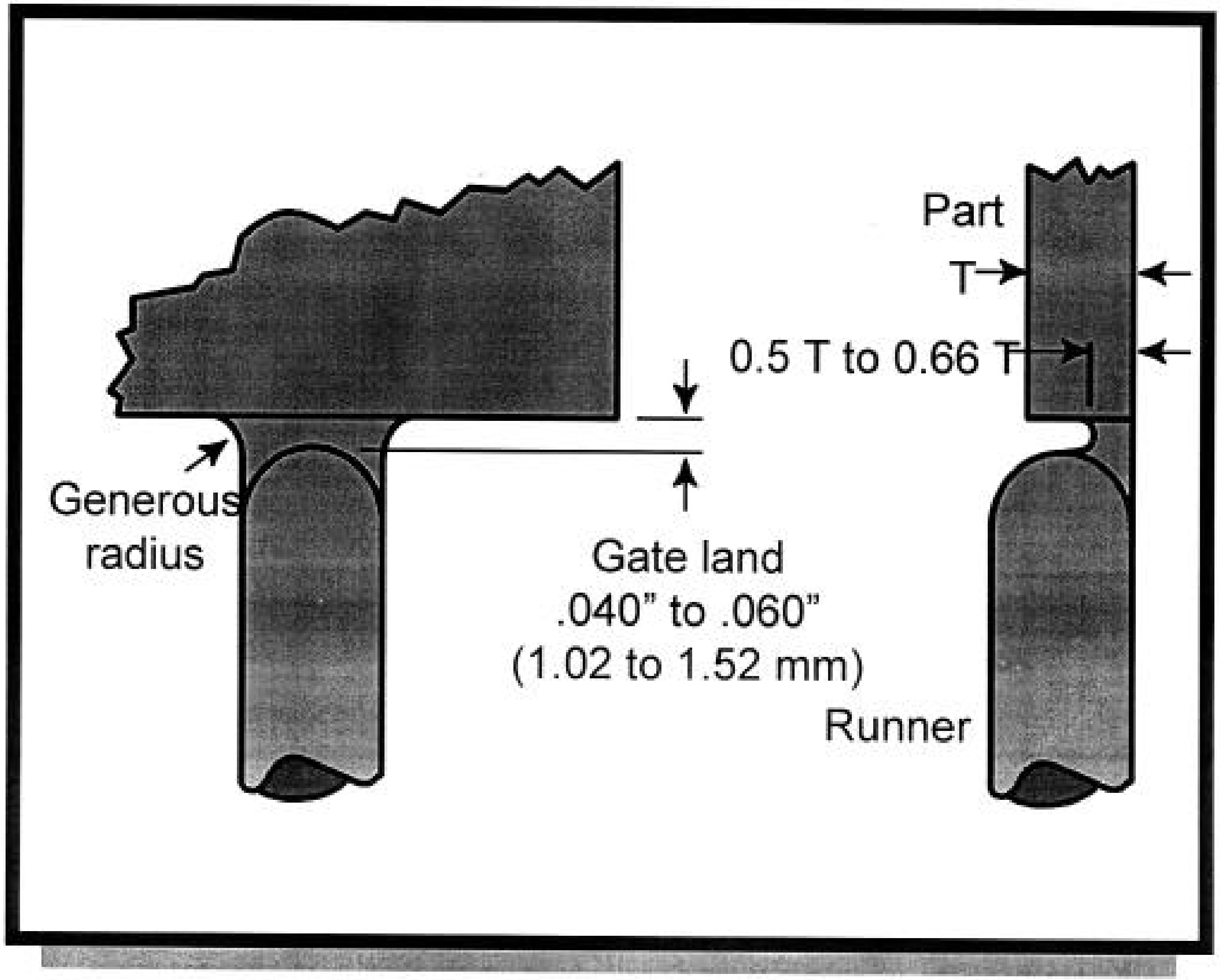
GATE INTO THICKER SECTIONS OF THE PART

- LESS SHEAR ON THE MATERIAL
- LESS PRESSURE TO FILL THE PART
- DECREASE CHANCE OF VOIDS OR SINKS

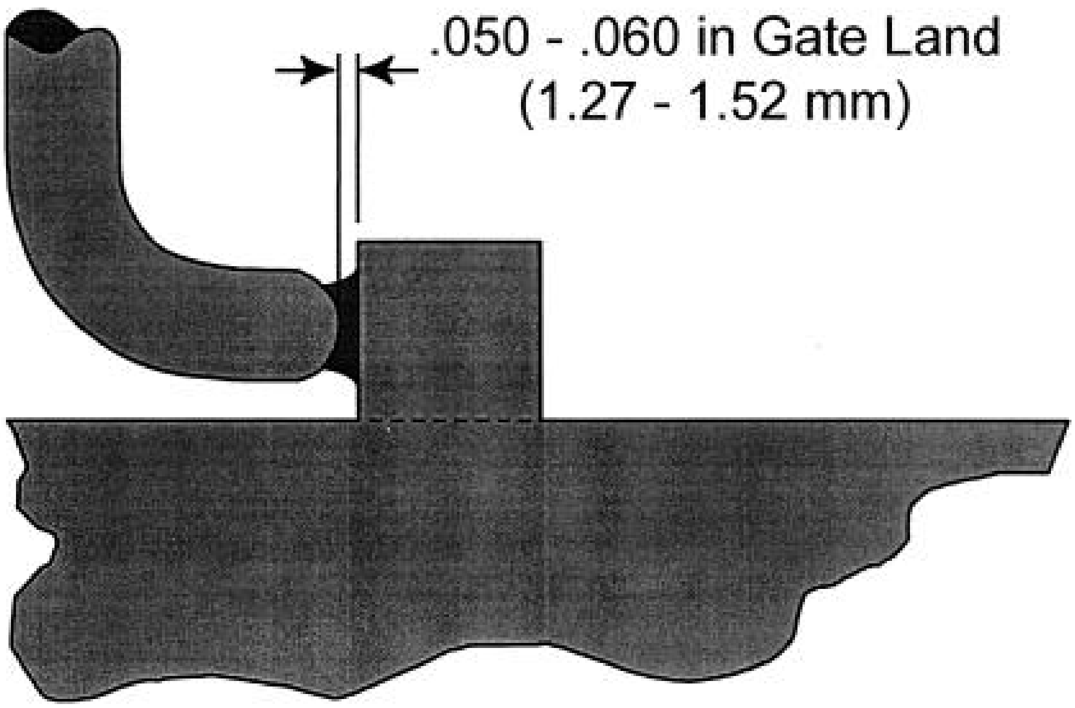
FAN GATE CONFIGURATION



EDGE GATE DESIGN



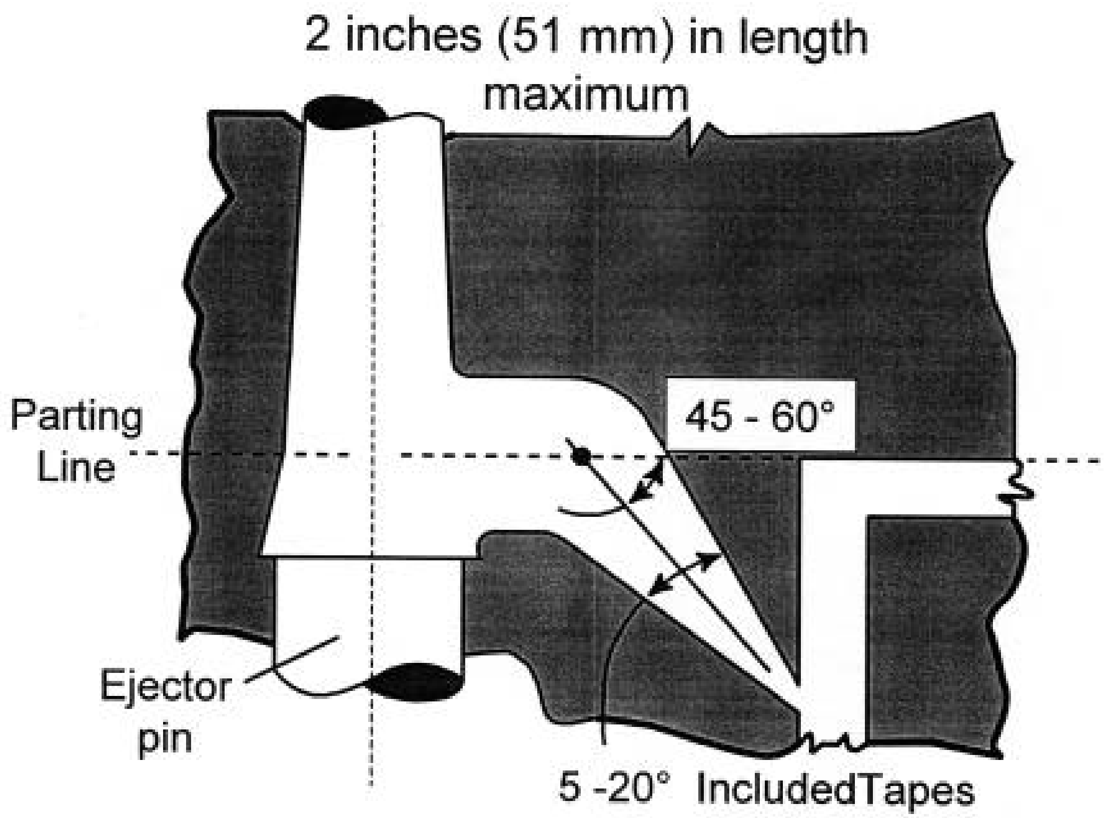
EDGE GATING INTO A TAB



NOTES

- REDUCE BLEMISH PROBLEMS ON PART
- TAB MUST BE CUT AWAY
- TAB THICKNESS = PART THICKNESS

TYPICAL TUNNEL GATE DESIGN



NOTES

TUNNEL GATING

ROUND GATES VS. RECTANGULAR GATES

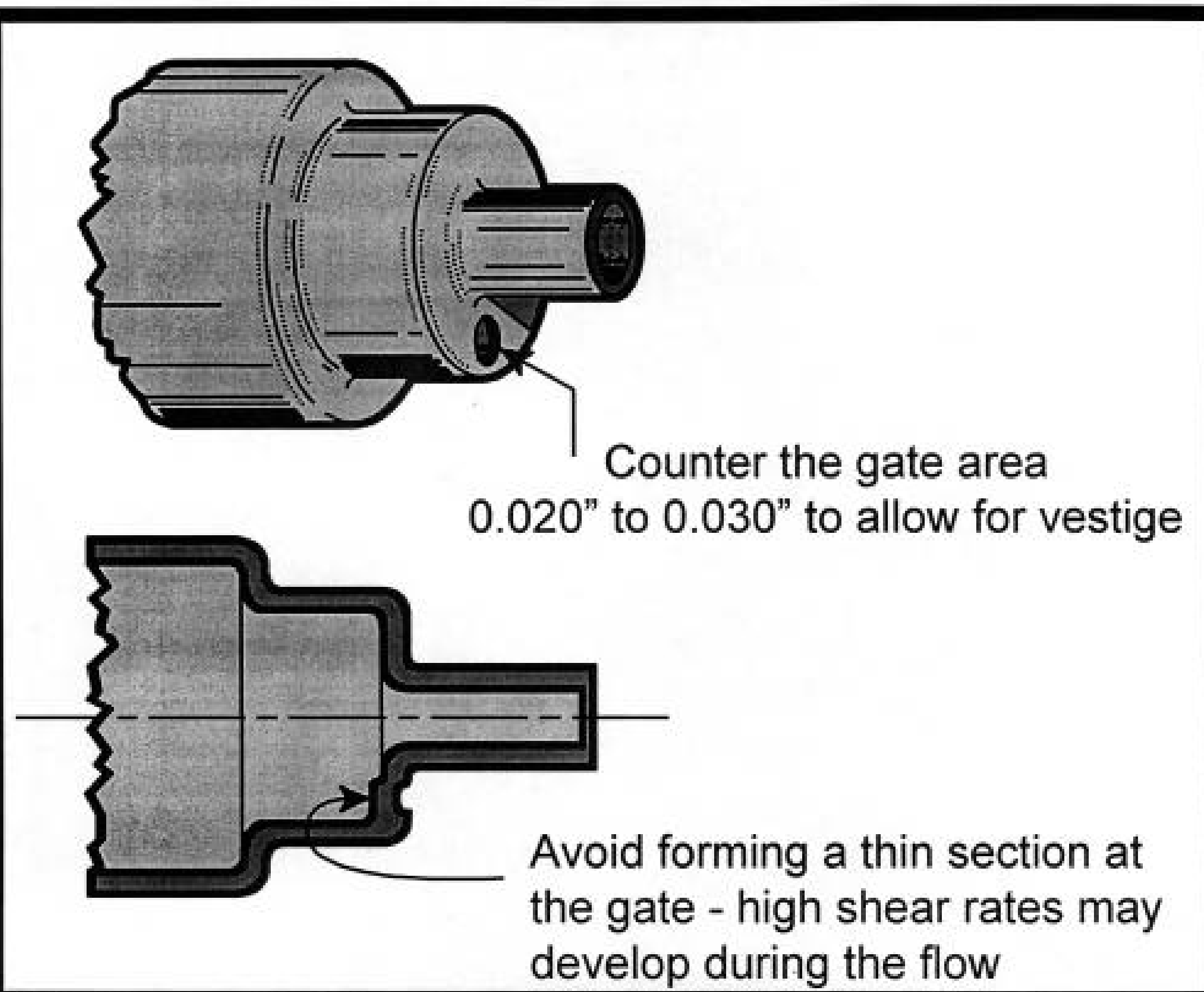
Round Gates

- Easy to machine
- Downward angle forms an oval on vertical plane more difficult to shear off
- Changing diameter affects flow and freeze-off

Rectangular Gates

- Must be burned in
- Improved flow control for tight tolerances
  - Widen gate to increase flow
  - Modify thickness to control freeze-off time

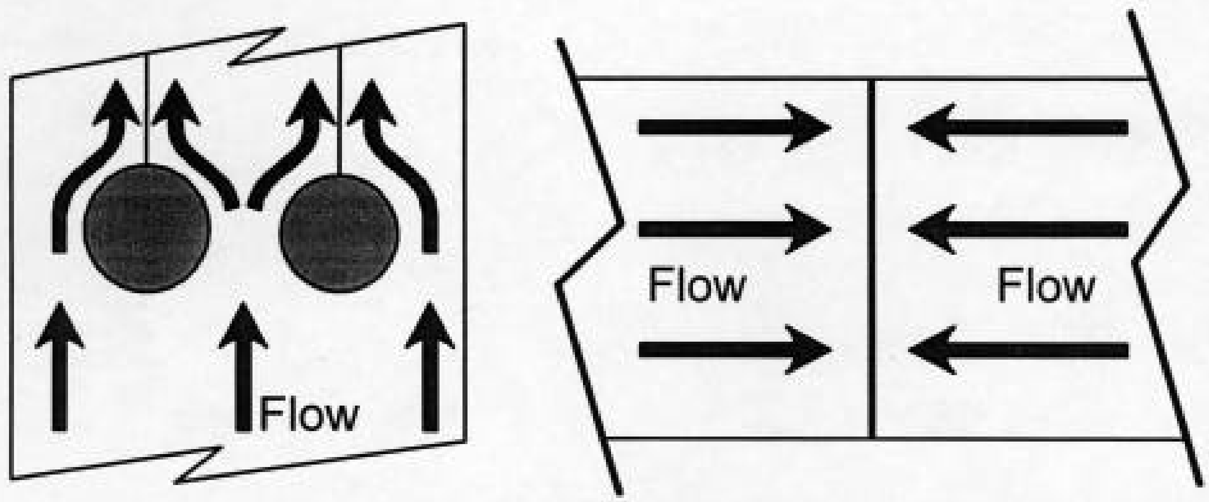
GATING SMALL PARTS



NOTES

- GATE DIAMETER 0.030 - 0.050 IN. (0.76 - 1.27 MM) FOR MOST SMALL PARTS
- GATE INTO THICK SECTIONS
- SIZE GATE ACCORDING TO PART SIZE

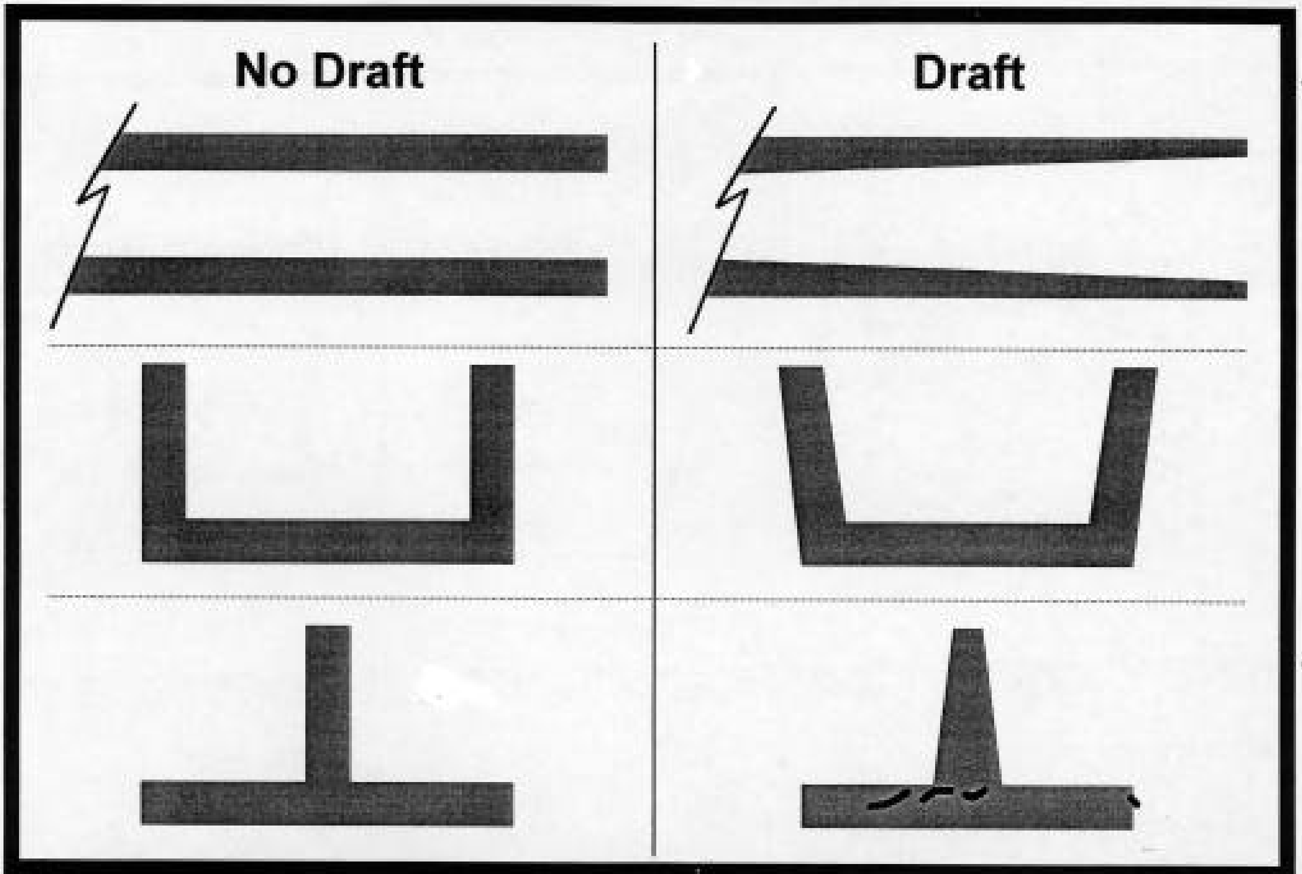
WELDLINES



NOTES

- WELDLINES FORM AT THE MATING OF TWO FLOW FRONTS
- WELDLINES WOULD BE MORE SUSCEPTIBLE TO CRACKS IN A PART
- PROCESSING CONDITIONS WILL INFLUENCE THE STRENGTH OF A WELDLINE

DRAFT ANGLES



NOTES

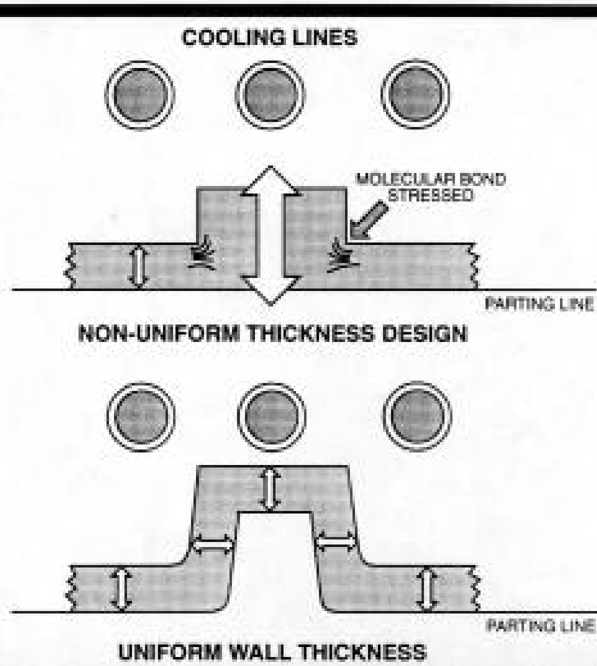
DRAFT ANGLE GUIDELINES

- 1 DEGREE PER SIDE RECOMMENDED
- 1/2 DEGREE PER SIDE MINIMUM
- ZERO DEGREE DRAFT NOT RECOMMENDED
  - – CAN BE ACCOMPLISHED IN SOME CASES SUCH AS SHORT CORES, THICK PARTS OR SLEEVE EJECTORS
  - – CAN CAUSE TOOL "LOCK-UP" IF NOT CAREFUL
  - – DISCUSS WITH YOUR TOOLMAKER

TO INCREASE MOLDABILITY OF A LOW DRAFT PART

- POLISH IN THE DIRECTION OF DRAW
- IMPROVE COOLING IN THE CORE
- SURFACE TREAT THE MOLD STEEL
- AIR POPPET WILL BREAK THE VACUUM

UNIFORM WALL THICKNESS



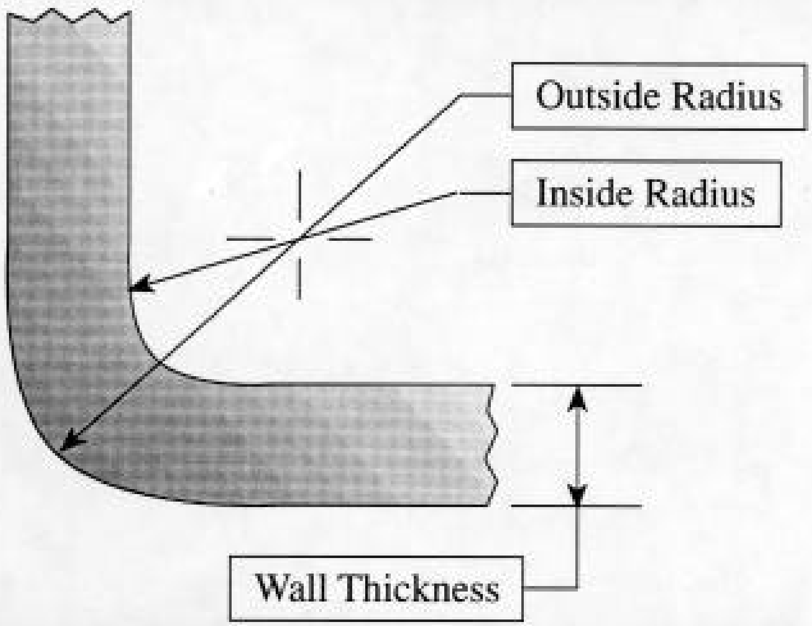
CRITICAL CONSTRAINTS

- MAINTAIN UNIFORM WALL THICKNESS

NOTES

- THICK WALLS COOL SLOWLY AND ALLOW INCREASED SHRINKAGE.
- THIN WALLS COOL QUICKLY AND ALLOW MINIMAL SHRINKAGE.
- DIFFERENT COOLING RATE AND SHRINKAGE AT INTERSECTION OF THICK AND THIN WALLS STRETCHES MOLECULAR BONDS AND INCREASES MOLDED-IN STRESS.

UNIFORM WALL THICKNESS: CORNERS



CRITICAL CONSTRAINTS

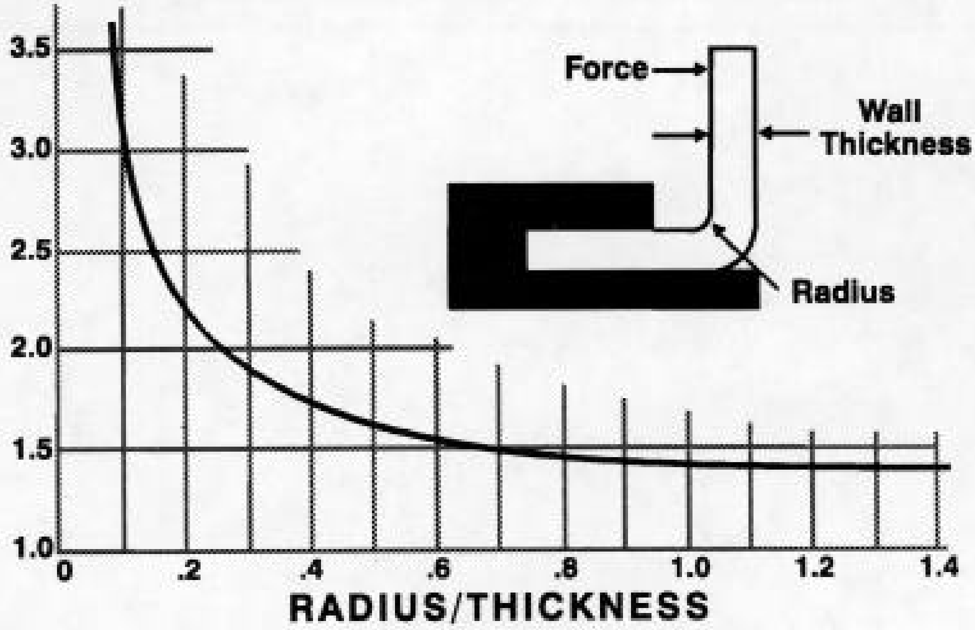
- USE SAME CENTER POINT FOR BOTH RADII.
- OUTSIDE RADIUS= INSIDE RADIUS + WALL THICKNESS.

NOTES

- ORIGIN OF BOTH RADII MUST BE COINCIDENT TO PREVENT THICK OR THIN CORNERS.
- THIN CORNERS WEAKEN PART.
- THICK CORNERS COOL SLOWLY INCREASING MOLDED-IN STRESS AND POTENTIAL WARPAGE RISK.

RADIUS DESIGN

Stress-Concentration Factor



This curve gives an indication of the proper radius to be used for a given wall thickness. (Courtesy - S.P.I. Plastics Engineering Handbook.)

CRITICAL CONSTRAINTS

MINIMUM SUGGESTED RADII: 1/4 NOMINAL WALL THICKNESS

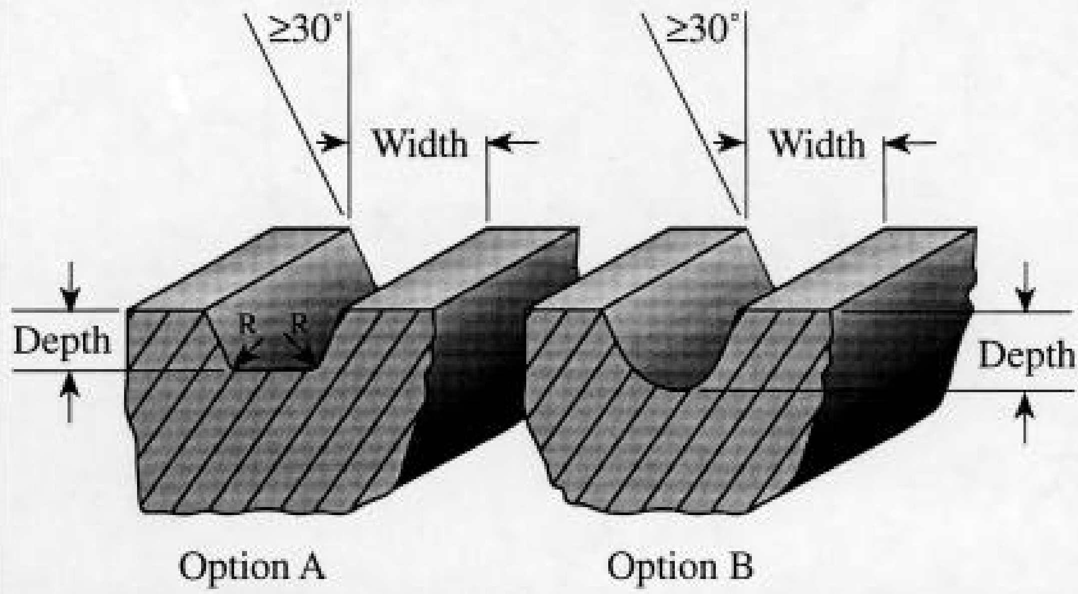
SUGGESTED RADII: 1/2 TO 3/4 NOMINAL WALL THICKNESS

NOTES:

MINIMUM SUGGESTED RADII SHOULD BE 1/2 NOMINAL WALL THICKNESS WHEN USING NOTCH SENSITIVE MATERIALS.

LARGER RADII DISTRIBUTES STRESS UNIFORMLY.

MOLDED-IN LETTERING



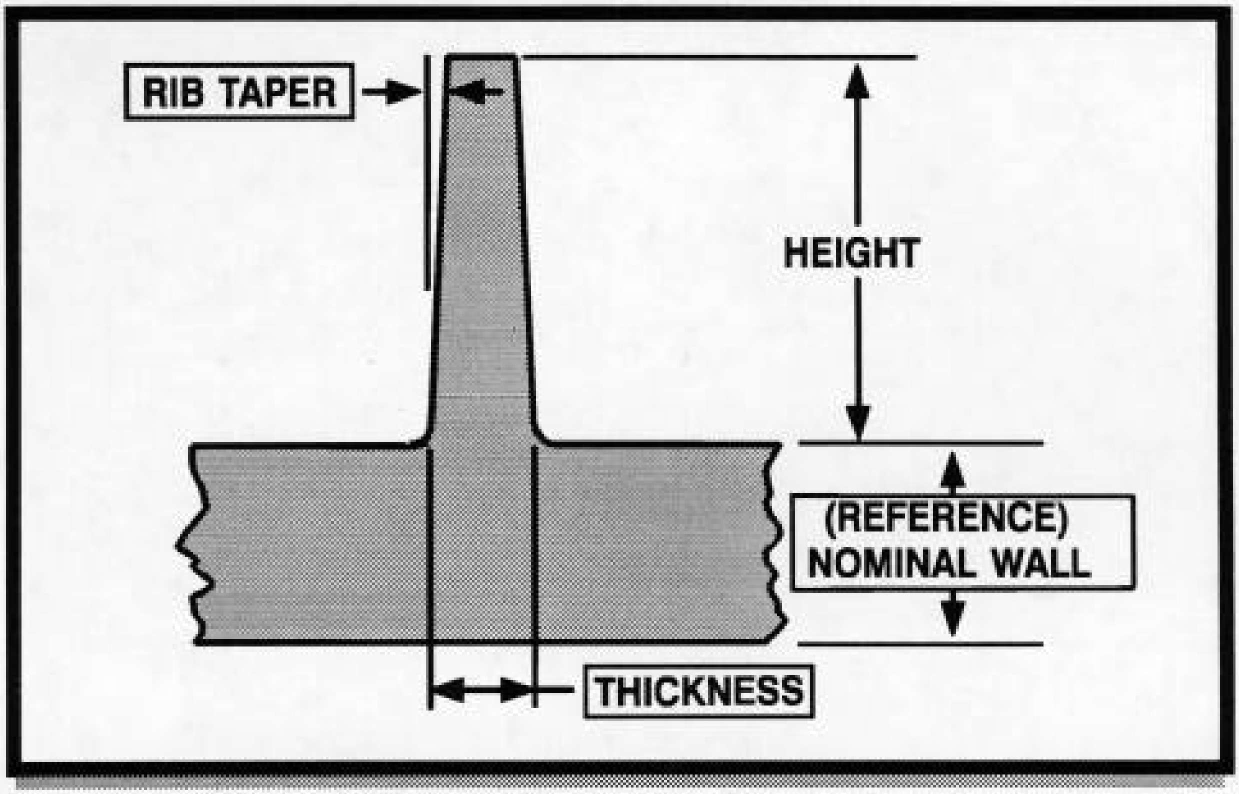
CRITICAL CONSTRAINTS

- WIDTH= 2XDEPTH
- DEPTH= 0.010 INCH (MAXIMUM)
- RADIUS= REFER TO RADIUS DESIGN GUIDELINES IN THE DESIGN & ENGINEERING HANDBOOK

NOTES

- DEPTH GREATER THAN SHOWN ABOVE MAY CAUSE AESTHETIC PROBLEMS SUCH AS FLOW SWIRLING OR TEARDROPS.

RIB DESIGN



CRITICAL CONSTRAINTS

THICKNESS: 1/2 TO 2/3 NOMINAL WALL THICKNESS

HEIGHT: LESS THAN 3 TIMES THICKNESS

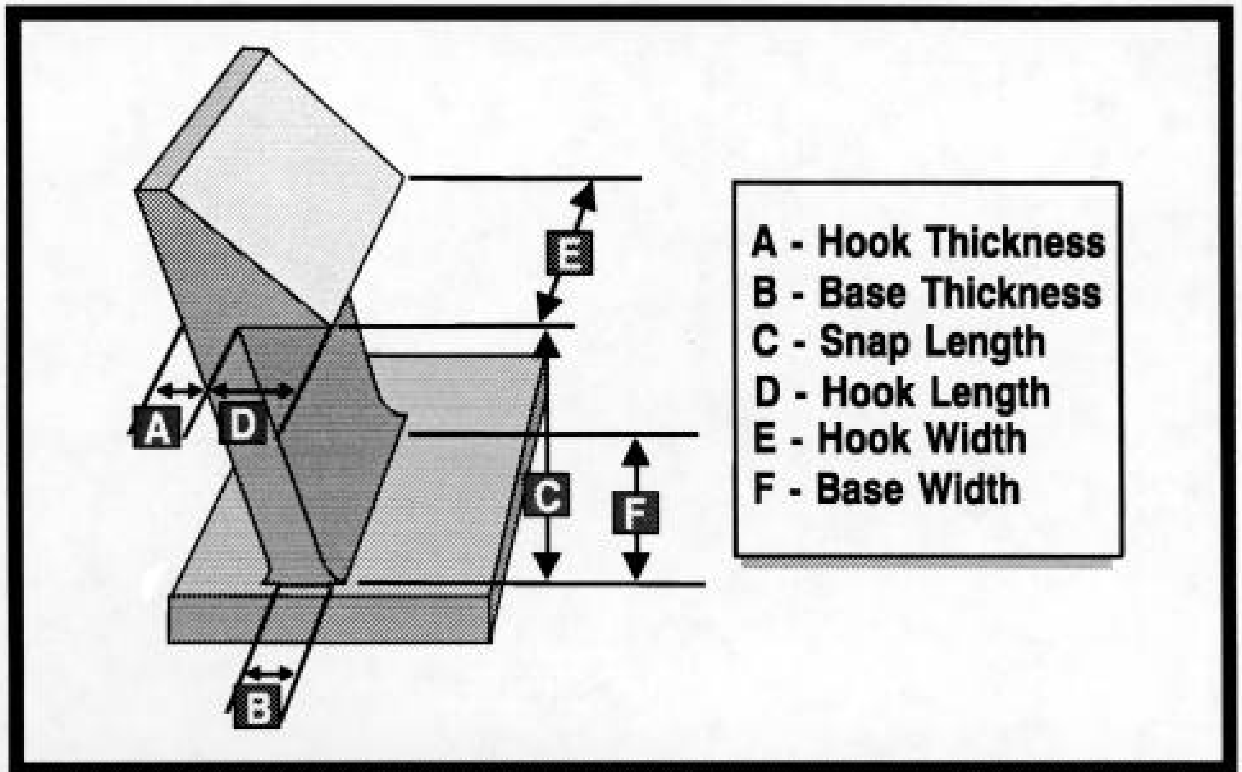
TAPER: 1° PER SIDE

NOTES:

THICKNESS: EXCESSIVE THICKNESS PROMOTES SINKMARKS.

HEIGHT: EXCESSIVE RIB HEIGHT COMBINED WITH TAPER WILL PRODUCE THIN WALLS REQUIRING INCREASED INJECTION PRESSURE TO FILL.

CANTILEVER SNAP-FIT



CRITICAL CONSTRAINTS

- SNAP LENGTH AND DEFLECTION ARE THE TWO MOST CRITICAL FACTORS IN SNAP-FIT DESIGN.
- LATCH DEFLECTION MUST RETURN TO THE ZERO POSITION AFTER ENGAGEMENT TO PREVENT STRESS RELAXATION (CREEP).

NOTES

- INCLUDED IN THE DESIGN AND ENGINEERING HANDBOOK IS A DISKETTE CONTAINING A SNAP-FIT CALCULATOR PROGRAM.
- THE GUIDELINES ON THE FOLLOWING PAGE COMBINED WITH THE DISKETTE WILL EXPEDITE SNAP-FIT DESIGN.

CANTILEVER SNAP-FIT

NOTES (CONTINUED)

0.) FOLLOW START-UP DIRECTIONS ON DISKETTE LABEL.

1.) FOR CANTILEVER CALCULATION SELECT OPTION #3.

2.) INPUT THICKNESS OF LATCH AT BASE, DIMENSION "B". BASE THICKNESS SHOULD BE 1/2 TO 2/3 NOMINAL WALL THICKNESS TO MINIMIZE SINKMARKS AND MOLDED-IN STRESS.

3.) PROGRAM WILL PROMPT FOR TAPERED OR NON-TAPERED THICKNESS. TAPERED LATCHES REDUCE OUTER FIBER STRAIN.

4.) INPUT THICKNESS OF LATCH AT HOOK, DIMENSION "A".

5.) INPUT WIDTH OF LATCH AT BASE, DIMENSION "F".

6.) PROGRAM WILL PROMPT FOR TAPERED OR NON-TAPERED WIDTH. TAPERED LATCHES REDUCE OUTER FIBER STRAIN.

7.) INPUT WIDTH OF LATCH AT HOOK, DIMENSION "E".

8.) INPUT LENGTH OF SNAP, DIMENSION "C". MEASURED FROM BASE TO BOTTOM OF HOOK. THE LENGTH WILL HAVE SIGNIFICANT EFFECT ON ENGAGEMENT STRAIN.

9.) INPUT MAXIMUM DEFLECTION OF LATCH DURING ENGAGEMENT, DIMENSION "D". THE DEFLECTION WILL HAVE SIGNIFICANT EFFECT ON ENGAGEMENT STRAIN.

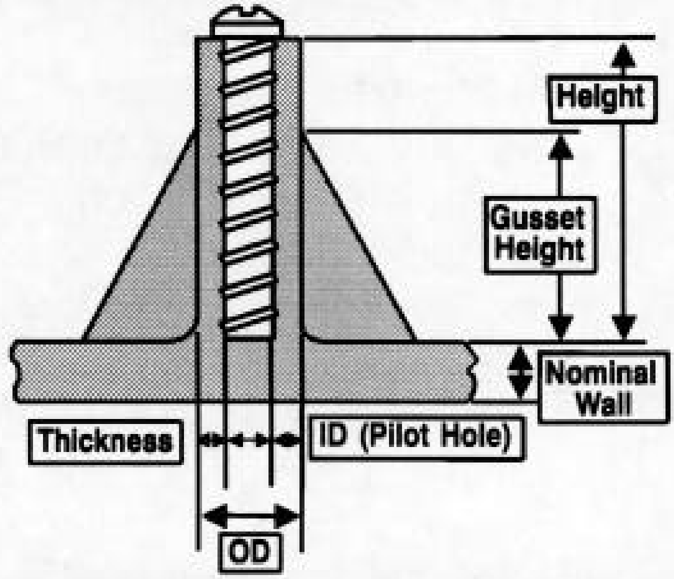
10.) INPUT MODULUS OF ELASTICITY OF MATERIAL.

11.) PROGRAM WILL ALLOW PARAMETERS TO BE CHANGED. SELECT "N" TO CALCULATE STRAIN.

12.) MODIFY PARAMETERS TO ACHIEVE 75% OF MATERIAL YIELD STRAIN MAXIMUM.

BOSS DESIGN

Diameter Ratio = OD/ID
Diameter Ratio = 2-3
Thickness = 1/2 To 2/3 Nominal
Height = (Pull Out & Reassembly Needs)
Gusset Height = 2/3 Height
Taper = 1°/Side



CONSTANT

$$\text{DIAMETER RATIO} = \frac{\text{OUTSIDE DIAMETER}}{\text{INSIDE DIAMETER}}$$

CRITICAL CONSTRAINTS

DIAMETER RATIO: 2-3
THICKNESS: 1/2 TO 2/3 NOMINAL WALL THICKNESS
HEIGHT: TO SUIT PULLOUT AND REASSEMBLY REQUIREMENTS
GUSSET HEIGHT: 2/3 HEIGHT
TAPER: 1° PER SIDE

NOTES

DIAMETER RATIO: MINIMUM RATIO OF 2 REDUCES RISK OF BOSS FAILURE DUE TO HOOP STRESS

NOTES CONTINUED ON NEXT PAGE

BOSS DESIGN

NOTES (CONTINUED)

THICKNESS: EXCESSIVE THICKNESS PROMOTES SINKMARKS

HEIGHT:

USE SHORT BOSS IF:

A.) ONE TIME ASSEMBLY

B.) LOW PULLOUT FORCE NEEDED

USE TALL BOSS IF:

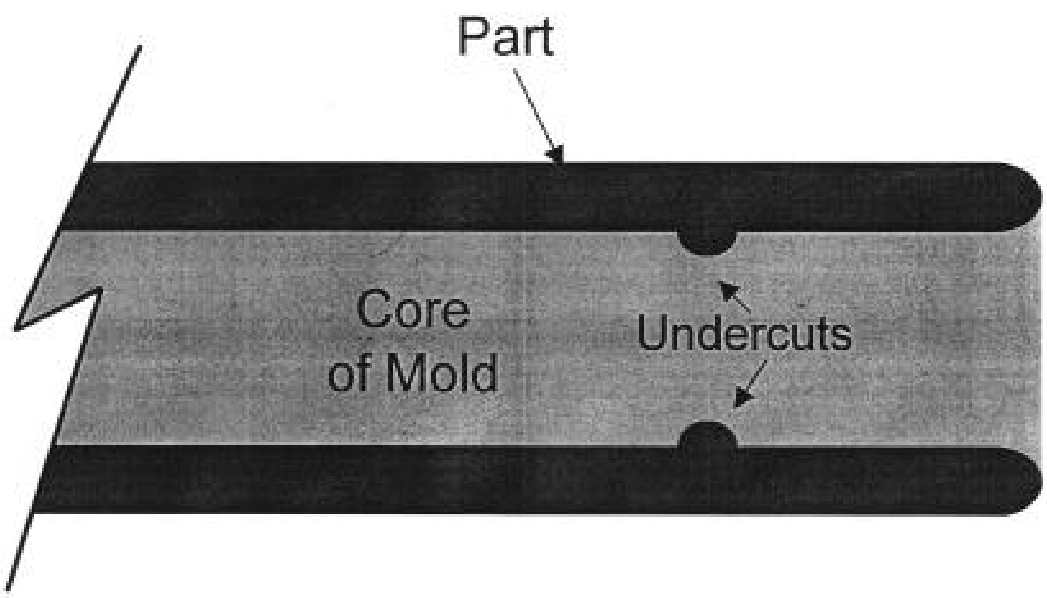
A.) MULTIPLE ASSEMBLY/DISASSEBLY REQUIRED

B.) RELATIVELY LARGE PULLOUT FORCE NEEDED

TALL BOSS PROVIDES MORE THREADS FOR REASSEMBLY ENGAGEMENT AND INCREASES PULLOUT STRENGTH

GUSSET HEIGHT: DISTRIBUTES APPLIED STRESS OVER A LARGER AREA

UNDERCUTS



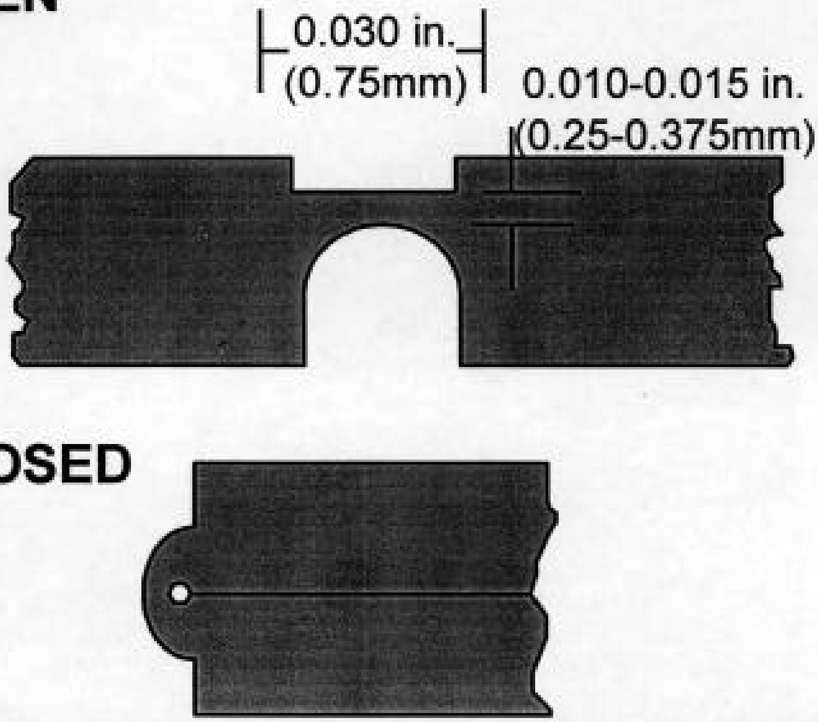
NOTES

- THE ABILITY TO USE AND THE SIZE OF THE UNDERCUT WILL DEPEND ON THE MATERIAL TO BE USED.

LIVING HINGE

OPEN

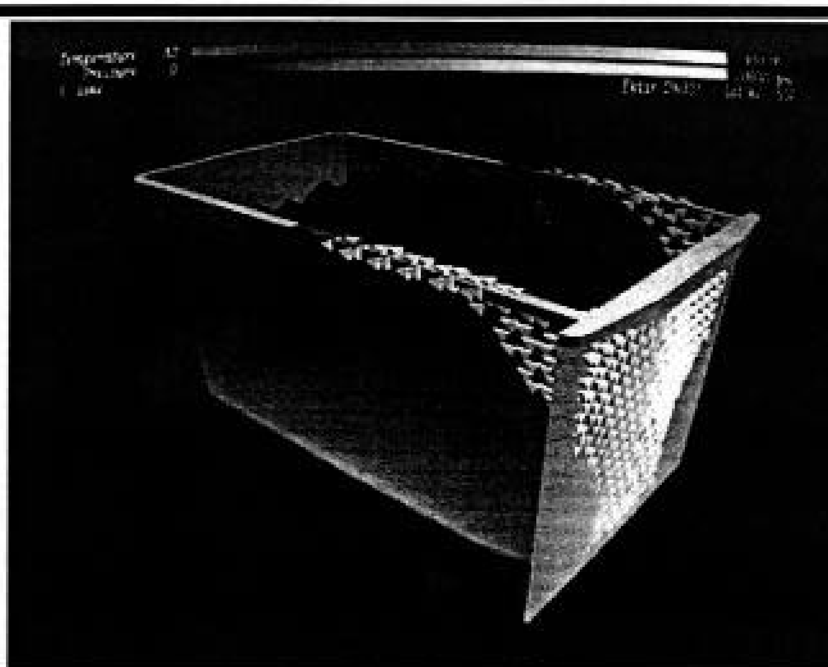
CLOSED



NOTES

- DIFFICULT TO ACHIEVE WITH MANY MATERIALS DUE TO FLOW THROUGH THE THIN SECTION
- MAINLY USED WITH POLYOLEFINS. MANY MATERIALS WILL FAIL AFTER REPEATED USE

MOLD FILLING ANALYSIS



BENEFITS

- PROVIDES TOOL FOR EVALUATION AND MODIFICATION OF PRELIMINARY PART DESIGN.

REQUIRED INPUTS

- **MATERIAL PROPERTIES**
  [SPECIFIC HEAT, THERMAL CONDUCTIVITY, MELT DENSITY, SHEAR RATE/VISCOSITY DATA] PROVIDED BY MATERIAL SUPPLIER
- **PROCESSING CONDITIONS**
  [MELT TEMPERATURE, MOLD TEMPERATURE, FILL SPEED] PROVIDED BY MATERIAL SUPPLIER

NOTES CONTINUED ON NEXT PAGE

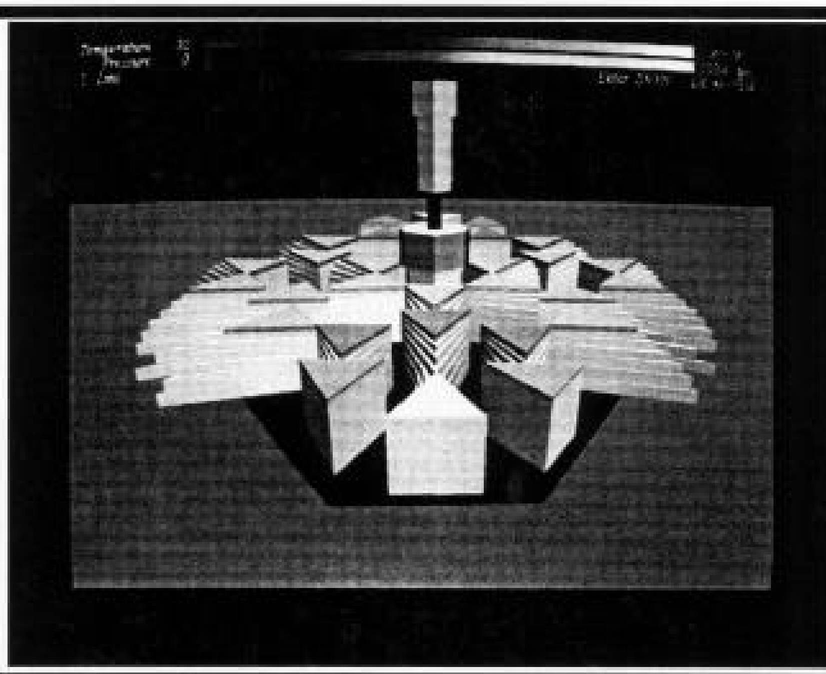
REQUIRED INPUTS

- **PART GEOMETRY**
  [WIRE FRAME COMPUTER MODEL] MODEL MAY BE PROVIDED BY OEM IN FORM OF IGES THREE DIMENSIONAL SURFACE OR WIRE FRAME MODEL. MODEL MAY ALSO BE CREATED BY COMPUTER ANALYST (MATERIAL SUPPLIER) BASED UPON TWO DIMENSIONAL PRELIMINARY DESIGN DATA PROVIDED BY THE OEM IN FORM OF HARD COPY PART DRAWINGS.
- **FINITE ELEMENT MODEL (FEM)**
  FEM REPRESENTING PART GEOMETRY PROVIDED BY MATERIAL SUPPLIER. FEM INCORPORATES SPRUE AND/OR RUNNER SYSTEM. PART WALL THICKNESSES ARE MODELED INTO THE FEM.

NOTES CONTINUED ON NEXT PAGE

MOLD-FILLING ANALYSIS

CONTINUED



POSSIBLE OUTPUTS

- MINIMUM SUGGESTED WALL THICKNESS FOR THE MATERIAL/GEOMETRY
- SPRUE/GATE LOCATION FOR BALANCED FILL PATTERN
- RUNNER/GATE DESIGN TO BALANCE FILLING OF DIFFERENT PARTS IN FAMILY TOOL
- MAXIMUM SHEAR HEATING AND THERMAL PATTERN THROUGHOUT FILL
- PREDICTED WELD LINE LOCATIONS
- FILL PATTERN

NOTES CONTINUED ON NEXT PAGE

OUTPUT FORMAT

- GLYPH ANALYSIS OUTPUT WILL CONSIST OF:
  1. WRITTEN REPORT WITH HARD COPY PLOTS OR SKETCHES
  2. VIDEO ANALYSIS SHOWING GLYPH SCREEN, NARRATED BY ANALYST

TIME REQUIREMENTS

- 1-2 WEEKS TYPICALLY REQUIRED FOR MODEL CREATION MODELING TIME DEPENDENT ON COMPLEXITY OF PART
- ADDITIONAL 1-2 WEEKS REQUIRED FOR COMPLETION OF ANALYSIS. ANALYSIS TIME DEPENDENT ON SIZE OF COMPUTER FEM (FINITE ELEMENT MODEL) AND TYPE OF OUTPUT DESIRED. FOR EXAMPLE RUNNER BALANCING AND WALL THICKNESS MINIMIZATION REQUIRE SEVERAL EDUCATED TRIAL & ERROR SIMULATIONS.

PART DESIGN CHECKLIST

NOMINAL WALL

- **UNIFORM THICKNESS**
  - UNIFORM CAVITY PRESSURE
  - UNIFORM COOLING
  - UNIFORM SHRINKAGE
- **CORNER RADII**
  - IMPROVED MELT FLOW
  - REDUCED RESIDUAL STRESS (SHRINKAGE)
  - REDUCED WARPAGE
- **DRAFT ANGLES**
  - REDUCED CYCLE TIMES (EJECTION)
  - REDUCED PART COST (CYCLE TIME)
  - REDUCED STRESS (SHRINKS ONTO CORE)

PROJECTIONS

- **THICKNESS AT NOMINAL WALL**
  - REDUCED RESIDUAL STRESS
  - POTENTIAL SINKMARKS
  - STRONGER PARTS
  - REDUCED CYCLE TIME (EJECTION)
- **HEIGHT**
  - FLOW
  - VENTING
  - EJECTION
- **LOCATION**
  - SPACING BETWEEN PROJECTIONS
  - AVOID FREE-STANDING PROJECTIONS (VENTING)
  - TALLEST PROJECTIONS ON CORE HALF (EJECTION)
  - ALIGN WITH FLOW DIRECTION
- **DRAFT ANGLES**
  - 1° PER SIDE MINIMUM

HOLES

- **CORE PINS**
  - LENGTH (STRENGTH)
  - COOLING
  - DRAFT
- **SHAPE**
  - NO SHARP CORNERS (SHRINKAGE)
  - WELDLINES
- **LOCATION**
  - WELDLINES
  - SPACING BETWEEN HOLES
- **DRAFT ANGLES**
  - REDUCED STRESS (SHRINKAGE AROUND PIN)
  - REDUCED CYCLE (EJECTION)