

# **TMS** **CADCentre**

## **SOLIDWORKS®**

### **Plastics**



# Contents

## Introduction

About This Course .....	2
Prerequisites .....	2
Course Design Philosophy .....	2
Using this Book .....	2
About the Training Files .....	3
Windows .....	3
Conventions Used in this Book .....	3
Use of Color .....	4
More SOLIDWORKS Training Resources .....	4
Local User Groups .....	4
Injection Molding .....	5
Fill Stage .....	5
Pack Stage .....	6
Cool Stage .....	6
Ejection .....	6
SOLIDWORKS Plastics .....	7
SOLIDWORKS Plastics Standard .....	8
SOLIDWORKS Plastics Professional .....	8
SOLIDWORKS Plastics Premium .....	8
This Course .....	8

## Lesson 1: Basic Fill Analysis

Basic Fill Analysis .....	10
Stages in the Process.....	10
New Study.....	12
Injection Process.....	12
Number of Injection Units .....	12
Element Types.....	13
Shell Elements .....	13
Solid Elements .....	13
Units .....	13
User Interface .....	14
Injection Units.....	15
Material.....	15
Plastic Material Database .....	16
Boundary Conditions .....	17
Injection Location.....	17
Create Mesh .....	18
Simulation Type .....	20
Cool.....	20
Fill.....	21
Pack.....	21
Warp .....	21
Run .....	21
Fill Results .....	23
Fill Time .....	23
Weld Lines .....	25
Results Adviser.....	26
Exercise 1: Basic Fill Analysis.....	28

## Lesson 2: Detecting a Short Shot

Detecting Short Shots .....	32
Stages in the Process.....	32
Fill Properties .....	33
Defining Fill Properties .....	34
Filling Time and Injection Pressure Considerations.....	34
Report Text File .....	37
Flow Front Central Temperature.....	38
Pressure at End of Fill.....	38
Configurations .....	39
Thickness Change.....	39
Exercise 2: Short Shots.....	42

### Lesson 3: Automation Tools

Automation Tools . . . . .	46
Stages in the Process . . . . .	46
Duplicate Study . . . . .	47
Plastics File Management . . . . .	48
Batch Manager . . . . .	48
Batch Controls . . . . .	49
Compare Results . . . . .	50
Summary . . . . .	51
Report . . . . .	52
Exercise 3: Design Changes . . . . .	55

### Lesson 4: Injection Locations and Sink Marks

Injection Locations and Sink Marks . . . . .	58
Stages in the Process . . . . .	58
Injection Location Rules . . . . .	59
Positioning the Injection Location . . . . .	59
Single vs. Multiple Injection Locations . . . . .	59
Predict Fill Pattern . . . . .	60
Injection Location Advisor . . . . .	61
Sink Marks . . . . .	65
Visibility Commands . . . . .	66
Visibility Command Types . . . . .	66
Measure . . . . .	67
Minimizing Sink Marks in Ribs . . . . .	68
Nominal Wall Thickness Advisor . . . . .	70
Exercise 4: Minimizing Sink Marks (1) . . . . .	71
Exercise 5: Minimizing Sink Marks (2) . . . . .	76

### Lesson 5: Materials

Material Properties . . . . .	80
Stages in the Process . . . . .	80
User-defined Database . . . . .	80
Material . . . . .	80
Resin Properties . . . . .	82
Temperature Properties . . . . .	83
Melt Temperature . . . . .	83
Mold Temperature . . . . .	83
Ejection Temperature . . . . .	83
Polymer Types . . . . .	83
Thermoplastic . . . . .	83
Thermoset . . . . .	83

Thermal Properties . . . . .	84
Specific Heat . . . . .	84
Thermal Conductivity . . . . .	85
Rheological Properties . . . . .	85
Transition Temperature . . . . .	85
No-Flow Temperature . . . . .	85
Juncture Loss Coefficients . . . . .	85
Viscosity . . . . .	85
PVT Data . . . . .	87
Thermo-mechanical Properties . . . . .	88
Thermal Expansion Coefficient . . . . .	88
Elastic Modulus . . . . .	88
Poisson's Ratio . . . . .	88
<b>Lesson 6:</b>	
<b>Mesh Manipulation</b>	
Mesh Manipulation . . . . .	92
Stages in the Process . . . . .	92
Local Mesh Refinement . . . . .	95
Advanced Mesh Control and Options . . . . .	96
Edit/Review . . . . .	98
Mesh . . . . .	98
Mesh Analysis . . . . .	98
Mesh Triangles . . . . .	99
Mesh Nodes . . . . .	99
Element Issues . . . . .	100
Leader Lines . . . . .	101
Edit Study . . . . .	105
Solid Mesh . . . . .	107
Solid and Shell Mesh . . . . .	107
Tetrahedral Elements . . . . .	107
Hexahedral Elements . . . . .	107
Specifying the Mesh Type . . . . .	107
Solid Mesh Size . . . . .	110
Hybrid Tetrahedral Parameters . . . . .	110
Hexahedral Parameters . . . . .	110
Exercise 6: Mesh Repairs . . . . .	112

## Lesson 7: Detecting Air Traps

Detecting Air Traps . . . . .	118
Stages in the Process . . . . .	118
Air Traps . . . . .	120
Dieseling Effect . . . . .	120
Plot Ranges . . . . .	120
Thickness Analysis . . . . .	121
Venting . . . . .	124
Venting Analysis . . . . .	124
Venting Locations . . . . .	124
Solver Settings . . . . .	124
Exercise 7: Air Traps . . . . .	128

## Lesson 8: Gate Blush

Gate Blush . . . . .	134
Stages in the Process . . . . .	134
Runner Elements . . . . .	135
Domains . . . . .	135
Gate Blush . . . . .	137
Shear Stress . . . . .	137
Reducing Gate Blush . . . . .	137
Exercise 8: Birefringence . . . . .	141
Birefringence . . . . .	141
Preprocessing Birefringence . . . . .	141
Post-Processing Birefringence . . . . .	143

## Lesson 9: Packing and Cooling Times

Packing and Cooling . . . . .	146
Stages in the Process . . . . .	146
Flow/Pack Switch . . . . .	147
Pack Stage . . . . .	148
Pack Settings . . . . .	148
Pack Analysis . . . . .	149
Pack Results . . . . .	149
X-Y Plot . . . . .	150
Volumetric Shrinkage at End of Packing . . . . .	151
Clipping Plane Mode . . . . .	153
Setting the Clipping Planes . . . . .	153
Isosurface Mode . . . . .	153
Cooling Times . . . . .	153
Temperature at Post-Filling End . . . . .	153
Nodal Temperature . . . . .	156
Exercise 9: Packing and Cooling Times . . . . .	157
Exercise 10: Configuring Multiple Gates . . . . .	160
Exercise 11: Birefringence Pack Analysis . . . . .	165

## Lesson 10: Multiple Cavity Molds

Multiple Cavity Molds . . . . .	170
Stages in the Process. . . . .	170
Mold Layouts . . . . .	171
Runner System . . . . .	172
Runner Channel Design . . . . .	173
Runner Types . . . . .	173
Searching for Polymers. . . . .	175
Clamping Force. . . . .	177
Clamp Force Limit . . . . .	177
Clamp Force Command . . . . .	177
Family Mold Layout. . . . .	181
Using Runner-Balancing. . . . .	183
Exercise 12: Multiple Cavity Molds. . . . .	187
Exercise 13: Runner-Balancing . . . . .	189
Exercise 14: Clamp Force. . . . .	191

## Lesson 11: Symmetry Analysis

Symmetry Analysis. . . . .	194
Stages in the Process. . . . .	194
Symmetry . . . . .	196
Cyclic Symmetry . . . . .	198
Cyclic . . . . .	199
Exercise 15: Half Symmetry. . . . .	201
Exercise 16: Symmetry Face . . . . .	204
Exercise 17: Cyclic Solid . . . . .	209
Exercise 18: Symmetric Jetting . . . . .	211

## Lesson 12: Valve Gates and Hot Runners

Valve Gates and Hot Runners. . . . .	216
Stages in the Process. . . . .	216
Hot Runners . . . . .	217
Valve Gates . . . . .	217
Control Valve . . . . .	218

## Lesson 13: Reaction Injection Molding

Reaction Injection Molding . . . . .	222
Stages in the Process. . . . .	222
Reaction Injection Molding . . . . .	223
Thermoset Material Ejection Criteria . . . . .	225
Exercise 19: Reaction Injection Molding . . . . .	229

## Lesson 14: Using Inserts

Using Inserts . . . . .	234
Stages in the Process . . . . .	234
Inserts . . . . .	235
Metal Material Database . . . . .	235
Insert Settings . . . . .	237
Hiding Cavities and Inserts . . . . .	240

## Lesson 15: Multi Material Overmolding

Multi Material Overmolding . . . . .	242
Stages in the Process . . . . .	242
Multi Material Overmolding . . . . .	243
Assigning Injection Units . . . . .	244

## Lesson 16: Co-Injection Molding

Co-Injection Molding . . . . .	248
Stages in the Process . . . . .	248
Thick Parts . . . . .	249
Co-Injection . . . . .	249
Gas-Assist . . . . .	249
Water-Assist . . . . .	249

## Lesson 17: Bi-Injection Molding

Bi-Injection Molding . . . . .	254
Stages in the Process . . . . .	254
Copy and Paste . . . . .	255
Bi-Injection . . . . .	255
Injection Start Value . . . . .	258

**Lesson 18:  
Cooling Analysis**

Cooling Analysis. . . . . 260  
 Stages in the Process. . . . . 260  
 Cooling . . . . . 261  
     Cool Simulation . . . . . 261  
 Cooling Channels and Mold Bodies . . . . . 261  
 Baffle. . . . . 263  
 Bubbler . . . . . 263  
 Cooling Simulations . . . . . 266  
     Coolant Input . . . . . 266  
     Mold Wall Temperature . . . . . 266  
 Coolant . . . . . 268  
 Mold . . . . . 268  
 Cool Parameters . . . . . 269  
     Other Parameters. . . . . 269  
 Cool Analysis . . . . . 271  
     Cool. . . . . 271  
 Cool Results . . . . . 271  
 Exercise 20: Cooling Analysis . . . . . 274

**Lesson 19:  
Warpage Analysis**

Warpage Analysis . . . . . 278  
 Stages in the Process. . . . . 278  
 Shrinkage . . . . . 283  
     Reducing Shrinkage . . . . . 283  
 Warpage . . . . . 283  
 Warp Parameters . . . . . 283  
 Warp Results . . . . . 285  
 Reducing and Fixing Warped Parts. . . . . 287  
     Thermal Contributions to Warping. . . . . 287  
     Typical Warp Shapes . . . . . 287  
     Residual Stress . . . . . 291