AUTODESK UNIVERSITY

Optimization of Injection Molding Process Settings using Iliad and Moldflow

Shubhamkar Kulkarni

Research and Development Engineer| @linkedin.com/shubhamkar-kulkarni

Learning Objectives

- Introduction to design exploration, multi-disciplinary optimization software Iliad
- Demonstrate the application of numerical optimization to injection molding simulation
- Use of meta-modelling to identify optimal injection molding settings

Outline

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Introduction to OmniQuest

Who we are and what we do

5

State of the Art

Summary of design exploration capabilities in Moldflow

25

Instructional Demo

A step-by-step walkthrough to Iliad-Moldflow optimization

5

Conclusion

Summary

Who we are

OmniQuest™

Beyond Human Intuition

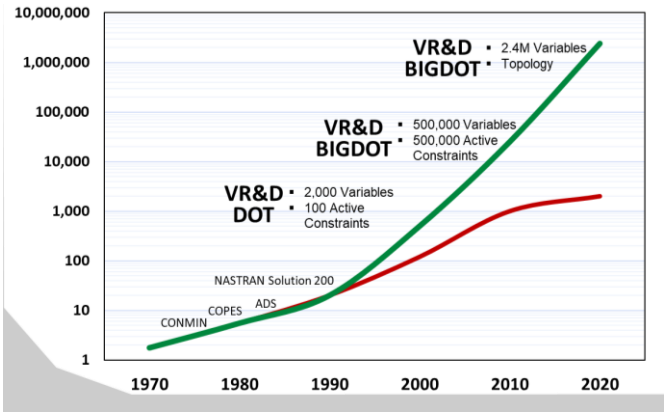
Vision

Optimization Unbound.

Mission

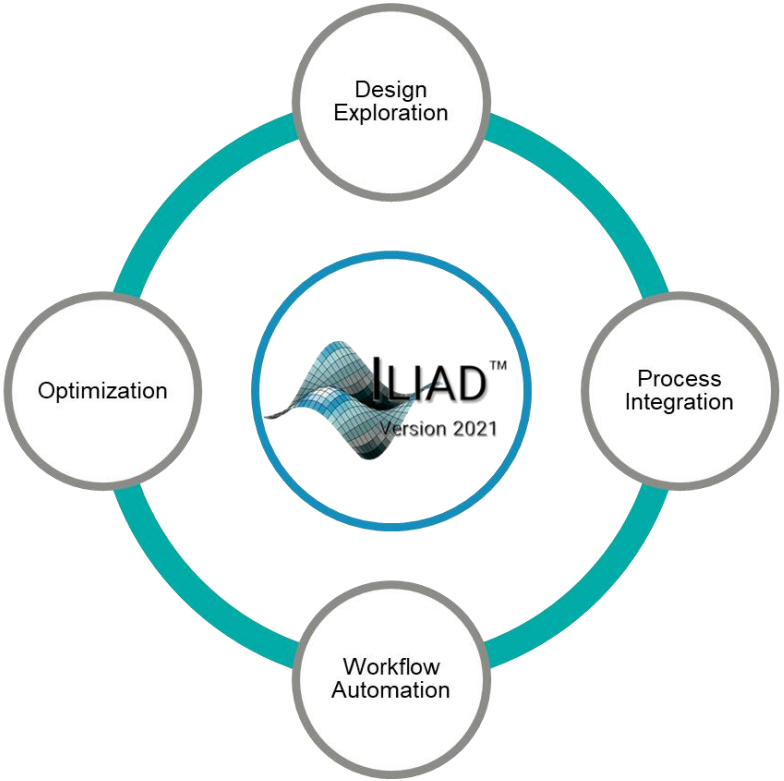
Creating optimal technology and software making Design Optimization commonplace.

Dr. Garret N. Vanderplaats
Chairman & Founder



Iliad™– Design Exploration & Automation Studio

Automation in Design



Iliad fulfills the following roles:

- Exploration of Design Space
- Integrating component analyses on to a single platform
- Optimizing design and process solutions
- Automatically improving the design solutions

Iliad Capabilities

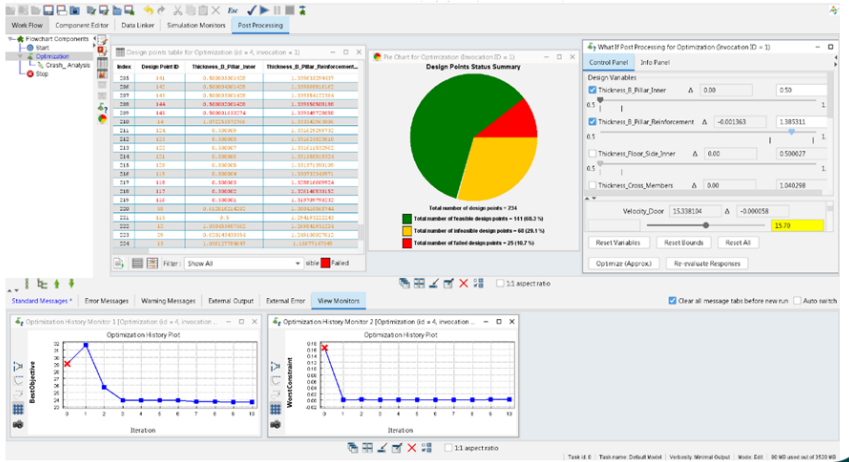
Dedicated Interfaces

- MATLAB
- MS Excel
- Python
- Moldflow
- ANSYS
- GENESIS
- ANSA
- META

Study Types

- Optimization
- Sensitivity Analysis
- Design of Experiments
- Meta Modeling
- Response Surface Approximation
- Probabilistic Analysis

ILIAD



Post-Processing

- Comprehensive Report
- What-if? Study
- Parallel Chart
- Pie Chart
- Powerpoint Report
- Design Point Table
- Response Surface
- Pareto Chart

Computation Types

- Parallel Run
- Remote Run

Real-time Control

- Loops (If/while/for)
- Handling Failure
- Simulation Monitors

Optimization with Iliad and Moldflow

Optimization in Injection Molding

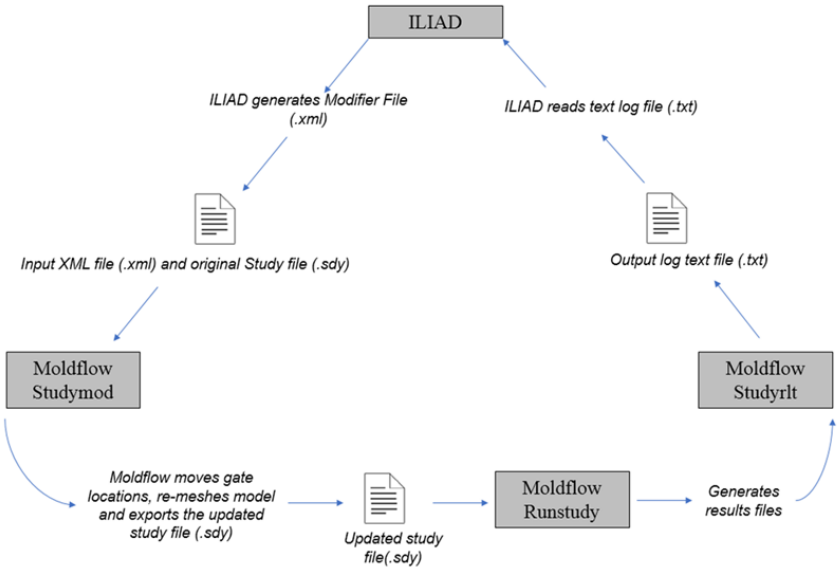
- Injection Molding process settings are optimized based on heuristic approaches.
- Challenges for design exploration:
  - High cost of tooling and equipment modification
  - High computational times for simulation
- Autodesk Moldflow Insight has solution exploration utilities

What Iliad Adds

Moldflow Capability	Feature	Applicable to	What Iliad Adds
Optimization	Design of Experiments	•Mold/melt temperature, Injection/packing time, Thickness Multiplier, Injection/packing profile multiplier •Flow front temperature, shear stress, injection pressure, clamp force, volumetric shrinkage, sink mark depth, part weight, cycle time	•In addition, to the interactive response surfaces created by Moldflow, Iliad can automatically run the analysis using optimal settings •Additional DOE designs with more control over the model order. •Equations displayed to the user •Dynamically evolving Response Surface model available
	Parametric Studies	•Geometry modification •Process settings	•Reduces the number of evaluations X Currently geometry modification is not supported
Process Optimization	Ram speed and packing pressure profile	•Ram speed profile •Packing pressure profile	X Currently not supported
Gate Location	Gate Region Locator Algorithm	•Gate location using geometry and molding feasibility	•Automatically modifies gate location based on analysis run results, reducing the need for manual intervention •Gates placed using optimization algorithms which read user given responses
	Advanced Gate Locator Algorithm	•Gate locations with none present. Uses flow resistance	

How Does it Work?

Iliad – Moldflow Interface

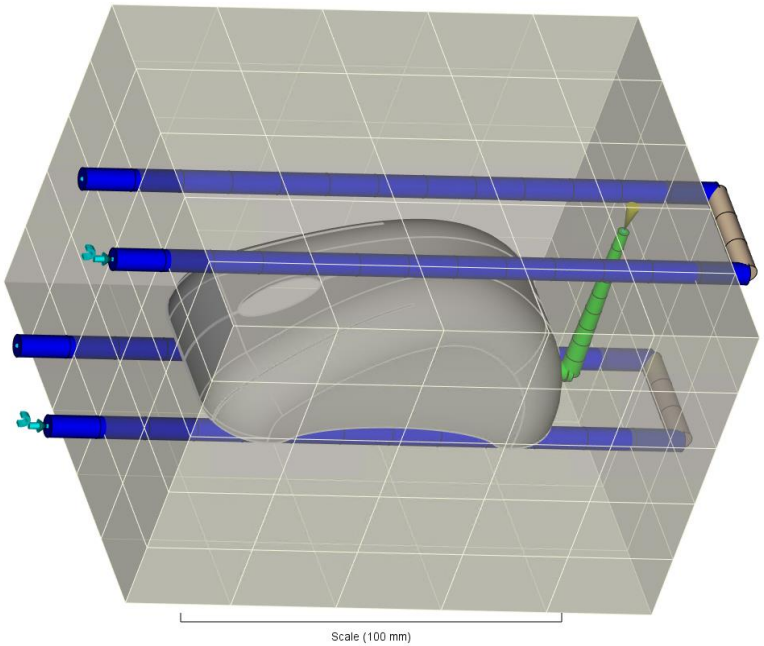


The interface uses:

- Studymod for modifying the study file
- Runstudy for running the updated study
- Studyrlt for exporting the result

Use cases

Case 1: Response Surface Driven Optimization



- The case study involves a cool+fill+pack+warp analysis
- The problem is solved using a response surface model
- Static response surface is used

Problem Formulation

Objective		Minimize differential Warpage	
		Lower Bound	Upper Bound
Design Variables	Coolant inlet temperature	293.15 K	333.13 K
	Cooling inlet flow rate	5E-5 m^3/s	5E-4 m^3/s

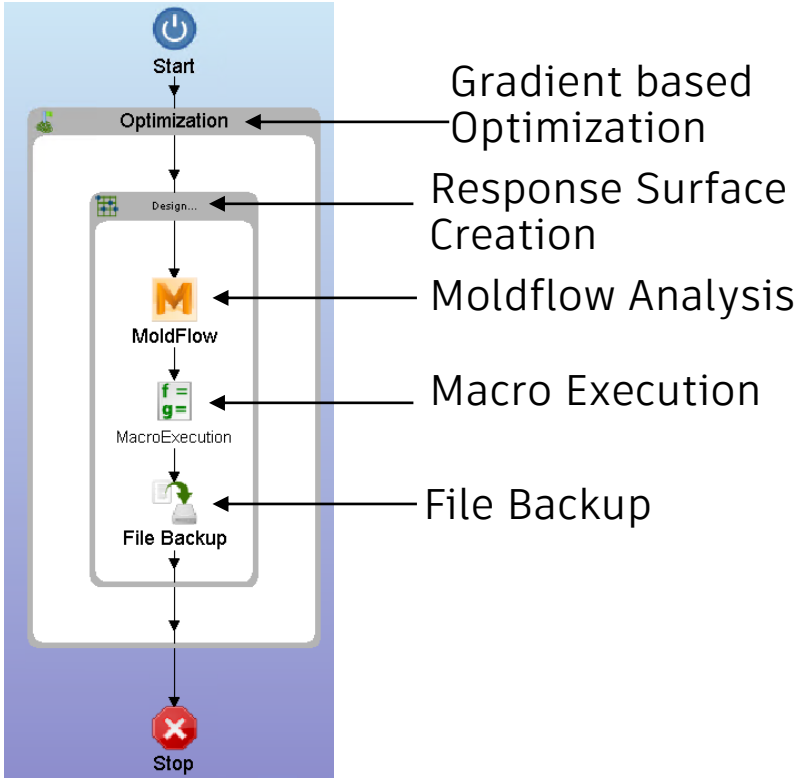
Files required:

1. The study file (.sdy) for the analysis.
2. The ASCII design file (.udm) for reading the inputs.
3. The ASCII log file generated using studymod.

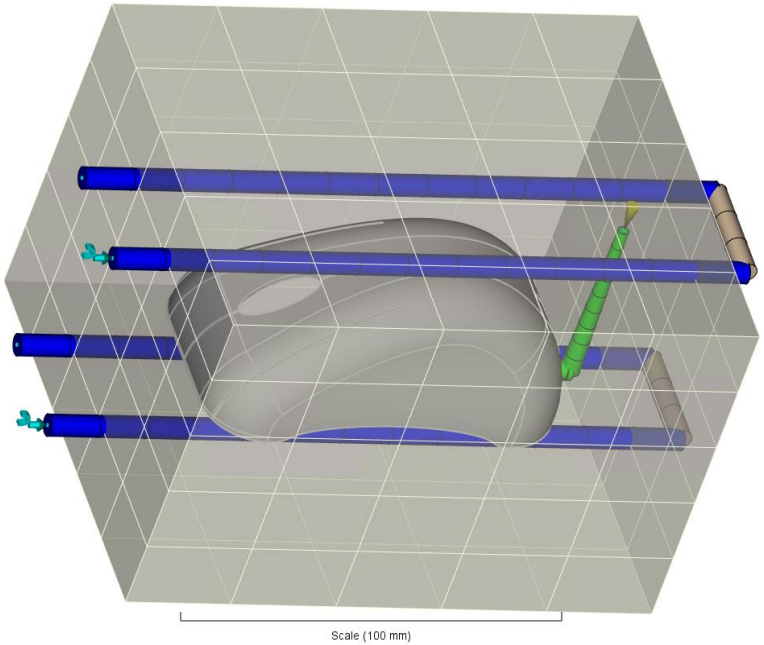
Workflow

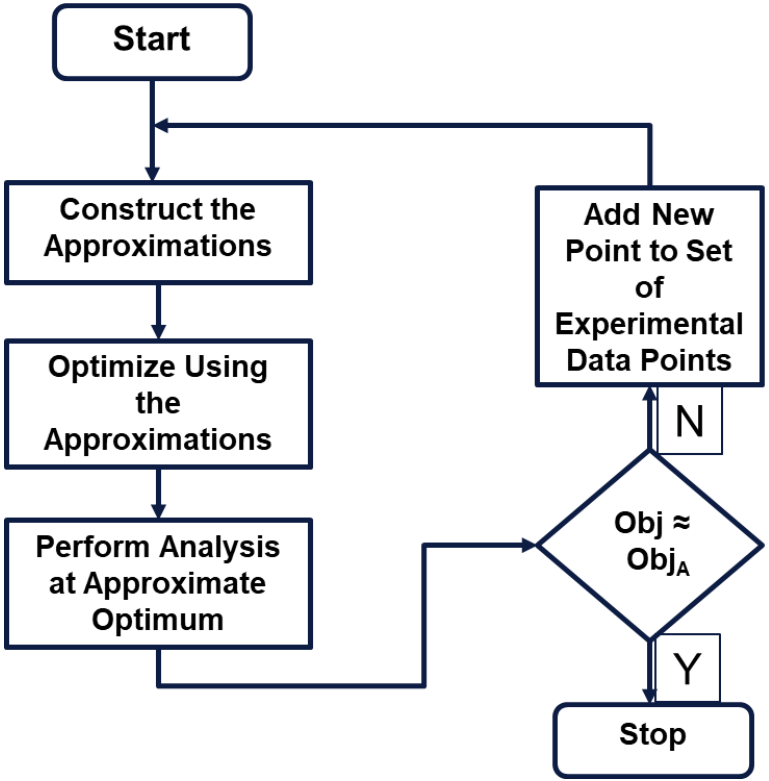
Procedure:

1. Create the Workflow for:
    i. Automatic execution of Moldflow analysis.
    ii. Execution of Macro for plot extraction
    iii. Backing up analysis files
    iv. Creating a response surface
    v. Optimization
2. Validation and Execution
3. Post-processing

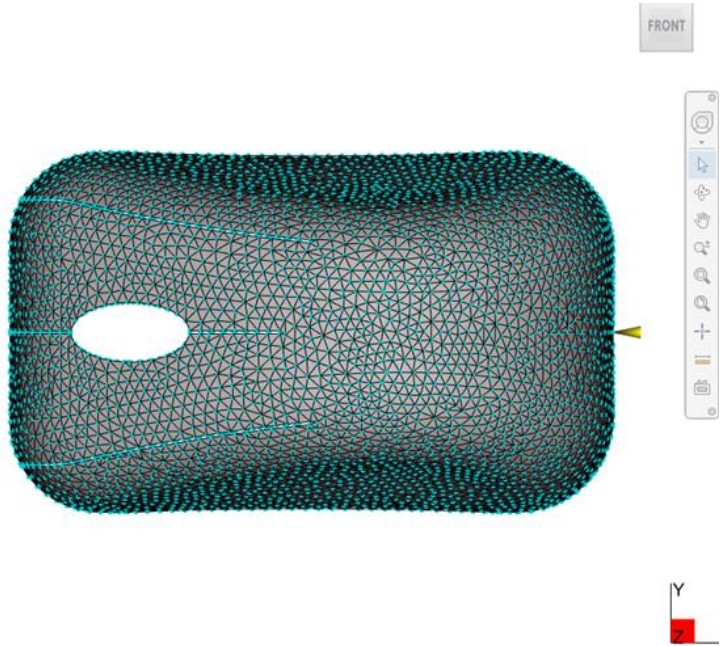


Case 2: Dynamic Response Surface Driven Optimization





Case 3: Gate Location Optimization



Objective		Minimize volumetric shrinkage	
		Lower Bound	Upper Bound
Constraints	Total mass after packing [kg]	0.012	
	Maximum Clamp force [N]		4E5
Design Variables	Melt Temperature [K]	500	550
	Injection Packing + Cooling time [s]	25	35
	Cooling time [s]	0.05	2
	Mold surface temperature [K]	350	375
	Gate_1 Y coordinate [m]	-0.05	0.05
	Gate_1 X coordinate [m]	-0.05	0.06

Conclusion

Summary

- Iliad enhances the design exploration capabilities inside Moldflow.
- Enables the application of numerical optimization through gradient and non-gradient algorithms.
- Supports the integration of Macros and other analysis.
- Enables quicker optimization by formulating and solving response surface models.