

Practical Scientific Molding Techniques

presented by:



ARoutsisAssociates

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Best Molding Practices

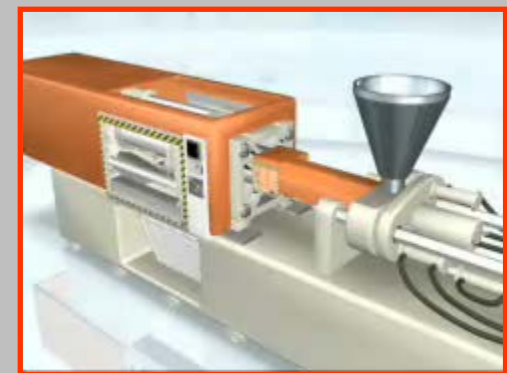
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6 / 45

Practical Scientific Molding Techniques

- Who Is A Scientific Molder?
- Determining Process Parameters
- Documenting Machine Outputs
- Scientific Troubleshooting
- Mold, Machine, & Process Evaluation
- Scientific Molding Equipment
- Special Offer
- Questions & Answers



Who Is A Scientific Molder?

Someone Who Uses Data To:

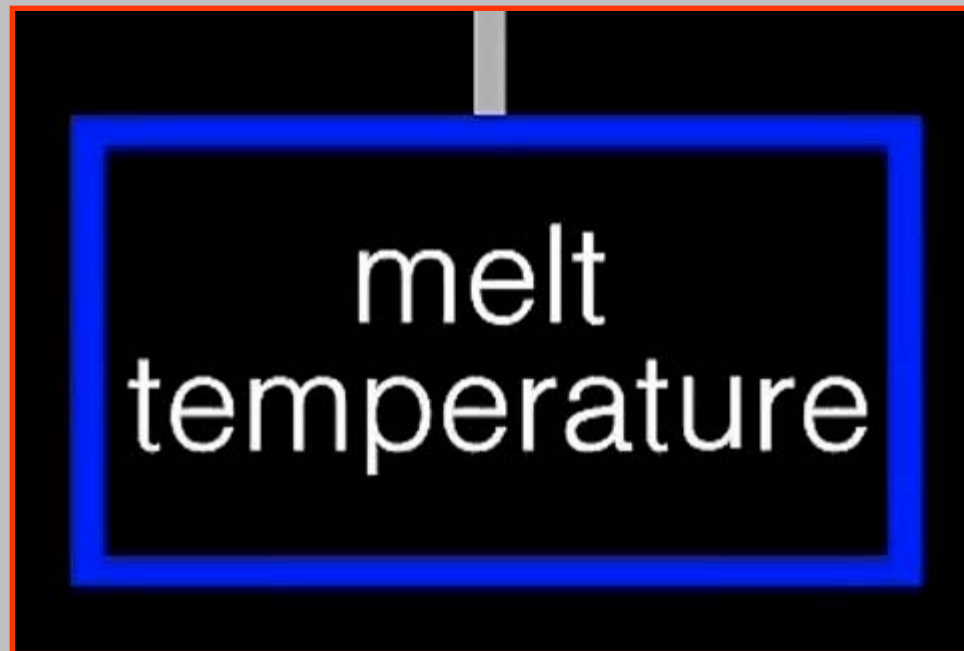
- Determine Process Parameters
- Document Process Outputs
- Troubleshoots Systematically
- Speaks In Specifics



Who Is A Scientific Molder?

Determines Process Parameters:

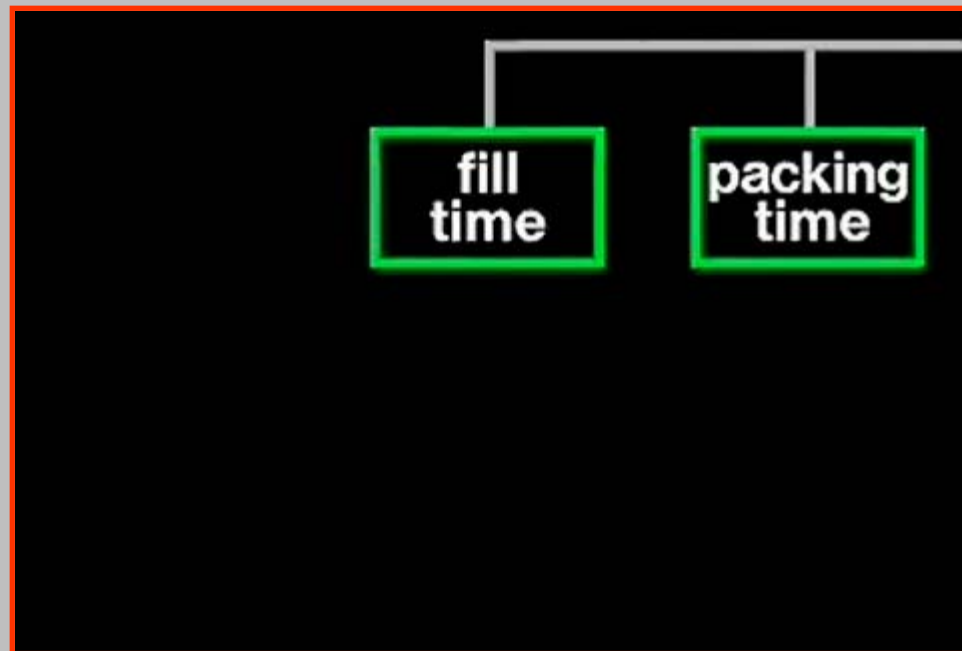
- Using Actual Melt Temperature
 - To Determine Barrel Temperature Settings



Who Is A Scientific Molder?

Determines Process Parameters:

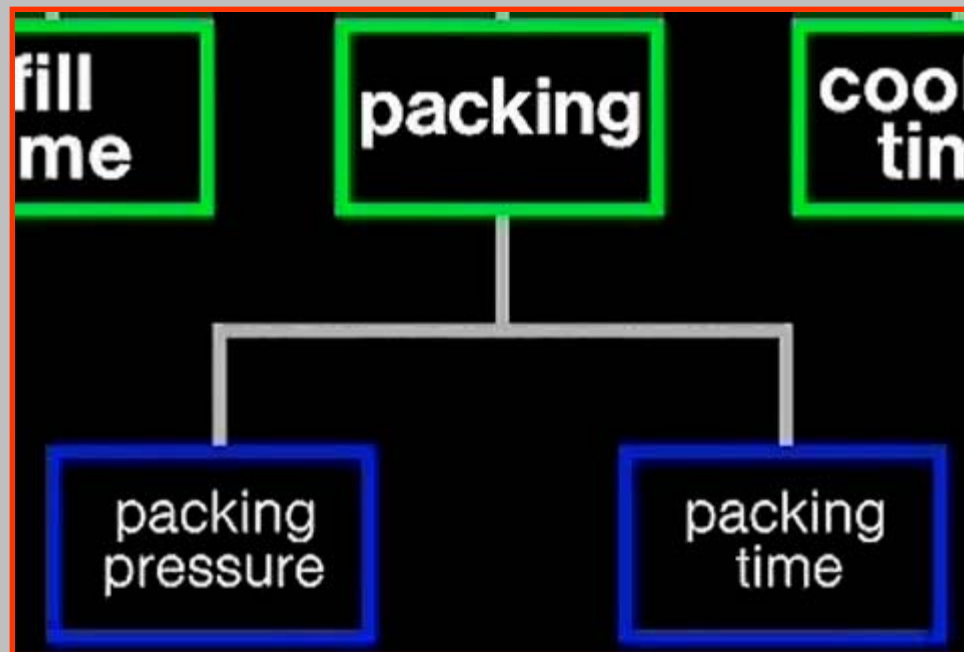
- Using Actual Fill Time
 - To Determine Injection Speed Settings



Who Is A Scientific Molder?

Determines Process Parameters:

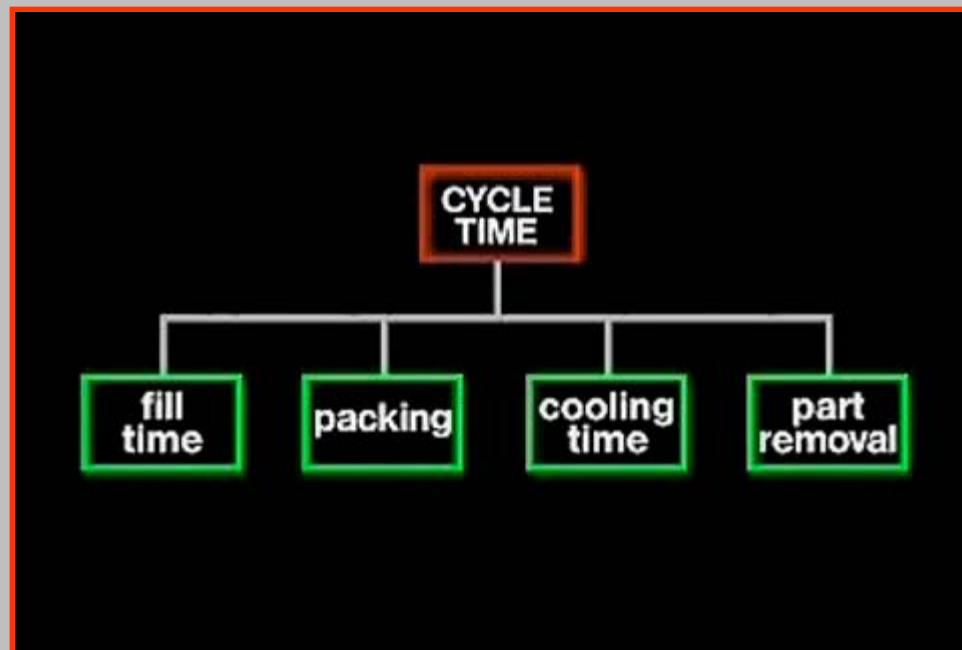
- Using Actual Plastic Pressure
 - To Determine Pack And Hold Settings



Who Is A Scientific Molder?

Determines Process Parameters:

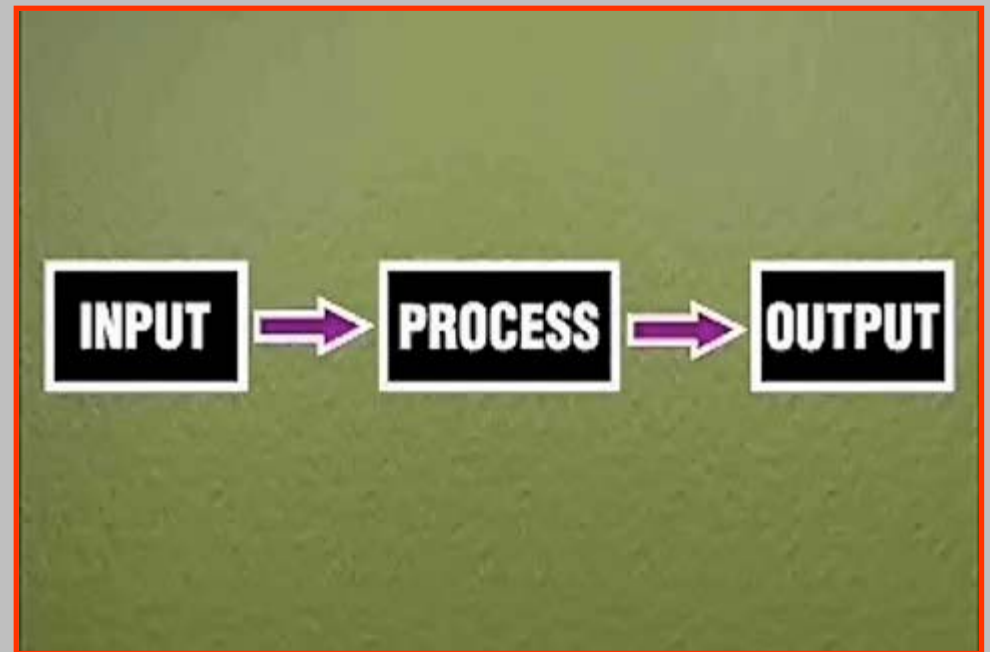
- Using Actual Coolant Temperature
 - To Determine Mold Temperature Settings



Who Is A Scientific Molder?

Documents Machine Independent Outputs:

- Temperatures
- Times
- Plastic Pressures
- Part Weights
- Additional Data



Documents Machine Independent Outputs

Process Outputs - Temperatures:

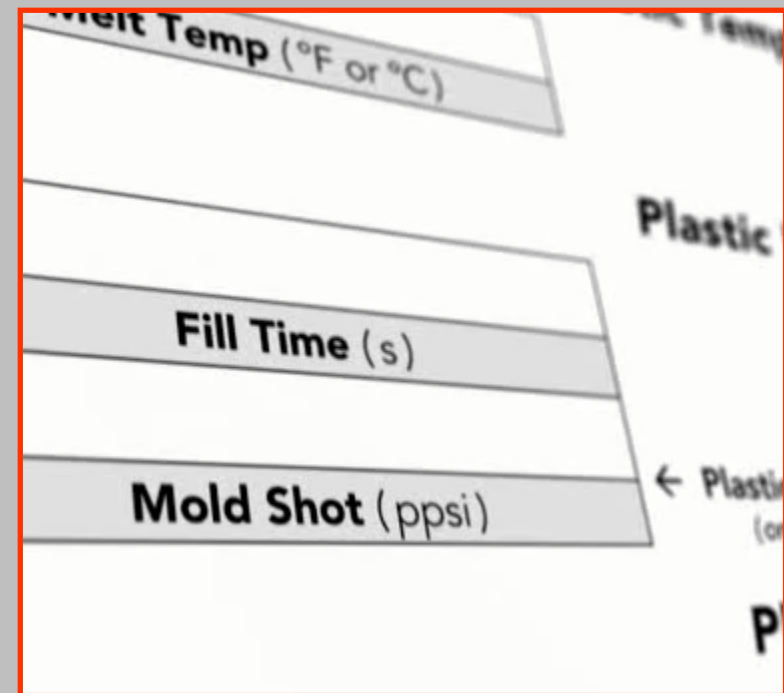
- Plastic Melt Temperature
- Coolant Temperature In
- Coolant Temperature Out



Documents Machine Independent Outputs

Process Outputs - Times:

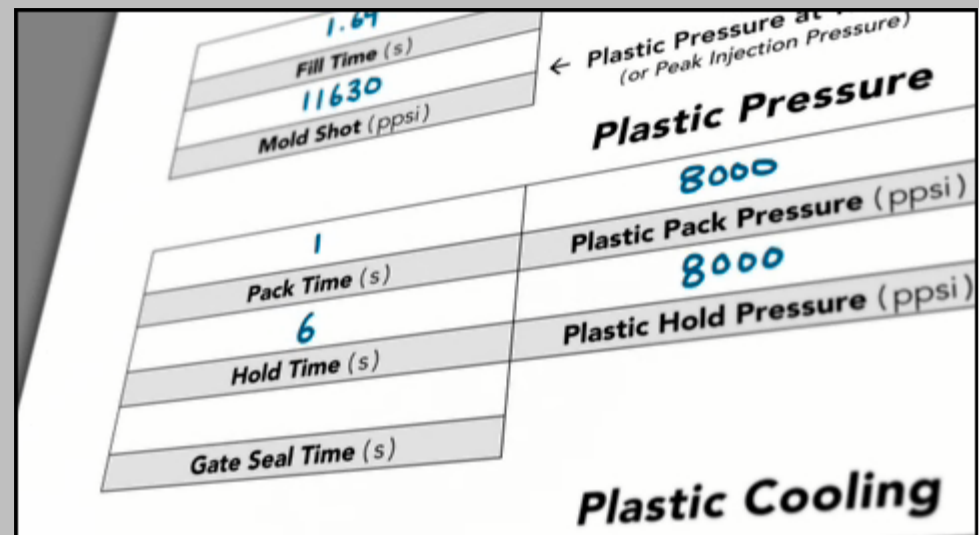
- Fill Time
- Pack Time
- Hold Time
- Gate Seal Time
- Cycle Time
- Recovery Time



Documents Machine Independent Outputs

Process Outputs - Plastic Pressures:

- Back Pressure
- Pressure At Transfer
 - And/Or Peak Pressure
- Pack Pressure
- Hold Pressure



Documents Machine Independent Outputs

Process Outputs - Weights:

- Fill Only Weight
- Fill & Pack Weight
- Final Part Weight



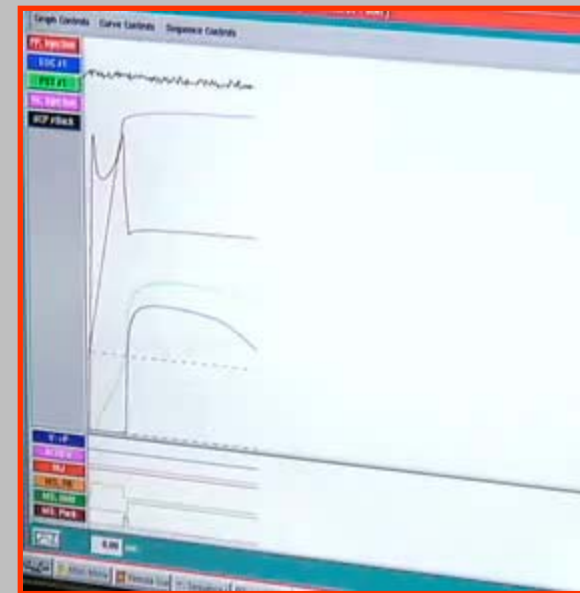
123.90
Fill & Pack Part Weight (g)
125.40
Final Part Weight (g)

110.72
Fill Only Part(s) Weight (g)
3220
Air Shot (ppsi)

Documents Machine Independent Outputs

Process Outputs - Additional Data:

- Cavity Measurements
- Quality Measurements
- Clamp Tonnage
- Photographs
- Observations
- Cavity Balance



Who Is A Scientific Molder?

Troubleshoots Using A Systematic Process:

- Step 1. Examining The Part To Ensure
 - Proper Diagnosis
 - No Other Defects Are Present



Who Is A Scientific Molder?

Troubleshoots Using A Systematic Process:

- Step 2. Rule Out Obvious Causes
 - Check The Simple Causes When Necessary



Who Is A Scientific Molder?

Troubleshoots Using A Systematic Process:

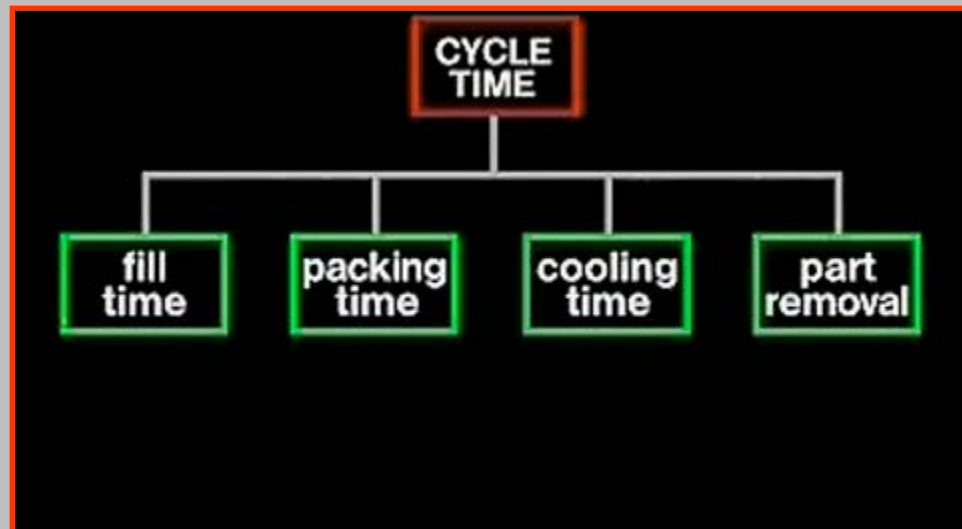
- Step 3. Compare With Documented Process
 - Focus On Related Outputs
 - Process Of Elimination



Who Is A Scientific Molder?

Troubleshoots Using A Systematic Process:

- Step 4. Return Process To Standard
 - Change One Parameter At A Time
 - Allow Each Change Time To Affect The Process



Who Is A Scientific Molder?

Troubleshoots Using A Systematic Process:

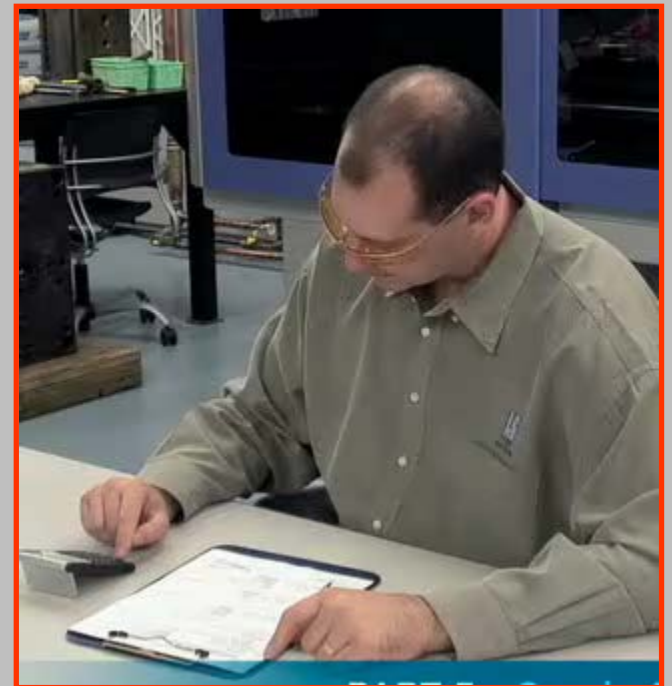
- Step 5. Verify Other Process Outputs
 - Verify Parameters Which Can Be Checked Easily
 - A Full Verification May Be Necessary
 - If Cause Not Found... Check The Mold, Machine, & Material



Who Is A Scientific Molder?

The Scientific Troubleshooter Uses Documentation To:

- Know How The Process Ran
- Determine What Changed
- Act On Knowledge
- Verify The Results
- Speak In Specifics



Anyone Can Be A Scientific Molder

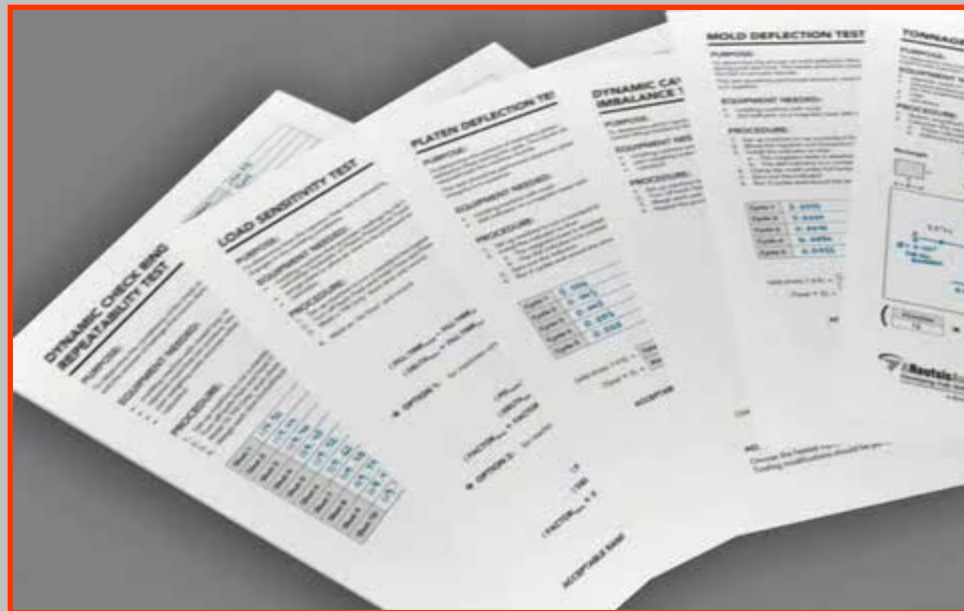
Education Is The Key:

- Learning
 - Online Training
 - Classroom Training
 - Trade Shows
 - Webinars
- Skills Development
 - Simulation Software
 - Practice On The Job
 - Hands-On Exercises



Common Scientific Tests

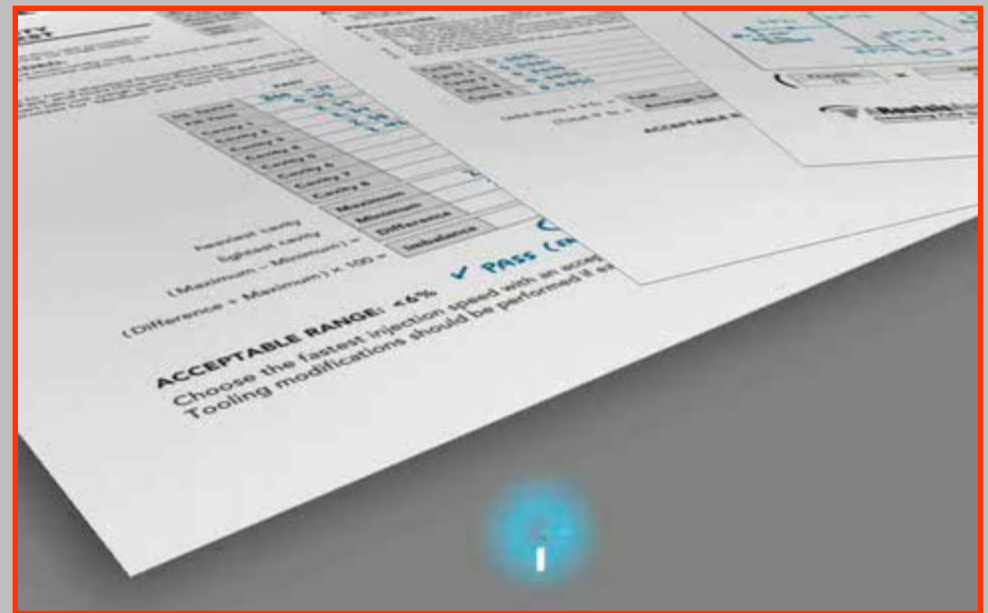
- Mold Evaluation
- Machine Evaluation
- Process Evaluation



Common Scientific Tests

Mold Evaluation:

- Dynamic Cavity Imbalance Test
- Mold Deflection Test
- Tonnage Calculation



Mold Evaluation

Dynamic Cavity Imbalance Test:

- Mold Short Shots At Different Speeds
- Measure Cavity Weights
- Determine Variation
- Determine Optimal Fill Rate

Cavity 8	2.42	
heaviest cavity Maximum	2.34	
lightest cavity Minimum	0.08	
(Maximum - Minimum) = Difference	3.3	%
(Difference + Maximum) x 100 = Imbalance	3.3	%

FAST

✓ **PASS (FAST SPEED)**

ACCEPTABLE RANGE: <6%
Choose the fastest injection speed with an acceptable imbalance
Tooling modifications should be performed if each imbalance ≥ 6%



Mold Evaluation

Mold Deflection Test:

- Place Indicator In Contact With Injection Unit
- Clamp Mold Under Tonnage
- Zero Out Indicator
- Determine The Average Deflection For 5 Cycles



(add shots 1→5) =	Total	0.0275
(Total ÷ 5) =	Average Deflection	0.0055

b. The dial indicator is in contact with r

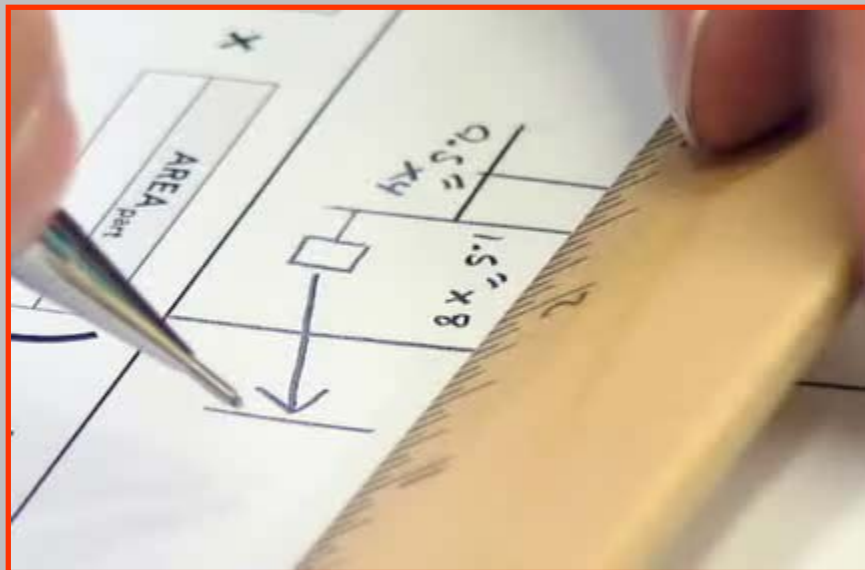
4. Clamp the mold under full tonnage and
5. Zero out the indicator
6. Run 5 cycles and record the amount

Cycle 1	0.0055
Cycle 2	0

Mold Evaluation

Tonnage Calculation:

- Sketch Mold Layout
- Determine Part And Runner Area
- Calculate Expected Tonnage Requirements



$3.5'' \times 1 = 3.5''$
 $4.0'' \times 2 = 8.0''$
 $0.5'' \times 4 = 2.0''$
 $1.5'' \times 8 = 12.0''$
 $0.5'' \times 16 = 8.0''$
 $\text{RUNNER length} = 33.5''$
 $\text{AREA runner} = 33.5'' \times 0.125'' = 4.2 \text{ in}^2$
 $\text{AREA part} = 0.5'' \times 0.75'' = 0.375 \text{ in}^2$
 $\times 16$

SKETCH AREA

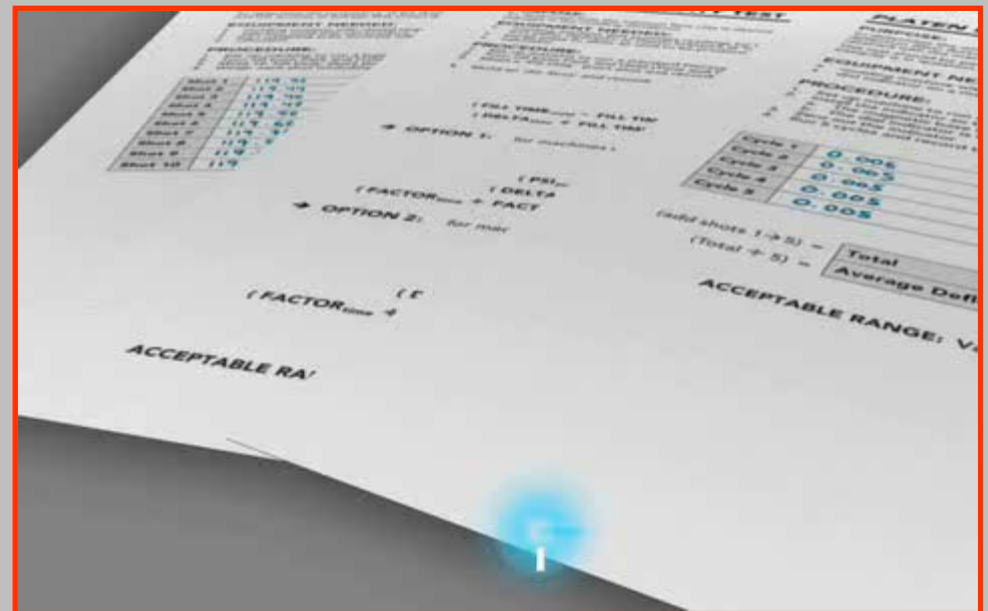
# Cavities	\times	AREA _{part}	$+$	AREA _{runner}	$=$	AREA _{projected}
16		0.375"		4.2		10.2 in ²
					\times	Tonnage Factor
						7.1
					$=$	Estimated Tonnage
						73 tons

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Common Scientific Tests

Machine Evaluation:

- Platen Deflection Test
- Dynamic Check Ring Repeatability Test
- Load Sensitivity Test



Machine Evaluation

Platen Deflection Test:

- Place Indicator In Contact With Stationary Platen
- Zero Out Indicator
- Determine The Average Deflection For 5 Cycles

(add shots 1→5) =	Total	0.026
(Total ÷ 5) =	Average Deflection	0.005

Cycle 1	
Cycle 2	
Cycle 3	
Cycle 4	

Machine Evaluation

Dynamic Check Ring Repeatability Test:

- Mold 10 Fill-Only Shots
- Measure Shot Weights
- Determine Variation

119.52	
119.44	
119.40	
119.47	
119.52	
119.62	
119.78	
119.54	
119.48	
119.48	

(add shots 1→10) = Total 1195.25

(Total ÷ 10) = Average 119.525

(Heaviest - Lightest) = Heaviest 119.78

Lightest 119.40

Difference 0.38

(Difference ÷ Average) × 100 = Variation 0.3 %

ACCEPTABLE RANGE: <3%

Weight each shot (including parts and run)

Shot 1	
Shot 2	
Shot 3	
Shot 4	
Shot 5	
Shot 6	
Shot 7	
Shot 8	
Shot 9	
Shot 10	

(H)

Machine Evaluation

Load Sensitivity Test:

- Mold Two Short Shots
 - In Mold & Short Shot
- Record For Both Shots:
 - Fill Time & Transfer Pressure
- Calculate:
 - Change In Time & Pressure
- Determine Load Sensitivity

PROCEDURE:
 1. Set up machine to run a standard Designated II process
 2. Turn off both Pack and Hold
 3. Mold a 'Fill Only' short shot and record:
 Mold an 'Air Shot' and record:

1st Stage Pressure at Transfer

FILL TIME _{mold}	1.64
FILL TIME _{air}	1.63
DELTA _{time}	0.01
FACTOR _{time}	0.006

(FILL TIME_{mold} - FILL TIME_{air}) =
 (DELTA_{time} ÷ FILL TIME_{mold}) = (to be used)

LOAD SENSITIVITY TEST

PURPOSE:
 To determine how the injection flow rate is altered by changes in the molding conditions.

EQUIPMENT NEEDED:

- molding machine that provides readings for Fill Time and other Hydraulic or Plastic readings at Transfer
- sprue data to allow air shot to be produced at the specified injection speed
- moldlets

PROCEDURE:

1. Set up machine to run a standard Designated II process
2. Run, fill, pack, hold, and hold (three sec. pressure)
3. Mold a 'Fill Only' short shot and record:
4. Mold an 'Air Shot' and record:

1st Stage F/E Time (Pressure at Transfer) (FILL TIME_{mold})
 1st Stage F/E Time (PSI_{air}) (FILL TIME_{air})
 1st Stage F/E Time (Pressure at Transfer) (PSI_{mold})
 1st Stage F/E Time (PSI_{air})

FILL TIME _{mold}	
FILL TIME _{air}	
DELTA _{time}	
FACTOR _{time}	

OPTION 1: (to determine rate)

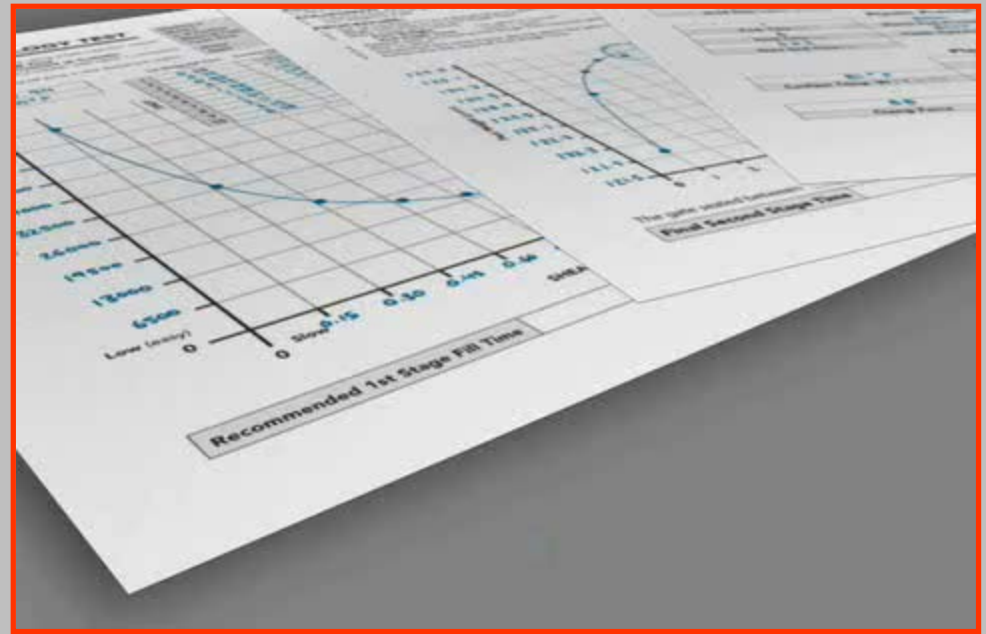
PSI _{mold}	11630
PSI _{air}	3220
DELTA _{psi}	8410
FACTOR _{psi}	0.841
Load Sensitivity	0.71 % per 10000 psi

(PSI_{mold} - PSI_{air}) =
 (DELTA_{psi} ÷ 10000) =
 (FACTOR_{time} ÷ FACTOR_{psi}) × 100 =

Common Scientific Tests

Process Evaluation:

- In-Mold Rheology Test
- Gate Seal Worksheet
- Process Worksheet

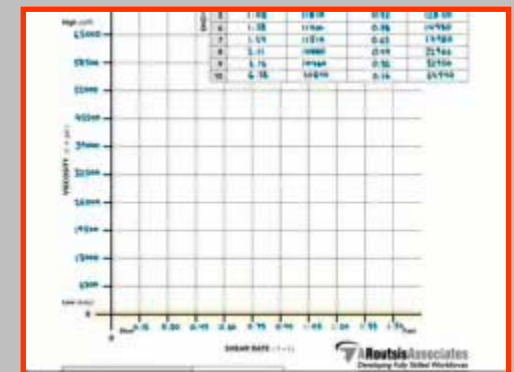


Process Evaluation

In-Mold Rheology Test:

- Mold Fill-Only Parts At 10 Different Flow Rates
- Record For Each Shot:
 - Fill Time & Transfer Pressure
- Calculate:
 - Shear Rate & Effective Viscosity
- Graph Shear Rate Vs. Viscosity
- Select Optimal Fill Time

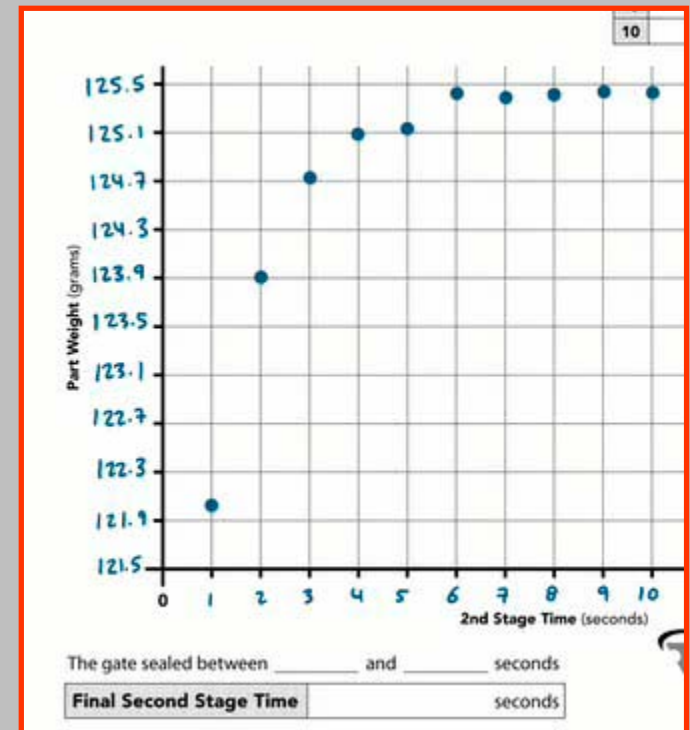
1st Stage Fill Time (t)	Transfer Pressure (psi)	Shear Rate (1 ÷ t)	Effective Viscosity (t × psi)
0.68	11500	1.47	
0.75	11750	1.33	
0.93	11910	1.20	
0.93	11910	1.08	
1.08	11890	0.93	
1.28	11700	0.78	
1.59	11310	0.63	
2.11	10880	0.47	
3.15	10460	0.32	
6.28	10340	0.16	



Process Evaluation

Gate Seal Worksheet:

- Mold Parts With Increasing 2nd Stage Time
- Record For Each Shot:
 - Part Weight
 - 2nd Stage Time
- Plot:
 - Part Weight Vs. 2nd Stage Time
- Select Final Second Stage Time



Process Evaluation

Process Worksheet:

- Measure And Record:
 - Temperatures
 - Times
 - Pressures
 - Etc.
- Focus On Process Outputs

Decoupled II
2-Stage DECOUPLED MOLDING™
PROCESS SHEET

Machine # 310-07
Mold # 1
Material Type ABS
Name JAM
Date 01/25/2012

Template Name
510 F
Melt Temp (T_m) 210

Plastic Temperature 1.0742
Plastic Back Pressure 110.72
Plastic Flow Rate 3.220
Plastic Pressure at Transfer (at Part Transfer Point) 121.90
Plastic Pressure 8000
Plastic Pack Pressure 5000
Plastic Hold Pressure 125.40
Plastic Cooling 15.0
Cooling Time 2.5
Coolant Flow 79
Coolant Temp. OUT 81
Clamp 8.783
Clamp Force 28
Clamp Type Toggle

Part Weight 11.430
Part Weight 3.220
Part Weight 12.540
Part Weight 12.540
Cycle Time 8.783

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Common Scientific Equipment

Scale:

- Accurate To At Least 0.5% Part Weight



Common Scientific Equipment

Pyrometer:

- Melt Probe
- Surface Probe



Common Scientific Equipment

Indicator:

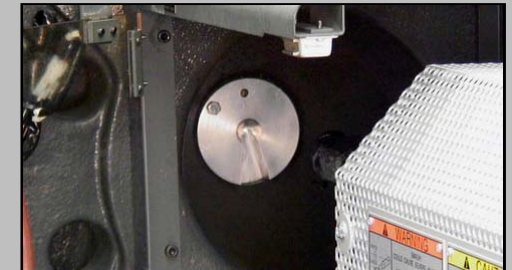
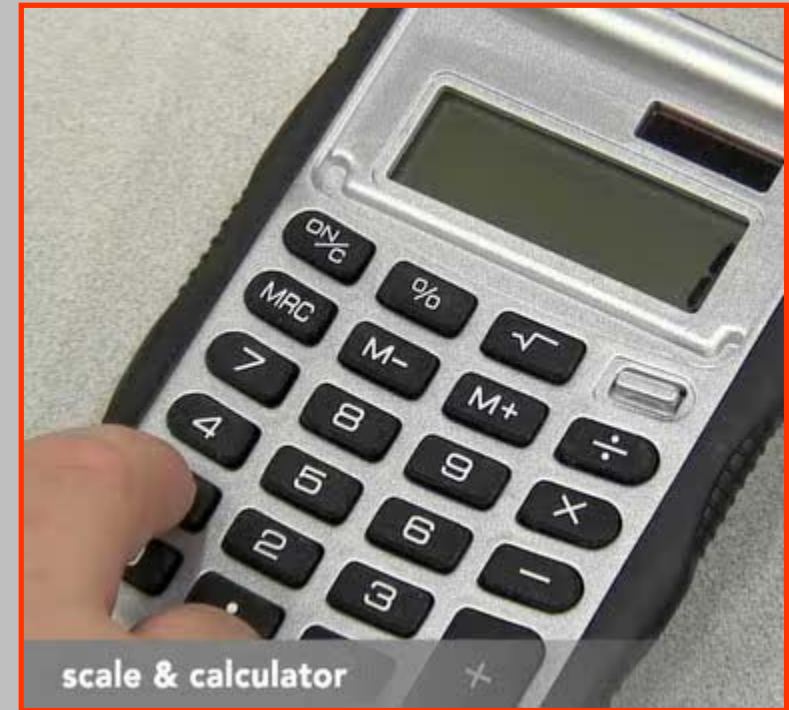
- Magnetic Base
- Adjustable Arm



Common Scientific Equipment

Additional Equipment:

- Calculator
- Flow Meter
- Ruler
- Purge Plate



Special Offer – 20% discount

Scientific Troubleshooter Package

- DECOUPLED MOLDINGSM Series
- Intelligent Molder Series
 - Machine Evaluation
 - Mold Evaluation
 - Process Evaluation



Practical Scientific Molding Techniques

Q & A Session

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