Practical Scientific Molding Techniques

presented by:

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Best Molding Practices

April 29, 2009

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?

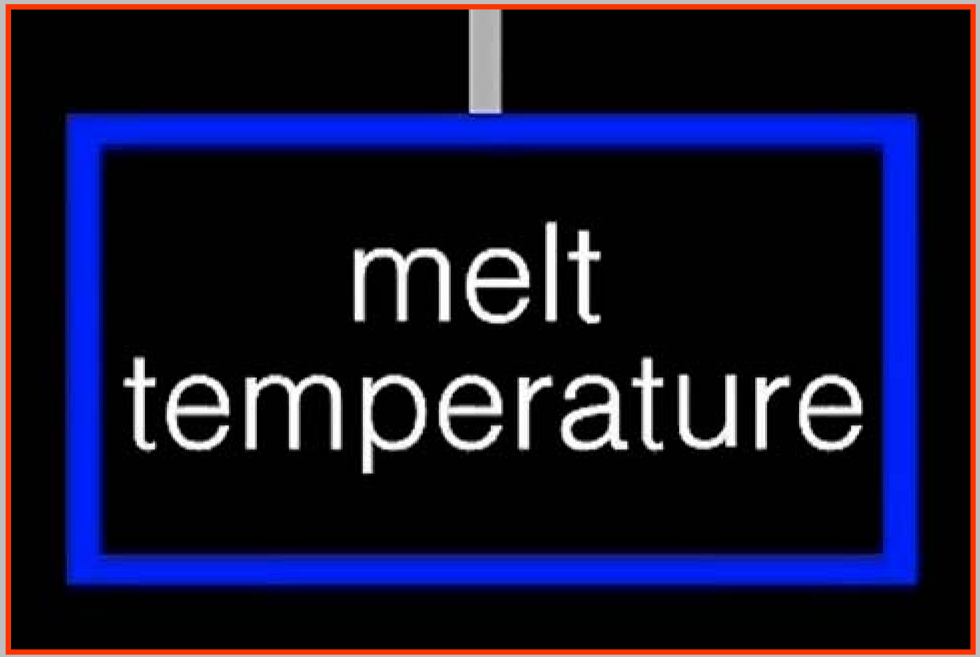
Someone Who Uses Data To:

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

Who Is A Scientific Molder?

Determines Process Parameters:

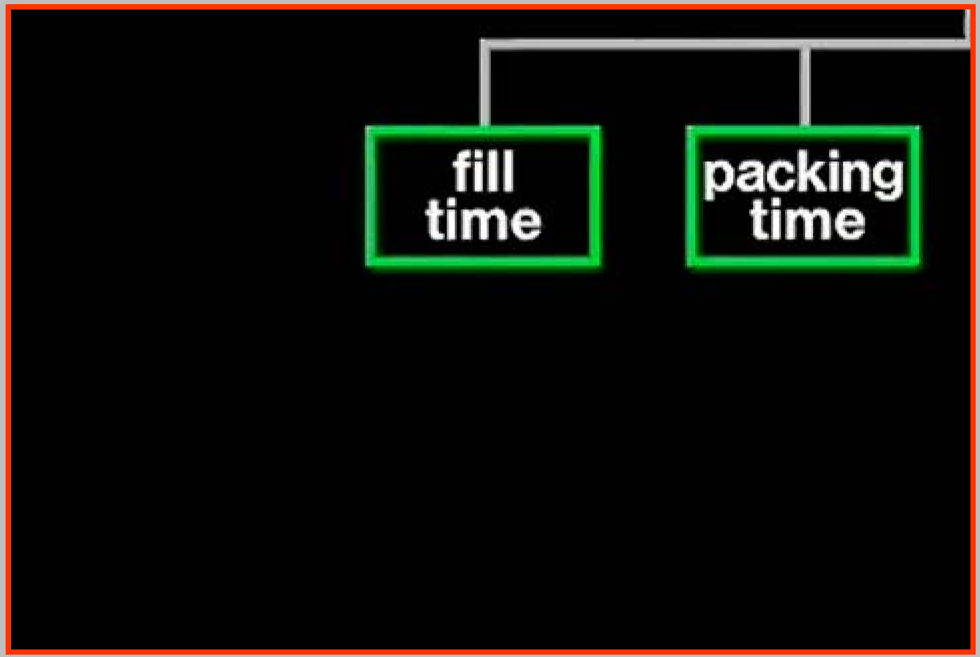
- Using Actual Melt Temperature
  - To Determine Barrel Temperature Settings



Who Is A Scientific Molder?

Determines Process Parameters:

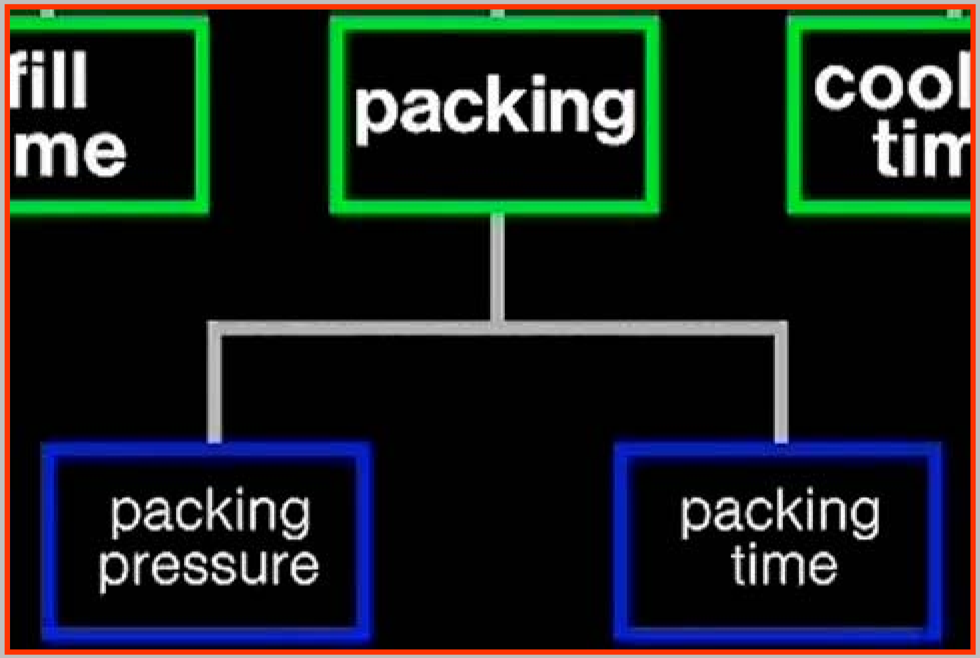
- Using Actual Fill Time
  - To Determine Injection Speed Settings



Who Is A Scientific Molder?

Determines Process Parameters:

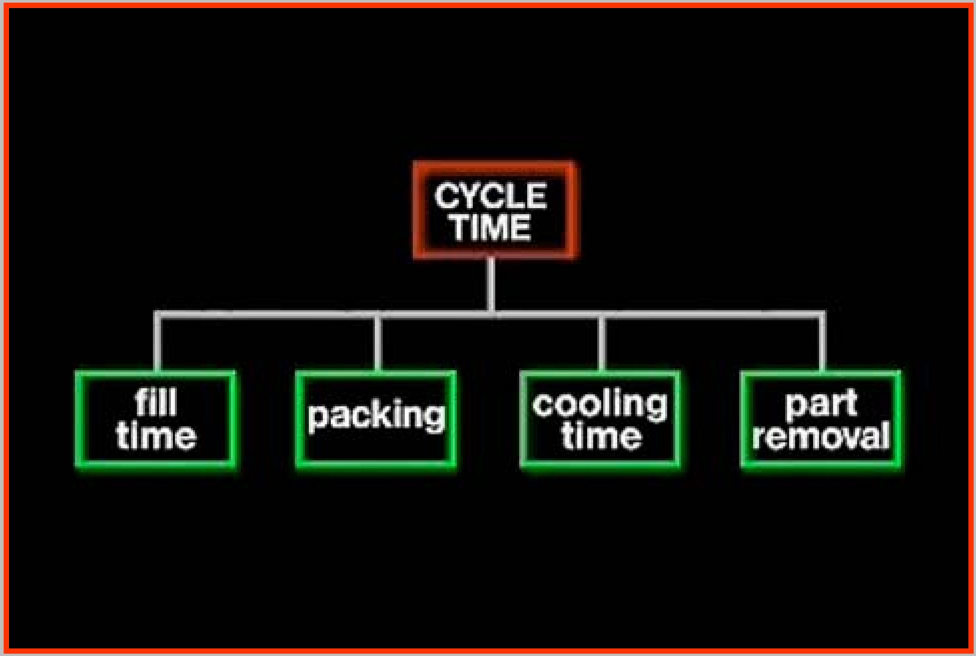
- Using Actual Plastic Pressure
  - To Determine Pack And Hold Settings



Who Is A Scientific Molder?

Determines Process Parameters:

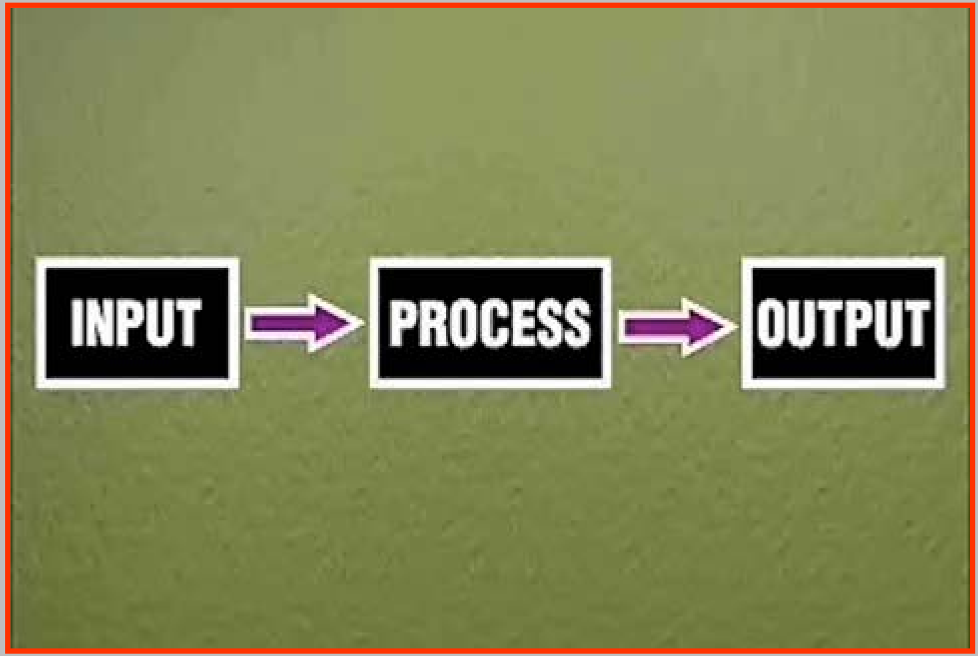
- Using Actual Coolant Temperature
  - To Determine Mold Temperature Settings



Who Is A Scientific Molder?

Documents Machine Independent Outputs:

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



Documents Machine Independent Outputs

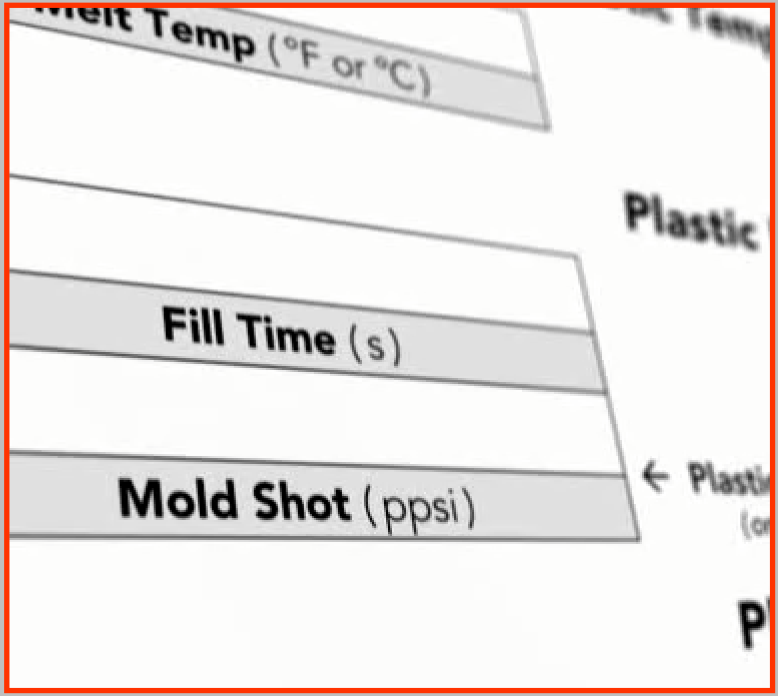
Process Outputs - Temperatures:

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

Documents Machine Independent Outputs

Process Outputs - Times:

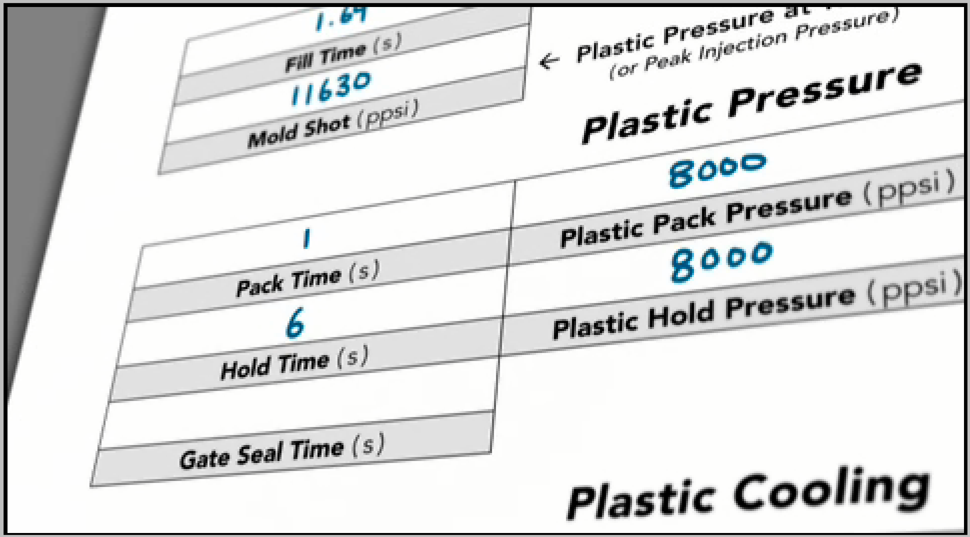
- Fill Time
- Pack Time
- Hold Time
- Gate Seal Time
- Cycle Time
- Recovery Time



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

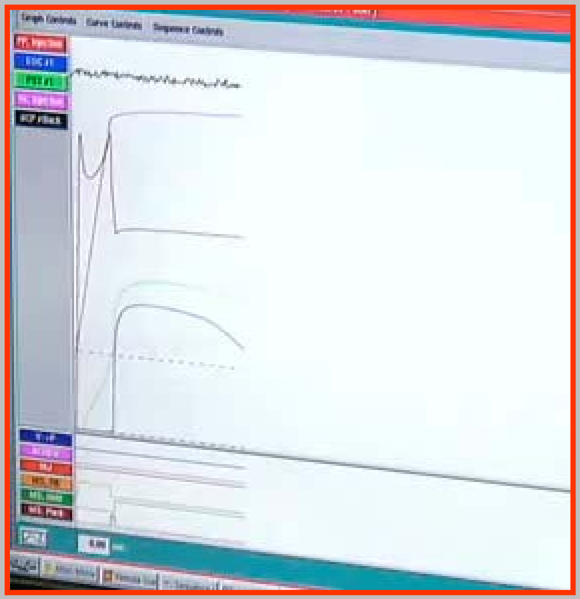
123.90
Fill & Pack Part Weight (g)
125.40
Final Part Weight (g)

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?

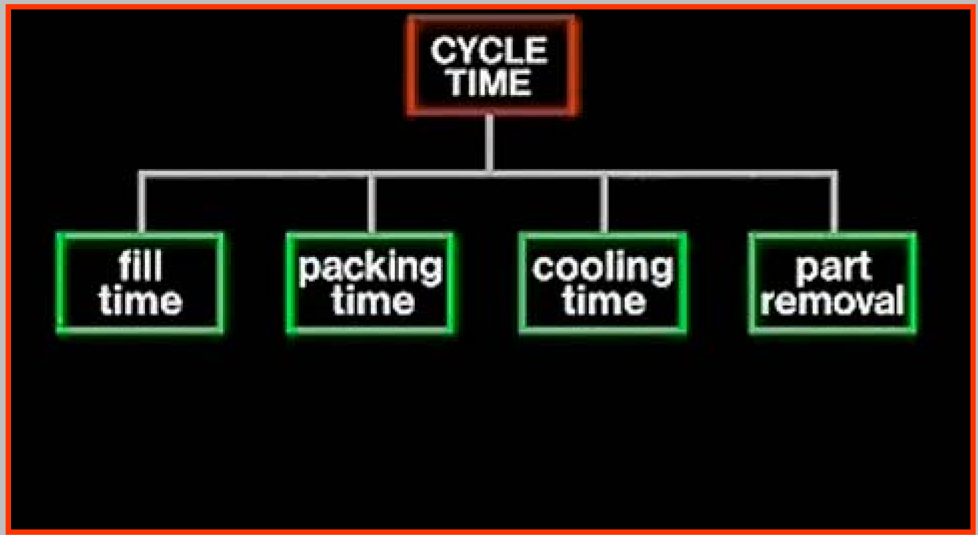
Troubleshoots Using A Systematic Process:

- 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?

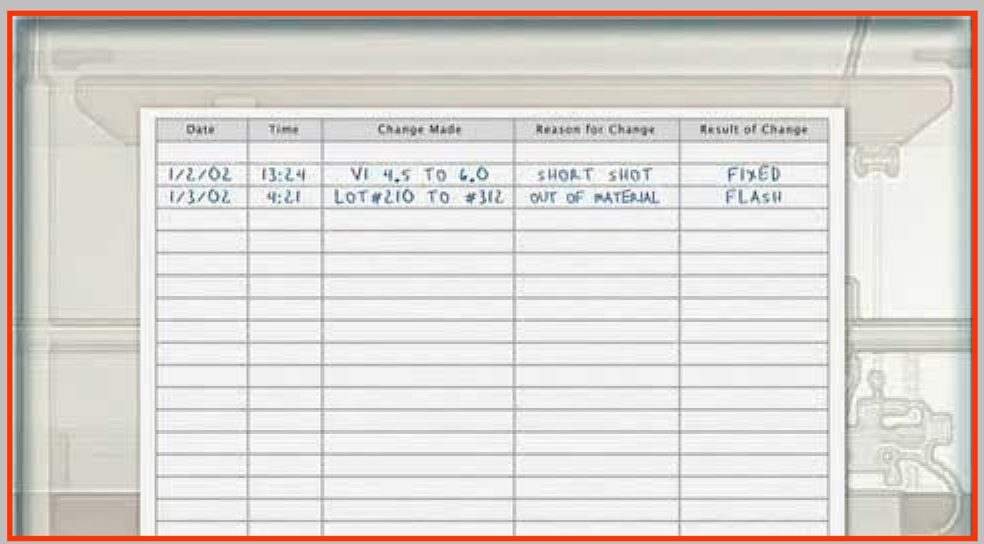
Troubleshoots Using A Systematic Process:

- 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?

Troubleshoots Using A Systematic Process:

- Step 6. Document Any Changes Made
  - Record Actions And Causes So That Others Can Follow And Learn



Date	Time	Change Made	Reason for Change	Result of Change
1/2/02	13:24	VI 4.5 TO 6.0	SHORT SHOT	FIXED
1/3/02	4:21	LOT#210 TO #312	OUT OF MATERIAL	FLASH

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

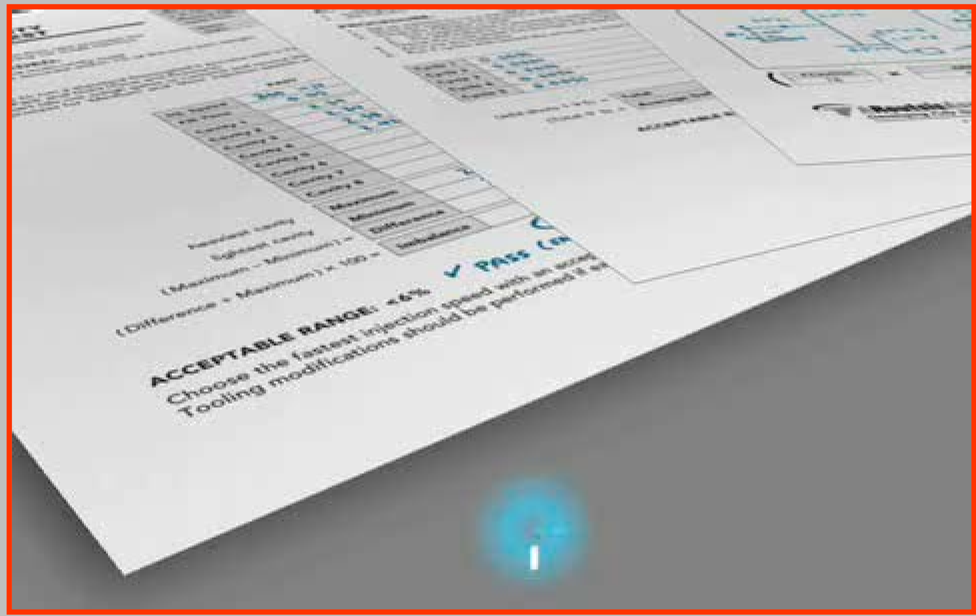
Common Scientific Tests

- Mold Evaluation
- Machine Evaluation
- Process Evaluation

Common Scientific Tests

Mold Evaluation:

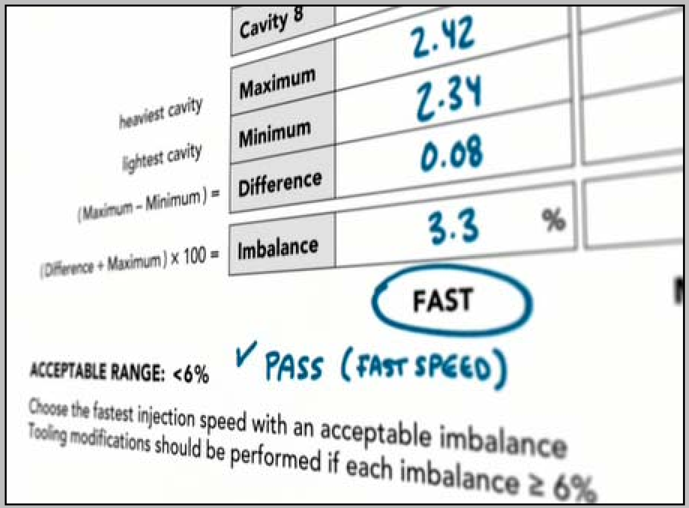
- Dynamic Cavity Imbalance Test
- Mold Deflection Test
- Tonnage Calculation



Mold Evaluation

Dynamic Cavity Imbalance Test:

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

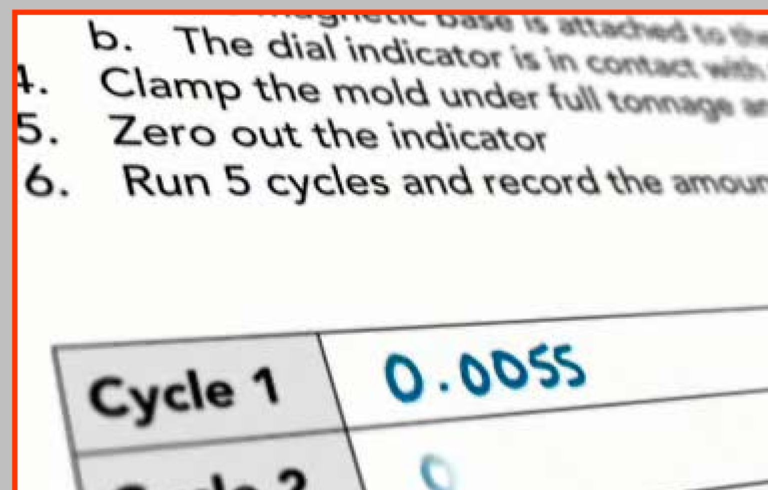


Mold Evaluation

Mold Deflection Test:

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

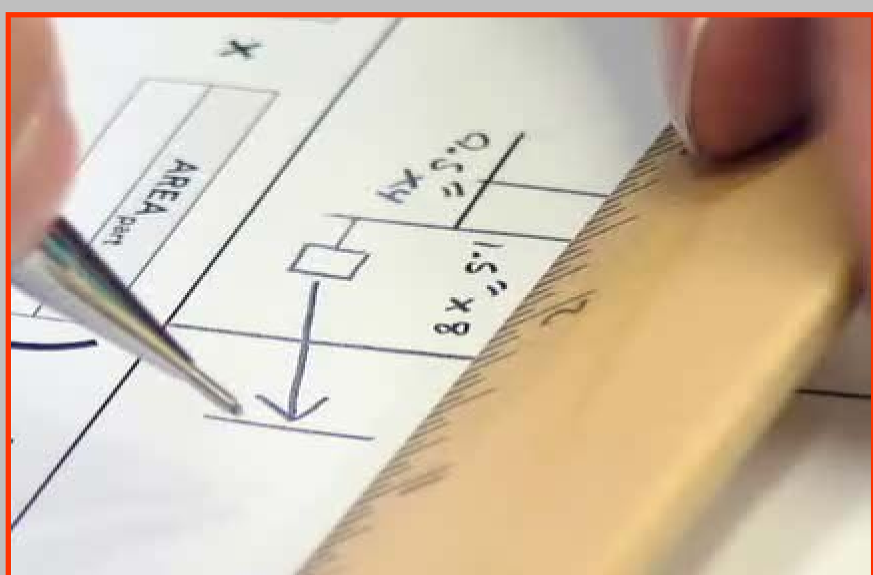
(add shots 1→5) =	Total	0.0275
(Total ÷ 5) =	Average Deflection	0.0055

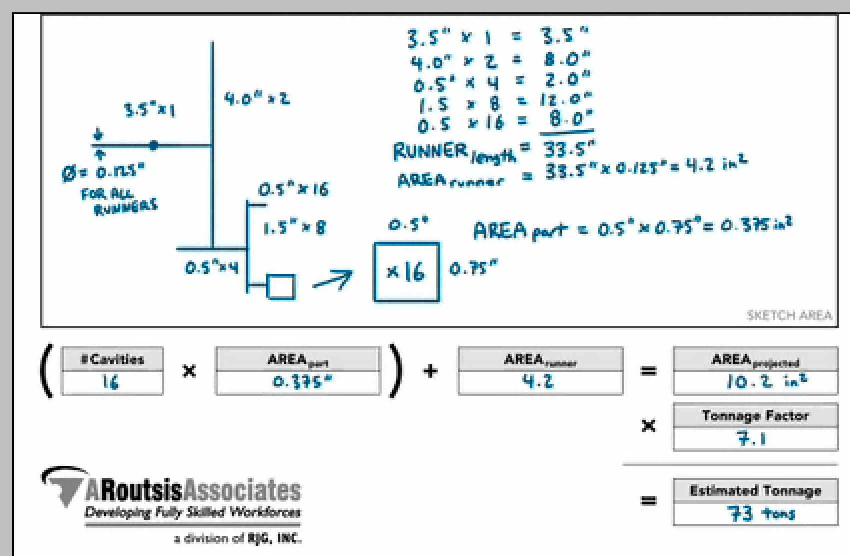


Mold Evaluation

Tonnage Calculation:

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

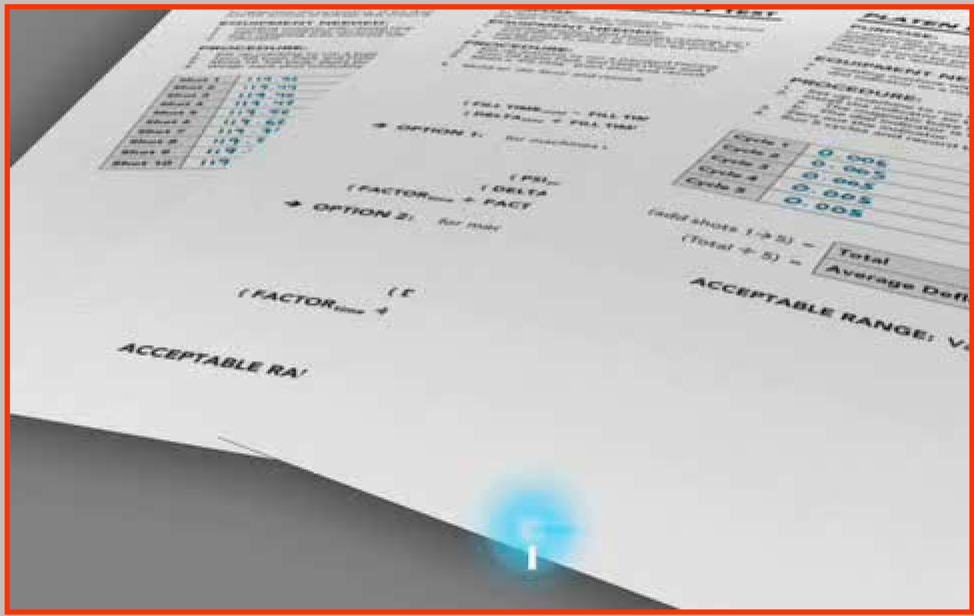




Common Scientific Tests

Machine Evaluation:

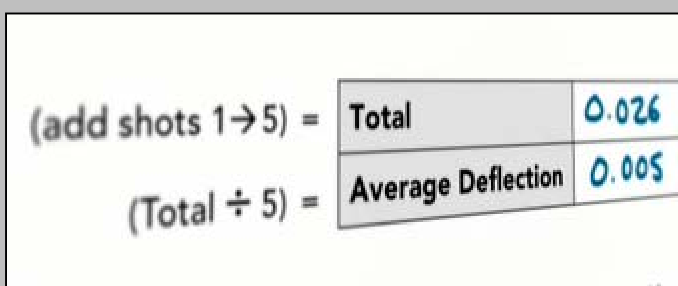
- Platen Deflection Test
- Dynamic Check Ring Repeatability Test
- Load Sensitivity Test



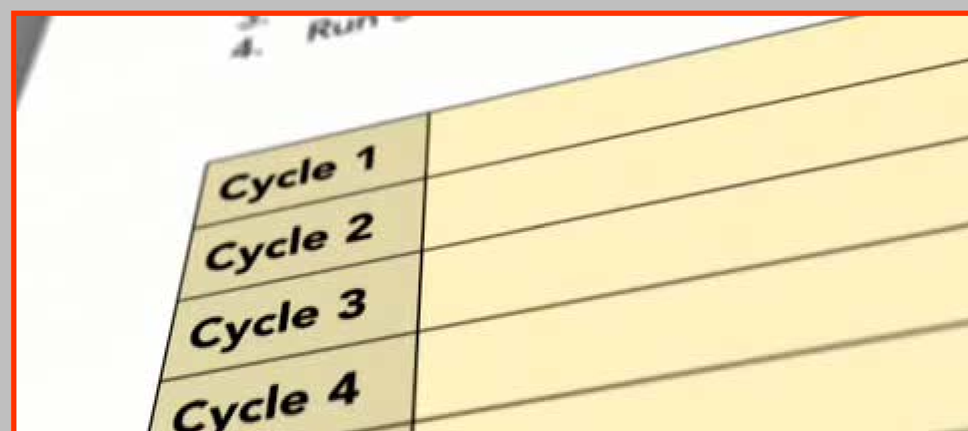
Machine Evaluation

Platen Deflection Test:

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



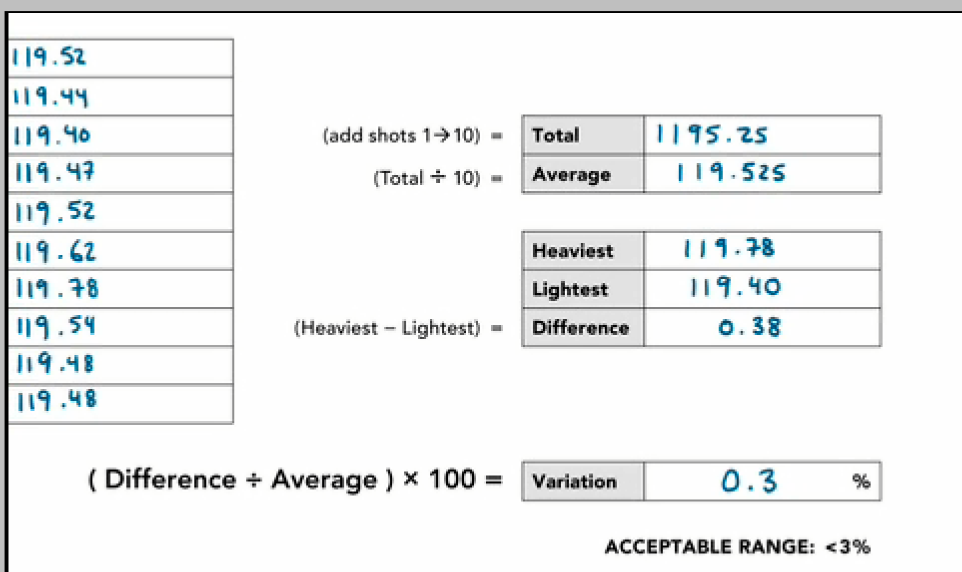
(add shots 1→5) =	Total	0.026
(Total ÷ 5) =	Average Deflection	0.005



Machine Evaluation

Dynamic Check Ring Repeatability Test:

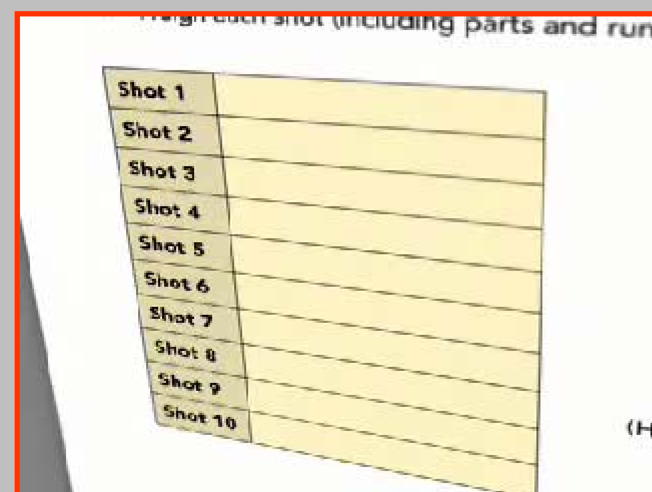
- Mold 10 Fill-Only Shots
- Measure Shot Weights
- Determine Variation



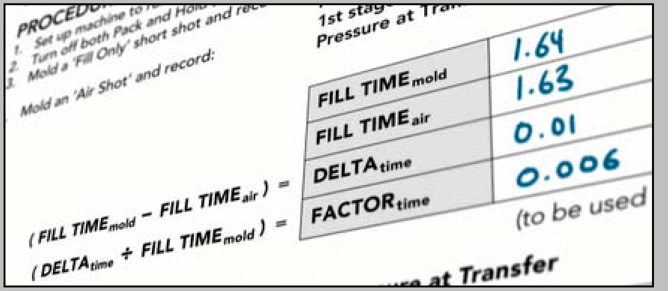
119.52
119.44
119.40
119.47
119.52
119.62
119.78
119.54
119.48
119.48

(add shots 1→10) =	Total	1195.25
(Total ÷ 10) =	Average	119.525
	Heaviest	119.78
	Lightest	119.40
(Heaviest – Lightest) =	Difference	0.38
(Difference ÷ Average) × 100 =	Variation	0.3 %

ACCEPTABLE RANGE: <3%



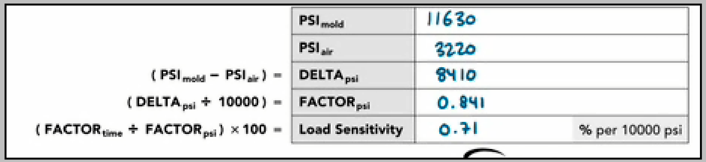
Machine Evaluation



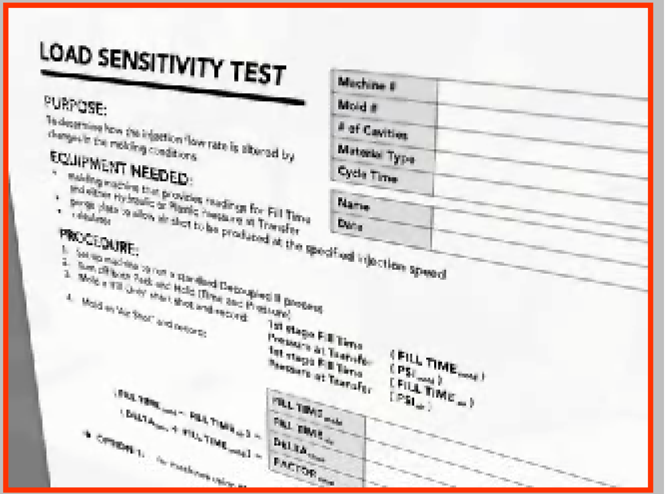
FILL TIME$_{mold}$	1.64
FILL TIME$_{air}$	1.63
(FILL TIME$_{mold}$ − FILL TIME$_{air}$) = DELTA$_{time}$	0.01
(DELTA$_{time}$ ÷ FILL TIME$_{mold}$) = FACTOR$_{time}$	0.006

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



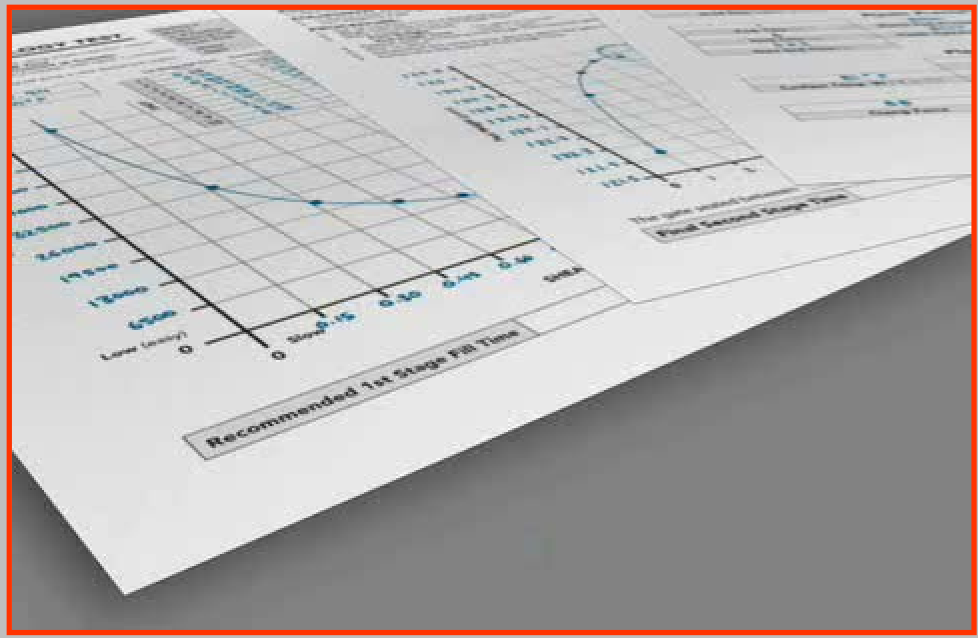
	PSI$_{mold}$	11630	
	PSI$_{air}$	3220	
(PSI$_{mold}$ − PSI$_{air}$) =	DELTA$_{psi}$	8410	
(DELTA$_{psi}$ ÷ 10000) =	FACTOR$_{psi}$	0.841	
(FACTOR$_{time}$ ÷ FACTOR$_{psi}$) × 100 =	Load Sensitivity	0.71	% per 10000 psi



Common Scientific Tests

Process Evaluation:

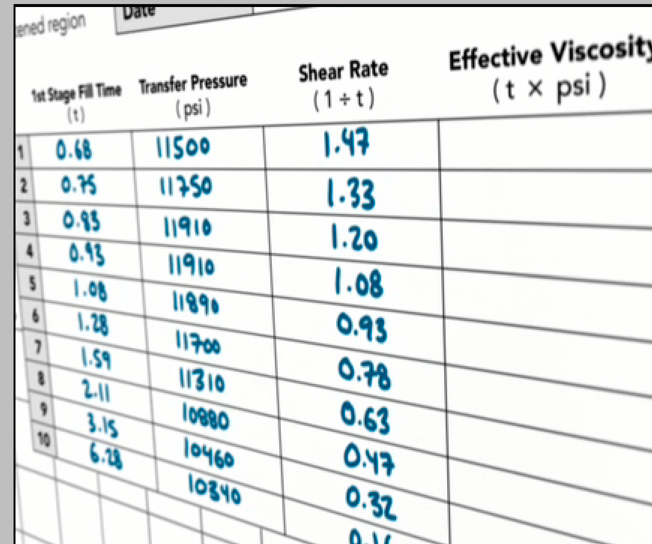
- In-Mold Rheology Test
- Gate Seal Worksheet
- Process Worksheet



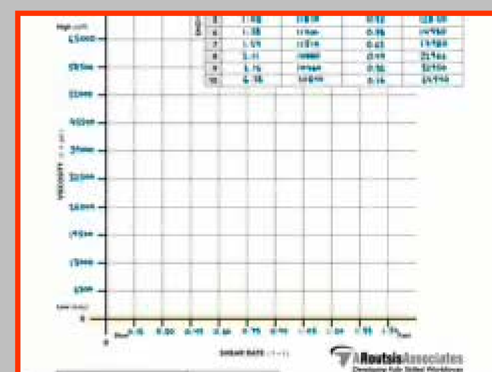
Process Evaluation

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



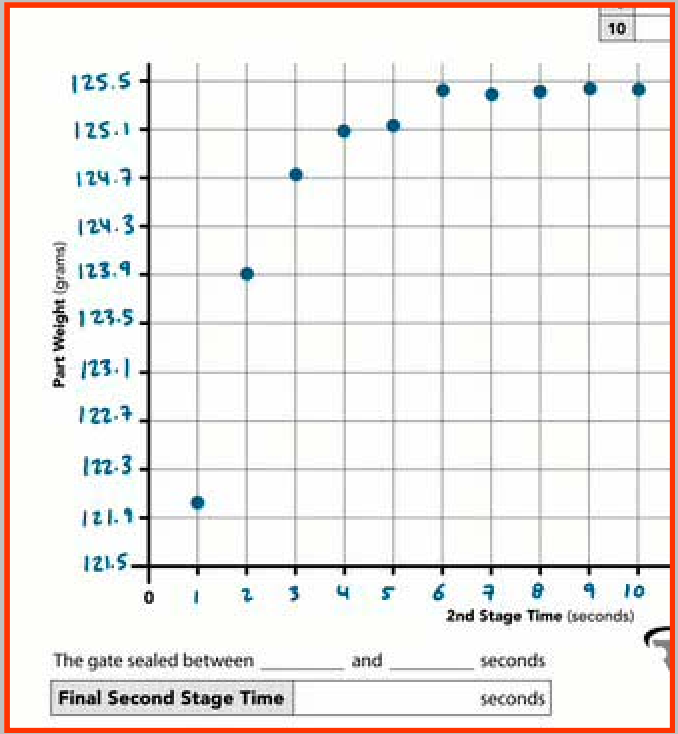
	1st Stage Fill Time (t)	Transfer Pressure (psi)	Shear Rate (1 ÷ t)	Effective Viscosity (t × psi)
1	0.68	11500	1.47	
2	0.75	11750	1.33	
3	0.83	11910	1.20	
4	0.93	11910	1.08	
5	1.08	11890	0.93	
6	1.28	11700	0.78	
7	1.59	11310	0.63	
8	2.11	10880	0.47	
9	3.15	10460	0.32	
10	6.28	10340	0.1	



Process Evaluation

Gate Seal Worksheet:

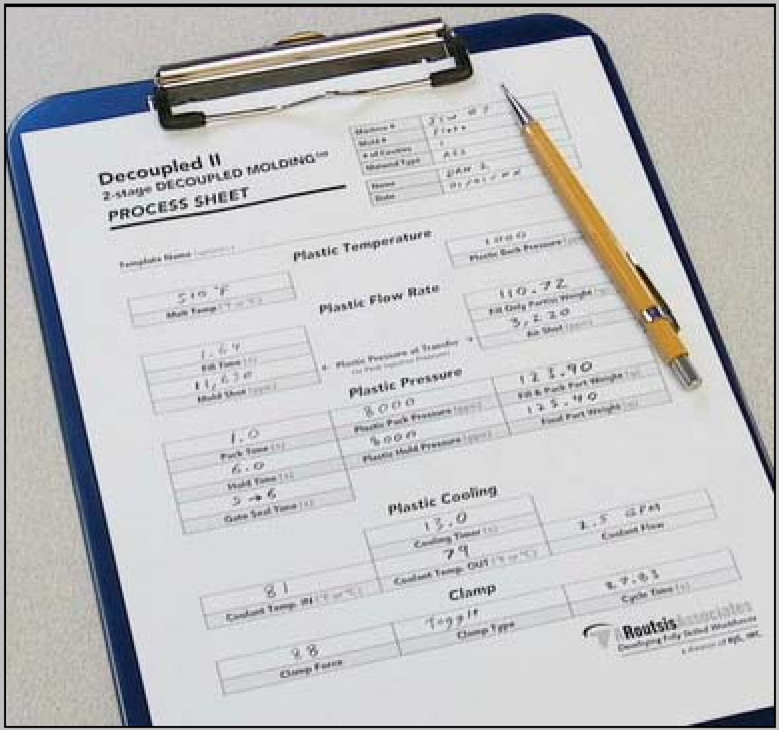
- Mold Parts With Increasing 2nd Stage Time
- Record For Each Shot:
  - Part Weight
  - 2nd Stage Time
- Plot:
  - Part Weight Vs. 2nd Stage Time
- Select Final Second Stage Time



Process Evaluation

Process Worksheet:

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



Common Scientific Equipment

Scale:

- Accurate To At Least 0.5% Part Weight

Common Scientific Equipment

Pyrometer:

- Melt Probe
- Surface Probe

pyrometer with melt temperature probe

surface temperature probe

Common Scientific Equipment

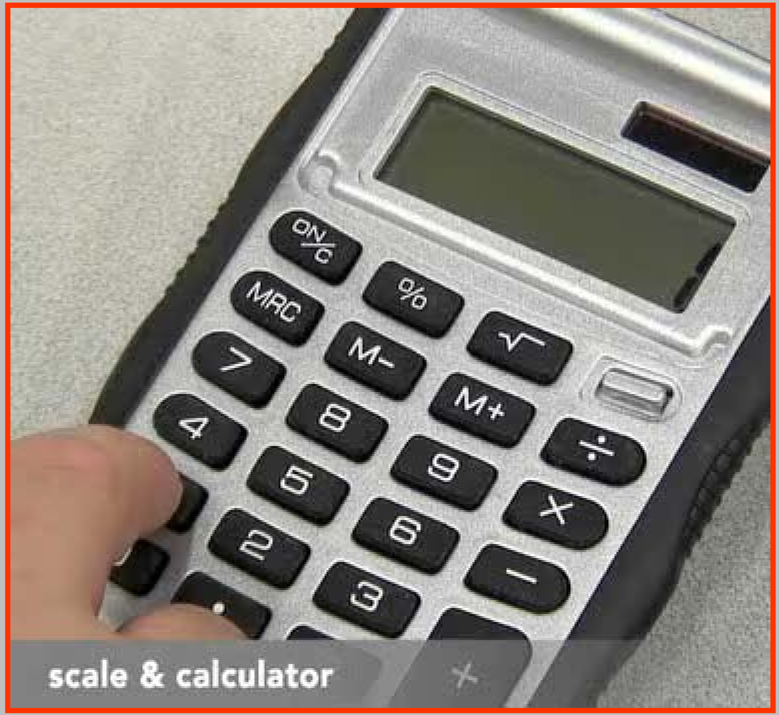
Indicator:

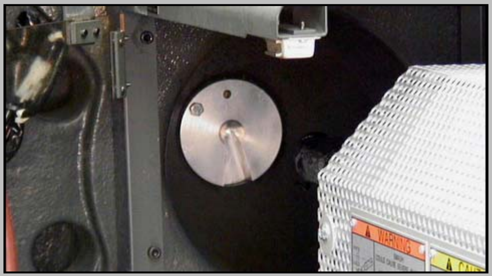
- Magnetic Base
- Adjustable Arm

Common Scientific Equipment

Additional Equipment:

- Calculator
- Flow Meter
- Ruler
- Purge Plate





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Practical Scientific Molding Techniques

Q & A Session

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