



Autodesk® Moldflow® as an Integral Part of Numerical Part Optimization

Andreas Wüst, BASF SE

Teamleader Num. Optimization and Crash Analysis

David Astbury, Autodesk

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Class Summary

This class will show you how Autodesk Moldflow can be integrated into numerical optimizations.

- We will discuss the issues you are likely to encounter during integration
- We will highlight the tools Autodesk provides to assist integration.

We will also show how the workflow changes when Moldflow is incorporated into the optimization process.

We will show the influences of fiber orientation on mechanical behavior due to changes in design variables.

Finally, we will give examples of the use of the new method of integrative optimization.

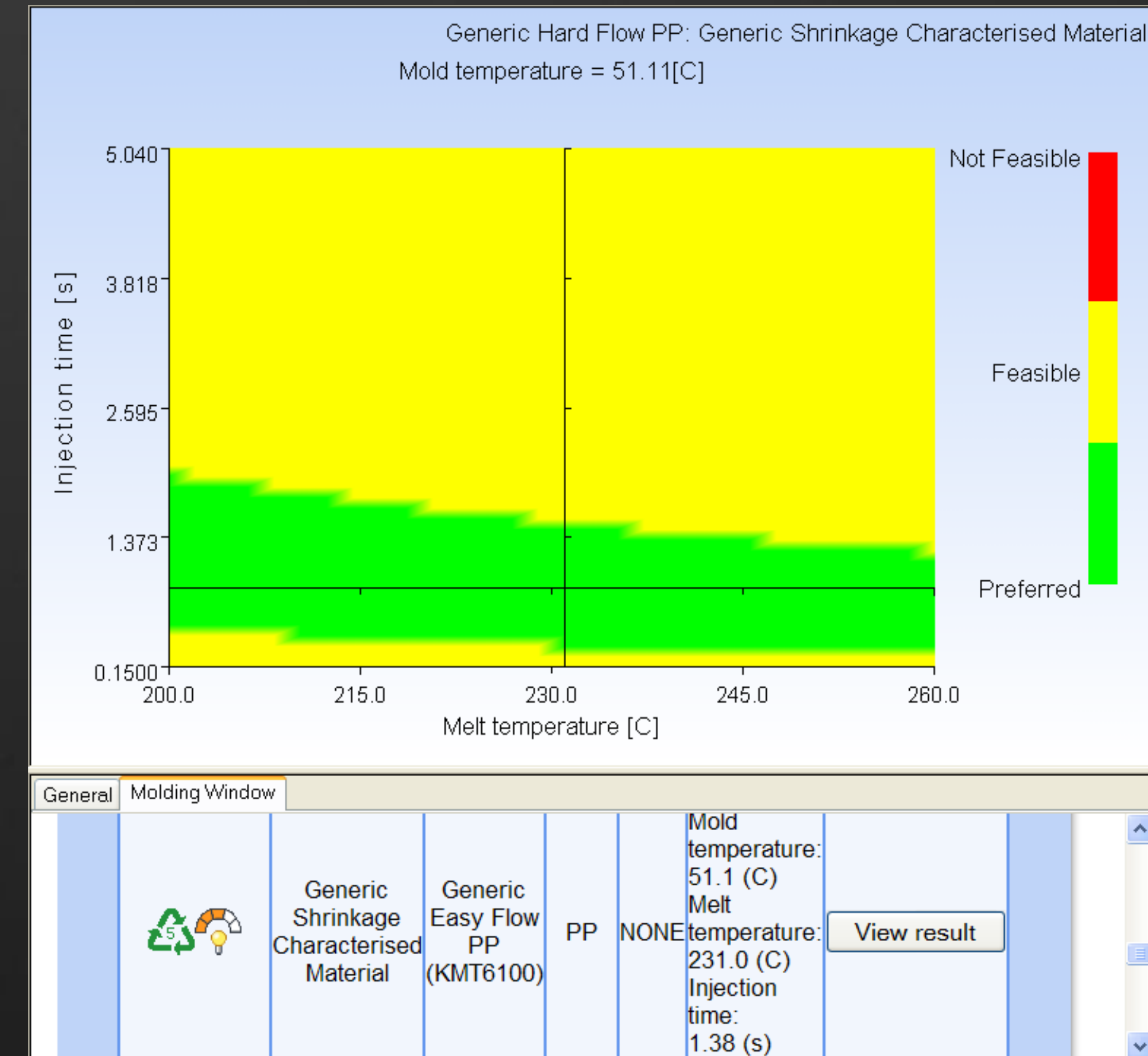
Learning Objectives

At the end of this class, you will be able to:

- Understand how Moldflow® capabilities can be enhanced by coupling it with other software
- Explain the importance and capabilities of numerical optimization
- Use a design approach that takes process as well as mechanical part behavior into account
- Explain the importance of fiber orientation for mechanical part behavior

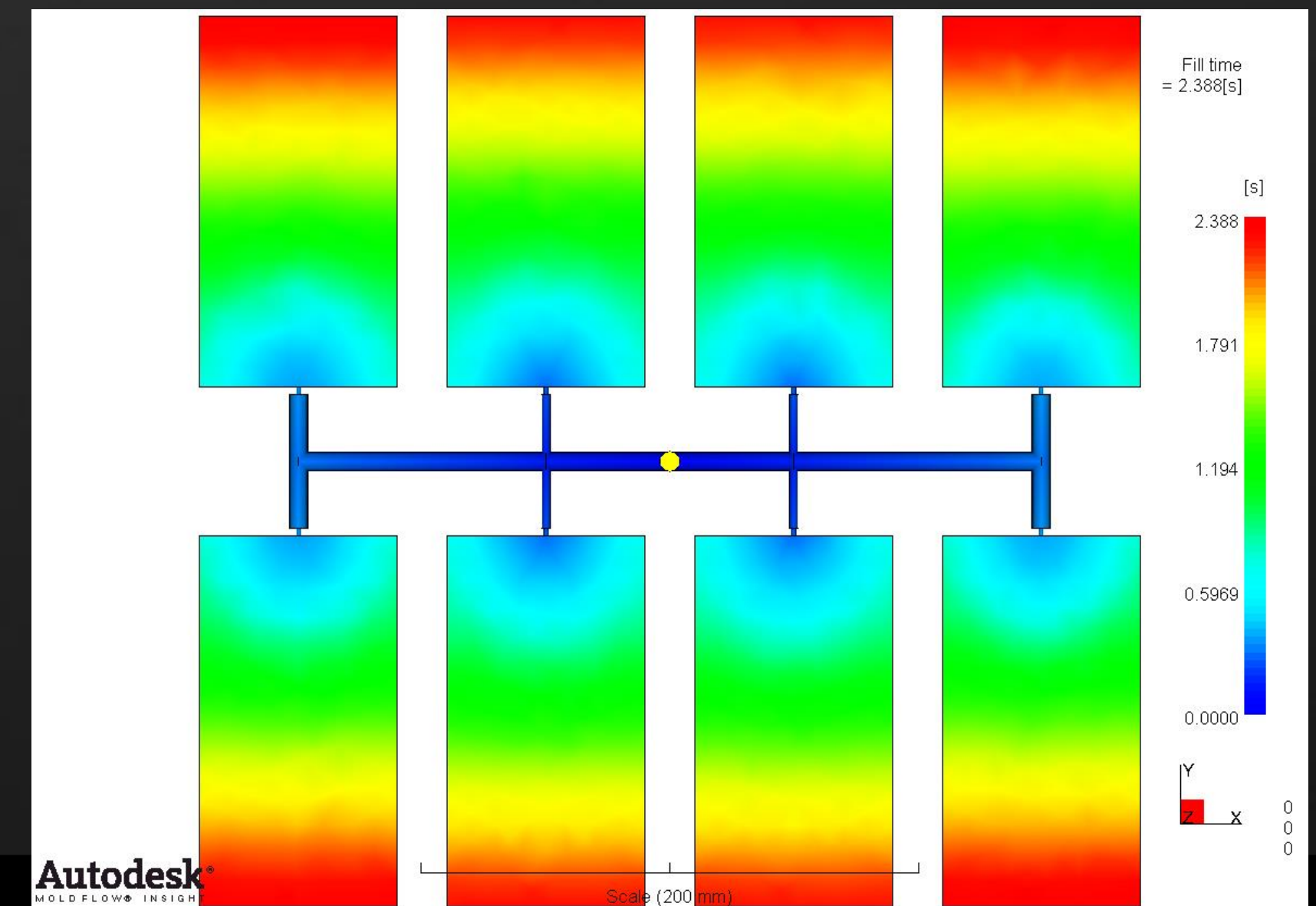
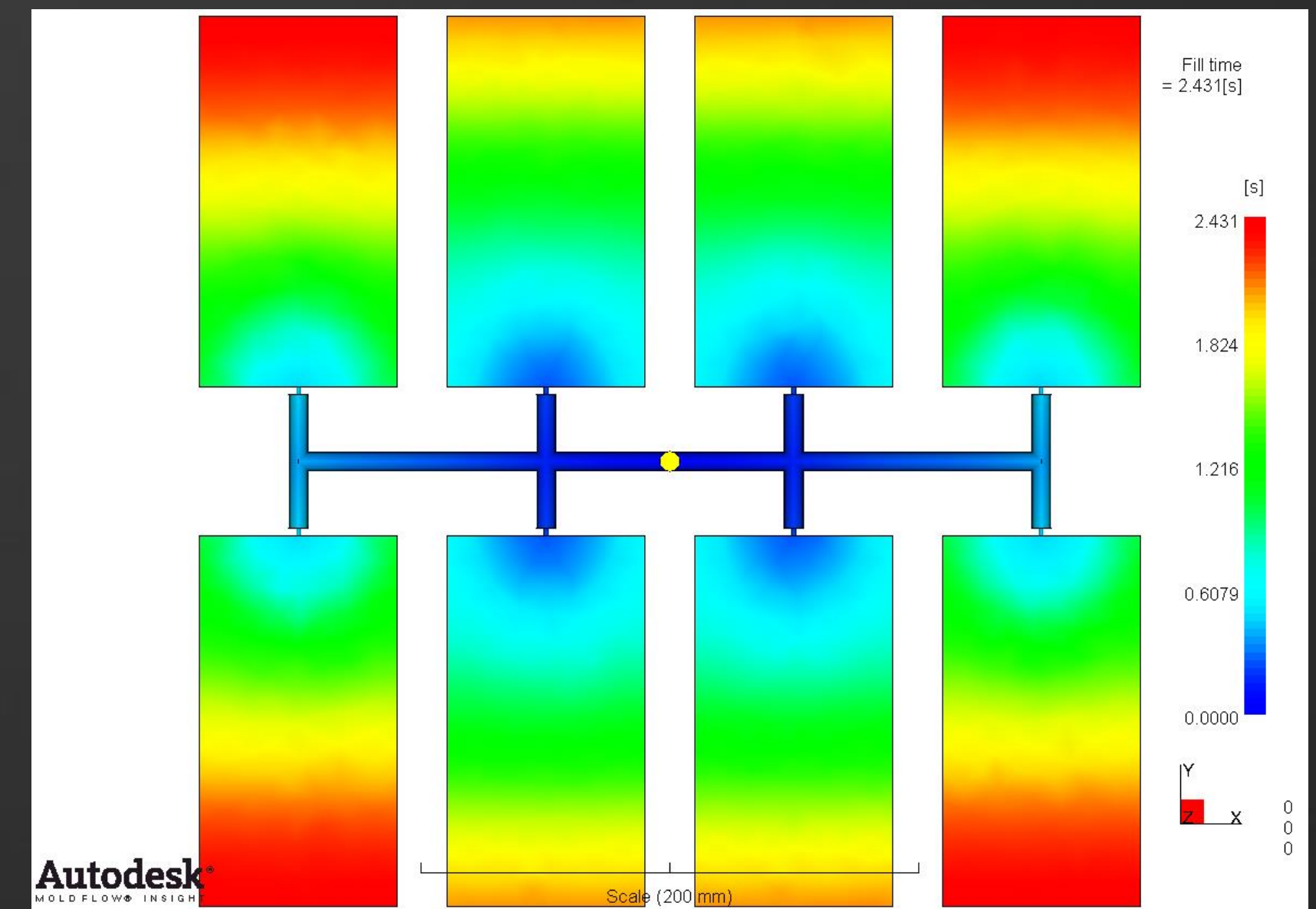
Optimization - The Current State

- **Automatic Injection Time**
 - **Basis: Expert System**
- Runner Balance
 - Basis: Expert System
- Gate Location
 - Basis: Simulated Annealing
- Design of Experiment (DOE)
 - Basis: Design of Experiment



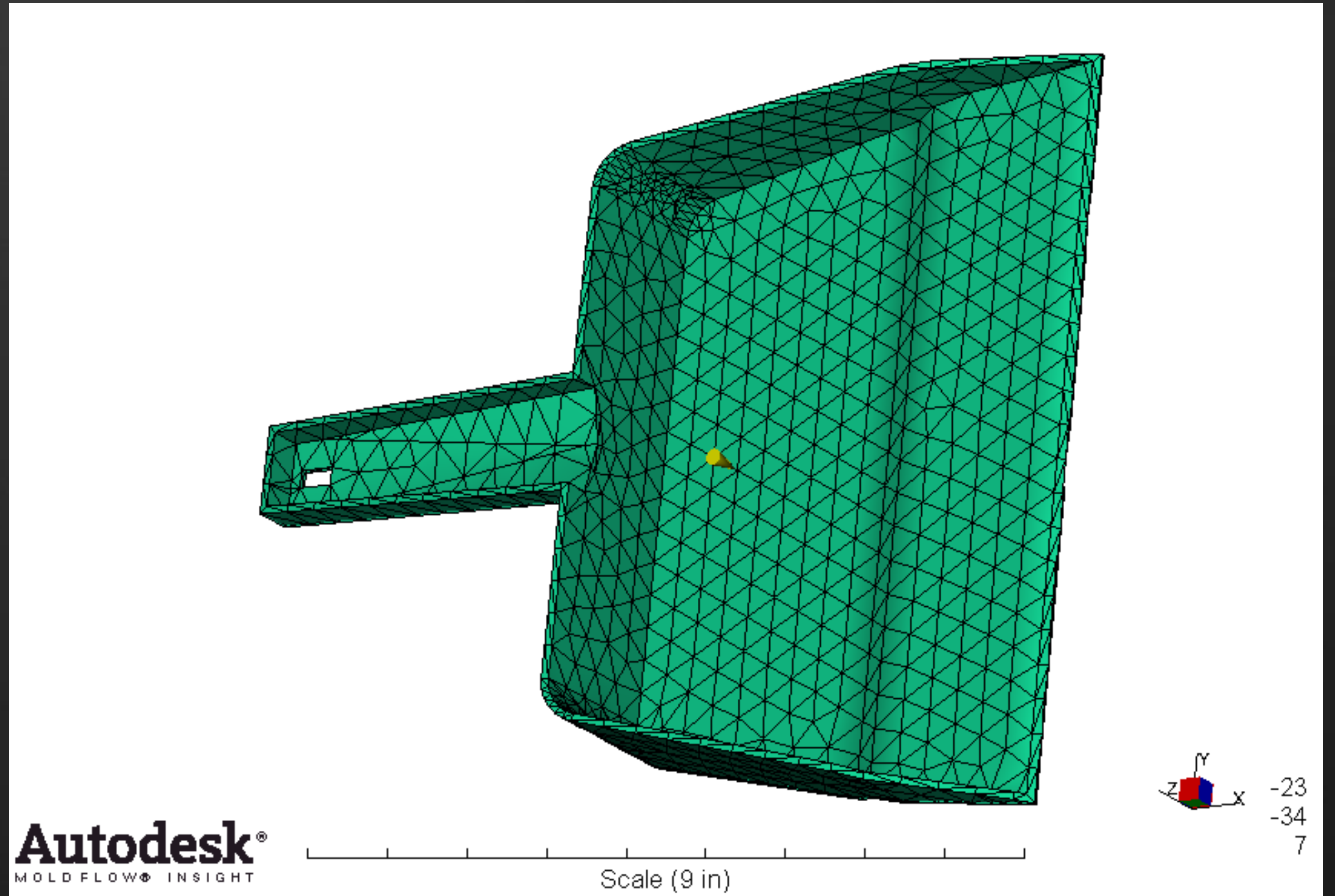
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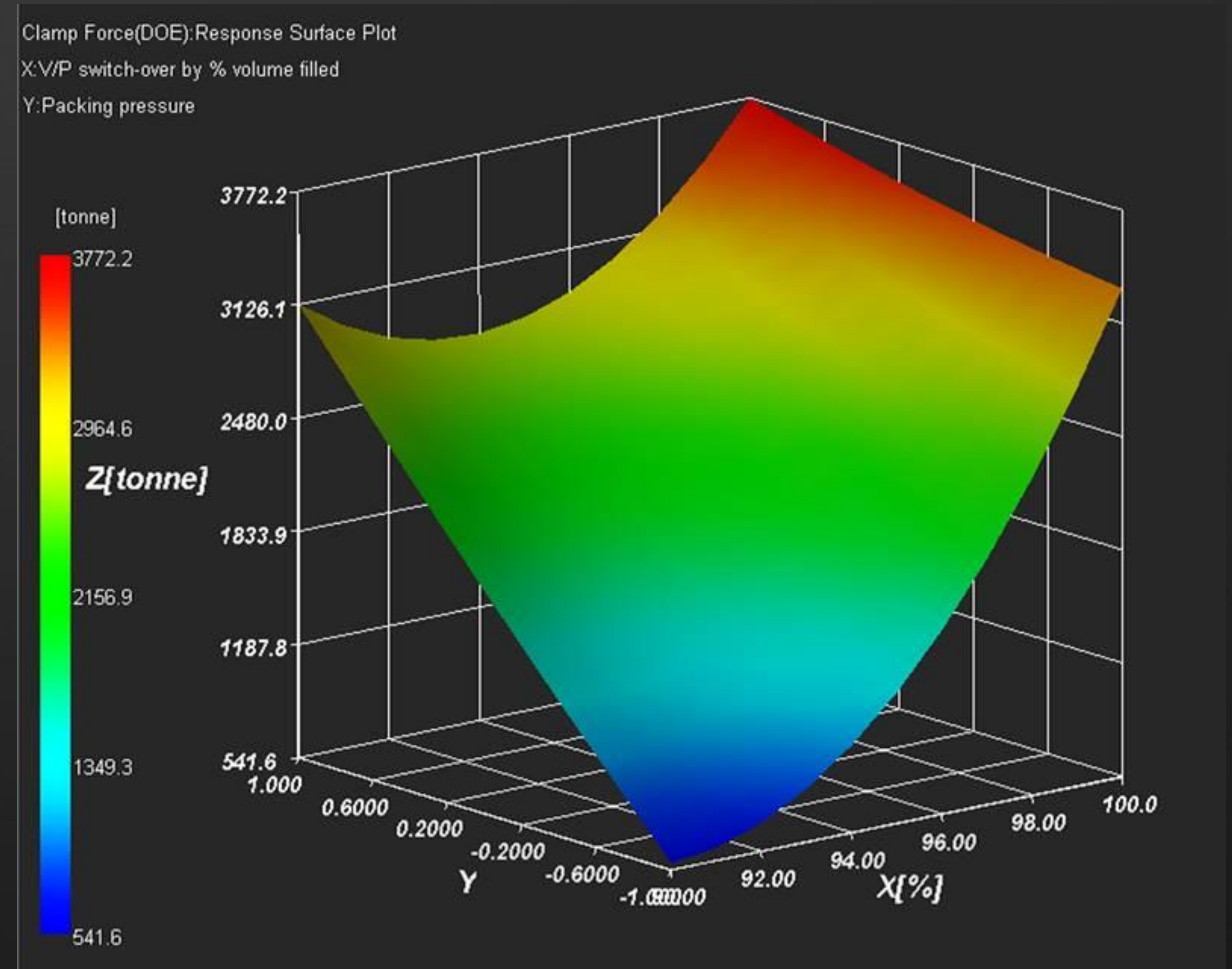
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Optimization – The current state

- Problem orientated/Directed
 - Exception DOE which is general purpose
- Embody Expert Knowledge to make them efficient
- Self contained
- Designed for Serial Execution
 - Except DOE which was designed to support Distributed HPC or Cloud

What if we want more ?

- Optimize an assembly
- Consider additional Multi-physics
 - Fracture
 - Fatigue
 - Crash/Contact
 - Structural
 - Strength
 - CFD
- Shape/Topology Optimization

Integrating Optimization – the Moldflow API

- Benefits

- No Additional Cost
- Com/OLE Interface

- Examples

- Injection Time Scan
- Gate Location

- Limitations

- Windows only
- Only run one instance per machine
- Some programming required
- Some optimization knowledge required

Integrating Optimization - 3rd Party Optimization Tools

- Benefits

- Wide range of optimization techniques offered
 - Gradient based
 - Design of Experiment
 - Stochastic
 - Game Theory
- Some tools have explicit interfaces with Autodesk Moldflow

- Limitations

- Usually some Cost
- Need to understand the basic principles of Optimization
- Some Interfacing work may be required
 - To setup Analysis Runs
 - To Extract Quality Measures

Integrating Optimization - 3rd Party Optimization Tools

- General Purpose – Therefore you need to consider:
 - What is my objective
 - Which Optimization technique should I use ?
 - How are multiple Quality Objectives Handled ?
 - Which Design Variable should I change ?
 - Design Variable Constraints ?
 - How much time/CPU do I have ?

Integrating Optimization - 3rd Party CAE Tools

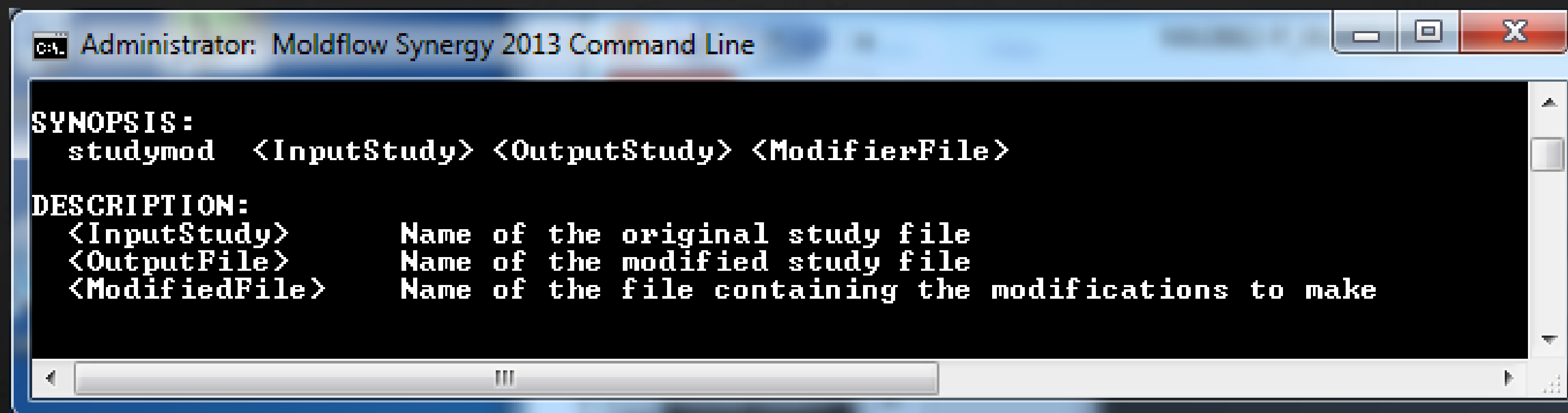
- Benefits
 - Allows physics/effects not addressed in Autodesk Moldflow to be considered.
- Limitations
 - Cost is usually high
 - Geometry Formats
 - Invariably will be different
 - Meshing Requirements
 - Invariably will be different
 - Result Formats
 - Invariably will be different
 - Great care must be take to not lose data fidelity when mapping results.

Recent Changes to Aid Optimization

- Fusion
 - Enhanced CAD Import via Fusion
-
- Autodesk Moldflow Design Link
 - New CAD import formats supported
- Two New Command based Tools
 - Study modification Tool (studymod)
 - Allow Geometry/Boundary Condition and property changes to a study file
 - Result Extraction Tool (studyrlt)
 - Allow extraction and simple calculations of Autodesk Moldflow result data

Studymod

- Studymod is a tool designed specifically to allow changes to geometry, boundary conditions and processing information to be modified in an Autodesk Moldflow Insight study (.sdy) file.
- *NOTE: This tool is designed for experienced Moldflow Users. Users should have a detailed knowledge of the Autodesk Moldflow Insight study (.sdy) file data formats before attempting to use studymod.*



```
Administrator: Moldflow Synergy 2013 Command Line

SYNOPSIS:
  studymod <InputStudy> <OutputStudy> <ModifierFile>

DESCRIPTION:
  <InputStudy>      Name of the original study file
  <OutputFile>      Name of the modified study file
  <ModifiedFile>    Name of the file containing the modifications to make
```


Studymod

▪ Example 1

Import a Midplane Ansys Mesh (f3d.ans) in mm and creates an Injection Node at node 4101

```
<?xml version="1.0" encoding="utf-8"?>
<StudyMod title="Autodesk StudyMod" ver="1.00">
  <UnitSystem>Metric</UnitSystem>
  <Mesh cmd="Import">
    <MeshType>MID</MeshType>
    <MeshUnit>mm</MeshUnit>
    <FileName>f3d.ans</FileName>
  </Mesh>
  <BoundaryCondition>
    <NDBC cmd="Create">
      <NodeID>4101</NodeID>
      <TSet>
        <ID>40000</ID>
      </TSet>
      <Vector>0.0 0.0 1.0</Vector>
    </NDBC>
  </BoundaryCondition>
</StudyMod>
```

StudyrIt

- Sets the Fill Control Option to Be Specified
- Sets the Injection Time to be 0.12345 sec
- Sets the Melt Temperature to 240 degC
- Sets the Mold Temperature to 60 degC
- Sets the Packing Profile to:

Time	%Pressure
0	70
5	80
10	90

```
<?xml version="1.0" encoding="utf-8"?>
<StudyMod title="Autodesk StudyMod" ver="1.00">
  <UnitSystem>Metric</UnitSystem>
  <Property>
    <TSet>
      <!--Process controller-->
      <ID>30011</ID>
      <SubID>0</SubID>
      <!-- Fill Control to Inject time-->
      <TCode>
        <ID>10109</ID>
        <Value>2</Value>
      </TCode>
      <!--Inject time-->
      <TCode>
        <ID>10100</ID>
        <Value>0.12345</Value>
      </TCode>
      <!--Melt temperature-->
      <TCode>
        <ID>11002</ID>
        <Value>240</Value>
      </TCode>
      <!--Mold surface temperature-->
      <TCode>
        <ID>11108</ID>
        <Value>60</Value>
      </TCode>
      <!--Filling pressure vs time-->
      <TCode>
        <ID>10702</ID>
        <Value>0.0 70</Value>
        <Value>5.0 80</Value>
        <Value>10.0 90</Value>
      </TCode>
    </TSet>
  </Property>
</StudyMod>
```


Studyrlt

- Studyrlt is a tool specifically designed to extract and calculate numerical information for the Autodesk Moldflow Insight result and output files.
- Key Features
 - Extract numerical Information from screen output
 - Extract screen output into a text file.
 - Extract numerical information from Moldflow Result File
 - Write Moldflow result data in XML format
 - Write geometric data in Patran format
 - Command Line Interface
 - Supported on Linux and Windows

Studyrlt

```
Administrator: Moldflow Insight 2013 Command Line

SYNOPSIS:
studyrlt <study> -message <sequence> <message ID> <occurrence> <item> [-unit SI|Metric|English]
<study> -exportoutput [<sequence>] [-output <filename>] [-unit SI|Metric|English]
<study> -xml <result ID>
<study> -exportpatran
<study> -result <result ID>
               -min|-max|-average|-stddev|-node <node number>|-element <element number>
               [-cavity|-gate|-runner|-sprue]
               [-component <number>] [-anchor <node1> <node2> <node3>]
               [-unit SI|Metric|English]

DESCRIPTION:
-message      Extract Results from Screen output
<sequence>    Which Analysis Sequence to extract results from.
               (1 = First analysis in sequence)
<message ID>  Message ID number as defines in cmmessage.dat
<occurrence>  Get the specified occurrence of the message ID
<item>        Get the specified Data Item
-unit         Show results in Visible unit SI(default), Metric or English

-exportoutput  Export screen output to a human readable file
<filename>    Write data to filename.txt

-exportpatran  Export a Patran file based on the specific study file

-xml <result ID>  Extract specified result set in XML format

-result <result ID>  Extract a numerical value from the specified result set
-min           Get the Minimum value of the result data set
-max          Get the Maximum value of the result data set
-average       Get the Average value of the result data set
-stddev       Get the Standard Deviation value of the result data set
-node <node number> Get the Result at a specified node (example -node 57)
-element <element number> Get the Result at a specified element (example -element 23)
-cavity       Only Consider Results in the cavity region
-gate         Only Consider Results in the gate region
-runner       Only Consider Results in the runner region
-sprue        Only Consider Results in the Sprue region
-component <number> Component to extracted 0 = Magnitude (default),
               1 = X
               2 = Y
               3 = Z
               (only applicable to vector based results)
-anchor <Node1> <Node2> <Node3> Apply Anchor plane defined by Nodes 1,2 and 3
               (only applicable to warpage results)
-unit         Show results in Visible unit SI(default), Metric or English

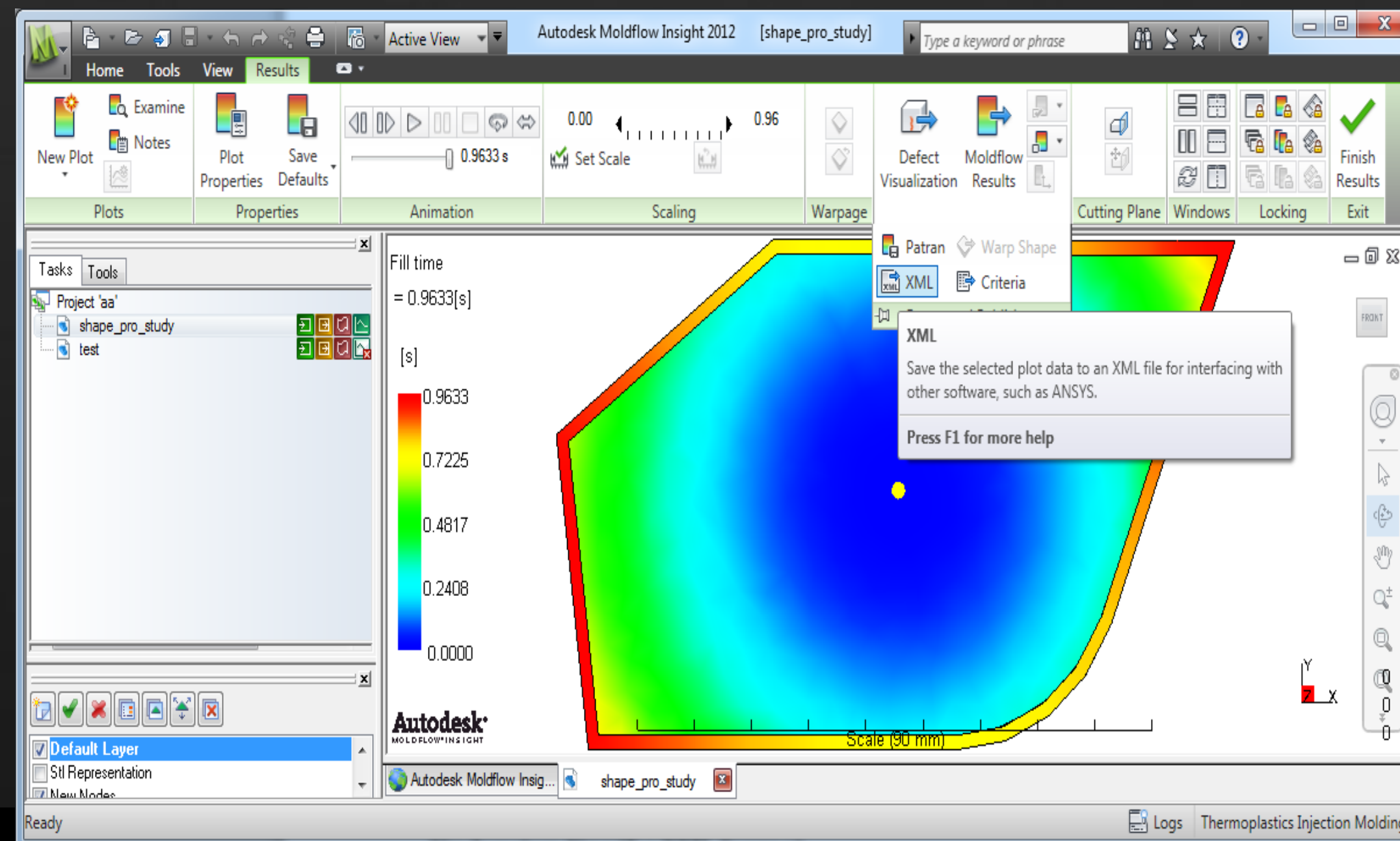
Note: Argument order is important please follow the argument order provided.
```


Studyrlt

■ Example 1

Write out the “Fill time” result (Result ID=1610) associated with the Autodesk Moldflow Plastics Insight study `cpu_base.sdy` in XML format.

studyrlt cpu_base.sdy -xml 1610



Studyrlt

- Example 2

Calculate the average "Bulk temperature" (Result ID=1460) associated with the Autodesk Moldflow Insight study `cpu_base.sdy` and show it in SI Units.

```
studyrlt cpu_base.sdy -result 1460 --average
```

- Example 3

Show the maximum (-max) Z deflection (-component 3) of the "Deflection, all effects" (Result ID=6250) in the cavity with an anchor plane defined at nodes 2020, 2012 and 2025 associated with the Autodesk Moldflow Plastics Insight study `cpu_base.sdy` and show it in Metric Units.

```
studyrlt cpu_base.sdy -result 6250 -max --cavity -component 2 -anchor 2020 2012 2025 --units Metric
```


Studyrlt

■ Example 4

Write the screen out to a file called *plaintext.txt* Insight study in Metric Units.

studyrlt cpu_base.sdy --exportoutput --output plaintext.txt -Units Metric

