Wax Injection Best Practices

Investment Casting Manufacturing Philosophy

30 Years Ago

- A State of the Art (aka Black Magic)
- Victim of the Seasons
- Success Was a Result of Experience and Subjectivity

Today

- ✓ Process Control
- ✓ Technology Driven
- ✓ Data Based Decision Making

Process Control Methodology

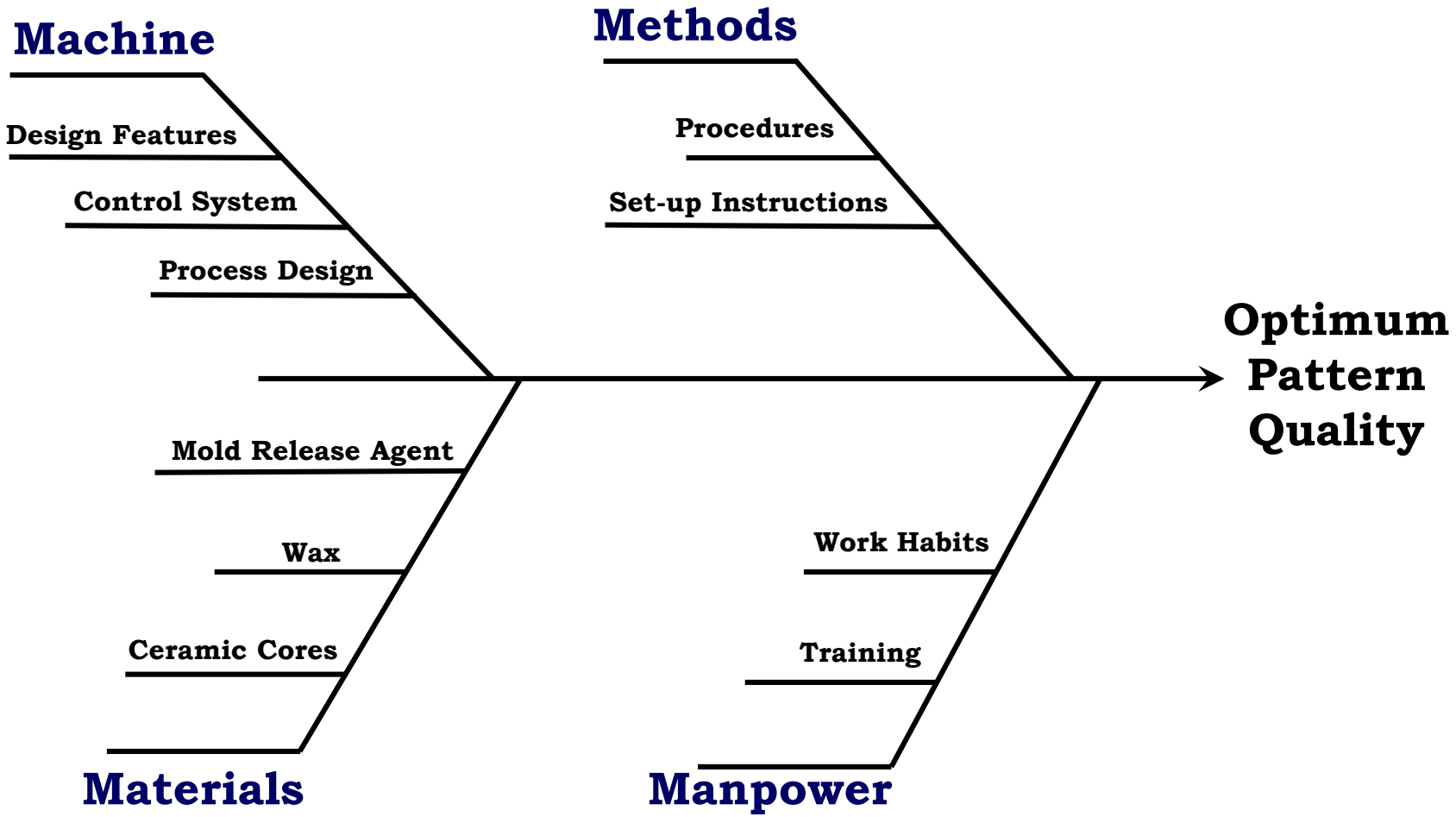
1. Determine Desired Process Outputs

2. Identify Variables That Affect Outputs

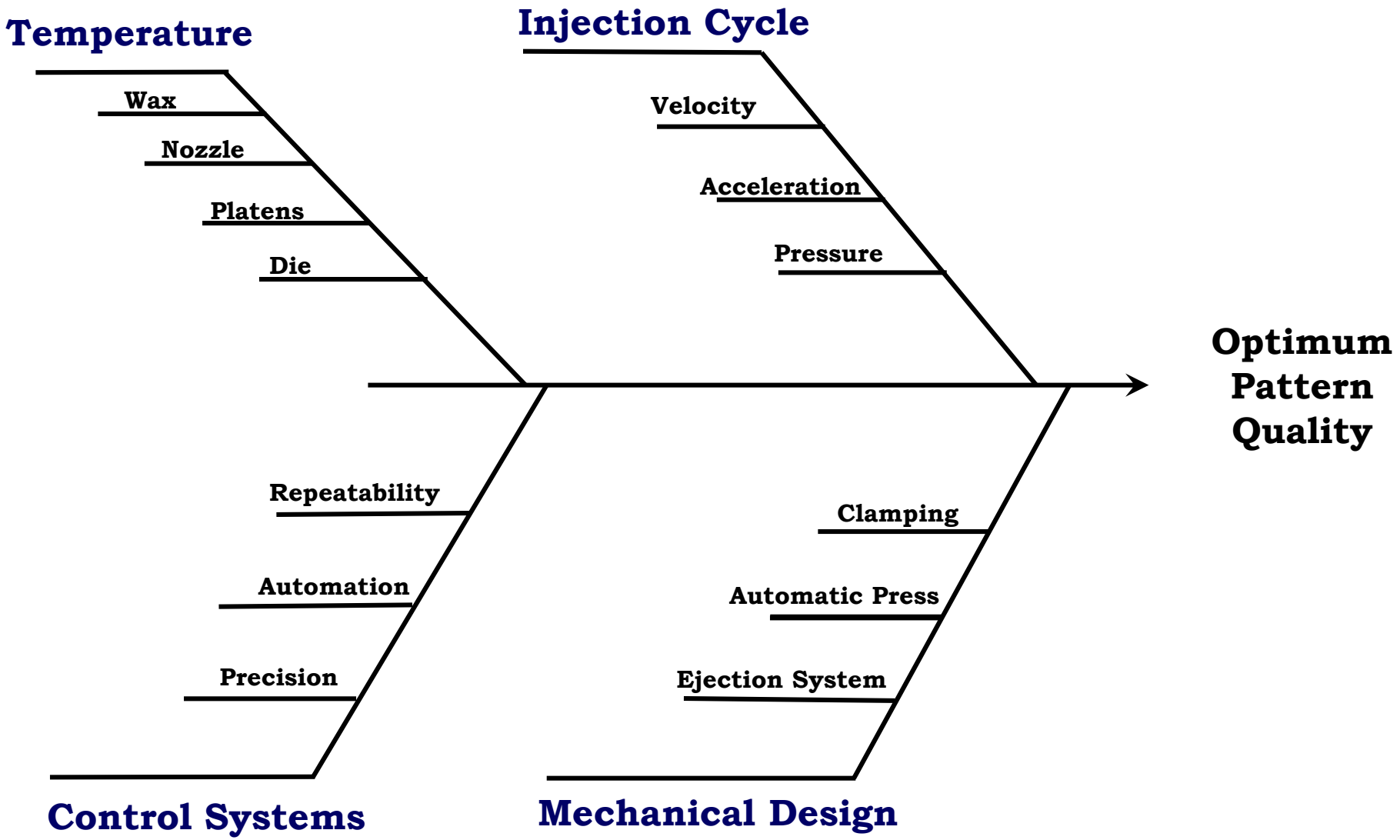
3. Systematically Control (Or Eliminate) Variables So That Output Is Consistently Achieved

- Output Variability = Input Variability + Process Variability

Cause and Effect Analysis



Process Variables – Machine Controls

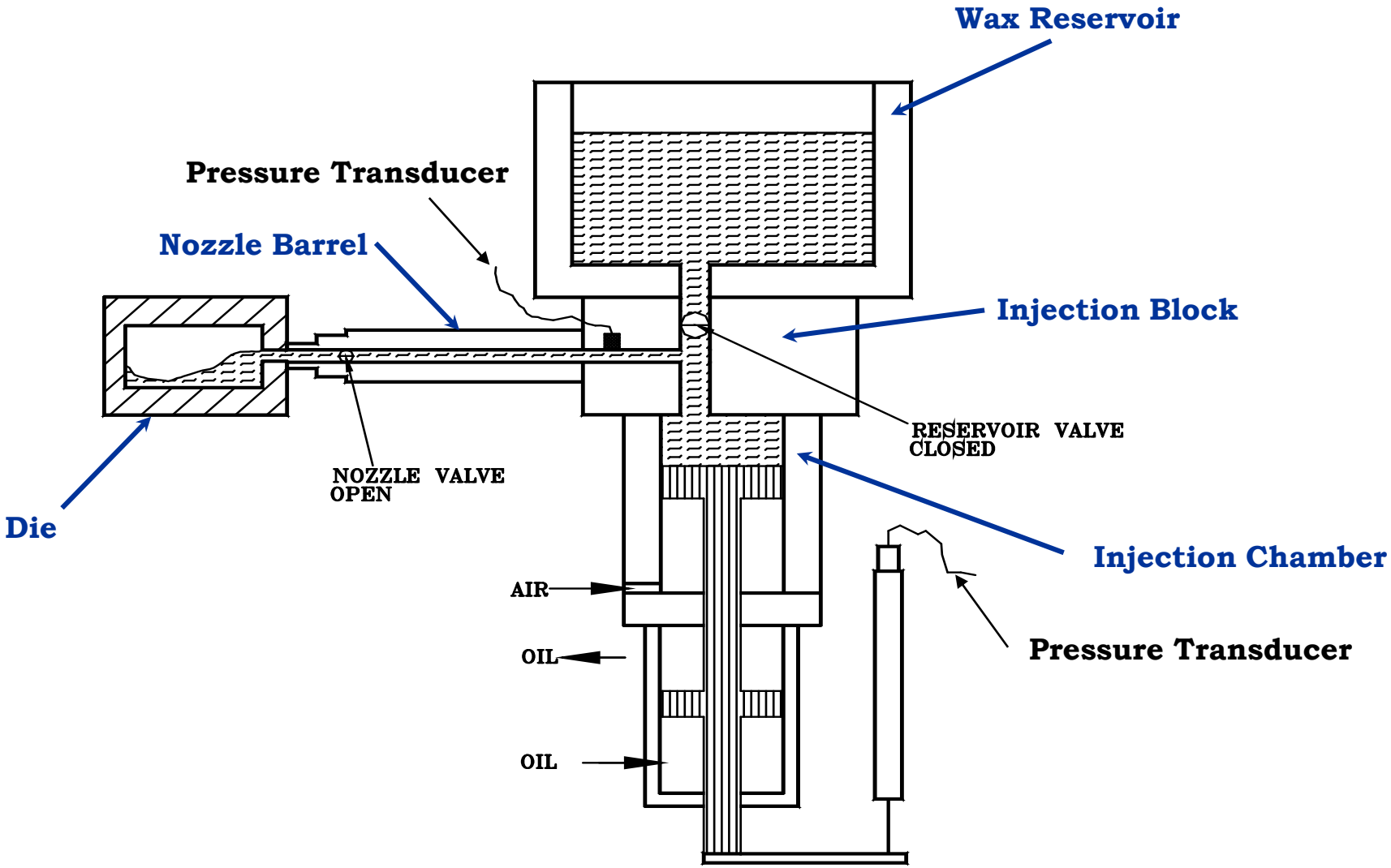


Controlling Process Variables

Injection Cycle Parameters

- Velocity
- Acceleration
- Pressure
- Temperature

Example Wax Injection System



Controlling Process Variables

Effects of Variation

Flow Control

Velocity

- Air Entrapment
- Flow Lines
- Knit Lines
- Splash

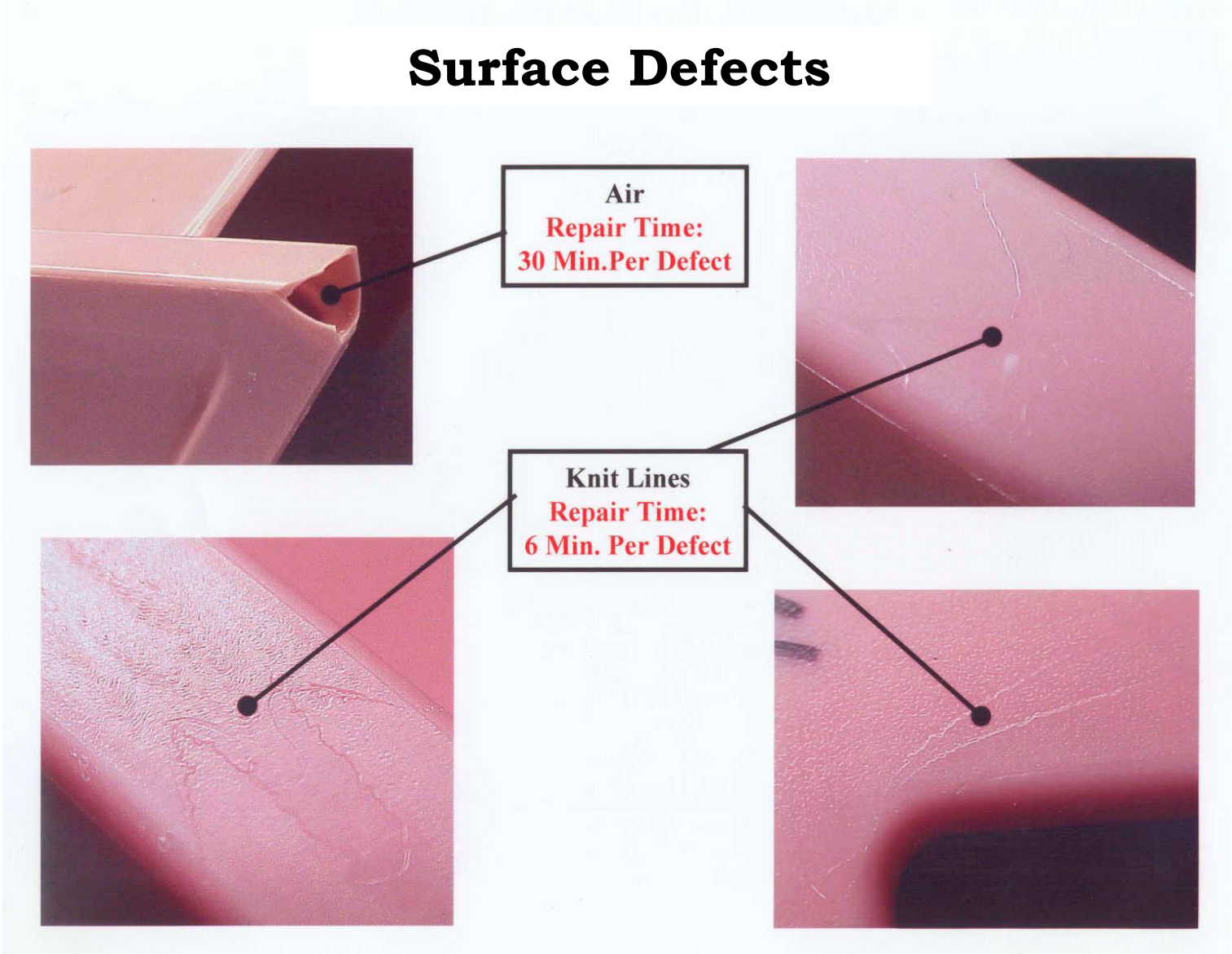
Acceleration

Pressure Control

- Sink
- Flash
- Non-Fill
- Pattern Cracking
- Core Breakage

Undesirable Output Variables

Surface Defects



Undesirable Output Variables

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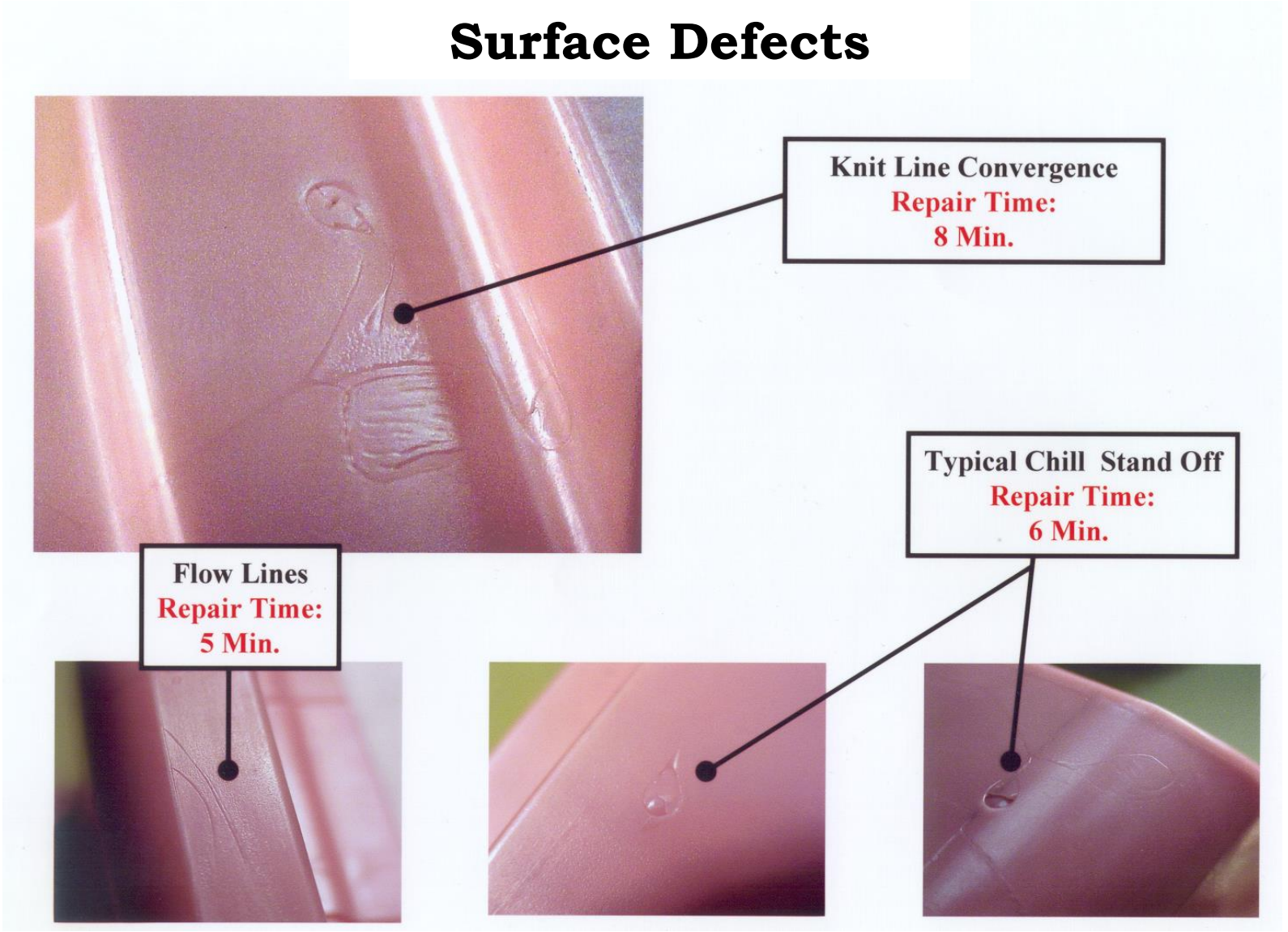
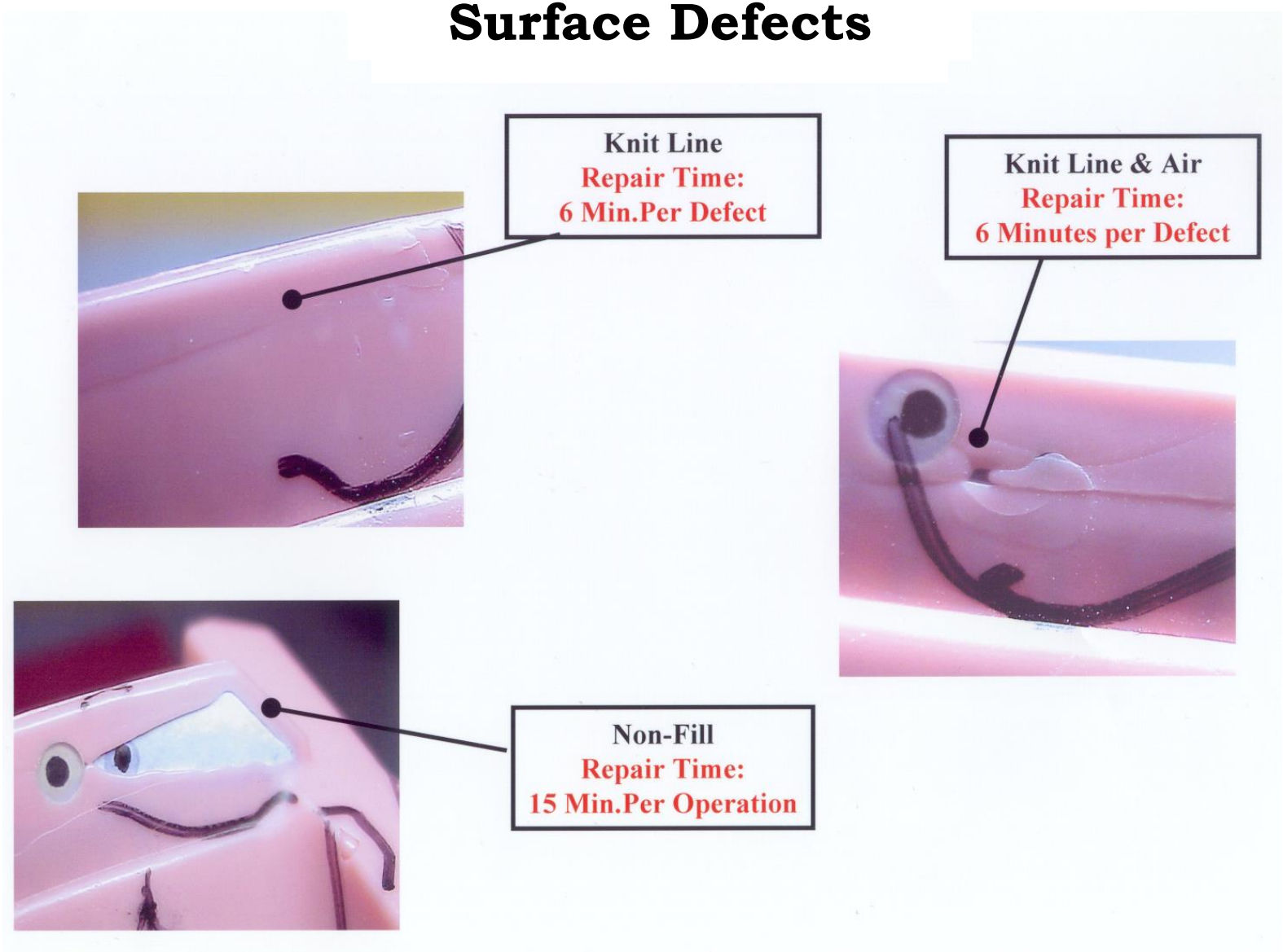


Undesirable Output Variables

Surface Defects



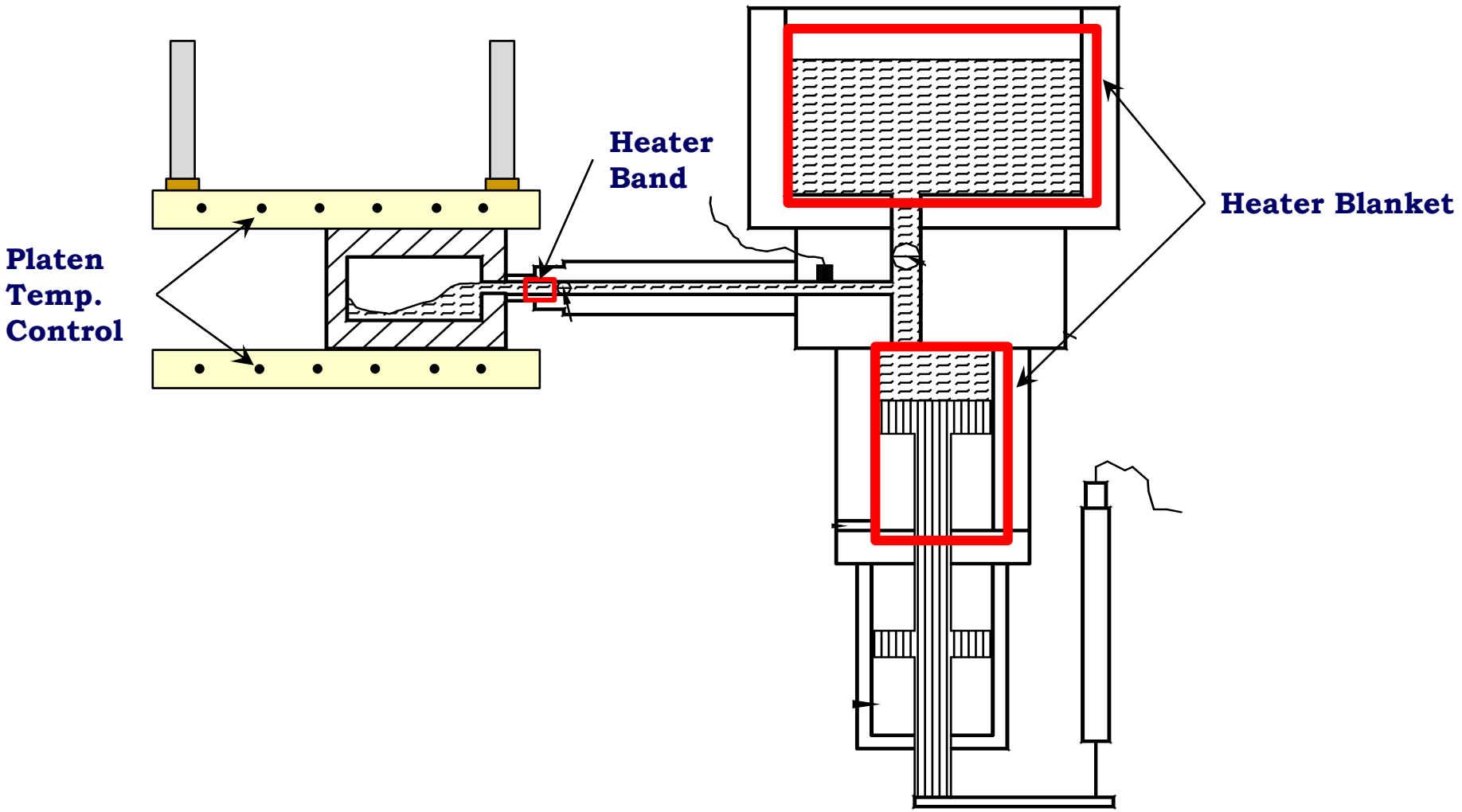
Temperature Variation

Temperature Control: The Most Significant Variable

Blisters
Sink (Cavitation)
Air Entrapment
Flash
Undersize Dimensions

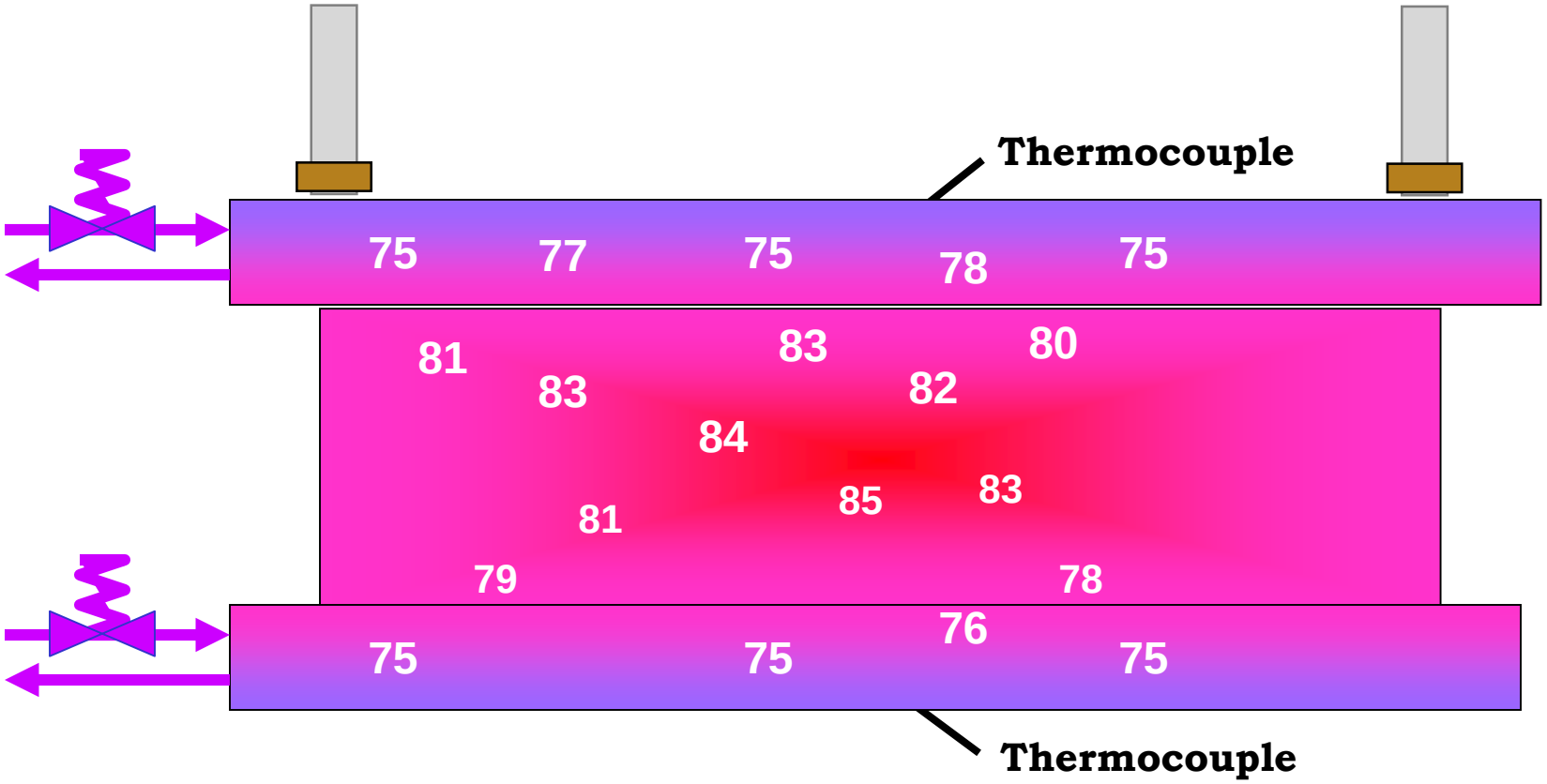
Flow Lines
Knit Lines
Non-Fill
Pattern Cracking
Oversize Dimensions

Injection System Temperature Control



Die Temperature Control

Using Platens w/Temperature Control



Desired Die Temp = 75°

Examples of Output Variation, Input Causes & Remedies

Flow Lines, Ripples & Knit Lines

Cause	Remedy
■ Cold Die	➢ Heat Die
■ Cold Wax	➢ Increase Wax Temperature
■ Wax Flow is too Low	➢ Increase Wax Flow
■ Injection Path is too Complex or too Small	➢ Make a More Direct Sprue Path and/or Enlarge Sprue

Trapped Air

Cause	Remedy
■ Hot Wax	➢ Decrease Wax Temperature
■ Die Improperly Vented	➢ Add or Enlarge Vents ➢ Eliminate Blind Vents
■ Vents filled with Wax	➢ Clean Mold
■ Wax Flow too High	➢ Decrease Max Wax Flow &/or Acceleration
■ Bad Machine Seals	➢ Service Machine
■ Stirring in Air	➢ Assure Wax Reservoir is at Proper Fill Level

Sink (Cavitation)

Cause	Remedy
Hot Wax	Decrease Wax Temperature
Low Injection Pressure	Increase Injection Pressure
Short Hold Time	Increase Hold Time
Small Sprue Runner	Increase Runner Size
Lack of Wax or Steel Chills	Add Chills to Large Cross-Sections

Questions

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Back-up Slides

Non-Fill

Cause	Remedy
■ Cold Wax	➢ Increase Temperature
■ Low Injection Pressure	➢ Increase Injection Pressure
■ Flow Rate Too Low	➢ Increase Flow
■ Cold Mold	➢ Warm up Mold
■ Small Injection Sprue	➢ Enlarge the Injection Sprue
■ Improper Mold Venting	➢ Add or Enlarge Vents ➢ No blind vents ➢ Clean vents

Pattern Oversize

Cause	Remedy
■ Long Hold Time	➢ Decrease Hold Time
■ Cold Wax	➢ Increase Wax Temperature
■ Incorrect Shrink Factor	➢ Check Mold Dimensions

Pattern Undersize

Cause	Remedy
Wax Temperature too High	Decrease Wax Temperature
Low Injection Pressure	Increase Injection Pressure
Hold Time too Short	Increase Hold Time
Small Injection Sprue	Enlarge Injection Sprue
Cold Mold	Increase Mold Temperature
Incorrect Shrink Factor in Tool	Inspect Tool and Correct if Necessary

Core Breakage

Cause	Remedy
■ Improper Core Fit in Die	➢ Clamp Die w/ Core in Place. ➢ Open Die & Check Core for Cracks. ➢ Open up Core Seats if required.
■ Wax Flow too High	➢ Decrease Max. Wax Flow and/or Acceleration Setting
■ Wax Viscosity too High	➢ Increase Wax Temperature
■ Injection Pressure too High	➢ Decrease Injection pressure to 50-150 PSI (3.5-10.5 Kg./cm²)