Release 2022 R1 Highlights
Ansys Forming

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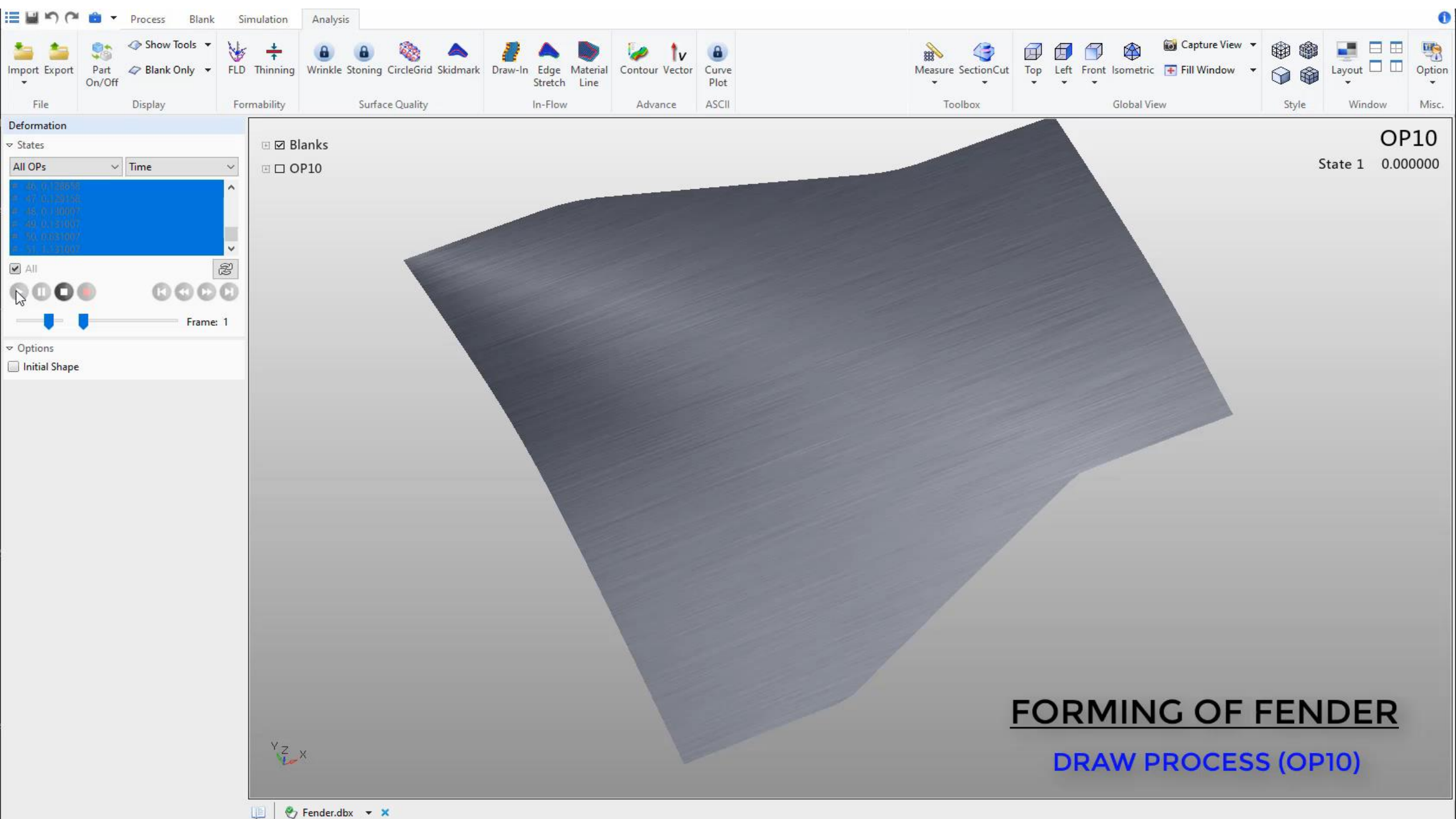
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OP10
OP10
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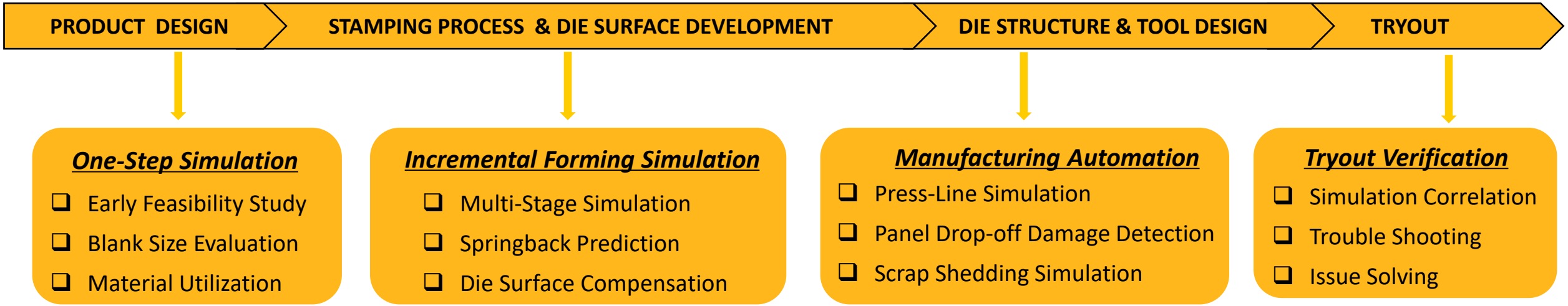
FORMING OF FENDER
DRAW PROCESS (OP10)
Fender.dbx

Background

Simulation in stamping process:



- LS-DYNA has been used in stamping simulation since early has 1990s
- LS-DYNA is the technology leader and has built a strong reputation in accuracy, especially in springback prediction.
  - ~20 patents in stamping simulations
  - Many ideas were initiated in LS-DYNA, such as smooth contact, modified Yoshida Model, springback compensation, formability index…

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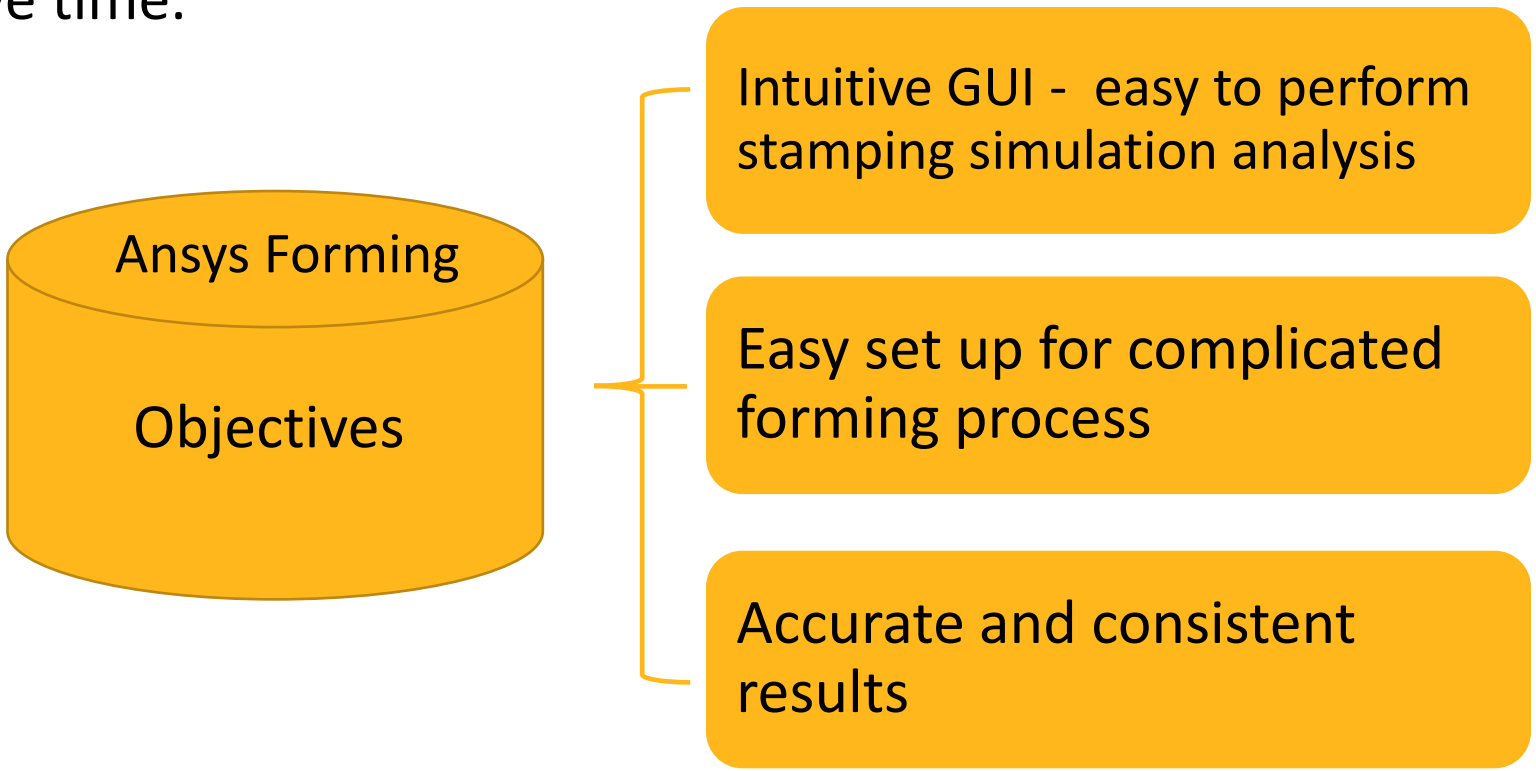
Objectives

Ansys Forming simulates metal stamping tasks through an end-to-end workflow that allows you to perform the entire die process in a single platform, easy to use GUI, with the fastest solve time.



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Ansys Forming Solution

Ansys Forming will provide solution for modeling and simulating entire forming process.

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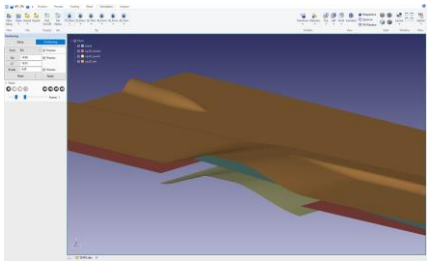
Fully Integrated Platform

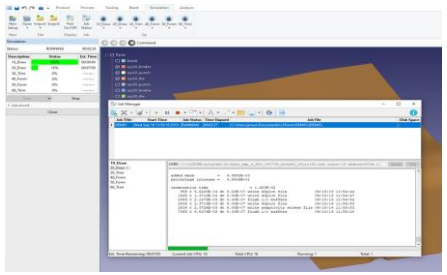
- In 2022 R1 release, Ansys Forming provides a unique platform which has a seamless fully integrated GUI with pre-post processing and uses LS-DYNA as a solver.
- Benefits of Ansys Forming:
  - Easy to setup multi-stage forming simulations
  - Customizable template-based method allows user to easily define different forming processes
  - A job-submitter allows user to run the job easily
  - User can seamlessly evaluate simulation results when the job is running

Pre-Processing → **Job Submission** → **LS-DYNA Solution** → **Post-Processing**

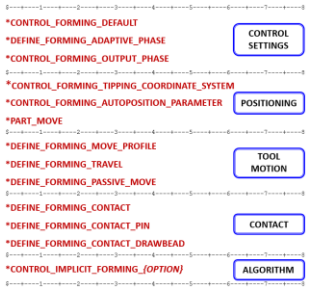
Model Setup



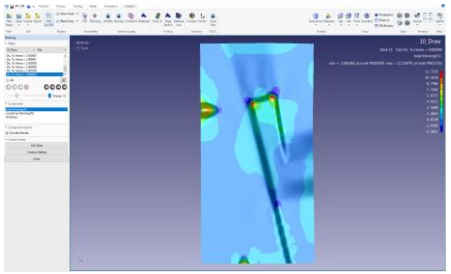
Job Runner



New Forming Keyword Features



Analysis



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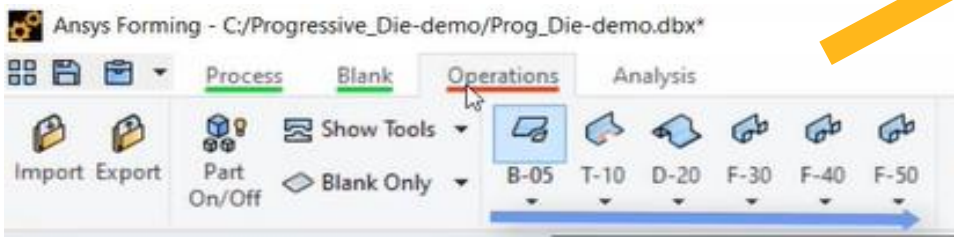
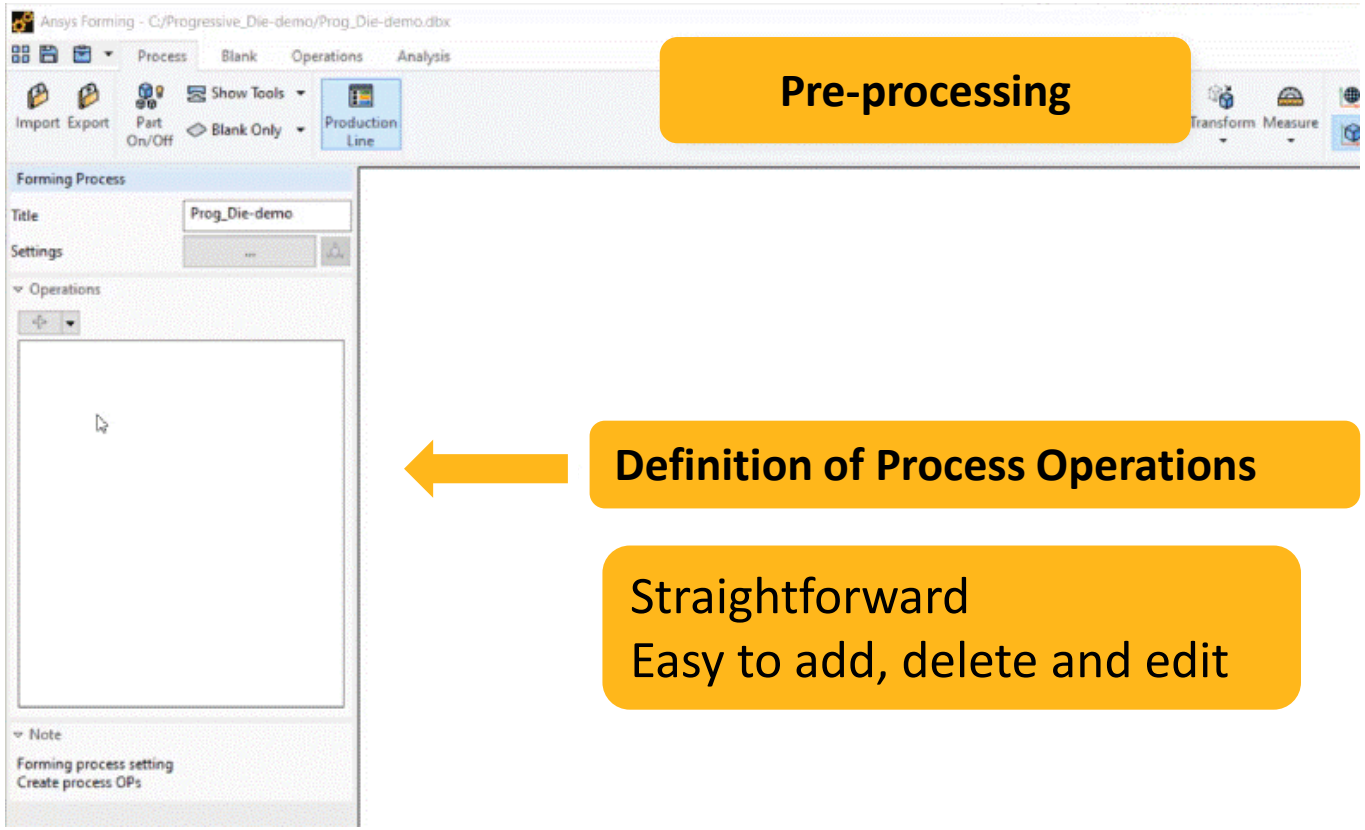
Process-based Workflow

During process design/verification, engineers must perform the simulations of drawing and secondary operations, such as trimming, flanging and restriking, as well as springback.

Process-based workflow is the key to analyze and optimize all the operations of a stamping process.

Straightforward Operation Definition
Easy to use: ADD, DELETE & EDIT





Pre-processing

Definition of Process Operations

Straightforward
Easy to add, delete and edit

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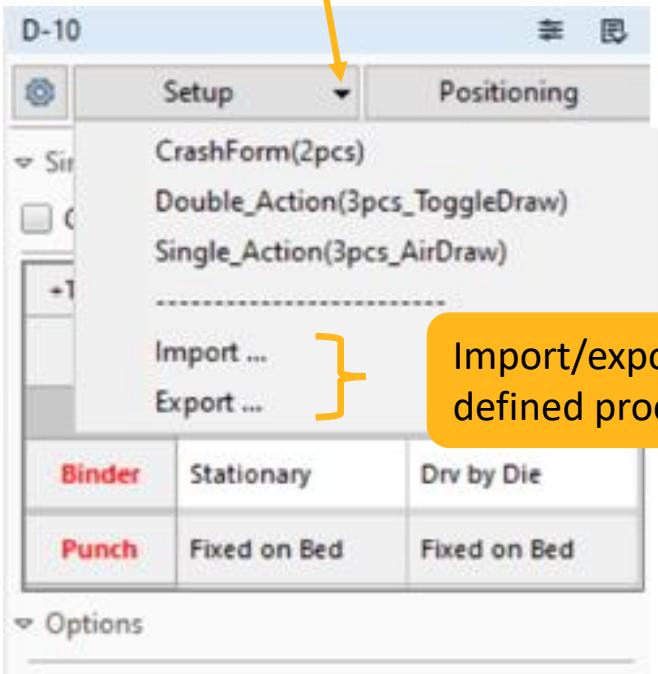
Preset/User-Defined Process Templates

Convenient to set up a typical process
Guidance for new forming users
Easy to edit for a complicated process

Drop down for a preset or user-defined process template



Import/export a user-defined process template

Preset Process Templates

Draw operation

CrashForm(2pcs)

Gravity

+Tool	Drawing
Die	Cls to Punch
Punch	Fixed on Bed

Single_Action(3pcs_AirDraw)

Gravity

+Tool	Closing	Drawing
Die	Cls to Binder	Travel->Pos: 0
Binder	Stationary	Drv by Die
Punch	Fixed on Bed	Fixed on Bed

Flanging(3pcs)

Gravity

+Tool	Closing	Forming
Pad	Cls to Post	Stationary
Flg1	Stationary	Travel->Pos: 0
Post	Fixed on Bed	Fixed on Bed

Flanging/Restrike

Double_Action(3pcs_ToggleDraw)

Gravity

+Tool	Closing	Drawing
Punch	Stationary	Travel->Pos: 0
Binder	Cls to Die	Stationary
Die	Fixed on Bed	Fixed on Bed

FormTrim

FormTrim(4pcs)

Gravity

+Tool	Closing	Forming
Pad	Cls to Post	Stationary
Flg1	Stationary	Travel->Pos: 0
**CutTool1	Drv by Flg1	Drv by Flg1
Post	Fixed on Bed	Fixed on Bed

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Innovative Tabular Tooling Setup

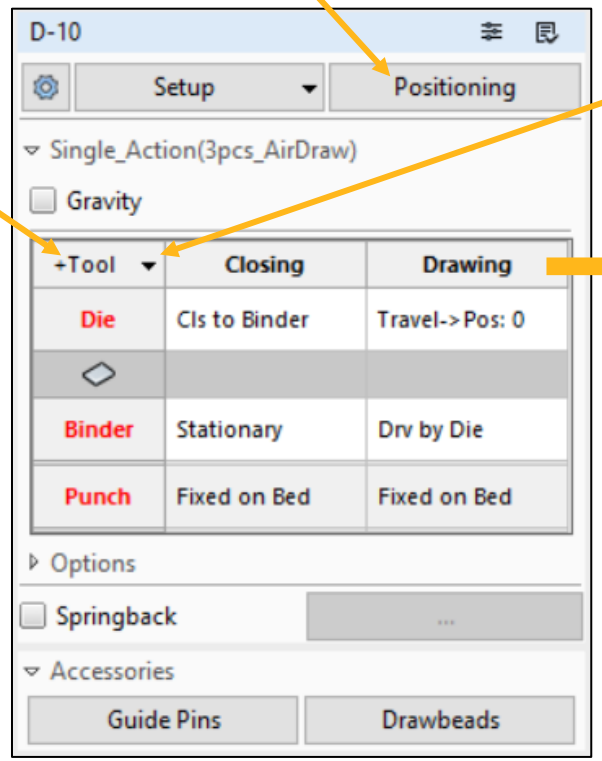
Flexible, easy and straightforward

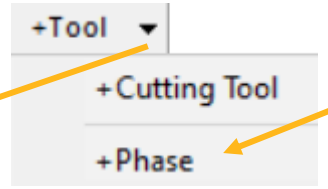
- Flexible to define complicated tool motion
- No limitation on total tool number
- Easy to manage the tools and accessories
- Integrated with gravity and springback options

Preview/adjustment of tool positioning

Click '+ Tool' to add a new tool

The first column is the tool list





Drop down from '+ Tool' and click '+ Phase' to add a new motion phase

The first row is the motion phase list specifying the tool motion phases in current operation stage

(e.g., a binder-closing phase and a drawing phase for a 3-piece air draw process)

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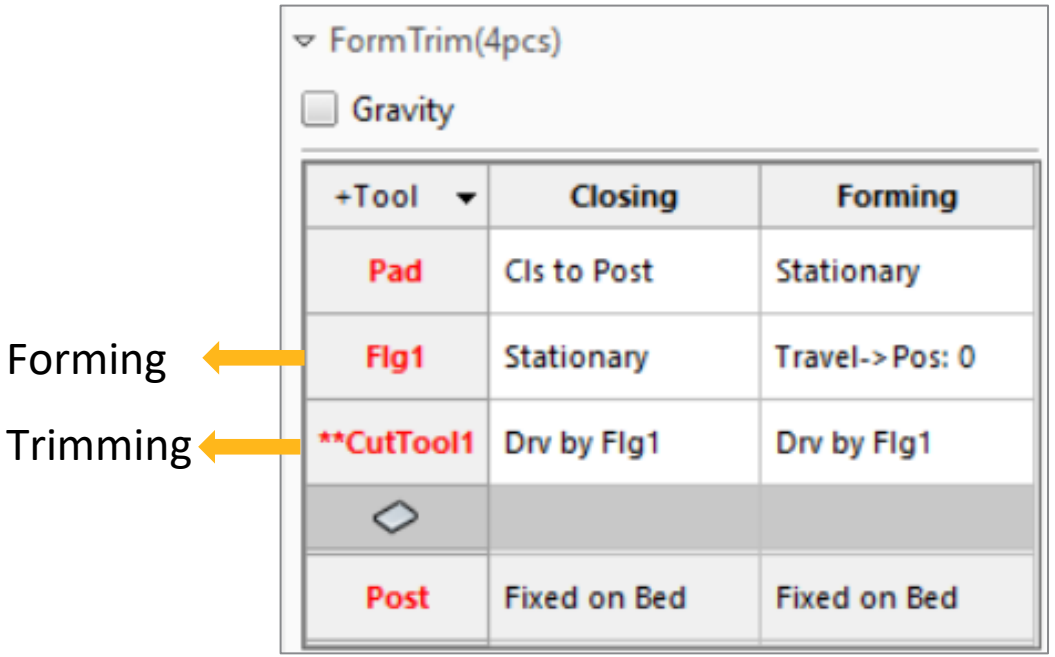
Breakthrough of Simulating ‘FormTrim’

Solver innovation to represent the real process

Interaction between GUI and LS-DYNA solver



- In the real processes, secondary operations of flanging or restriking are always associated with piecing or scrap cutting.
- With the newly added features, Ansys Forming can have multiple cut/trim at different times in one single simulation.
- Accurate modeling of actual FormTrim process
- Reduce the simulation time cost

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Intuitive Graphic Interface: Tipping

A process-based GUI with user-friendly functions is extremely important to forming users. Ansys Forming is oriented to industry engineers, and it is very easy to use.

Automatic Tipping of A Process-Design Model

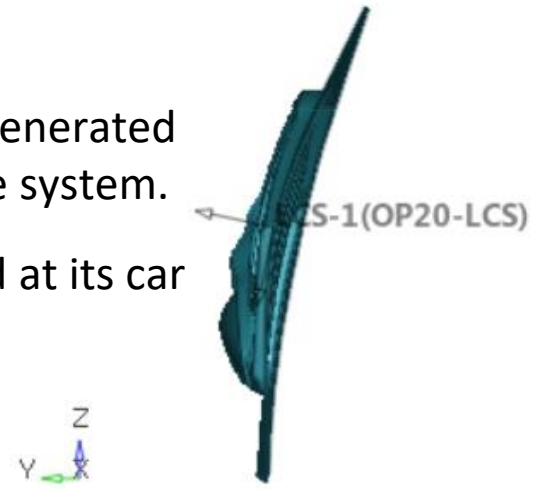
Very convenient for a multi-stage simulation with varied tipping angles

Directly utilize process-design data from user w/o any manual conversion

The model will be tipped automatically in each forming stage

A process-design model is generated in the car-design coordinate system.

That is, the model is located at its car position.



Automatically tipped into current stamping position

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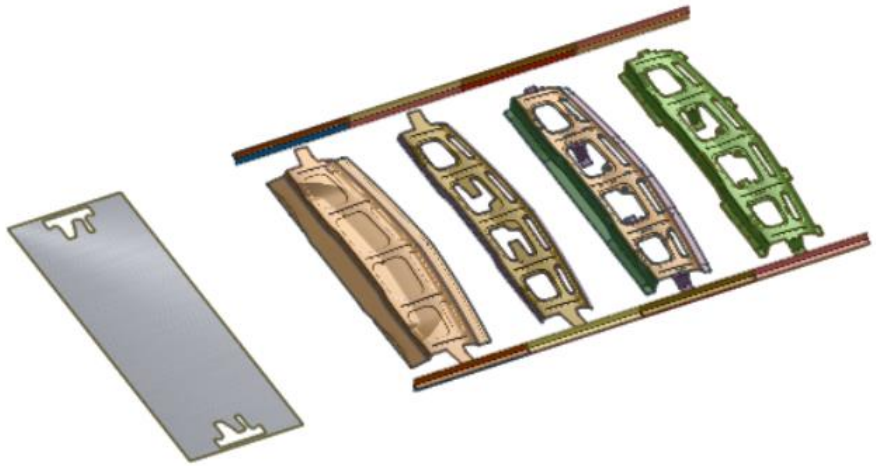
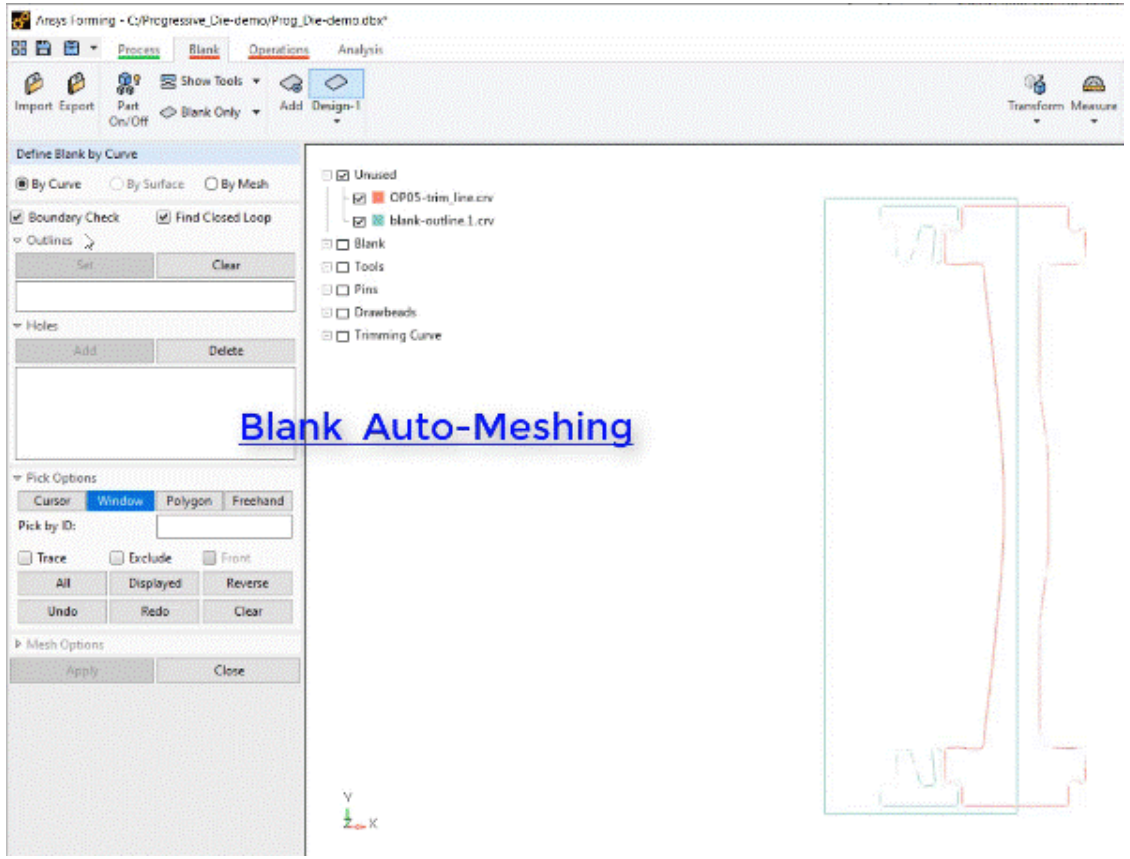
Auto-Meshing of Blank and Tool Geometry

Suitable for product designers and process engineers

Minimize prerequisites of FEA background



This strategy distinguishes Ansys Forming from any FEA-based GUI which needs user's manual editing on FE meshes.



- No need for users to edit/repair any element.
- Although the forming contact algorithm requires mesh normal consistency, a new forming solver feature has been implemented to achieve automatic normal adjustment.

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One Click for Gravity or Springback

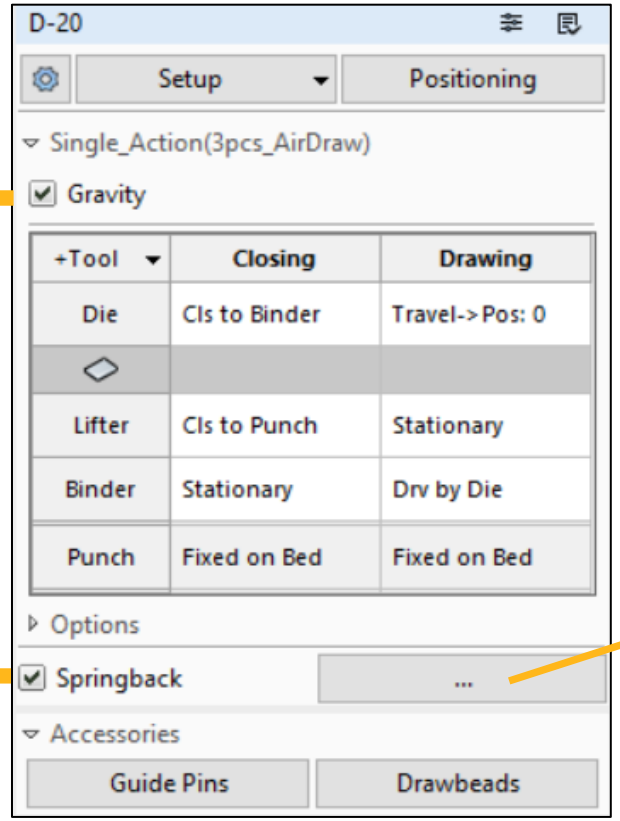
Straightforward and flexible to activate the option

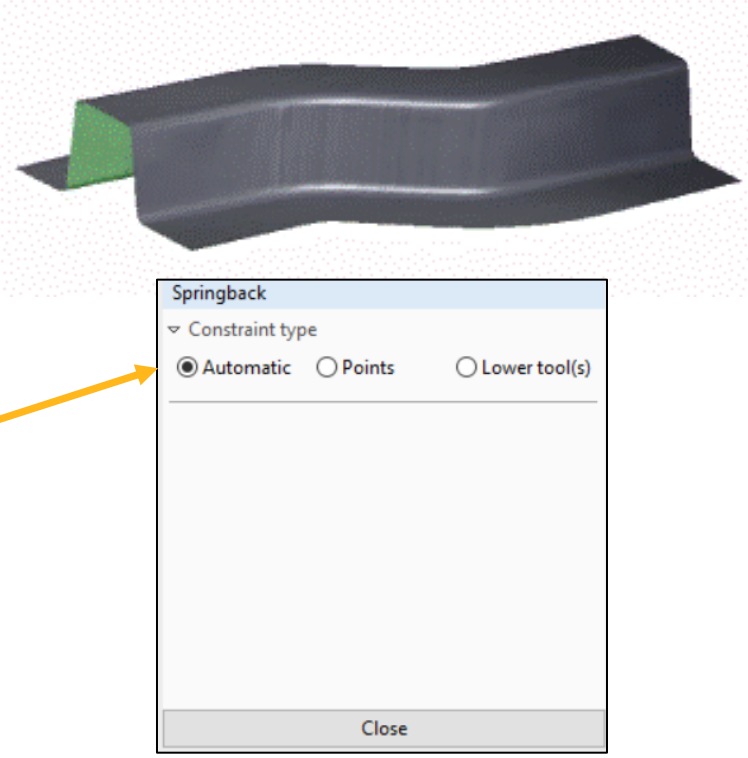
Default with an Auto-constrained springback algorithm

- Solver implemented algorithm with auto-constraints for springback prediction
- Suitable for product designers and process engineers

Gravity loading simulation

Springback prediction





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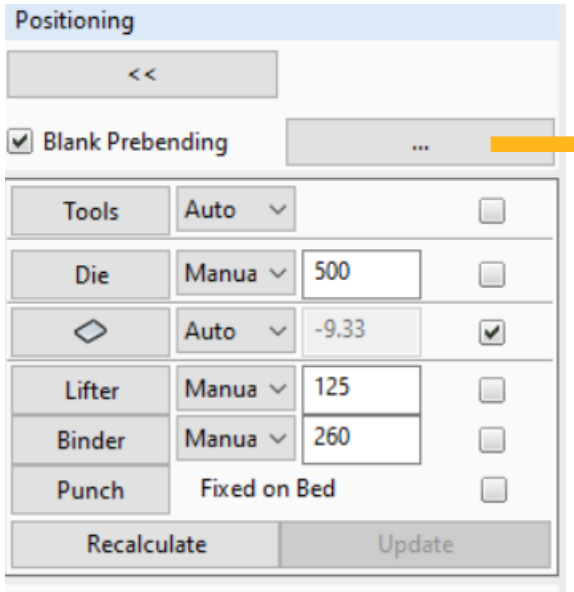
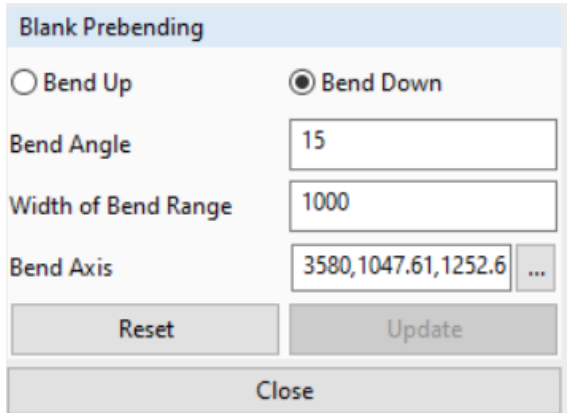
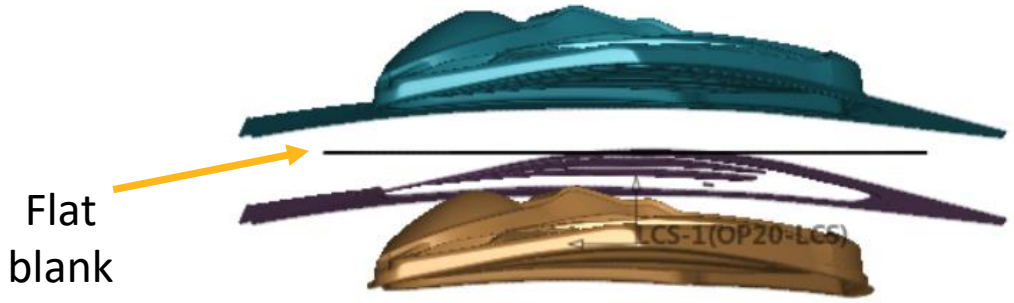
A Critical Function ‘Blank Pre-bending’

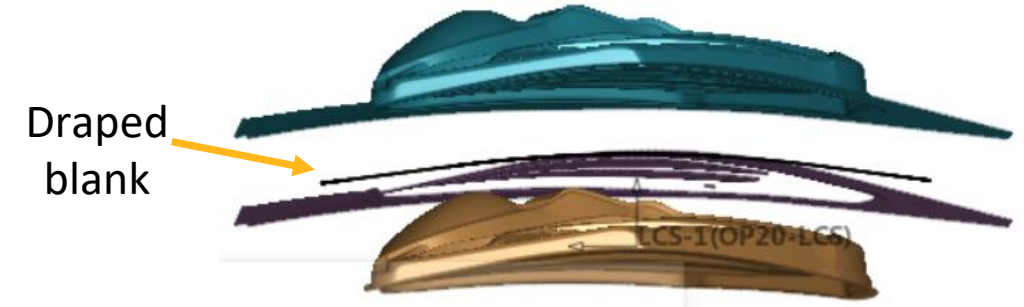
Convenient for user to create a draped blank shape

A draped blank shape is a MUST for a large-size blank to get an accurate gravity-loading result.









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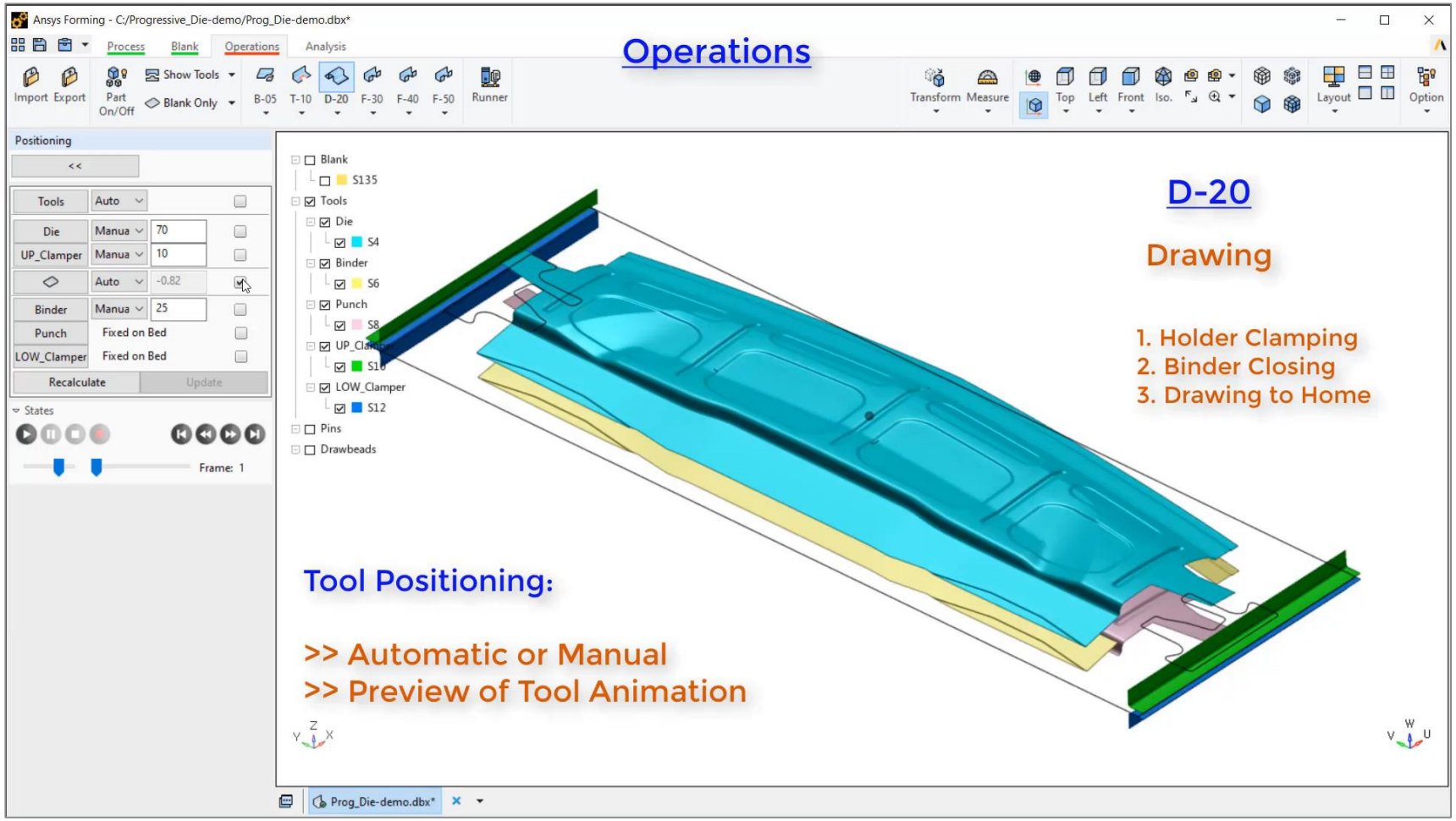
Animated Tool Motion Check

Preview of Tool Animation and Adjustment of Tool Position



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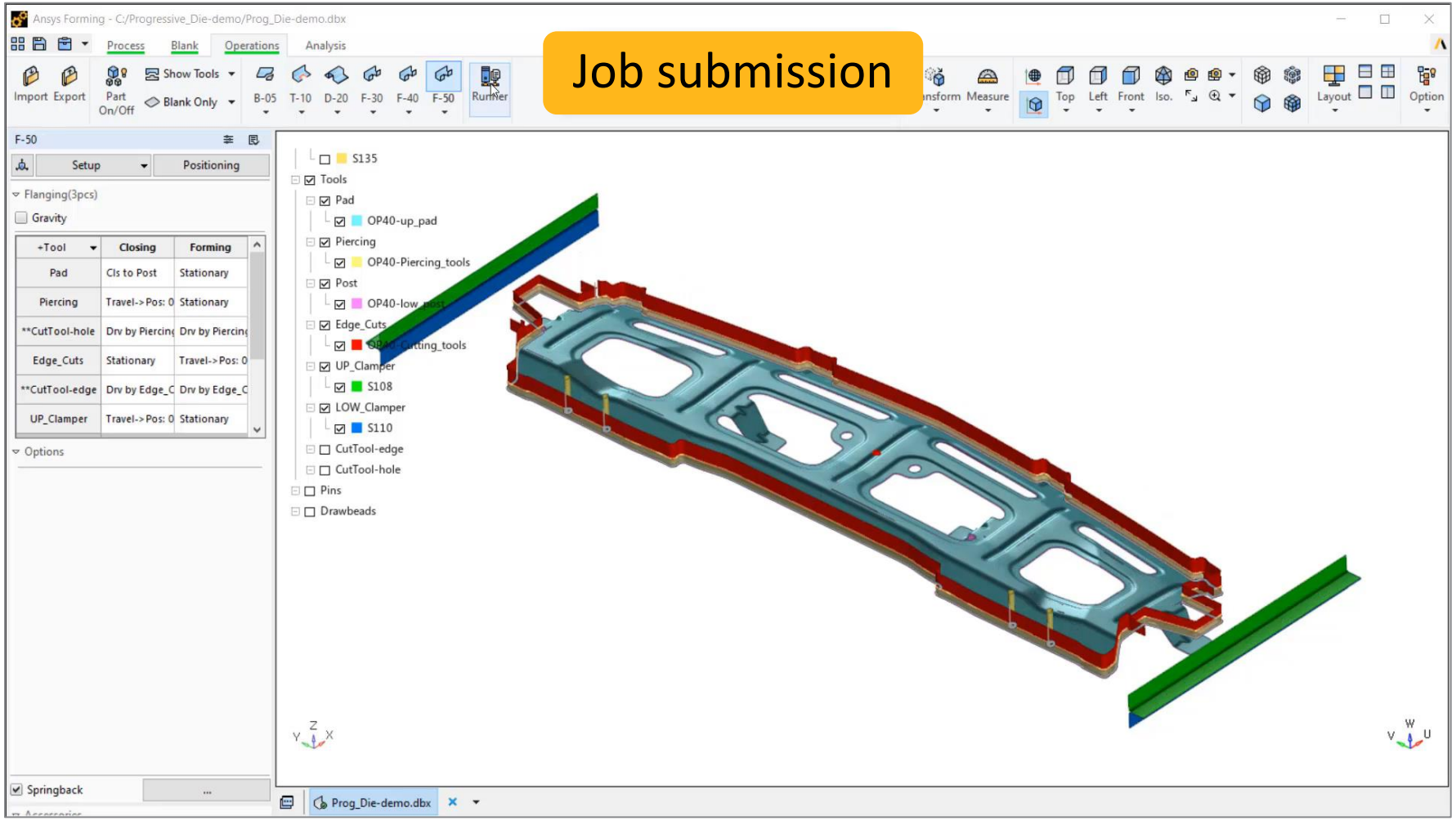
One Click to Submit Multi-stage Job

Auto start sequential jobs stage by stage



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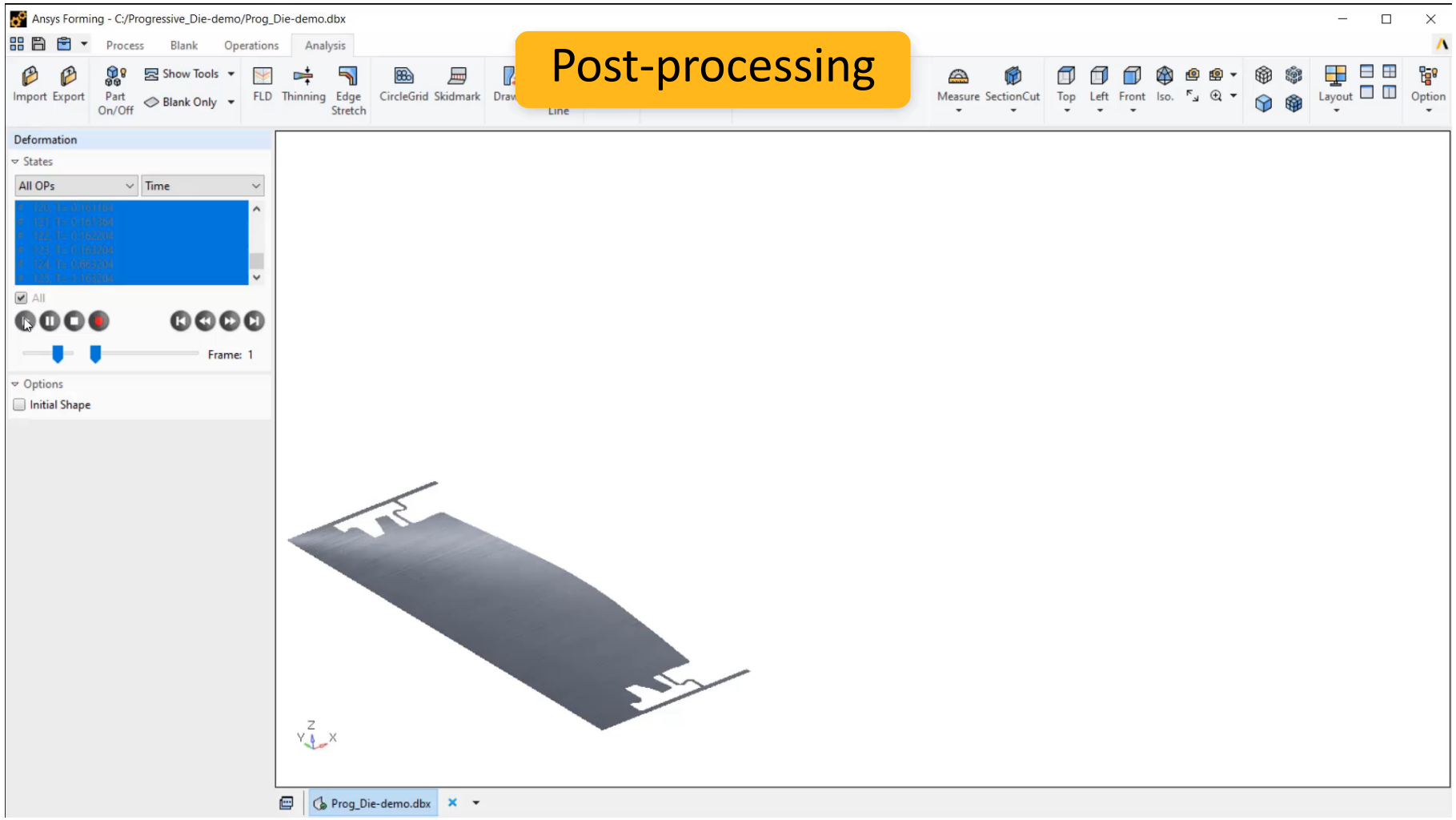
Dedicated Forming Post-Processing

- Intuitive GUI
- Special forming modules
- Integrated post-processing of multi-stage jobs
- Easy multiple-window management
- Up-to-date graphic rendering
- High software stability



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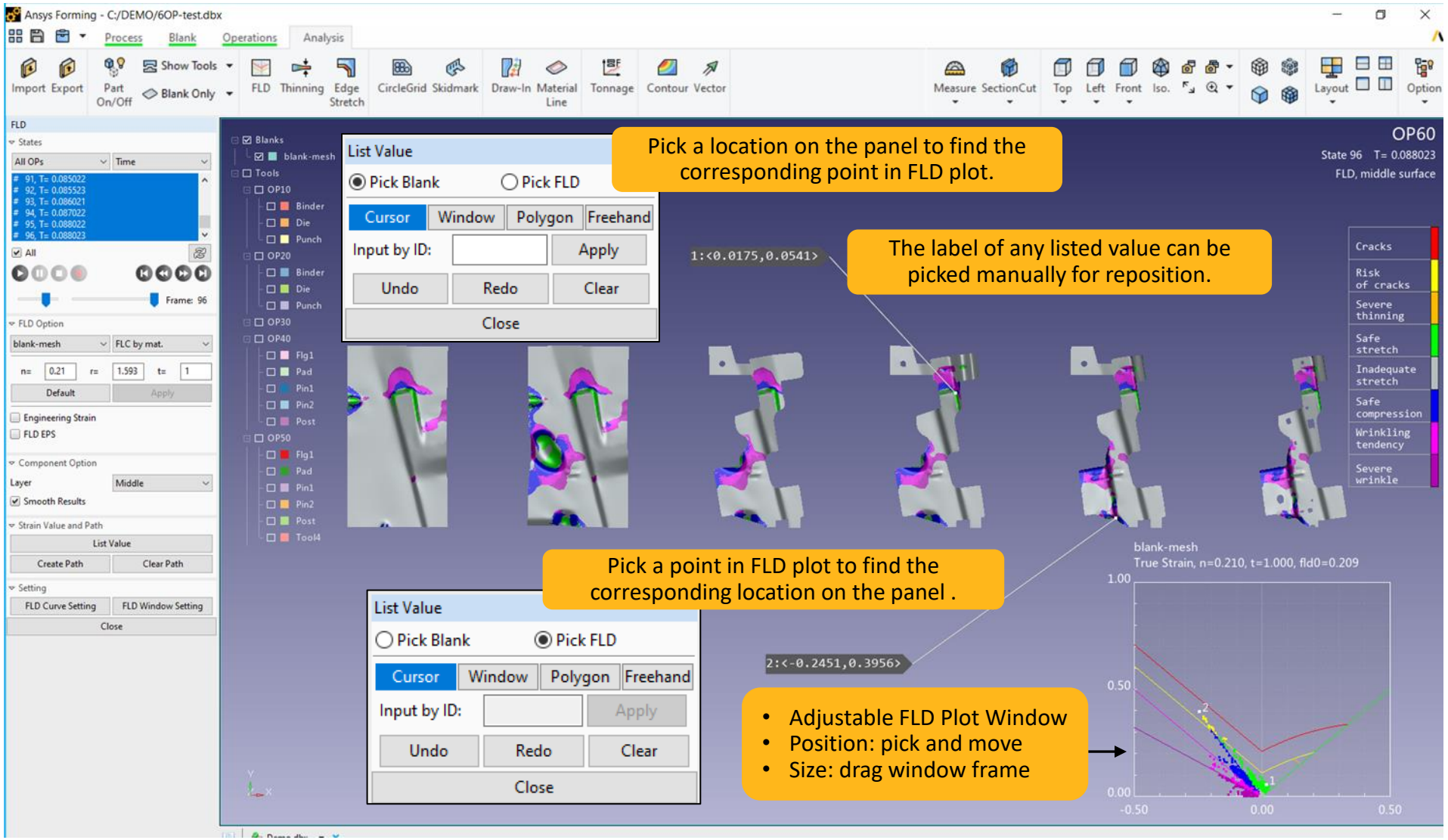
Forming Limit Diagram (FLD)



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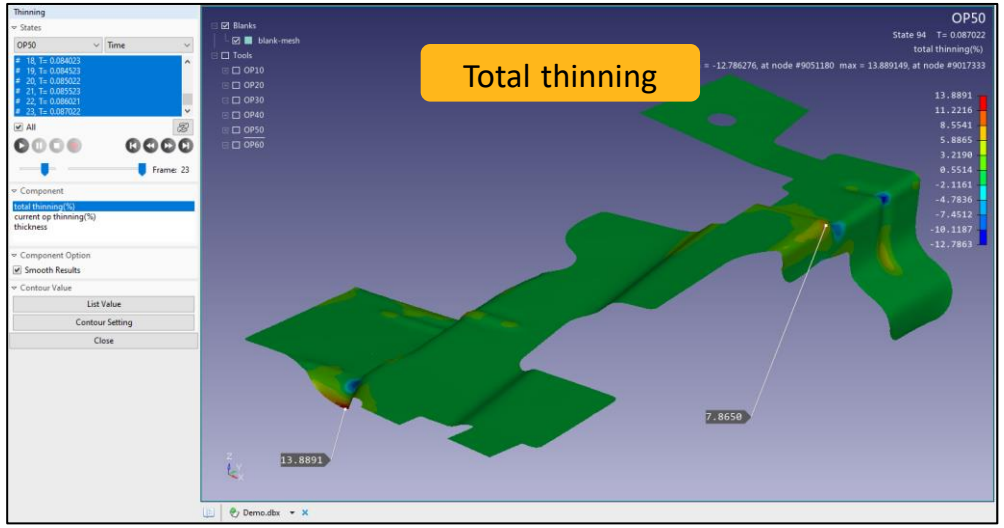
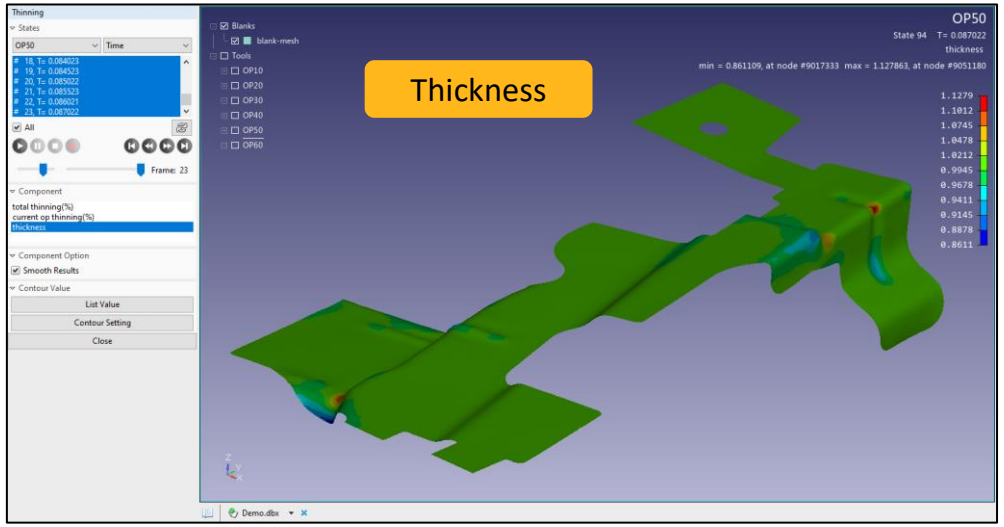
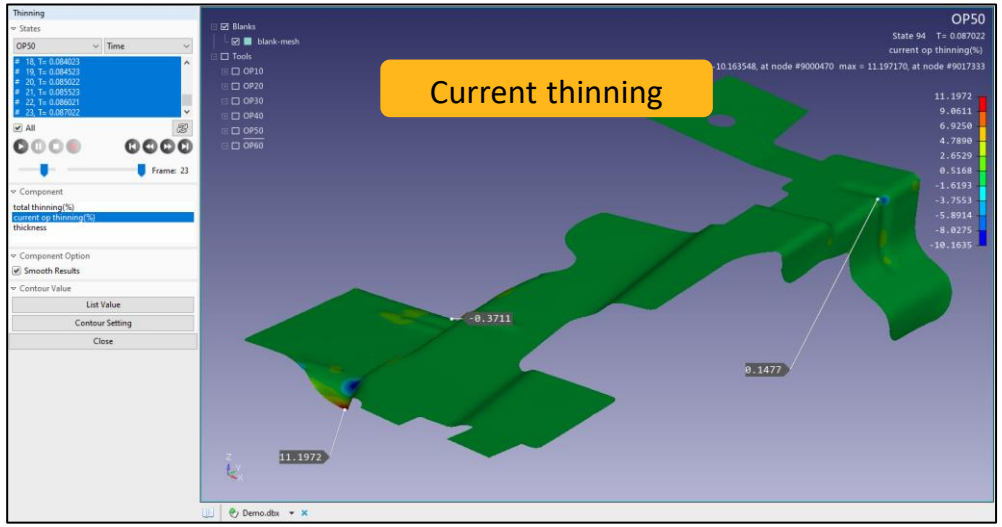
Thinning

Three contour options

- Total thinning (%)
- Current thinning (%)
- Thickness







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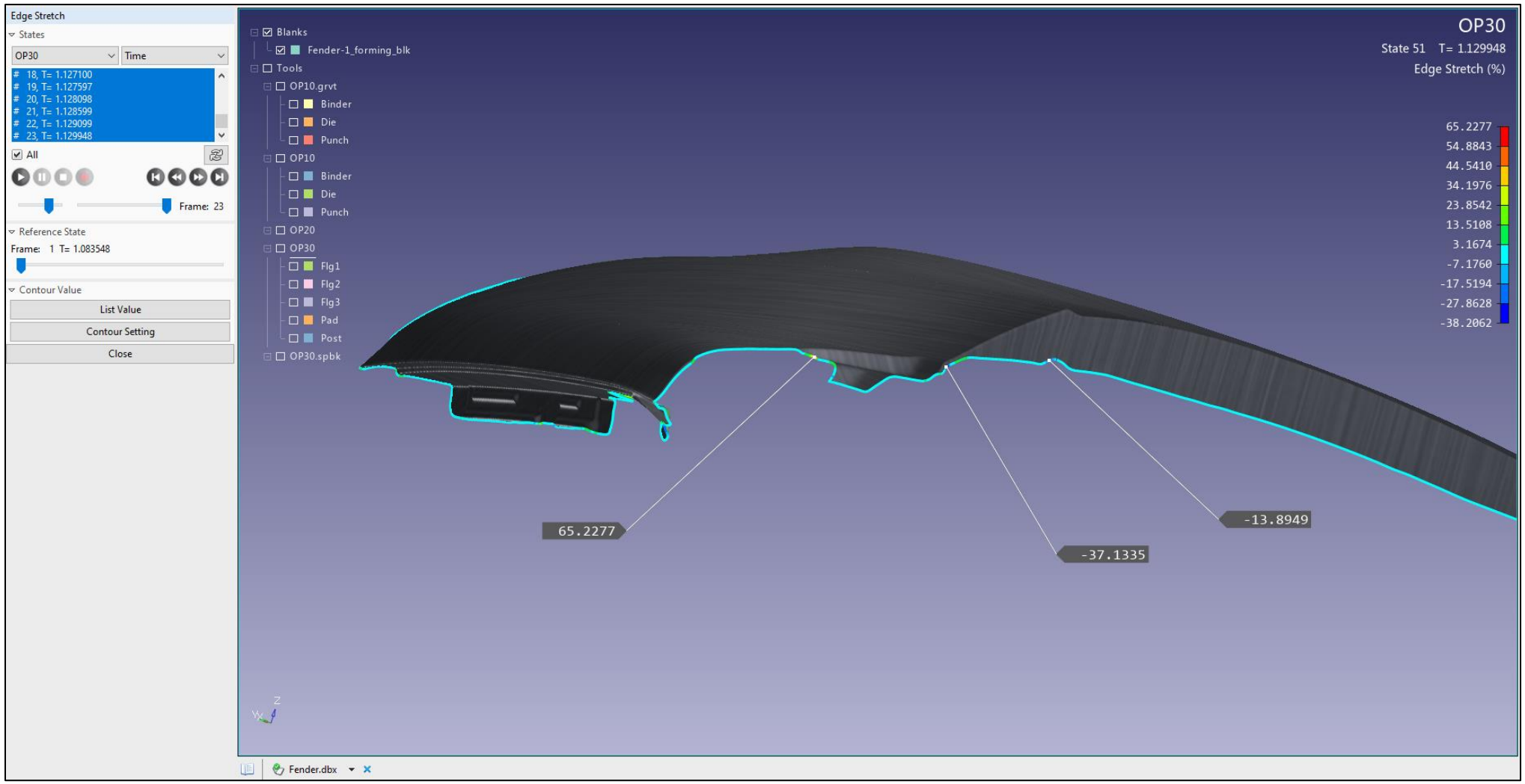
Edge Stretch



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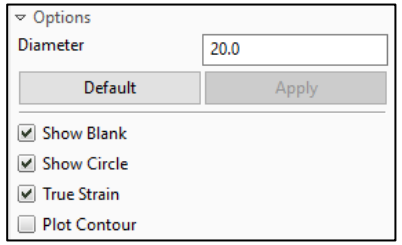
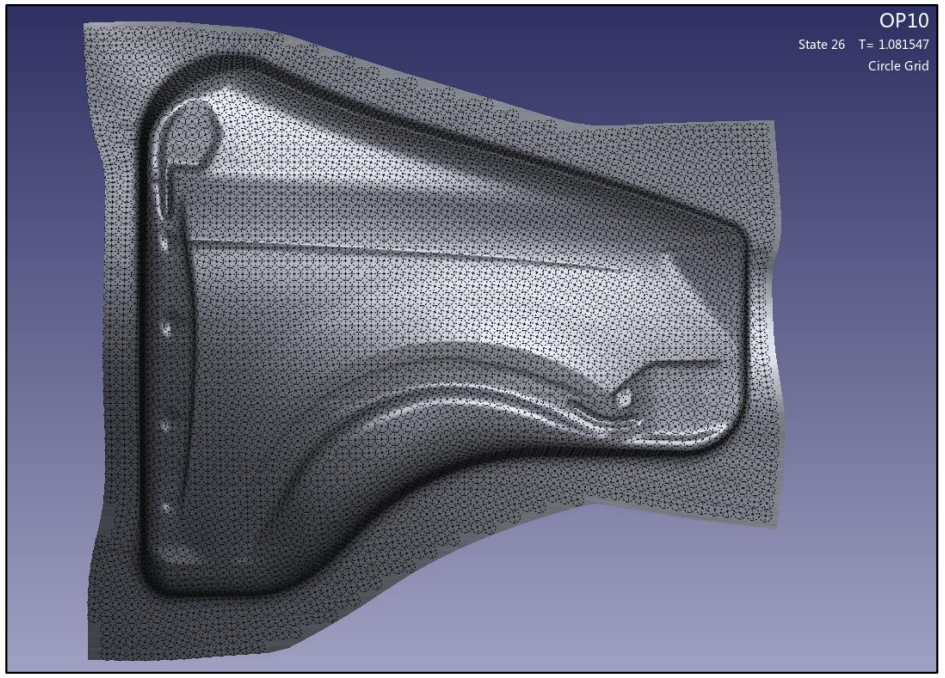
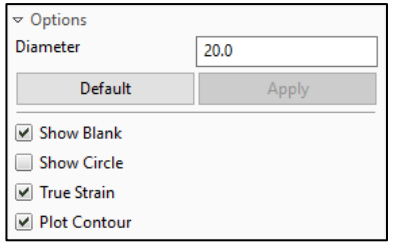
Circle Grid

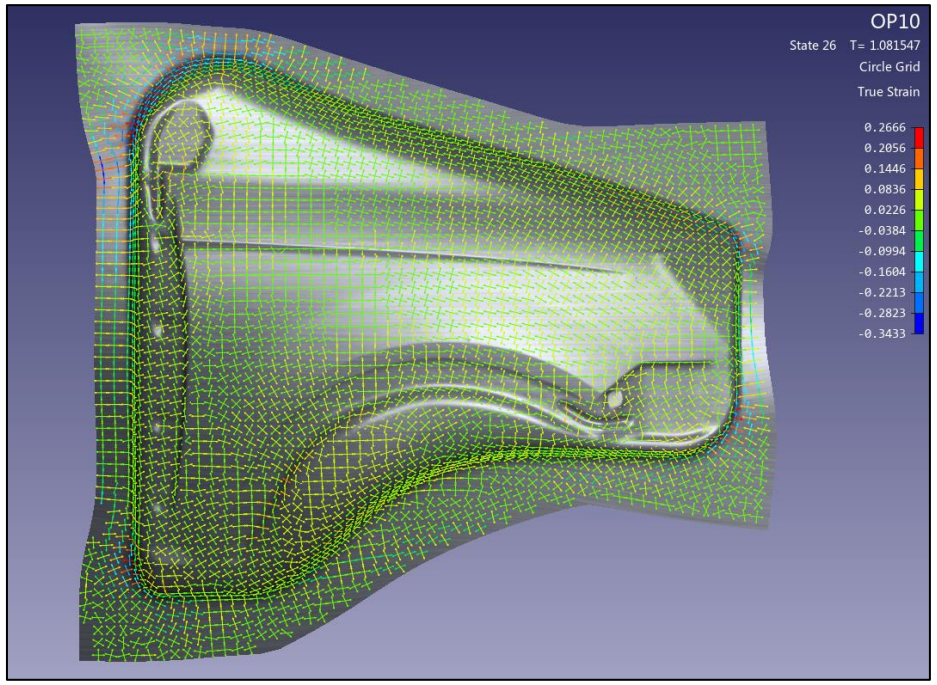
Circle Grid Mode





Strain Vector Mode





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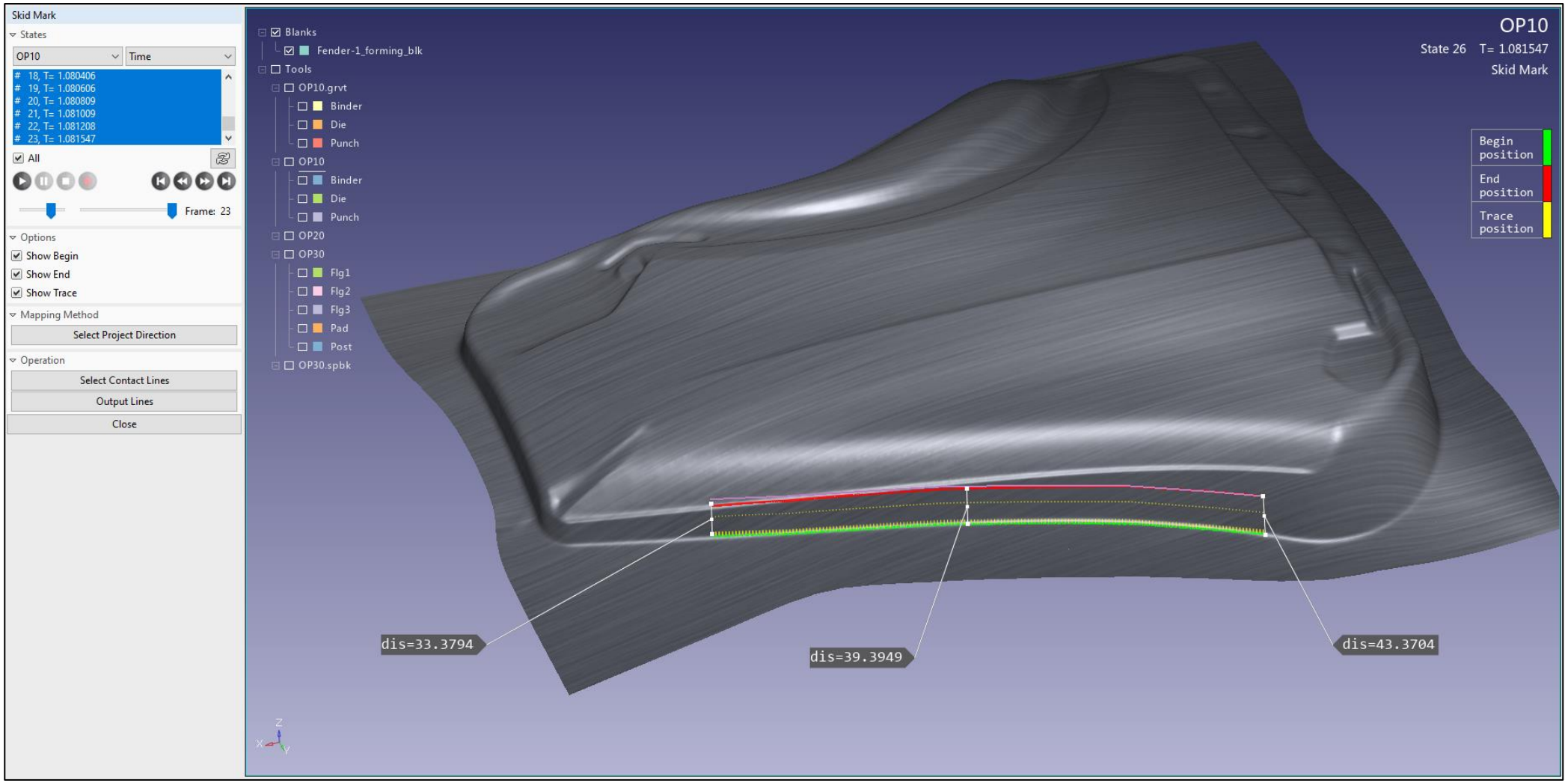
Skidmark



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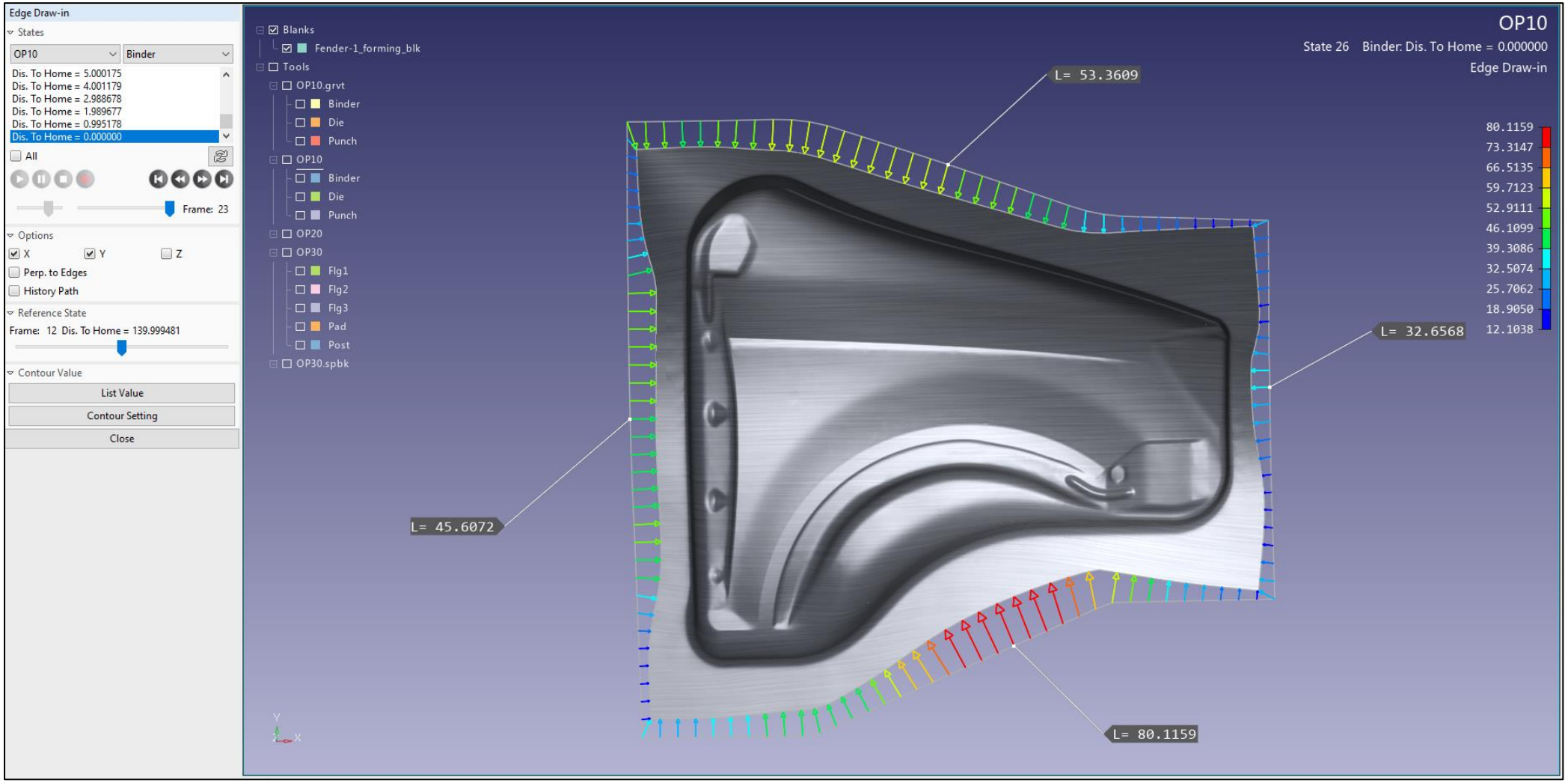
Draw-In



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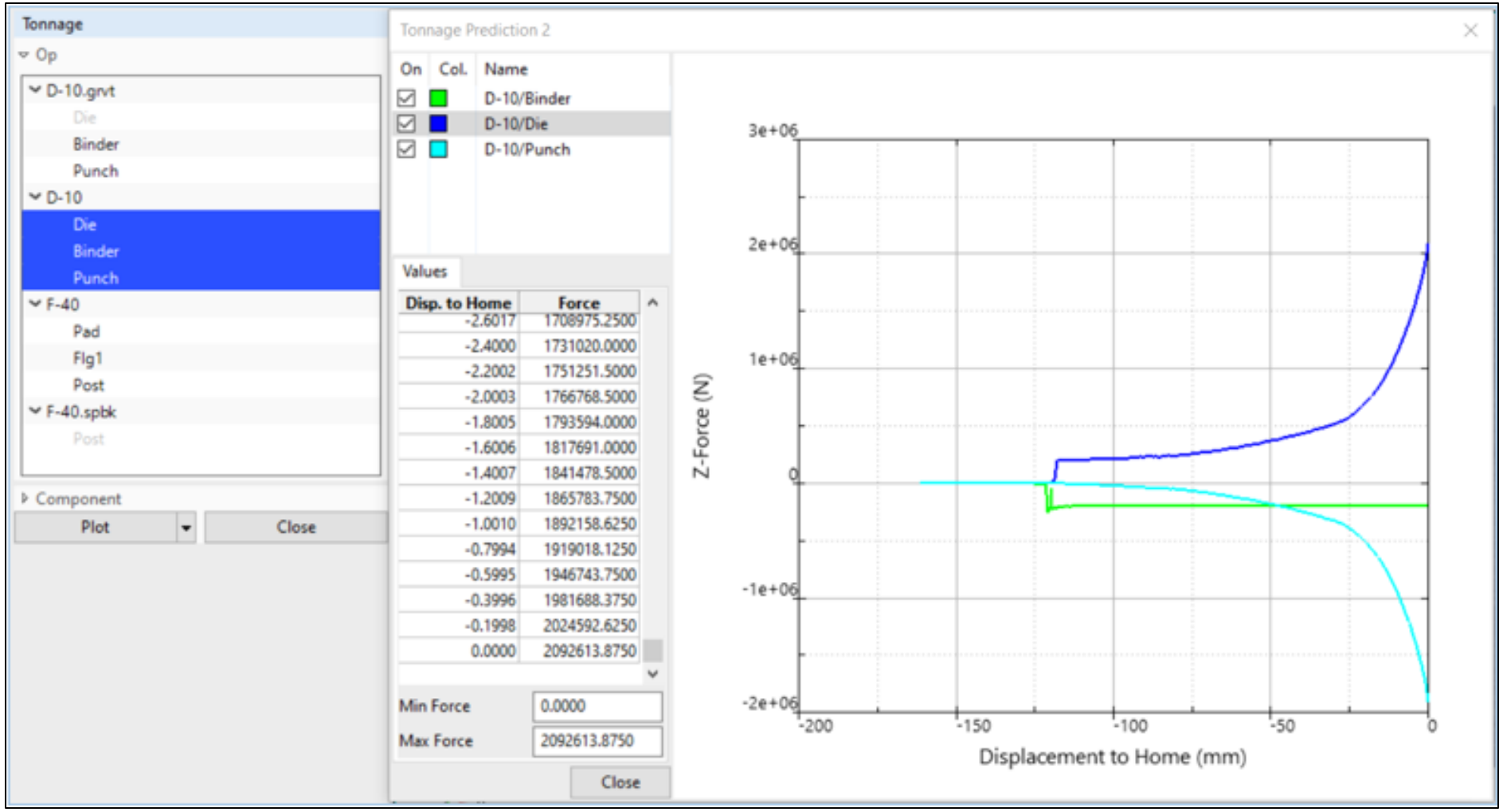

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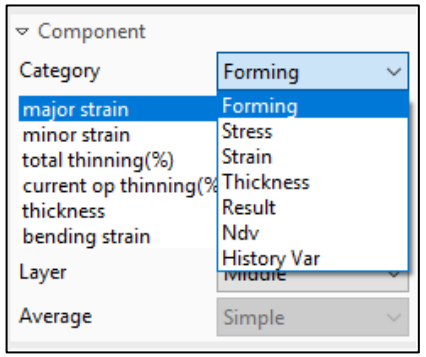
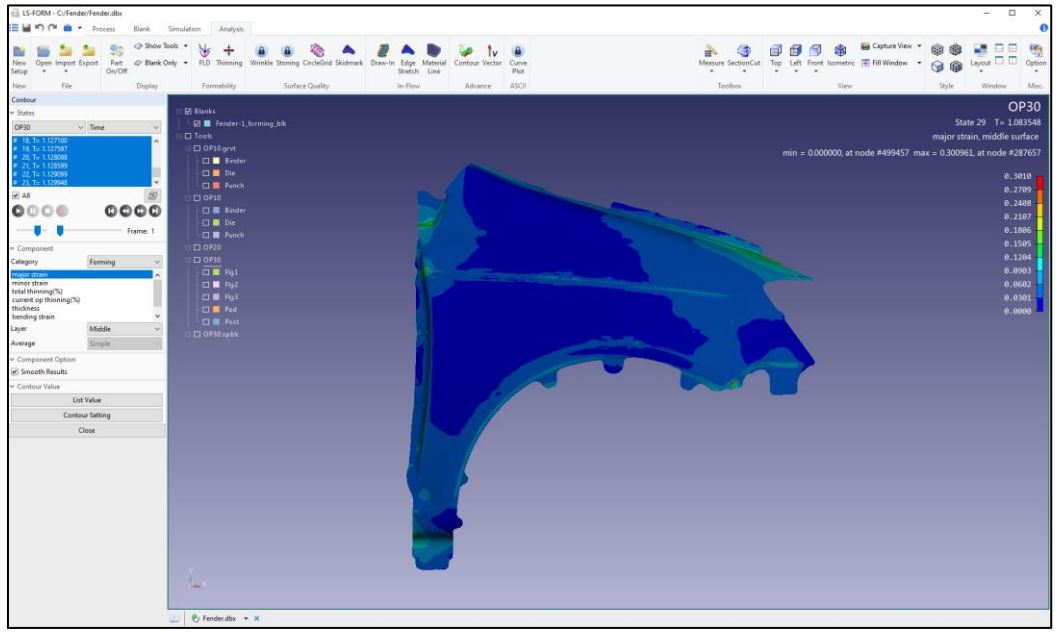
Contour

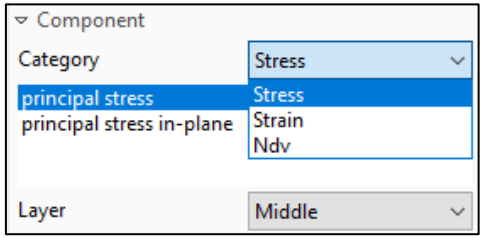
Contour of LS-DYNA Component Results

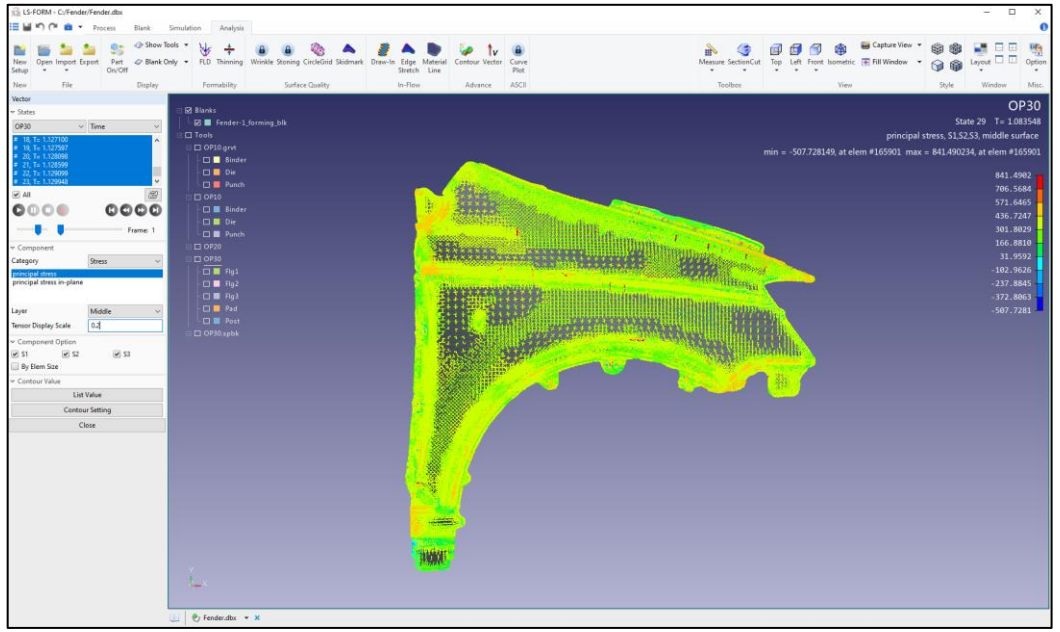




Vector

Contour of LS-DYNA Component Vectors





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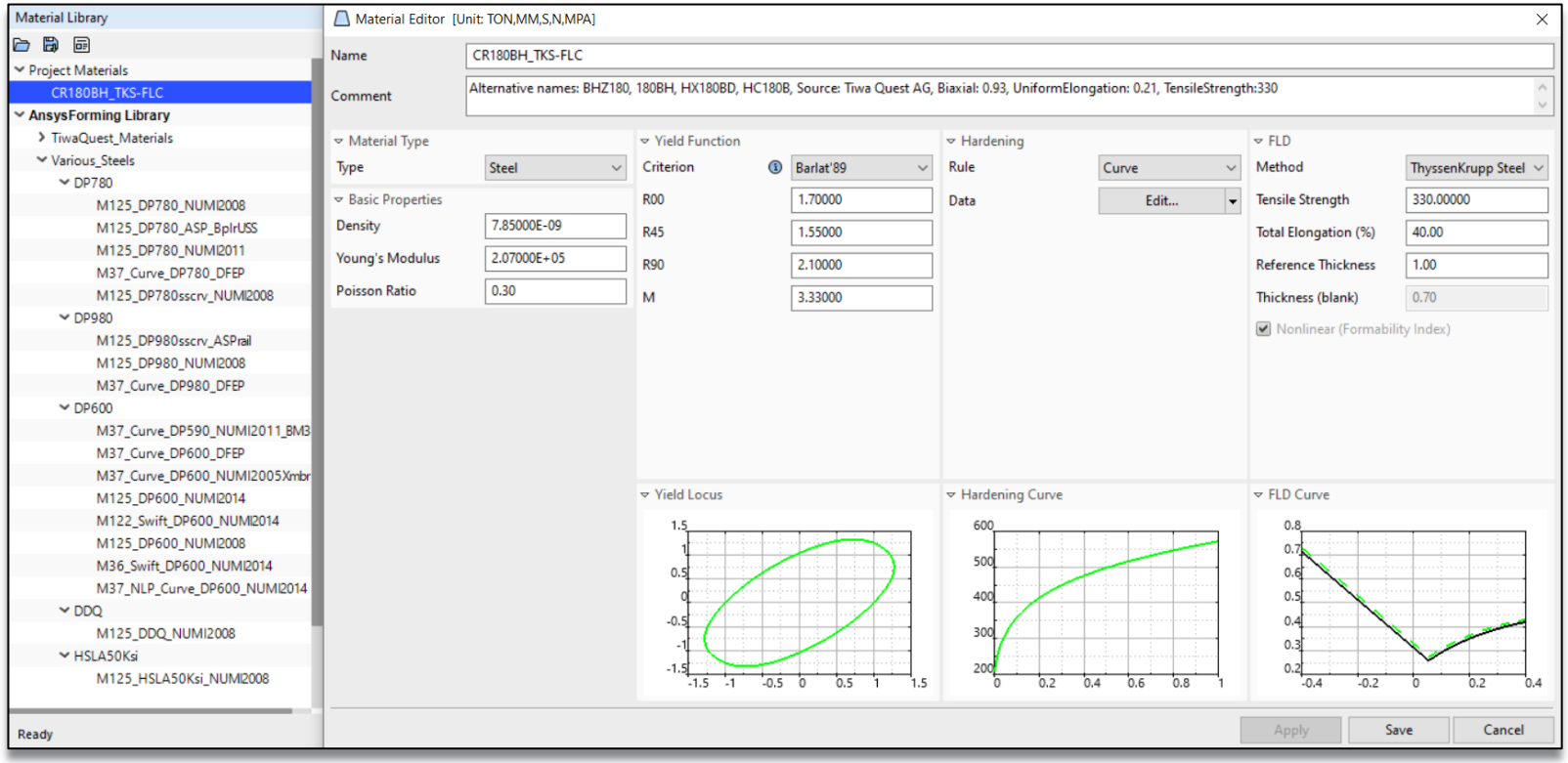
Accuracy and Efficiency

Ansys Forming takes full advantage of LS-DYNA state-of-the-art technologies to achieve accuracy and efficiency.

Dedicated Material Library Management

- ✓ Advanced LS-DYNA Material Models for metal forming
- ✓ Extendable forming material database
- ✓ Easy to define/modify new material
- ✓ Nonlinear FLD (Formability Index)



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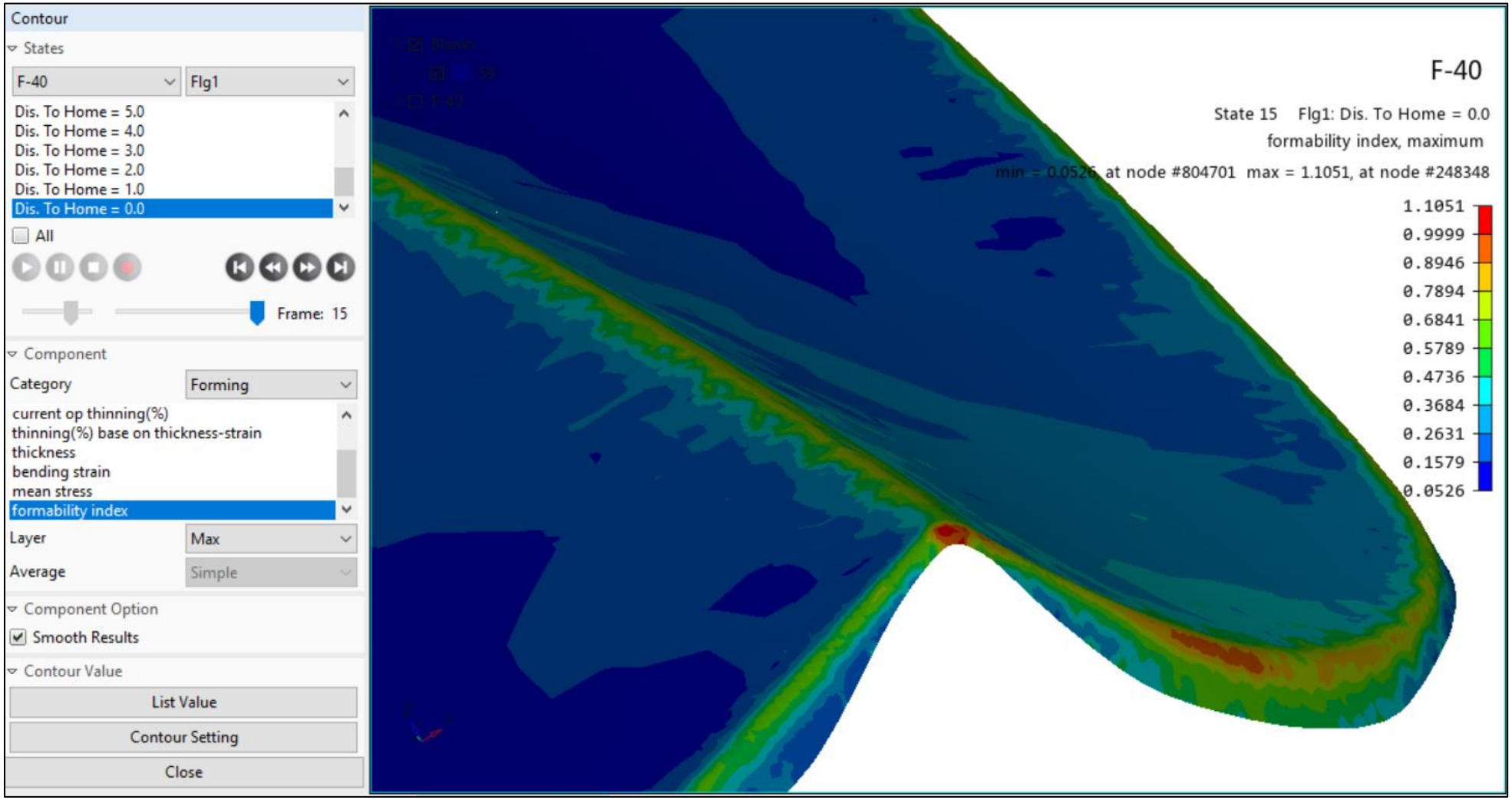
Accuracy and Efficiency

- Formability Index improves accuracy of formability by considering non-linear strain path effect



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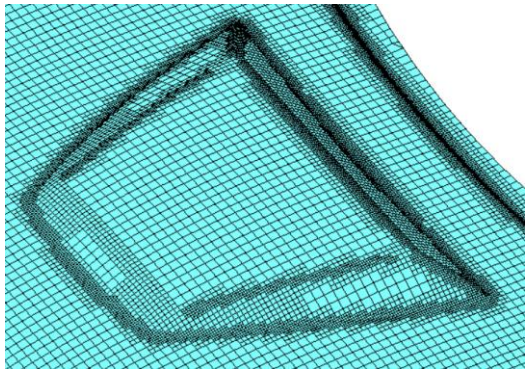
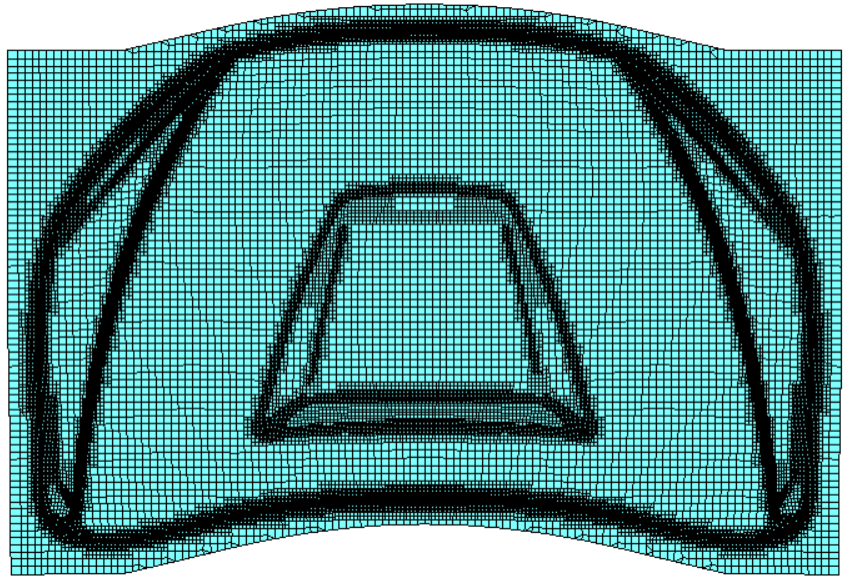
Smart Adaptivity

Efficient refinement approach for faster solution

- In stamping simulation, users tend to use initial coarse mesh and refine elements through adaptivity.
- Original mesh refinement is based on contact, which depends on the mesh quality of rigid body.
  - It tends to refine more elements than necessary.
- New mesh refinement ‘Smart Adaptivity’
  - More accurate in mesh refinement
  - Only refines very necessary areas
  - Less element number and faster





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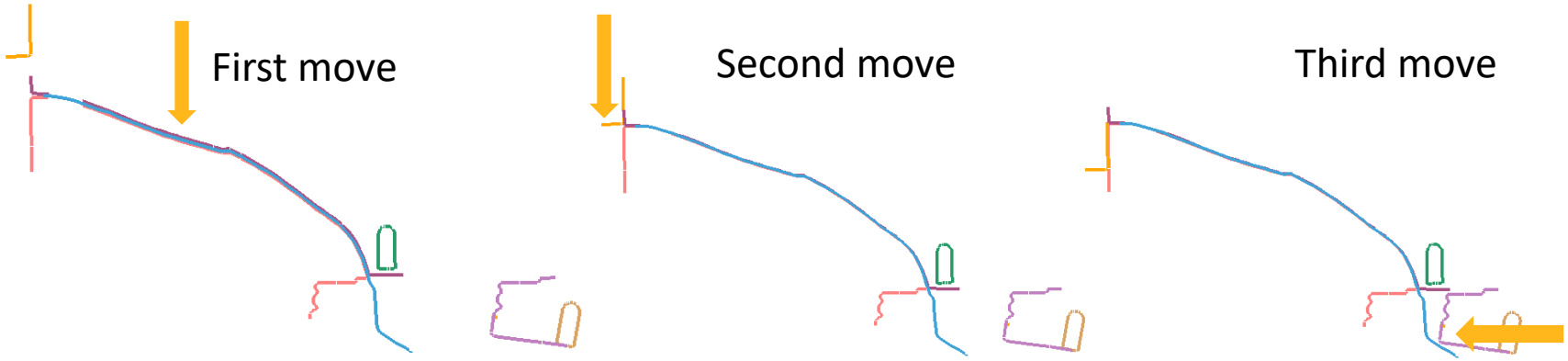
New Automatic Contact Move for tool positioning

Efficient strategy to reduce simulation time

- In stamping simulation, the initial tool position is not always close to the blank
  - Users prefer actual process setting, which may lead to large gap between the tool and the blank in initial starting position
  - Simulating the actual tool travel to close the gap is time consuming and computationally wasteful
  - Ansys Forming is enhanced by this new feature in solver to close the gap automatically



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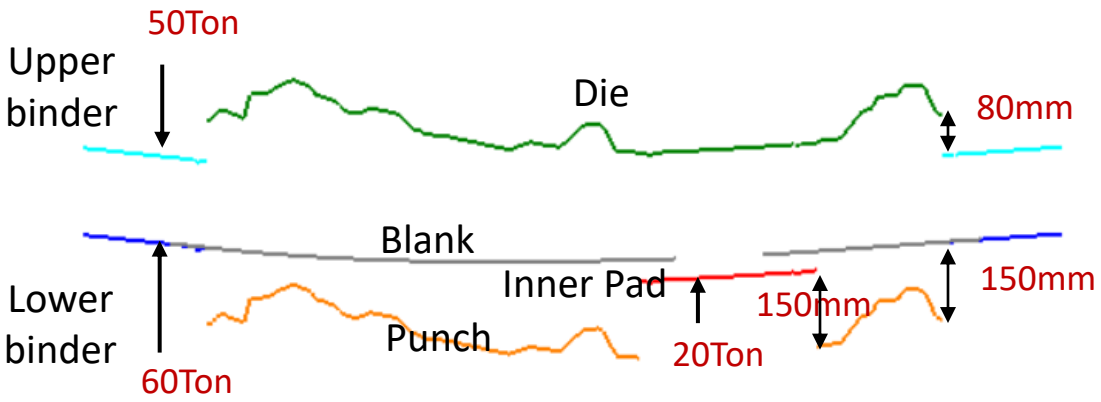
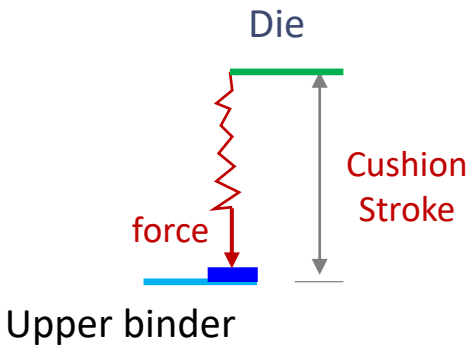
New ‘Cushion Stroke’ Algorithm in Solver

Dramatically simplify the tool setup and positioning

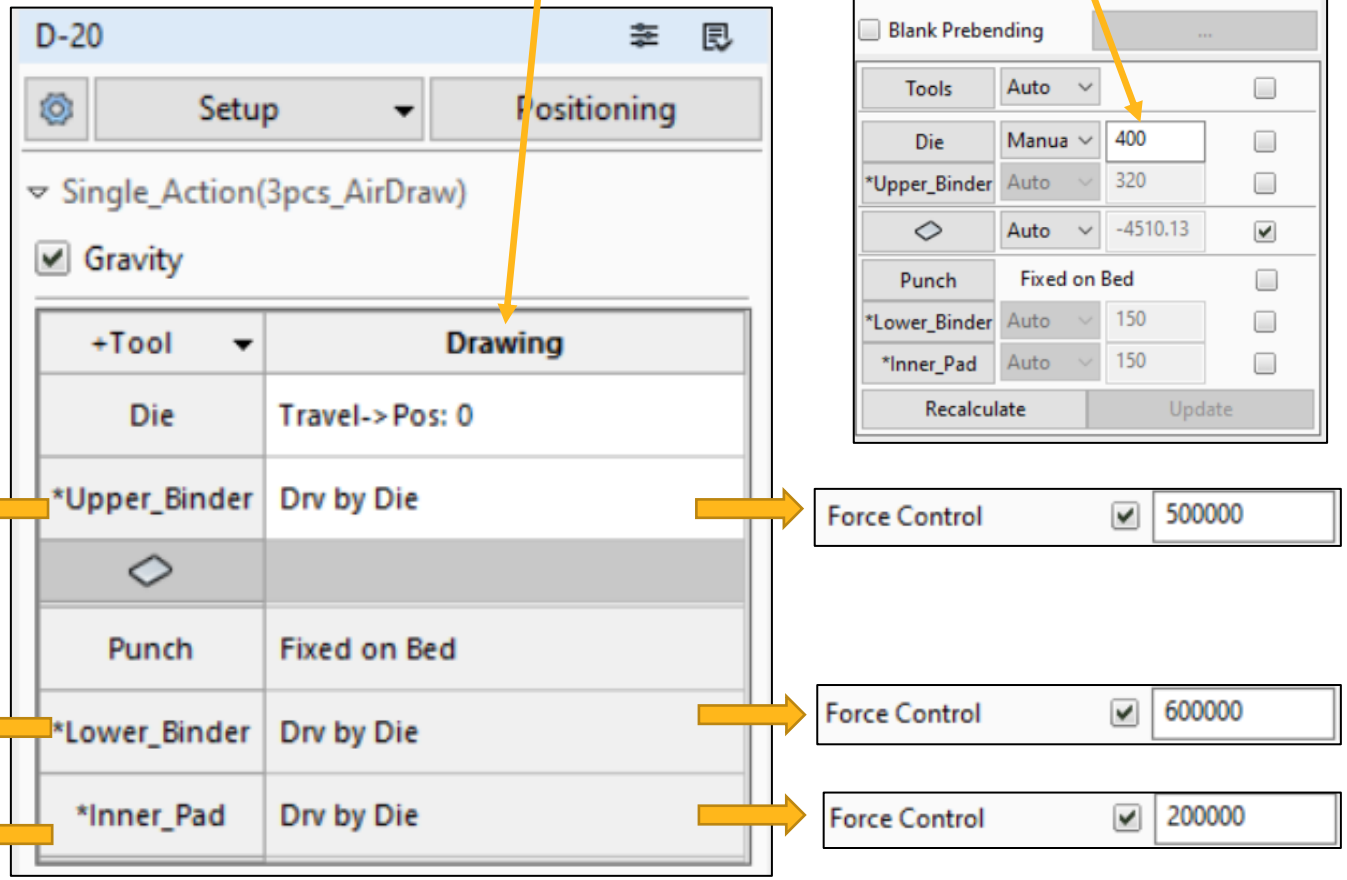
Suitable to complicated tool motion (e.g., pad motion)





Only one-phase setup if needed

Just need to position the die



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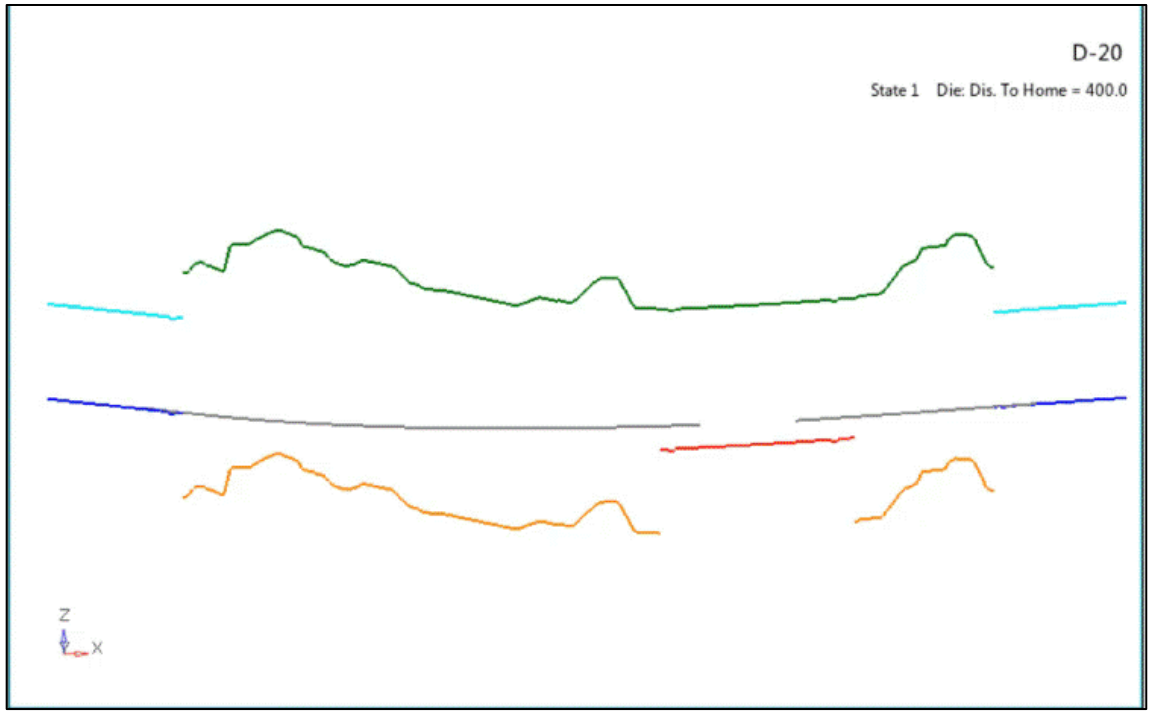
New ‘cushion stroke’ Algorithm in Solver

- New ‘cushion stroke’ algorithm in solver can simulate complex tool motion coupled with three force-controlled tools.
- Automatic contact move of upper tools for force-controlled binders to close
- Upper binder remains stationary until the die approaches
  - (Upper binder can not push the lower binder down because its force is smaller than lower-binder force)
- Die keeps moving and drives force-controlled lower binder and pad to home



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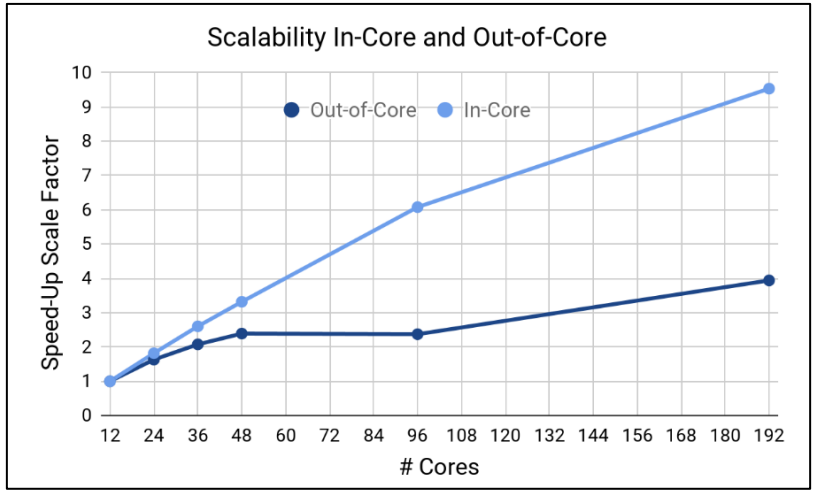
In-core Adaptivity

Efficient algorithm to save MPP solution time

- Traditional out-of-core adaptivity requires too much I/O, especially for large models.
- In-core adaptivity has the following advantages
  - I/O cost associated with restart can be avoided. For a model with 1 million elements, up to 70% of the total time is wasted for I/O purpose.
  - It also dynamically re-balances the load for each core
  - Significantly improves the performance
  - The speed continues to scale up; No saturation point is observed



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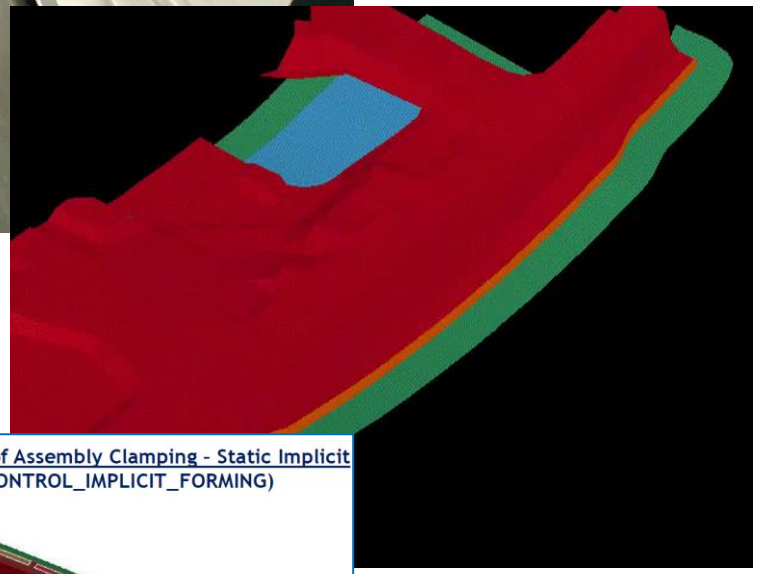
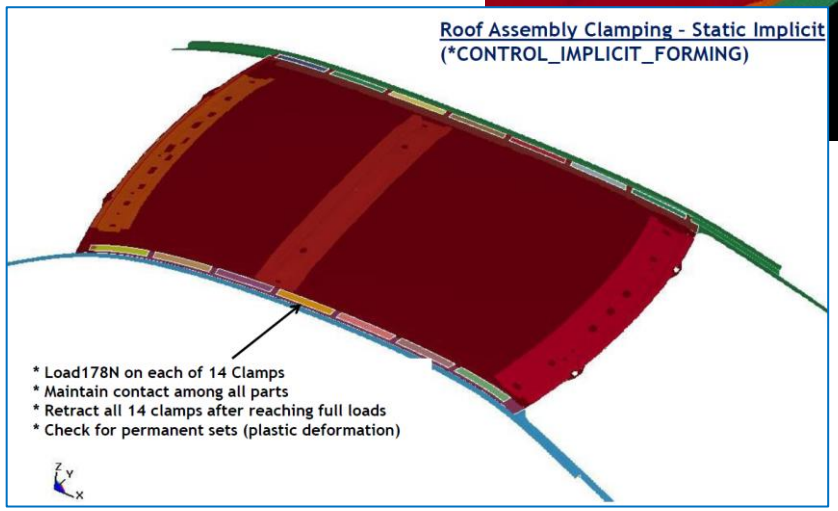
Future Roadmap

- Die Surface Compensation, Clamping (Springback Compensation)
- Forming Process Management
- Hemming
- Thermal Distortion
- Die Face Design





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