

Oasys LS-DYNA 11th Annual Update Meetings in India

Pune – 24th April 2018

Bangalore – 26th April 2018



Introducing JFOLD - a Simulation based Airbag Folding System for LS-DYNA

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Airbag safety system requirements

- In-position occupant injury prediction
- Out-of-position occupant injury prediction
- Component performance issues
 - **Trim and module fracture prediction**
 - **Airbag hang-ups**
 - **Incorrect deployment direction**

Fast virtual design

Realistic gas flow

Detect and solve problems during the early design phases using simulation

→ We need *more accurate* finite element airbag models



Demand for improved airbag model performance

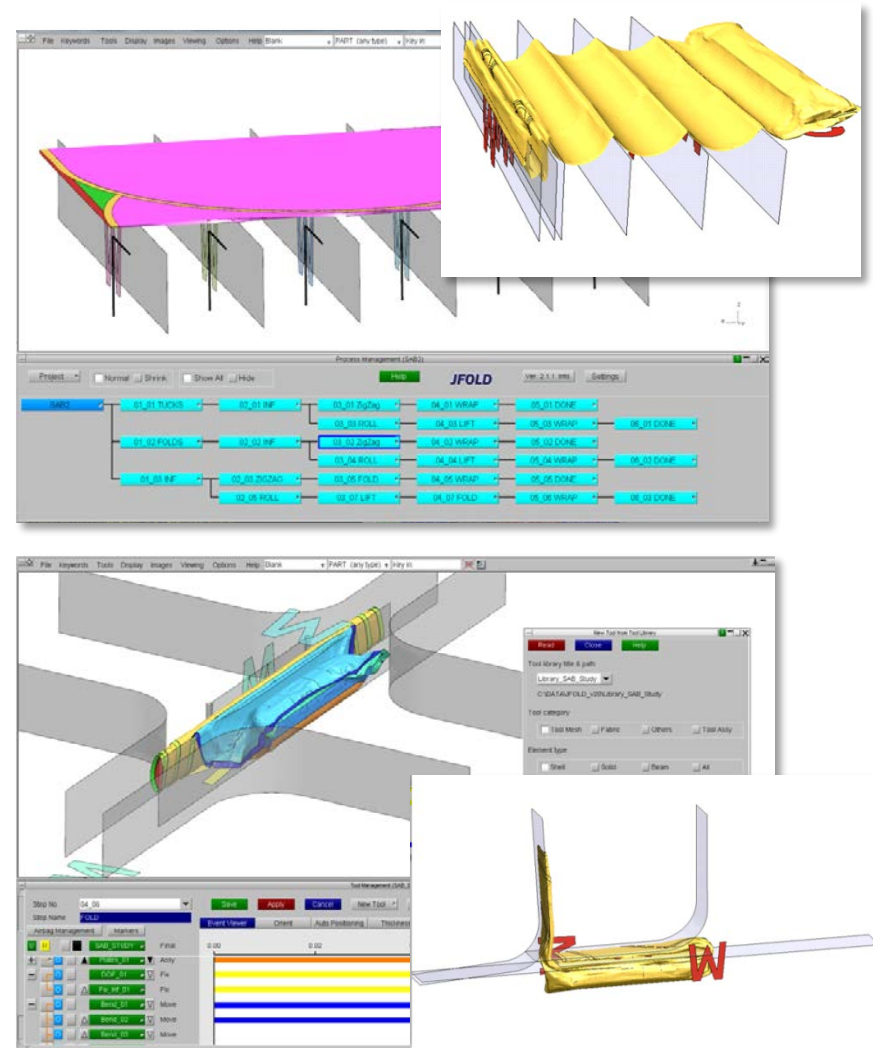
Airbag CAE models must accurately simulate the same deployment shape, timing and power as the real device.

In particular, we need...

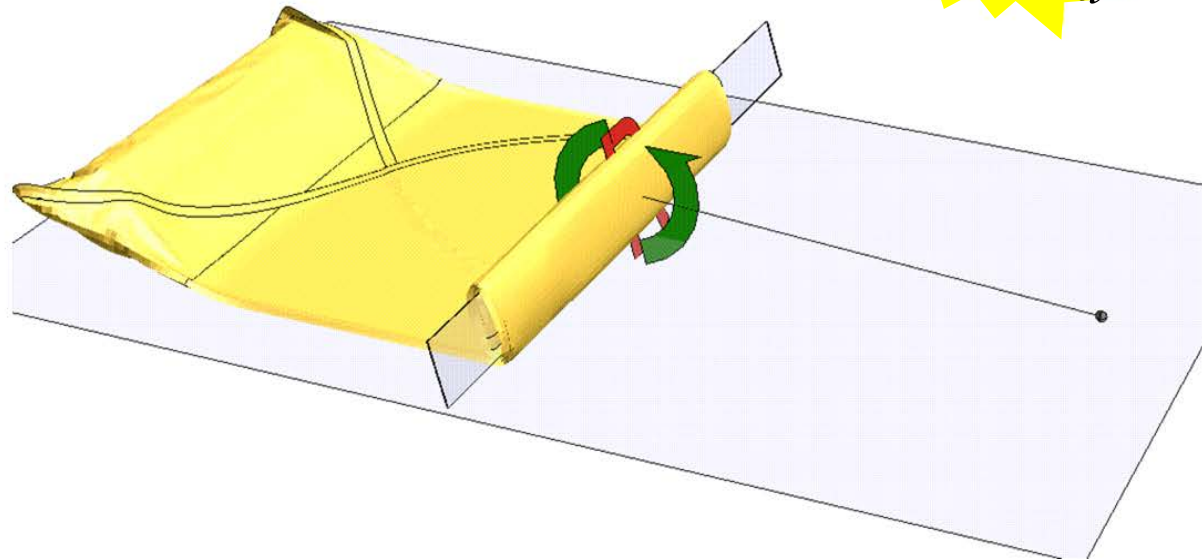
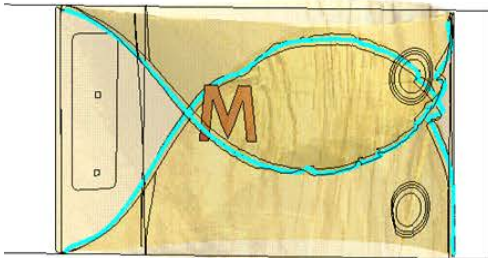
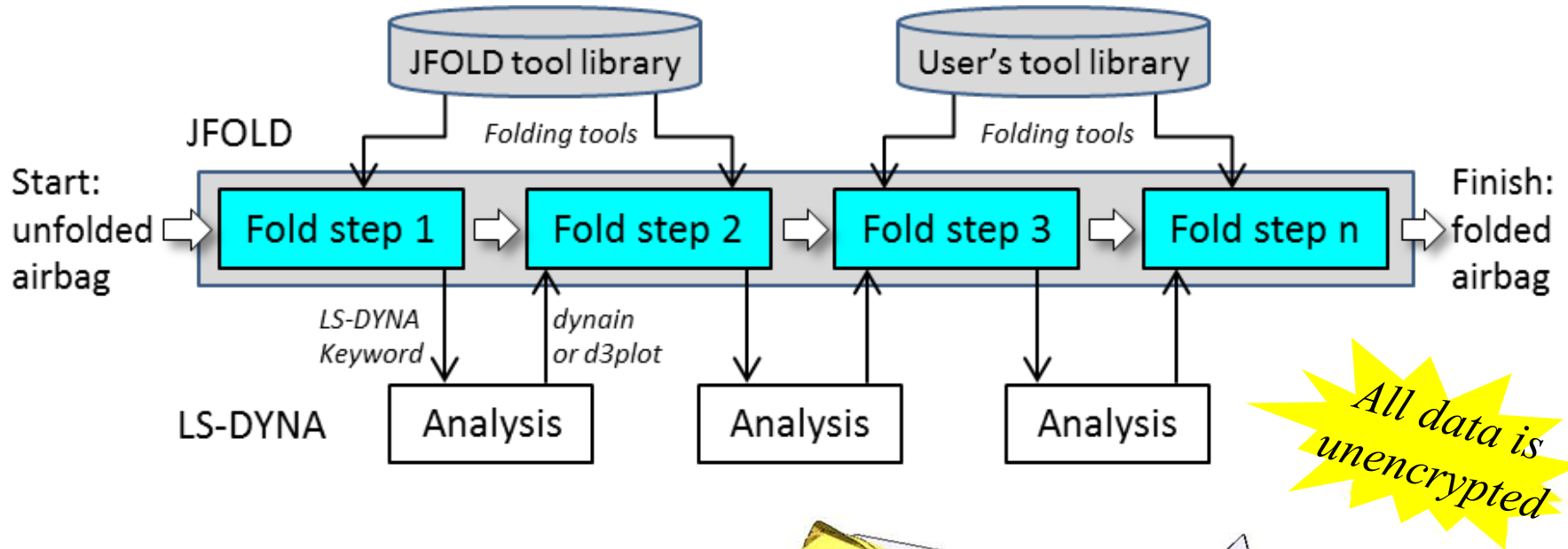
- Good model of the gas dynamics ✓ CPM
- Realistic folded condition ✓ JFOLD
- Correct fabric behaviour ✓ FORM=14
- Robust contacts ✓
- Good trim material failure models ✓
- ... etc.



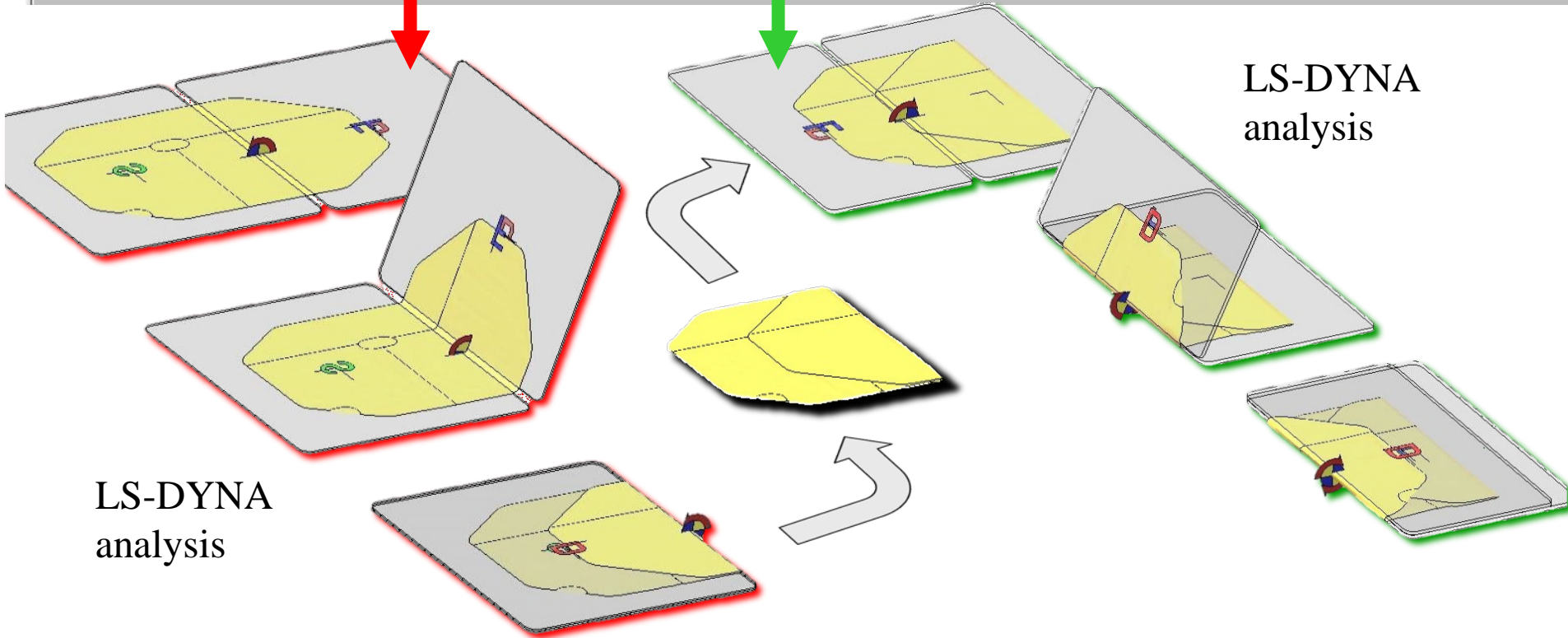
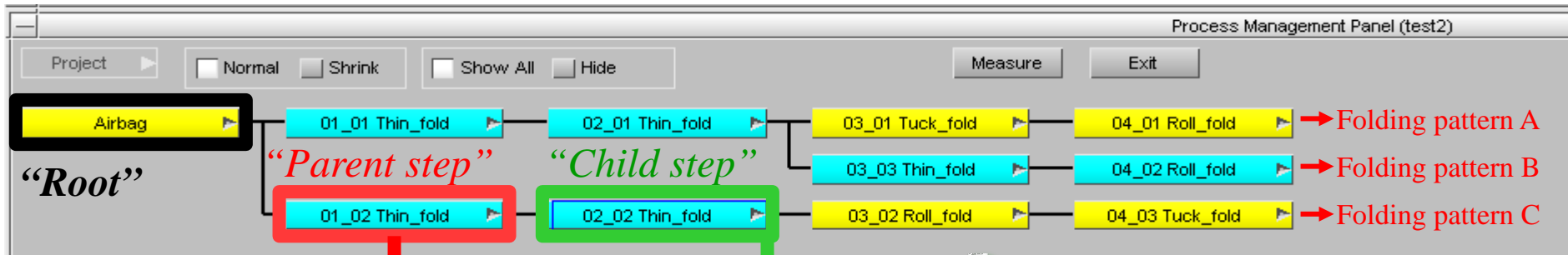
Constantly improved to make folding quicker and easier.



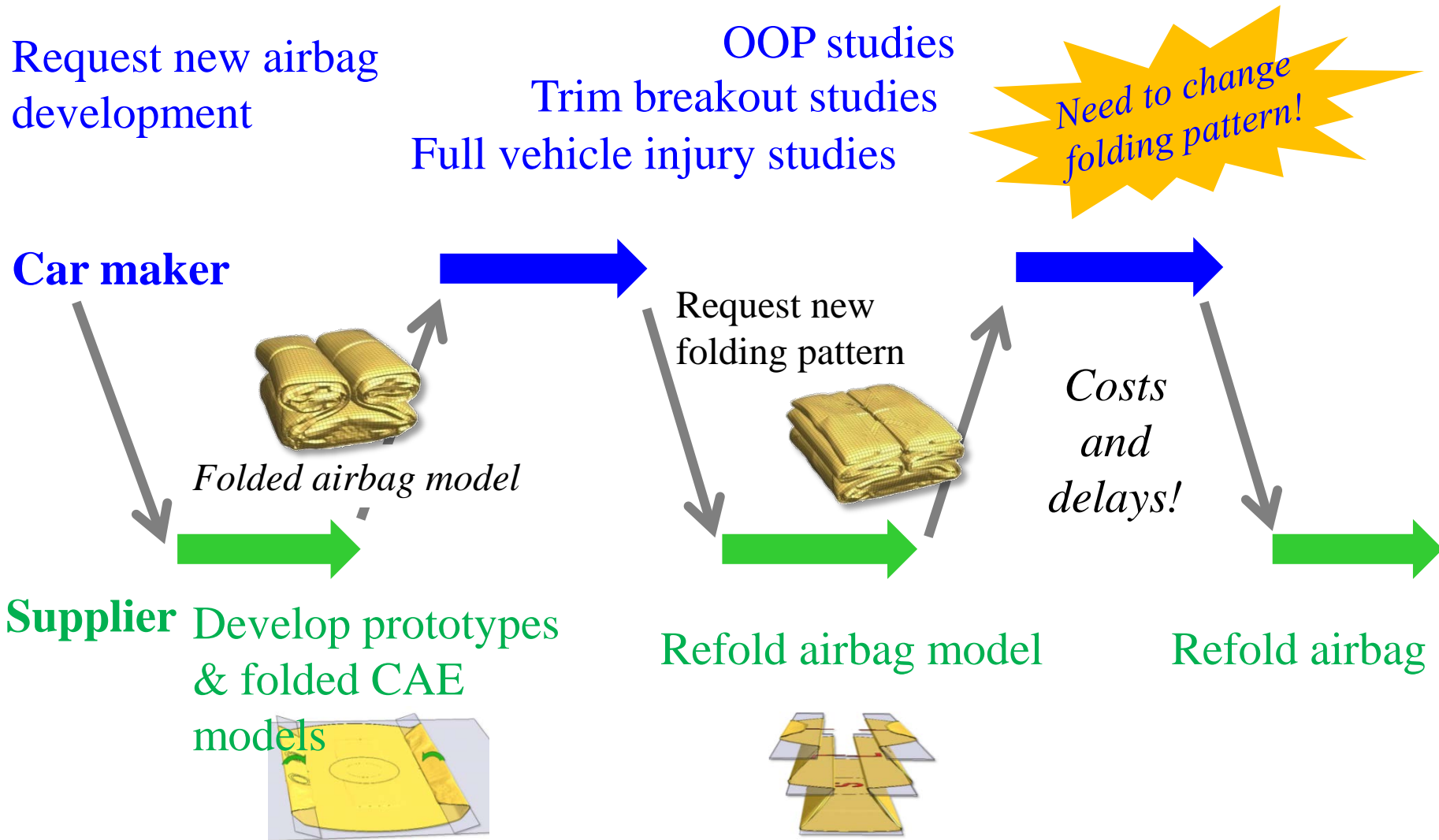
How JFOLD works



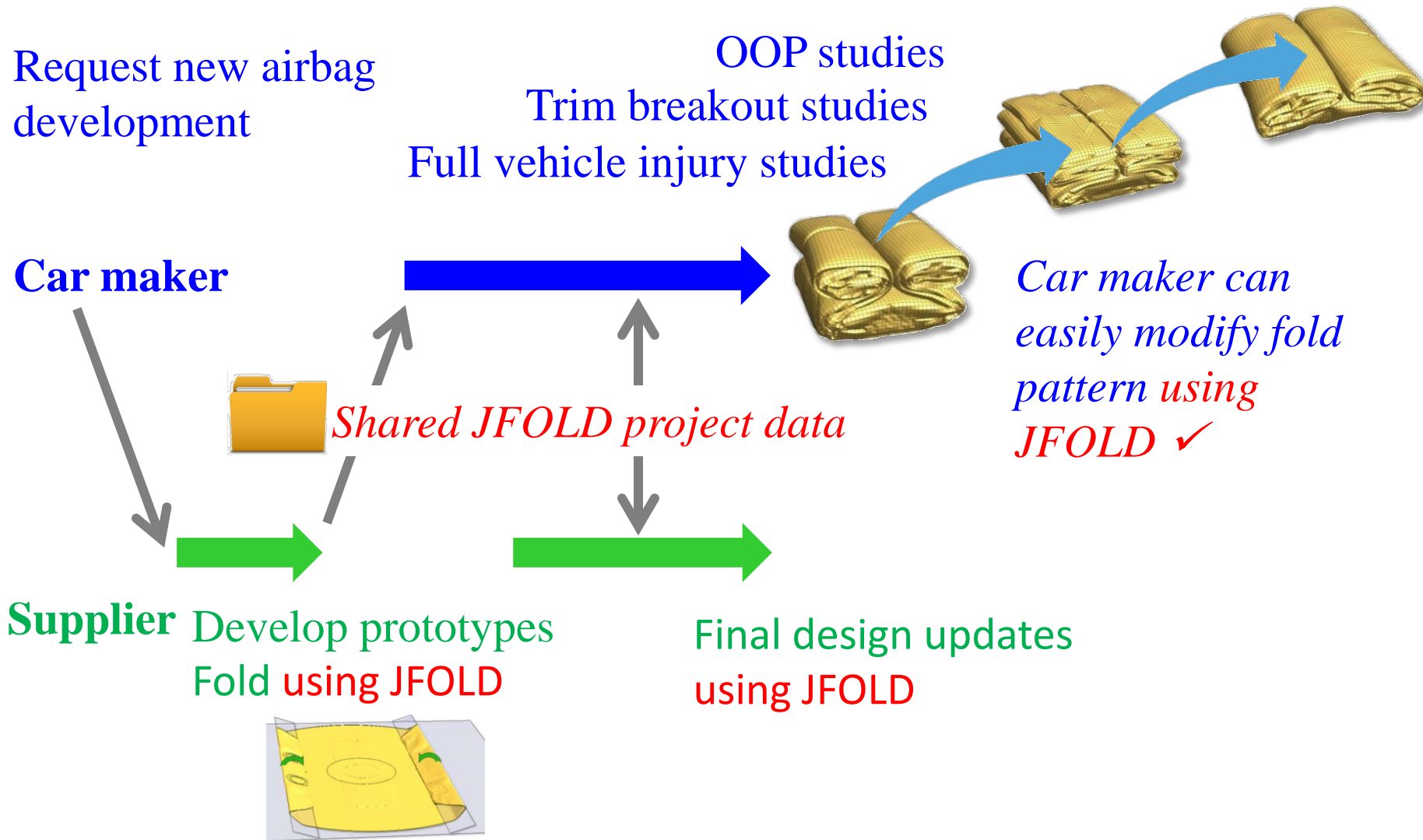
Process Management Panel



Project Sharing Capability



Project Sharing Capability



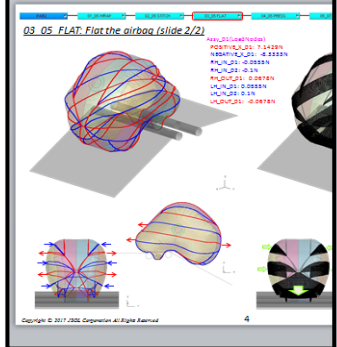
Six Free Example Projects including Two Tutorials



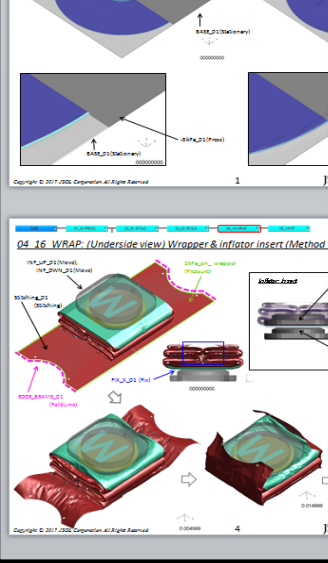
3D Passenger airbag



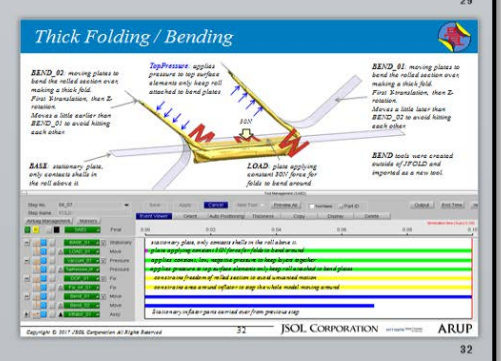
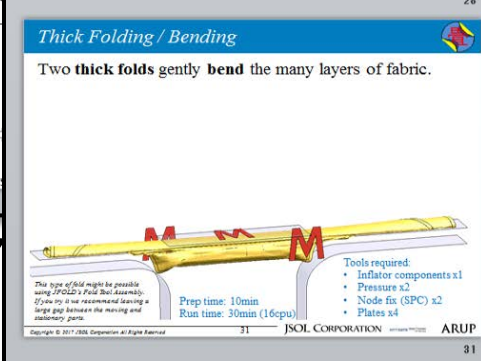
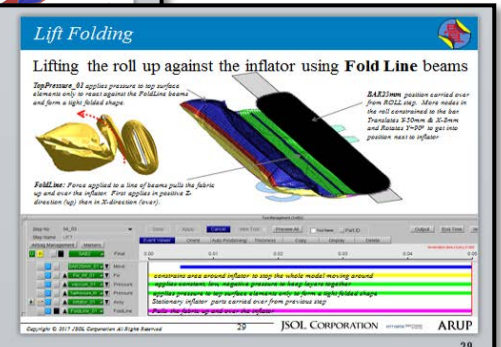
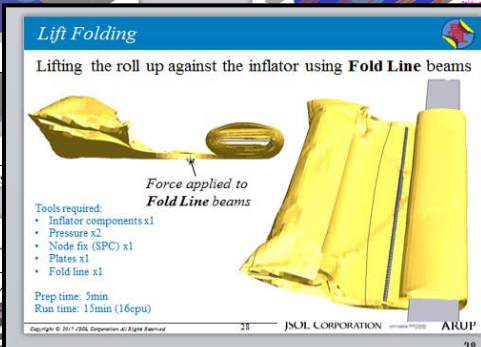
Driver's airbag



Also: curtain airbag



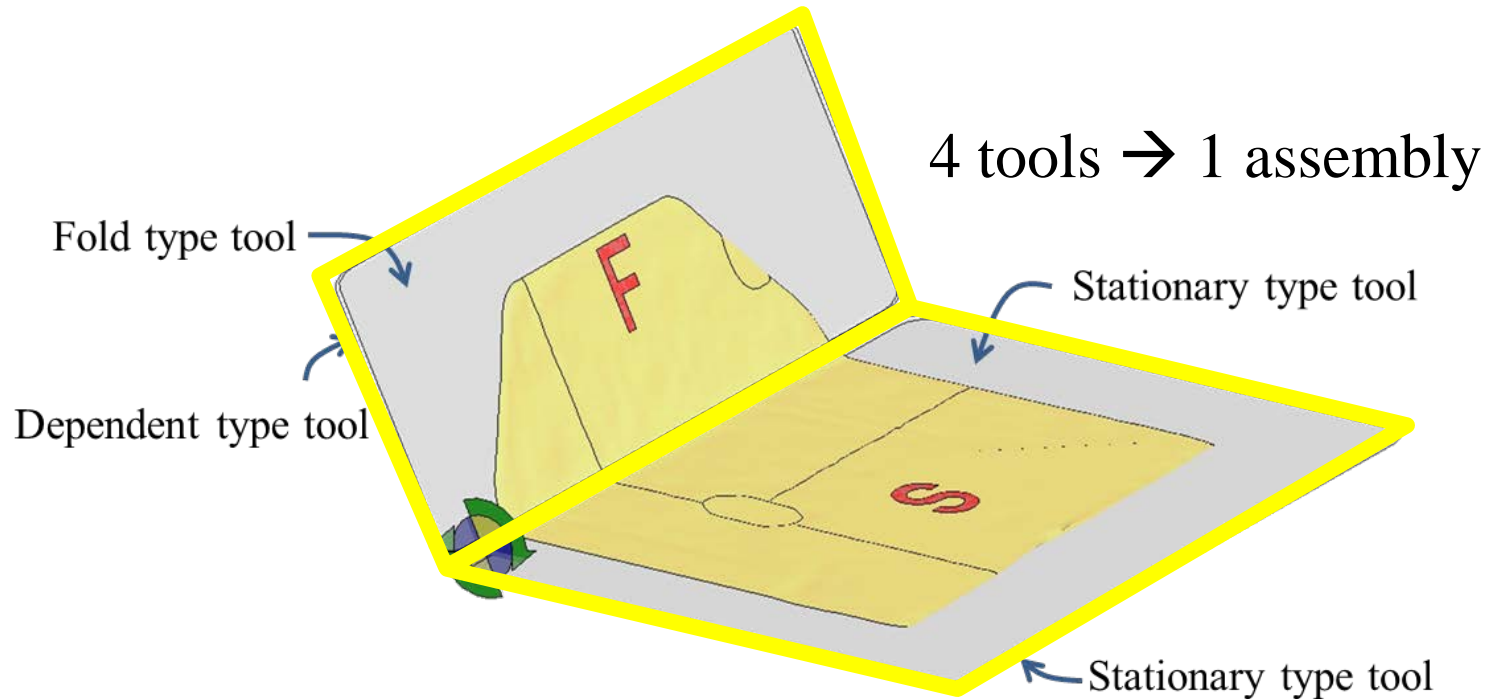
Side airbag



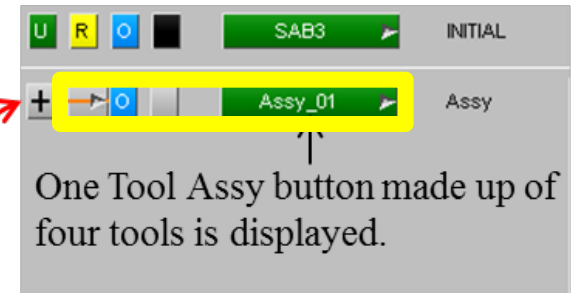
Example of Built-in Tool Assembly



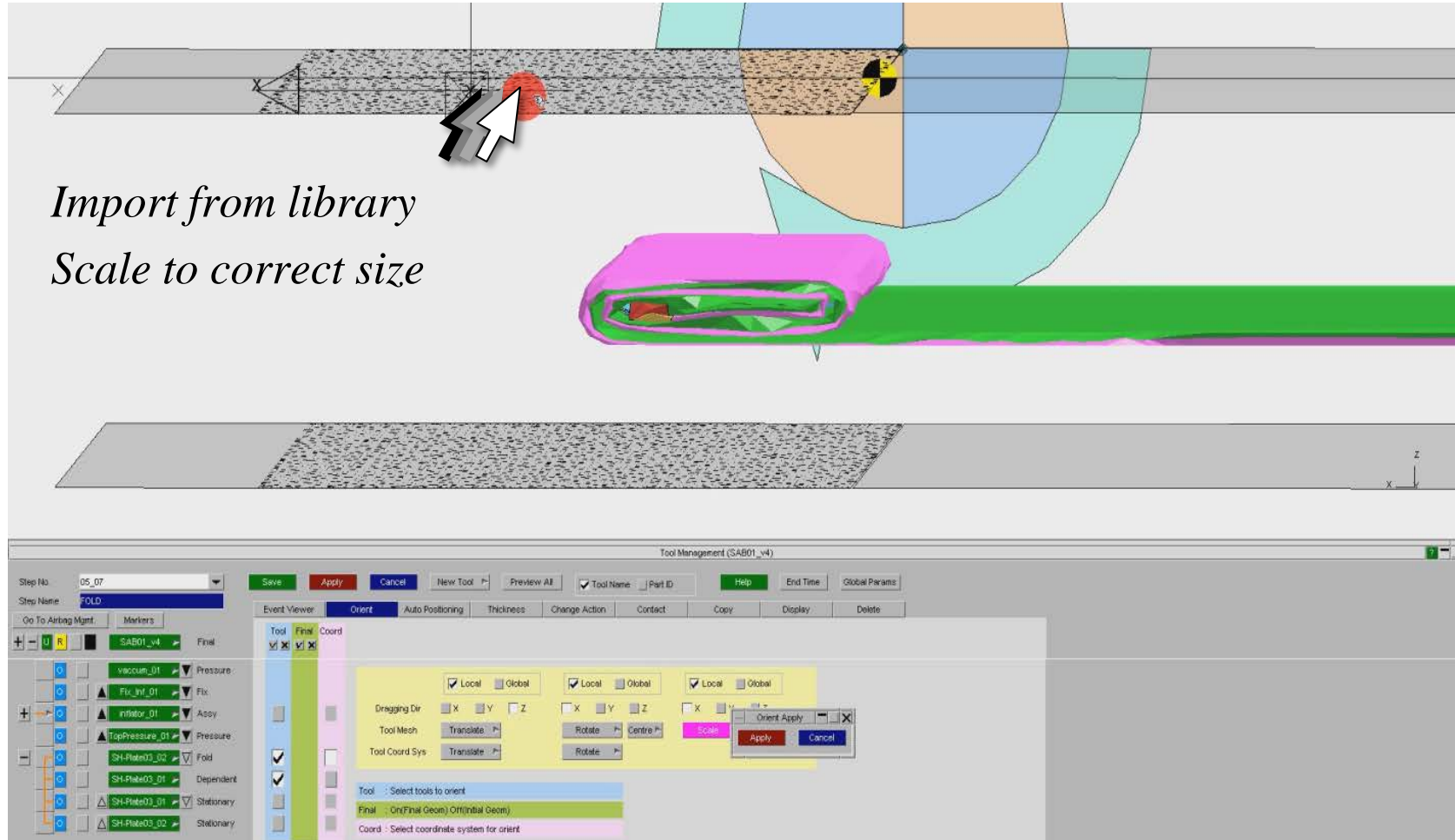
Thin Folds were made using the built-in Fold Tool assembly:



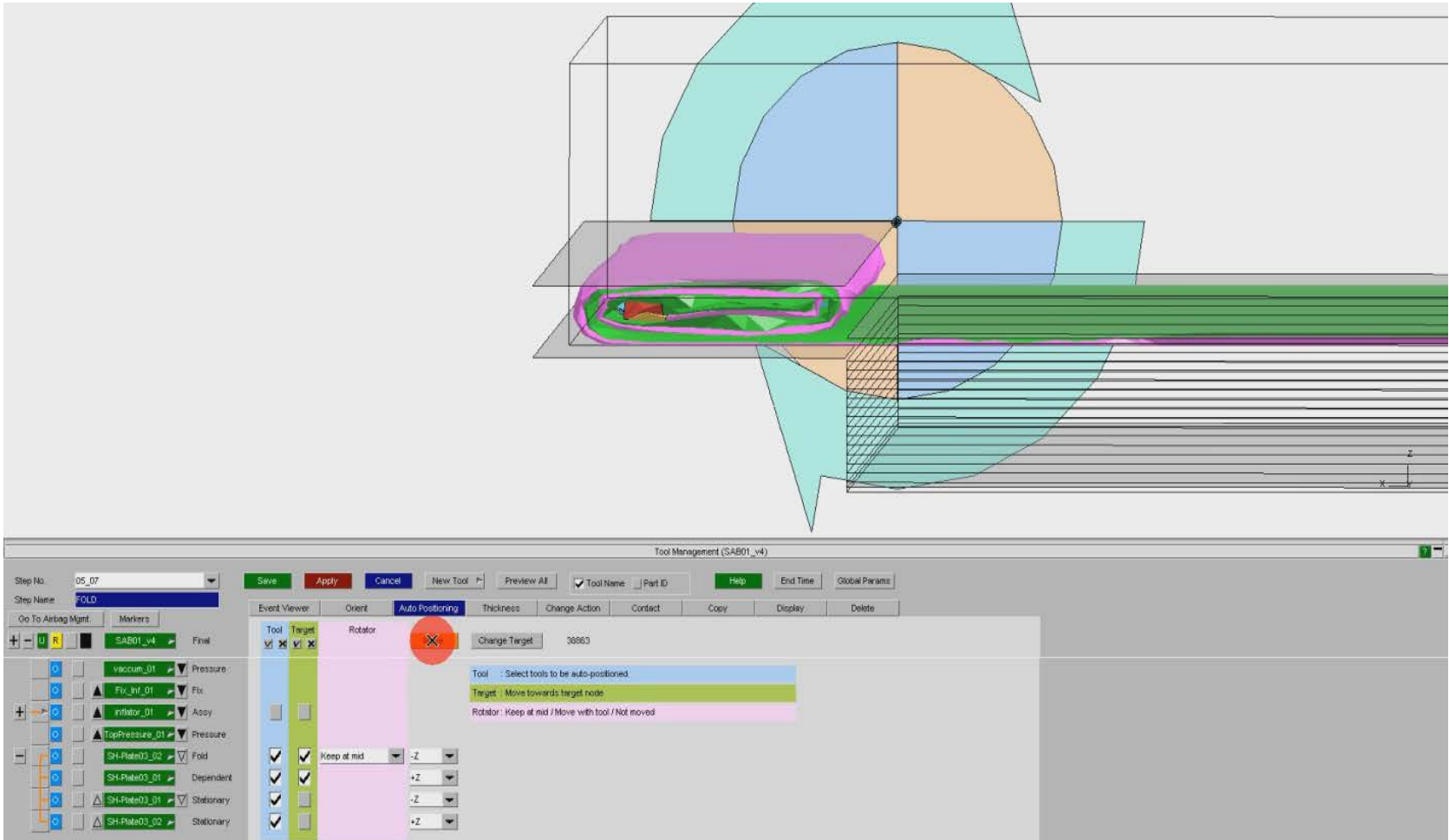
Four tools are assembled as Tool Assy.



Example of how to set up the **Folding Tool**



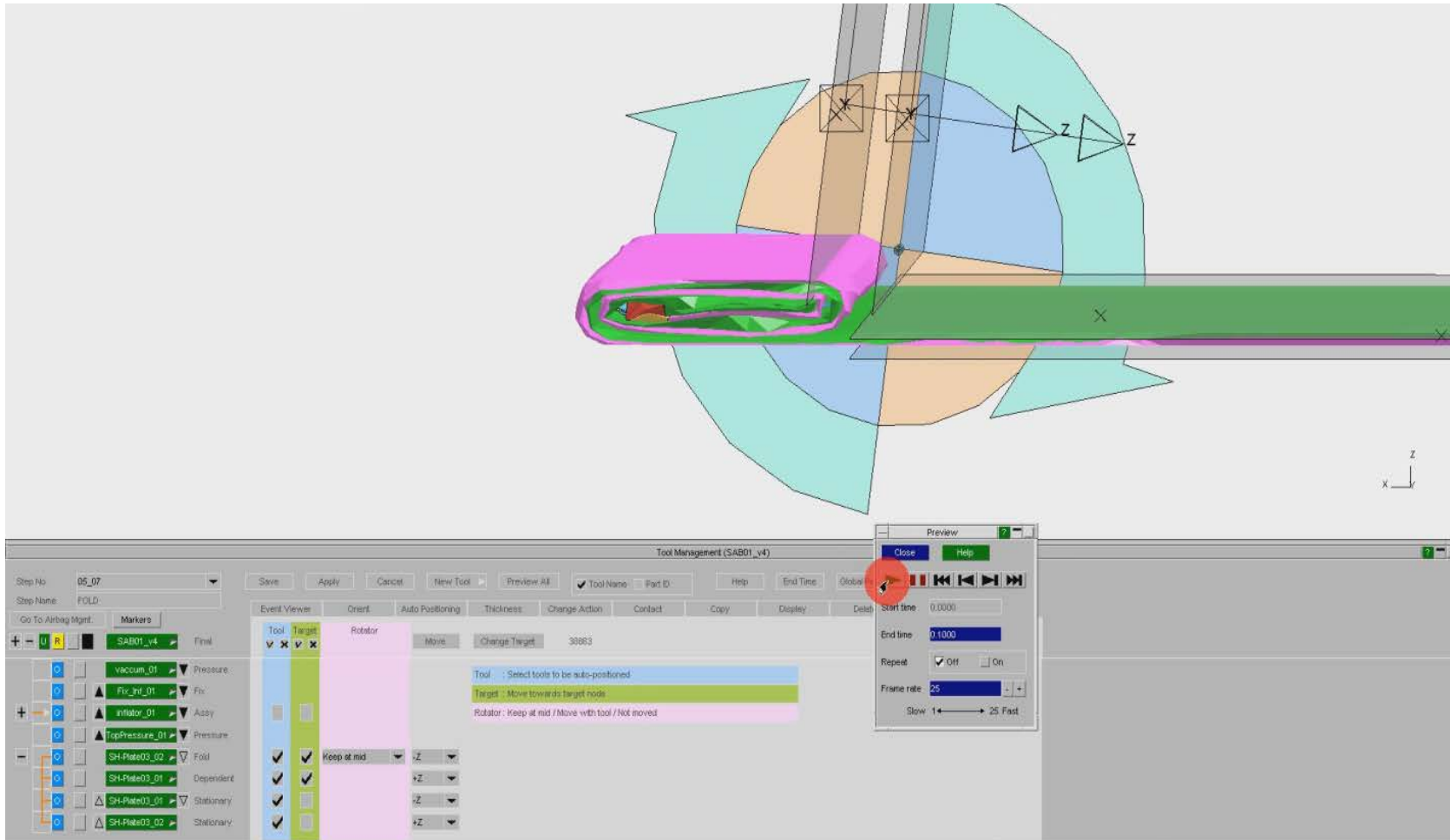
The **Auto-Move** function positions all plates just slightly away from the airbag fabric automatically



Example of Built-in Tool Assembly



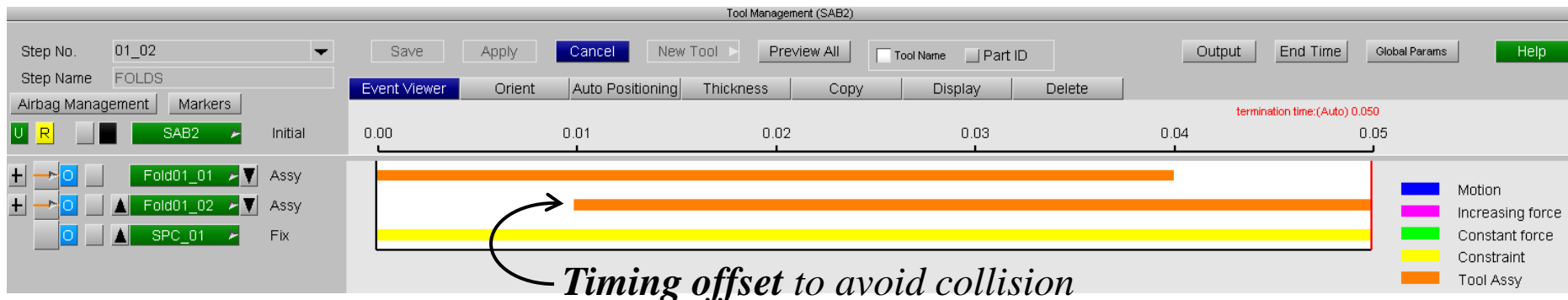
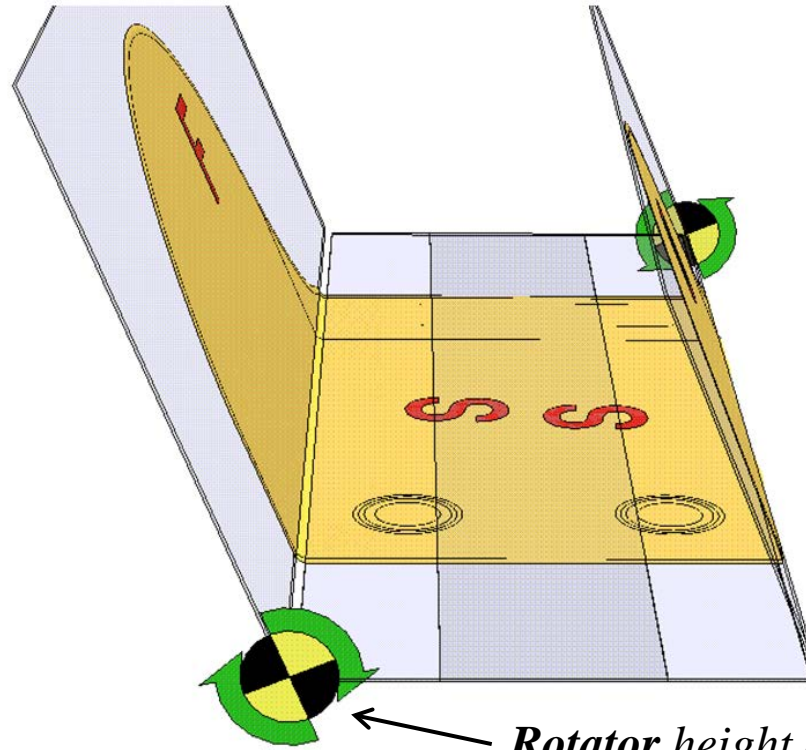
Preview function animates the tool motion



Example of Built-in Tool Assembly

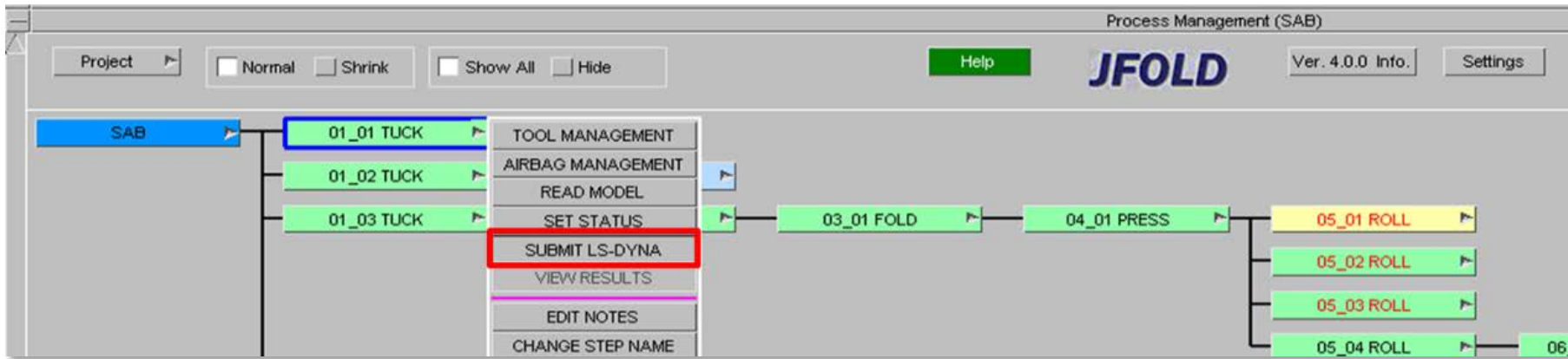


In this example, two **folding assemblies** were used: the left folds over the right.





JFOLD can submit LS-DYNA on local processors
(Remote & batch submission under development)



Colour of buttons
shows run status →

Updates automatically
when finished.

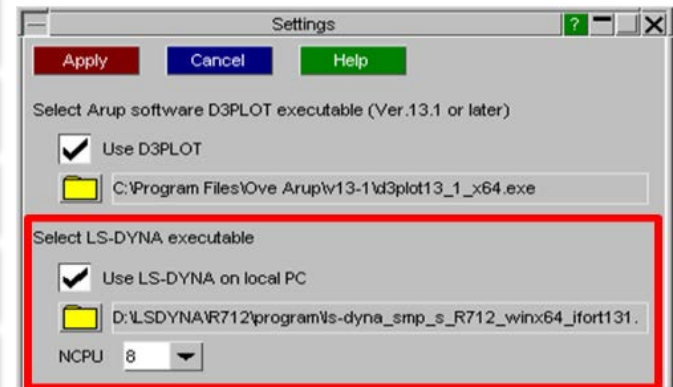
Edit mode

Running (JFOLD submit)

Running (user submit)

Finished : Normal termination

Finished : Error termination





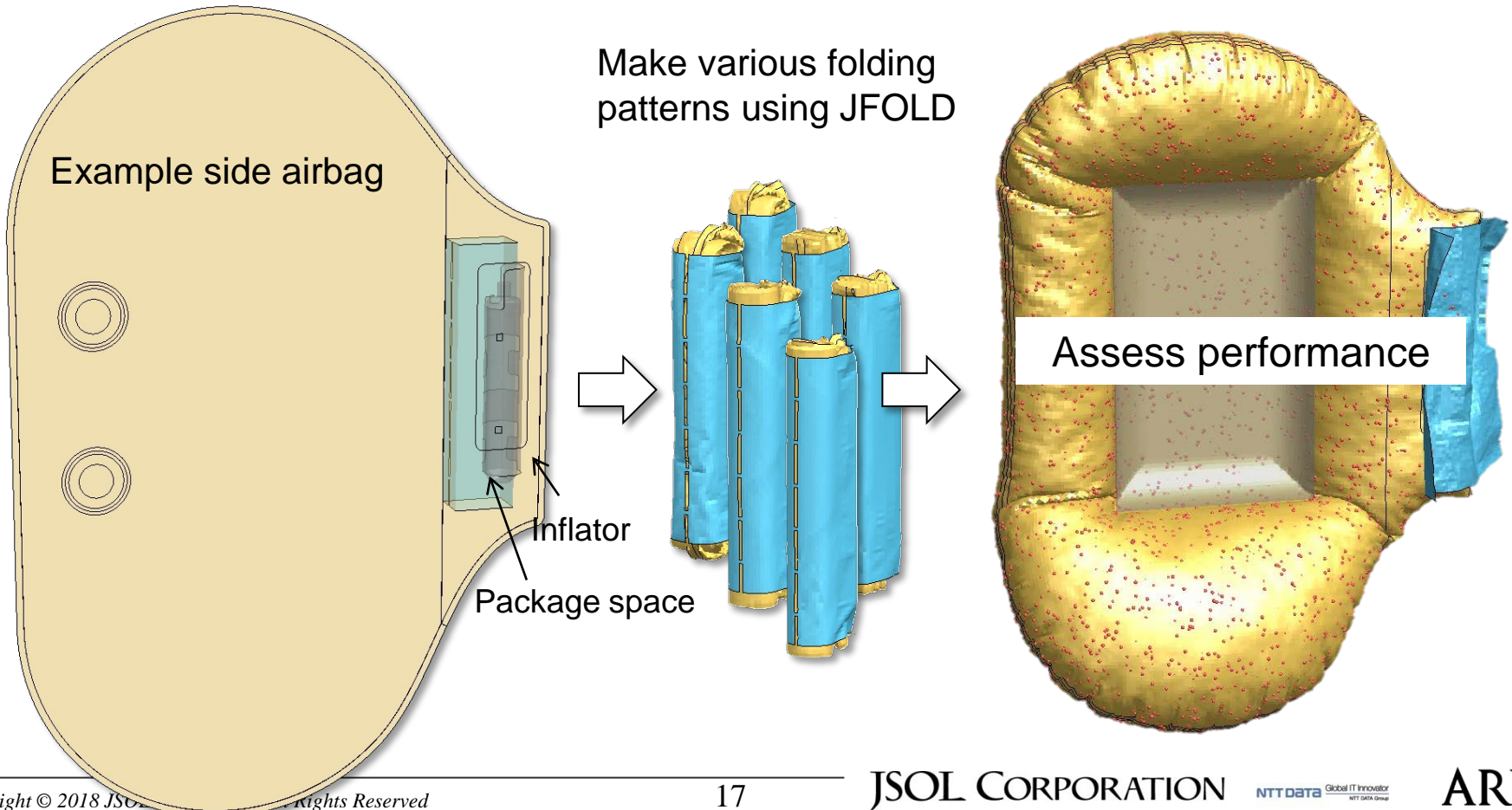
Side Airbag Example

Side Airbag Folding and Deployment Study



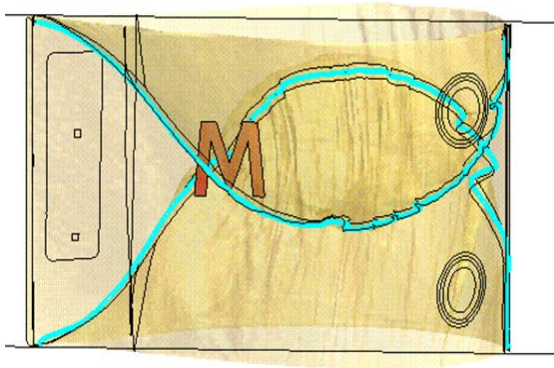
Study Objectives:

1. Demonstrate JFOLD using a simple airbag and common folding techniques
 2. Compare deployment performance of each design using CPM in LS-DYNA
- JFOLD data created in this study will be made freely available to JFOLD customers*

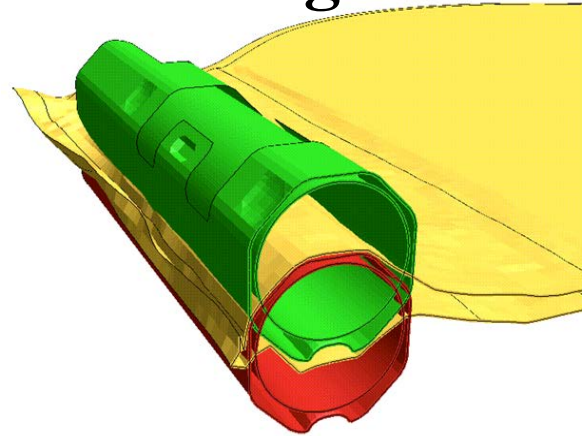




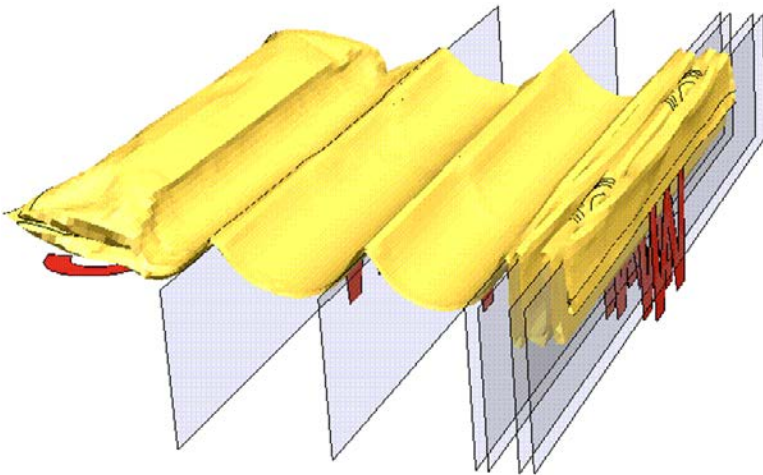
Tuck Folding



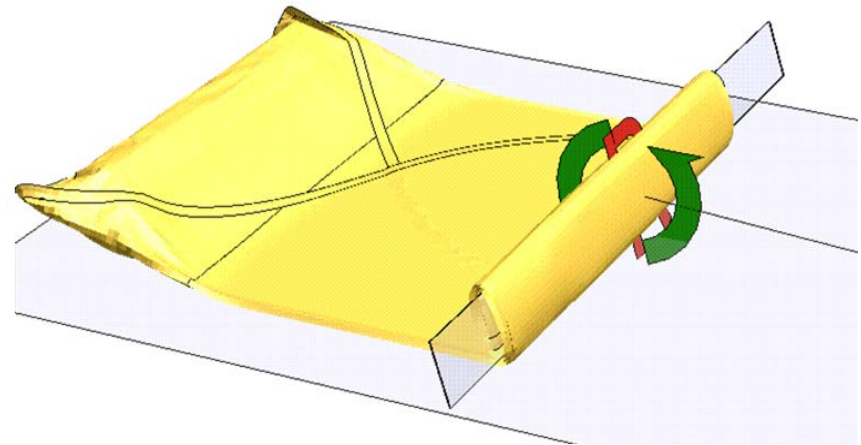
Inflator fitting



Zig-Zag Folding



Roll Folding

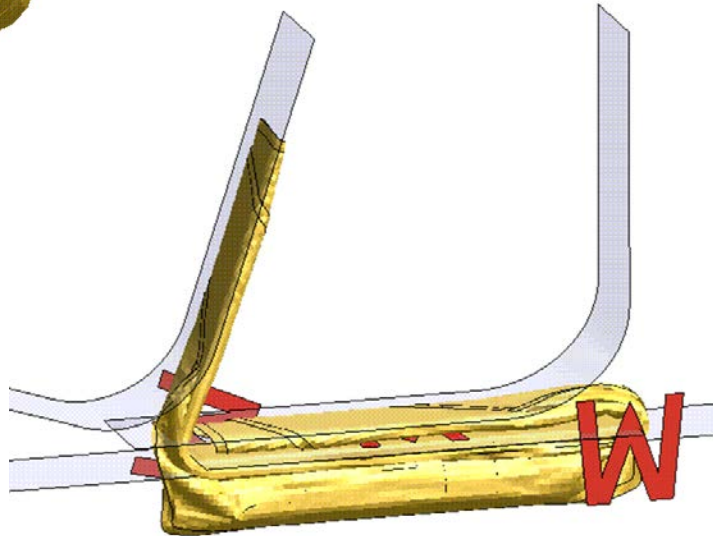




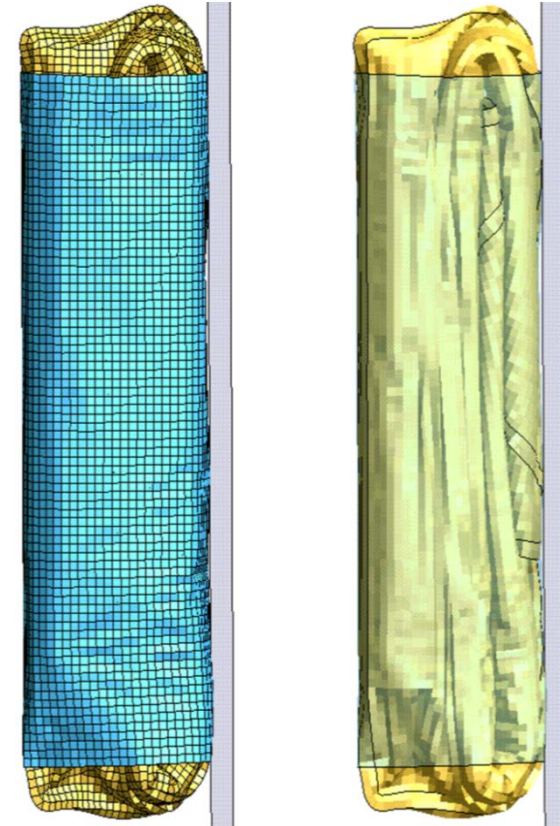
Lift Folding



Thick Folding



Wrapper Fitting



Copying Tools to A New Step



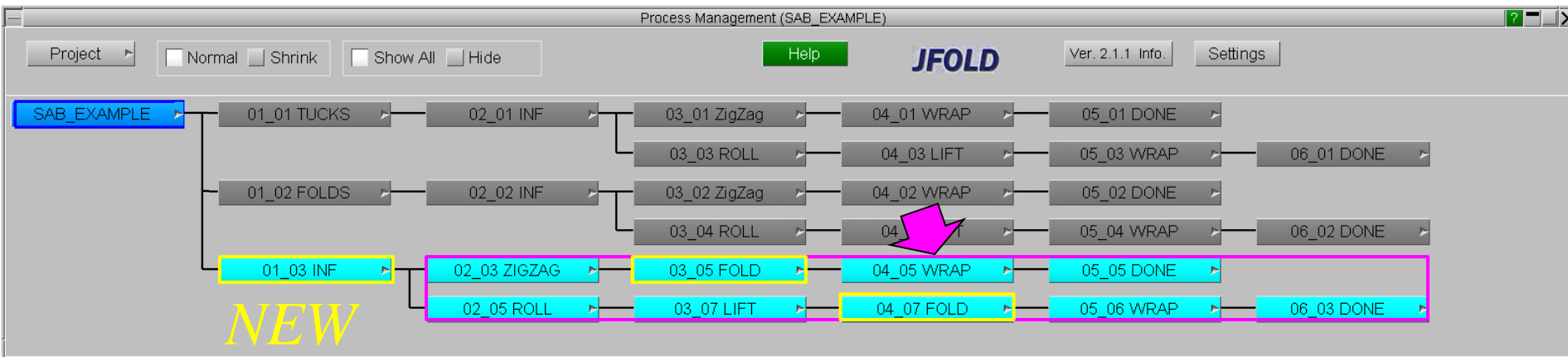
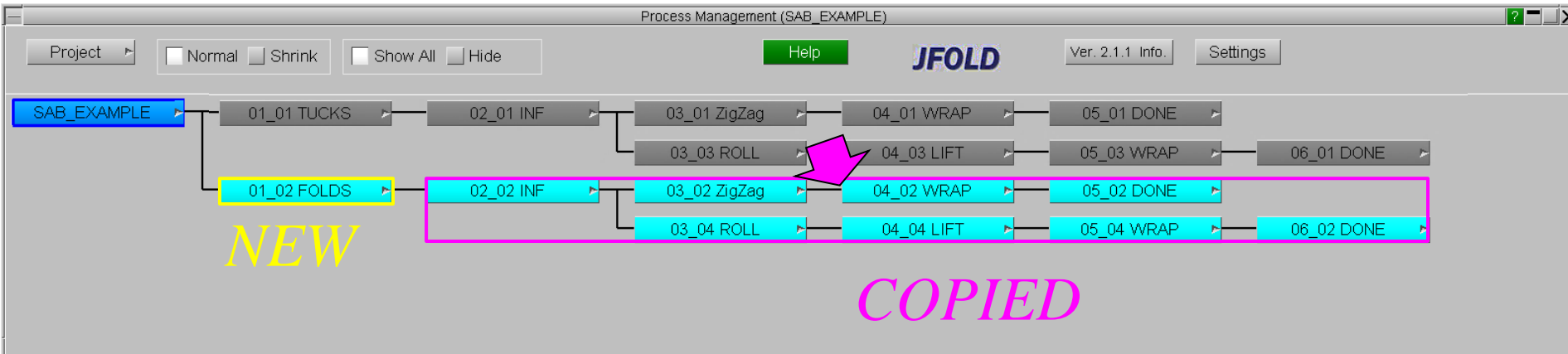
Copying tools saves preparation time!



Copying Tools to A New Step



Copying tools saves preparation time!

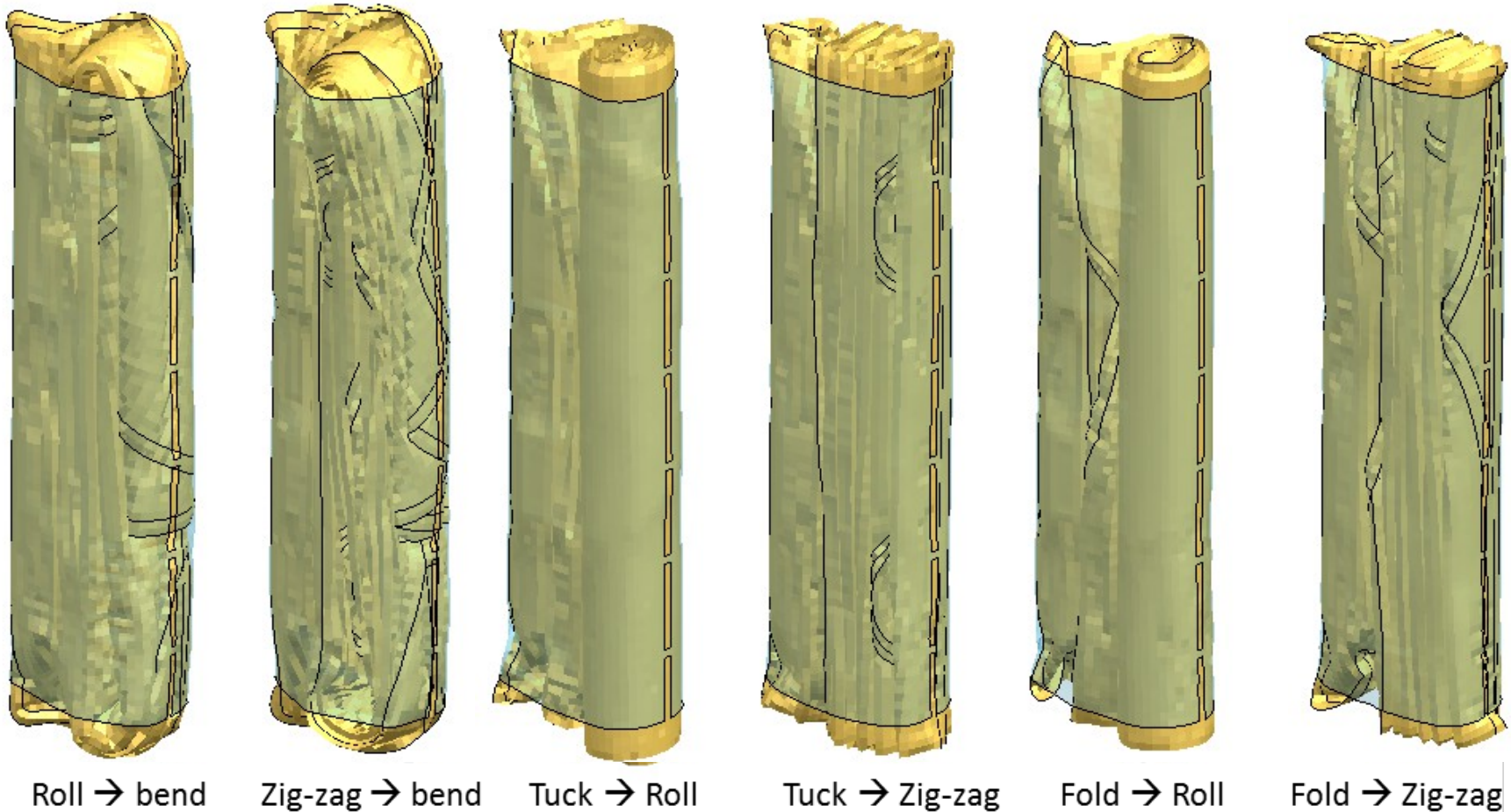


Mostly COPIED

Final Mods for CPM Deployment Analysis



Wrapper elements deleted to create a perforated **tear line**.



Roll → bend

Zig-zag → bend

Tuck → Roll

Tuck → Zig-zag

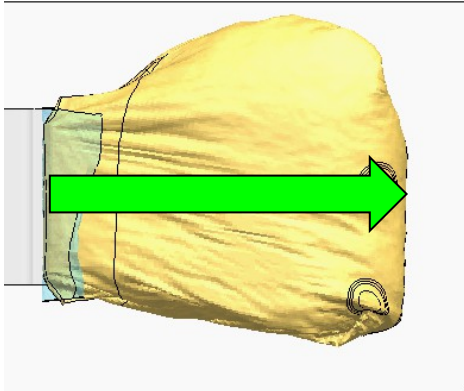
Fold → Roll

Fold → Zig-zag

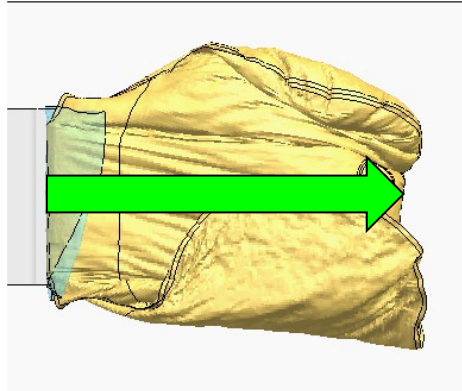
Impactor Deployment Results



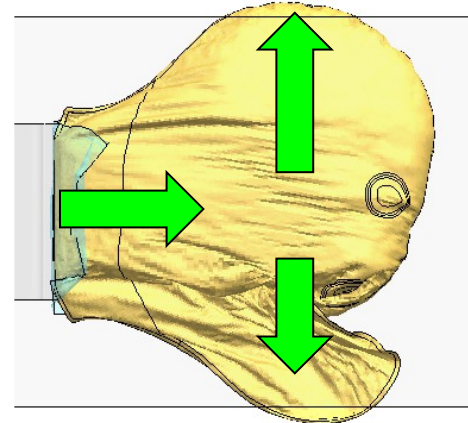
Tuck → Zig-zag



Fold → Zig-zag



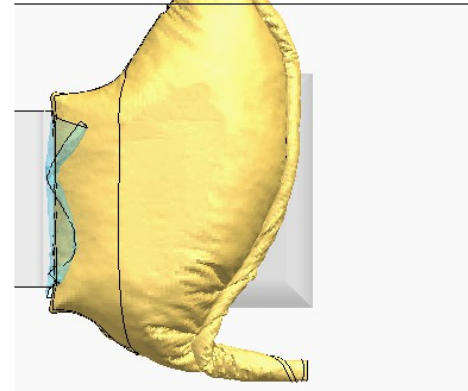
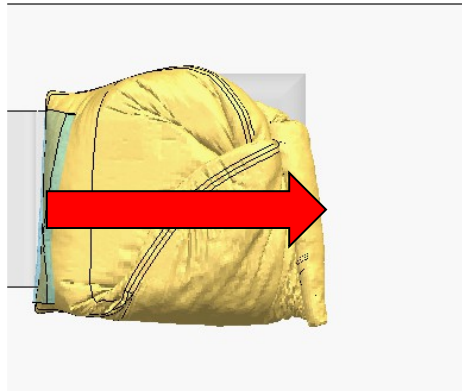
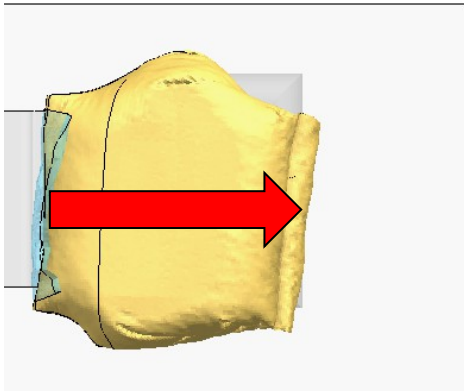
Zig-zag → bend



ZIGZAG = FASTER

ZIGZAG + BEND = FASTEST

ROLL = SLOWER



Tuck → Roll

Fold → Roll

Roll → bend



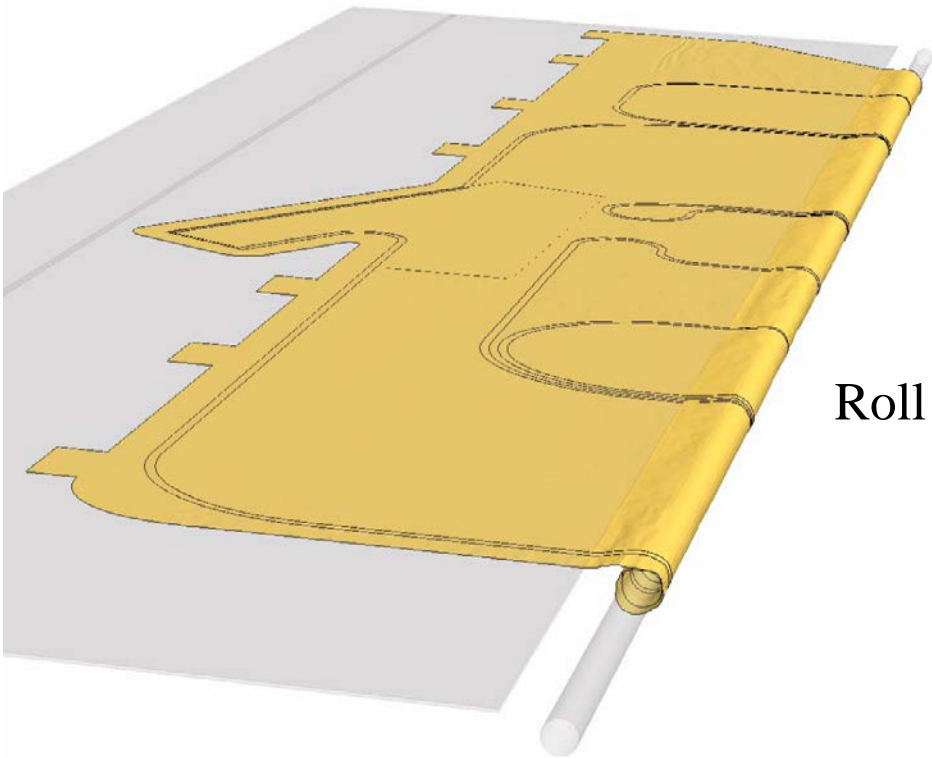
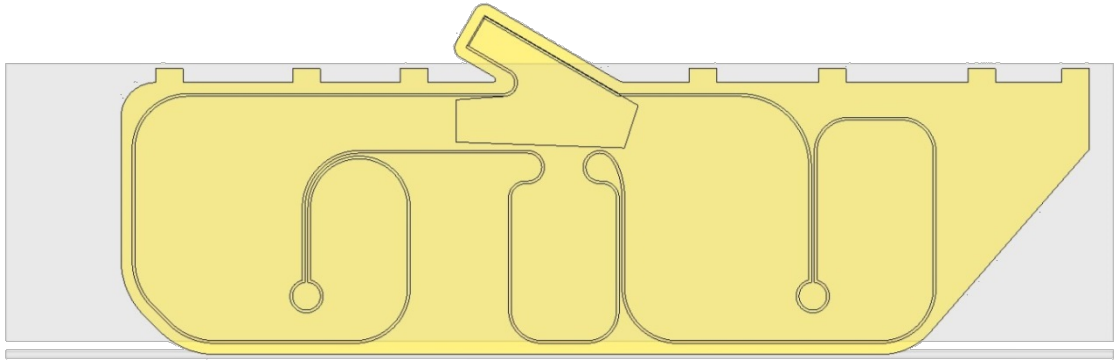
Curtain Airbag Example

Curtain Airbag Example

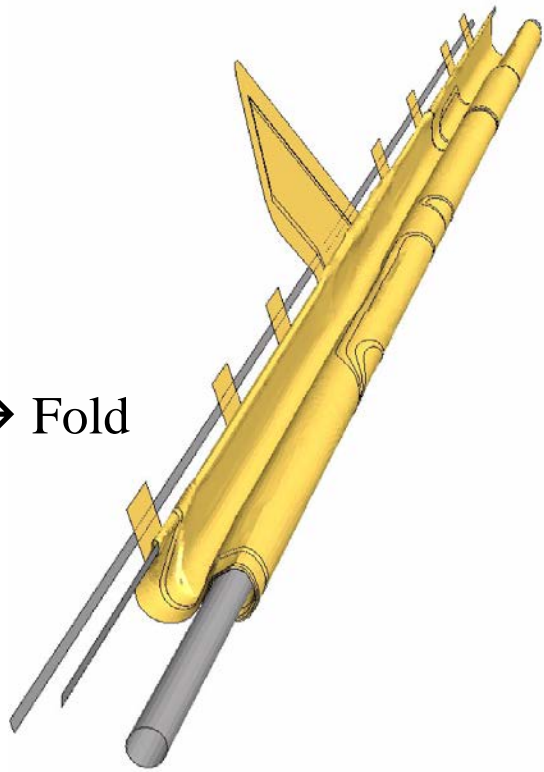


*Typical design,
demonstration model*

*Free examples show **easiest & quickest** ways to make different fold types.*



Roll → Fold



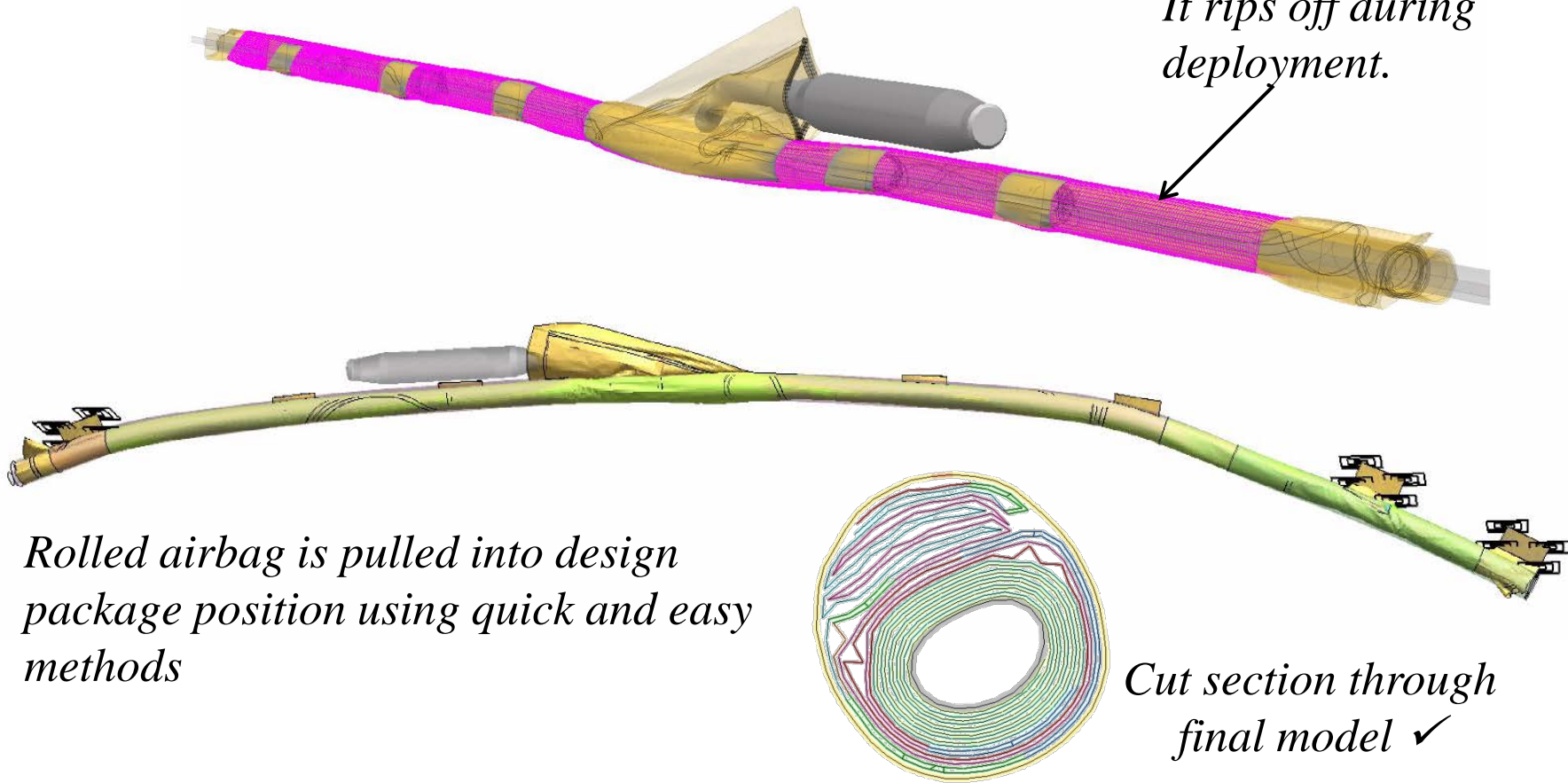
Curtain Airbag Example



*Free examples show **easiest & quickest** ways to make different fold types.*

Inflator fitted into pocket.

*Fit **cover** - keeps the airbag together. It rips off during deployment.*

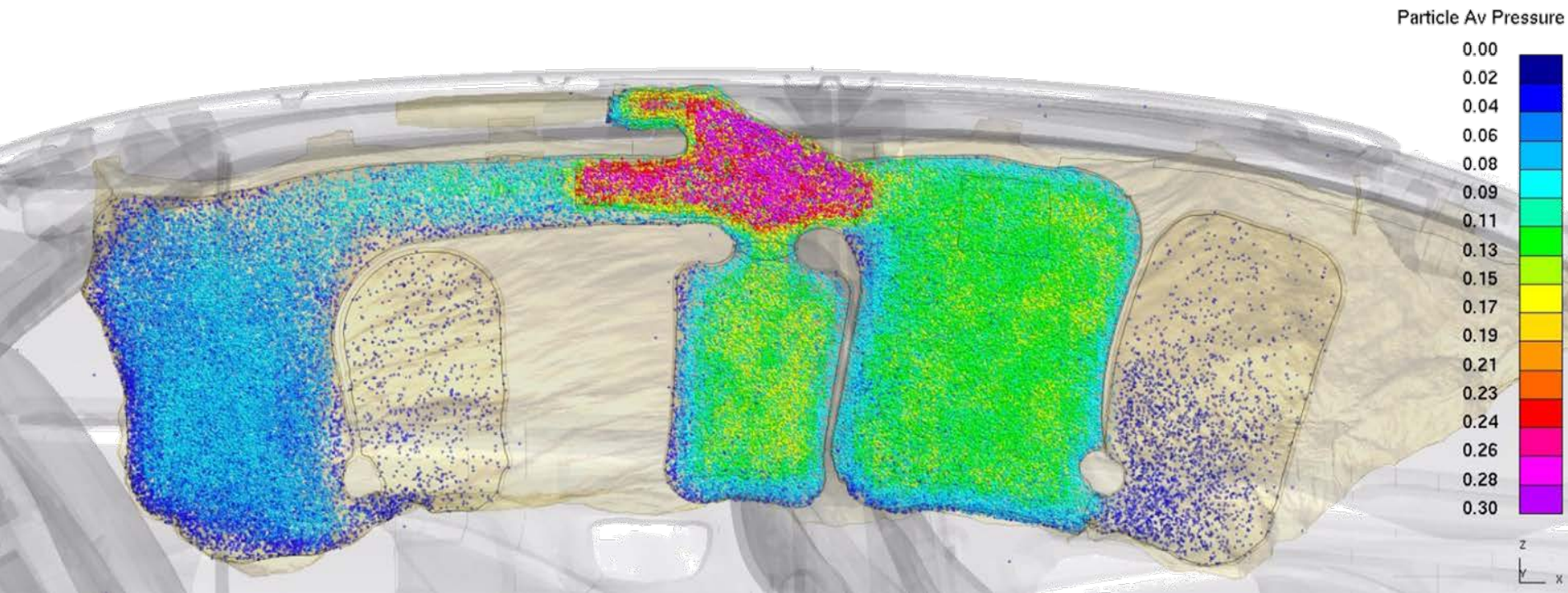


Rolled airbag is pulled into design package position using quick and easy methods

Cut section through final model ✓



*Particle mapping can roughly visualise **pressure field** ✓*



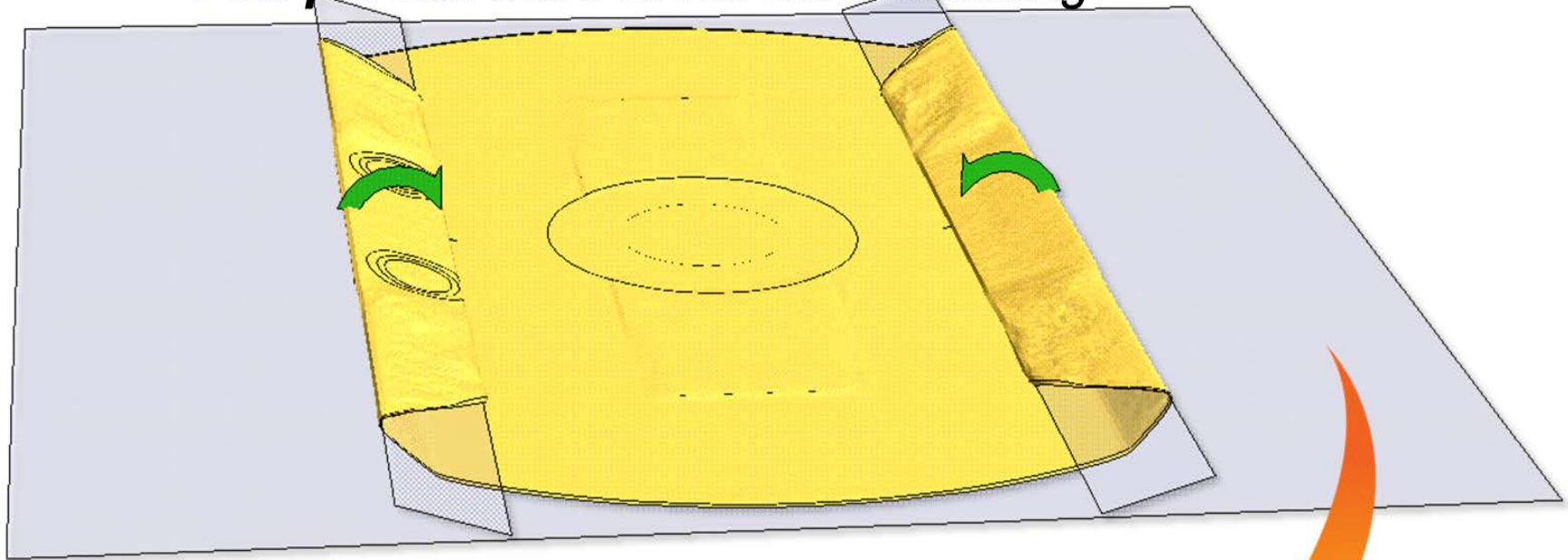


Driver's Airbag Example

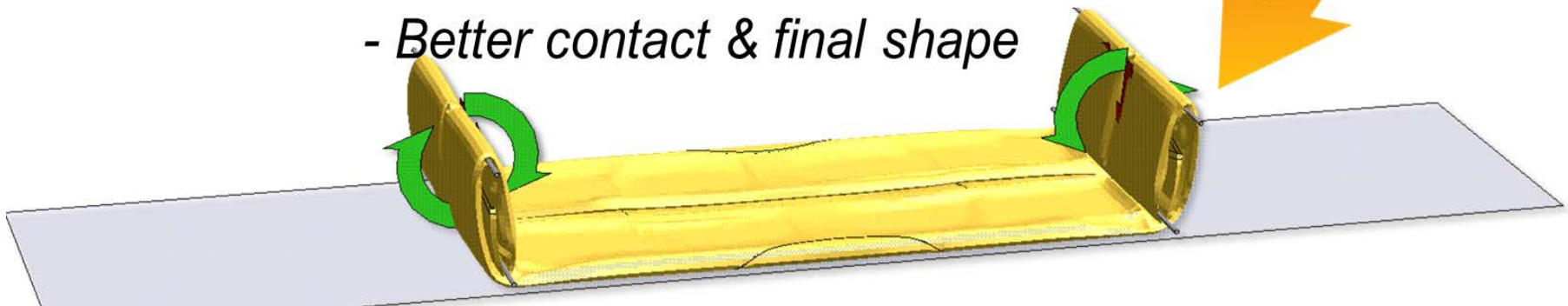
Roll Folding using JFOLD



Flat panels used to roll the flat airbag



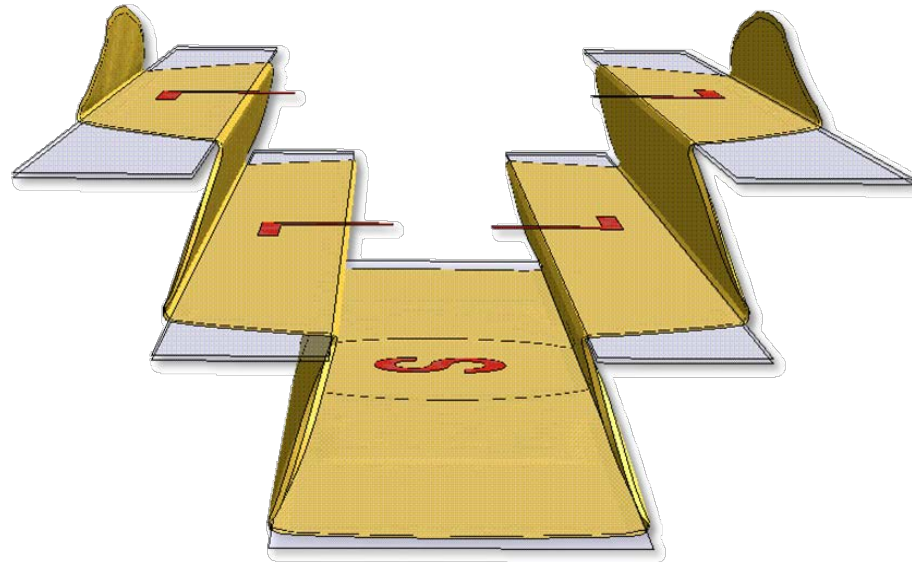
Rods used to roll thicker sections
- Better contact & final shape



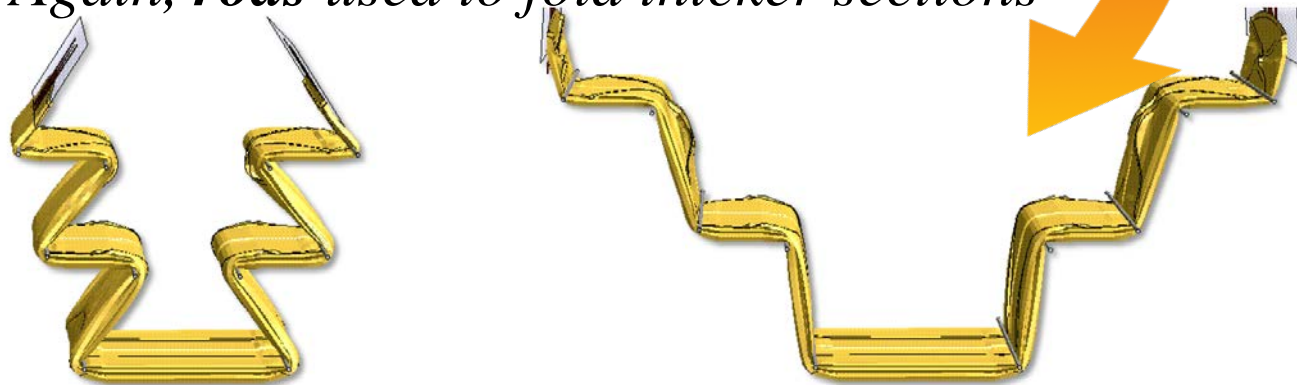
Zig-Zag Folding using JFOLD



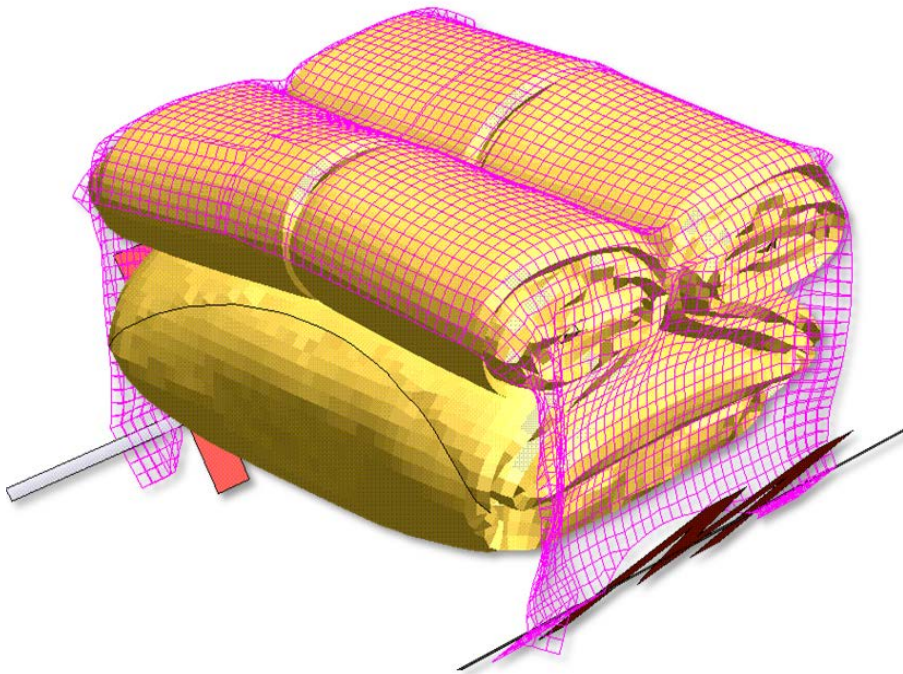
JFOLD's Z-Fold Tool assy. used to create accordion pattern



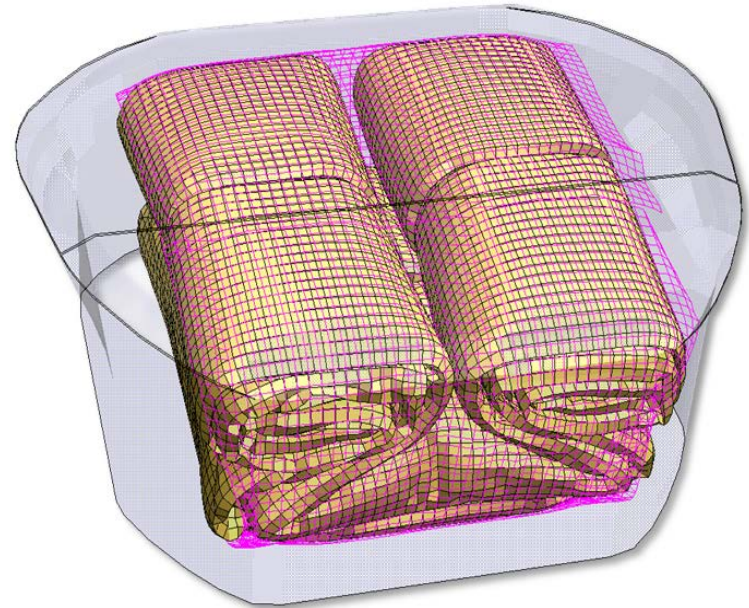
*Again, **rods** used to fold thicker sections*



Wrapper Fitting



Case Fitting



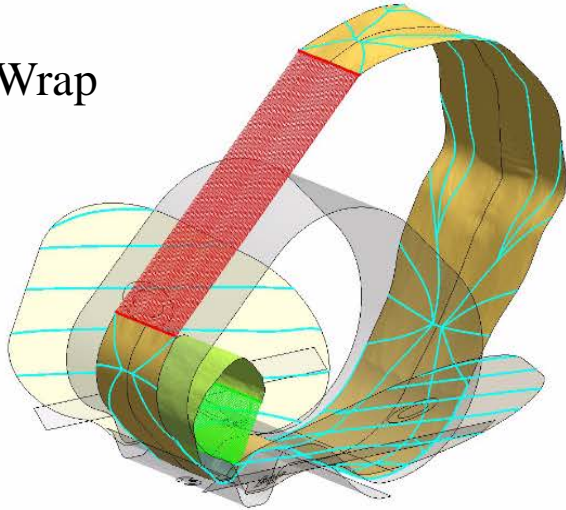


Passenger Airbag Example

Passenger Airbag Example

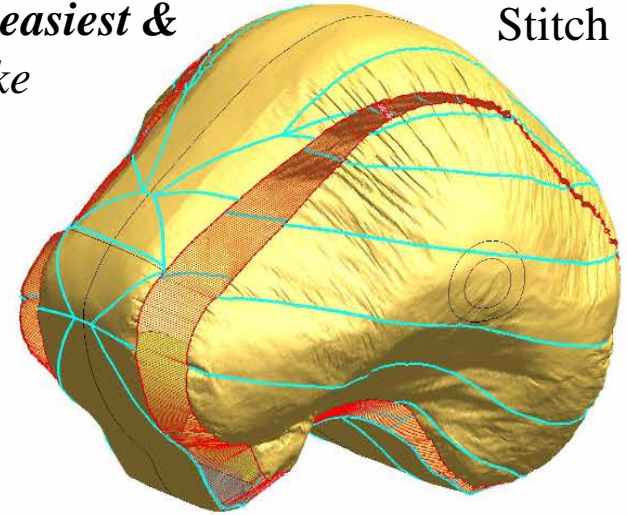


Wrap

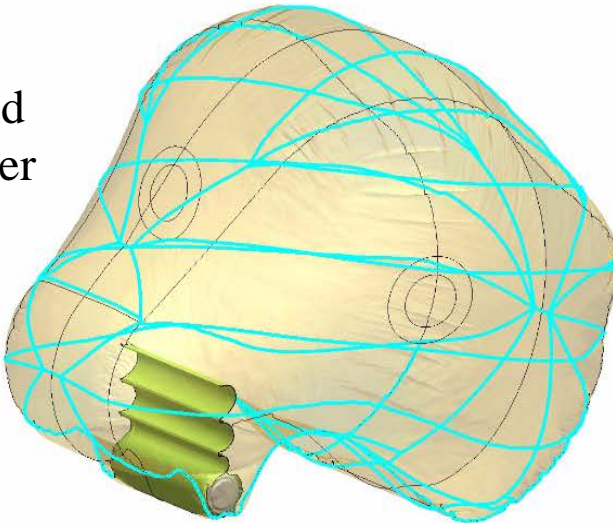


*Free examples show **easiest & quickest** ways to make different fold types.*

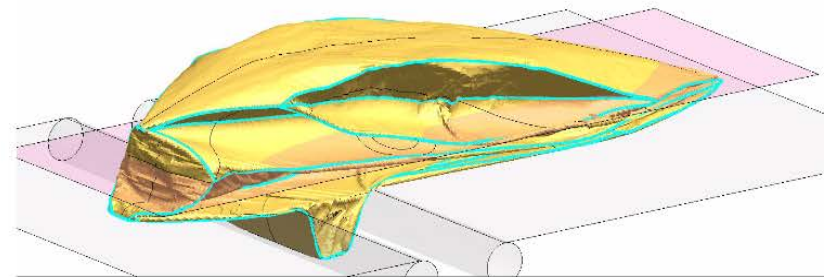
Stitch



Fold
inner



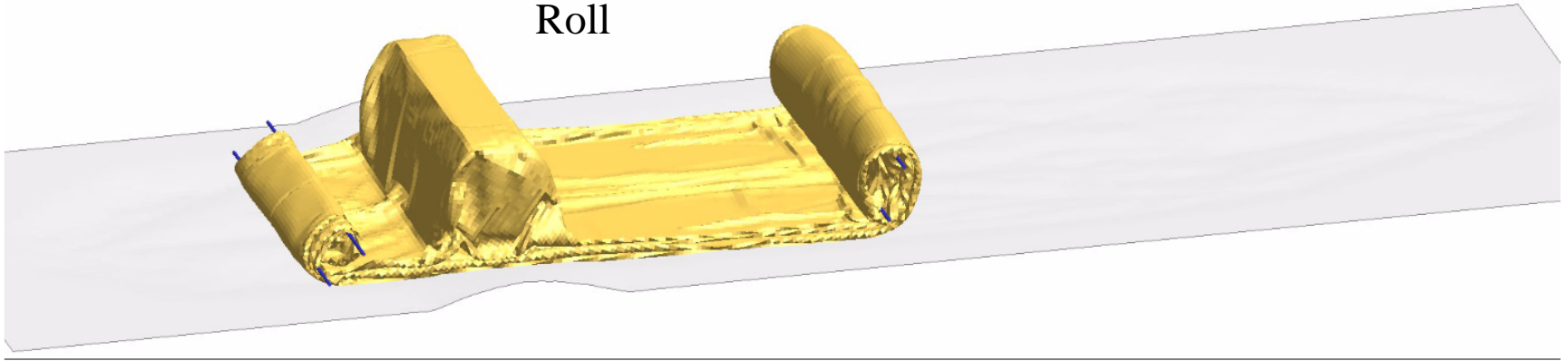
Collapse



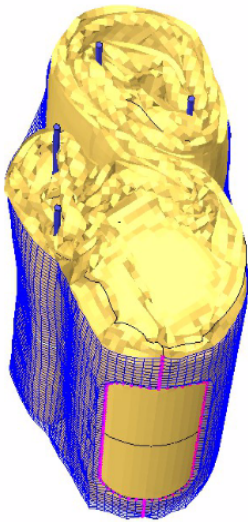
Passenger Airbag Example



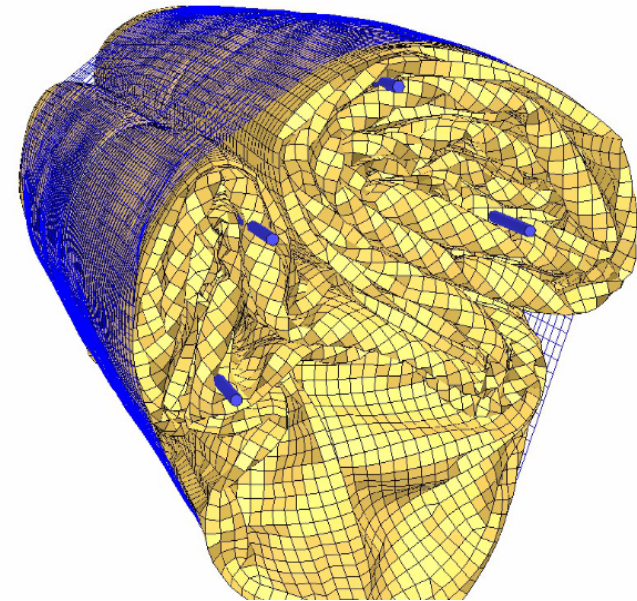
Roll

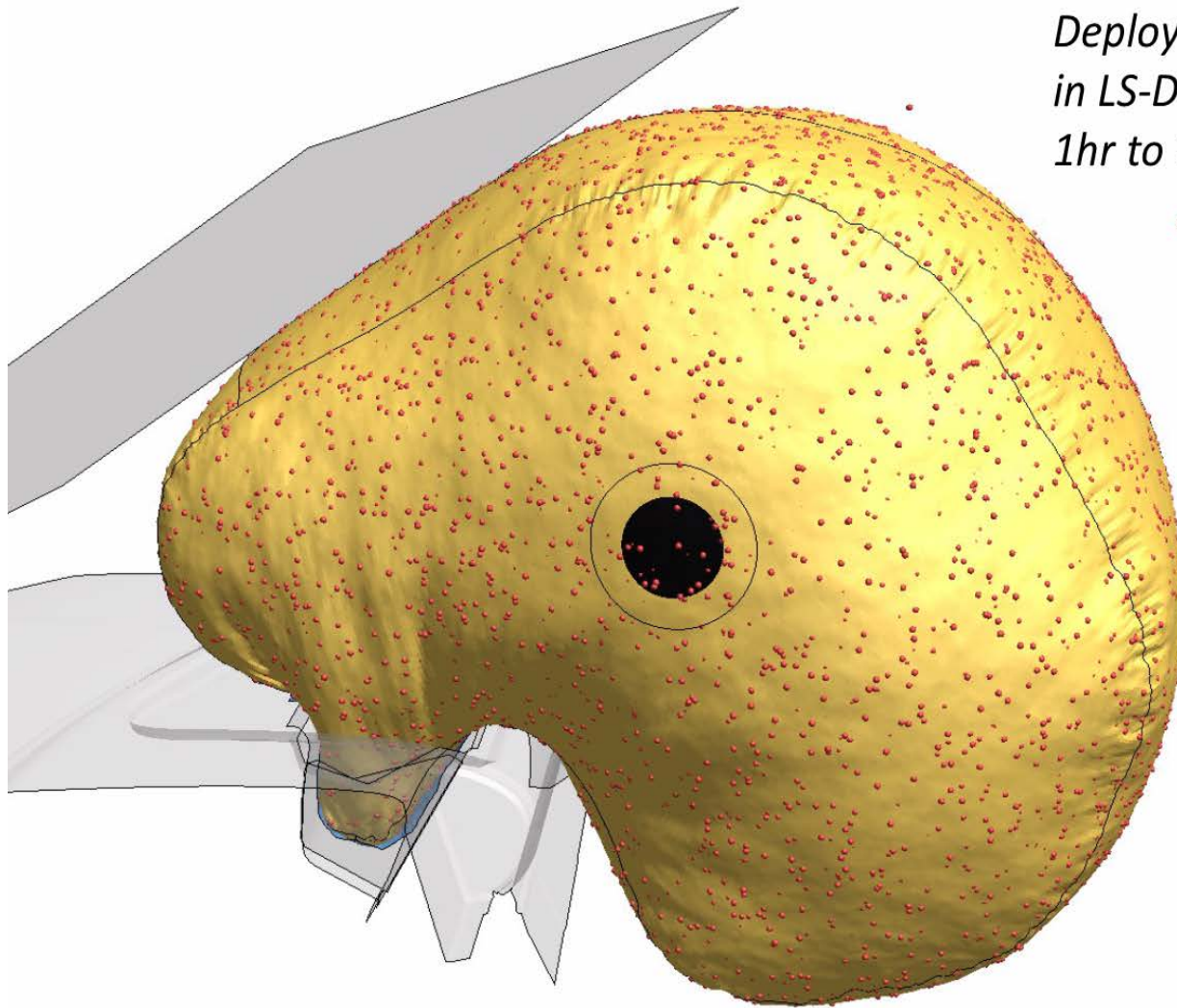


Wrap



Relax





*Deployed using *AIRBAG PARTICLE
in LS-DYNA (400,000 particles)
1hr to 75ms (64cpu)*



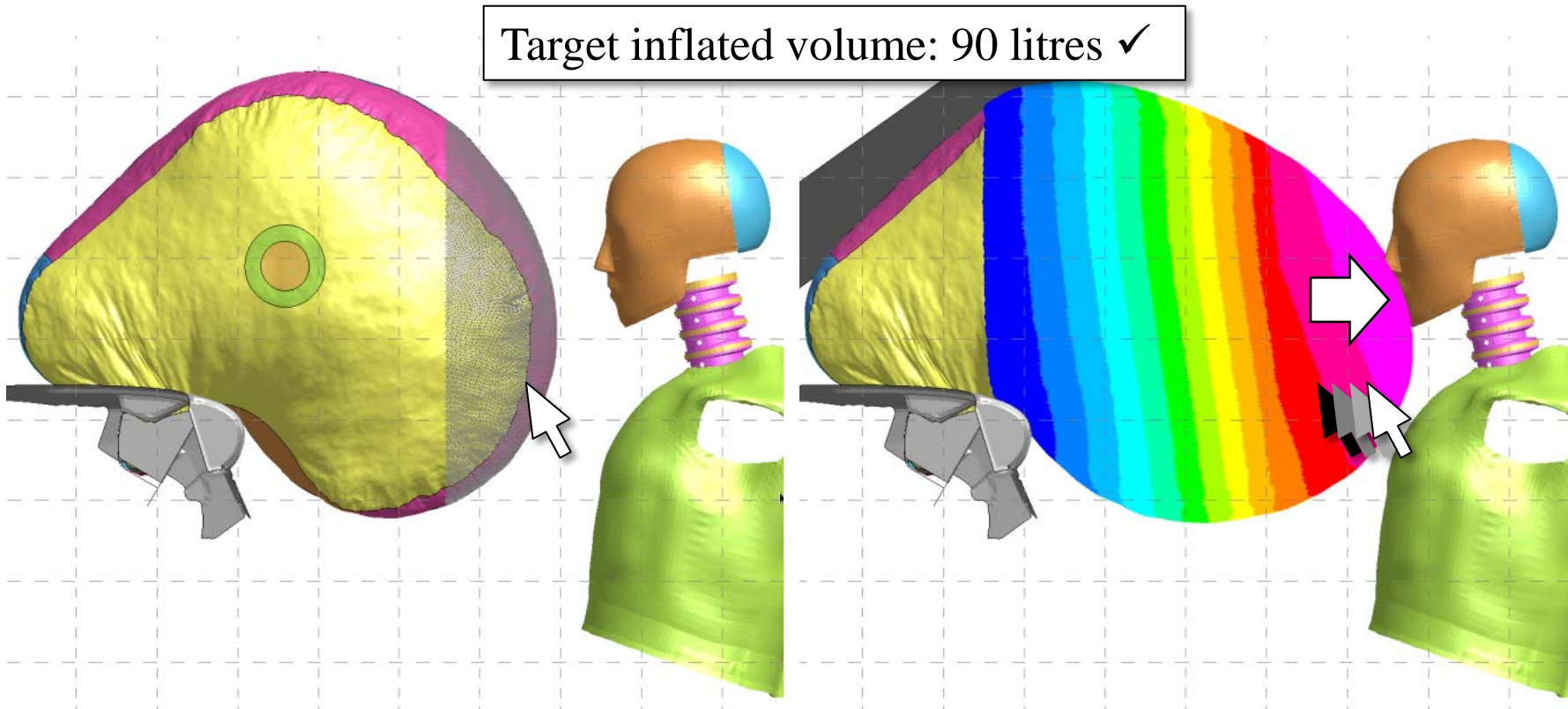


New Morphing Function

Shape Morphing – 3 step process:



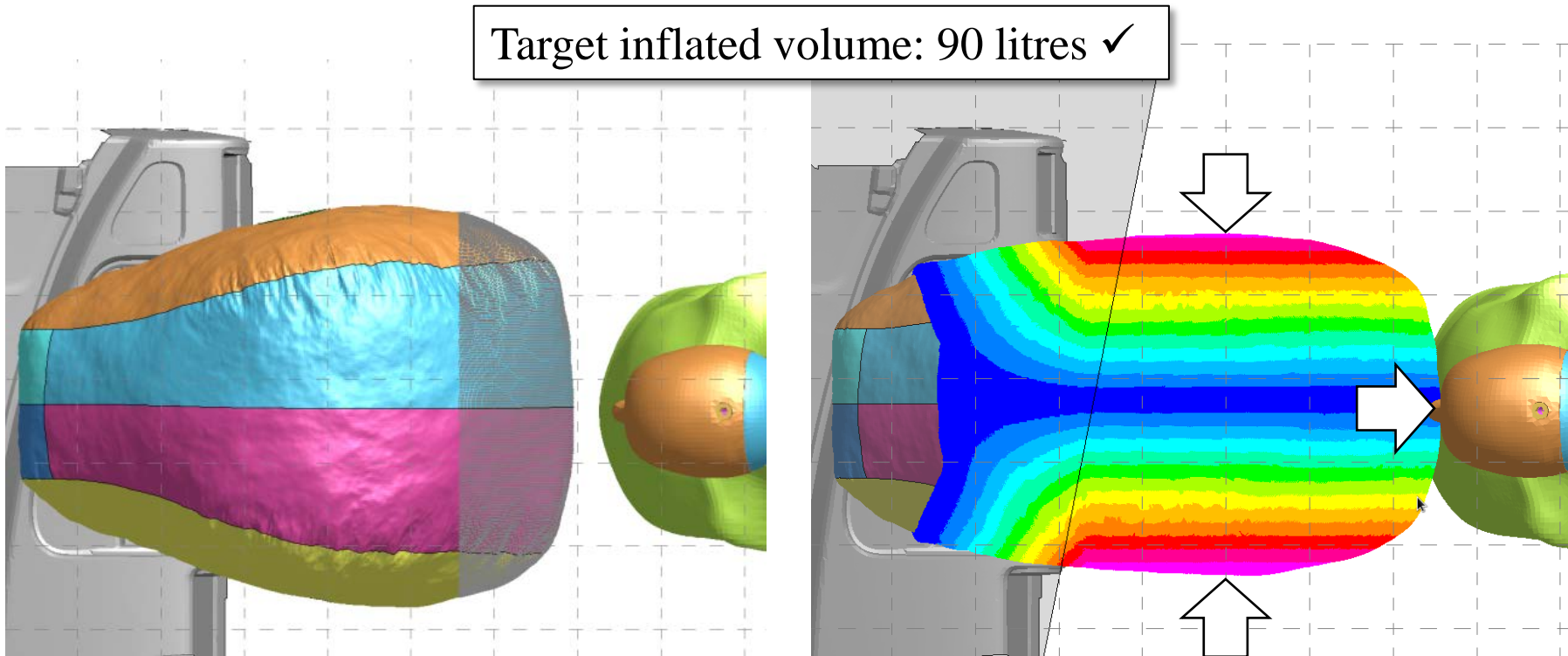
1. Morph the inflated bag to roughly desired shape
 - Interactive morphing to change size and shape
 - JFOLD reports volume, distance to occupant etc.



Shape Morphing – 3 step process:



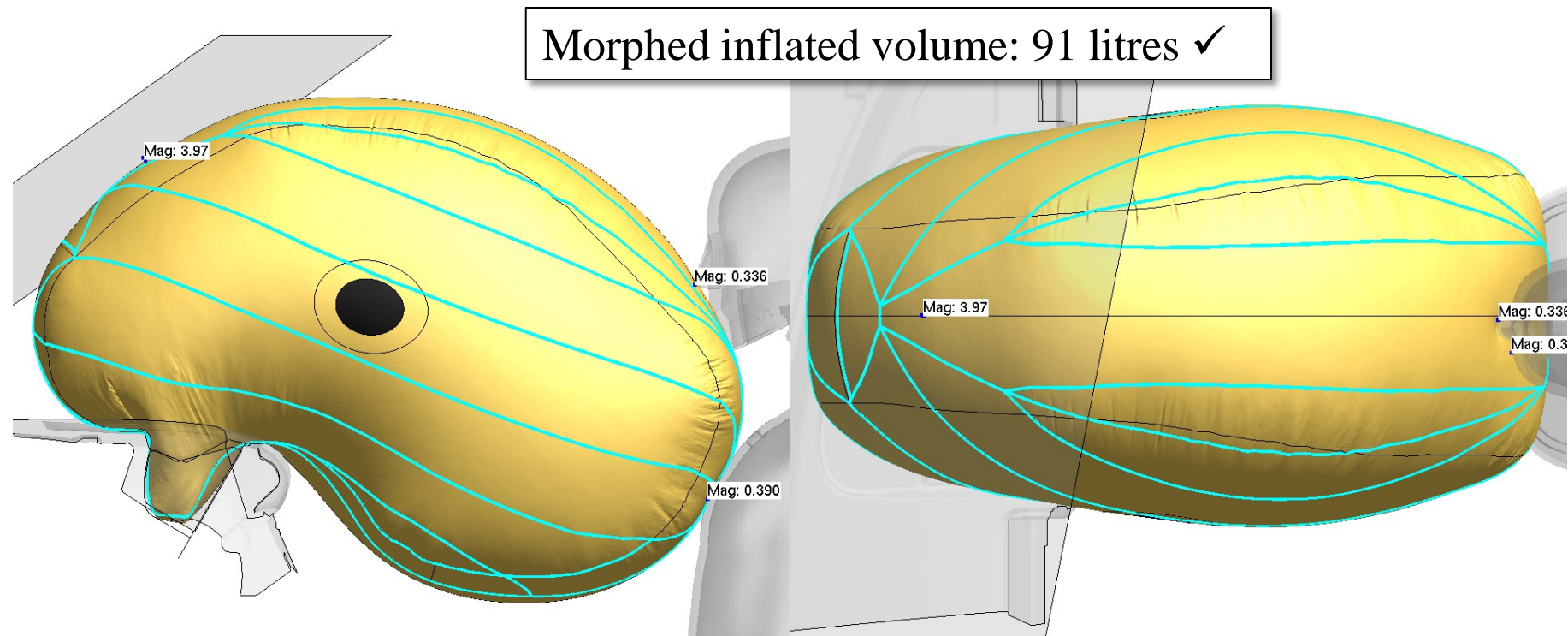
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Shape Morphing – 3 step process:



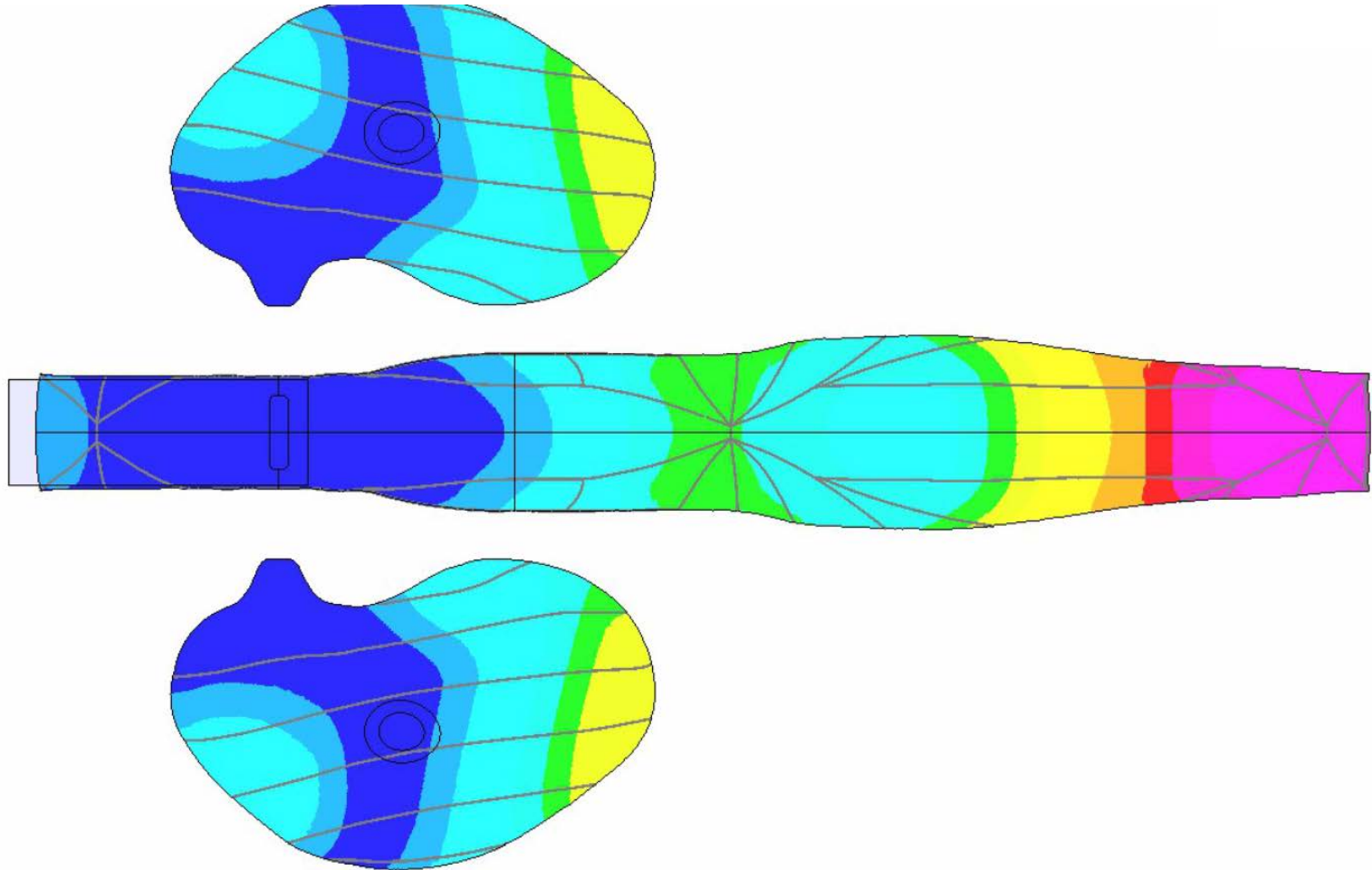
2. Run simulation to change the original shape to the morphed shape
 - Low pressure inflation, interacts with parts to reduce wrinkles
 - Check volume, distance to occupant, force on occupant etc.
 - Morph again if needed



Shape Morphing – 3 step process:

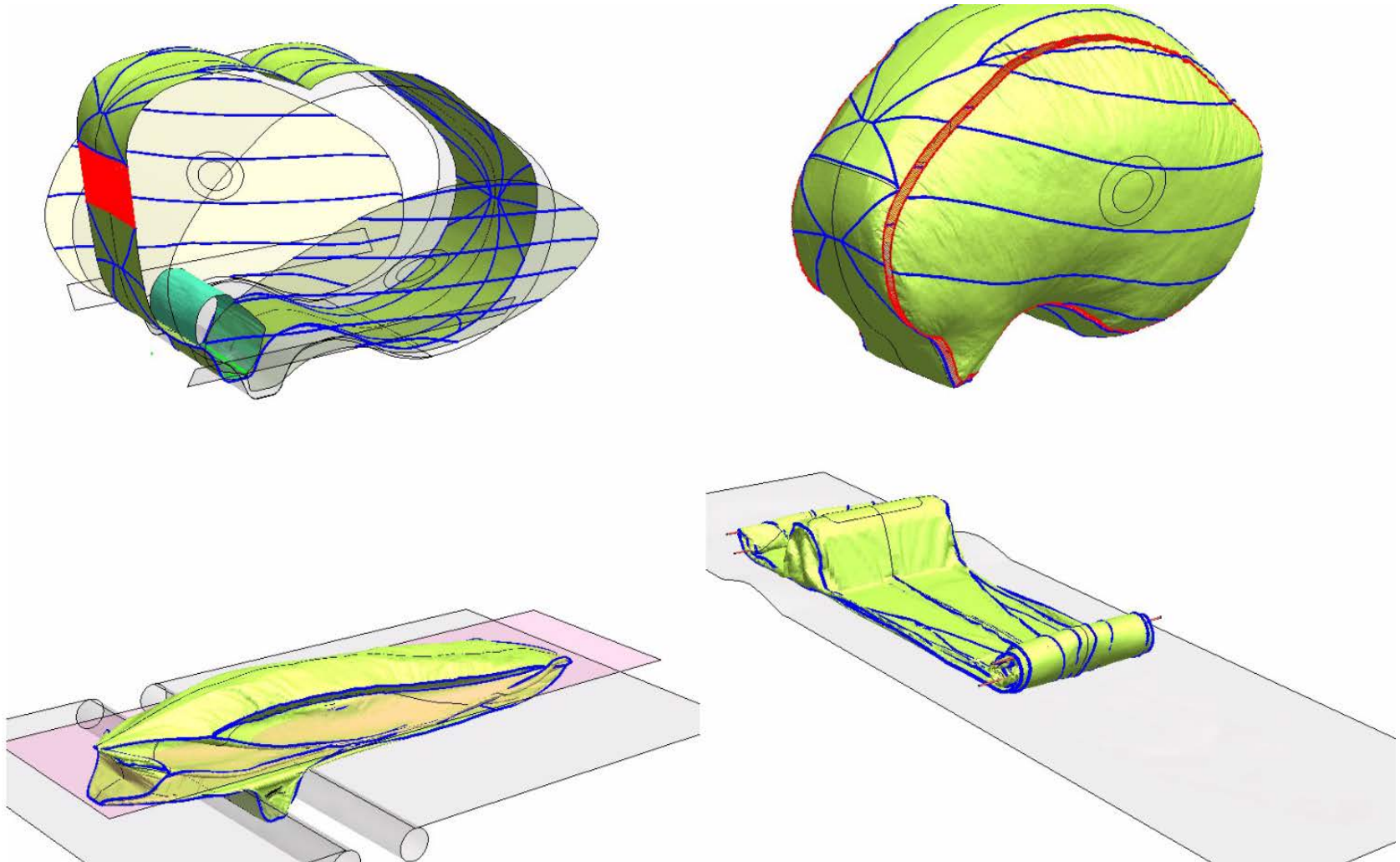


3. Map fabric elements into the new morphed shape.



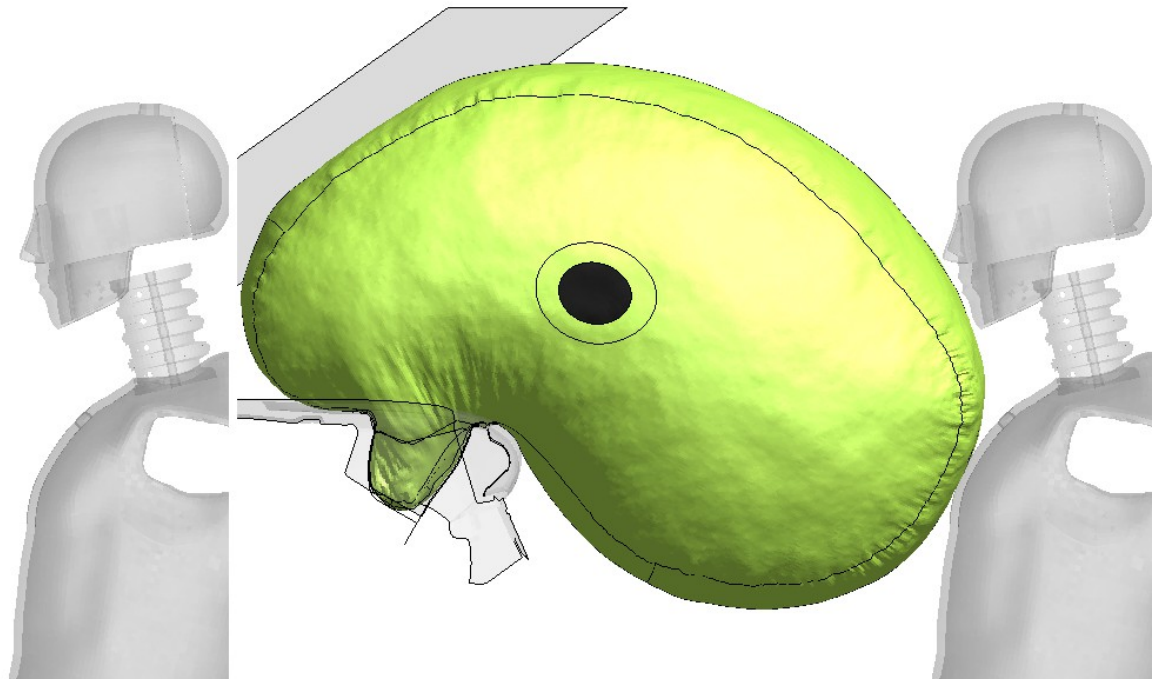
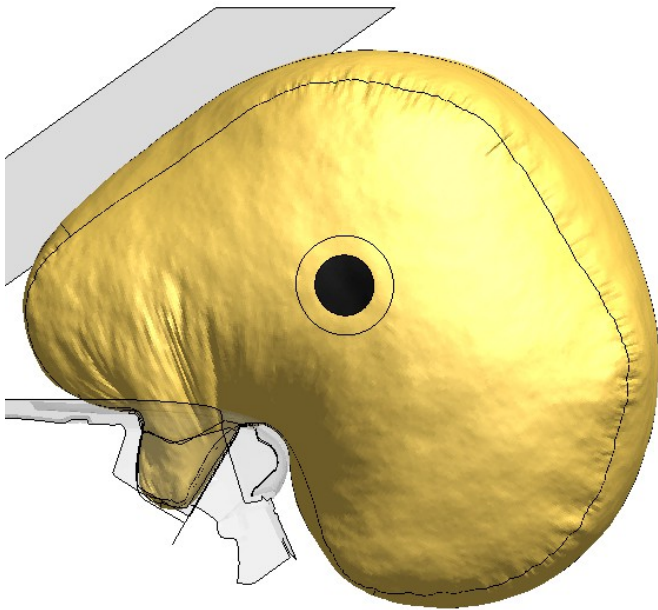


Refold the new geometry using the same steps as before





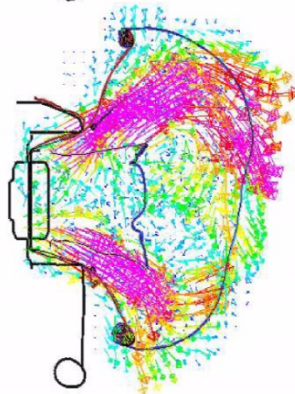
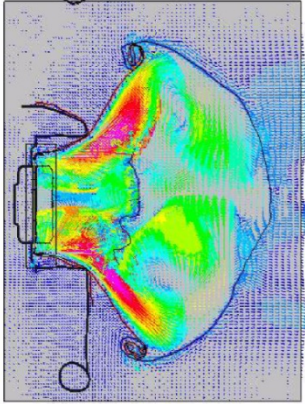
Original PAB compared to morphed shape (CPM)



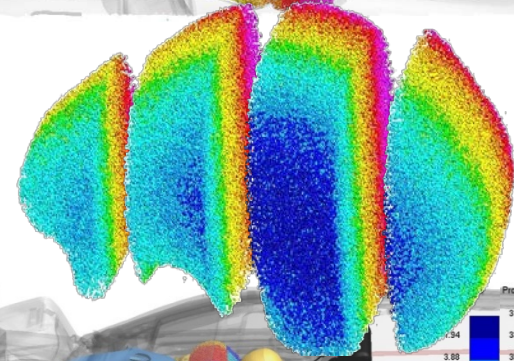
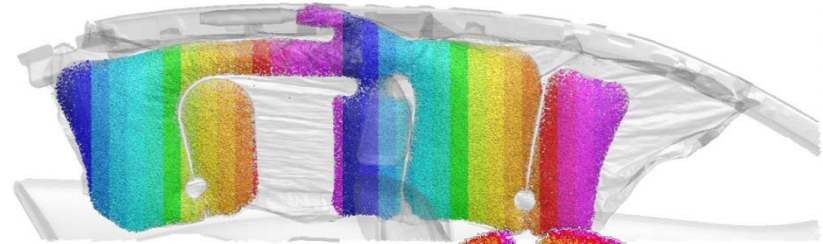
Design improved ✓



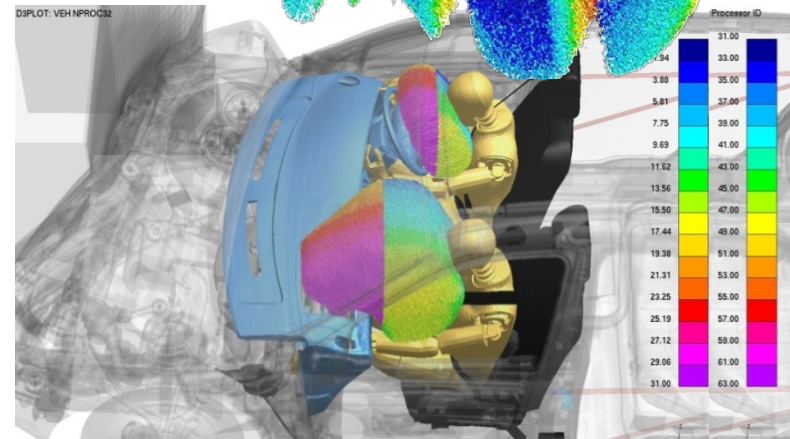
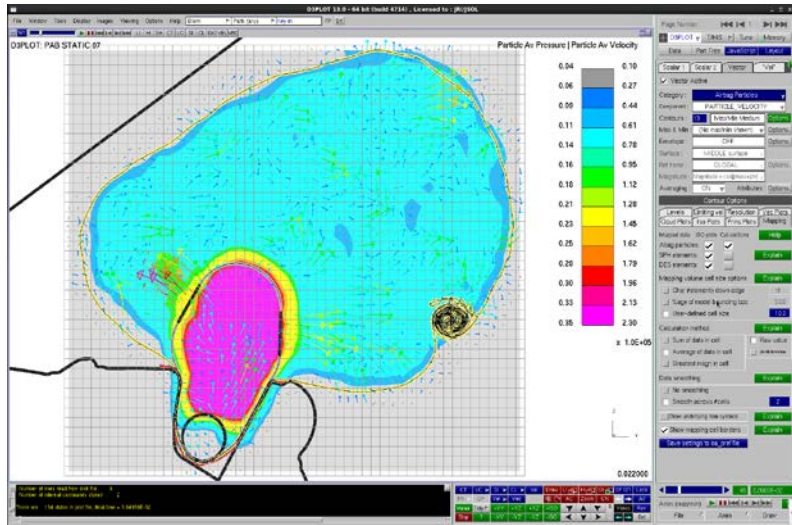
Particle flow control for **better gas dynamics**



Decomposition control for **faster run times**



Post-processing for **better flow visualisation**





- In this study JFOLD and LS-DYNA were used to demonstrate examples of SAB, CAB, DAB and PAB folding.
- Various JFOLD tools and techniques were used to quickly generate the models.
- JFOLD is a proven enabler for fast and realistic simulation based folding.
- User feedback, requests and continuous research into quicker and easier folding techniques drives the development of the software.
- For more details please see Arup.



Thank you very much

Shinya Hayashi
JSOL Corporation

Richard Taylor
Arup