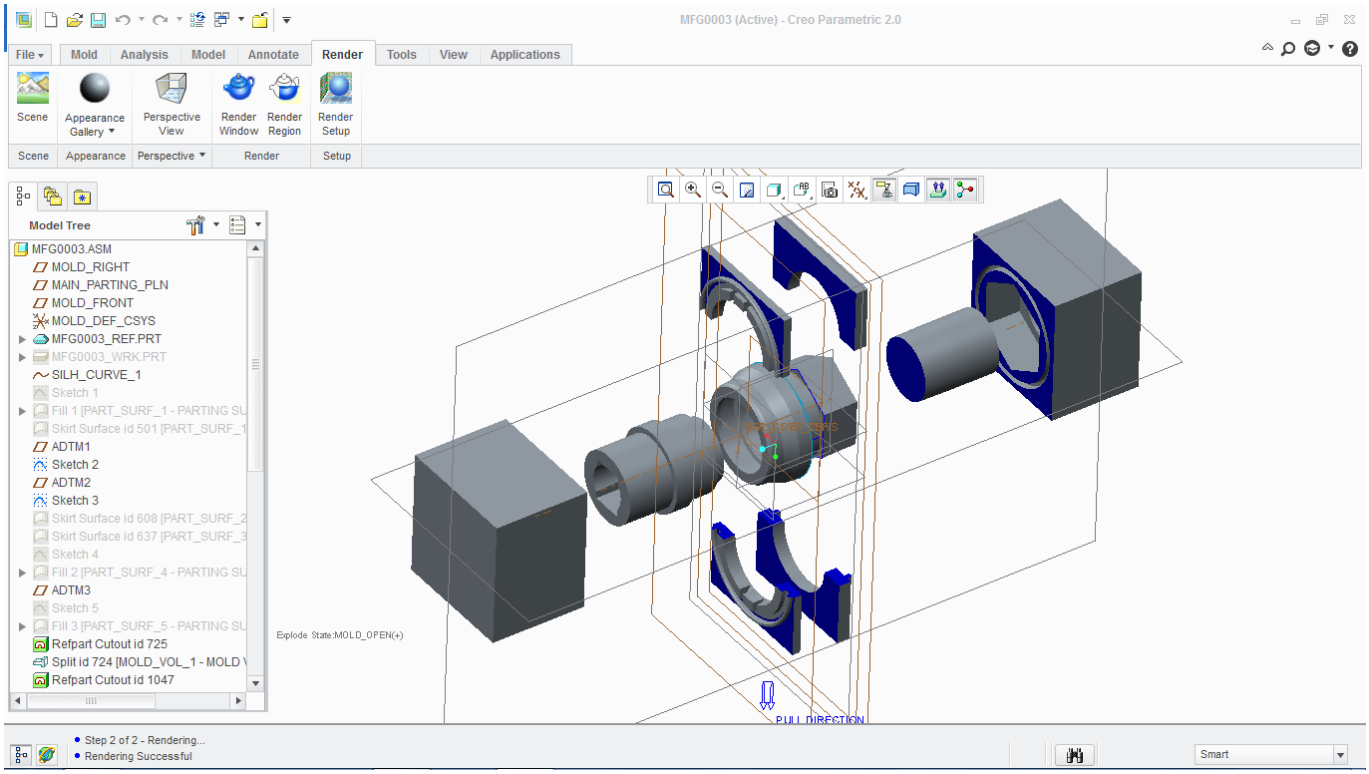
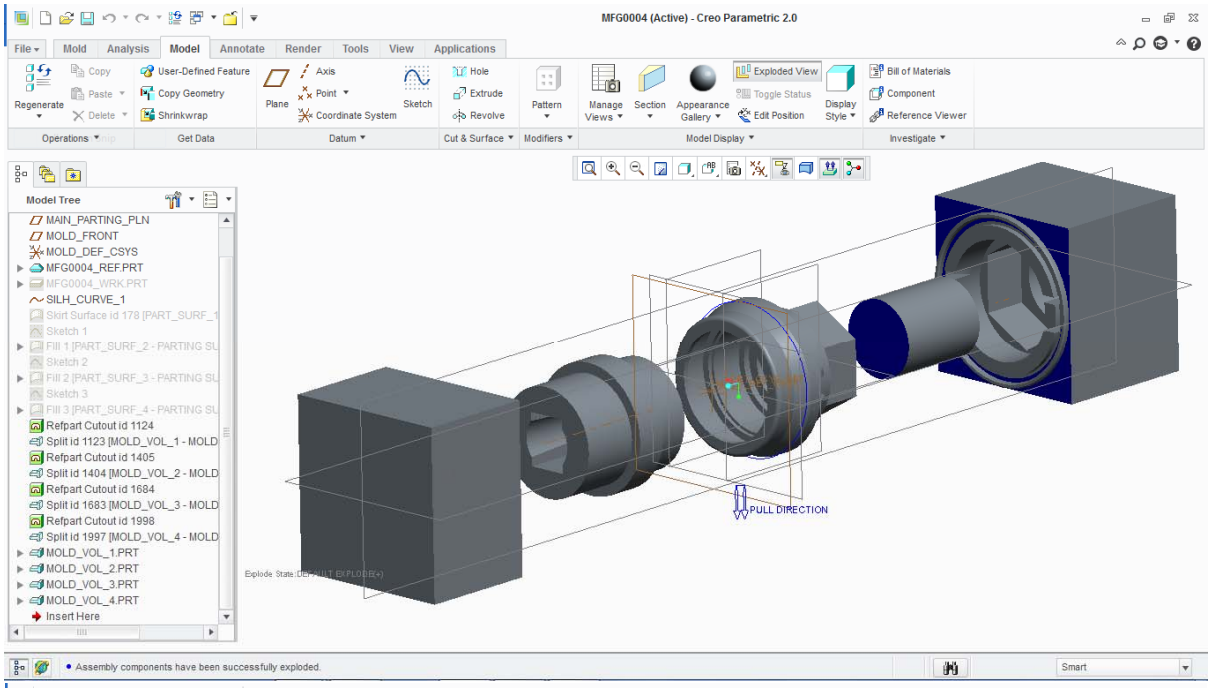
Mold Design and Manufacturing

Mold Cavity Design:–

- Step1 • Achieving a Reference Model
- Step 2 • Adding required shrinkage
- Step 3 • Specifying Workpiece
- Step 4 • Making Parting Surfaces
- Step 5 • Selecting the required Mold Volumes
- Step 6 • Extracting Mold Volumes

This project involved design of Mold and its manufacturing for a variety of parts used in the irrigation system as pipe fittings. Most of the parts had a deep undercut on the inner surface due to which, a normal single inner core was avoided and a sliding/collapsible core was used instead. Some of the molds were manufactured using lathe and milling CNC machine which were inputted with CNC program generated on the computer on DELCAM software. Some of the parts and their molds have been shown below.




MFG0004 (Active) - Creo Parametric 2.0
File
Mold
Analysis
Model
Annotate
Render
Tools
View
Applications
Regenerate
Copy
Paste
Delete
User-Defined Feature
Copy Geometry
Shrinkwrap
Plane
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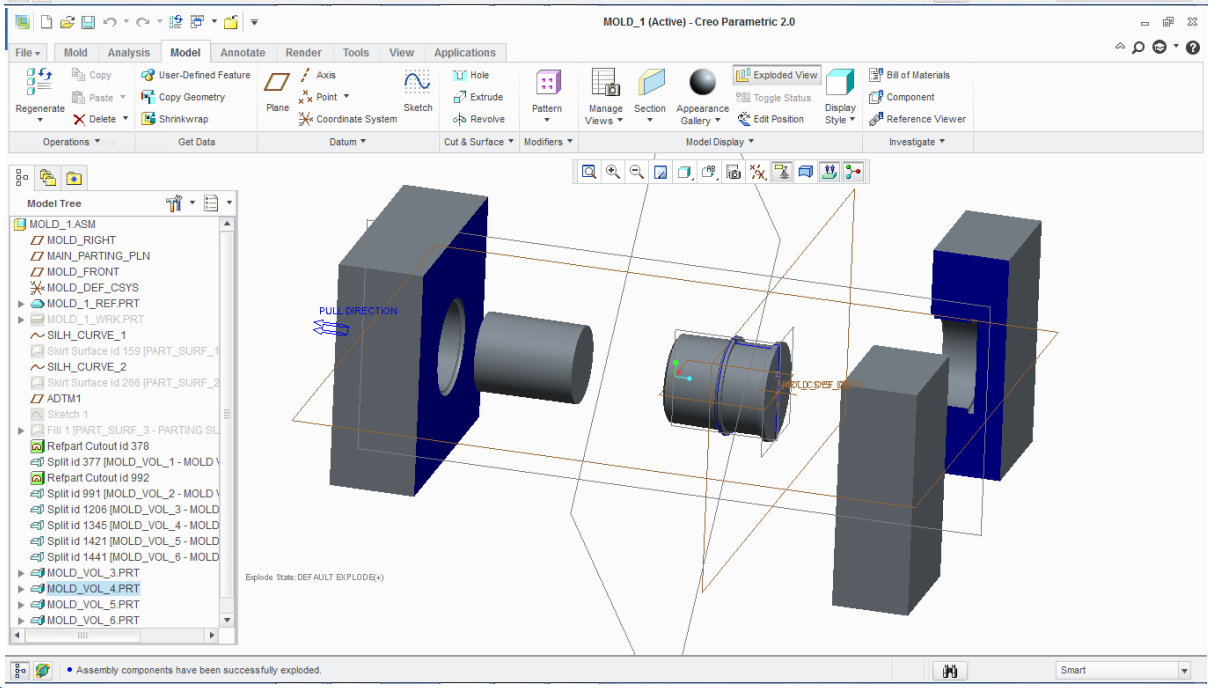
Coordinate System
Sketch
Hole
Extrude
Revolve
Pattern
Manage Views
Section
Appearance Gallery
Exploded View
Toggle Status
Edit Position
Display Style
Bill of Materials
Component
Reference Viewer
Operations
Get Data
Datum
Cut & Surface
Modifiers
Model Display
Investigate
Model Tree
MAIN_PARTING_PLN
MOLD_FRONT
MOLD_DEF_CSYS
MFG0004_REF.PRT
MFG0004_WRK.PRT
SILH_CURVE_1
Skirt Surface id 178 [PART_SURF_1
Sketch 1
Fill 1 [PART_SURF_2 - PARTING SU
Sketch 2
Fill 2 [PART_SURF_3 - PARTING SU
Sketch 3
Fill 3 [PART_SURF_4 - PARTING SU
Refpart Cutout id 1124
Split id 1123 [MOLD_VOL_1 - MOLD
Refpart Cutout id 1405
Split id 1404 [MOLD_VOL_2 - MOLD
Refpart Cutout id 1684
Split id 1683 [MOLD_VOL_3 - MOLD
Refpart Cutout id 1998
Split id 1997 [MOLD_VOL_4 - MOLD
MOLD_VOL_1.PRT
MOLD_VOL_2.PRT
MOLD_VOL_3.PRT
MOLD_VOL_4.PRT
Insert Here
PULL DIRECTION
Explode State:DEFAULT EXPLODE(+)
Assembly components have been successfully exploded.
Smart


MOLD_1 (Active) - Creo Parametric 2.0
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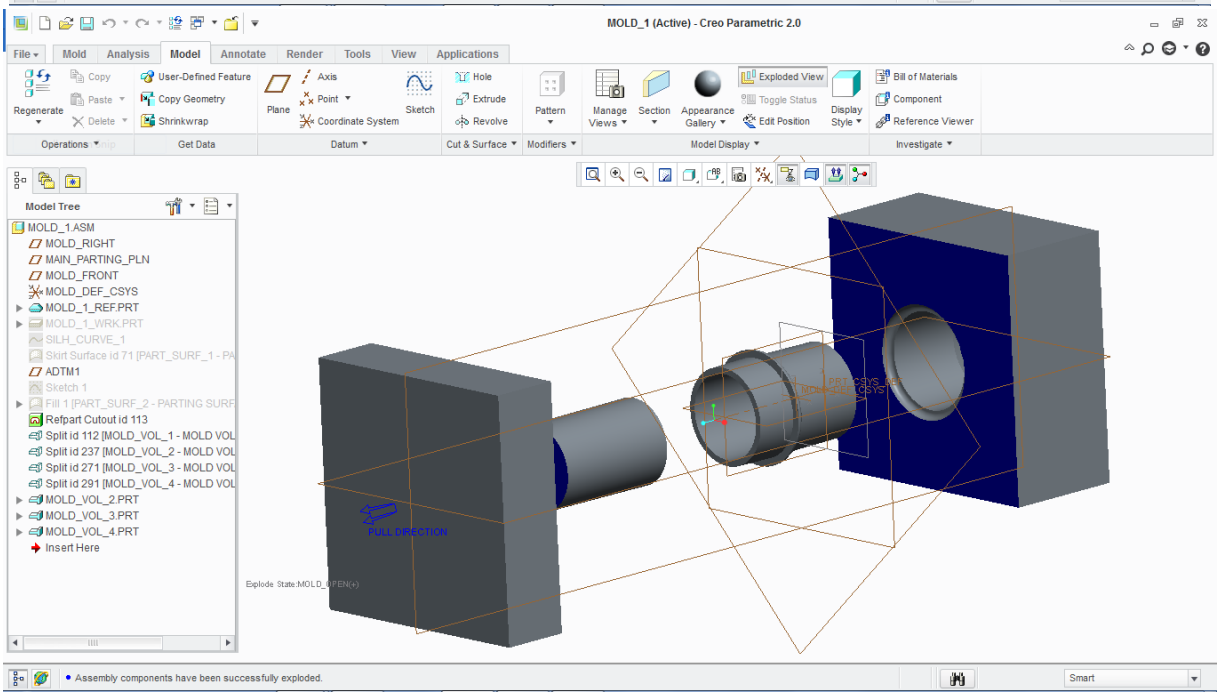
Model Tree
MOLD_1.ASM
MOLD_RIGHT
MAIN_PARTING_PLN
MOLD_FRONT
MOLD_DEF_CSYS
MOLD_1_REF.PRT
MOLD_1_WRK.PRT
SILH_CURVE_1
Skirt Surface id 159 [PART_SURF_1
SILH_CURVE_2
Skirt Surface id 266 [PART_SURF_2
ADTM1
Sketch 1
Fill 1 [PART_SURF_3 - PARTING SU
Refpart Cutout id 378
Split id 377 [MOLD_VOL_1 - MOLD V
Refpart Cutout id 992
Split id 991 [MOLD_VOL_2 - MOLD V
Split id 1206 [MOLD_VOL_3 - MOLD
Split id 1345 [MOLD_VOL_4 - MOLD
Split id 1421 [MOLD_VOL_5 - MOLD
Split id 1441 [MOLD_VOL_6 - MOLD
MOLD_VOL_3.PRT
MOLD_VOL_4.PRT
MOLD_VOL_5.PRT
MOLD_VOL_6.PRT
PULL DIRECTION
Explode State:DEFAULT EXPLODE(+)
Assembly components have been successfully exploded.
Smart


MOLD_1 (Active) - Creo Parametric 2.0
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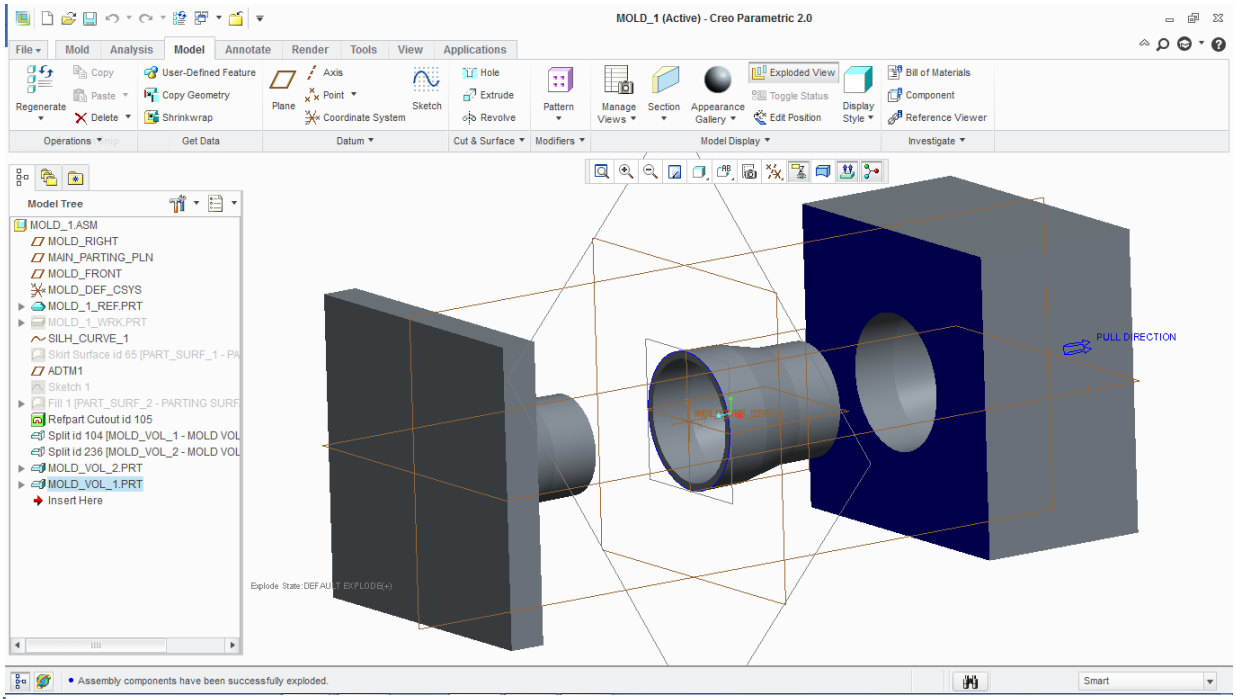
Model Tree
MOLD_1.ASM
MOLD_RIGHT
MAIN_PARTING_PLN
MOLD_FRONT
MOLD_DEF_CSYS
MOLD_1_REF.PRT
MOLD_1_WRK.PRT
SILH_CURVE_1
Skirt Surface id 71 [PART_SURF_1 - PA
ADTM1
Sketch 1
Fill 1 [PART_SURF_2 - PARTING SURF
Refpart Cutout id 113
Split id 112 [MOLD_VOL_1 - MOLD VOL
Split id 237 [MOLD_VOL_2 - MOLD VOL
Split id 271 [MOLD_VOL_3 - MOLD VOL
Split id 291 [MOLD_VOL_4 - MOLD VOL
MOLD_VOL_2.PRT
MOLD_VOL_3.PRT
MOLD_VOL_4.PRT
Insert Here
PULL DIRECTION
Explode State:MOLD_OPEN(+)
Assembly components have been successfully exploded.
Smart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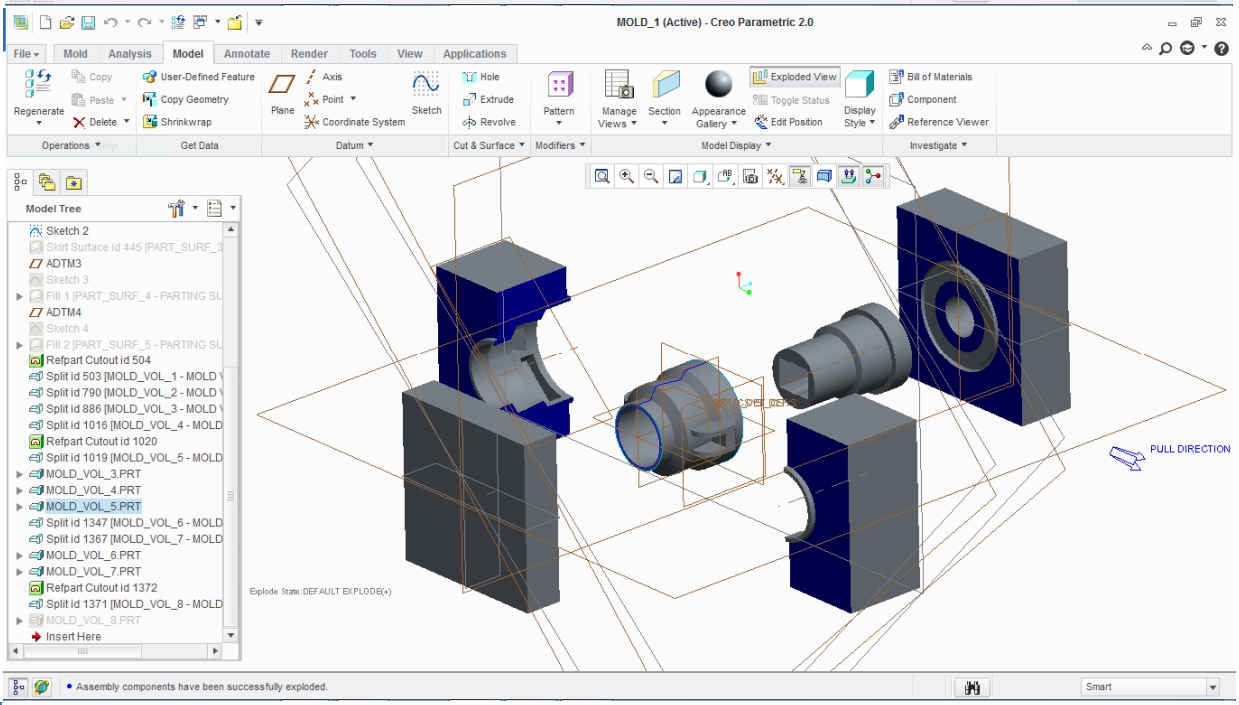
Model Tree
MOLD_1.ASM
MOLD_RIGHT
MAIN_PARTING_PLN
MOLD_FRONT
MOLD_DEF_CSYS
MOLD_1_REF.PRT
MOLD_1_WRK.PRT
SILH_CURVE_1
ADTM1
Sketch 1
Refpart Cutout id 105
MOLD_VOL_2.PRT
MOLD_VOL_1.PRT
Insert Here
PULL DIRECTION
Explode State:DEFAULT EXPLODE(+)
Assembly components have been successfully exploded.
Smart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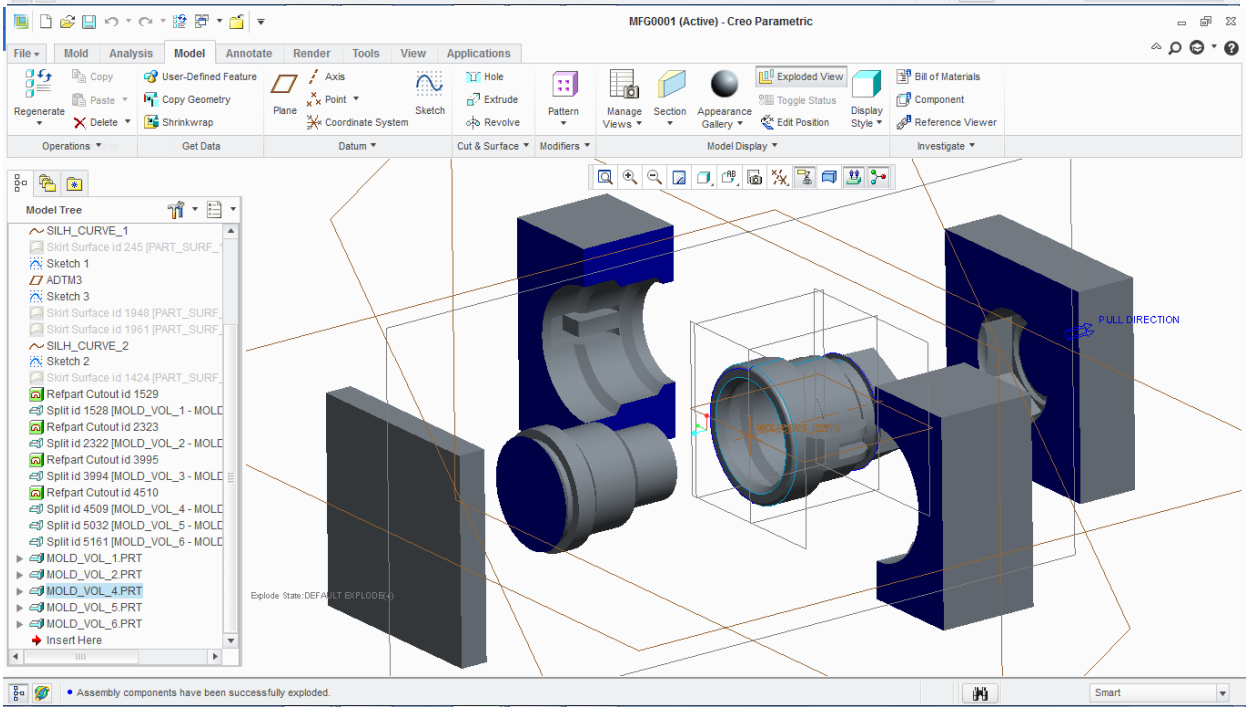
Model Tree
Sketch 2
ADTM3
Sketch 3
ADTM4
Sketch 4
Refpart Cutout id 504
Refpart Cutout id 1020
MOLD_VOL_3.PRT
MOLD_VOL_4.PRT
MOLD_VOL_5.PRT
MOLD_VOL_6.PRT
MOLD_VOL_7.PRT
Refpart Cutout id 1372
MOLD_VOL_8.PRT
Insert Here
PULL DIRECTION
Explode State:DEFAULT EXPLODE(+)
Assembly components have been successfully exploded.
Smart


MFG0001 (Active) - Creo Parametric
File
Mold
Analysis
Model
Annotate
Render
Tools
View
Applications
Regenerate
Copy
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Delete
User-Defined Feature
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Shrinkwrap
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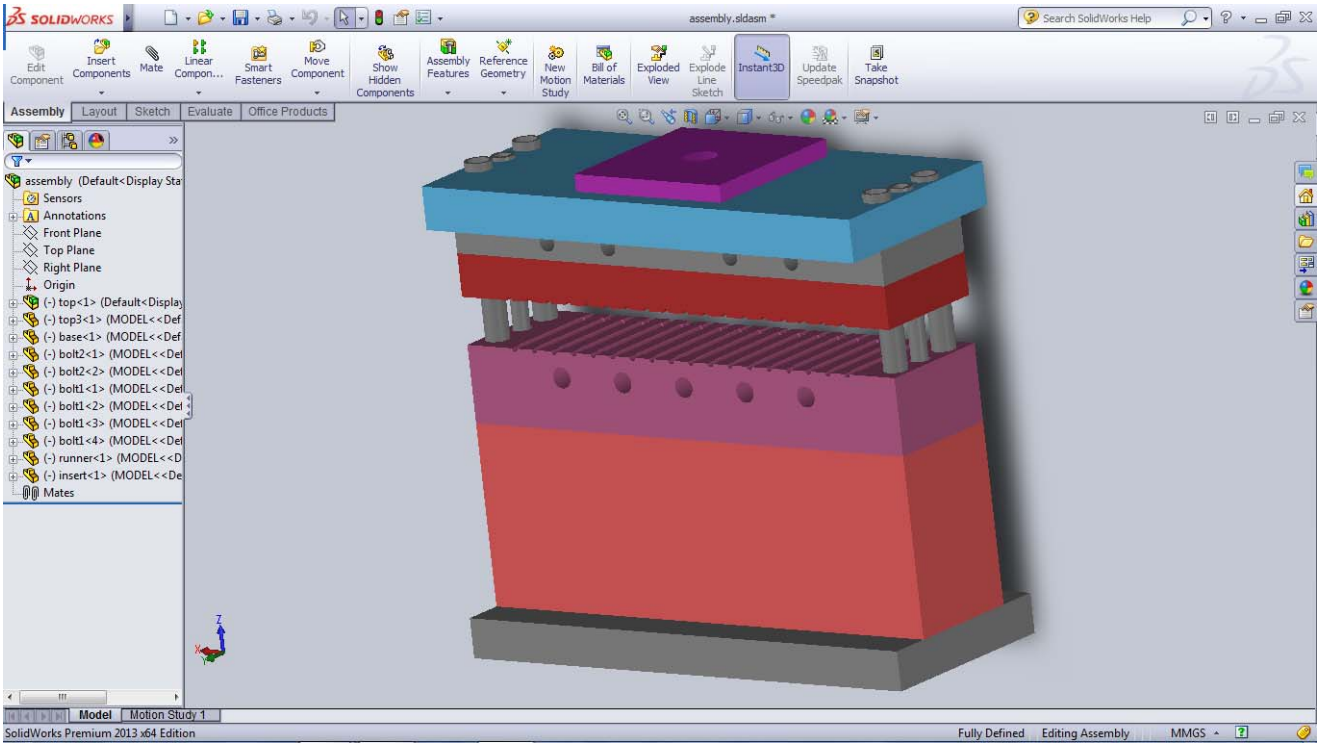
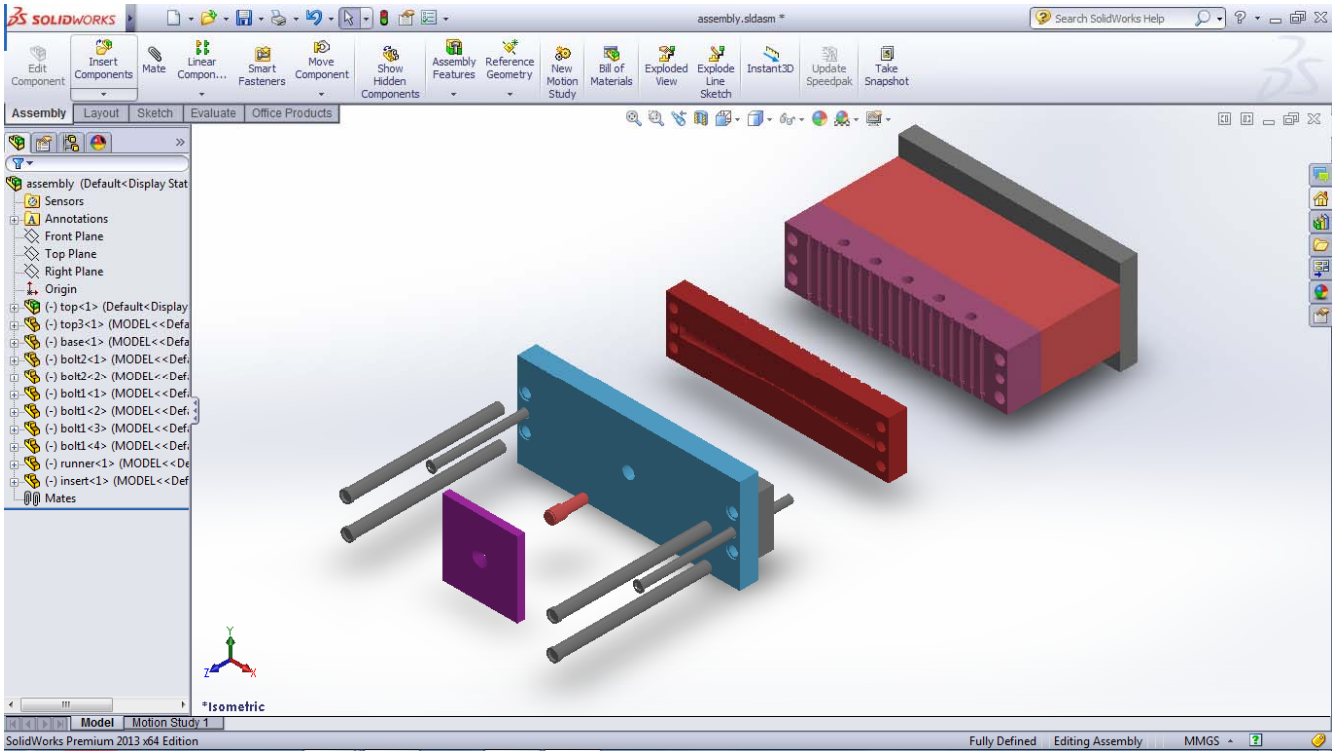
SILH_CURVE_1
Sketch 1
ADTM3
Sketch 3
SILH_CURVE_2
Sketch 2
Refpart Cutout id 1529
Refpart Cutout id 2323
Refpart Cutout id 3995
Refpart Cutout id 4510
MOLD_VOL_1.PRT
MOLD_VOL_2.PRT
MOLD_VOL_4.PRT
MOLD_VOL_5.PRT
MOLD_VOL_6.PRT
Insert Here
PULL DIRECTION
Explode State:DEFAULT EXPLODE(+)
Assembly components have been successfully exploded.
Smart

Mold Flow Analysis:-

This project focussed on injection of plastic over the steel rod to make the handle for buckets. It involved multiple injection points, simultaneous injections, complicated runner system involving a cold sprue with cooling channels. It is important to have a mold flow analysis for the whole system as plastic flow needs to be confirmed in all the parts of the cavity and compute the cycle time of the injection cycle. The pressure drop and the average temperature also are important parameters for the analysis. The air traps also needs to be found so that apt air vents are provided to prevent defects of the molded part.



Moldbase for Vertical Injection Molding Machine

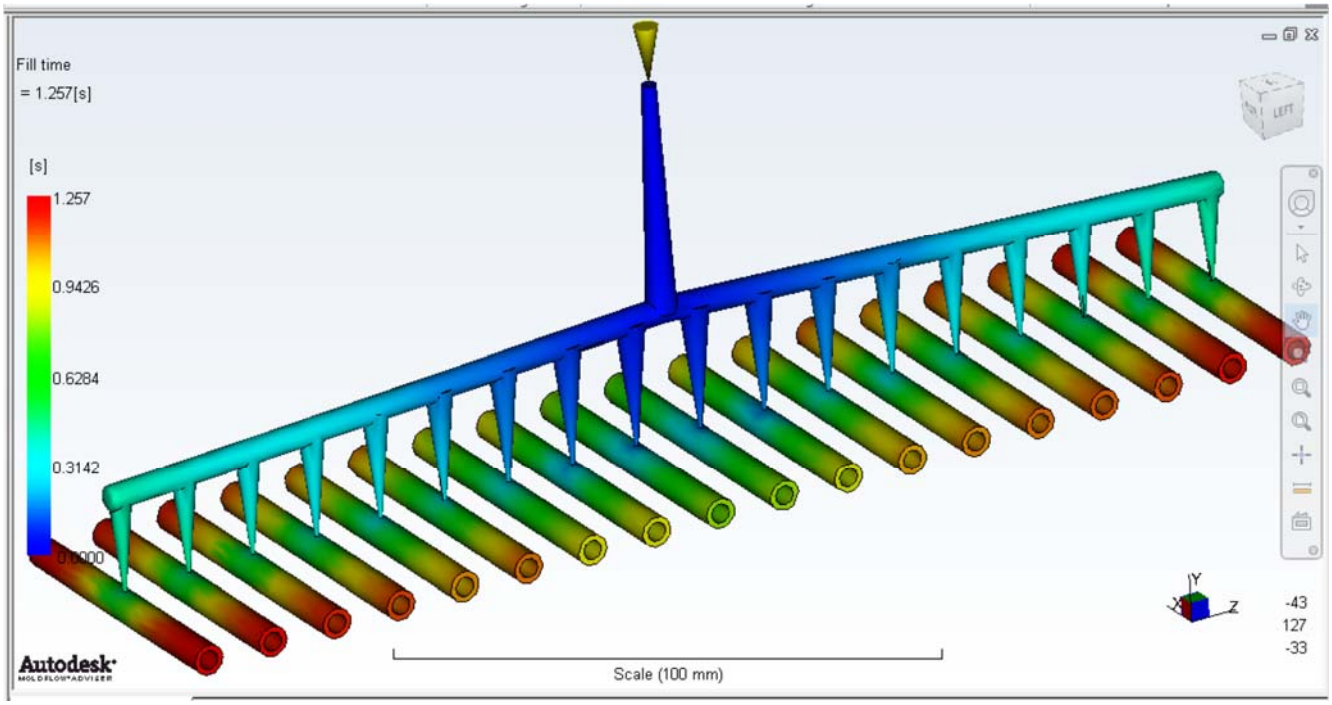


For the part two runner systems were made and analysed to find the more efficient and optimal of the two. One was for the same diameter taper runner geometry while the other was for varying diameter runner geometry. The results were then discussed upon and it was concluded that the varying diameter runner geometry would be better because of its easier machinability aspect and a satisfactory and complying flow profile.

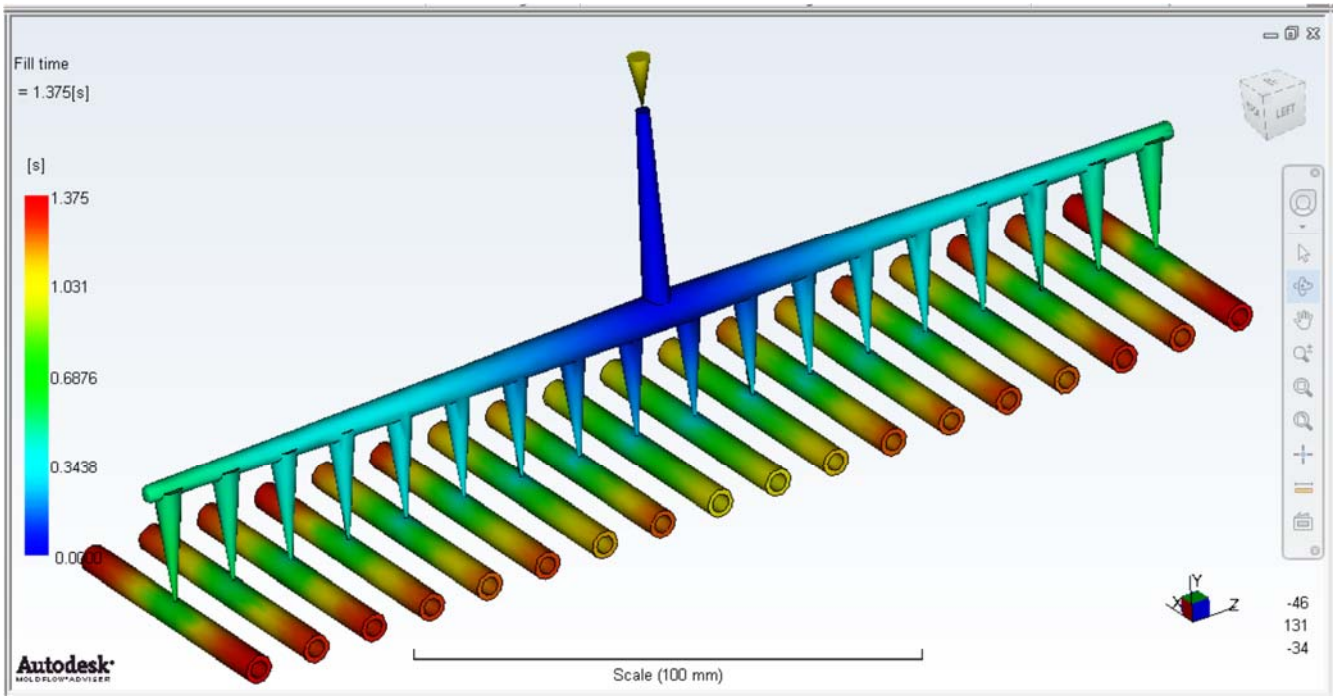
The parameters considered were Fill time, Plastic flow, Confidence of fill, Quality prediction, Injection pressure, Pressure drop, Temperature at flow front, Average temperature, Time to reach ejection temperature, Air traps, Weld lines and Volumetric shrinkage at ejection.

The analysis was initialised with:-

- Melt temperature: 240.0 (C)
- Mold temperature: 40.0 (C)
- Injection locations: 1
- Max. machine injection pressure: 180.000 (MPa)



Fill time for tapered runner geometry



Fill time for varying diameter runner geometry

Pricing Strategy for the Mold Designs Proposed:-

Sample calculations for a Mold Design depicting the parameters on which the pricing strategy is dependent on.

Automated Cost Estimation for Mold Manufacturing								
						RATE		COST
1	**Geometric Model**							
	A	Volume of Bounding Box	333200	mm^3		5	/1000mm^3	166.6
	B	Volume of Model	43884.5	mm^3		5	/1000mm^3	21.94225
	C	Total Surface Area	27338.6	mm^2		10	/1000mm^2	273.386
	D	Number of Features	1			10	/feature	10
2	**Documentation**							
	A	Drawing	1			100	/drawing	100
3	**Mold Design**							
	A	Number of Parts	3			500	/part	1500
4	**Part Program generation**							
			no. of operations					
		mold vol 1	2			50	/operation	100
		mold vol 2	3			50	/operation	150
		mold vol 3	2			50	/operation	100
4	**Machining Time**							
	A	MRR Volume						
		radius(Cylindrical W/P)	32	mm				
		block length(Rectangular W/P)	170	mm				
			model volume(mm^3)	workpiece volume(mm^3)	volume to be machined(mm^3)			
		mold vol 1	1192208	1268132	75924	10	/1000mm^3	759.24
		mold vol 2	1752375	1910868	158493	10	/1000mm^3	1584.93
		mold vol 3	185053	228406.3523	43353.35229	10	/1000mm^3	433.5335
	B	Machining Time Based on Simulation	10	hrs		100	/hour	1000
5	**Material cost**							
		to be provided by customer/actual market						
							TOTAL	6199.632