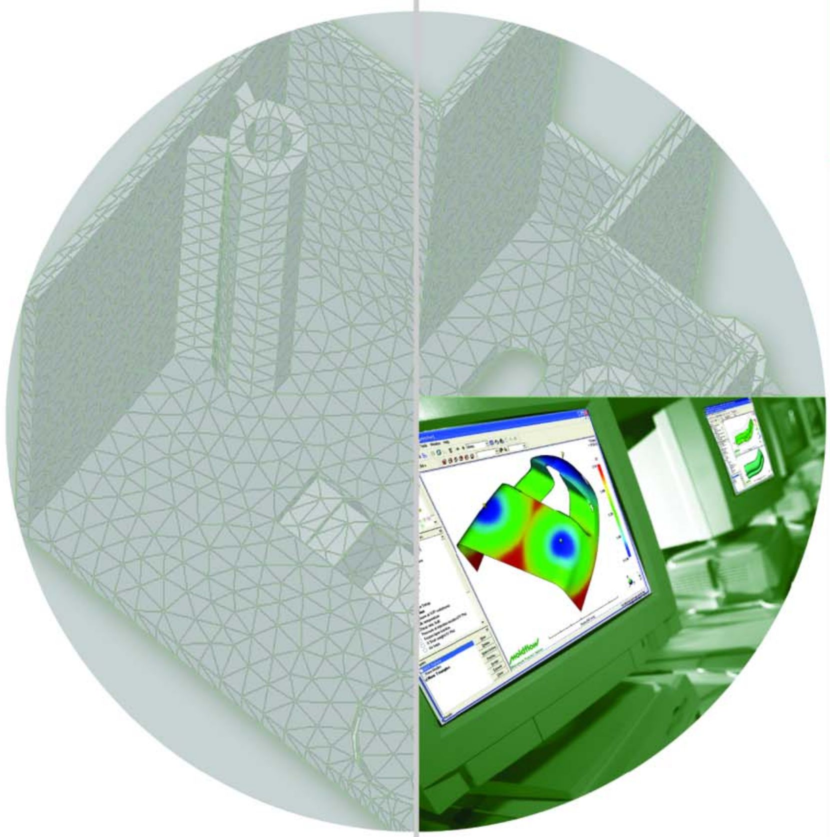
Moldflow Plastics Insight®

Release 6.0



Simulation Fundamentals Training PowerPoint Slides

MOLDFLOW PLASTICS INSIGHT

Course Introduction and Company Review

Simulation Fundamentals

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Personal Introduction

- Attendees in Class
  - Name
  - Company, Position
  - Used flow analysis before?
    - MPA
    - MPI
    - Others
  - Used finite element analysis
  - Experience with
    - Materials
    - Part design
    - Tooling
      - Design
      - Building
    - Processing
  - MPI Modules used
    - Flow
    - Cool
    - Warp
    - Fiber
    - MDL
    - Fusion
    - 3D
  - What CAD systems are used
  - Hardware used
  - Reason for taking training course

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Schedule of the Training Course

- Monday
  - Company Overview
  - Injection Molding Overview
  - Finite Element Overview
  - Design Principles
  - Synergy Interface Review
  - How to Use Help
  - A Quick Cool Flow Warp Analysis
  - Flow Analysis Steps
- Tuesday
  - Model Requirements
  - Model Translation & Cleanup
  - Modeling Tools
  - Using Magics STL Expert
  - Using CAD Dr.
  - Material search
  - Gate Placement

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Schedule of the Training Course

- Wednesday
  - Molding Window Analysis
  - Fiber Filling and Packing Analysis
  - Results Interpretation and Customization
  - Runner and Gate Design
- Thursday
  - Basic Packing
  - Valve Gates
  - Flow Leaders
  - Flow Analysis Process Settings
  - Create Reports
  - Moldflow Communicator
  - Job Manager
- Friday
  - Guided project

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Global Operations

- Corporate Headquarters
  - Framingham Massachusetts (US)
- Development offices
  - Melbourne Australia
  - Ithaca, New York (US)
  - Los Angeles, California (US)
  - London England
- Sales offices, Design
  - US, 6
  - Europe, 8
  - Asia, 4
- Sales offices, Manufacturing
  - Americas, 8
  - Europe, 5
  - Asia, 1

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Design Analysis Solutions

- Moldflow Plastics Advisers
  - Part and Mold Design for Manufacturability
- Moldflow Plastics Insight
  - In-depth Part and Mold Design Optimization
- CAD Connectivity
  - Moldflow Design Link
  - Moldflow Magics STL Expert
  - Moldflow CAD Doctor
  - Moldflow Midplane Generator

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Moldflow Manufacturing Solutions

- Manufacturing Execution Systems
  - Shotscope
    - Process monitoring and analysis
  - CellTrack™
    - Tracks and reports production and machine efficiencies

- Factory Automation
  - Moldflow Plastics Xpert
    - Process setup, optimization, monitoring
  - Altanium
    - Hot runner process control

Moldflow Plastics Insight

- MPI/Flow
- MPI/Cool
- MPI/Warp
- MPI/Fiber
- MPI/Gas
- MPI/Optim
- MPI/Mucell
- MPI/Co-Injection
- MPI/Injection Compression
- MPI/Shrink
- MPI/Stress
- MPI/Reactive Molding
- MPI/Microchip Encapsulation
- MPI/Underfill Encapsulation

All MPI modules based on Midplane mesh

MPI/Fusion and MPI/3D add different mesh type analysis capability

Supported Molding Processes and Mesh Types

Thermoplastics Injection Molding	Mesh Type		
	Midplane	Fusion	3D
Fast Filling	✓	✓	
Fill	✓	✓	✓
Flow	✓	✓	✓
Core Shift	✓	✓	✓
Standalone Packing			✓
Fiber Flow	✓	✓	✓
Cooling	✓	✓	✓
Warpage	✓	✓	✓
Stress	✓		

Supported Molding Processes and Mesh Types

Thermoplastics Injection Molding	Mesh Type		
	Midplane	Fusion	3D
Shrinkage	✓	✓	
Process Optimization	✓	✓	
Design of Experiments	✓	✓	
Molding Window	✓	✓	
Gate Location	✓	✓	
Runner Balance	✓	✓	

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Supported Molding Processes and Mesh Types

Thermoplastics Overmolding	Mesh Type		
	Midplane	Fusion	3D
Fill	✓	✓	✓
Flow	✓	✓	✓
Fiber Flow	✓	✓	✓
Overmolding	✓	✓	✓
Overmolding Warpage			✓

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Supported Molding Processes and Mesh Types

Microcellular Injection Molding (Thermoplastics)	Mesh Type		
	Midplane	Fusion	3D
Fill	✓	✓	
Flow	✓	✓	
Fiber Flow	✓	✓	
Cooling	✓	✓	
Warpage	✓	✓	

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Supported Molding Processes and Mesh Types

Co-Injection Molding (Thermoplastics)	Mesh Type		
	Midplane	Fusion	3D
Flow	✓		
Fiber Flow	✓		
Cooling	✓		
Warpage	✓		
Stress	✓		

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Supported Molding Processes and Mesh Types

Gas-Assisted Injection Molding (Thermoplastics)	Mesh Type		
	Midplane	Fusion	3D
Fill	✓		✓
Flow	✓		✓
Fiber Flow	✓		✓
Cooling	✓		
Warpage	✓		
Stress	✓		

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Supported Molding Processes and Mesh Types

Injection-Compression Molding (Thermoplastics)	Mesh Type		
	Midplane	Fusion	3D
Flow	✓		
Fiber Flow	✓		
Cooling	✓		
Warpage	✓		
Stress	✓		

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Supported Molding Processes and Mesh Types

Microchip Encapsulation (thermosets)	Mesh Type		
	Midplane	Fusion	3D
Flow	✓	✓	✓
Wire Sweep	✓	✓	✓
Paddle Shift	✓	✓	✓
Dynamic Paddle Shift			✓
Warpage			✓
Runner Balance	✓	✓	

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Supported Molding Processes and Mesh Types

Reactive Molding (thermosets)	Mesh Type		
	Midplane	Fusion	3D
Flow	✓	✓	✓
Runner Balance	✓	✓	
Multiple Injection Barrel Flow	✓		
Warpage			✓

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Supported Molding Processes and Mesh Types

RTM/SRIM (thermosets)	Mesh Type		
	Midplane	Fusion	3D
Flow	✓	✓	✓
Runner Balance	✓	✓	
Underfill Encapsulation (thermosets)			
Flow	✓	✓	✓

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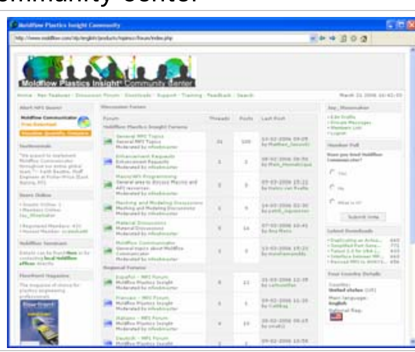
Moldflow Services

- Training
  - Kalamazoo, MI
  - Framingham, MA
  - Web based
  - Self-paced
  - On-Site
- www.moldflow.com
- Customer Support
  - Methods
    - Phone
      - 1-800-284-FLOW
    - Email
      - Support@moldflow.com
    - Moldflow Community Center
      - From Synergy
        - Help ➡ Moldflow On the Web ➡ Moldflow community Center
  - About
    - How to
    - Software usage
    - Installation
  - On-Site

www.moldflow.com

Moldflow Community Center

- Updated daily
- Tips
- Discussion forum
- Downloads



Moldflow Community Center

- Submit support cases
- Manage cases
- Search for solutions
- Download revisions
- Documentation
- Training information

Moldflow Curriculum

- MPI
  - Simulation Fundamentals
  - Advanced Simulation: MPI/Flow
  - Advanced Simulation: MPI/Cool
  - Advanced Simulation: MPI/Warp
- MPA
  - Mold Adviser
  - Part Adviser

Moldflow Certification

- User
  - Bronze
    - After Simulation Fundamentals
  - Silver
    - After Advanced Classes
  - Gold
    - After silver for a year
- Company
  - After users are silver certified

Certifying the Student

- Student attends MPI, course
- Passes (80%) an exam
- Gets "personal" certification
  - Simulation Fundamentals
  - MPI/Flow
  - MPI/Cool
  - MPI/Warp
- Valid for 2 years
- No cost for certification exam

Resources Available

- The training manual
- On-line help
- Other members of your class
- The instructor
- The internet
  - Moldflow Community Center

QUESTIONS?

Injection Molding Overview

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Introduction

- Aim
  - The aim of this chapter is to review
    - The injection molding process
    - Flow behavior of thermoplastics in injection molds
- Why do it
  - Understanding injection molding and flow behavior is critical for proper use of MPI

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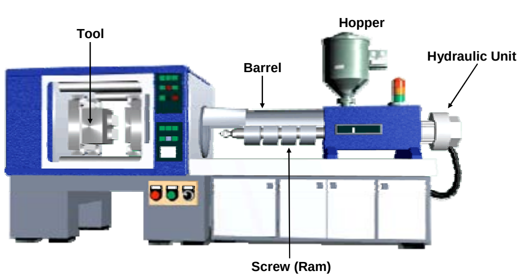
Injection Molding Machine



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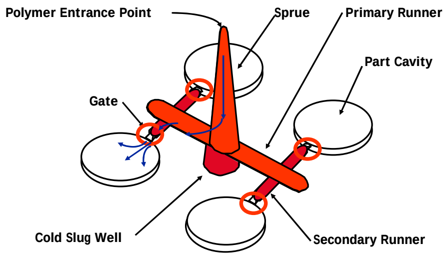
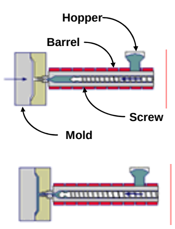
Injection Molding Terminology

Mold Components



Injection Molding Process

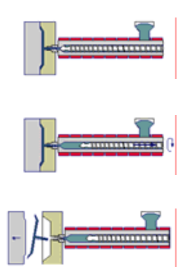
- Filling
  - Mold closes
  - Screw forward
  - Frozen polymer skin forms at mold walls
- Packing Time
  - Cavity filled
  - Pressure applied to polymer
  - Cooling occurs
  - Gate freezes



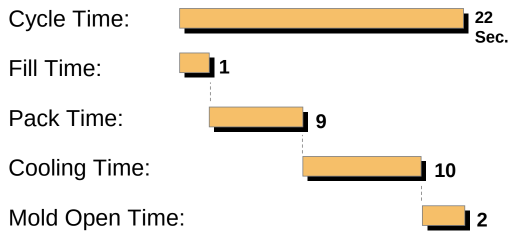
Screw is applying a specified pressure to the polymer melt in order to pack more plastic into the cavity.

Injection Molding Process

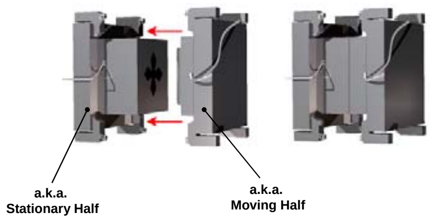
- Cooling
  - Part continues to cool until rigid enough to withstand ejection
  - Screw moves back plasticating resin for next shot
- Mold Open
  - Part is ejected



Injection Molding Cycle



The Injection Mold



Injection Pressure

- Pressure is required to push the plastic into the mold cavity
- Limited by machine capability
  - Hydraulic pump limitations
  - Usually around 140 – 180 MPa
  - Modern machines can go up to 300 MPa
- Major influence on final part dimensions

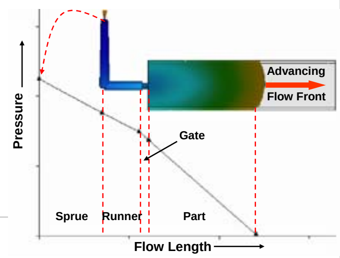
Variables Affecting Injection Pressure

- Part Design
- Mold Design
- Processing Conditions
- Material Selection

- Each area is affected by other areas
- Some are easily changed, while others are not

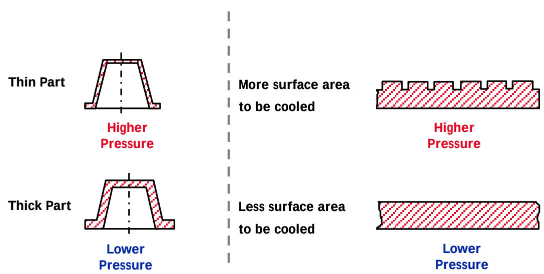
Pressure - Drives Flow

- Flow is driven by pressure
  - Overcomes the melt's resistance to flow
- Plastics flow from high to low pressure areas
- Pressure decreases along the flow length



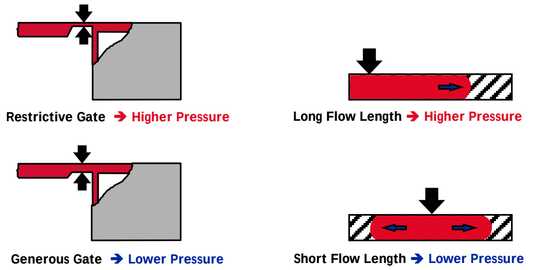
Part Design Affecting Injection Pressure

- Part Thickness
- Surface Area



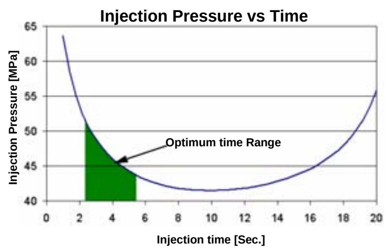
Mold Design Affecting Injection Pressure

- Gate size
- Flow length (gate location)



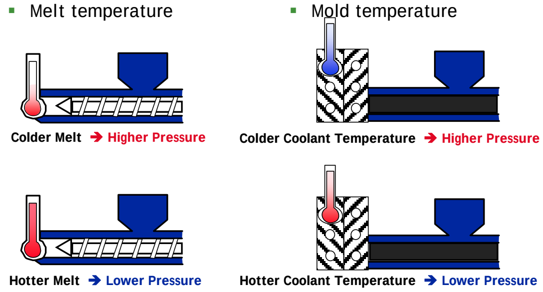
Processing Conditions Affecting Injection Pressure

- Fill time



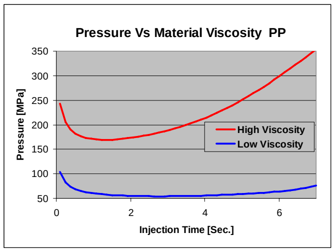
Processing Conditions Affecting Injection Pressure

- Melt temperature
- Mold temperature



Material Selection Affecting Injection Pressure

- Different grades of the same material can have widely different pressure requirements



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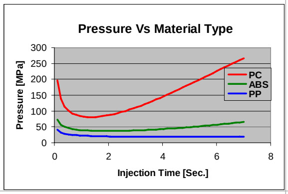
Material Selection Affecting Injection Pressure

- Material selection affects injection pressure
  - Different materials have different required pressures
- Resin Flow Properties
  - Low melt index g/10 min = higher pressure
  - High melt index g/10 min = lower pressure



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Factors Affecting Injection Pressure

Variable	Change	Inj. Press.
Part Thickness	Thin	⇧
	Thick	⬇
Surface Area	High	⇧
	Low	⬇
Gate Size	Small	⇧
	Large	⬇
Flow Length	Long	⇧
	Short	⬇
Fill Time	Too Short	⇧
	Too Long	⇧
	Optimal	⬇
Melt Temperature	Low	⇧
	High	⬇
Mold Temperature	Low	⇧
	High	⬇
Velocity Profile	Improper	⇧
	Optimal	⬇
Melt Index	Low	⇧
	High	⬇
Viscosity	Low	⬇
	High	⇧

⇧ Requires Higher Injection Pressure

⬇ Requires Lower Injection Pressure

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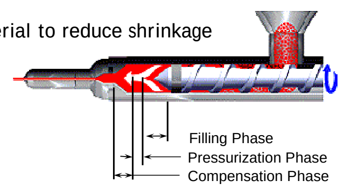
Flow Behavior

What Does a Plastic Molecule Do in an Injection Mold?

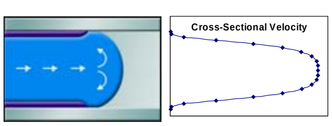
Phases of Molding

- Filling
  - Volumetrically fill the cavity
- Pressurization
  - Build up pressure in the cavity
- Compensation
  - Add extra material to reduce shrinkage



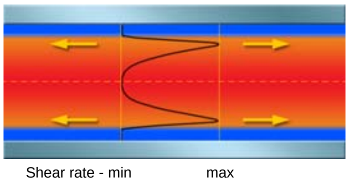
Fountain Flow

- Fastest flow rate is in the center of the cross section
- First material in forms frozen skin by the gate
- Last material in is the center of the cross-section
- Has direct influence on molecular and fiber orientation



Cross-Sectional Flow & Molecular Orientation

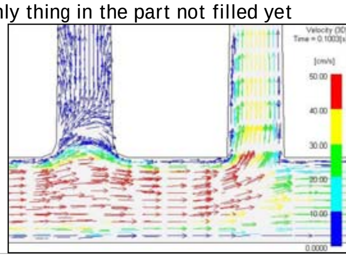
- Molecular orientation is caused by shear flow
- The highest amount of shear is inside the frozen layer
  - Produces the highest orientation



Cross-Sectional Flow

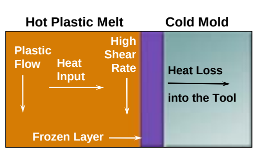
- 3D Flow analysis
  - Left rib is filled
  - Right rib is the only thing in the part not filled yet

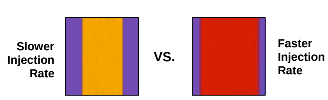
Scaled so velocities higher than 50 are red



Cross-Sectional Heat Transfer

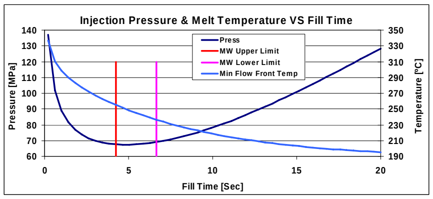
- Should be a balance between
  - Heat input from shear
  - Heat loss to the tool





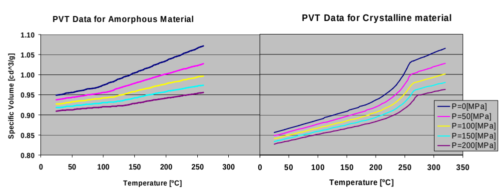
Pressure and Temperature vs Time

- Pressure will always be a “U” shaped curve
- Temperature will always fall with as injection time increases
- Optimum molding window has flow front temp near melt temp



Specific Volume –pvT Diagram

- Displays relationship of a range processing melt temperatures and pressures over the specific volume



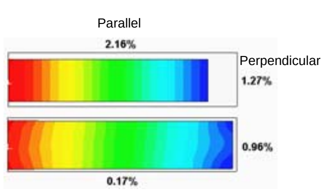
Shrinkage

- Normally
  - Unfilled materials, shrink most in flow direction
  - Filled materials, shrink most perpendicular to flow direction

Same material and processing for both parts.

Top part not considering glass fibers.

Bottom part calculated with fiber orientation.



QUESTIONS?

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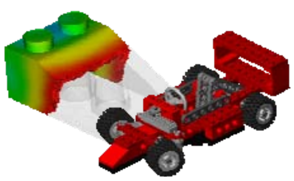
Finite Element Analysis Overview



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Introduction

- Aim
  - Review the finite element meshes used by MPI
- Why do it
  - MPI uses 3 mesh types all have
    - Advantage
    - Disadvantages
  - Understanding the mesh types and capability is critical for their proper application

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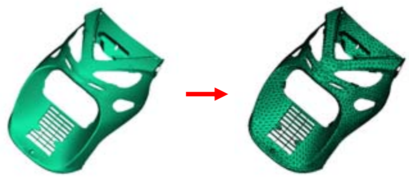
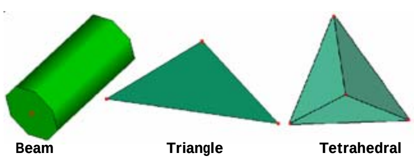
Terminology

- Mesh
  - Division of the physical domain into a number of sub-domains, or elements



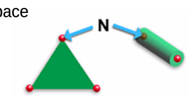
Terminology

- Element
  A single sub-domain of a finite element mesh
- Elements used in Moldflow software are:
  - Two-node linear elements (beams)
  - Three-node triangular elements (shell)
  - Four-node tetrahedral elements (3D)

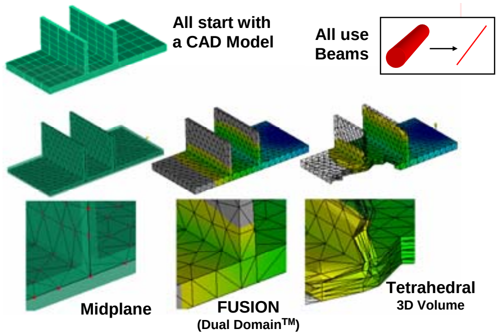


Terminology

- Node
  - Used in a model to
    - Determine a coordinate position in space
    - Assign
      - An injection location
      - A coolant inlet
  - In a mesh
    - Nodes are the vertices of Midplane, Fusion, and 3D mesh elements and the ends of beam elements
    - Certain analysis results are recorded at mesh nodes



Mesh Types Used in Moldflow

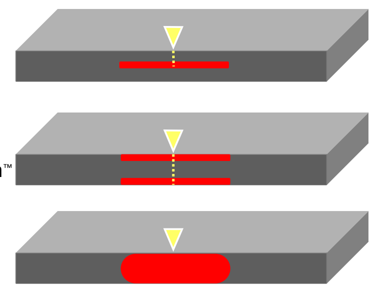


Mesh Types

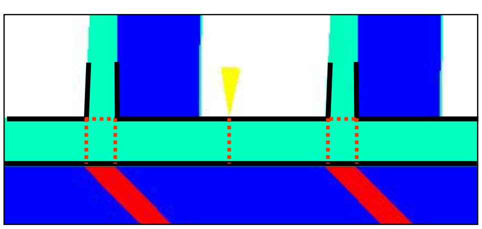
Midplane

Fusion
Dual Domain™

3D Solid



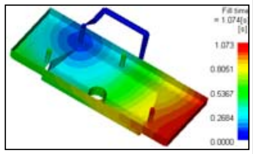
FUSION: Dual Domain™ Mesh



Connector elements synchronize prediction:
Consistency between the results on the opposite sides is matched by using "connectors" - elements with zero flow and heat resistance.

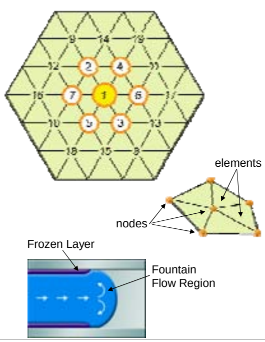
Midplane and Fusion Mesh Assumptions

- For **thin-walled** parts
  - Flow width should be at least 4 times the thickness
- Uses generalized Hele-Shaw model
  - Laminar flow of generalized Newtonian fluid
  - Inertia and gravity effects are ignored
  - In plane heat conduction is negligible
  - Thermal convection in gapwise (thickness) direction neglected
  - Heat loss from edges ignored
- Flow analyses includes
  - Fill
  - Flow (Fill + Pack)
  - Gate Location
  - Molding Window
  - Runner Balance
  - DOE



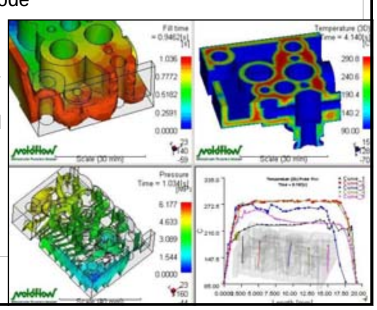
How Fusion & Midplane Calculate Flow Front Growth

- From injection node
  - The flow front grows to connected nodes
- When a node fills other nodes are added
- Melt temperature is homogeneous entering the mold
- Polymer freezes as it hits the mold wall

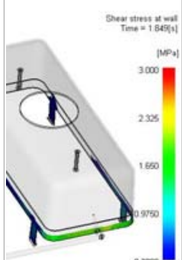


3D Mesh Assumptions

- Designed for thick and "Chunky" geometries
- Uses full 3D Navier-Stokes model
  - Solves at each node
    - Pressure
    - Temperature
    - Velocity, X, Y, Z
  - Considers heat conduction in all directions
  - Optional
    - Inertia
    - Gravity



QUESTIONS?



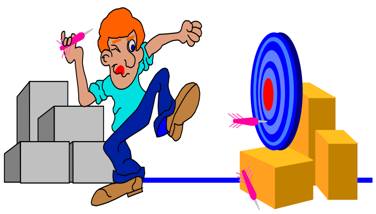
Moldflow Design Principles

Introduction

- Aim
  - Review the Moldflow Design Principles
  - Used with MPI
- Why do it
  - MPI analyzes molding issues
    - Addressed in the Moldflow Design Principles
  - Following Moldflow Design Principles reduces problems
    - Part design
    - Mold design
  - Makes parts easier to mold

Design Principles

- Use Design Principles and Moldflow technology so you don't have to do this:



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Design Principles

- Unidirectional and controlled flow pattern
- Flow balancing
- Constant pressure gradient
- Maximum shear stress
- Uniform cooling
- Positioning weld and meld lines
- Avoid hesitation effects
- Avoid underflow
- Balancing with flow leaders and flow deflectors
- Controlled frictional heat
- Thermal shut off for runners
- Acceptable runner/cavity ratio

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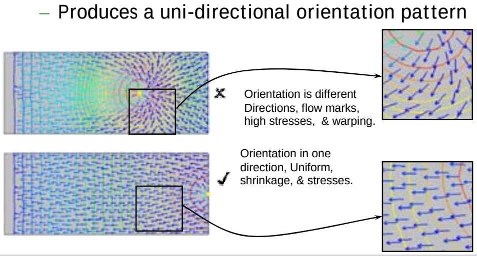
Unidirectional and Controlled Flow Pattern

- Plastic should flow in one direction with a straight flow front throughout filling
  - Produces a uni-directional orientation pattern



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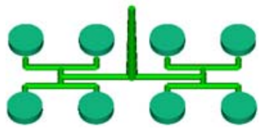
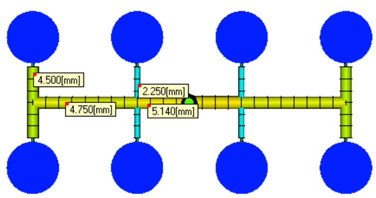
Flow Balancing

- All flow paths within a mold should be balanced,
  - Equal fill time and pressure
- Naturally balanced runner system
  - Also called geometrically balanced
  - Same distance and conditions between the nozzle and all cavities
  - All cavities filling at the same time pressure and temperature



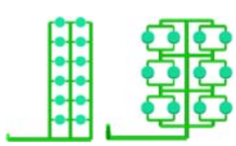
Flow Balancing

- Artificially balanced runner system
  - Flow length is different between sprue and the parts
  - Sizes of the runners are different
  - All cavities at the same pressure & time



Flow Balancing

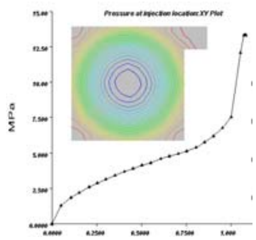
- Artificially balanced runners
  - Limitations:
    - Very small parts
      - Pressure to fill runners is higher than parts
    - Parts with very thin sections
    - Parts where sink marks are important
    - Smaller molding window than naturally balanced system
  - The higher the ratio of runner lengths
    - More difficult to balance



Constant Pressure Gradient

- Most efficient filling pattern has a constant pressure gradient
  - Pressure drop per unit length
  - Spikes normally indicate a balance problem

Pressure spikes at the end of fill due to shrinking flow front



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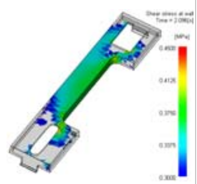
Maximum Shear Stress

- Shear stress during filling should be less than the critical level
  - Value of critical level depends on the material and application
  - Generic limit in material database
  - Shear Stress at the wall refers to the frozen/molten layer interface
    - This will be the maximum shear stress in the cross section

Material: ABS
Stress Limit: 0.3 MPa
Stress is plotted above the material limit



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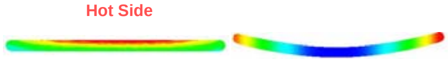
Uniform Cooling

- Molded parts should be cooled uniformly cavity to core
- When non-uniform cooling occurs parts bow to the hot side
  - Molecules on hot side of the tool have longer time to cool so they shrink more

Hot Side



Cold Side

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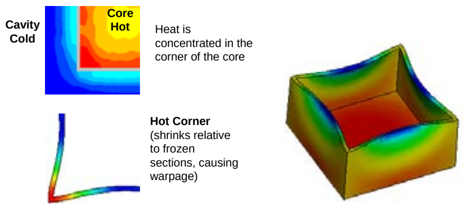
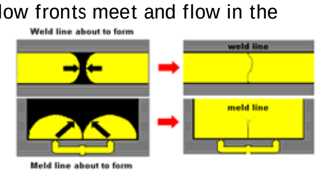
Uniform Cooling

- On box-like structures
  - If the inside corner is hot the walls will bow in towards the inside



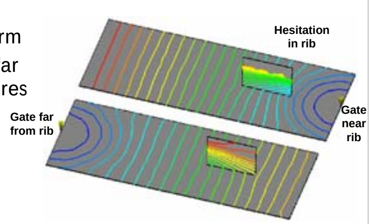
Weld and Meld Lines

- Eliminate if possible
- Position in the least sensitive areas,
- Weld Lines
  - Formed when two flow fronts meet head on
- Meld Lines
  - Formed when two flow fronts meet and flow in the same direction



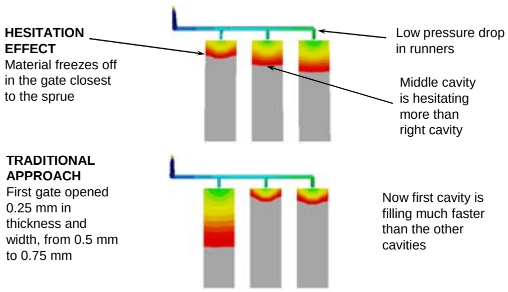
Hesitation Effects

- Slowing down of the flow front
- Limiting hesitation
  - Make wall thickness uniform
  - Position gates far from thin features
  - Fill faster



Avoid Hesitation Effects

DON'T use gate size to balance cavities



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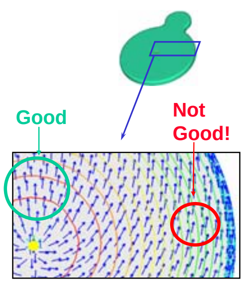
Avoid Underflow

- A change in flow direction between the time an area fills and the end of fill
- The **blue** velocity angle arrows should be perpendicular to the **multi-color** fill contour lines



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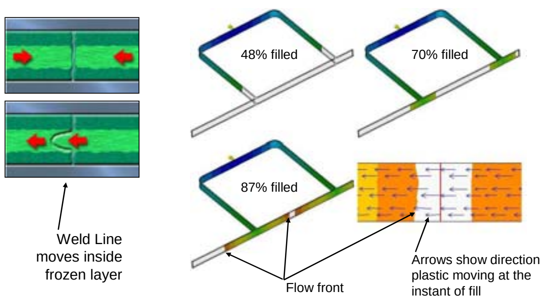
Avoid Underflow



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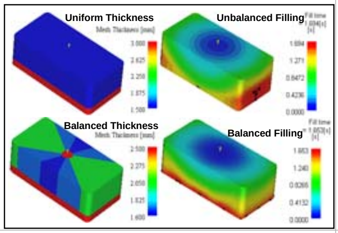
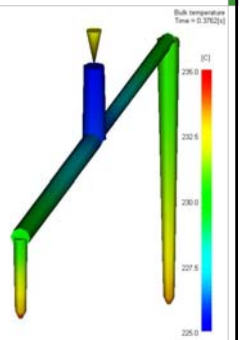
Flow Leaders and Flow Deflectors

- Subtle increase “leader”
- Subtle decrease “deflector”
- Influence the filling pattern
  - Create a balanced fill within the part
  - Move weld lines



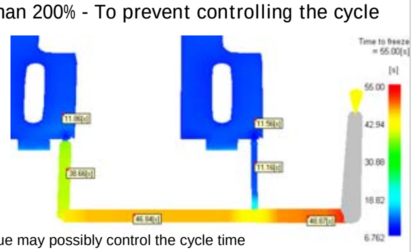
Controlled Frictional Heat

- Runners should be sized so there is shear heat in the runner
  - Reduces part
    - Fill pressure
    - Shear stress
  - Reduces melt temperature at machine nozzle
- Optimize temperature at part
- Reduce temperature at sprue so temp at part correct



Thermal Shutoff of Runners

- Runners should freeze relative to the part freeze
  - No less than 80% - To prevent packing problems
  - No more than 200% - To prevent controlling the cycle time

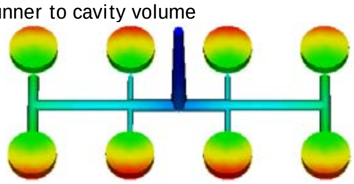


Smallest runner is OK
Largest runner and sprue may possibly control the cycle time

Acceptable Runner/Cavity Ratio

- Design runner systems for high pressure drops
  - Minimizes material in the runner
  - Lower ratio runner to cavity volume

The volume of the runners should be 20% or less of the part volume



Volume of parts: 5.4 cc
Volume of feed system: 4.6 cc
Feed system: 85% of part volume

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QUESTIONS?

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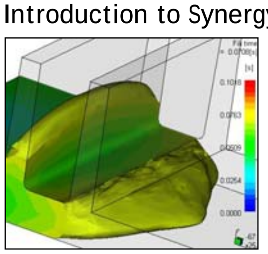
Introduction to Synergy



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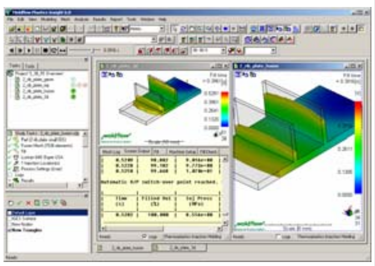
Introduction

- Aim
  - Learn the features of Synergy
- Why do it
  - Synergy is the pre and post processor for MPI
- Overview
  - Introduce
    - Main components of user interface
    - Creating and opening projects
    - Preferences
    - Entity selection
    - Properties
    - Model manipulation

MPI/Synergy

- Single environment for all pre-processing and post-processing tasks



Starting Synergy

- Desktop icon
- Start menu
  - All programs ➡ Moldflow Plastics Insight 6.0 ➡Plastics Insight 6.0

MPI/Synergy User Interface Components

- Several main components
  - Main menu
  - Context menu
  - Toolbars
  - Panels
  - Display window
  - Wizards

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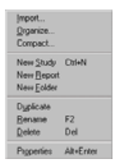
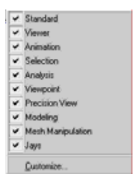
Menus & Toolbars

- Menu
  - Main
  - Context
    - Activated on right click
    - Different depending on where activated
- Toolbar
  - Group of icons that perform a task





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Toolbar Customization

- Toolbar Appearance
  - Flat icons
  - Large Buttons
- Toolbar Customization
  - Drag the button to any toolbar
  - Modify existing toolbars or create your own
- Docking

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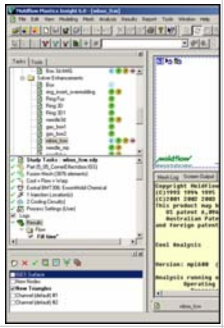
Panels

- Left side of Window
- Uninterrupted view of display area
- Tabs
  - Tasks
    - Project pane
    - Study tasks
  - Tools
    - Geometry creation
    - Mesh Editing
    - Diagnostics



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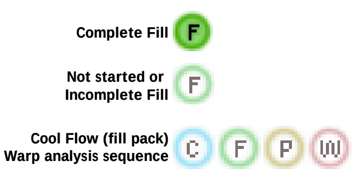
Project Pane

- Manages studies (models)
- Can have sub folders
- Lists analysis sequence for each study



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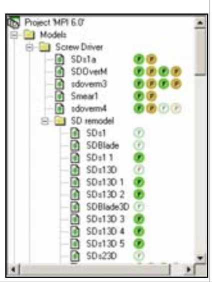
Studies

- Contain all information necessary for analysis
  - Imported or created geometry
  - Finite element mesh
  - Analysis sequence
  - Material information
  - Injection location(s)
  - Process settings
- Open
  - Double click
  - Drag and drop
- File extension *.sdy



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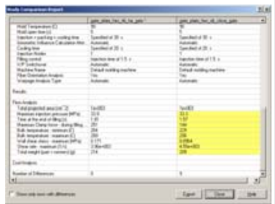
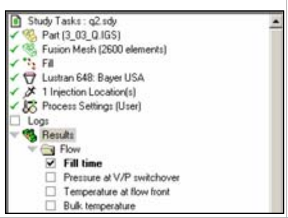
Compare Studies

- Two or more studies can be compared
- Select the studies in the Project View
- Right click and select Compare Studies
- Yellow fields are different from the first study



Study Task List

- Open and active studies have a study task list
- Lists basic steps needed to perform an analysis
- Green check mark indicates task is done so an analysis can start
- Lists results



Tools Tab

Contains tool box of commonly used tools

- Create nodes
- Create curves
- Create Regions
- Surface tools
- Move/Copy
- Create Beam / Tri / Tetra
- Nodal mesh tools
- Edge mesh tools
- Global mesh tools
- Mesh Diagnostics
- Set Constraints
- Set loads

Quick navigation between tools with F2-F12 keys and customized toolbars

Layers

- Used to organize entities
- Turn on and off the display of entities
- Set the color and display method
- Separate various parts of the model
- Aid in model
  - Problem diagnostics
  - Cleanup
- Scaling results
  - Results automatically scaled by visible layers

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Layers

- Status
  - Highlighted
    - Layer that is manipulated
    - Blue background
  - Bold
    - Active layer
    - New geometry is placed on active layer
  - Checked
    - On – entities on this layer are displayed
  - Unchecked
    - Off – entities not displayed

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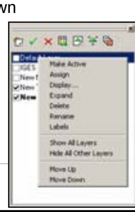
Layers

- Create layer
- Delete layer
- Activate layer
- Layer display properties
- Assign to layer
- Expand entities on layer
- Clean layers

- Context Menu
  - Rename
  - Labels
  - Show All Layers
  - Hide All Other Layers
  - Move Up
  - Move Down



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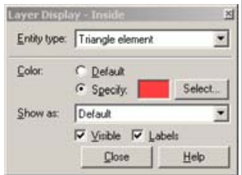
Layers – Display Properties

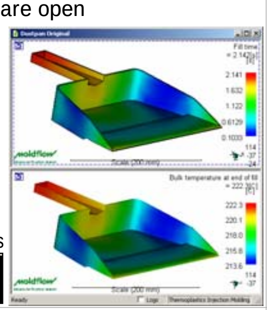
- Entity type
  - Pick the entity type if more than one type on layer
- Color
  - Specify, Red the specify color unless changed
- Show as
  - Default
  - Solid
  - Solid + Element edges
  - Transparent
  - Transparent + Element edges
  - Shrunken



Display Window

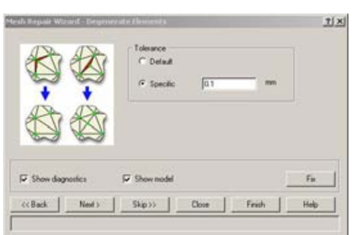
- Location where documents are open
- Many documents can be open at one time
- Split

- Locking
  - Views
  - Animations
  - Plots
  - One window or all windows



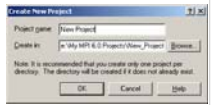
Wizards

- Cavity duplication
- Runner creation
- Cooling circuit
- Mold surface
- Mesh repair
- Process settings
- Custom Plots
- Report Generator



Create and Open Projects

- Create projects in new or existing folder on the computer
  - File ➔ New Project
  - Use **Browse** to get path to folder
  - Enter the new or existing folder name in the Project name field



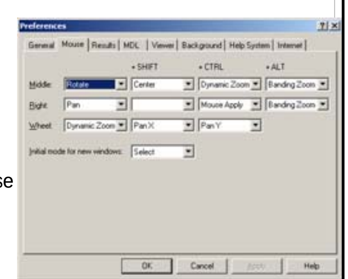
- Open existing project
  - Navigate to folder
  - Click on *.mpi file name
  - Click **Open**

MPI/Synergy Preferences

- General
- Mouse
- Results
- MDL
- Default Display
- Viewer
- Background
- Help System
- Internet

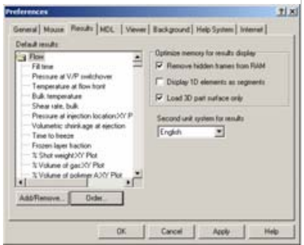
Preferences - Mouse

- Mouse button programming
  - Set
    - Middle
    - Right
    - Wheel
    - With
      - Shift
      - CTRL
      - ALT
  - Set the initial mouse mode for new windows (Left button)



Preferences – Results

- Set second unit on results
- Add/Remove results from being created during analysis
- Change the order they appear in the Study Tasks List
- Optimize memory is for 3D results



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Preferences – Default Display

- Every entity has display defaults
- Can be changed at any time
- Display of layers override defaults

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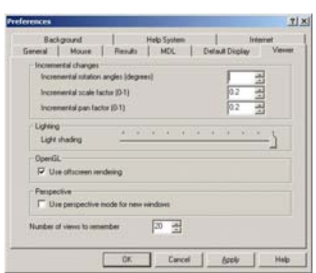
Preferences - Viewer

- Light shading
  - Slider to the right
    - Most shading and best depth perception
  - Slider to the left
    - No shading color on part exactly matches scale
- Views to remember
  - Previous view – Next view



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Preferences - Background

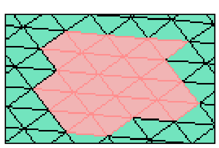
- Solid color
- Color gradient
  - Set color of the 4 corners

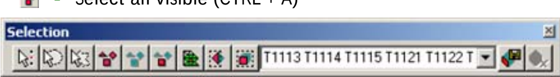
Preferences - Internet

- Automatically launch Moldflow Community Center (MCC)
- Upload Log files
- Report animation settings

Entity Selection

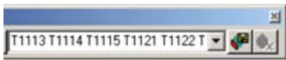
- Click on an element
- Hold down the control key to select multiple entities
- Click and drag the mouse to band select multiple entities
- Click a polygon band
- Band select facing items only
- Band select enclosed items only
- Hold down the shift key to de-select by banding
- Selecting by a property group
- Select all visible (CTRL + A)

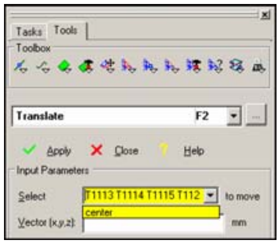




Saving Entity Selection

- Managed through a toolbar
- Integrated with the modeling commands
- Combined with layers to give extended functionality





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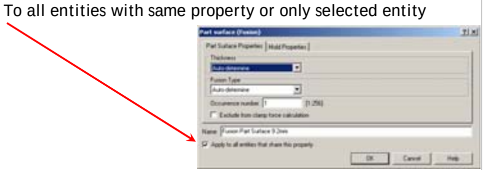
Properties

- Editing
  - Select element to edit
  - Open dialog
    - Edit ➡ Properties
    - Right click ➡ Properties
  - Make changes
    - To all entities with same property or only selected entity



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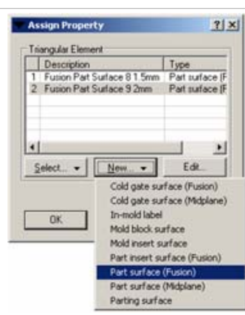
Properties

- Creating
  - Select entities
  - Edit ➡ Assign Property
  - Pick type of property
    - Only properties in list can be used for the selected element and mesh type
  - Enter required data
- Removing
  - Edit ➡ Remove unused properties



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Common Tools

- Model Manipulation
  - Rotation
    - Dynamic
    - Default
    - Key-in
  - Pan
  - Zoom
    - Dynamic
    - Banded
  - Center
  - Cutting Plane
- Undo- Redo

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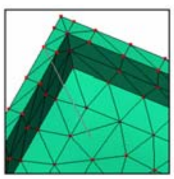
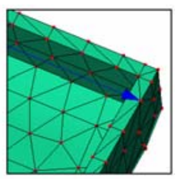
Common Tools

- Measurements
  - Model can be manipulated between node picks
    - Rotate
    - Pan
    - Zoom





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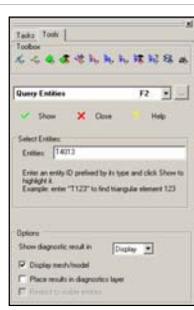
Common Tools

- Query
  - Modeling ➡ Query Entities (CTRL + Q)
  - Query one entity to display information about it
    - Triangle – Nodes, Layer, Thickness
    - Nodes – Coordinates, Layer
    - All others – Layer
  - Select entity
  - Type in entity
    - T – Triangle
    - TE – Tetrahedral
    - N - Node
    - B - Beam



T4013 (N600, N601, N635) is on layer "New Triangles", thickness = 1.905000 mm

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QUESTIONS?

How To Use Help

Accessing online Help in MPI

Introduction

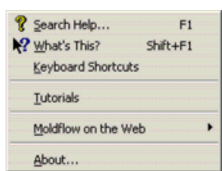
- Aim
  - Learn the features of MPI's help system
- Why do it
  - MPI's help contains a wealth of information from solver theory to results interpretation
- Overview
  - Accessing
  - Home page
  - Contents
  - Index
  - Text search
  - Panel/Dialog help
  - Context-sensitive (What's this) help
  - Favorites
  - Help Commands

Accessing

- Help menu
- Help icons on toolbars
- Help buttons on panels or dialogs
- F1 key

Accessing - Help Menu

- Search Help
  - Brings up help dialog
  - Tiles with Synergy
- What's this ?
  - Shift + F1
  - On toolbars and dialogs
- Keyboard Shortcuts
- Tutorials
- Moldflow on the Web
- About Moldflow Plastics Insight



Accessing

- Help icons on toolbars
  - Help
  - What's this?
- Help buttons on panels or dialogs
  - Dialog specific What's this
  - General help
- F1 key
  - Context sensitive
  - Primarily used for results interpretation

Help Menu - Keyboard Shortcuts

- Lists all the available shortcuts
  - Menus
  - Dialogs
    - For example, mesh tools

Keyboard shortcuts - Menus

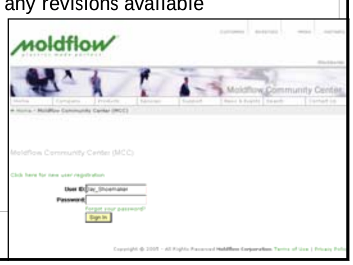
File menu	
New Project	Alt + F, W
Open Project	Ctrl + O
Close Project	Alt + F, T
New Study	Ctrl + N
New Report	Alt + F, N, R
New Folder	Alt + F, N, F
Close	Alt + F, C
Save Study	Ctrl + S
Save Study As...	Alt F, A
Save All Studies	Alt + F, L
Import	Alt + F, I
Export	Alt + F, E
Add	Alt + F, D
Organize Project	Alt + F, Z
Compact Project	Alt + F, M
Project Properties	Alt + F, J
Print	Ctrl + P
Print Preview	Alt + F, V
Print Setup	Alt + F, R
Preferences	Alt + F, F
Exit	Alt + F, X

Help Menu - Tutorials

- Access
  - Help ➡ Tutorials
  - Help Homepage
- Short tutorials on 5 topics
  - Getting Started
    - Full analysis process
  - Basic modeling
  - Mesh editing
  - Post Processing
  - Automating MPI (API)

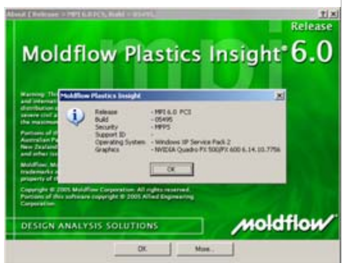
Help Menu - Moldflow on the Web

- Moldflow home page
- Moldflow Community Center
- Internet Auto Revision Update
  - Checks if there are any revisions available



Help Menu - About Moldflow Plastics Insight

- Provides specific information on MPI
  - Release
  - Build
  - Support ID
- More button adds
  - Security data
  - Operating System
  - Graphics



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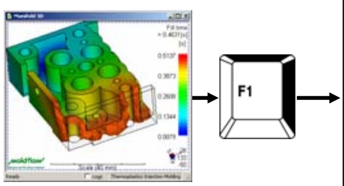
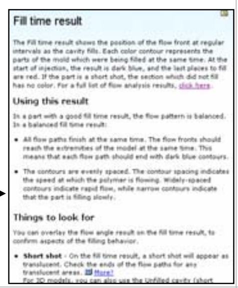
F1 Help

- Primarily used to get help on displayed results
  1. Click on the result
  2. Press F1





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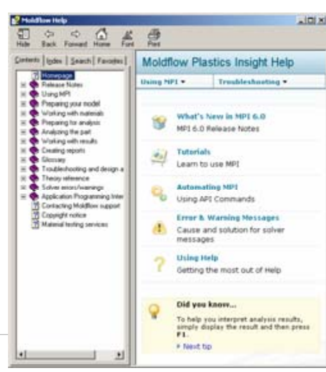
Help Home Page

- Links to major topics
- Menus to common help topics
  - Using MPI
    - Getting Started
    - Analyzing the part
    - Design Advice
    - Results
  - Troubleshooting
    - Flow problems
    - Molding problems



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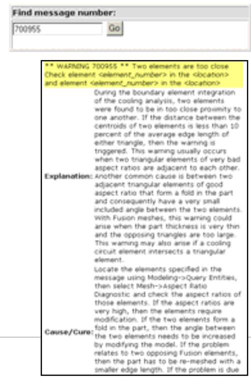
Home Page - Warning and Error Messages

- Quick search for the errors or warnings
- Warnings and errors are found in Screen Output when the analysis is done or running



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Home Page - Using Help

- Describes the various methods that help can be accessed
- Good examples on how searching can be done

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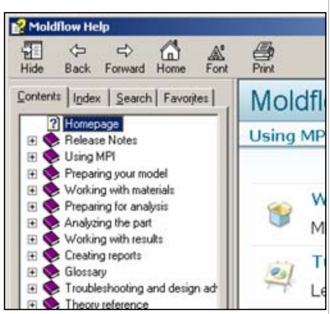
Finding the Right Topic

- Contents
- Index
- Search
- Favorites



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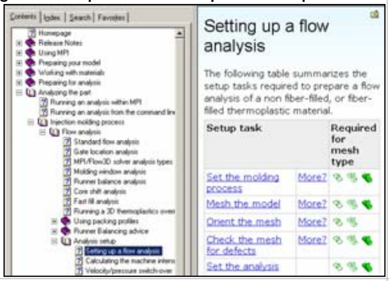
Contents

- Find information based on categories
- Navigate through sub-topics to find specific topic



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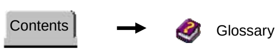
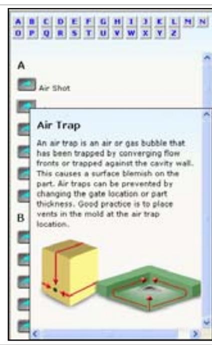
Glossary

- Located on the Contents tab of the online help
  - Contains terms relating to MPI and the injection molding industry





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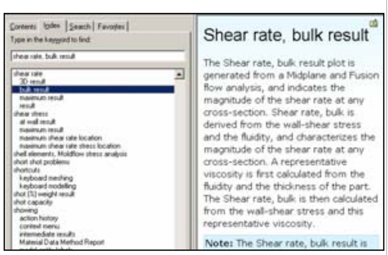
Index

- Listing of subject in help
- Enter subject and/or scroll through the list



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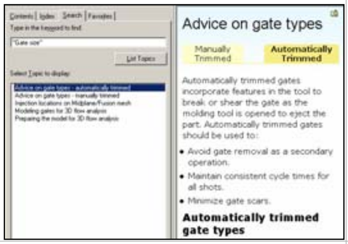
Search

- Full Text Search
- Search for one or more words
  - Quotes “ “ to define phrase
- Use
  - And (Default)
  - Or
  - Not
  - Near



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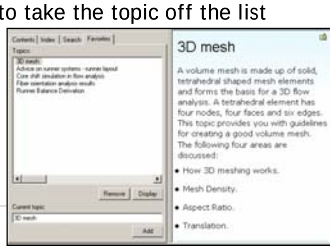
Favorites

- Bookmark topic
  - Click Add Button
- Double click on topic to display or use the Display button
- Use Remove button to take the topic off the list



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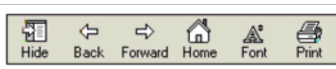
Help Commands



- Hide
  - This hides or shows the navigation pane of the help
- Back
  - Goes to the previous help topic
- Forward
  - Goes to the next help topic when Back has been used
- Home
  - Goes to the home page of the help
- Font
  - Toggles through a number of different font sizes for the help
- Print
  - Prints the current help topic

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QUESTIONS?

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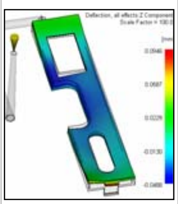
A Quick Analysis



Cool/Flow/Warp

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Introduction

- Aim
  - Complete a Cool, Flow, and Warp analysis
- Why do it
  - Shows overall procedure for running a analysis
    - Cool + Flow + Warp
    - Basic steps in this chapter are typical for any analysis project

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The Steps…

Two different parts to choose from for Fusion or 3D

1. Open Project
2. Import IGES file
3. Mesh IGES geometry
4. Diagnose mesh quality
5. Fix Mesh
6. Verify mesh quality
7. Set the injection location
8. Create Runners
9. Create Cooling Lines
10. Set Analysis Sequence
11. Select Material
12. Assign Process Settings
13. Run Analysis
14. Review Results
15. Create Report

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The Parts

- Snap Cover
  - Fusion model

- 3 Snap Cover
  - 3D model

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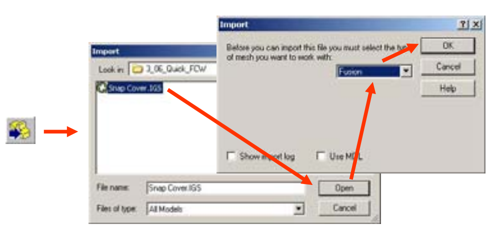
Import IGES

- Snap Cover
  - Import as a Fusion model



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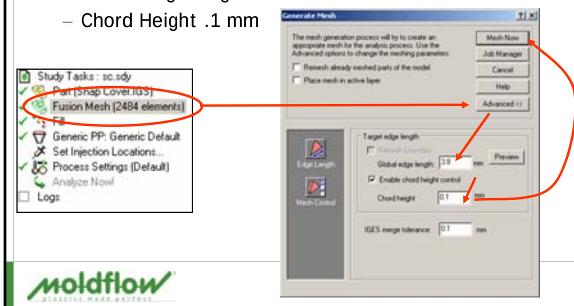
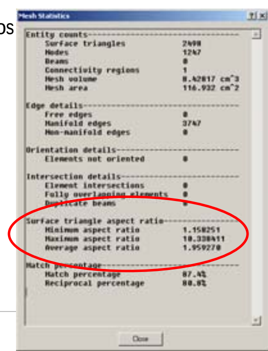
Mesh IGES Geometry

- Mesh the IGES geometry using Advanced settings
  - Global edge length 3.5 mm
  - Chord Height .1 mm



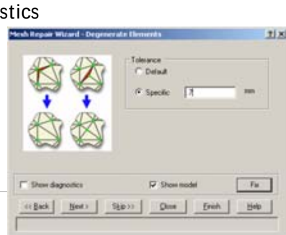
Check Mesh

- Mesh ➡ Mesh Statistics
  - Only problem – Aspect ratios



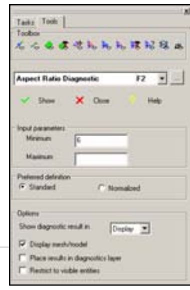
Mesh Repair Wizard

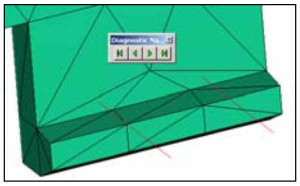
- Finds and fixes most mesh problems
- Each page a different problem
- On Degenerate Elements
  1. Set tolerance to 0.7 mm
  2. Toggle on Show Diagnostics
  3. Use Dynamic Navigator
  4. Find problem
  5. Click Next



Check for Remaining Aspect Ratio Problems

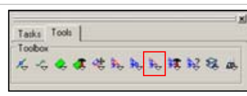
- Aspect Ratio Diagnostic
  - It toolbox – Mesh Diagnostic
- Use Dynamic navigator

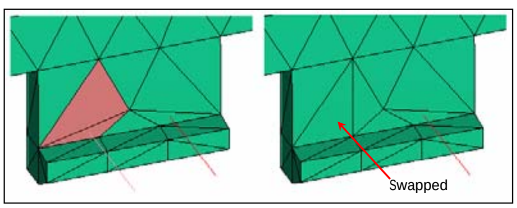




Fix Mesh –Swap Edges

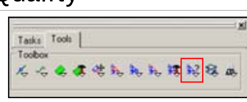
- Toolbox
  - Edge mesh tools
- Pick two elements that share a edge

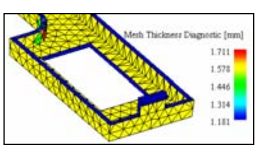


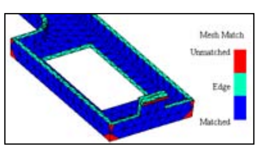


Fusion Only -Verify Mesh Quality

- Thickness Diagnostic
- Fusion Mesh Match Ratio Diagnostic





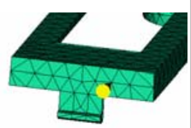


3D Only – Create and Verify Mesh

1. Change mesh type to 3D
2. Convert surface (Fusion) mesh to 3D
3. Run Mesh repair wizard
   – Checks for 3D mesh errors
   – Corrects errors found

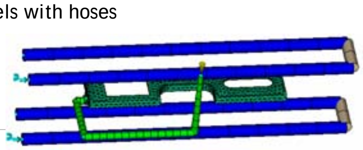
Create the Runner

- Set injection location
- Modeling ➨ Runner System Wizard
  1. Create runners for single cavity tool
  2. Sprue location: 0.0X, -50 mm Y,
  3. Parting Plane Z: -6.35 mm
  4. Sprue Orifice: 3.97 mm, 60 mm long, 2.38º inc angle
  5. Runner Diameter: 4.0 mm
  6. Gate: 1.5 mm orifice, 15º inc. 45º angle to mold



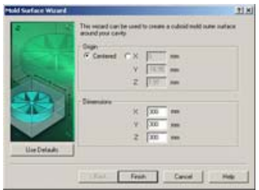
Create the Water Lines

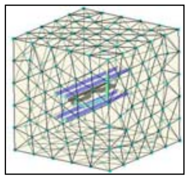
- Modeling ➨ Cooling Circuit Wizard
  – 10 mm channel diameter
  – 25 mm from part
  – X axis aligned
  – 2 channels
  – 30 mm spacing
  – 50 mm extend past part
  – Connect channels with hoses



Mold Boundary

- Modeling ➡ Surface Wizard
  - Creates volume of space for cooling analysis
  - Set 300 mm cube





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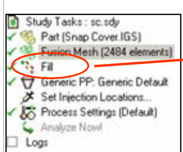
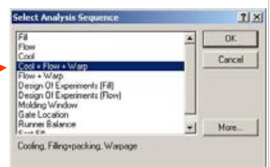
Set Analysis Sequence

- Set up a Cool / Flow / Warp analysis sequence





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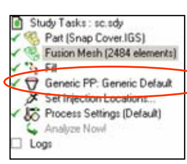
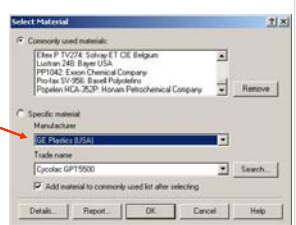
Select a Material

- Use the following polymer
  - **Fusion - GE Plastics (USA), Cycolac GPT5500**
  - 3D - Huntsman Chemical Company, 5824S





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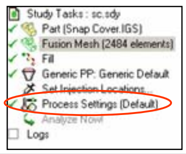
Assign Process Settings

- Change only
  - Cooling
    - Inject+pack+cooling time, Specified, 15 seconds
  - Flow
    - Fill control, Injection time, 1 seconds
  - Warp
    - Isolate cause of warpage, Checked



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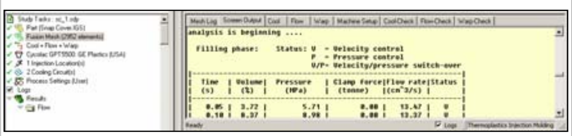
Run Analysis

1. Double-click Analyze Now!
2. Watch logs



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Fusion - Review Results

- Cooling
  - Temperature (top), part
- Flow
  - Fill Time
  - Bulk Temperature at end of fill
  - Pressure
  - Volumetric Shrinkage (at ejection)
- Warp
  - Z Deflection, all effects and variants

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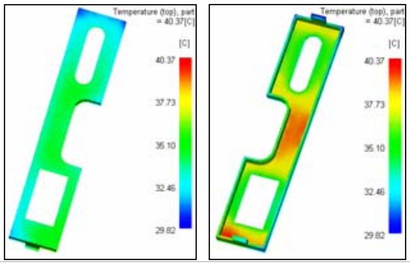
Fusion - Temperature (Top) Part

- Cycle averaged mold surface temperature
  - Plastic / metal interface



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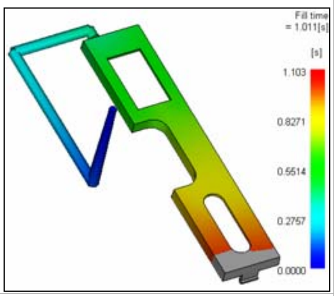
Fusion - Fill Time

- Shows progression of the flow front through the part



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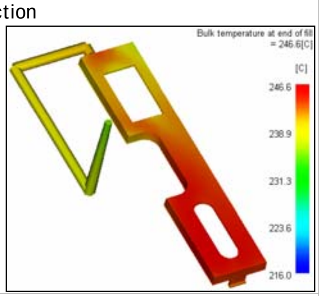
Fusion - Bulk Temperature at end of fill

- Velocity weighted temperature average
  - Through the cross section
  - At the end of fill



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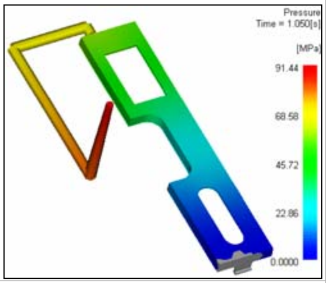
Fusion - Pressure

- Pressure distribution at various points in time
  - This case at 2.1 sec
  - ~at V/P switchover
- Animated by time



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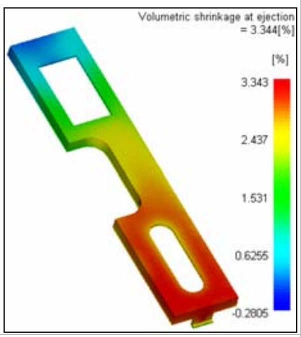
Fusion - Volumetric Shrinkage (at ejection)

- Volumetric change in element
  - At ejection
- Negative numbers indicate expansion



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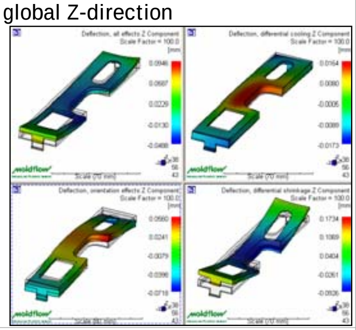
Fusion - Warpage Results

- Deflections in the global Z-direction
  - All effects
  - Cooling
  - Shrinkage
  - Orientation



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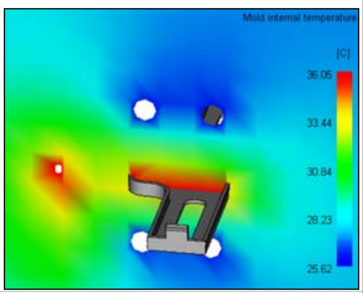
3D - Review Results

- Cooling
  - Mold internal temperature
- Flow
  - Fill Time
  - Temperature (3D)
  - Pressure
  - Volumetric Shrinkage (3D)
- Warp
  - Z Deflection, all effects and variants

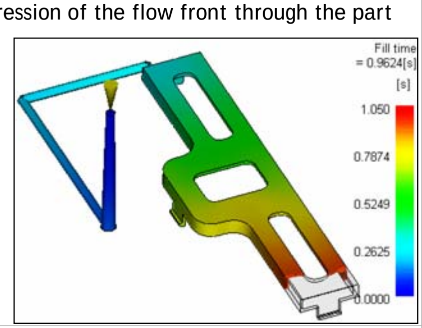
3D – Mold Internal Temperature

- Cycle averaged mold temperature



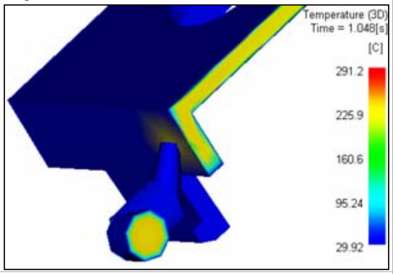
3D - Fill Time

- Shows progression of the flow front through the part



3D - Temperature (3D)

- Temperature through part thickness
  - Animated through time



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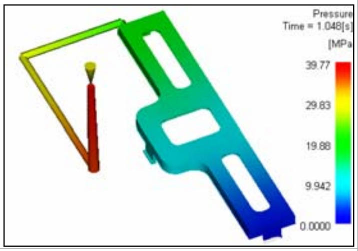
3D - Pressure

- Pressure distribution at various points in time
  - Animated by time



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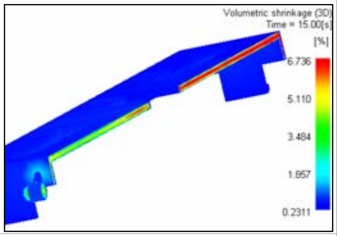
3D - Volumetric Shrinkage (3D)

- Volumetric change in element
  - Animated through time
  - Viewing through thickness



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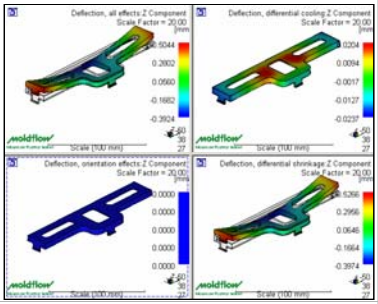
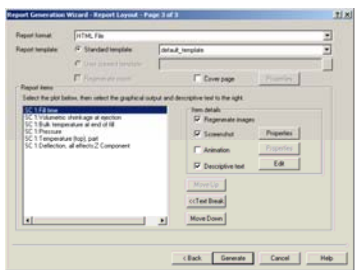
3D - Warpage Results

- Deflections in the global Z-direction
  - All effects
  - Cooling
  - Shrinkage
  - Orientation



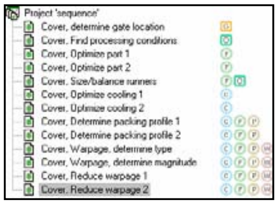
Create Report

- Create images when viewing results
- Edit report
  - Add Cover page
  - Add text



QUESTIONS?

Flow Analysis Steps



Introduction

- Aim
  - Review steps involved in a flow analysis
- Why do it
  - Every part is different
  - Basic analysis steps the same
  - Analysis objectives different
- Overview
  - Concentrate on steps of filling
  - Look at
    - Packing
    - Cooling
    - Warpage

Moldflow Design Philosophy

- Number of gates
  - Based on the pressure to fill the cavity
  - Minimum number of gates to fill the cavity
- Position of gates
  - Position gates to achieve a balanced fill
- Flow pattern
  - Straight fill pattern
  - No changes in direction during filling
    - Unidirectional

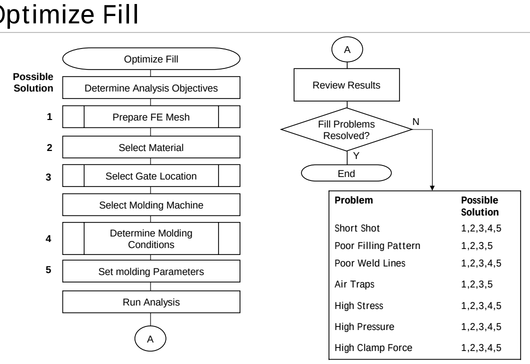
Moldflow Design Philosophy

- Runner Design
  - Balanced filling of all cavities
  - Minimum volume
- Sequence of Analysis
  - Optimize the cavity first
  - Design the runners to properly fill/pack the part(s)

Project Design Procedure Using Moldflow

- Determine the analysis objectives for the project
- Discuss the project with all disciplines involved
- Use previous experience of analyst
- Use Moldflow Design Principles
- Use Moldflow Design Rules with the software
- Interpret results and make changes where necessary
- Discuss changes with all disciplines involved
- Repeat analysis until acceptable results achieved

Optimize Fill



NOTE: The Fill process assumes that the model is of the part only and does not contain a feed system.

Determine Analysis Objectives

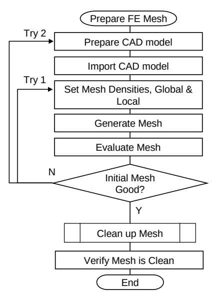
The Most Important Step

- Will the part fill?
- What material should be used?
- What are optimum processing conditions?
- Where should the gate be?
- How many gates are required?
- Where will the weld lines be?
- Are there air traps?
- How thick should the part be?
- Is the flow within the part balanced?
- Are the ribs too thin to fill?
- Are the ribs too thick?
- Can the part be packed enough?
- Will the snap fit break?
- Is the press big enough?
- Are the runners balanced?
- What size should the runners be?
- Can the runner volume be smaller?
- Is the gate the right size?
- Is the cooling uniform?
- Will the part warp within tolerance?

moldflow

Prepare FE Mesh

- May need to iterate if mesh is not clean from CAD system



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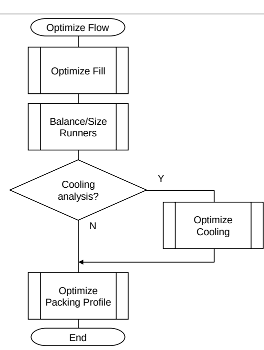
Optimize Flow

- Adds to Fill
  - Runner optimization
  - Cooling analysis
    - Optional
    - Highly recommended
  - Packing analysis



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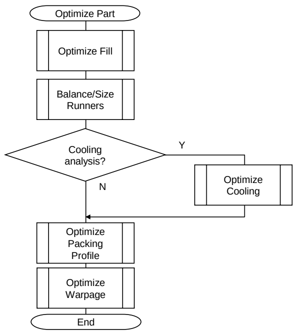
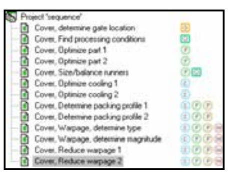
Optimize Part

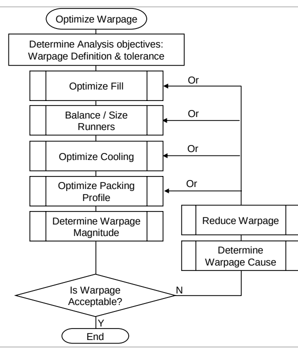
- Adds to Flow
  - Warpage optimization



Optimize Warpage

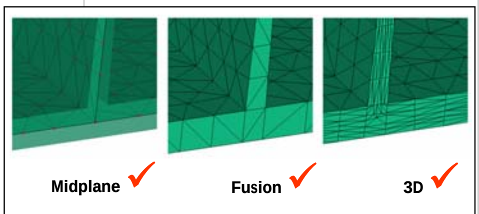
- Solving involves iterations back to previous work





QUESTIONS?

Model Requirements for a Flow Analysis

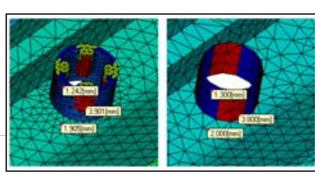


Introduction

- Aim
  - Understand the requirements of a good mesh for midplane, Fusion and 3D
- Why do it
  - A good mesh is critical for accurate results
  - Get better models from CAD when requirements are understood
  - Easier translation
- Overview
  - General mesh requirements
  - 3D specific requirements

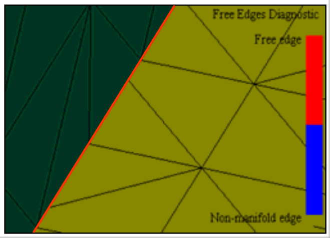
Mesh Types & Model Requirements

- Often same requirements for different mesh types
  - Fusion
  - 3D
    - Most of the time 3D models are built from Fusion meshes
    - Must have good Fusion model to create 3D model
  - Midplane
- Some requirements specific to the mesh type



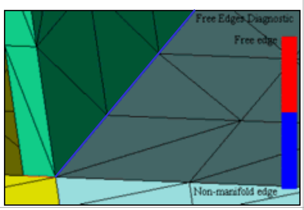
Free Edges

- Edge of an element that does not touch another element
- Fusion & 3D
  - Must not have any free edges
- Midplane
  - Will occur at part edges



Non-Manifold Edges

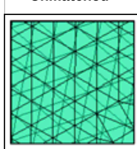
- Edge where 3 or more elements share the edge
  - A "T" intersection
- Fusion & 3D
  - Must NOT have any non-manifold edges
- Midplane
  - Will have non-manifold edges at all rib intersections



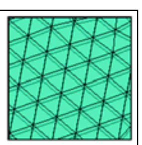
Match Ratio – Fusion Only

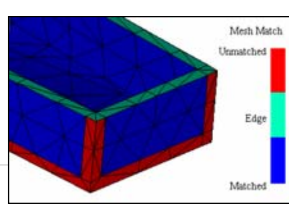
- An element on one side of wall thickness matched to another element on the other side of the wall
- Fusion
  - Poor match relates to poor thickness determination
  - Should be least 85% for Flow, 90% for Warp

Unmatched



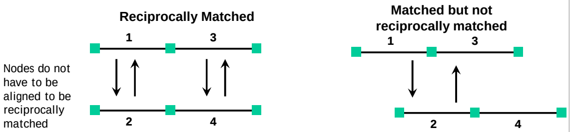
Matched





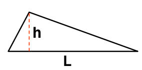
Reciprocal Match Ratio – Fusion Only

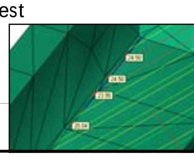
- When two elements on opposite walls are matched with each other
  - 100% reciprocal match is when all matched elements are reciprocally matched
- Should be over 90% reciprocal match
  - For good warpage results



Aspect Ratio

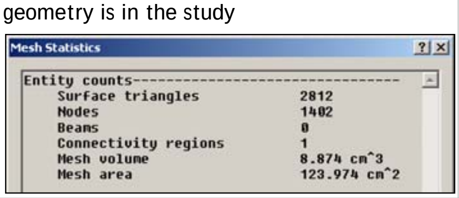
- Ratio of Length to Height of an element
- Fusion & Midplane
  - Average < 3:1
  - Maximum < 6:1
    - Higher can be tolerated for flow analysis,
    - High ratios cause problems with cool and warp
- 3D
  - Maximum 30:1 on Fusion mesh to be converted
  - Tetrahedral mesh ratio < 50:1 is best





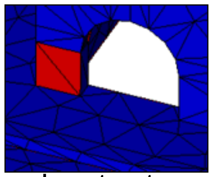
Connectivity Regions

- A group of elements that are connected together
- All mesh types must have one connectivity region for the part
- Mesh statistics will report more than one region if cooling geometry is in the study



Element Orientation

- Define the “Top” positive normal side and “Bottom” side of elements
- Fusion
  - Must have the Top (Blue) side pointing outward
- Midplane
  - Orientation should be consistent
- 3D
  - Not applicable



Two elements not correct

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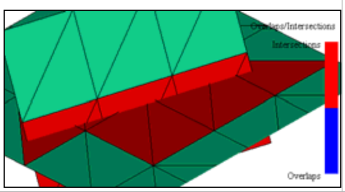
Intersecting Elements

- Intersections
  - Elements intersect the plane of other elements
  - Shown in Red
- Fusion & 3D & Midplane
  - Must not have any



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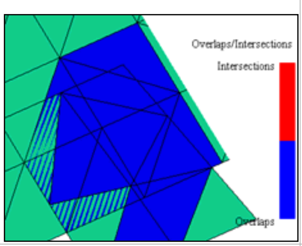
Overlapping Elements

- Overlaps
  - Elements in the same plane intersect (take the same space)
  - Shown in Blue
- Fusion & 3D & Midplane
  - Must not have any



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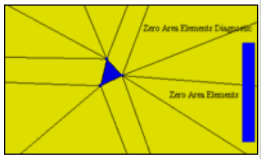
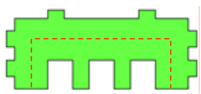
Zero Area Elements

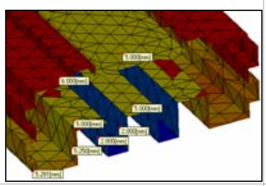
- Zero Area Element
  - Very low volume or edge length
  - Normally caused by very high aspect ratio elements
- Fusion & 3D & Midplane
  - Must not have any



Thickness Representation

- Ensure the thickness of the model is correct
- "Chunky" geometry
  - Fusion will not calculate the thickness correctly
- Must be represented by a 3D model



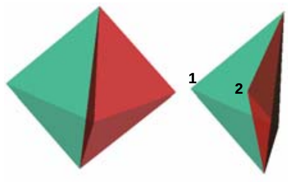


Chunky Geometry

- Less than 4:1 width : thickness ratio
- Prefer a ratio of greater than 10:1
- Heat Transfer only done on faces (blue) not in thickness direction (Green)
  - 2:1 ratio - thickness is 33% of the perimeter
  - 4:1 ratio - thickness is 20% of the perimeter
  - 10:1 ratio - thickness is 9% of the perimeter

3D only – Inverted Elements

- Must not have inverted elements

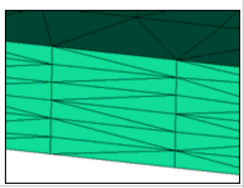


Correct

Inverted
Node 1 and 2 on the same side of the face shared by the two elements

3D only - Number of Element Layers

- Default number of rows 6
  - Used for most applications
- 8 rows better for 3D fiber orientation
- As number of rows increases so does the aspect ratio
  - This can lead to problems with Navier-Stokes solver

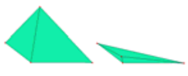


3D Only

- Collapsed faces
  - A node is defined on two opposing faces
  - Local zero thickness
  - Must not have
- Internal long edges
  - Edge length of element inside part to the edge length on the part surface
  - Should be <2.5:1

3D Only

- Extremely large volumes
  - Ratio of volume of element to the average
  - Should be under 20:1
- High aspect ratios
  - Maximum aspect ratio should be < 50:1
- Small angle between faces
  - Node close to the plane formed by the plane of the other elements
  - Should be > 2 degrees



Summary of Model Requirements

Mesh Feature	Fusion	3D	Midplane
Free edges	Must NOT have any	Same as Fusion	Can have at boundary of holes and parting line
Non-manifold edge	Must NOT have any	Same as Fusion	Is a "T" cross-section - Ribs
Manifold edge	Only kind of edge allowed	Same as Fusion	Same as Fusion
Match Ratio	> 85% for flow and 90% for warp	Not Applicable	Not Applicable
Reciprocal Match	Should be above 90% for warp	Not Applicable	Not Applicable
Aspect Ratio	Average <3:1 Maximum <6:1	Maximum <30:1 of Fusion before conversion	Same as Fusion

Summary of Model Requirements

Mesh Feature	Fusion	3D	Midplane
Connectivity Regions	One region for the part	Same as Fusion	Same as Fusion
Element Orientation	The top (blue) side of the element pointing outward	Same as Fusion before conversion	Consistent mesh orientation
Intersections	Must NOT have any	Same as Fusion	Same as Fusion
Overlapping Elements	Must NOT have any	Same as Fusion	Same as Fusion
Zero Area Elements	Must NOT have any	Same as Fusion	Same as Fusion
Thickness Representation	Must have thicknesses properly modeled	Not Applicable	Same as Fusion

Summary of Model Requirements

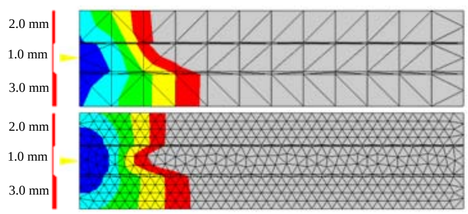
Mesh Feature	Fusion	3D	Midplane
Connectivity Regions	One region for the part	Same as Fusion	Same as Fusion
Element Orientation	The top (blue) side of the element pointing outward	Same as Fusion before conversion	Consistent mesh orientation
Intersections	Must NOT have any	Same as Fusion	Same as Fusion
Overlapping Elements	Must NOT have any	Same as Fusion	Same as Fusion
Zero Area Elements	Must NOT have any	Same as Fusion	Same as Fusion
Thickness Representation	Must have thicknesses properly modeled	Not Applicable	Same as Fusion
Number of 3D Layers	Not Applicable	6 Layers typically OK, 8 better for Fiber orientation	Not Applicable

Summary of Model Requirements

Mesh Feature	Fusion	3D	Midplane
Inverted tetras	Not Applicable	Must NOT have any	Not Applicable
Collapsed faces	Not Applicable	Must NOT have any	Not Applicable
Number of 3D Layers	Not Applicable	6 Layers typically OK, 8 better for Fiber orientation	Not Applicable
Internal long edge	Not Applicable	<2.5:1	Not Applicable
Extremely large volume	Not Applicable	<20:1	Not Applicable
High aspect ratio (Tets)	Not Applicable	<50:1	Not Applicable
Small angle between faces	Not Applicable	>2 degrees	Not Applicable

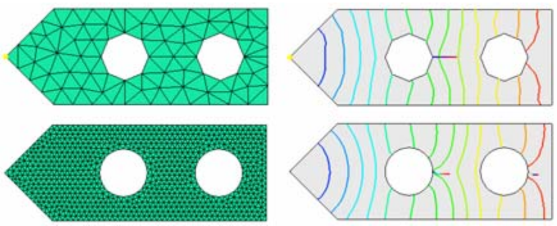
Mesh Density Effects - Hesitation

- To pick up hesitation, three rows of elements across a major change in thickness are required



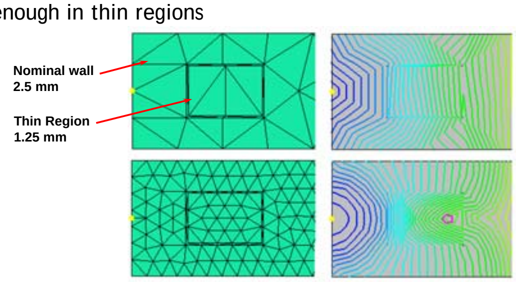
Mesh Density Effects - Weld Lines

- The mesh at the weld line location must be dense enough to pick up the weld line



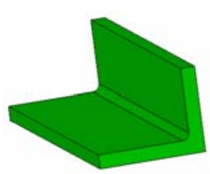
Mesh Density Effects - Air Traps

- Air traps may not be predicted if the mesh is not fine enough in thin regions



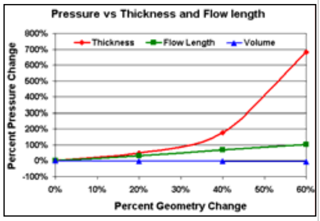
Mesh Detail

- Model must represent **FLOW** characteristics
  - **Thickness**
  - **Flow length**
  - **Volume**
- Small features of a part should be eliminated from a flow model
  - Blends
  - Radii
  - Fillets



Effect of Geometry on Fill Pressure

- Thickness
  - Greatest effect on pressure
- Flow length
  - Second greatest effect
- Volume
  - Virtually no effect



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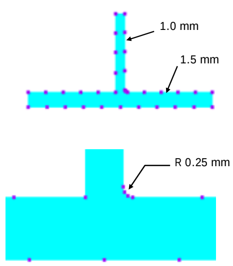
Effect of Corner Radii

- Fusion & Midplane
  - No effect on pressure
  - Purple dots are nodes
    - To represent radii, small node spacing is required
    - Creates high aspect ratio for very minor thickness changes
- 3D
  - Can see local effect of corner radii but must have very high mesh density



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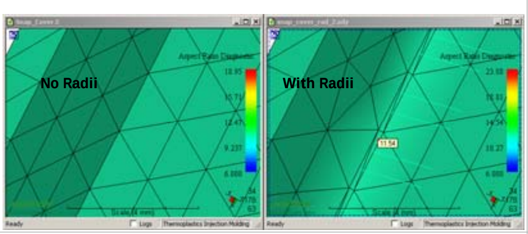
A Model With and Without Radii

- No Radii 14 elements > 6:1 aspect ratio
- With Radii 561 elements >6:1 aspect ratio



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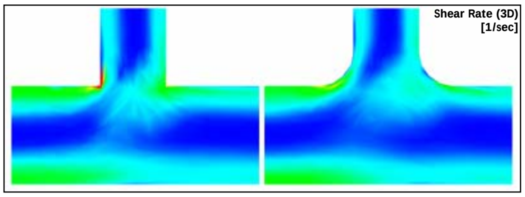
A Model With and Without Radii

- 3D can pick up local high shear at sharp corners
- Requires very fine mesh
- Only has local affect



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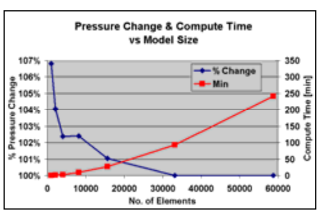
Compute Time, Mesh Density and Accuracy

- As mesh density increases
  - The compute time increases exponentially
  - Limited accuracy improvement



Material, ABS
1.9 mm nominal wall
Processing Cond. 60-235-1
Computer 2.8 GHz, 1 Gig Ram

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QUESTIONS?

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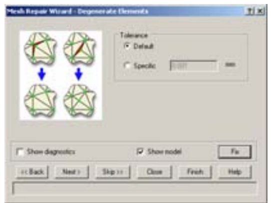
Model Translation and Cleanup



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Introduction

- Aim
  - To learn how to import, check and fix models from CAD systems
- Why do it
  - Vast majority of models used for analysis are imported from CAD
- Overview
  - Basic steps
    - Import CAD model
    - Mesh model
    - Check for errors
    - Fix mesh with Mesh Repair Wizard and manually

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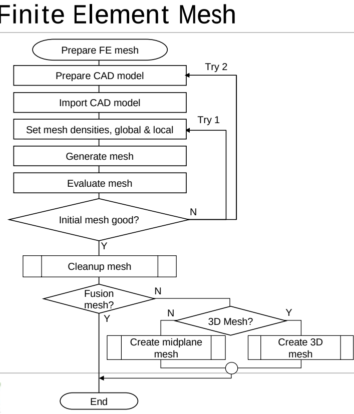
Preparing a Finite Element Mesh



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Prepare CAD Model

- In Synergy - must mesh
  - Stereo-lithography (.stl)
  - IGES (.igs, .iges)
- In MDL - must mesh
  - STEP AP203 (.stp, step)
  - Parasolid (.x_t, .x_b, .xmt_xmb, .xmb, .xmt)
  - IGES (.igs, .iges)
  - Pro-e (.prt)
  - Catia (.catpart)
  - Solidworks (.sldprt)
- In Synergy - is meshed
  - Moldflow (.mfl)
  - C-MOLD (.cmf)
  - IDEAS Universal (.unv)
  - Ansys Prep 7 (.ans)
  - Nastran (.nas)
  - Nastran Bulk Data (.bdf)
  - Patran (.pat)
  - Fem (.fem)

Parasolid, Pro-e, Catia and Solidworks need separate licenses of MDL

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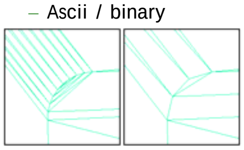
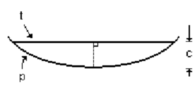
CAD System Export Options for STL

- STL
  - Chord height
  - Angle control
  - Facet deviation
  - Ascii / binary



Fine STL   Coarse STL



C = M/(1000 x Q)

where:

c = chord height
p = part surface
t = tessellated surface
M = model size (the distance between opposite diagonals of the bounding box of the part)

Q = part quality (recommended 0.3, limits 0.1 to 1.0)

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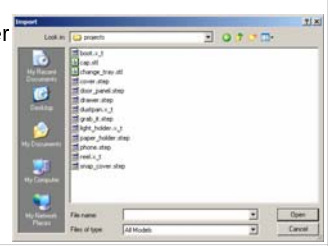
Import a Model

- Access
  - Import Icon
  - **File ➡ Import**
- Navigate to the folder
- Click on the file
- Click **Open**



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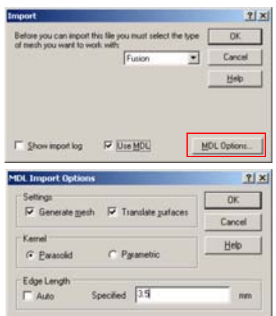
Import a Model - Geometry

- Mesh type
  - Midplane
  - Fusion
  - 3D
  - If solid geometry
    - Pick Fusion
    - Cleanup model
    - Change mesh type as needed
- Use MDL –IGES only
- MDL Options

Import a Model – MDL Options

- Settings
  - Translate surfaces
    - Synergy used to generate the mesh
    - Recommended
  - Generate mesh
    - MDL Mesh generator used
- Edge Length
  - Auto
    - MDL determines
  - Specified
    - User inputs

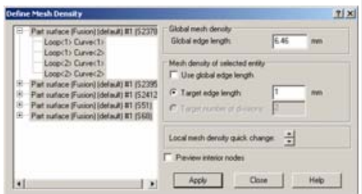


Import a Model - STL

- Mesh type
  - Midplane
  - Fusion
  - 3D
  - Pick Fusion
    - Cleanup model
    - Change mesh type as needed
- Units
  - Change if necessary
  - Refer to dimensions listed

Local Mesh Sizing

- Access
  - **Mesh ➡ Define Mesh Density**
  - Context menu (right click)
- Set
  - On geometry
  - Before meshing
- Change densities
  - Global
  - local
- Preview



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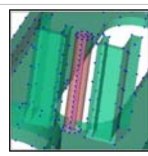
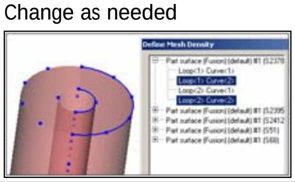
Setting Local Mesh Density



- Select entities to list in dialog
- Open **Define Mesh Density** dialog
- Pick subset of entities in list by clicking on the loop
  - Blue lines highlight the loops
- Click Apply to preview - Change as needed
- Generate mesh

Will **Not** work on STL models directly as the entire STL is considered on entity



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Generate Mesh

- Access
  - Click on mesh icon in study tasks list
  - **Mesh ➡ Generate Mesh**

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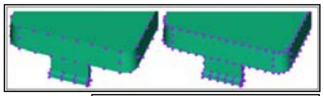
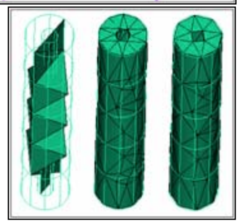
Generate Mesh - Edge length

- Global edge length
  - Main control of mesh density
- Chord height
  - Controls mesh density around curved features
- Use Preview button
  - View mesh density before meshing





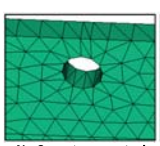
Off .01mm 0.2mm

Generate Mesh – Mesh Control

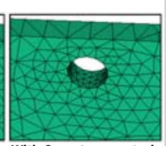
- NURBS Surface mesher
  - Advancing Front
    - Default
    - Most options with this mesher
  - Legacy
    - Split-based mesher
    - Not as good as advancing front

Generate Mesh – Mesh Control

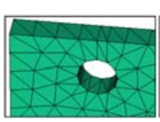
- Surface curvature control
  - Puts finer mesh on curved surfaces
- Proximity control
  - Puts finer mesh on surfaces closer together than global edge length
- Chord height must be on for both



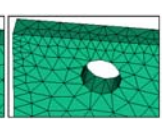
No Curvature control



With Curvature control



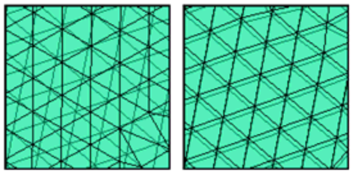
No Proximity control



With Proximity control

Generate Mesh – Mesh Matching

- Post processing step
  - Ensures elements are lined up



Surface Mesh Guidelines

- Not all setting are appropriate to use for Fusion meshes generally
- Global edge length
  - Use Preview button as a guide
  - Fine enough to capture
    - Wall thickness changes
    - Weld lines
    - Other critical detail
  - Fusion up to several times the nominal wall
  - 3D up to about 2 times nominal wall

Surface Mesh Guidelines

- Chord height
  - Default on at 0.1
  - Use to capture critical circular detail
  - Use preview to see affect of the value
- Mesh match
  - Off for
    - 3D (Fusion to be converted)
    - Midplane
  - On for Fusion
  - May create small sliver elements than need to be fixed

Surface Mesh Guidelines

- Surface curvature control
  - Ensures fine mesh on curved surfaces
- Proximity control
  - Ensures fine mesh on surfaces close together
- Both controls
  - Chord height must be on
  - Primarily used for 3D models
  - For Fusion mesh
    - May be too fine
    - May decrease match ratio

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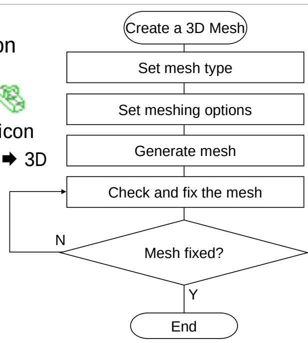
3D Meshing

- After cleaning up Fusion mesh
- Set mesh type
  - Right click on Fusion icon
  - Select Set mesh type ➡ 3D



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3D Meshing

- Elements through the thickness
  - Default 6
  - Minimum 4
  - 8 recommended for fiber filled
  - Higher to capture very fine detail
  - May need finer surface mesh with higher number of layers

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3D Meshing

- Use surface mesh optimization
  - Cleans up problem areas if found
  - Fusion mesh should be clean before converting
- Use surface mesh matching
  - Determines placement of internal nodes by matched elements

Small slivers fixed by mesh optimization

Matching may need to be off on very chunky parts

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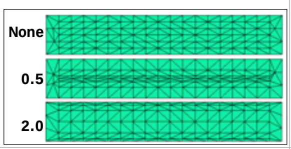
3D Meshing

- Tetra aspect ratio control
  - Decoupled layer optimization and aspect ratio reduction
  - Reduces elements and aspect ratios
- Node biasing
  - Changes layer thickness of elements
  - >1 thinner at wall
  - < thinner in center



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3D Meshing Guidelines

- Use appropriate surface mesh
  - Edge length ~double thickness
- Clean model before conversion
  - Remove: Overlaps, intersections, free edges etc.
- Aspect ratio before conversion
  - Below 30:1
  - Preferred closer to 6:1
- If 3D mesh fails
  - Review the log file
  - Repair areas mentioned in the log file
- Validate mesh with Mesh Repair Wizard

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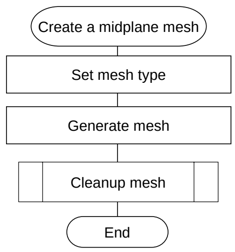
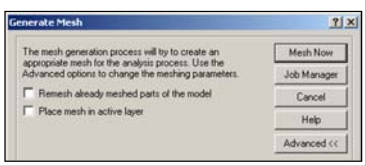
Midplane Meshing

- Start with clean Fusion mesh
- Set mesh type to Midplane
- Generate mesh
  - Remeshing existing mesh
- Clean mesh



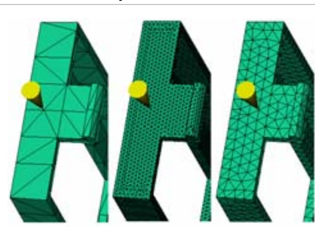
Generate Mesh

- Mesh now
  - Immediately meshes part
- Job Manager
  - Opens Job Manager
  - Can send meshing to different queues



Evaluate the Mesh – Visual Inspection

- Ensure mesh requirements met
- Models thickness changes
- Good Weld line definition



To Coarse 1004 elements | To Fine 58760 elements | About right 8178 elements

Evaluate the Mesh – Mesh Statistics

- Tool that checks and reports on the mesh quality
  - Entity Counts
  - Edge Details
  - Orientation Details
  - Intersection Details
  - Aspect Ratio
  - Match Ratio
- Mesh ➡ Mesh Statistics

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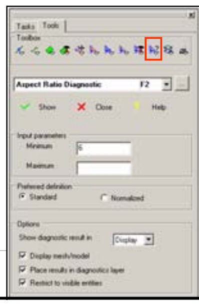
Evaluate the Mesh – Mesh Diagnostics

- Mesh ➡ Mesh Diagnostics
- Displays specific mesh problem
  - Aspect ratio
  - Overlapping, intersecting elements
  - Orientation
  - Connectivity
  - Free, non-manifold edges
  - Thickness
  - Occurrence number
  - Zero area elements
  - Fusion mesh match info
  - Others for cooling
- Put on Diagnostics layer
  - Used for fixing problems
- Restrict to visible entities



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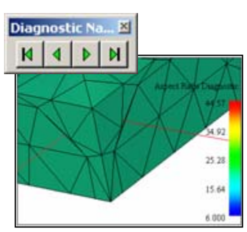
Evaluate the Mesh – Diagnostic Navigator

- Move between entities identified in the diagnostic
- Automatically displayed when a diagnostic viewed
- Very handy when cleaning up mesh



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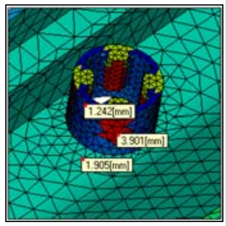
Evaluate the Mesh – Thickness

- Fusion model thickness assigned automatically
- Check for accuracy
- If not correct
  - Could be sign of low mesh density for part
  - Element properties can be manually changed
  - Changes should not be significant



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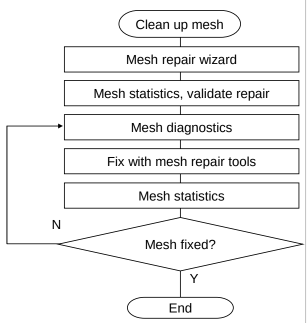
Cleanup the Part

- Once part is
  - Meshed
  - Evaluated
- Cleanup can begin
  - Automatic
  - Manual
- Verify cleanup



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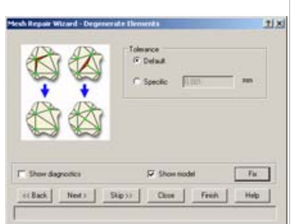
Cleanup the Part - Mesh Repair Wizard

- Stitch free edges
- Fill Hole
- Overhang
- Degenerate elements
- Flip normals
- Fix overlap
- Collapsed faces
- Aspect ratio



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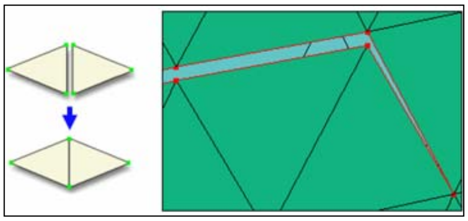
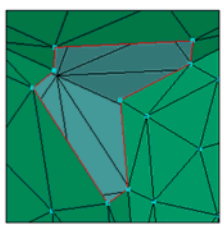
Mesh Repair Wizard – Stitch Free Edges

- Merge nodes across a free edge less than specified tolerance



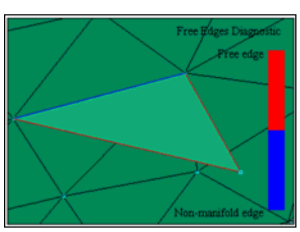
Mesh Repair Wizard – Fill Hole

- Creates elements to fill a hole shown be free edges



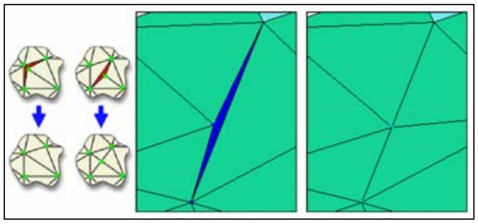
Mesh Repair Wizard – Overhang

- Deletes element that has one non-manifold and 2 free edges



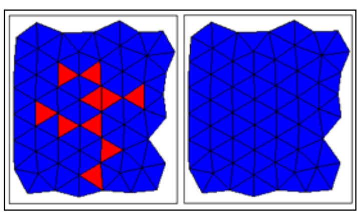
Mesh Repair Wizard – Degenerate Elements

- Merges nodes or inserts then merges to fix elements below a tolerance



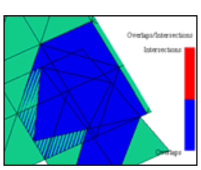
Mesh Repair Wizard – Flip Normals

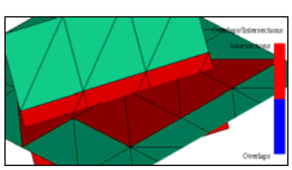
- Orients the mesh so all the elements have the correct orientation
  - Blue side facing outward



Mesh Repair Wizard – Fix Overlap

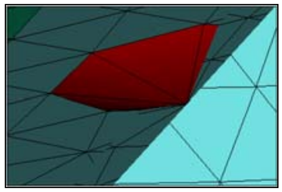
- Attempts to correct
  - Intersections
    - Elements passing through the plane of another
  - Overlaps
    - Elements occupying the same area





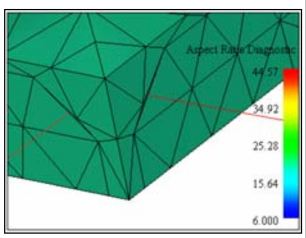
Mesh Repair Wizard – Collapsed faces

- Red elements are a collapsed face
  - Node defining the red element is also used on a opposite face



Mesh Repair Wizard – Aspect Ratio

- Attempts to fix elements with an aspect ratio higher than the target

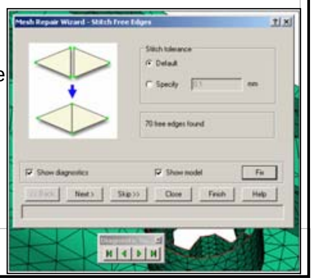


Mesh Repair Wizard -3D

- Inverted elements
- Collapsed elements
- Mesh refinement through thickness
- Edge length ratio
- Volume ratio
- Maximum aspect ratio
- Minimum angle between tetra faces

Using the Mesh Repair Wizard

- Click
  - Show diagnostics
  - Use diagnostic navigator to see problems
- Tolerance
  - Change if necessary
  - Show diagnostics to see change
- Click Fix or Next to correct



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Validate Repairs

- After using the Mesh Repair Wizard
- Check the mesh
- Fusion or Midplane
  - Mesh statistics
- 3D
  - Run Mesh Repair Wizard again

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Mesh Repair Tools

- On Tools pane
- In Mesh ➡ Mesh Tools menu
- Tools
  - Create elements
  - Nodal mesh tools
  - Edge mesh tools
  - Global mesh tools

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Mesh Repair Tools

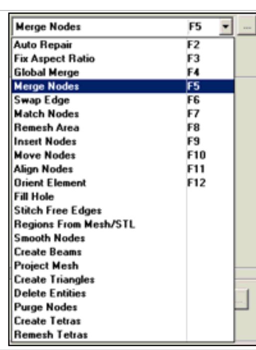
- Create elements
  - Create triangles
  - Create beams
  - Create tetras
- Edge mesh tools
  - Swap edge
  - Stitch edge
  - Fill hole

Mesh Repair Tools

- Nodal mesh tools
  - Insert Node
  - Move Node
  - Align Node
  - Purge Node
  - Match Node
  - Merge Node
- Global mesh tools
  - Remesh Area
  - Smooth Nodes
  - Orient Element
  - Delete Elements
  - Project Mesh
  - Global Merge
  - Auto Repair
  - Fix Aspect Ratio
  - Create Regions
  - Orient AI

Mesh Repair Tools

- Navigation
  - Pick tool from
    - Menu
    - Toolbox
    - Toolbars
      - Mesh manipulation
      - Customized
  - Once picked
    - Select from combo box
    - Use F2-F12 keys

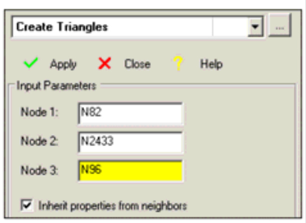


Mesh Repair Tools

- Entity filters
  - Any item
    - Will select any type of item or a coordinate in space
  - Node
    - Selects a node by clicking on the node or band selecting
    - Default for most tools
  - Nearest node
    - Selects a node by clicking on an element close to the node
    - Clicking directly on the node may not select
    - Default for some tools

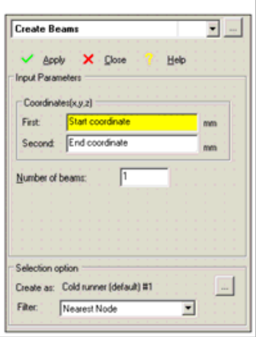
Create Triangles

- Creates triangles
- 3 nodes selected manually
- By default property of new element inherited from a neighboring element



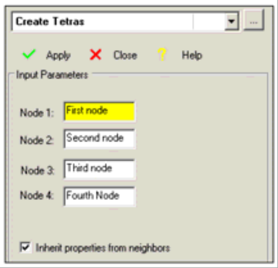
Create Beams

- Creates one or more beam elements
- Pick start and end coordinate
- Define the beam properties before creating



Create Tetra

- Creates tetras
- 4 nodes selected manually
- By default property of new element inherited from a neighboring element



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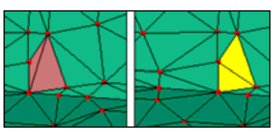
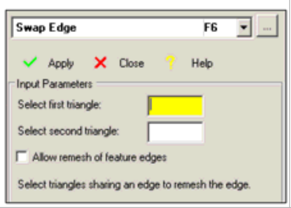
Swap Edge

- Pick two elements that share an edge
- Apply re-meshes the two elements
- Allow remesh of feature edge may need to be on to work



Elements selected **Swapped**



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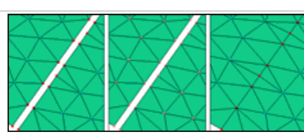
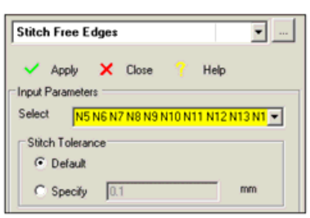
Stitch Free Edges

- Merges nodes within tolerance
  - Must be on free edge
- Splits elements as Necessary





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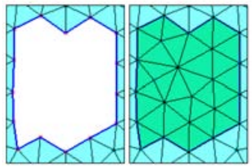
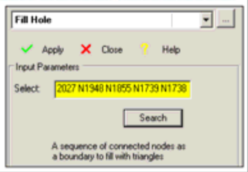
Fill Hole

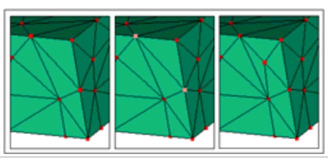
- Fills a void in model
- Select one node on free edge
- Search for remaining nodes

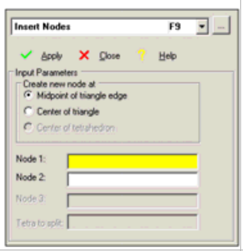




Insert Nodes

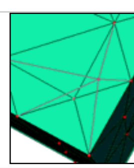
- Creates a node
  - Between two existing nodes
  - Center of elements
- Splits elements as necessary to keep mesh connected

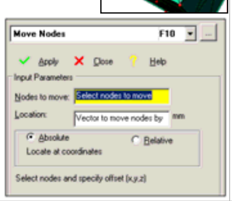




Move Nodes

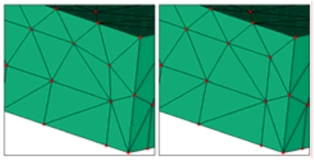
- Move nodes by
  - Click and drag
  - Select and enter
    - Absolute coordinates
    - Relative coordinates

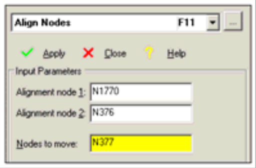




Align Nodes

- Moves one or more nodes to a line definition
- Pick 2 nodes to define the line
- Pick nodes to move





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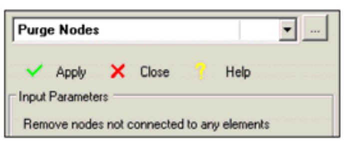
Purge Nodes

- Removes any nodes not connected to any element in the model



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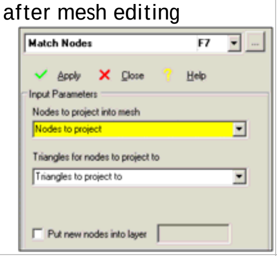
Match Node

- Matches nodes on side of the wall to elements on the other side of the wall
- Used to improve matching after mesh editing



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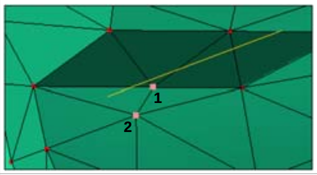
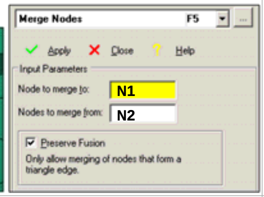
Merge Nodes

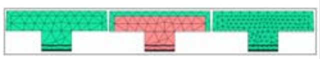
- Manually merge nodes
- First node picked is the node that remains
- One or more nodes get merged into the first
- Normally Preserve Fusion should be left on





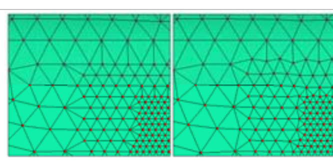
Remesh Area

- Meshes selected entities with new target length entered
- Steps
  - Select elements to change
    - Both sides for Fusion
  - Change target edge length
    - Do not change radically
    - Transitions will not be good
  - Apply

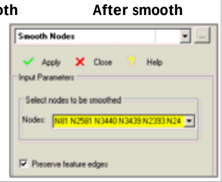


Smooth Nodes

- Averages nodal spacing
- Helps with transitions between fine and course meshes

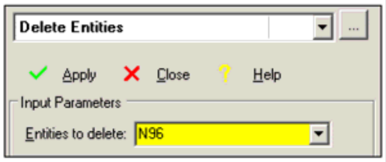


Before smooth After smooth



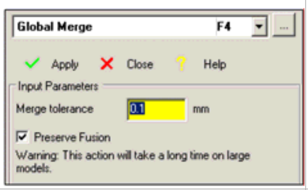
Delete Entities

- Deletes selected entities



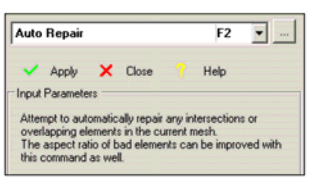
Global Merge

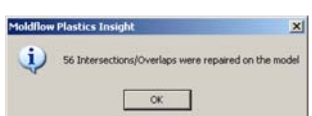
- Merges nodes closer together than tolerance
- Preserve Fusion prevents collapse of the wall thickness
- May need to turn off Preserve Fusion to fix model
- Reports number of elements fixed



Auto Repair

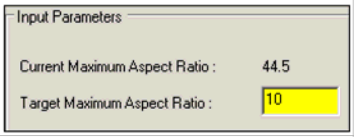
- Automatically fixes
  - Intersections
  - Overlaps
- Reports on number fixed and remaining problems





Fix Aspect Ratio

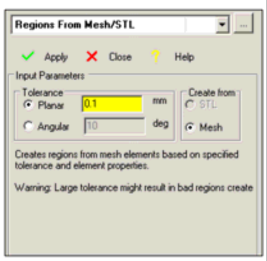
- Attempts to automatically fix aspect ratio problems
- Reports current maximum and target aspect ratio
- Reports maximum aspect ratio when done



Create Regions

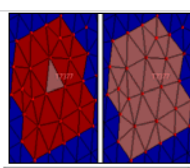
- Creates regions on the model
  - From
    - Existing mesh
    - STL model
- Use planar tolerance on predominantly flat parts
- Use “Angular tolerance” on predominantly curved parts

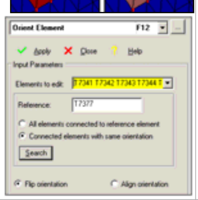
STL files are created into regions so local mesh densities can be defined



Orient Elements

- Fixes inconsistent orientation
- For Fusion the entire outside should be blue
- Select elements by
  - Directly picking
  - Pick seed and searching
- Flip or align elements





Verify Cleanup

- Once mesh cleanup is done
- Fusion / midplane
  - Run mesh statistics
- 3D
  - Run Mesh Repair Wizard again

How to Fix Common Problems Manually

- Low match ratio
  - Decrease global mesh length, remesh
  - Decrease local mesh length
- Thickness
  - Decrease global mesh length
  - Assign or edit properties
- Connectivity
  - Stitch free edge
  - Global merge
  - Merge node

How to Fix Common Problems Manually

- Intersections and overlaps
  - Auto repair
  - Merge
  - Delete entities
  - Fill hole
- Free or non-manifold edges
  - Create nodes
  - Merge nodes
  - Delete entities
  - Fill hole

How to Fix Common Problems Manually

- High aspect ratio elements
  - Merge nodes
  - Swap edge
  - Insert node
  - Move node
  - Align nodes
- Un-oriented elements
  - Orient all
  - Orient elements

When to Quit Fixing the Mesh

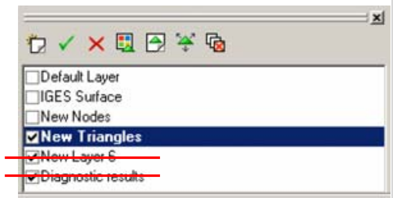
- Depends on the analysis sequence
  - If going on to cool and warp, the mesh must be good
- All models must have NO
  - Intersections
  - Overlaps
  - Free edges
  - Non-manifold edges
  - Un-oriented elements
  - Zero Area Elements

When to Quit Fixing the Mesh

- Fusion & Midplane
  - Flow
    - Aspect ratio should be < 6:1
    - Aspect ratio can be tolerated at high levels in small areas up to about 20:1
  - Cool and warp
    - Aspect ratio should be below 6:1 all areas
- 3D
  - Aspect ratios of surface mesh can be 30:1 before conversion to 3D mesh

Cleanup Layers

- Delete all layers used during cleanup
- Move all entities back to their original layer



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QUESTIONS?

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Practice - Housing

- Already Meshed
- Has several areas to be cleaned up
- Practice with Mesh Cleanup Tools

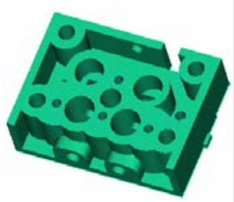
moldflow

Practice - Fusion

- Cover
  - Meshed with several different mesh settings to compare meshes
  - Use Mesh Repair Wizard
  - Use manual cleanup

Practice – 3D

- Manifold
  - Meshed with several different mesh settings to compare meshes
  - Use Mesh Repair Wizard
  - Use manual cleanup
  - Converted to 3D
  - 3D mesh checked and fixed



Practice - Optional Models

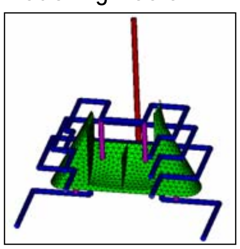
- Snap cover
  - With and without radii
- Snap cover in various formats
  - STL
  - Step
  - Parasolid
  - Iges
  - Pro-e

- Dustpan
  - Fusion
  - Midplane generation

- Housing
  - MDL options

QUESTIONS?

Modeling Tools

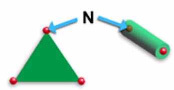


Introduction

- Aim
  - Learn about the modeling tools available inside Synergy
  - Learn how to create basic geometry or features in the model
- Why do it
  - Changing the geometry inside MPI will avoid going thru the complete process of cleaning the imported CAD
- Overview
  - Terminology
  - Properties
  - Features likely to be modeled within Synergy

Terminology

- Node
  - Used in a model to
    - Determine a coordinate position in space
    - Create curves and regions
    - Assign
      - An injection location
      - A coolant inlet
      - A constraint
      - A load
  - In a mesh
    - Nodes are the vertices of Midplane, Fusion, and 3D mesh elements and the ends of beam elements
    - Certain analysis results are recorded at mesh nodes



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Terminology

- Curve
  - A line in three-dimensional space
  - Can be straight or contain bends
  - Used in a model to create geometries
    - Runners
    - Gates
    - Cooling circuits
    - Regions
  - MPI supports the following curve types
    - Line
      - a straight curve defined by two end points
    - Arc
      - can be an arc or circle
    - Spline
      - a cubic spline interpolation on a supplied set of points

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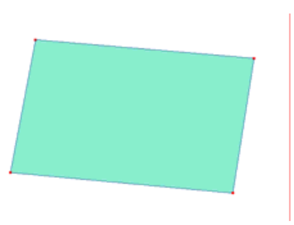
Terminology

- Region (flat surface)
  - A planar space defined by a consistent set of curves
  - The curves connect but must not intersect



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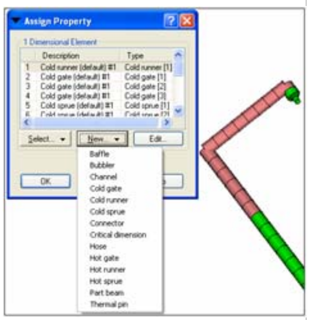
Assigning Properties

- Depending on the type of element selected
  - Beam or curve
  - Triangle
  - Tetras
- The list of properties to assign will be different

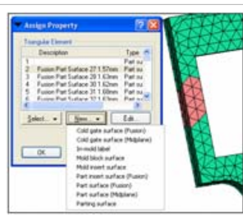
Properties – Beam Elements

- For curves or beam elements
  - Baffle
  - Bubbler
  - Channel
  - Cold gate
  - Cold runner
  - Cold sprue
  - Connector
  - Critical dimension
  - Hose
  - Hot gate
  - Hot runner
  - Hot sprue
  - Part beam
  - Thermal pin



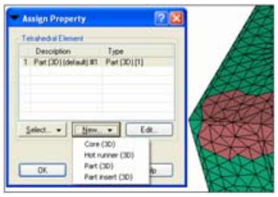
Properties - Triangles

- For triangles
  - Cold gate surface (Fusion)
  - Cold gate surface (Midplane)
  - In-mold label
  - Mold block surface
  - Mold insert surface
  - Part insert surface (Fusion)
  - Part insert surface (Midplane)
  - Part surface (Fusion)
  - Part surface (Midplane)
  - Parting surface



Properties - Tetras

- For tetras:
  - Core (3D)
  - Hot runner (3D)
  - Part (3D)
  - Part insert (3D)



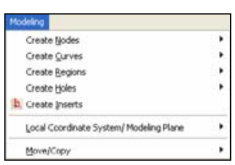
Features Likely to be Modeled within Synergy

- Simple beam geometries such as
  - Runners
  - Gates
  - Sprues
  - Cooling channels
- Part geometry
  - Mostly midplane
  - Editing tools are limited compared to CAD

*Beam geometry creation covered in other chapters

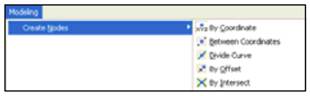
Modeling Menu

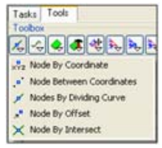
- Create Nodes
- Create Curves
- Create Regions
- Create Holes
- Local Coordinate System/Modeling Plane
- Move/Copy



Create Nodes

- By Coordinate
- Between Coordinates
- Divide Curve
- By Offset
- By Intersect (of curves)





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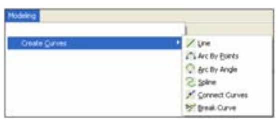
Create Curves

- Line
- Arc by Points
- Arc by Angle
- Spline
- Connect Curves
- Break Curve



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Line – Input Parameters

- Second coordinate has two options
  - Absolute
    - Second will be located at the absolute specified position from First
  - Relative
    - Second will be located at a relative distance and direction from First

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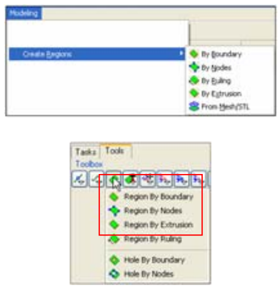
Create Regions

- By Boundary
- By Nodes
- By Ruling
- By Extrusion
- From Mesh/STL

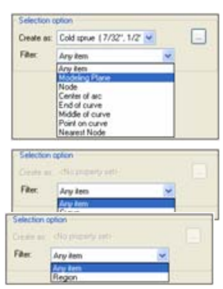


Create Holes

- By Boundary
- By Nodes

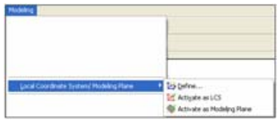
Filter

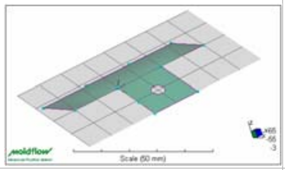
- Helps select a required model or mesh entity
- Snaps to the nearest instance of the selected model or mesh entity
- Filter options depend on the entity dialog box



Local Coordinate System/Modeling Plane

- Define option creates a new local coordinate system
- Activate as LCS links the following actions to be relative to the LCS
- Activate as modeling plane makes new geometry to be created in the new XY plane





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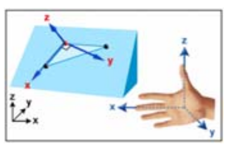
Defining a Local Coordinate System (LCS)

- Coordinates
  - First
    - Defines the origin of the LCS
  - Second
    - Defines the X axis in the LCS
  - Third
    - Defines the XY plane of the LCS
- Z direction based on the right hand rule



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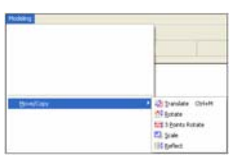
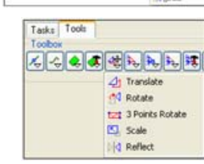
Move/Copy

- Translate
- Rotate (around an axis)
- 3 Points Rotate
- Scale
- Reflect (mirror about XY, YZ, XZ planes)





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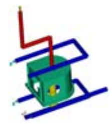
Practice

- Midplane users
  - Speedo
    - Finish creating part geometry
    - Use LCS and Modeling plane
  - Dustpan
    - Create entire part with curves and regions
- Fusion & 3D users
  - Speedo
    - Use LCS and Modeling plane



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QUESTIONS?

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Moldflow Magics STL Expert

STL Model Editing & Optimization Software

moldflow

Introduction

- Aim
  - Learn how Moldflow Magics STL Expert can be used to fix & optimized the original CAD file
- Why do it
  - When importing a model inside MPI previously optimized by Moldflow Magics STL Expert the cleanup time process inside MPI is reduced
- Overview
  - Program features:
    - STL Fix Wizard
    - Manual Fixing Tools
    - Optimization Tools
    - Measurement Tools
  - Supported Models
  - Licensing & Hardware Support

Introducing Moldflow Magics STL Expert

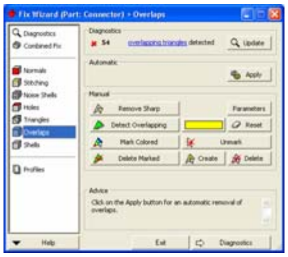
- View, measure, correct and optimize models in …
  - Stereolithography (STL)
  - IGES
  - Native and Standard 3D CAD Solid model formats
- Convert IGES and 3D CAD Solid models to STL
- Locate errors with STL
- STL Fix Wizard for automated repair
- Manual editing and fixing tools
- Measuring tools
- Optimization tools

Key Features – STL Fix Wizard

- STL Fix Wizard
  - Calculates number of occurrences of various issues
  - Suggests the best solution path to fix issues

Key Features – Manual Fixing Tools

- Manual tools complement STL Fix Wizard
- Manual tools arranged by the type of issue
- Coupled with advise for effective utilization



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Key Features – Optimization Tools

- Triangle Reduction
  - Reduce triangle count without any distorting or modifying the part geometry
  - Reduce model complexity and size
  - Improves the efficiency of MPA & MPI analyses

Before Reduction = ~960K triangles

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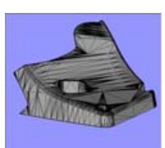
Key Features – Optimization Tools

- Remesh
  - Creates a uniform mesh
  - Uniform sized elements
  - Fewer large aspect ratio elements
  - Improves success rate of MPA analyses



Original STL

After Remeshing

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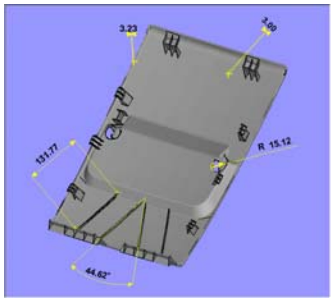
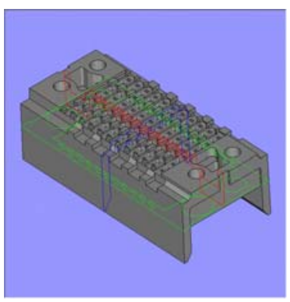
Key Features – Measurement Tools

- Measure
  - Thickness
  - Distance
  - Radius/diameter
  - Angle
  - Coordinates
- Feature recognition
  - Points/lines/arcs/circles/cylinder



Other Key Features

- Advanced editing tools
  - Rotate/Translate/Rescale the model
- Labeling tools
  - Label points, part dimensions, measurements both on-screen and hardcopy print
- Clipping/Model sectioning
  - View cross-section of the part
  - Dynamically move clipping planes



Supported Models

- Standard
  - STL
  - IGES
  - MGX (Materialise compressed STL format)
- Using Moldflow Design Link (MDL)
  - Parasolid
  - SolidWorks
  - Pro/ENGINEER
  - CATIA V5
  - STEP

Licensing & Hardware Support

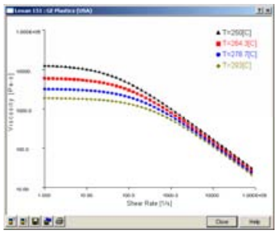
- Licensing
  – Both Node-locked and Network Floating licenses available
- Supported Hardware
  – Intel Pentium/Xeon-based Windows XP/2000

Practice Session

- Overview of Moldflow Magics STL Expert
  – Activities designed to familiarize you with the usage of Moldflow Magics STL Expert

QUESTIONS?

Material Searching

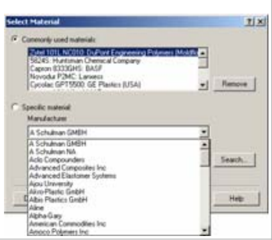


Introduction

- Aim
  - Learn techniques for searching and comparing materials
- Why do it
  - Find specific material to use in an analysis
  - Find several materials to evaluate
- Overview
  - Search method depends on the information available

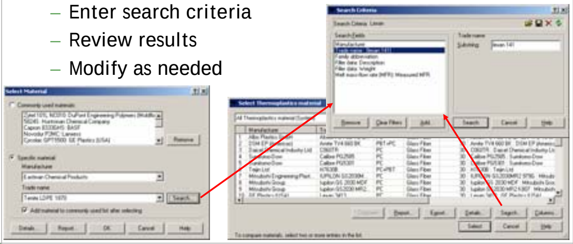
Material Selection

- Commonly used materials
  - Last 20 materials used are listed
  - Number of materials user definable in Preferences
- Specific Material
  - Lists
    - Manufacturer
    - Trade name
  - If material known it can be found in list



Material Searching Techniques

- Searching can be done on properties stored in the material database
  - Add search fields if necessary
  - Enter search criteria
  - Review results
  - Modify as needed



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Common Search Fields

- Manufacturer
  - Dupont, BASF etc.
- Trade name
  - Zytel, Capron etc.
- Moldflow Viscosity index
  - Single point measurement of viscosity
  - VI(240)0125
- Tester information
  - Moldflow, manufacturer etc.
- Filler data
  - Glass fiber, mineral etc.
- CRIMS information
  - shrinkage data

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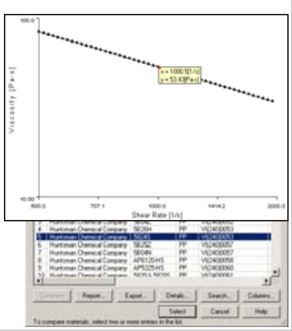
Moldflow Viscosity Index

- Single point data
  - Used for
    - Material comparison
    - Narrow family list
  - Format VI(240)0053
    - 240 is melt temperature
    - 0053 is the viscosity in Pa-S
  - Most materials use different reference temperatures



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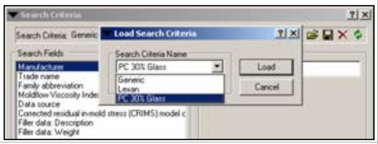
Saving and Loading Searches

- Searches can be saved
  - Use the diskette Icon
  - Enter Name
  - Will save all fields being used and the values of the fields
- Saved searches can then be loaded for later use



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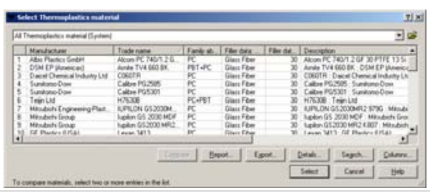
Review Search Results

- Column headings
  - Click to sort
  - Drag to re-position
- Columns button
  - Add or delete visible columns
- Report button
  - Shows testing and quality information
- Compare button
  - Compares 2 or more selected materials



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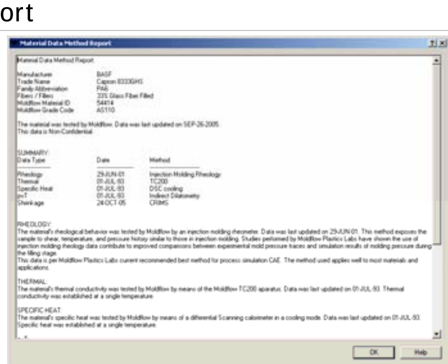
Report



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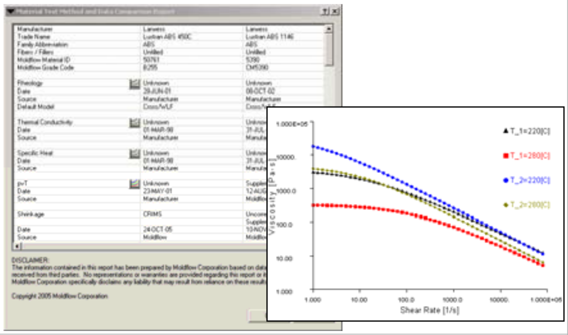
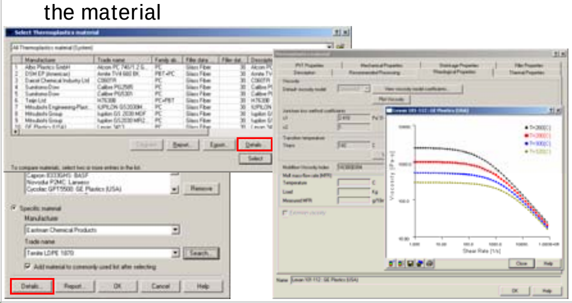
Compare

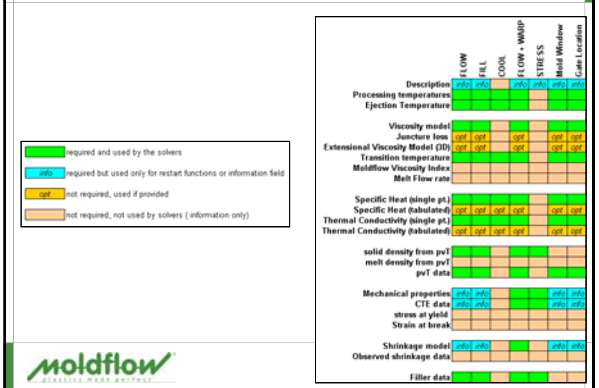


Material Details

- Click on Details button to see all the data stored for the material



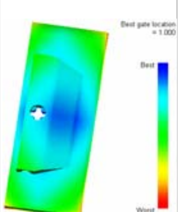
MPI Data Requirements by Analysis Type



Practice

- Find material with known
  - Manufacturer
  - Trade name
- Find PC
  - Use search
  - Add search fields to narrow search
- Use Moldflow viscosity index to limit search
- Plot viscosity
- Review material report

QUESTIONS?



Gate Placement

Design Considerations and Analysis

Introduction

- Aim
  - Review gate placement guidelines
  - Run a gate location analysis
- Why do it
  - Gate location can be very a critical factor in overall part quality
- Overview
  - Look at gate locations and influence on filling
  - Run a gate location analysis
  - Review results

Guidelines for Gate Placement

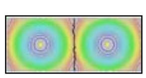
- Place gates to achieve filling that is
  - Balanced
  - Unidirectional
- Place gates
  - In thicker areas
  - Far from thin areas
  - Against a wall to prevent jetting
  - To prevent weld lines from forming
    - In weak regions of the part
    - Where they will be visible
  - To prevent gas traps
- Add gates to
  - Reduce fill pressure
  - Prevent overpacking
- Gate placement depends on
  - Type of tool – 2 or 3 Plate
  - Runners – Hot or Cold
  - Gate Type – Edge or Sub
  - Tooling or Functional restriction

Place Gate to Achieve Balanced Filling

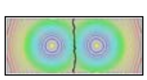
- Very balanced fill
  - Unidirectional orientation, possible packing variation

- Mostly balanced fill
  - Radial orientation, possible warpage due to orientation

- Mostly balanced fill
  - Radial orientation,Large weld line formed at near EOF



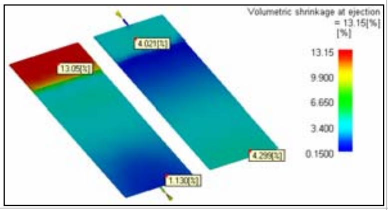
- Unbalanced fill
  - Weld line forms early, Radial orientation



Gate in Thicker Areas

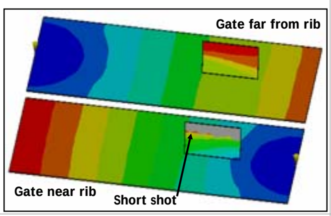
- Helps pack the thicker area better
- Generally lowers pressure to fill the part

The thick area is 5 mm the thin is 2 mm Both parts are scaled to the same range



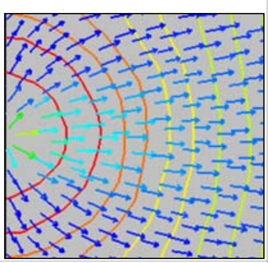
Gate Far From Thin Areas

- With significant changes in wall thickness
  - Avoid gating close to thin areas
- Polymers favor the path of least resistance
  - Difficult to filling the thin feature
  - If at all



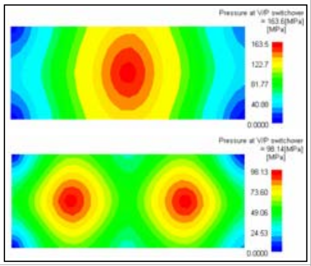
Place Gates to Achieve Unidirectional Filling

- Place gates to achieve unidirectional flow
- Molecular orientation consistent across the part
  - Reducing warpage
- Best for long narrow parts
- Possible disadvantages
  - Non-uniform packing
  - Higher fill pressures



Add Gates to Reduce Pressure

- With long flow lengths
  - Fill pressures may be too high
- Add gates
  - Maintaining balance
  - Shorter flow length
  - To reduce pressure



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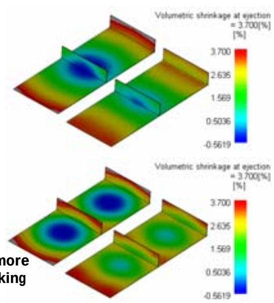
Prevent Overpacking by Adding Gates

- Center gate over packs center rib
- Two gates prevents center rib over pack
- Volumetric shrinkage more uniform

Center gate, overpacked rib



Two gates, more uniform packing

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Gate Location Analysis

- Analysis considers
  - Processability
    - Is it possible to produce a part at this location
  - Minimum Pressure
    - Produces lower shear rate and shear stress levels
  - Geometric Resistance
    - Where would gating not cause overpacking
  - Thickness
    - Is it possible to pack the part effectively at this location?

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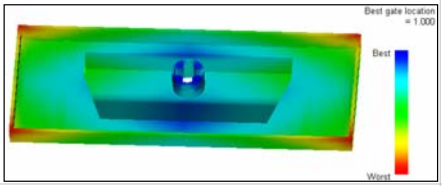
Gate Location Process Settings

- Normally the default process settings can be used
- Optional settings include
  - Molding machine
  - Advanced options
    - Maximum injection pressure
    - Maximum clamp force

Looking at the Results

- Analysis is a one + one technique
  - If no gate is specified
    - The best single gate is determined
  - With a gate(s) specified
    - Next best location determined



Looking at the Results

- Screen Output file or Results Summary
  - Maximum clamp force
  - Maximum injection pressure
  - Recommended gate location at node number

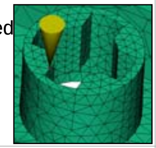
```
Copyright Moldflow Corporation and its worldwide subsidiaries. All rights reserved.
Gate Location Analysis
Version: mpi600  (Build 05512)
Analysis running on host: MF-JAY
        Operating System: Windows XP Service Pack 2
          Processor type: GenuineIntel x86 Family 15 Model 2 Stepping 9 ~3192 MHz
    Number of Processors: 2
   Total Physical Memory: 1022 MBytes

   Maximum design clamp force                        =     5600.18 tonne
   Maximum design injection pressure                 =      144.00 MPa
   Recommended gate location(s) are:
      Near node                                      =        1845
Execution time
   Analysis commenced at        Sun Jan 15 10:15:14 2006
   Analysis completed at        Sun Jan 15 10:16:04 2006
   CPU time used                       48.17 s
```

Setting a Gate Location Based on Results

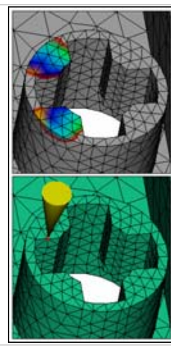
```
Recommended gate location(s) are:
     Near node                  =   1845
```

- In Log find Gate node
- Query Entities
  - Ctrl+Q or Modeling ➡Query Entities
  - Enter *Nnode number*
    - N1845
  - Place on a diagnostics layer
- Display queried entities layer
  - Toggle other layers on and off as needed
- Click the injection locations icon
- Select the node
  - Create Copy if prompted



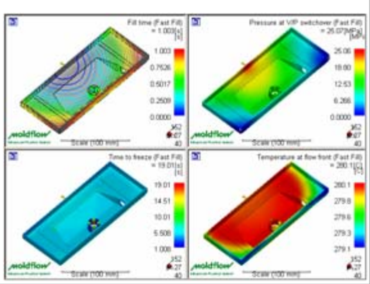
Setting a Gate Location Based on Results

- Open second window of the part
- Arrange windows
- Lock Views
- Use gate location results as guide for setting gate location
  - Scale or query results if necessary



Gate Location Validation – Fast Fill Analysis

- Non-Newtonian
- Non-Isothermal
- Incompressible
- Results
  - Fill time
  - Pressures
  - Temperature
  - Time to Freeze
  - Air trap – Weld lines



Practice - Cover

- Design Criteria
  - Material
    - BASF, Capron 8333GHS
  - 2-plate tool
  - Cold runners
  - Tunnel gates
  - Gate limited to side walls

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Optional Models

- Paper holder
  - Use Material Lanxess Lustran SAN 29
  - 2-plate tool with a cold runner system
- Phone
  - Use Material Bayer MaterialScience Bayblend FR 2000
  - 2-plate tool with a hot runner system
- Door panel
  - Use Material Lanxess Novodur P2MC
  - Restricted to only edge gates
  - 2-plate tool

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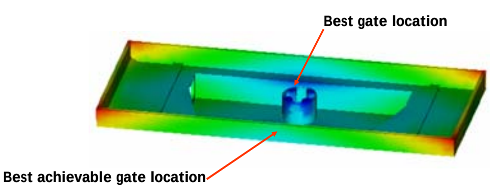
Cover Results

- With the restriction of using tunnel gates
  - Best achievable gate location is on the side
- With a fiber-filled material
  - This location may cause significant orientation problems



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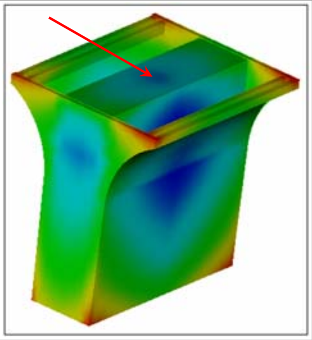
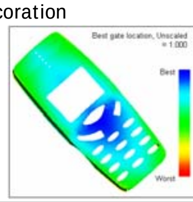
Paper Holder

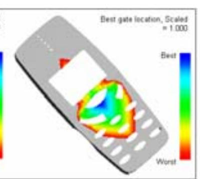
- Best gate location controlled by thick areas
- Center of bottom
  - Practical
  - High on best location scale



Phone

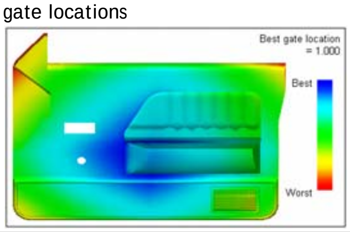
- Best location probably not practical
- Edge of large window possibly better
- Will depend on
  - Gate blush
  - Post mold decoration





Door Panel

- Must be edge gates
- Best starting place
  - Along the bottom edge
  - Between the best gate locations



QUESTIONS?

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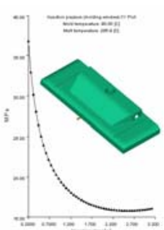
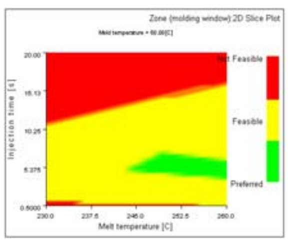
Molding Window Analysis





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Introduction

- Aim
  - Find optimum molding conditions and wide processing window
- Why do it
  - Optimum molding conditions a good start for FEA analysis
  - Wide processing window creates a stable process
- Overview
  - Set up analysis based on machine and general guidelines
  - Review results to find good molding conditions

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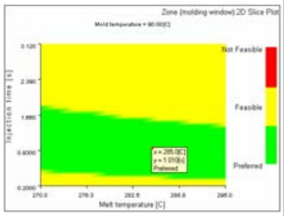
Molding Window Benefits

- Look at the "Big Picture" of molding a part
- Very quick to run
  - Normally ~minute
- Gives good starting point for further analysis

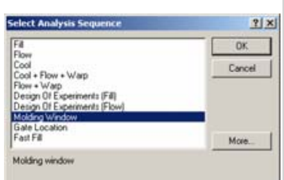


What Questions Can Be Investigated?

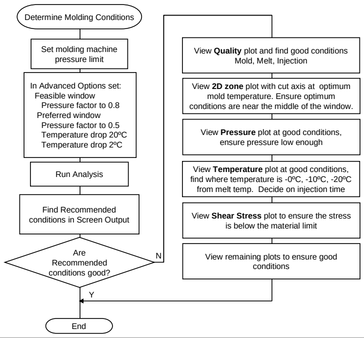
- Will the part fill?
  - Is pressure low enough?
- What is the number and basic position of gates?
  - Add gates to reduce the pressure
- How big is the molding window?
  - Small window indicates the part will be difficult to produce
- What material will work best?
  - What material is easier to fill
  - Size of molding window
- Can the part wall thickness be changed?
  - How thin can you go?
- What is the part's cooling time

Analysis Inputs Required

- Midplane or Fusion model
  - Cavity-based analysis
  - No runners
- Analysis sequence - Molding Window
- Injection location
- Material
- Process settings



Running a Molding Window Analysis

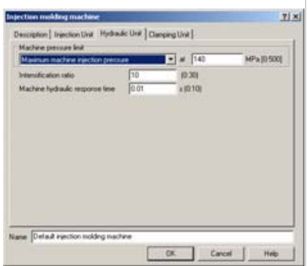


Process Settings

- Injection molding machine
- Process parameters
  - Mold temperature
  - Melt temperature
  - Injection Time
- Advanced options

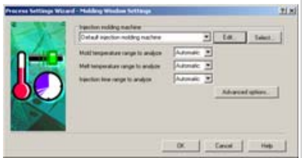
Injection Molding Machine

- Set maximum machine injection pressure to limit of machine
  - Default 180 MPa (26,100 psi)
  - If the capacity is not known use 140 MPa (20,300 psi)



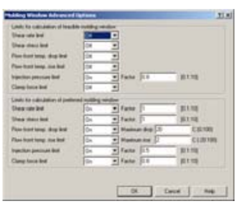
Process Parameters

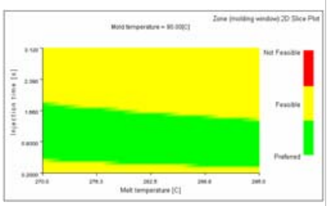
- Default value Automatic
  - Temperature range defined in material database
  - Injection time defined by analysis
- Normally defaults used
- Setting ranges best if comparing materials
  - Normally run defaults then determine ranges



Advanced Options

- Define how molding window calculated
  - Feasible molding window limits
  - Preferred molding window limits





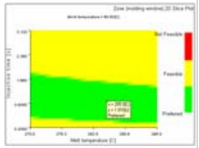
Advanced Options – Change Default Settings

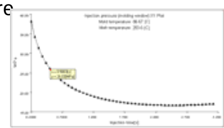
- Feasible window
  - Pressure factor to 0.8
    - Default 1.0, 100% of machine capacity
- Preferred window
  - Pressure factor to 0.5
    - Default 0.8
  - Flow front temp drop limit to 20ºC (36ºF)
  - Flow front temp rise limit to 2ºC (4ºF)
- Changes will only affect the Zone plot

Molding Window Analysis Interpretation

```
Recommended Mold Temperature    :      90.00 C
Recommended Melt Temperature    :     290.45 C
Recommended Injection Time      :     0.4384 s
```

- Log files
- Zone plots
  - 2D Slice
- XY Graphs
  - Quality
  - Injection pressure
  - Minimum flow front temperature
  - Maximum shear stress
  - Maximum cooling time
  - Maximum shear rate





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General Interpretation Procedure

Look at how processing conditions influence the results

1. Screen output log file
   - Look at recommended conditions
2. Quality XY plot
   - Set X axis to Injection time
   - Set mold and melt to recommended
   - Decide to
     - Keep recommended
     - Determine alternative conditions
3. 2D Zone plot
   - Determine size of molding window
   - Find where processing conditions are in the window

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General Interpretation Procedure

4. Injection pressure XY
   - Set X axis to Injection time
   - Set mold and melt to conditions from Quality plot
   - Check if pressure is too high
5. Minimum flow front temperature
   - Set X axis to Injection time
   - Set mold and melt to conditions from Quality plot
   - Determine injection time for temperature drops from melt temperature
     - 0ºC, 10ºC (18ºF) & 20ºC (36ºF)
   - Decide on injection time to use

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General Interpretation Procedure

6. Shear Stress
   - Look at it compared to the limit for the material
7. Check remaining plots for problems
   - Cooling time
     - Look how cooling time changes with change in mold temperature
   - Shear rate
     - Ensure shear rate is not too high
     - Should never be a problem

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Screen Output log File

- Review
  - Recommended molding conditions
  - Compare to temperature ranges analyzed
  - Becomes basis for viewing results

```
   Match data was computed using the maximal-sphere algorithm
   Mold temperature range to analyze                    =   Automatic
      from mold temperature                             =      80.0 C
      to   mold temperature                             =      95.0 C
   Melt temperature range to analyze                    =   Automatic
      from melt temperature                             =     270.0 C
      to   melt temperature                             =     295.0 C
   Injection time range to analyze                      =   Automatic
   Limits for calculation of feasible molding window
      Shear rate limit                                  =       Off
      Shear stress limit                                =       Off
      Flow front temperature drop limit                 =       Off
      Flow front temperature rise limit                 =       Off
      Injection pressure limit factor                    =      0.80
      Clamp force limit                                 =       Off
   Limits for calculation of preferred molding window
      Shear rate limit factor                           =      1.00
      Shear stress limit factor                         =      1.00
      Flow front temperature drop limit                 =     20.00 C
      Flow front temperature rise limit                 =      2.00 C
      Injection pressure limit factor                   =      0.50
      Clamp force limit factor                          =      0.80
Maximum Design Clamp Force     7000.22 tonne
Maximum Design Injection Pressure    :      140.00 MPa
Recommended Mold Temperature   :      90.00 C
Recommended Melt Temperature   :     290.45 C
Recommended Injection Time     :     0.4384 s

Execution time
   Analysis commenced at        Tue Jan 17 17:46:00 2006
   Analysis completed at        Tue Jan 17 17:46:04 2006
   CPU time used                        3.08 s
```

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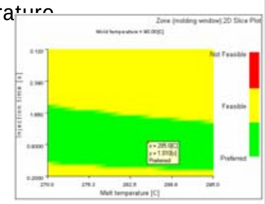
2D Zone Plot

- Defines the size of the molding window
  - Size determined by
    - Machine pressure limit
    - Advanced options settings
- Set cut axis to mold temperature
- Want large green area
- Query will indicate values at pick location



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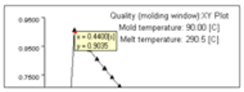
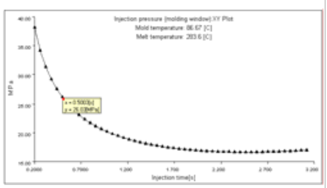
Quality Plot

- Set X axis to time in result properties
- Set mold and melt to recommended
- Decide if recommended conditions are practical
  - In middle of the range?
  - Move mold and melt sliders to see effect on quality
  - Pick mold and melt to use
  - Query max quality for time



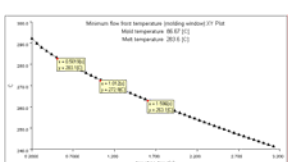
Injection Pressure

- Set X-axis to injection time
- Make sure pressure not too high
  - Design limit should be 70 MPa (10,000 psi) or about 50% of machine limit
  - Check at specific conditions by query
    - Pick on curve to find injection time



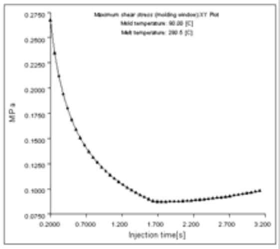
Minimum Flow Front Temperature

- Set X-axis to injection time
- Query to find 0ºC, 10ºC (18ºF) & 20ºC (36ºF) temp drops from melt temperature
  - Represents good window
  - 0º represents the fastest time
  - 10ºC (18ºF) the middle
  - 20ºC (36ºF) the end



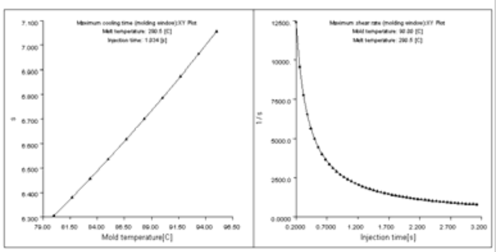
Shear Stress

- Set X-axis to injection time
- Make sure shear stress not too high
  - Should be well below limit in material DB



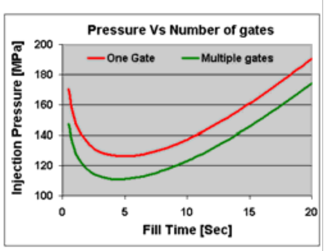
Check Remaining Plots

- Check to make sure no problems are present
  - In particular make sure the shear stress is below the design limit in the database



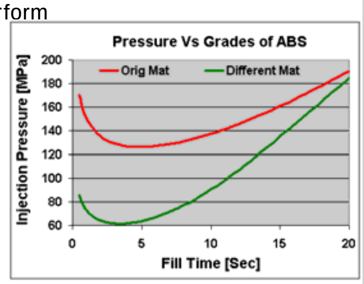
Use to Investigate Number of Gates

- Use Molding Window analysis to quickly check out if multiple gates will help lower the pressure
- Try different gate locations



Different Materials

- Use the Molding Window analysis to see how different materials will perform



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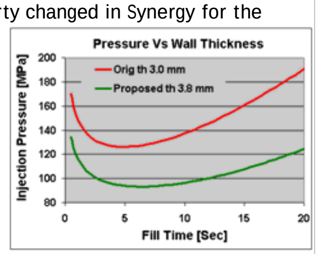
Proposed Wall Thickness Change

- Investigate how pressures change with changes in wall thickness
  - Wall thickness property changed in Synergy for the quick test



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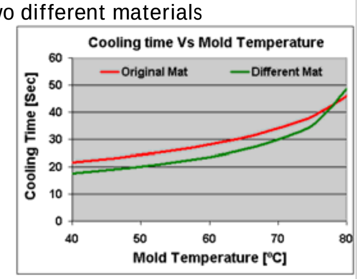
Compare Cooling Times

- See the effect of mold temperature on cooling times
- Also comparing two different materials



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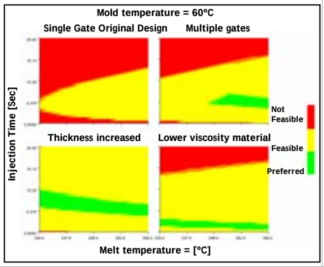
Summary

- Zone plots of the different examples
  - Original design will not work
  - Adding gates has small window
  - Increased thickness has larger window
  - Lower viscosity can fill the part



Practice

- Material
  - Use BASF, Capron 8333GHS
- Gate locations
  - Center gate
- Design Criteria
  - 2-plate tool
  - Determine optimum processing conditions for the given gate location

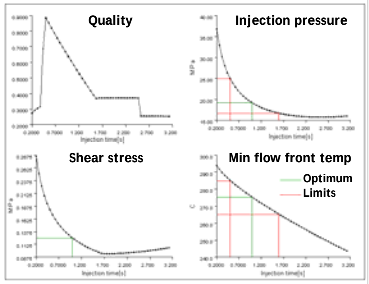
Practice

- Cell Phone
  - Material
    - PC+ABS, Bayer material science Bayblend FR 2000
  - Design Criteria
    - Determine which gate location is best, center or end gate

- Door Panel
  - Materials
    - ABS, Chi Mei, Polylac PA-727
    - ABS, Asahi Kasei, Stylac 190F
  - Design Criteria
    - Determine which material is going to work best

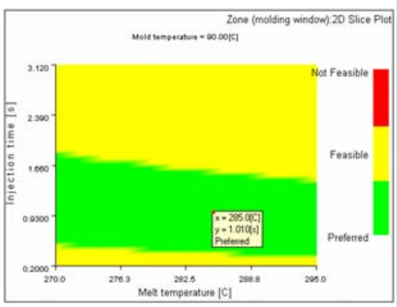
Cover

- Recommended conditions
  - Mold Temp
    - 90ºC
  - Melt Temp
    - 285ºC
  - Injection Time
    - 1.0 Sec
    - @~10ºC temp drop



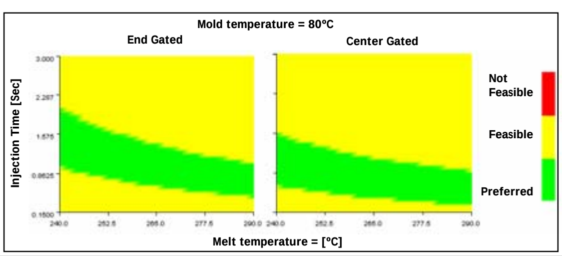
Cover

- Optimum conditions in the Zone plot



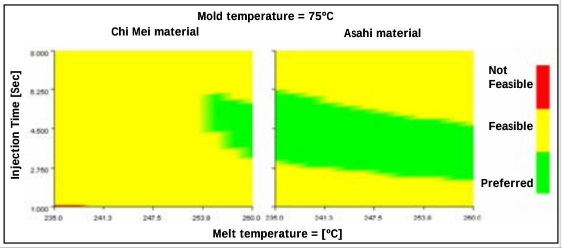
Phone

- Middle Gate 80ºC – 270ºC – 0.5 Sec
- End Gate 80ºC – 270ºC – 0.5 Sec



Door Panel

- Common Processing Conditions 75ºC – 257ºC – 4.5 sec
- Chi Mei grade pressure 68 MPa
- Asahi grade pressure 47 MPa



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QUESTIONS

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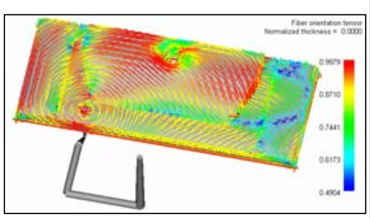
Fiber Filling and Packing



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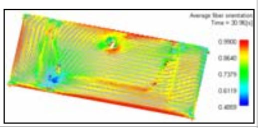
Introduction

- Aim
  - Introduce MPI/Fiber, background, running, interpreting results
- Why do it
  - Critical to use MPI/Fiber when going to Warp and Stress with a fiber filled material
- Overview
  - Background of fiber analysis is reviewed
  - Analysis results are interpreted

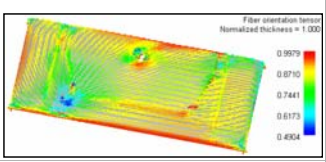
What is MPI/Fiber

- Also called
  - Fiber analysis
  - Fiber flow analysis
- Module used to calculate
  - Orientation of short fiber fillers in the molded part
  - Resulting thermo-mechanical properties of the composite part
- Fiber orientation significantly affects
  - Shrinkage
  - Warpage



Running MPI/Fiber

- Need
  - License of MPI/Flow
  - License of MPI/Fiber
  - Fiber filled material
- Can be used with all 3 mesh types
- Outputs are used in
  - MPI/Warp
    - (all 3 mesh types)
  - MPI/Stress
    - (Midplane only)



Why Run MPI/Fiber

- Fiber orientation is the main cause of warpage for fiber filled thermoplastics
- Fibers changes the mechanical properties of the composite
- Fiber orientation varies with
  - Flow front shape
  - Thickness
  - Geometry
- Must optimize fiber orientation to solve warpage problems

Why use Fillers

- Fillers improve the material matrix properties
  - Increased stiffness
  - Increased strength
  - Reduced creep and stress relaxation over time
    - Time dependant properties
  - Increased upper temperature use limits
  - Improved dimensional stability
  - Reduced material costs
  - Increased electrical and thermal conductivity

Types of Fillers

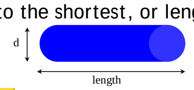
- Reinforcing Fibers
  - Glass, carbon, fibrous minerals, boron, kevlar
    - Increased flexural stiffness (modulus)
    - Increased tensile strength
    - Reduced creep and stress relaxation over time
    - Increased heat deflection temperature
    - Improved dimensional stability (reduced shrinkage)
- Conductive Fillers
  - Carbon fiber, graphite, aluminum powders
    - Increased electrical conductivity
    - Improved thermal conductivity

Types of Fillers

- Coupling Agents
  - Silanes, titanates
    - Improved interface bonding between matrix and fibers
- Flame Retardants
  - Chlorine, bromine, phosphorous, metallic salts
    - Reduces occurrence and spread of combustion
- Extender Fillers
  - Calcium carbonate, silica, clay
    - Reduces material cost

Filler vs. Fiber

- MPI/Fiber is used to analyze fiber filled thermoplastic materials
- Only fillers with aspect ratio greater than 1 are analyzed in MPI/Fiber (shape of fiber)
- Aspect ratio
  - The ratio of the longest side to the shortest, or length divided by diameter l/d



  - AR < 1, flakes 
  - AR =1, cubes or spheres 
  - AR > 1, fiber like 

Aspect Ratios for Different Fillers

- Aspect ratio < 1
  - Glass, metal, mica
- Aspect ratio = 1
  - Talc, minerals
- Typical aspect ratio for fibers = 25
  - Average/default aspect ratio for short fiber
  - Glass, carbon, kevlar
- Highest aspect ratio allowed = 5.0+E6
  - Long fibers are broken up passing through the machine
    - A high aspect ratio fiber can be run with the short fiber assumption

Results from MPI/Fiber

- All standard flow analysis results
- Average Fiber Orientation
- Fiber Orientation Tensor
- Poisson's Ratio
- Shear Modulus
- Tensile Modulus
  - 1st principal direction
  - 2nd principal direction - perpendicular to 1st
- Linear Thermal Expansion Coefficient
  - 1st principal direction
  - 2nd principal direction - perpendicular to 1st

MPI/Fiber results are symmetrical through the thickness unless a cooling analysis has been run

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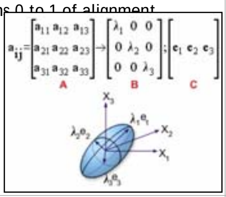
General Orientation Ellipsoid

- Used to describe the fiber orientation
- Graphically defines second order tensor
  - A – 9 components of the coordinate system or
  - B – Eigenvalues and C - Eigenvectors
    - Eigenvalues – statistical proportions 0 to 1 of alignment
    - Eigenvalues – principle direction of fiber orientation
- For display the 3D ellipsoid
  - Projected to a plane forming a plane ellipse



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Orientation Tensor

- Txx – Magnitude of alignment in global X direction
- Tyy – Magnitude of alignment in global Y direction
- First principal value – magnitude of alignment in direction with most alignment
  - Default
  - Most useful

Orientation Ellipsoid Notation	Fiber Plot Properties Notation
a_{11}	T_{xx}
a_{22}	T_{yy}
a_{33}	T_{zz}
a_{12}	T_{xy}
a_{13}	T_{xz}
a_{23}	T_{yz}

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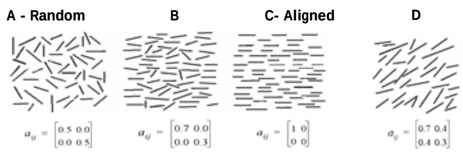
Orientation Results

- A – Fibers random in plane of element
- B – Most fibers aligned in X direction
- C – All fibers aligned in X direction
- D – Principal alignment not in X direction



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MPI/Fiber Input to Warp and Stress

- Layer based data used as input include
  - Fiber orientation
  - Mechanical properties
    - Elastic modulus
    - Shear modulus
    - Poisson's ratio
    - Thermal expansion coefficients
  - In-cavity residual stress
- Can be exported to other structural analysis packages

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Fiber Property Requirements

- Filler type
- Weight fraction - converted from
  - Weight fraction
  - Fiber density
  - Composite density
- Aspect ratio
- Density
- Thermal properties
  - Specific heat
  - Thermal conductivity
- Mechanical data
  - Elastic modulus
  - Poisson's ratio
  - Coefficient of thermal expansion
  - Shear modulus

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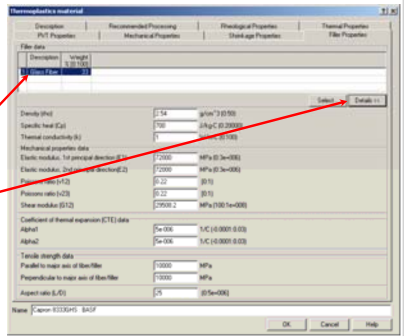
Fiber Properties

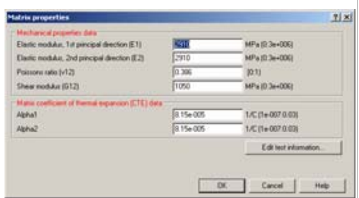
Highlight the filler

Click **Details** to see the properties



Material Properties

- Mechanical Properties tab is the composite (polymer + filler)
- Fiber properties are mechanical properties of the filler
- Matrix properties are for the base polymer (no filler)
- Solver uses Fiber properties and Matrix properties
  - If Matrix properties don't exist they are calculated by the flow solver

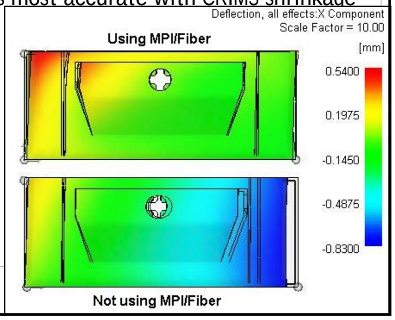


MPI/Fiber Assumptions

- Short fiber analysis
  - Long glass fibers are assumed to break in the machine so they will be "short" when entering the part
- Fibers are evenly distributed throughout the volume
- Fibers align
  - Parallel to flow direction in high shear rate areas
  - Transverse or random to flow direction at the center line
- Fiber to fiber interaction is considered, C_i
- Variation of orientation based on thickness is also considered, D_z

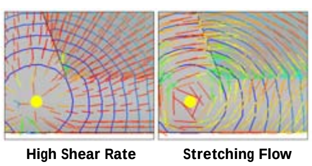
Fiber and Warp

- Warpage analysis uses fiber results when available
- Warpage results most accurate with CRIMS shrinkage data

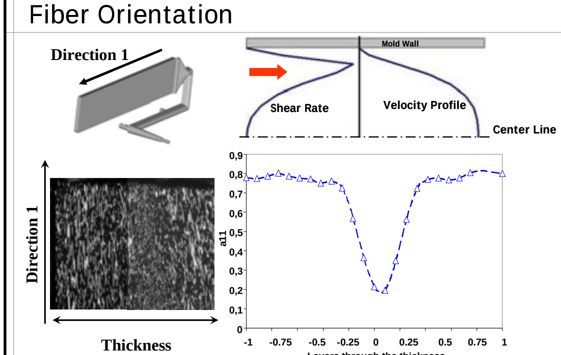


Fiber Orientation

- Fiber orientation is complex
- Two rules of thumb exist
  - High shear rate
    - Tend to align fibers in the direction of flow
  - Stretching flows
    - Tend to align fibers in direction of stretching
    - A radial flow pattern fibers are aligned perpendicular to the flow



Fiber Orientation

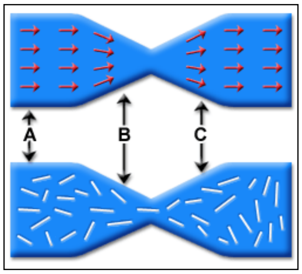


Converging vs. Diverging Flow

A = Entrance: Random Fibers

B = Converging Flow: Flow aligned Fibers

C = Diverging Flows: Transverse Alignment



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Other Factors Affecting Orientation

- Part geometry
- Processing conditions
  - Filling speed - most influence
    - Thicker core and thinner skin layers
- Fiber average aspect ratio and concentration
  - Increased aspect ratio and concentration
    - Yields increased flow aligned orientation

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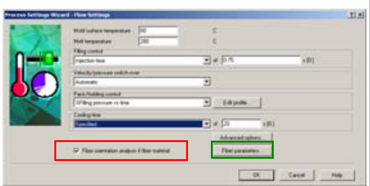
Running a Fiber Analysis

- Select a polymer material with fiber content
- In the Process Settings Wizard select
  - Check - Fiber orientation analysis if fiber material
    - Checked by default
  - Optional - Fiber parameters



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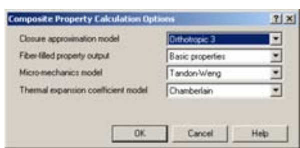
Fiber Parameters

- Calculate fiber interactions using
  - Auto-calculated C_i and D_z values (Default)
    - Dz based on average part thickness, C_i calculated using D_z
  - Auto-Calculated D_z Specified C_i
  - Specified C_i and D_z
- Fiber inlet condition at gate
  - Fibers aligned at skin/transverse at core
  - Fibers aligned at skin/random at core

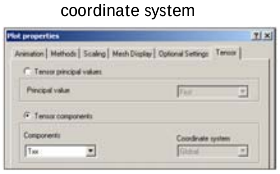
Composite Property Calculation Options

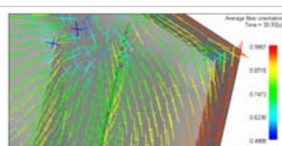
- Information included for research and development in the fiber code
- Default values appropriate for most conditions
  - Not recommended to change



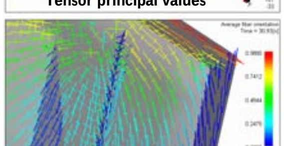
Reviewing Midplane and Fusion Results

- Tensor Principal values
  - First – Default
  - Shows alignment in direction of alignment
- Tensor components
  - Alignment based on coordinate system





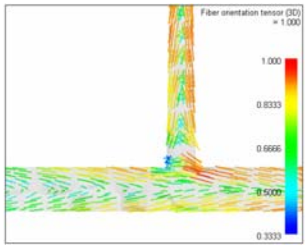
Tensor principal values



Tensor Components (T_{xx})

Reviewing 3D results

- Tensor Principal values
  - First – Default
  - Range from ~0.33 to 1
- 3D random = 0.33
- In plane random 0.5
- Fully aligned 1.0



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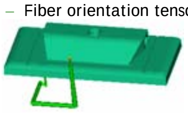
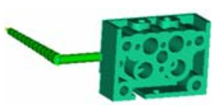
Exercise

- Cover, Fusion model
- Use Capron 8233GHS
- Evaluate the current gating location
- Review results
  - Fill time
  - Pressure
  - Average fiber orientation
  - Fiber orientation tensor

- Manifold, 3D model
- Use Capron 8233GHS
- Review results
  - Fill time
  - Pressure
  - Fiber orientation tensor





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QUESTIONS?

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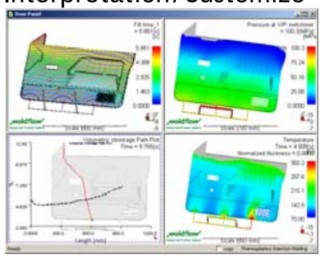
Results Interpretation/Customize



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Information

- Aim
  - Review types of results available
    - How to manipulate and interpret them
- Why do it
  - Understanding the results available and how to manipulate is critical to solving problems
- Overview
  - Result
    - Types
    - Definitions
  - Plot properties
  - Result manipulation

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Types of Results

- Single dataset
  - One value for filling or packing
  - Animation is minimum to maximum of result unit
- Intermediate Results
  - Results recorded through time

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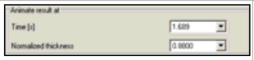
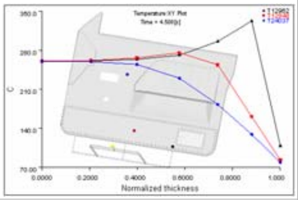
Result Types



- Intermediate Profiled
  - Results through the thickness
  - Results recorded through time
- XY Plot
  - 2D graph of results
  - Geometry dependant results
- Highlight
- Text file



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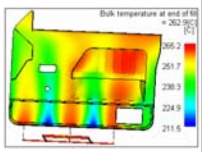
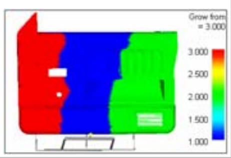
Single Dataset Results

- Fill time
- Temperature at flow front
- Bulk temperature at end of fill
- Frozen layer fraction at end of fill
- Pressure at V/P switchover
- Pressure at end of fill
- Grow from
- Sink Index
- Time to freeze
- Volumetric shrinkage at ejection





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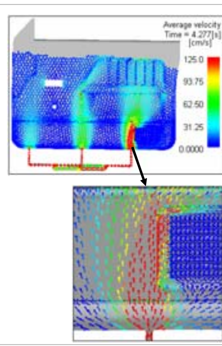
Intermediate Results

- Pressure
- Average velocity
- Bulk temperature
- Frozen layer fraction
- Shear rate, bulk
- Shear stress at wall
- Volumetric shrinkage
- Average fiber orientation (Fiber analysis only)



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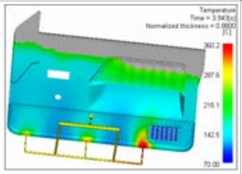
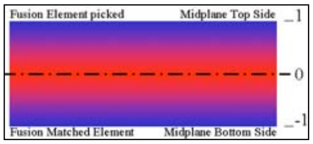
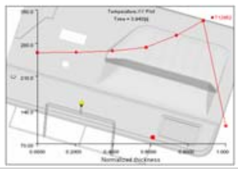
Profiled Results

- Shear Rate
- Temperature
- Velocity
- Fiber orientation tensor (fiber flow only)

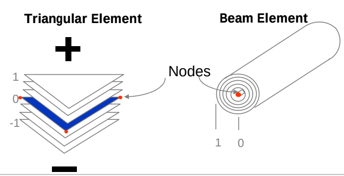






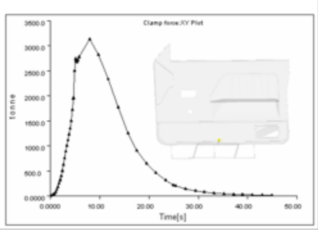
Profiled Results - Terminology

- Triangular elements use Finite Difference methods
  - Thickness divided into laminae or laminates
  - Profiled results store information on each laminae
  - Results on laminae referred to as Normalized Thickness



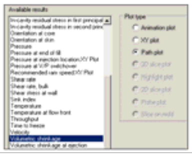
XY Plot

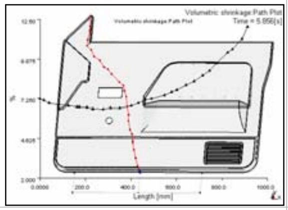
- Clamp force: XY plot
- % Show weight: XY Plot
- Pressure at injection location: XY Plot
- Recommended ram speed: XY Plot



Geometry Dependant Results (Path Plot)

- Any plot can be made into a plot path
- First node picked is the reference
- X-axis can be defined by
  - Distance from first entity
  - Total length of path
  - X, Y, or Z Coordinate





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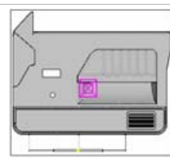
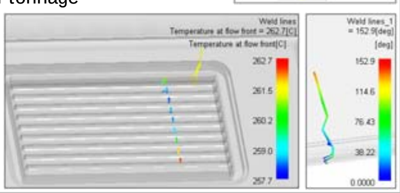
Highlight

- Weld lines
  - Customizable
- Air traps
- Clamp force centroid
  - At maximum tonnage





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Text File

- Screen output
  - Analysis startup information
  - Inputs to the analysis
  - Running status
  - Error messages
  - Run times
- Results summary
  - Similar to Screen output except for running status
  - Useful to review to get a sense of how well the analysis ran
- Analysis check
- Machine setup

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Screen Output File

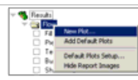
Table showing progression of analysis

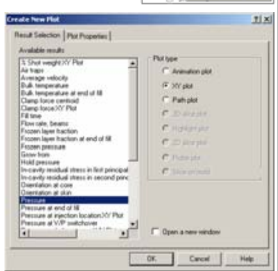
Filling phase: Status: V = Velocity control
P = Pressure control
V/P= Velocity/pressure switch-over

Time (s)	Volume (%)	Pressure (MPa)	Clamp force (tonne)	Flow rate (cm^3/s)	Status
0.23	2.06	26.79	6.58	296.12	V
0.45	5.72	42.93	18.52	581.55	V
0.68	10.55	44.51	29.42	587.23	V
0.90	15.45	46.07	47.09	586.74	V
1.13	20.15	48.55	82.46	580.91	V
1.35	24.85	51.35	127.01	581.82	V
1.58	29.51	54.46	182.07	581.39	V
1.81	34.36	57.85	249.80	583.03	V
2.03	38.98	61.01	321.04	586.03	V
2.26	43.67	64.07	401.55	587.49	V
2.48	48.31	67.42	502.74	587.12	V
2.70	52.91	71.27	627.43	587.51	V
2.93	57.63	75.16	757.79	589.25	V
3.16	62.24	78.98	892.89	590.75	V
3.38	66.87	82.15	1009.98	594.01	V
3.60	71.47	84.67	1114.70	595.82	V
3.83	76.20	87.08	1225.57	596.70	V
4.06	81.04	89.56	1348.97	597.30	V
4.28	85.56	92.34	1497.50	597.87	V
4.51	90.30	96.38	1718.66	598.97	V
4.73	94.85	100.20	1944.79	598.96	V
4.74	95.12	100.32	1960.32	595.54	V/P
4.95	97.84	92.00	2501.26	278.43	P
5.18	98.83	82.80	2737.70	93.42	P
5.24	99.02	80.26	2701.46	76.61	P
5.41	99.39	80.26	2677.81	73.42	P
5.64	99.76	80.26	2712.56	59.62	P
5.85	99.98	80.26	2767.66	48.62	P
5.86	100.00	80.26	2776.45	47.78	Filled

Result Creation

- New results may need to be created
  - XY plots
    - Intermediate
    - Profiled
    - Path plot
  - Second copy of existing results
- Results ➡ Create New Plot
- Context menu
  - Results icon in study tasks list
- Results toolbar



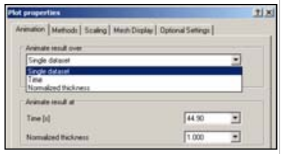


Properties of the Results

- Results ➡ Plot properties, Context menu, or 
- Property categories
  - Animation
  - Methods
  - Scaling
  - Mesh Display
  - Optional Settings
  - Highlight
  - XY Properties (1)
  - XY Properties (2)
  - Deflection

Animation Properties

- Animate result over
  - Depends on the result
  - Possible methods
    - Single dataset
    - Time
    - Normalized thickness
- Animate result at
  - Depends on the result
  - Possible methods
    - Time
    - Normalized thickness



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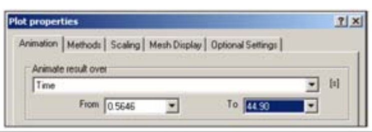
Animation Properties

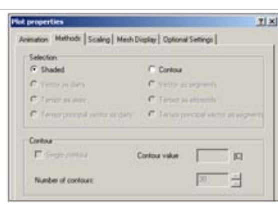
- Animate result over
  - Can limit the range of animation
    - Normally Time
  - Very useful to limit a Flow result to only fill
    - Bulk Temperature is a good example

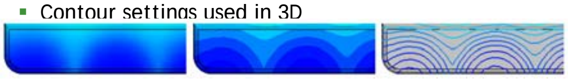


moldflow

Methods Properties

- Sets the style of display
- Normally
  - Shaded or Contour
- Some results use other methods
  - Vector
  - Tensor
- Contour settings used in 3D





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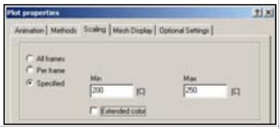
Scaling Properties

- All frames
  - All results at each time step scaled to min/max of all time steps (Frames)
- Per Frame
  - Min/max of currently displayed frame
- Specified
  - User controlled scale
  - Normally best to check OFF extended color
    - Extended color will plot the min or max color if value out of range



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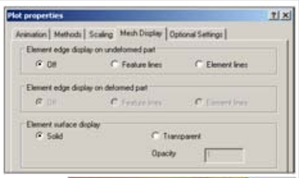
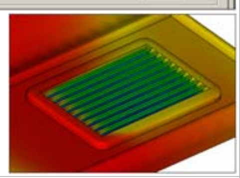
Mesh Display Properties

- How the model will be displayed
  - In most cases, edge display is off
- Filling
  - Solid, (most common)
  - Transparent
  - May need to adjust when overlaying results





Feature lines turned on

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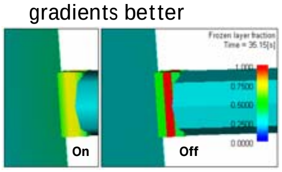
Optional Settings

- To see elemental results as elements
  - Turn off Nodal Averaged
  - May need to change animation setting
- Banded useful to see gradients better



Nodal averaged

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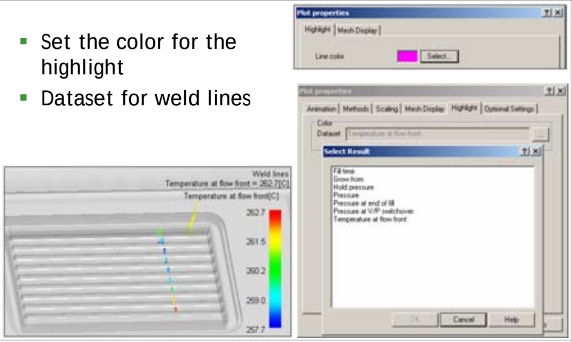
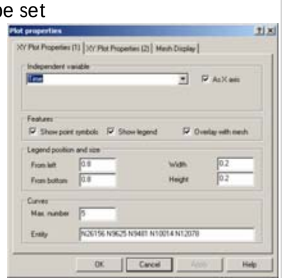
Highlight

- Set the color for the highlight
- Dataset for weld lines



XY Plot Properties(1)

- Independent variable
  - If profiled result, it can be set
    - Normalized thickness
    - Time
- Set axis of independent variable
- Position legend
- Define entities to plot



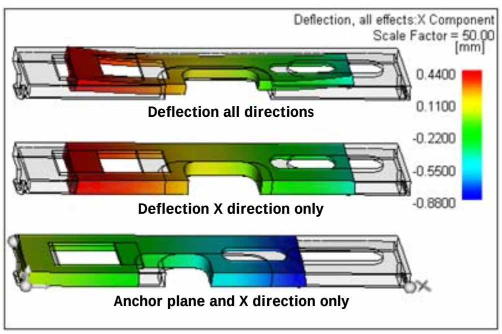
XY Plot Properties(2)

- Scale X & Y axis
  - Automatically
  - Manually
- Titles

Deflection

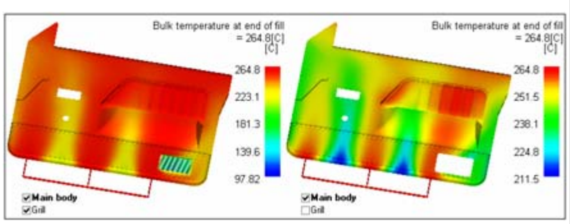
- Color
  - Dataset
    - Can show any result over deflected shape
  - Magnitude/Component
    - All effects
    - Component
      - X, Y, Z Etc.
  - Reference coordinate System
  - Coordinate system type
- Scale factor
  - Magnitude
  - Direction to apply scale to

Deflection



Scale by Layers

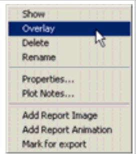
- Results automatically scale by visible layers

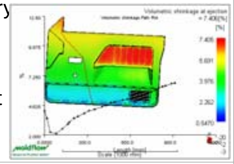


All part layers on   Grill layer off, results scaled by visible layers

Overlay

- Multiple results can be overlaid
- Procedure
  - Display one result
  - Highlight the second result
  - Right click and select overlay
  - Activate first result if necessary
- Only one result can be shaded
- Mesh Display
  - May need to set to transparent





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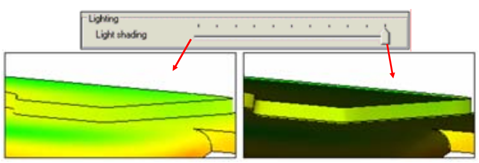
Lighting

- In preferences dialog
  - On viewer tab
- Shading adjusts color to see depth
- Distorts color from scale
- Maximum shading can make results look vivid and brilliant - best used on 3D results



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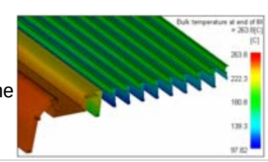
Cutting Plane

- Slices away part
- Useful to see small detail inside the part
- Get a sense of the thickness on a Fusion model
- More than one plane can be active at one time
- New planes can be created
  - The screen is the new plane



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Help on Interpretation

- F1 key
  - Ensure the result window is activated before pressing F1

Fill time result

The Fill time result shows the position of the flow front at regular intervals as the cavity fills. Each color contour represents the parts of the mold which were being filled at the same time. At the start of injection, the result is dark blue, and the last places to fill are red. If the part is a short shot, the section which did not fill has no color. For a full list of flow analysis results, click here.

Using this result

In a part with a good fill time result, the flow pattern is balanced. In a balanced fill time result:

- All flow paths finish at the same time. The flow fronts should reach the extremities of the model at the same time. This means that each flow path should end with dark blue contours.
- The contours are evenly spaced. The contour spacing indicates the speed at which the polymer is flowing. Widely-spaced contours indicate rapid flow, while narrow contours indicate that the part is filling slowly.

Things to look for

You can overlay the flow angle result on the fill time result, to confirm aspects of the filling behavior.

- **Short shot** - On the fill time result, a short shot will appear as translucent. Check the ends of the flow paths for any translucent areas. More?

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QUESTIONS?

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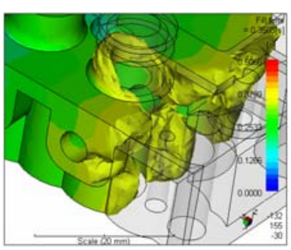
3D Results and Manipulation



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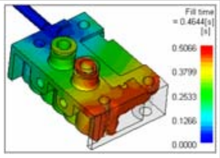
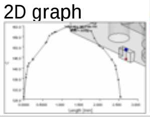
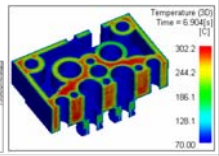
3D Result Classifications

- Single Dataset
  - One result written
- Intermediate
  - Multiple results written during filling and packing
- XY Plots
  - Intermediate results converted to an 2D graph
  - Probe plots

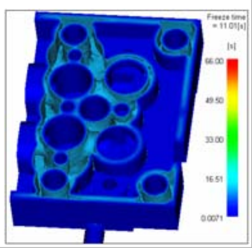






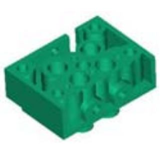
Single Dataset Results

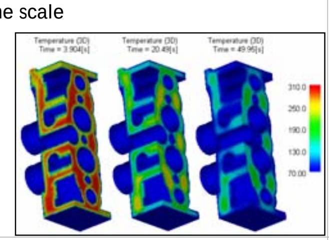
- Single Dataset Results
  - Fill Time
  - Time to Freeze
  - Shear Rate Maximum
- Modifications often used
  - Shaded
  - Single Contour
  - Feature lines & Transparent
  - Banded color
  - Cutting plane



Intermediate Results

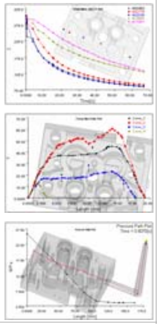
- Animated through time
- Most results used with a cutting plane
  - 2 planes used below
  - All plots use the same scale





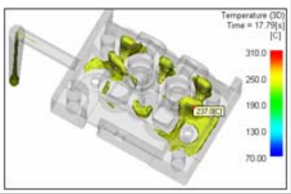
XY Plots

- Intermediate results
  - Converted to XY plot
  - Interior nodes picked by placing nodes/elements on new layer
- Probe
  - Shows results through thickness
- Path plot
  - Any result with data shown at various locations on the part



Single Contour

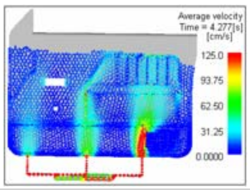
- Shows iso-surface
  - Set specific value
    - Non-time based intermediate results
  - Animate by
    - Time
    - Unit of result for single dataset
- Example
  - Temperature
  - Areas above transition at ~18 seconds

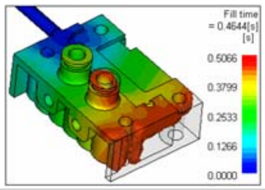


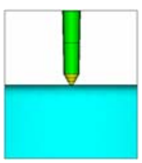
QUESTIONS?

Exercise

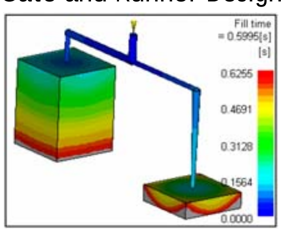
- Pick a part
  - Truck Panel – Fusion
  - Manifold – 3D
- Review the results







Gate and Runner Design



Introduction

- Aim
  - Review gate types and runner designs
  - Learn how to model feed systems and balance runners
- Why do it
  - Critical to properly model gates and to balance runner systems
- Overview
  - Review gate designs and how to model
  - Learn manual and automatic feed system modeling
  - Learn how to balance runners

Gate Types

- Manual Trim
  - Edge
  - Tab
  - Sprue
  - Diaphragm
  - Ring
  - Fan
  - Flash
- Automatic Trim
  - Submarine
  - Cashew
  - Pin
  - Hot drop
  - Valve

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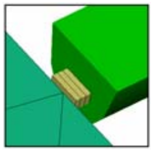
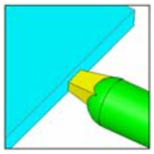
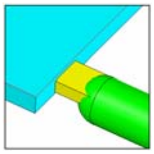
Edge Gate

- Most common manual trim gate
- Thickness 50% to 75% nominal wall
- Typical width – 2 to 4 x the thickness
- Can be constant thickness or tapered
- Modeling
  - 2-noded beam element
  - 3 elements minimum
  - 3D Tet's







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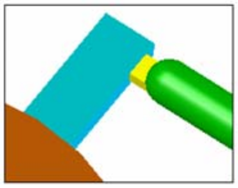
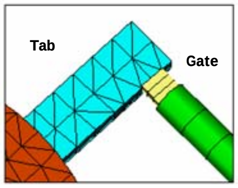
Tab Gate

- Gate goes into tab that goes to the part
- Similar to edge gate
- Used to lower shear stress in the part
  - Stress stays in the tab





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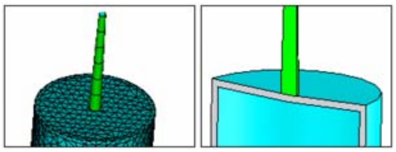
Sprue Gate

- Sprue directly into part
- Size at part dependant on sprue orifice size
- Modeled by
  - Beam elements
    - Midplane
    - Fusion
    - 3D
  - Tet's
    - 3D



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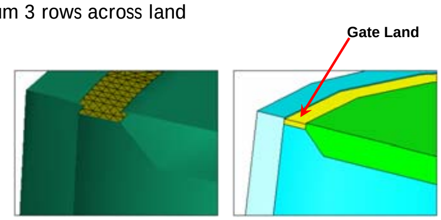
Diaphragm Gate

- Used to gate into the inside diameter of round parts
- Normally has thin land at part
- Modeled with shell elements
  - Minimum 3 rows across land



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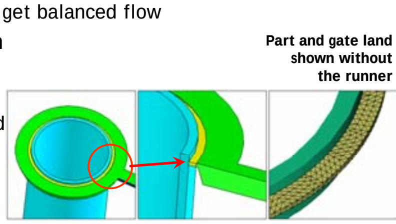
Ring Gate

- Like a diaphragm gate but is for the outside of the part
- Not recommended
  - Difficult to get balanced flow
- Modeled with
  - Beams
  - Triangles in gate land



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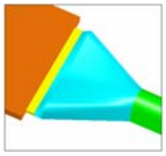
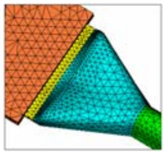
Fan Gate

- Wide edge gate
- Sized to achieve a flat flow front entering the part
- Modeled
  - 3D the best
  - Midplane
    - Combination of beams and tri's
  - Fusion
    - Rather thick and chunky
    - May be difficult as fusion





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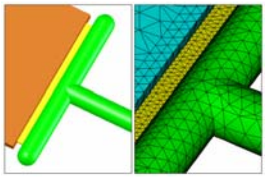
Flash Gate

- Similar to ring and fan gates
- Designed to have flat flow front entering part
  - Difficult to achieve
- Not recommended
- Modeled
  - 3D the best
  - Midplane
    - Combination of beams and triangles
  - Fusion
    - Rather thick and chunky
    - Must use beams to represent "runner" portion



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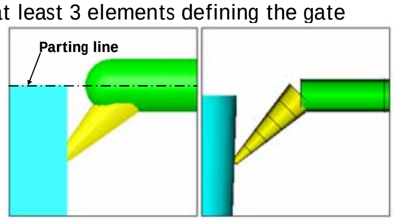
Submarine Gate

- Tapered round gate that intersects the part below the parting line
- Nominal orifice diameter 25% to 75% nominal wall
- Should have at least 3 elements defining the gate



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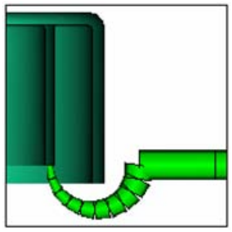
Cashew Gate

- Curved tunnel gate
- Difficult to machine
- Possible maintenance problem



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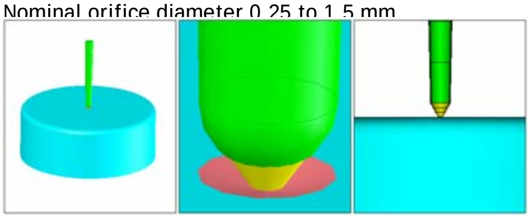
Pin Gate

- Used in 3 plate molds
- Very small orifice
- Modeled with beams
- Nominal orifice diameter 0.25 to 1.5 mm



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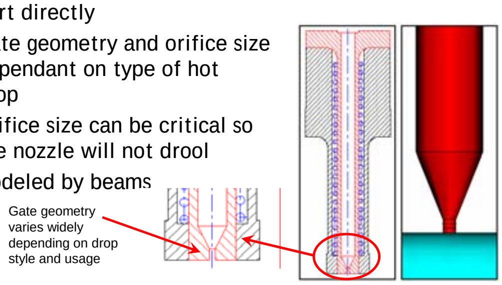
Hot Drop

- Delivers hot material to the part directly
- Gate geometry and orifice size dependant on type of hot drop
- Orifice size can be critical so the nozzle will not drool
- Modeled by beams



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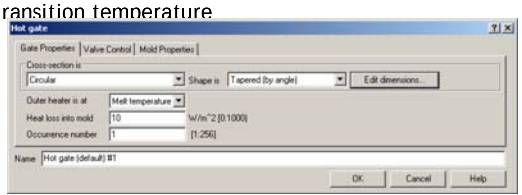
Hot Drop

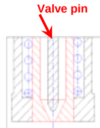
- Orifice transition between
  - "Hot" runner
  - "Cold" runner
- Can set outer heater temperature to a value near the transition temperature

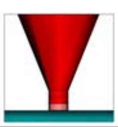


moldflow

Valve Gate

- Similar to a hot drop but the gate orifice is closed by a pin
- Last element in gate assigned valve gate controller
  - Many options for control
- Modeled by beams





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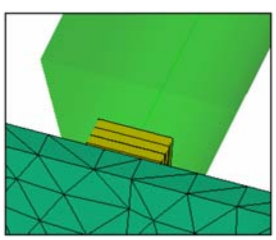
Elements in a Gate

- Gates should have a minimum of 3 elements across the gate to accurately predict
  - Gate freeze time
  - Shear rate
  - Pressure



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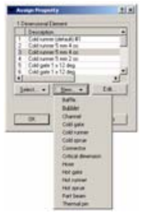
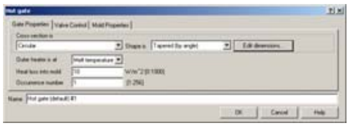
Setting the Cross Section

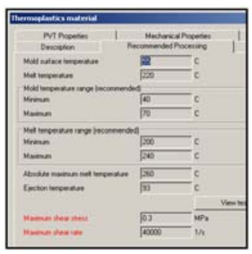
- Select the elements
- Assign properties
  - Choose the type of property
  - Set the properties
  - Or . . .
- Edit properties
  - If property type correct but dimensions must change





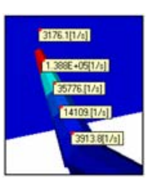
Gate Sizing

- Gates should be sized using shear rate as a guide to refine the gate size from nominal values
- Shear rate guidelines are found in the material database

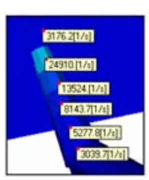


Gate Sizing

- Keep the gate shear rate below the material limit
- If the gate geometry allows
  - Reduce shear rate to about 20,000 1/sec.
- Easy for large gates
  - Edge
  - fan
  - flash
- Difficult for
  - Sub-gates
  - hot drops
- Impossible for
  - Pin gates



Before Sizing

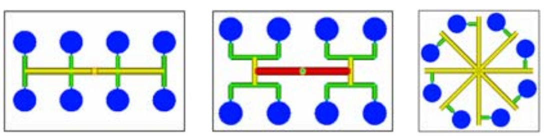


After Sizing

QUESTIONS?

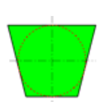
Runner Layouts

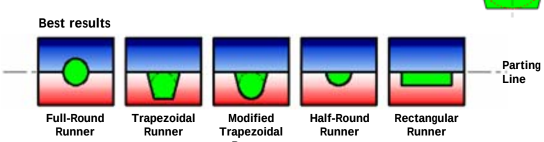
- Three common layouts
  - Standard, Herringbone
  - “H” Pattern, Geometrically balanced
  - Radial



Runner Cross-Sectional Shapes

- Best cross-section is full round
- Good substitute is trapezoidal or modified trapezoidal
  - Depth should be equal to round and sides tangent to circle





Standard Runner Sizing

- Standard sizes for runners are material dependant
- Several sources of these values are available including
  - Material Suppliers
  - Reference books
- Typically a wide range is given

Material	Diameter		Material	Diameter	
	mm	inch		mm	inch
ABS, SAN	5.0 - 10.0	3/16 - 3/8	PET	3.0 - 8.0	1/8 - 5/16
Acetal	3.0 - 10.0	1/8 - 3/8	Polyethylene	2.0 - 10.0	1/16 - 3/8
Acrylic	8.0 - 10.0	5/16 - 3/8	Polypropylene	5.0 - 10.0	3/16 - 3/8
Nylon	2.0 - 10.0	1/4 - 3/8	Polystyrene	3.0 - 10	1/8 - 3/8
Polycarbonate	5.0 - 10.0	3/16 - 3/8	PVC	6.0 - 16	1/4 - 5/8

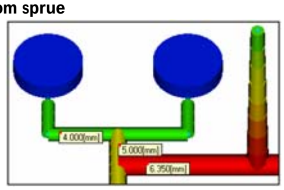
Runner Sizes

- Dependant on
  - Runner length
  - Material viscosity
  - Pressure requirements of the part
- Without analysis runners are often larger than needed wasting
  - Material
  - Cycle time
  - Money!!

Branched Runners

- Runners should get smaller from sprue to gate
  - On geometrically balanced runners
  - Keeps pressure gradient about equal
  - Use $D_{feed} = d_{branch} \times N^{1/3}$
    - D_{feed} = **Runner closer to sprue**
    - D_{branch} = **Runner farther from sprue**
    - N = **No of branches**

5.04 mm = 4 mm x $2^{1/3}$

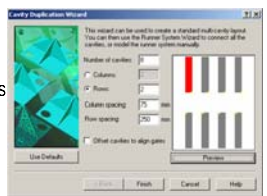


Runner Creation

- Create with Wizards
  - Cavity Duplication Wizard
  - Runner System Wizard
- Manual construction
  - Copy
  - Create curves
  - Create beams

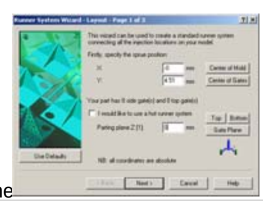
Cavity Duplication Wizard

- Assumes parts are in the XY plane
- Assign an injection location on the part
- In preview
  - Red part is the original
  - Yellow dot is the gate
- Define
  - Number of cavities
  - Number of columns or rows
  - Center to center spacing
- Align by gates if not quite on centerline



Runner System Wizard

- Creates a balanced runner system
- Assumes XY plane is the parting plane
- Page 1
  - Locate sprue
    - Defaults to center of mold
  - Confirm type of gates
    - Side gates are sub-gates
    - Top gates are
      - Pin gates (3-plate mold)
      - Hot drops
  - Check for hot runners
  - Set location of parting plane



Runner System Wizard

- Page 2
  - Define sprue size
    - Standard DME sprue
      - 2.38º included angle
      - 1.19º taper angle
  - Define runner diameter
  - Define shape
    - Round
    - Trapezoidal
  - Define drops for
    - Top gates
    - Hot runners

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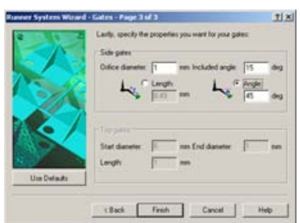
Runner System Wizard

- Page 3
  - Define gate size
  - Gates always round cross section
  - Side gates
    - Assumes sub-gate
    - If edge gate
      - Set included angle to 0
      - Define length
  - Top gates for
    - 3-plate tool
    - Hot Drop
      - Always cold



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Manual Runner Construction

- Order of construction dependant on the tool layout
- Position cavities so 0, 0, 0 (X,Y,Z) location is at base of sprue - optional
  - Called tool position
- Duplicate cavities
- Construct
  - Gate(s)
  - Runners
  - Sprue
- Create curves then mesh or create beams directly

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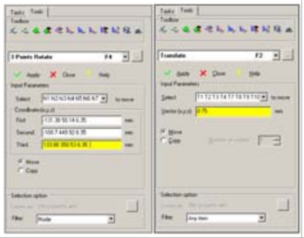
Adjust the Position of a Part

- 3 Point Rotate
  - Copy or move part in space creating a new global coordinate system
  - Move to "Tool Position"
- Translate
  - Move part(s) so 0,0,0 is at the base of the sprue
  - Copy part(s) to create additional cavities



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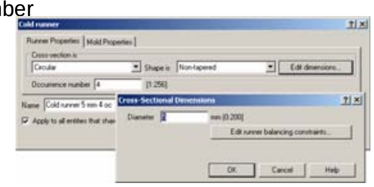
Entity Properties

- Occurrence number
  - Runners
  - Gates
  - Cavities
- Cross-sectional
  - Shape
  - Size
- Runner constraints
  - Limits runner sizes during runner balancing
  - Gates, and sprues not sized



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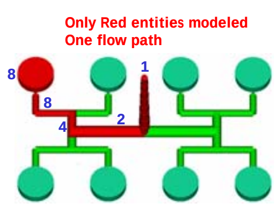
Occurrence Numbers

- Accounts for symmetry
  - Within a flow path
  - For geometrically balanced tools - one cavity is needed
    - Each time runner splits occurrence number doubles
      - Sprue = 1
      - Main = 2
      - Secondary = 4
      - Last runner Part, Gates = 8
- Minimizes cavities modeled



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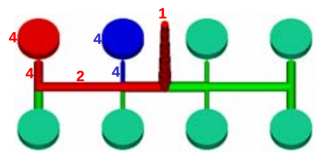
Occurrence Numbers

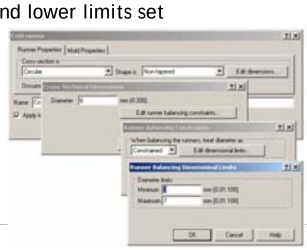
- Non-geometrically balanced have more than one flow path
  - Example below has two
- Occurrence number is determined by the number of times an entity occurs within a flow path

Red entities are flow 1
Blue entities are flow 2



Runner Constraints

- Runner size constraints set for runner balancing
  - Fixed – Will not change
  - Unconstrained – Can change to anything necessary
  - Constrained – Upper and lower limits set
- Default
  - Unconstrained
- Gates and sprue are not sized by runner balancing
  - Only runners sized

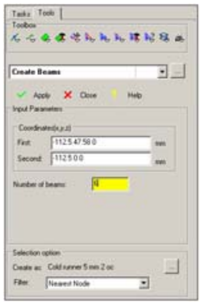


Feed System Construction

- Create curves
  - First coordinate
    - Typically an existing node
  - Second coordinate
    - Specified with global or relative coordinates
    - Depends on the situation
  - Properties
    - Best to set properties as curve is created
- Mesh curves
  - L/D ratio ~2.5:1
- Minimum of 3 elements

Feed System Construction

- Create beams
  - First coordinate
    - Typically an existing node
  - Second coordinate
    - Enter in active coordinate system
    - Click on an existing node
  - Number of beams
    - Ensure a L/D ratio of ~2.5:1
- Not recommended for tapered sections
- Minimum of 3 elements



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QUESTIONS?

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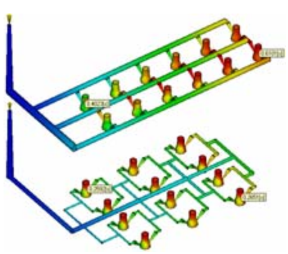
Runner Balancing

- Changes the size of runner elements
  - Each part/flow path takes about the same
    - Pressure to fill
    - Time to fill
- Process controlled by the target pressure
- Creates a new study with the revised sizes



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Why Balance the Runners?

- Ensure parts will fill evenly (balanced)
- Ensure packing is uniform
- Larger processing window
- Maintain an acceptable pressure magnitude
- Minimize runner volume

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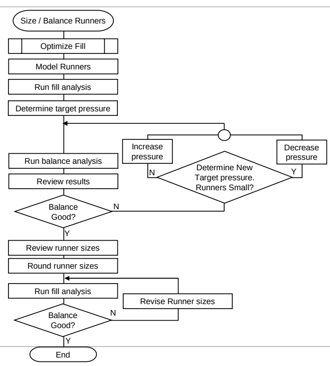
Runner Balance Procedure



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Runner Balance Procedure

- Optimize fill
  - All part optimization issues
    - Gate location
    - Molding conditions
- Model runners
  - Constrained as necessary
- Run fill analysis with runners
  - Use flow rate rather than injection time
  - Ensures proper fill time for the parts
  - Switchover @ 100%

$$\text{Flow Rate} = \frac{\text{Total volume of the parts}}{\text{Injection time for the part}}$$

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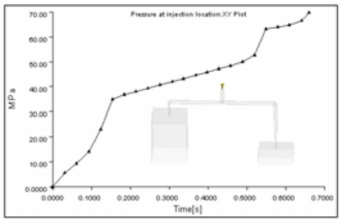
Runner Balance Procedure

- Determine Target Pressure
  - Pressure at the Injection location
    - Higher pressure decreases runner size
    - Normally start near the maximum pressure



Runner Balance Procedure

- Runner Balance Analysis
  - Based on a fill analysis
    - Adds a 2nd page to the Process Settings wizard
  - Target pressure
  - Advanced . . . Runner Balance
    - Mill tolerance
      - Increment of the runner size change
    - Maximum iterations
      - No. of analyses run at max
    - Time Convergence tolerance
      - % time difference between first and last cavities to fill
    - Pressure Convergence tolerance
      - Difference between actual and target pressures

Runner Balance Procedure

- Review Runner Balance Results
  - Two results created
    - Original study
      - Screen output file
      - Volume Change
    - New study
      - Contains revised runner sizes
      - Has (Runner Balance) appended to the study name
      - Has **fill** analysis results

Runner Balance Procedure

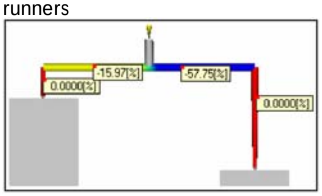
- Review Results
  - Screen Output runner balance iteration table
    - Imbalances should go below tolerances

```
Balance Target Pressure        70.0000 MPa
Mill Tolerance         0.1000 mm
Maximum Iteration Limit   20
Time Convergence Tolerance        5.0000 %
Pressure Convergence Tolerance        5.0000 MPa
Section Convergence Tolerance        0.7000

Iteration   Time Imbalance   Pressure Imbalance  Section Imbalance
                  (%)               (MPa)
  0         21.3837           17.3280            0.6160
  1          1.1076            6.2320            0.3364
  2          2.6103            5.6440            0.3224
  3          1.5539            5.5660            0.3094
  4          0.1441            5.7650            0.2930
  5          1.7397            4.6430            0.2674
Ideal Balance Complete: Allowing for mill tolerance and pressure control
  6          1.7397            4.6430            0.2674
```

Runner Balance Procedure

- Review Results, Volume Change
  - Shows runner volume change
    - Original to revised
  - Negative indicates reduction in volume
  - Zero indicates fixed runners

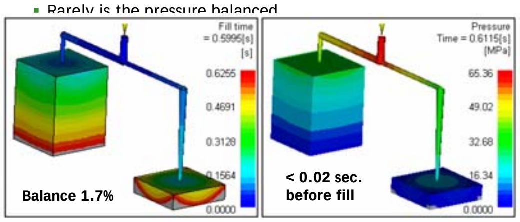


Runner Balance Procedure

- Review Results, New Study
  - (Runner Balance) appended to the study name
    - Time balance
      - Is the time to fill the cavities close enough?
      - Is 5% OK, or should it be tighter?
    - Pressure balance
      - Is the pressure even between the cavities?
      - If not, is it OK anyway?
    - Runner sizes
      - Are the runner sizes good, too small or big?
      - Can they be averaged or rounded to close standard sizes?

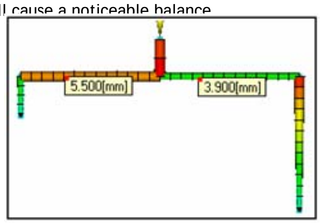
Runner Balance Procedure Review

- Results, Time and Pressure Results
  - Time imbalance may be very small
  - Pressure may suggest the balance is not close
    - Rarely is the pressure balanced



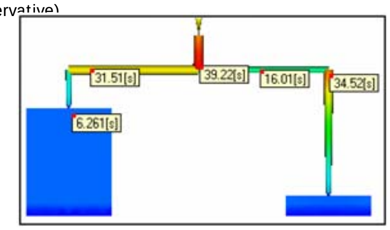
Runner Balance Procedure

- Review Results, Revised Thickness
  - Review revised runner sizes
  - Thickness can be rounded
    - Too much change will cause a noticeable balance



Runner Balance Procedure

- Review Results, Time to Freeze
  - Runner cooling time should not be less than
    - 80% of part
    - 100% (conservative)



Runner Balance Procedure

- Round runner sizes
  - Nearest standard size if close
  - Re-run fill to validate final sizes
- Validate Beyond Filling
  - Packing
    - Volumetric shrinkage should be uniform
      - Between cavities
        - » Indicate the runners are not too small
      - Across cavities
        - » Good packing profile
  - Warpage
    - Linear dimensions should be similar and within tolerance
    - Warp shape/magnitude should be similar

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QUESTIONS?

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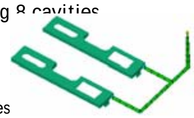
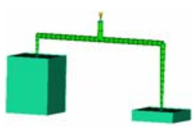
Practice

- Modeling practice
  - Create 2-cavity layout representing 8 cavities
    - Use given drawing
    - Use Cavity Duplication Wizard
    - Use occurrence numbers
    - Use manual runner creation techniques
  - Create 2-cavity box & lid family tool
    - Use Runner System Wizard
- Runner Balance
  - 2-cavity box & lid family tool
  - Preliminary inputs provided





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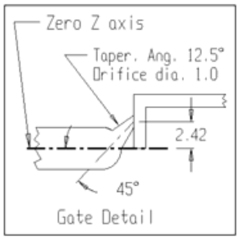
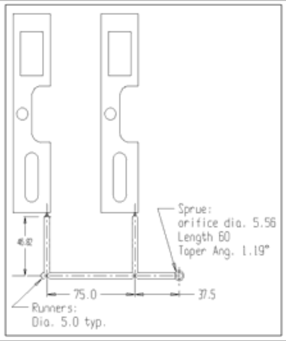
Snap Cover Detail





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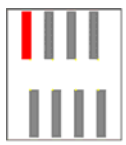
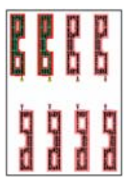
Snap Cover – Duplicate Cavities

- Use Cavity Duplication Wizard
  - 8 cavities
  - Specified by rows
  - Column spacing 75 mm
  - Row spacing 260 mm
  - Align gates
- Delete 6 of 8 cavities
- Assign occurrence numbers to cavities





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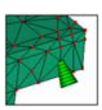
Snap Cover - Model Gate

- Normally created with beams
- Create curve
  - Gate layer
- Mesh curve
  - Place on gate layer
  - At least 3 elements
- Pick first coordinate
  - Node on part
- Set gate properties
  - Size/shape
  - Occurrence No.



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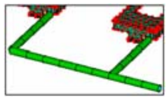
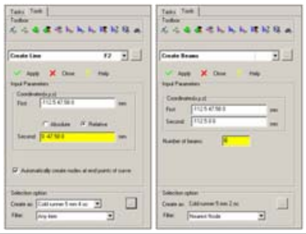
Snap Cover - Model Runners

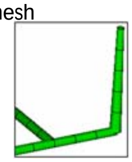
- Create
  - Runner layer
  - Curve then mesh to get beams
  - Beams directly
  - L/D ratio 2.5:1 to 3:1
  - Minimum 3 elements
- Set properties
- Create coordinates
  - Existing nodes and/or
  - Coordinates in space





Model Sprue

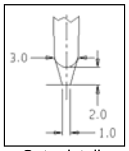
- Set properties
  - Use database of standard sizes
- First Coordinate
  - Top of sprue
- L/D ratio 2.5:1 to 3:1
- Create curve then mesh



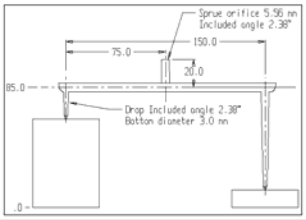
QUESTIONS?

Box and Lid Runner System Modeling

- Initial study has both parts added
  - Used the File ➡ Add command
- Runner system Wizard used to create feed system
- Constrain the drops



Gate detail



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Box and Lid Runner Balance Analysis

- Run fill analysis with runner system
  - Material Austran SAN23, Huntsman Chemical Co.
  - Mold 60ºC, melt 225ºC, flow rate 56.7 cm^3/sec
  - Switchover at 100%, Pack Pressure 100% fill pressure
- Determine target pressure
  - Use pressure at injection location: XY plot
- Run the balance analysis
  - Use 70 MPa as the target pressure
- Review results
  - Time
  - Pressure

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QUESTIONS?

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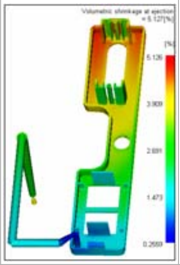
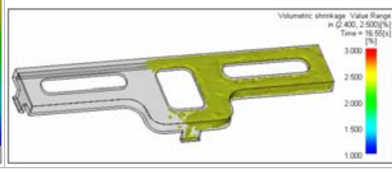
Basic Packing



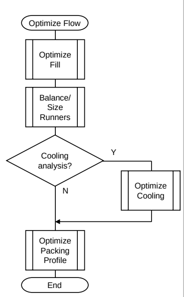


Introduction

- Aim
  - Learn procedures for running a packing analysis
- Why do it
  - Main output of packing is volumetric shrinkage
  - Primary importance for shrinkage/warpage, sink marks
- Overview
  - When to run packing
  - Definitions
  - Input parameters
  - Running a packing analysis
  - Reviewing results

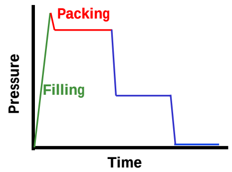
When to Run a Packing Analysis

- Packing is part of flow/part optimization
- Packing done after
  - Filling optimized
    - Gate location
    - Molding conditions
    - All filling issues addresses
  - Runners sized/balanced
  - Cooling analysis finished
    - Optional but recommended
    - Defines tools ability to extract heat



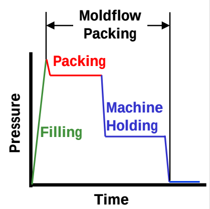
Definitions

- Packing pressure
  - Magnitude of pressure applied after the velocity to pressure switch-over (V/P switch-over)
- Packing time
  - The time pressure is applied after V/P switch-over



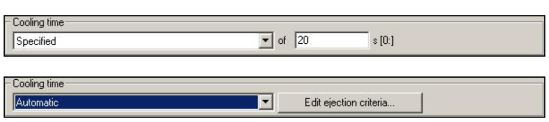
Definitions

- Hold pressure
  - Used interchangeably with packing time
  - Also used to define a pressure other than “packing”
  - Normally a lower value
- Hold time
  - The time hold pressure is applied
- In process settings wizard
  - There is no difference between packing and holding



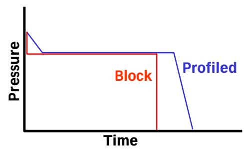
Definitions

- Cooling time
  - The time the part is held in the mold after pressure is removed
  - Also called cure time
- Specified with a packing analysis if cooling analysis is not done first



Packing Inputs

- Packing Profile
  - Packing Pressure
  - Packing Time
    - Time to get to pressure
- Cooling Time



Packing pressure vs time

	Duration s [0:300]	Packing pressure MPa [0:500]
1	0	36
2	8.8	36
3	0	0

Block

Packing pressure vs time

	Duration s [0:300]	Packing pressure MPa [0:500]
1	1	36
2	8.8	36
3	1	0

Profiled

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Packing Pressure

- Typical ranges from 20% to 100% of the fill pressure
  - Can be higher or lower
- Good starting point is 80% of fill pressure
- Don't exceed machine's clamp tonnage capacity
- Maximum packing pressure based on clamp tonnage
  - Defines the highest pressure that should be used

$$P_{max} = \frac{F}{A} 100 \times 0.8$$

P_{max} = Maximum packing pressure that should be used
F = Machine clamp force limit (tonnes)
A = Total projected area of the model (cm^2)
100 = Unit conversion
0.8 = Safety factor, use 80% of maching capacity

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Packing Time

- Gates must freeze while pressure is applied
- Start with a very long pack time
  - Ensures gate freeze
- In subsequent analyses
  - Packing time can be shortened to the time required to freeze the gates
- Cooling time can be added
  - The part should reach the ejection temperature

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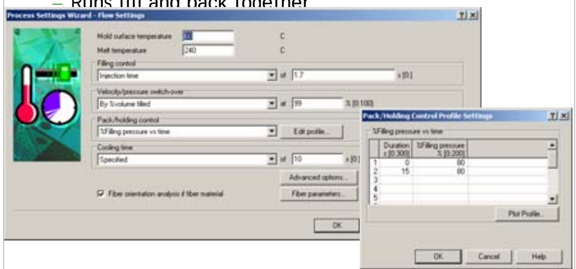
Running a Packing Analysis

- Select Flow as analysis sequence
  – Runs fill and pack together



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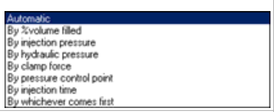
Velocity/Pressure Switchover

- Automatic
  – Default
  – Switches over when decompression of polymer would fill the cavity
- By %Volume filled
  – Most common if automatic not used
- By injection pressure
- By Hydraulic pressure
- By clamp force
- By Pressure control point
  – Used to define a pressure transducer used for switchover
- By injection time
- By whichever comes first



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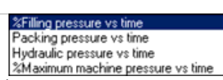
Methods Pack/Hold Control



- %Filling pressure vs time
  – Default – use when
    - Not sure what the fill pressure will be
    - Clamp tonnage not an issue
- Packing pressure vs time
  – Used when the packing pressure is known
- Hydraulic pressure vs time
  – Intensification ratio * hydraulic pressure = pack pressure
  – Not often used
- %Maximum machine pressure vs time
  – Rarely used only used if molding machine uses this method and need to duplicate a process

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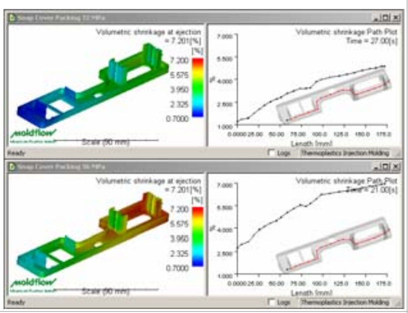
Midplane and Fusion Results

- Volumetric shrinkage
  - The more uniform the shrinkage the better
  - Volumetric shrinkage at ejection most common to use
  - Volumetric shrinkage path plot can be useful
- Frozen layer fraction
  - Check when the gate freezes
    - Gate freezes when the fraction is 1.0
    - Gate must be frozen at end of packing
      - If not re-run the packing analysis with a longer pack time
- Pressure XY plot
  - Check how pressure differs across the part
- Hold Pressure
  - Maximum pressure seen in the cavity after switchover

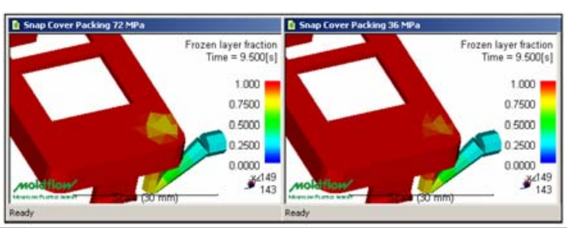
Volumetric Shrinkage

- Left
  - Shaded images
  - Shrinkage at ejection
- Right
  - Path plots
  - Animate through time



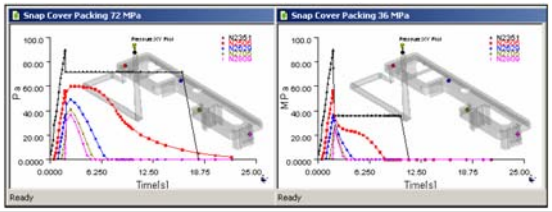
Frozen Layer Fraction

- Determine gate freeze
- Often a judgment when packing no longer effective



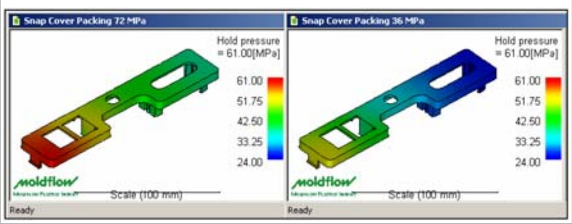
Pressure XY

- Determine
  - Pressure decay
  - Pressure at various locations
- The more uniform the pressure the better



Hold Pressure

- Shows maximum pressure after switchover
- Uniform gradients better

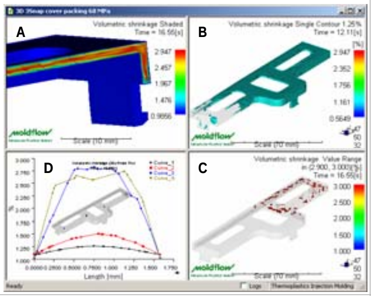


3D Results

- Volumetric shrinkage
  - The more uniform the shrinkage the better
  - Shown through thickness
  - Most variation in the center of the cross section
  - Several methods to view shrinkage
- Temperature
  - Check when the gate freezes
    - Single contour at transition temperature
  - Check temperature decay in part
- Pressure XY plot
  - Check how pressure differs across the part

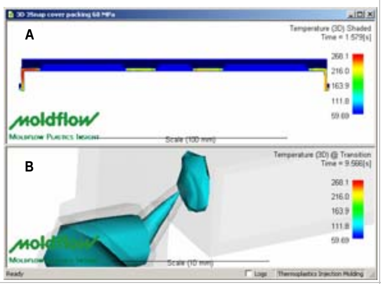
Volumetric Shrinkage

- A- Shaded result with cutting plane
- B- Single contour with time animation
- C- Single contour with value range animation
- D- Probe plot



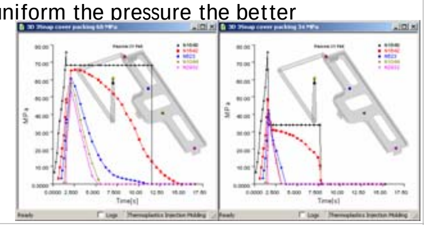
Temperature

- A- Shaded image with cutting plane
- B- Single contour set at transition temperature
  - Animate to find time when gate separates from part (frozen)



Pressure XY Plot

- Determine
  - Pressure decay
  - Pressure at various locations
- The more uniform the pressure the better



Practice

- Parts
  - Snap cover
    - Fusion
  - 3 Snap cover
    - 3D
  - Pick part to analyze
- Procedure
  - Run analysis with given conditions
  - Interpret results
  - Run analysis with pack pressure half the first analysis
  - Compare results

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QUESTIONS?

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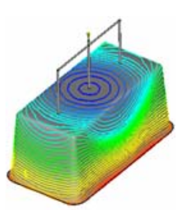
Valve Gates



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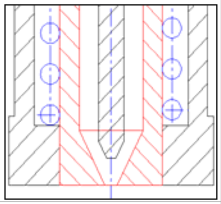
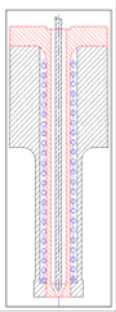
Valve Gates

- Type of hot runner with a gate that is opened and closed by a controlled pin
- Used to control the filling
  - Sequential gating
  - No gate vestige
  - Packing control
  - Balancing



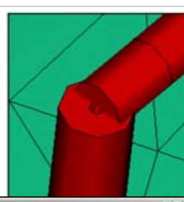
Modeling Valve Gates

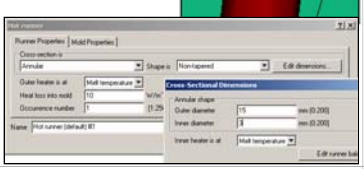
- The “valve gate” is the last element in the hot drop
- The flow channel can be
  - Annular if the valve pin passes through the flow channel
  - Circular if the plastic flow path and valve pin are parallel to each other in the drop
    - Some newer styles of valve gates have this type of flow channel



Modeling an Annular Hot Drop

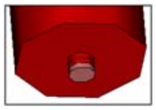
- Select element(s)
- Cross-section Annular
- Enter outer and inner diameters
  - Inner diameter is the pin diameter

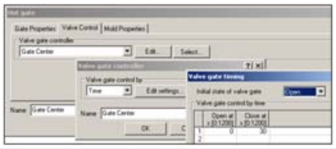




Modeling the Valve Gate

- Ensure all elements in the gate are hot
- Ensure only the last element is assigned a valve gate controller
- Select a new controller for each gate
- Enter a new name for each controller
- Set the initial state
- Set timer properties





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Valve Gates Control Type – Parameter Matrix

- Several Combinations of control and Parameters

Control Type / Parameter	Time	Flow Front	Pressure	% Volume	Ram Position
Initial State	✓	✓	✓	✓	✓
Trigger Location		✓	✓		
Delay Time		✓			

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Valve Gates Control Type

Control Type	Description
Time	Specifies the time from start of injection when the valve gate state is changed. The state can change several times during the cycle.
Flow Front	Specifies the gate to open when the flow front in the cavity reaches the gate. Additional change of state times can be entered. This is used to set up sequential gating.
Pressure	Specifies the change is state based on a pressure at the gate or a specified location. Additional change of states based on pressures can be entered.
%Volume	Specifies the change is state based on a % of part volume filled. Additional change of states based on volume can be entered.
Ram Position	Specifies the change is state based on ram displacement. Additional change of states based on ram displacements can be entered.

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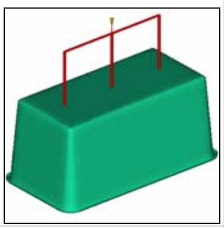
Valve Gates Parameters

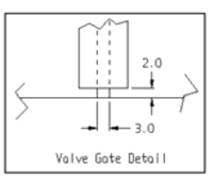
Control Type	Description
Initial State - Open	Select this option if the valve gate is initially open and the first event you will specify is the closing of the valve gate.
Initial State - Closed	Select this option if the valve gate is initially closed and the first event you will specify is the opening of the valve gate.
Trigger location - Gate	Select this option if you want the initial opening/closing of the valve gate to be triggered by an event at the gate node associated with the selected valve gate.
Trigger location - Specified	Select this option if you want the initial opening/closing of the valve gate to be triggered by an event at a specified node in the model.
Node No	Specifies the node for the Trigger location.
Delay time	Specifies that the valve gate will be opened at the required time, in seconds, after the flow front has reached the trigger location. If you do not want a delay time to apply, enter 0.

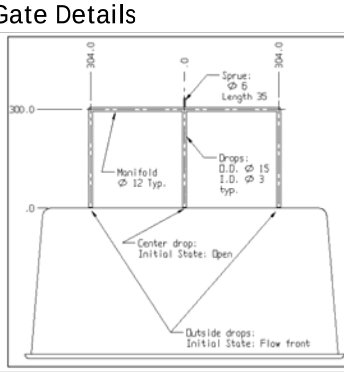
Practice

- Tub model
  - Design Criteria, Use valve gates to eliminate weld lines
- Use Runner System Wizard to create the runners per the supplied drawing
- Simulate
  - Without valve gates
  - With valve gates

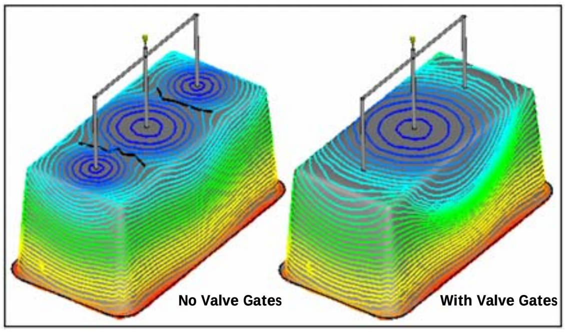


Tub Runner and Gate Details



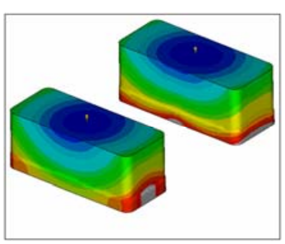


Results



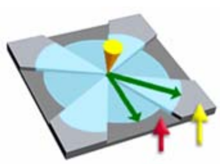
QUESTIONS?

Flow Leaders and Deflectors



Flow Leaders and Deflectors

- Subtle changes in nominal wall thickness
  - Designed to control the flow front
- Flow leaders
  - Thicker parts of the cavity
  - Increases the flow front velocity
  - Yellow arrow
- Flow deflectors
  - Thinner parts of the cavity
  - Decreased flow front velocity
  - Red arrow



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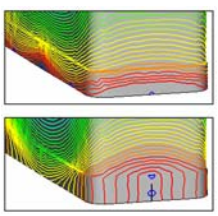
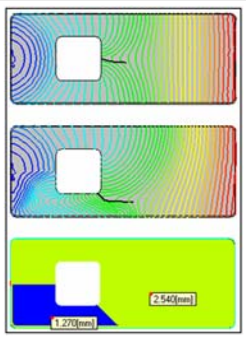
Why Use Flow Leaders and Deflectors

- Balance flows
- Move weld lines





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Advantages and Disadvantages

- Flow Leader
  - Advantages
    - Reduce shear stress
    - After tool is cut flow leader can be added by removing steel
  - Disadvantages
    - Add material volume
    - Possible increase in cycle time
- Flow Deflector
  - Advantage
    - Reduce material volume
  - Disadvantage
    - Possible reduction in structural integrity

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Thickness Changes

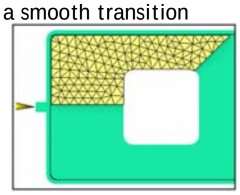
- Leaders/deflectors thickness changes
  - Should be less than a 25% change from nominal wall
- Thickness transition
  - Should be smooth and gradual
  - Reality midplane is a step
  - Fusion & 3D can model a bevel transition

Setting the Thickness

- Midplane
  - Easy to change the thickness property of selected elements
- Fusion
  - Can set thickness like midplane
  - Can only use for flow to test flow leader/deflector
  - Must re-translate with revised thicknesses if going on to cool and warp
- 3D
  - Test as Fusion model if possible
  - Otherwise must re-translate

Model Preparation

- Use layers to set up flow leader/deflector
  - Select elements whose thickness is to be changed
  - Assign them to a new layer
  - Rename the layer
- Possibly align nodes to create a smooth transition



Practice - Window Cover Model

- Design Criteria
  - Gate location fixed
  - Weld line to be moved to upper right corner of window
  - Move by adding flow deflector
  - Material
    - Lanxess Lustran ABS 450C
  - Molding conditions
    - Mold temperature 60ºC
    - Melt temperature 250ºC
    - Injection time 2.5 s

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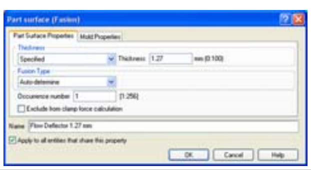
Changing Thickness

- Select the elements that need to be changed
  - Flow deflector layer
- Assign Properties from the Edit menu
  - Select an existing property or
  - Create a new one



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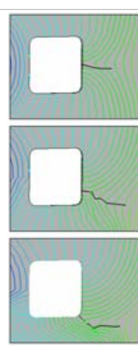
Window Cover

- Run three analyses
  - Nominal wall
  - 1.9 mm flow deflector
  - 1.27 mm flow deflector
- Compare results
  - Fill time
  - Weld line
  - Flow front temperature
  - Frozen layer thickness

Nominal Wall

1.9 mm th

1.27 mm th



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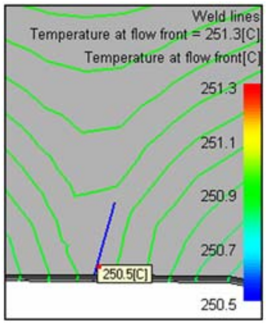
Window Cover

- Flow front temperature
  - At weld lines
  - Option for weld line results
  - Help determines quality



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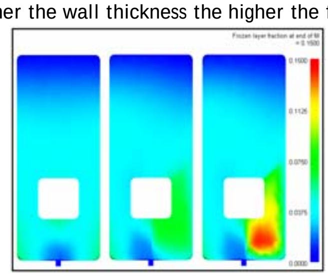
Window Cover

- Frozen Layer Fraction in flow deflector
  - Thinner the wall thickness the higher the frozen layer



Nominal Wall 1.9 mm 1.27 mm

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QUESTIONS

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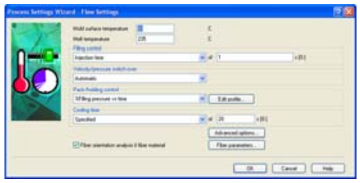
Flow Analysis Process Settings Detail



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Supported Molding Processes and Mesh Types

Thermoplastics Injection Molding	Mesh Type		
	Midplane	Fusion	3D
Fast Filling	✓	✓	
Fill	✓	✓	✓
Flow	✓	✓	✓
Core Shift	✓	✓	✓
Standalone Packing			✓
Fiber Flow	✓	✓	✓
Overmolding	✓	✓	✓

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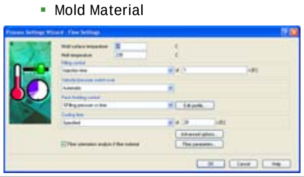
Process Settings Between Mesh Types

- Similarities
  - Flow Settings (main page)
  - Advanced Options
    - Molding Material Properties
    - Process controller
    - Injection Molding Machine
    - Mold Material
- Differences
  - Solver parameters
    - Different tabs and parameters



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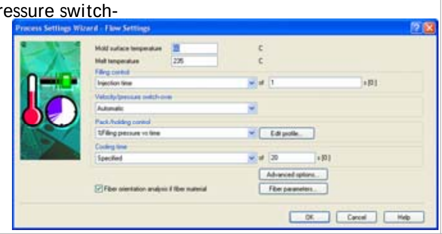
Flow Settings

- Mold surface temperature
- Melt temperature
- Filling control
- Velocity/pressure switch-over
- Packing/holding control
- Cooling time
- Advanced Options



Temperatures

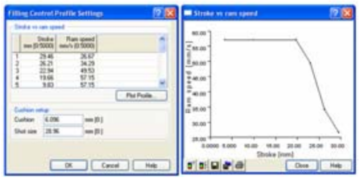
- Mold surface temperature
  - Default value from material database
  - Midrange mold temperature
  - Represents the Plastic/metal interfaces
  - Must be below the material's ejection temperature
- Melt temperature
  - Default value from material database
  - Midrange melt temperature
  - Represents temperature entering at injection location
  - Must be above the materials transition temperature

Filling Control

- Automatic
  - Calculates a fill time
    - Achieves nearly uniform flow front temperature
    - Using entered mold and melt temperatures
  - Don't use with runners in the study
- Injection time
- Flow rate
- Ram Speed Profile
  - Various methods to control the velocity of the ram
  - Generic and machine specific methods

Ram speed Profile

- %shot volume vs. %flow rate
- %Stroke vs. %ram speed
- Stroke vs. ram speed
- Stroke vs. %maximum ram speed
- Stroke vs. flow rate
- Stroke vs. %maximum flow rate
- Ram speed vs. time
- %Maximum ram speed vs. time
- Flow rate vs. time
- %Maximum flow rate vs. time

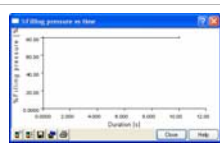


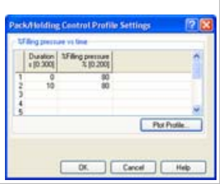
Velocity/Pressure Switch-over

- Automatic
  - Determines switchover based on melt decompression
  - Default method
- % Volume filled
- Injection pressure
- Hydraulic pressure
- Clamp force
- Pressure control point
  - Identify node and pressure at node
- Injection time
- Whichever comes first

Pack/Holding Control

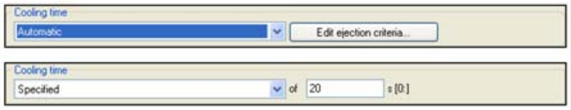
- %Fill Pressure vs. time
  - Default 80% of fill pressure for 10 seconds
- Packing pressure vs. time
- Hydraulic pressure vs. time
- %Maximum machine pressure vs. time





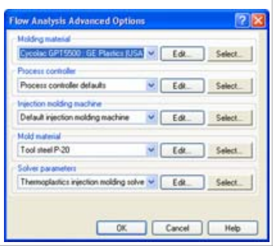
Cooling Time

- Set for Flow analysis
  - Field not available in Cool + Flow analysis sequence
- Specify time
- Automatically determine
  - Specify
    - Ejection temperature
    - Percentage of part frozen



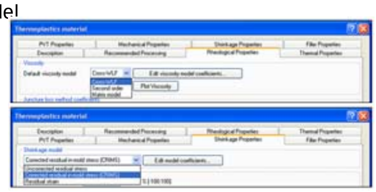
Advanced Options

- Molding material
- Process controller
- Injection molding machine
- Mold material
- Solver parameters



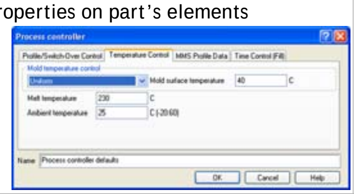
Molding Material

- Edit allows you to change data for the material
  - Affects current study and all duplicated from the study
- May need to change
  - Viscosity model
  - Shrinkage model



Process Controller

- Profile/Switch-over Control
  - Same as the main dialog
- Temperature Control
  - May want to change the cavity and core temperatures
  - Need to set up properties on part's elements
- Measured Profiles
  - MMS Input
- Time Control
  - Clamp open time



moldflow

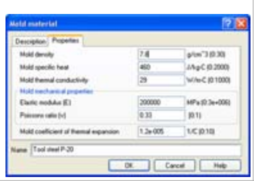
Injection Molding Machine

- May need to set
  - Injection Unit parameters
    - For use with Injection profile
  - Pressure limit
  - Clamp tonnage limit
    - Do not exceed max clamp
      - Reduces flow rate during fill if clamp force limit reached

moldflow

Mold Material

- Global setting
  - Used on properties with no specific setting
- P-20 is default
  - Can be changed
    - From large database of materials
    - Manually edit data
- Used in thermal calculations



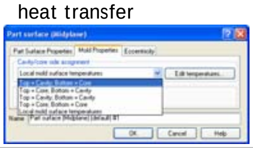
moldflow

Solver Parameters

Solver Parameter Tab	Mesh Type		
	Midplane	Fusion	3D
Mesh/Boundary	✓	✓	
Intermediate Output	✓	✓	
Convergence	✓	✓	
Restart	✓	✓	
Fiber Analysis	✓	✓	✓
Core Shift	✓	✓	✓
Interface	✓		
Flow Analysis			✓
Cool Analysis			✓
Mesh			✓

Mesh/Boundary (Midplane / Fusion)

- No. of Laminates
  - 8, 10, 12, 14, 16, 18, 20
- Heat transfer coefficient
  - Models heat transfer between the plastic and mold
  - Higher values indicate better heat transfer

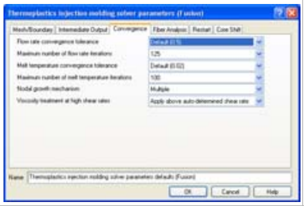


Intermediate Output (Midplane / Fusion)

- Set number of intermediate results by
  - Constant intervals
  - Specified times
- Profiled not recorded by default

Convergence (Midplane / Fusion)

- Flow rate convergence tolerance
- Maximum number of flow rate iterations
- Maximum number of melt temperature iterations
- Nodal growth mechanism
- Viscosity treatment
  - Reduces possible flow instability
  - Limits rate of viscosity drop at high shear rates
- Defaults work well



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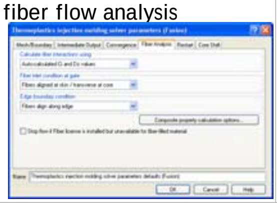
Fiber Analysis (Midplane / Fusion / 3D)

- All parameters used to modify
  - Values used in fiber orientation models
  - Change models used
- Not recommended to change any of the defaults
- Provided for research into fiber flow analysis



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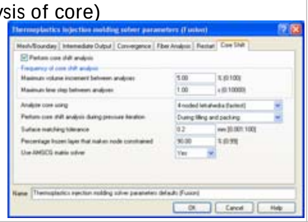
Core Shift (Midplane / Fusion)

- Setup core shift analysis
- Interactive analysis between
  - Flow
  - Warp (Structural analysis of core)
- Core must be modeled with tetrahedral elements
- Must have warp license



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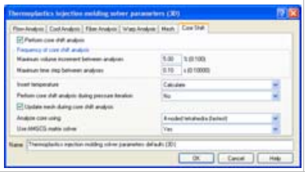
Core Shift (Midplane / Fusion / 3D)

- For more accuracy but longer analysis times
  - Increase frequency of core shift analysis
  - Use 10-noded elements for final analysis
  - Perform core shift during pressure iteration



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Interface (Midplane)

- Creates interface to other CAE programs to conduct warpage analysis
- Requires warp and interface licenses

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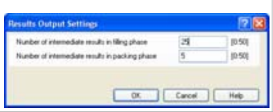
Flow Analysis (3D)

- Solver setup
  - Coupled
    - Navier-Stokes
      - Optional,- inertia and gravity
  - Segregated (legacy solver)
- Intermediate Results
  - During filling and packing
  - Default 5 steps – Normally increase
- Recovery data
  - Allows for restart if system failure



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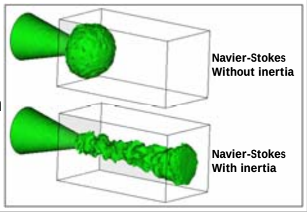
3D Flow Solvers -Inertia

- Without Inertia
  - Very fast run time ~ 0.25 hr
  - Best when wall thickness changes not great
- With Inertia
  - Most accurate
  - Can predict jetting
  - Run time ~2.0 hr
  - Requires very fine mesh
  - Many intermediate results



~157,000 elements

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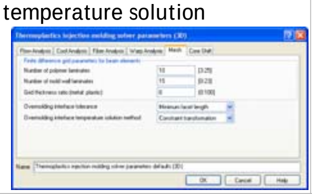
Mesh (3D)

- Finite difference grid parameters
  - Determines number of laminates for beams
  - Grid ratio determines mold laminate thickness
- Overmolding interface tolerance
- Overmolding interface temperature solution



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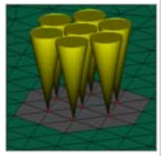
Difference Between Midplane/Fusion and 3D

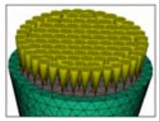
- Midplane and Fusion
  - Hele-Shaw assumptions applicable
    - No pressure variation in thickness
    - Velocity calculated from pressure gradient alone
    - Laminar flow
  - In-plane conduction ignored
  - Edge heat loss ignored
  - Inertia and gravity ignored
- 3D
  - Solves at each node
    - Pressure
    - Temperature
    - 3 Velocity components
  - Considers heat conduction in all directions
  - Provides option to consider
    - Inertia
    - Gravity effects

moldflow

3D Injection Location Assignment

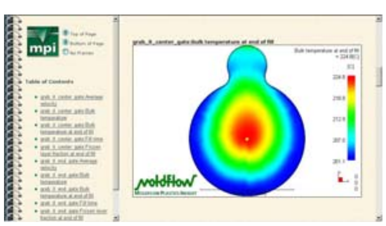
- Injection area determined by all surface elements touching an injection location
- Parts
  - If fine meshes are used
    - Several injection locations may need to be defined to create a realistic gate area
- Runners
  - Beams – node at end of beam
  - tetrahedral runners
    - Assign injection locations to all nodes at the end of the sprue





QUESTIONS?

Create Reports



Introduction

- Aim
  - Learn about the Report Generation Wizard to quickly make reports in the formats
    - HTML
    - Power Point
    - Word Document
- Why do it
  - The wizard is quick and easy way to create reports
- Overview
  - Launching the Report Generator Wizard
  - Steps to complete a report within MPI

Steps to Create a Report

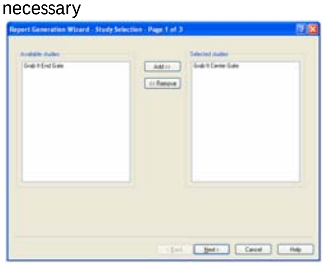
1. Open the Report Generator Wizard
2. Select studies
3. Select studies' results
4. Select report format
   1. Customize report details (optional)
5. Generate report

Open Report Wizard

- Open the Report Wizard
  - Report menu
    - Report Generation Wizard
  - Project pane
    - Context menu, New Report

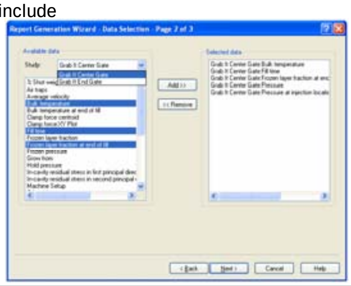
Select Studies

- All studies in a project are available for a report
- Open studies automatically selected
- Use Add & Remove keys as necessary
  - Multiple studies can be selected at once using the control and/or shift keys



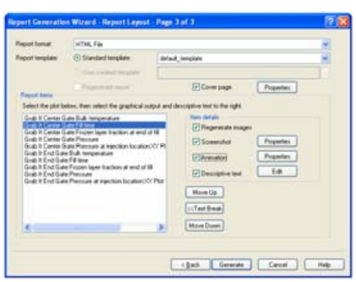
Results Included in Report

1. Select the study in the drop-down list
2. Select the results to include
3. Click **Add**



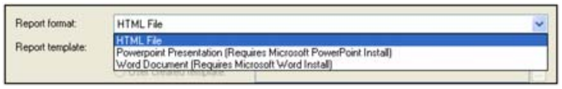
Format the Report

- Report format
- Report template
- Cover page
- Report item details
  - Screenshot
  - Animation
  - Text
  - Position in report
  - Extra text
  - Rename plot
- Generate the report



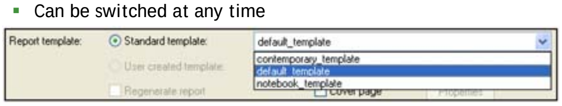
Report Formats

- Select the report format to be used
  - HTML
  - Powerpoint document
  - Word document
- Can be switched at any time



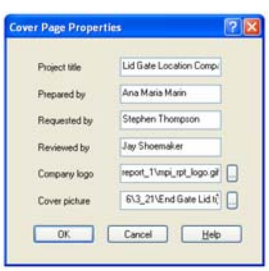
Report Templates

- Select the report template to be used
  - Contemporary
  - Default
  - Notebook
- Can be switched at any time



Cover Page

- If desired add a cover page
- Add information as needed



Plot Formatting

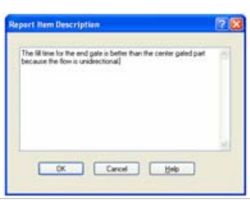
- Set item details
  - Screen shot, small file size
  - Animation, large file size
  - Descriptive text, notes user writes about the result
- Change order of plots if necessary
- Double click on plot name to change the plot name
- Add Text Break
  - Text without plot

Screen Shot Properties

- Set image parameters
  - Open studies
    - Rotation & magnification based on screen
  - Closed studies
    - Rotation set by rotation angles
  - Use previously saved viewpoints
- Use existing image
  - Most flexible
    - Create image Edit ➡ Save image to file or Ctrl+F
      - Created exactly like you want
    - Import image
    - Change plot name as necessary

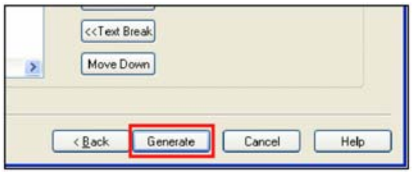
Adding Text

- Image – Descriptive text
- Text break – Text without associated image
- Enter Information
  - Type directly into dialog
    - Disadvantage, while the wizard is active, results can't be manipulated
  - Copy/Paste from other application
    - Advantage, can type notes in separate program
    - Results can be manipulated to aid in the description write-up



Generate Report

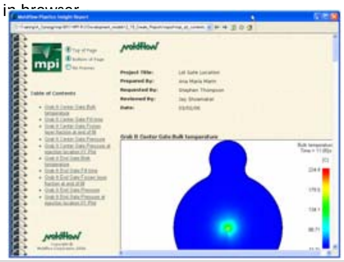
- Click the generate button to build the report
  - Report will be displayed after generation



moldflow

Viewing the Report

- Report automatically displayed for viewing
- At any time the report can be opened for viewing
  - Report menu ➨ View in browser



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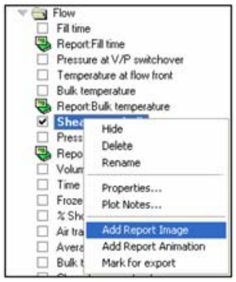
Editing the Report

- Make changes to an existing report
  - **Report** menu
    - Add cover page
    - Add Image
    - Add Animation
    - Add Text
    - Edit
      - Opens the Report Wizard
- Re-generate report after changes made
  - Open report Wizard use Generate button

moldflow

Report Generation Options

- For results create multiple
  - Images
  - Animations
- Updated to existing report dynamically
- Plot Notes
  - Create before entering the wizard



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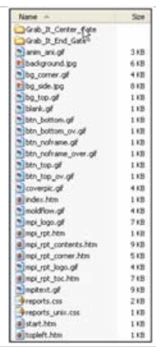
Sending the Report

- E-mail report to anyone on internet
- Zip up report maintaining directory structure of the report
  - Folder to zip is called **Report** from the project directory
- Open zip file maintaining structure
- Open the report with the file Start.htm



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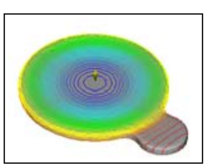
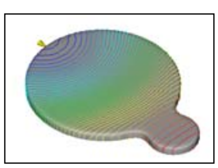
Exercise

- Create and view a report based on two different studies of the lid





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QUESTIONS?

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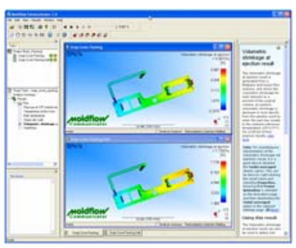
Moldflow Communicator



moldflow

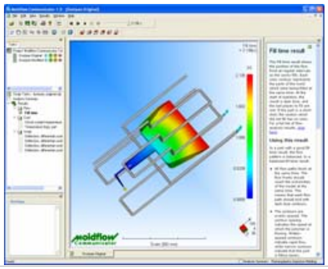
Introduction

- Aim
  - Learn about the Moldflow Communicator functionality
- Why do it
  - Moldflow communicator is a powerful way to show results to customers
- Overview
  - Moldflow Communicator requirements
  - Moldflow Results file
  - Analysis Quantification
  - Analysis Criteria

moldflow

Moldflow Communicator (MC)

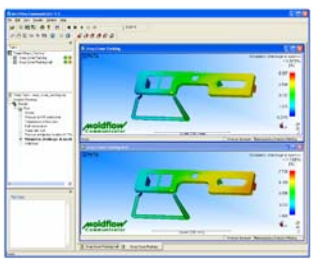
- Standalone product
- View results and quantify result quality
- Anyone can use it
  - Share Moldflow results with colleagues around the world
- Supports
  - MPI 6.0 Rev 1
- Reads
  - Moldflow results file (*.mfr)
  - Criteria file



moldflow

Moldflow Communicator Features

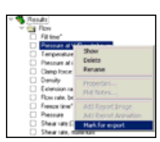
- View results
  - Dynamically
  - Interactively
- Compare results between two studies
  - Compare to established criteria
- Synchronize
  - Model orientation
  - Result selection



moldflow

Moldflow Results File (MFR)

- Single compressed file containing
  - One or two studies
    - Up to eight results per study
  - User specified results
  - Used by Moldflow Communicator
- Created in Synergy
  1. Select for export
  2. Right click ➡ Mark for export
     - * Asterisk appears on results marked for export
     - Right click again to unmark
  3. Save study before exporting
  4. File ➡ Export
     - Extension - *.mfr



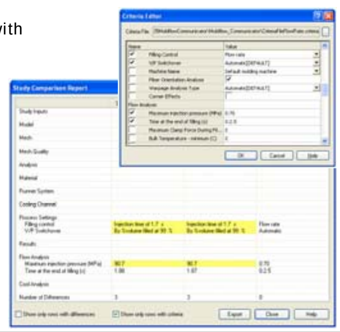
moldflow

Moldflow Communicator – Analysis Quantification

- Ensures results come from a reliable source
- Information automatically stored in MFR
- Includes
  - Creator information
  - Analysis product information
  - Model attributes
  - Analysis attributes
  - Results attributes
- Quantification information found in the Communicator

Moldflow Communicator - Analysis Criteria

- Compare model/results with set criteria
- Set Criteria for result comparison
  - Tools ➔ Criteria Editor
- Categories
  - Product
  - Mesh
  - Analysis
  - Material
  - Process Settings
  - Flow analysis
  - Cooling analysis
  - Diagnostics

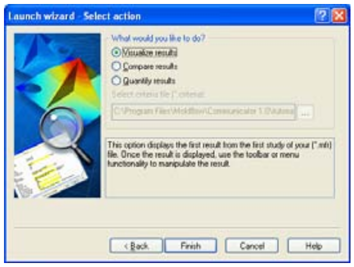


Open Results File in Moldflow Communicator

1. Select Results file from the Launch wizard dialog or browse for the file

Moldflow Communicator – Action option

2. Select the action option from the Launch wizard dialog
   - Visualize results
   - Compare results
   - Quantify results
3. Click Finish



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Practice

- Create a Moldflow Results file from Synergy and view it using Moldflow Communicator

moldflow

QUESTIONS?

moldflow

Job Manager

Introduction

- Aim
  - Learn about the Job Manager functionality
- Why do it
  - By understanding and using the different features of the Job Manager you will be able to manage analysis resources efficiently
- Overview
  - Control analysis for all mesh types and all modules
  - Allow jobs to run at a later time
  - Setup jobs to run on other systems

Accessing the Job Manager

- Analysis ➡ Job Manager
- Ctrl + J
- Analyze Now context menu

Job Manager Functions

- Sends analysis jobs to different queues
- Manages server properties
- Sets job priorities
- Schedule jobs

moldflow

Job Queues

- Three job queue types
  - For each server where the Job Manager is installed
  - Priority jobs
    - Analysis started as soon as it enters the queue
  - Batch queue
    - Started manually
    - Started at specific date/time
  - Distribution queue
    - Sends jobs to available servers
      - Must have license

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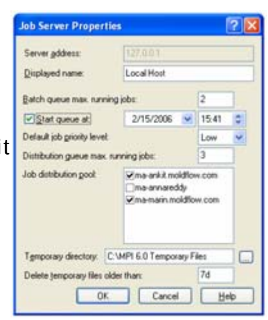
Managing Server Properties

- Add server address
- Set displayed server name
- Set batch queue job limit
- Set job priority level
- Set distributed job run limit
- Indicate servers in distribution Pool
  - The machines that can be used to run a job



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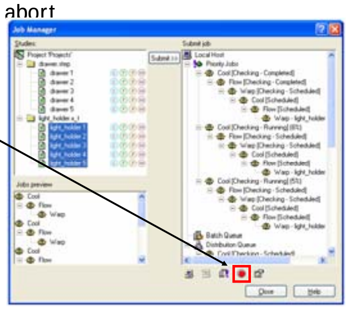
Submit Analyses

- Highlight one or more studies in the Studies field
- Highlight the queue the analysis to run in
- Click the Submit button
- Also drag studies to the queue

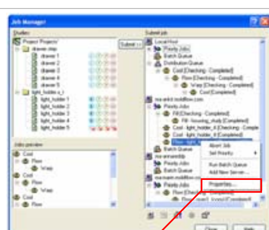
Abort Analysis

- Click on the job to abort
- Click the **Abort** button
  - Stop sign



Analysis Properties

- Properties window displays
  - Analysis type
  - Model name
  - Project directory
    - Location of the original study file
  - User
  - Submitted from
    - Host machine from where the analysis was launched



Runstudy

- Command prompt utility used to run jobs without the job manager
- **PC**
  - **Start ➔Programs ➔Moldflow Plastics Insight <release_no> ➔Plastics Insight Command Shell**
- Unix – any shell window
- Example
  - **Runstudy**
    - **Brings up help on the utility**
  - **runstudy -project bracket two_gate**
    - Runs the study two_gate in the project bracket

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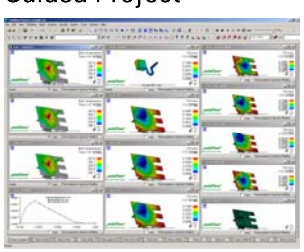
QUESTIONS?

moldflow

Guided Project



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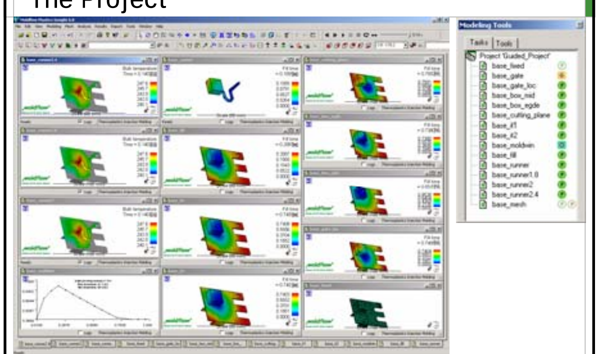
What you will do?

- Work through an entire project
  - Cleanup a model
  - Running different analysis
  - Finding problems
  - Solving the problems
- Working issues
  - Identify problems
    - Refer to the result interpretation chapter
  - Use different result manipulations
  - Use the worksheet
  - Use different analysis sequences in a logical order

What you will do?

- Repair model
- Order of analysis steps
  - Finding the gate location
  - Identify and fixing fill problems
  - Make model changes to remove problems
  - Determine the optimum molding conditions
  - Add a runner system
  - Run analysis with runner
  - Identify and fixing runner system problems

The Project



QUESTIONS?