Sample Feasibility Study

XYZ Company
Widget Part Design

Prepared For:

XYZ Company
1234 Anywhere Street
Any Town, State 12345-6789

Prepared By:

Some Engineer
Plastics Technology Center
Penn State Erie, The Behrend College
Erie, PA 16511-1088

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OBJECTIVE

The objective of this project was to determine the feasibility of manufacturing a plastic widget. All required information to conduct the study was supplied by XYZ Company. This information included the following:

- Part drawings or sketches
- Description of part application and requirements
- Production information
- Miscellaneous information as requested

EXECUTIVE SUMMARY

Given the part design and requirements, the manufacturing materials and process were selected (see Table 1.1). The parts were determined to be injection molded from a general-purpose polypropylene material. After selecting the process and material, there were then several types of molds selected to manufacture the parts. The mold types are as follows:

1. *Single Cavity, Center Sprue gate, (SC, CSG)*
2. *Single Cavity, Hot Runner Edge gated, Fan or Multiple Tab gates (SC, HREG)*
3. *Two Cavity, Hot Runner Edge gated, Fan or Multiple Tab gates (TC, HREG)*

Table 1.1: **Part Information**

Annual Volume:	10, 25, 50, 75, and 100,000
Part Geometry:	Per print
Estimated Part Volume:	579.9 cm^3
Manufacturing Process:	Injection Molding
Suggested Material:	General Purpose Polypropylene
Part Requirements:	Flatness
Target Tool Costs:	\$50,000 - \$75,000
Target Part Costs:	\$5.00

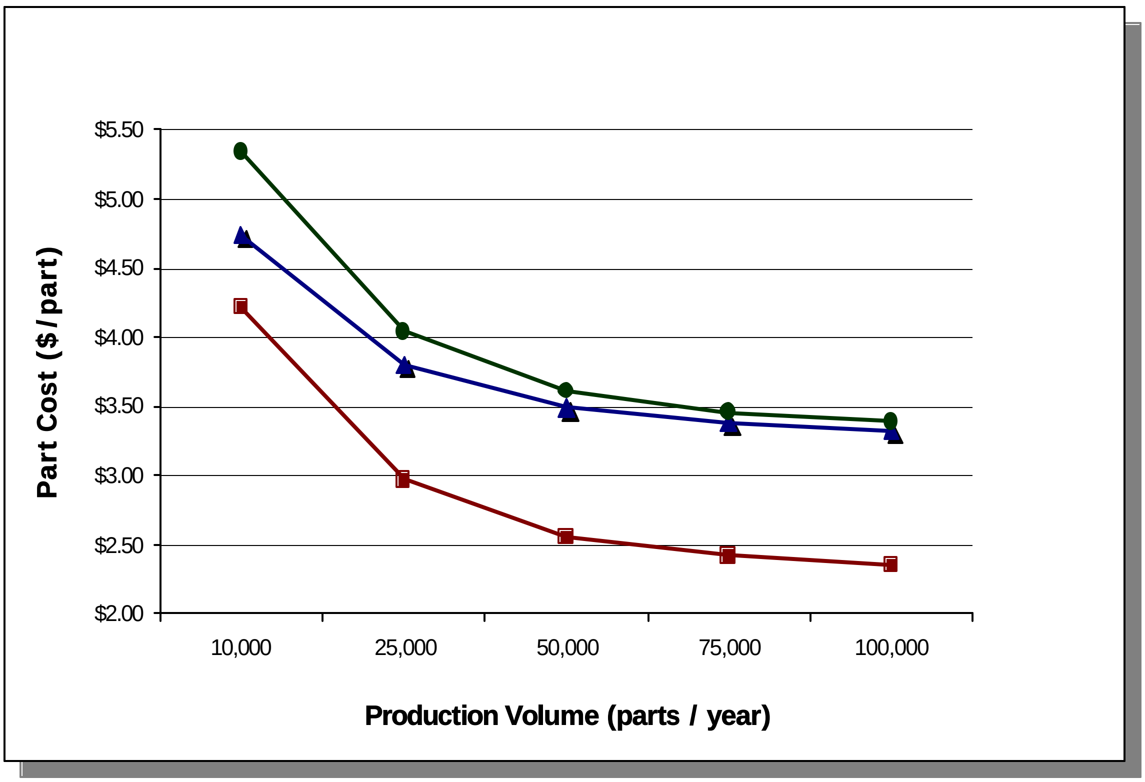
After determining the molding process and material estimates, tooling and parts costs could then be calculated. The cost estimates for the various tools and production volumes mentioned previously can be found in the following table.

Table 1.2: **Tooling and Purchased Cost Estimates**

		Part Costs				
Type of Tool	***Est. Tool Cost***	***10,000***	***25,000***	***50,000***	***75,000***	***100,000***
SC, CSG	$49,000	$4.74	$3.80	$3.49	$3.38	$3.33
SC, HREG	$68,000	$4.22	$2.97	$2.56	$2.42	$2.35
TC, HREG	$65,000	$5.34	$4.04	$3.61	$3.46	$3.39

To provide additional information showing the influence of production volume on part cost, refer to Chart 1.1: Part Cost versus Production Volume.

Chart 1.1: **Part Cost Versus Production Volume**



From Table 1.2 and Chart 1.1 it can be seen that the two-cavity tool produces the lowest cost parts with a medium range part cost. However, all part cost estimates except the SC, HREG at 10,000 parts per year fall within the targeted part cost range. These estimates appear to be in the targeted range for both tool and part costs. The decision on which tool to select can not be made at this time; we recommend a 3D mold filling analysis be performed to determine the best gating location given the part geometry.

Based upon these estimates, the PTC recommends that this is a feasible plastic part design, providing any additional costs such as packaging, decorating, assembly, etc. do not cause the part cost to exceed the $5.00 target cost. For this study, the aforementioned costs were not estimated per XYZ Company's request. Copies of the spreadsheets showing the part cost estimates can be found in the Appendix.

Tooling and Part Cost Estimations

The tooling cost estimations discussed earlier are based upon discussions between the PTC and a local toolmaker. These ballpark figures are to be used for estimations only. The part cost estimates have been calculated using a spreadsheet developed by the PTC. These spreadsheets use estimations for tool costs, cycle time, material costs, and machine costs (refer to the Appendix). When reviewing these spreadsheets, it can be seen that there are many inputs that are used to estimate the part cost. Since most of the inputs are estimated, the spreadsheets provide what is referred to as a " ballpark" figure for the calculated part cost.

The costs listed in the previous tables and graphs reflect what is referred to as the purchased part cost. This would be an estimate of what XYZ Company could expect to pay per part if they were to purchase the molded parts from an injection molder. The costs for each production volume are highlighted in pink and include the cost of the tool amortized at 10% over 5 years with a 5% scrap rate. If XYZ Company were to manufacture these parts in-house, the cost of the parts including the amortization over 5 years at 10% interest with a 5% scrap rate is shown highlighted in yellow. Once again these costs are calculated from estimates and are "ballpark" figures only. Material and machine costs were taken as averages from the December issues of *Plastic News* and *Injection Molding Magazine*. The material costs found in *Plastics News* were for high volume production purchases and are therefore inflated from $0.70 / lb to $1.00 / lb to reflect the lower volume of material purchased. The machine rate is inflated to cover any hourly rates for operators which may be required. When estimating these figures, conservative values are used to provide a slight over-estimate to cover any unexpected costs which may arise later.

Design and Manufacturing Recommendations

From the blueprints and drawings it appears that there is uniform wall thickness throughout the part. This uniform thickness is recommended to ensure a good plastic part. Due to the ribbing on the part, there is a possibility for warpage. We recommend reducing the thickness of the ribs to approximately half that of the nominal wall. This will prevent some of the warpage and other cosmetic defects that could occur otherwise.

As mentioned earlier, we are recommending that these parts be injection molded from a polypropylene material. We feel that this process and material will provide XYZ Company with plastic widgets that meet all criteria for both cost and performance. Also, we recommend that a 3D filling analysis be performed on this design. This is recommended because it will assist in identifying potential problems in the molding process and allow the PTC to vary gate location, process conditions, and/or geometry to predict problems and determine solutions. A filling analysis will allow the PTC to make these changes before the tool is cut and will reduce potential costs associated with reworking a tool.

Some recommendations on processing parameters can be found in Appendix II of this report. Using some of the general part and material information, a 2D filling analysis program, Sureshot, was used to determine the range for both melt temperature and injection time.

Appendix I

Part Cost Estimate Information

PTC Part Cost Estimation

Date:	*July 23, 1997*

PART INFORMATION:	
Project:	*XYZ Company*
Part Name:	*Widget*
Projected Area (in^2):	*0.00*
Volume (cm^3):	*579.90*
Mass (g):	*579.90*
Runner Volume (cm^3):	*0*

MOLD INFORMATION:	
No. of Cavities:	*2*
Estimated Cost:	*$65,000.00*

MATERIAL INFORMATION:	
Resin:	*PP*
Grade:	*General Purpose*
Cost ($/lb):	*$0.70*
Spec Gravity (g/cm^3):	*1*

FINANCING INFORMATION:	
Amortization (yrs):	*5*
Int Rate (%/yr):	*10*
Man markup (%):	*25*

PRODUCTION INFORMATION:	
Min Press Size (tons):	*0*
Cycle Time (s):	*45*
Machine Rate ($/hr):	*$125.00*
Scrap Rate (%):	*5%*
Hourly Prod (parts/hr):	*152*

SECONDARY OPERATIONS:	
Printing ($/prt):	*$0.00*
Assembly ($/prt):	*$0.00*
Packaging ($/prt):	*$0.00*
Misc ($/prt):	*$0.00*

ANNUAL VOLUMES:	PARTS/YEAR
Volume 1:	*10,000*
Volume 2:	*25,000*
Volume 3:	*50,000*
Volume 4:	*75,000*
Volume 5:	*100,000*

AMORTIZATION CALCULATIONS:	
i=	*0.0083333*
n=	*60*
A/P=	*0.0212470*

COST ESTIMATION CALCULATIONS:	
Material Costs:	*$0.89*
Production Costs:	*$0.82*
Secondary Costs:	*$0.00*
Man Cost (without tool)	*$1.72*
Purch Cost (without tool)	*$2.15*

COST CALCULATIONS:					
Production Volumes	**10,000**	**25,000**	**50,000**	**75,000**	**100,000**
Mold Cost:	*$1.66*	*$0.66*	*$0.33*	*$0.22*	*$0.17*
Manufactured Cost:	*$3.37*	*$2.38*	*$2.05*	*$1.94*	*$1.88*
Purchased Cost:	*$4.22*	*$2.97*	*$2.56*	*$2.42*	*$2.35*

PTC Part Cost Estimation

Date:	*July 23, 1997*

PART INFORMATION:	
Project:	*XYZ Company*
Part Name:	*Widget*
Projected Area (in^2):	*0.00*
Volume (cm^3):	*579.90*
Mass (g):	*579.90*
Runner Volume (cm^3):	*0*

MOLD INFORMATION:	
No. of Cavities:	*1*
Estimated Cost:	*$49,000.00*

MATERIAL INFORMATION:	
Resin:	*PP*
Grade:	*General Purpose*
Cost ($/lb):	*$0.70*
Spec Gravity (g/cm^3):	*1*

FINANCING INFORMATION:	
Amortization (yrs):	*5*
Int Rate (%/yr):	*10*
Man markup (%):	*25*

PRODUCTION INFORMATION:	
Min Press Size (tons):	*0*
Cycle Time (s):	*45*
Machine Rate ($/hr):	*$125.00*
Scrap Rate (%):	*5%*
Hourly Prod (parts/hr):	*76*

SECONDARY OPERATIONS:	
Printing ($/prt):	*$0.00*
Assembly ($/prt):	*$0.00*
Packaging ($/prt):	*$0.00*
Misc ($/prt):	*$0.00*

ANNUAL VOLUMES:	**PARTS/YEAR**
Volume 1:	*10,000*
Volume 2:	*25,000*
Volume 3:	*50,000*
Volume 4:	*75,000*
Volume 5:	*100,000*

AMORTIZATION CALCULATIONS:	
i=	*0.0083333*
n=	*60*
A/P=	*0.0212470*

COST ESTIMATION CALCULATIONS:	
Material Costs:	*$0.89*
Production Costs:	*$1.64*
Secondary Costs:	*$0.00*
Man Cost (without tool)	*$2.54*
Purch Cost (without tool)	*$3.17*

COST CALCULATIONS:					
Production Volumes	**10,000**	**25,000**	**50,000**	**75,000**	**100,000**
Mold Cost:	*$1.25*	*$0.50*	*$0.25*	*$0.17*	*$0.12*
Manufactured Cost:	*$3.79*	*$3.04*	*$2.79*	*$2.71*	*$2.66*
Purchased Cost:	*$4.74*	*$3.80*	*$3.49*	*$3.38*	*$3.33*

PTC Part Cost Estimation

Date:	*July 23, 1997*

PART INFORMATION:	
Project:	*XYZ Company*
Part Name:	*Widget*
Projected Area (in^2):	*0.00*
Volume (cm^3):	*579.90*
Mass (g):	*579.90*
Runner Volume (cm^3):	*0*

MOLD INFORMATION:	
No. of Cavities:	*1*
Estimated Cost:	*$68,000.00*

MATERIAL INFORMATION:	
Resin:	*PP*
Grade:	*General Purpose*
Cost ($/lb):	*$0.70*
Spec Gravity (g/cm^3):	*1*

FINANCING INFORMATION:	
Amortization (yrs):	*5*
Int Rate (%/yr):	*10*
Man markup (%):	*25*

PRODUCTION INFORMATION:	
Min Press Size (tons):	*0*
Cycle Time (s):	*45*
Machine Rate ($/hr):	*$125.00*
Scrap Rate (%):	*5%*
Hourly Prod (parts/hr):	*76*

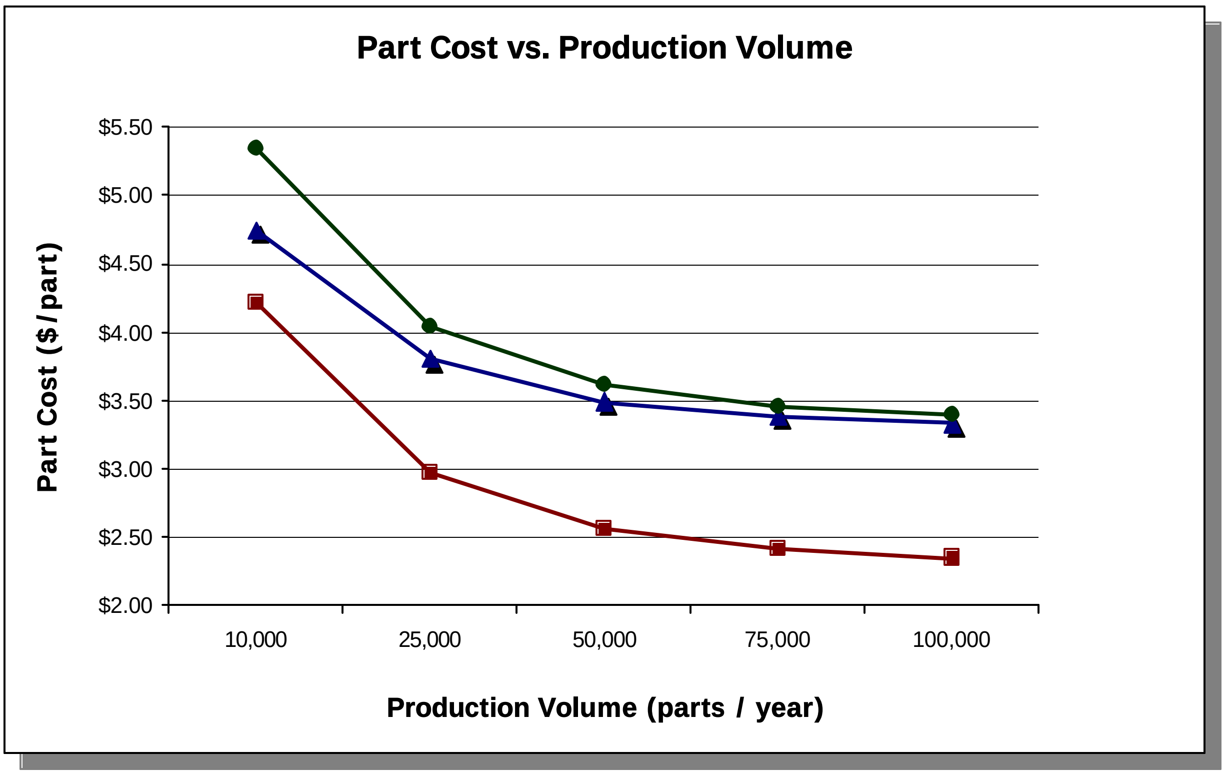
SECONDARY OPERATIONS:	
Printing ($/prt):	*$0.00*
Assembly ($/prt):	*$0.00*
Packaging ($/prt):	*$0.00*
Misc ($/prt):	*$0.00*

ANNUAL VOLUMES:	PARTS/YEAR
Volume 1:	*10,000*
Volume 2:	*25,000*
Volume 3:	*50,000*
Volume 4:	*75,000*
Volume 5:	*100,000*

AMORTIZATION CALCULATIONS:	
i=	*0.0083333*
n=	*60*
A/P=	*0.0212470*

COST ESTIMATION CALCULATIONS:	
Material Costs:	*$0.89*
Production Costs:	*$1.64*
Secondary Costs:	*$0.00*
Man Cost (without tool)	*$2.54*
Purch Cost (without tool)	*$3.17*

COST CALCULATIONS:					
Production Volumes	**10,000**	**25,000**	**50,000**	**75,000**	**100,000**
Mold Cost:	*$1.73*	*$0.69*	*$0.35*	*$0.23*	*$0.17*
Manufactured Cost:	*$4.27*	*$3.23*	*$2.89*	*$2.77*	*$2.71*
Purchased Cost:	*$5.34*	*$4.04*	*$3.61*	*$3.46*	*$3.39*


Part Cost vs. Production Volume
$5.50
$5.00
$4.50
$4.00
$3.50
$3.00
$2.50
$2.00
Part Cost ($/part)
10,000
25,000
50,000
75,000
100,000
Production Volume (parts / year)

Appendix II

Sure Shot Results

A Sure-Shot Moldability Assessment for:
XYZ Company – Widget Part – Center Gated

Processing Recommendations:
The area between the two injection time lines represents the acceptable set of molding conditions for all melt temperatures shown.

- Injection pressures for the cavity are less than 10,150 psi.
- Shear stresses at the gate and end of flow are less than 36 psi.
- The melt temperature drop during filling is less than 36° F.

Recommended Processing Conditions for XYZ Company – Widget Part – Center Gated made with PP and a mold temperature of 68° F are:

- Melt temperature between 392° F and 500° F

At the center of the melt temperature range (rounded up), the injection time range is between 2.15 and 4.98 seconds.

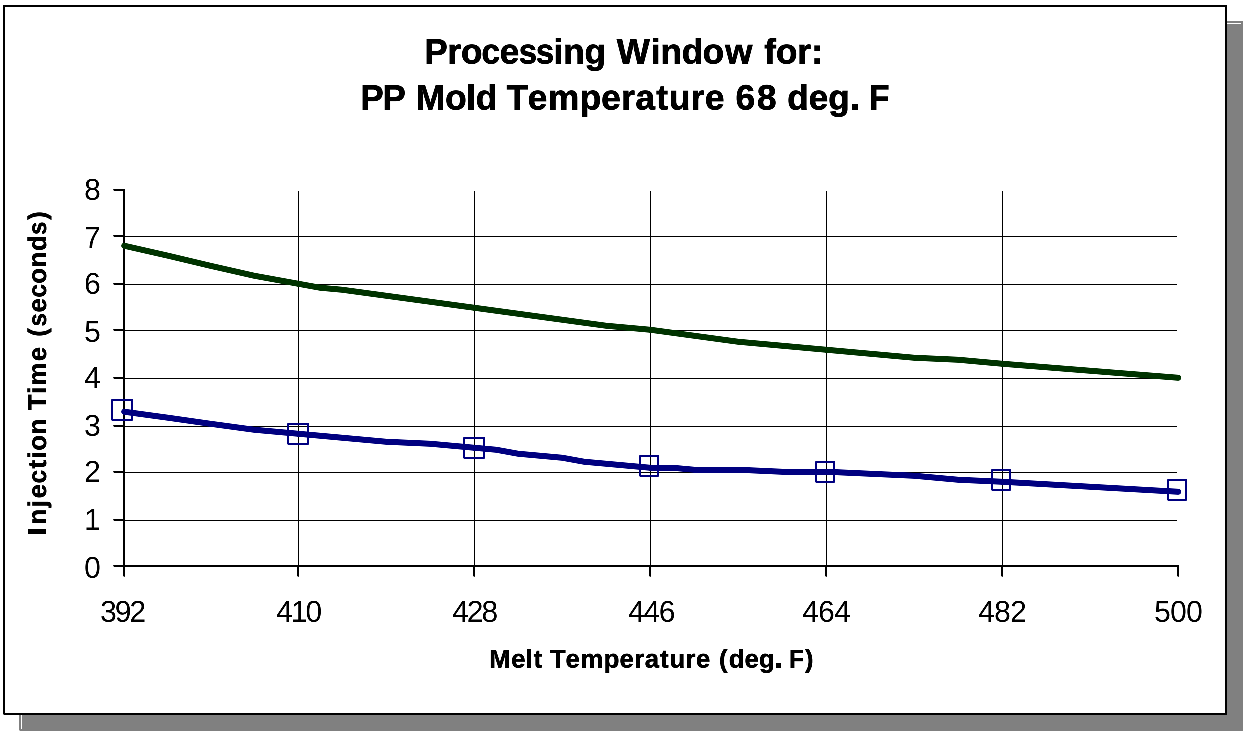
The allowable injection time range is 2.84 seconds. This should not be cause for concern. Examine other recommendations to decide if further work is indicated.

Filling Pattern:
It is important to determine if filling will be balanced because unbalanced filling will result in higher filling pressures, clamp pressures, and higher shear rates. Estimate if the fill pattern is balanced by comparing distances from the gate to all extremities of the part. This technique will work well if the wall thickness is relatively uniform along the various flow paths.

Hesitation Concerns:
This part should fill smoothly as the pattern will not be significantly influenced by variations in wall thickness. 3D filling analysis will not be required to avoid hesitations.

Gas Traps:
Study the product design to see if there is a possibility that plastic melt will split during fill and re-unite somewhere that could cause venting problems. If there is a possibility, such as a grille section, you should consider running a 3D filling analysis.

Visual Concerns:
The lack of visual requirements makes it less necessary to run filling analysis unless it is recommended for some other reason.


Processing Window for:
PP Mold Temperature 68 deg. F
Injection Time (seconds)
0
1
2
3
4
5
6
7
8
392
410
428
446
464
482
500
Melt Temperature (deg. F)

A Sure-Shot Moldability Assessment for:
XYZ Company – Widget Part – Edge Gated

Processing Recommendations:
The area between the two injection time lines represents the acceptable set of molding conditions for all melt temperatures shown.

- Injection pressures for the cavity are less than 10,150 psi.
- Shear stresses at the gate and end of flow are less than 36 psi.
- The melt temperature drop during filling is less than 36° F

Recommended Processing Conditions for XYZ Company – Widget Part – Edge Gated made with PP and a mold temperature of 68° F are:

- Melt temperature between 428° F and 500° F

At the center of the melt temperature range (rounded up), the injection time range is between 3.72 and 6.56 seconds.

The allowable injection time range is 2.84 seconds. This should not be cause for concern. Examine other recommendations to decide if further work is indicated.

Number of Cavities:
Every multiple cavity mold can benefit from the design of a balanced runner system. It is highly recommended that flow balancing be used to avoid excessive material usage and to assure that melt conditions entering the cavity are correct for the part. If the runner system is not naturally balanced, the need for a flow balanced system is even greater.

Number of Gates:
You can use Moldability Assessments to determine the viability of a single gate. If the assessment recommendations are not favorable, you might want to try a model representing multiple gates.

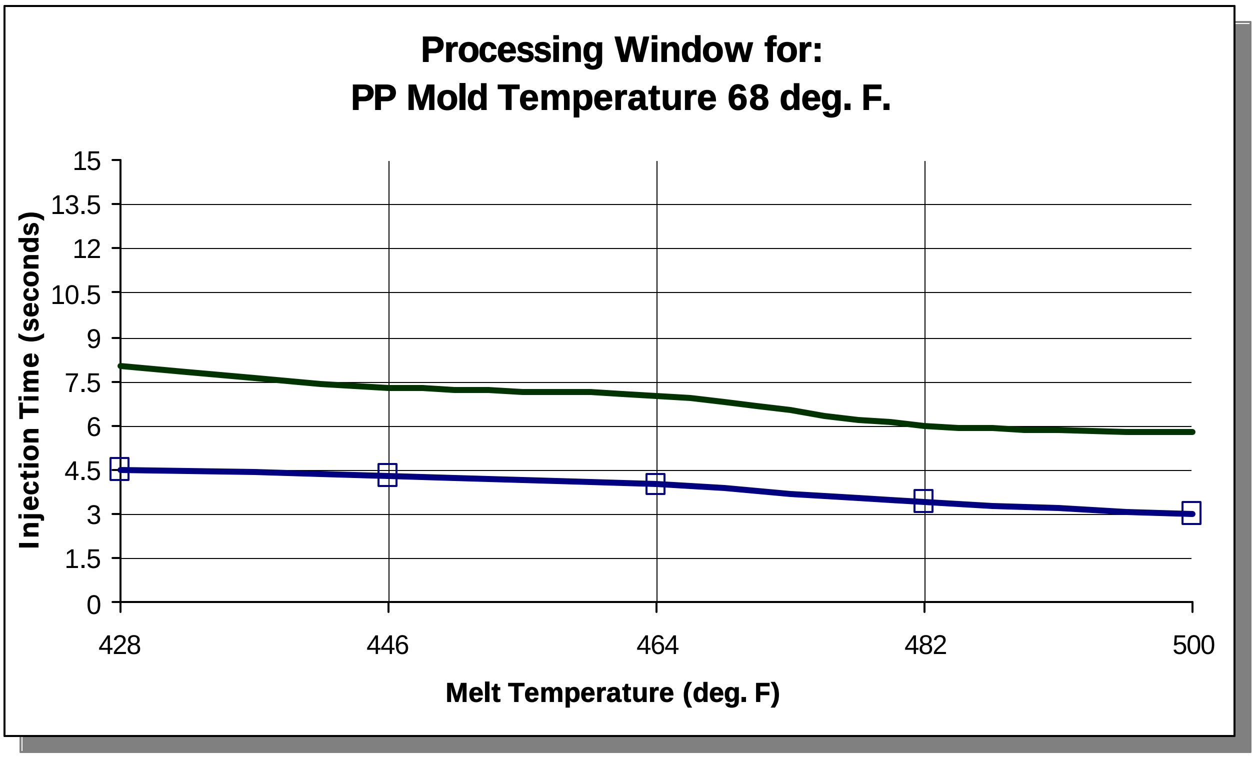
Filling Pattern:
It is important to determine if filling will be balanced because unbalanced filling will result in higher filling pressures, clamp pressures, and higher shear rates. Estimate if the fill pattern is balanced by comparing distances from the gate to all extremities of the part. This technique will work well if the wall thickness is relatively uniform along the various flow paths.

Filling Pattern:
A 3D filling analysis is always recommended for multiple gated parts unless you are very sure that the gates are well balanced. You should also be sure to design a balanced runner system. A balanced runner system provides plastic melt to the gates at the proper temperature and pressure to fill the part as it was planned for this moldability assessment. Balancing the runner system will also provide a check of shear rates and cooling times for the sprue and runner system. If runners are too small, you may over shear the material. Large runner diameters may lengthen the cycle time required for the mold.

Hesitation Concerns:
This part should fill smoothly as the pattern will not be significantly influenced by variations in wall thickness. 3D filling analysis will not be required to avoid hesitations.

Gas Traps:
Study the product design to see if there is a possibility that plastic melt will split during fill and re-unite somewhere that could cause venting problems. If there is a possibility, such as a grille section, you should consider running a 3D filling analysis.

Visual Concerns:
The lack of visual requirements makes it less necessary to run filling analysis unless it is recommended for some other reason.


Processing Window for:
PP Mold Temperature 68 deg. F.
Injection Time (seconds)
15
13.5
12
10.5
9
7.5
6
4.5
3
1.5
0
428
446
464
482
500
Melt Temperature (deg. F)