Sustainable Package Development using Virtual Modelling at Tetra Pak

Michael Bo Hansen, VM Manager, Tetra Pak

LS Dyna Users' Conference 2022, Gothenburg

Tetra Pak®
PROTECTS WHAT'S GOOD

Tetra Pak Packages Sold Yearly

$\sim 200 \cdot 10^9$

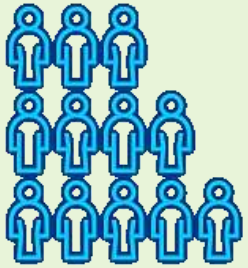
In 2021 we sold more than 192 billion packages. https://www.tetrapak.com/about-tetra-pak/the-company/facts-figures

Our Vision

We commit to making food safe and available, everywhere

Our company in numbers

Figures at January 1 2022



25,147
employees

>192 billion
Tetra Pak® packages sold in 2021

€ >11.145 billion
net sales in 2021

8
Technical training centres

6
Customer innovation centres

54
Production plants

28
Market companies

94
Sales offices

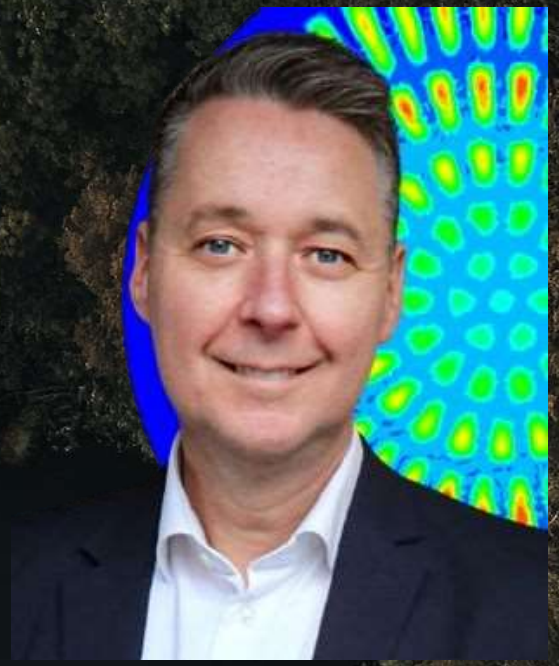
6
Research & Development Centres

>200
Collaborating with >200 recycling facilities

50 billion
packages were collected and sent for recycling

78 billion
litres of product delivered

Michael Bo Hansen



- Michael Bo Hansen
  - Virtual Modelling Manager
  - M.Sc. in Mechanical Engineering
  - MBa
  - Simulation 20+ years
  - People Manager 10+ years

Gemello Engineering supporting Tetra Pak

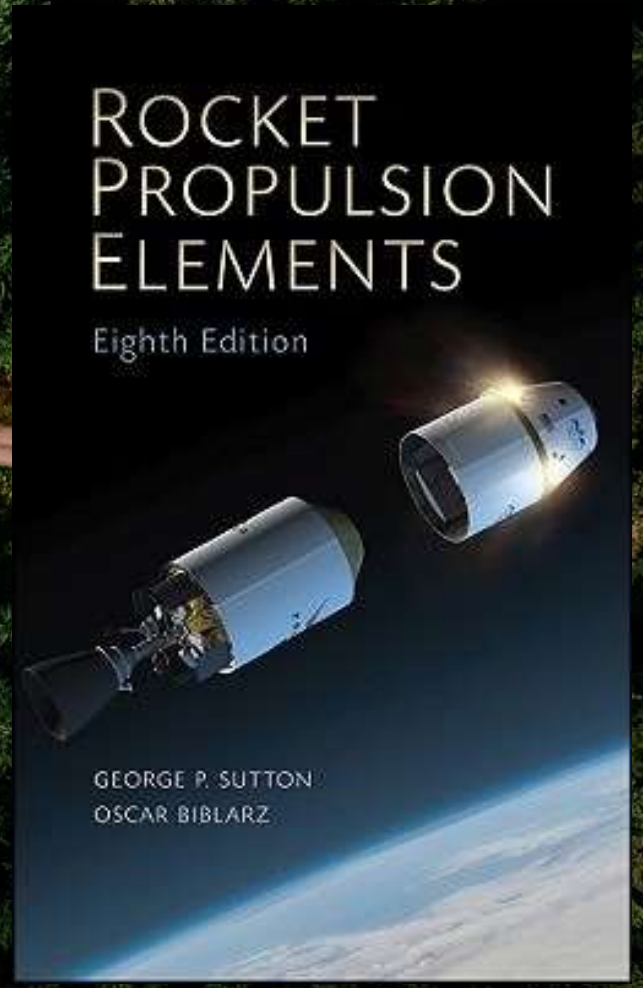
Anders Harrysson

Magnus Harrysson

Filip Claesson

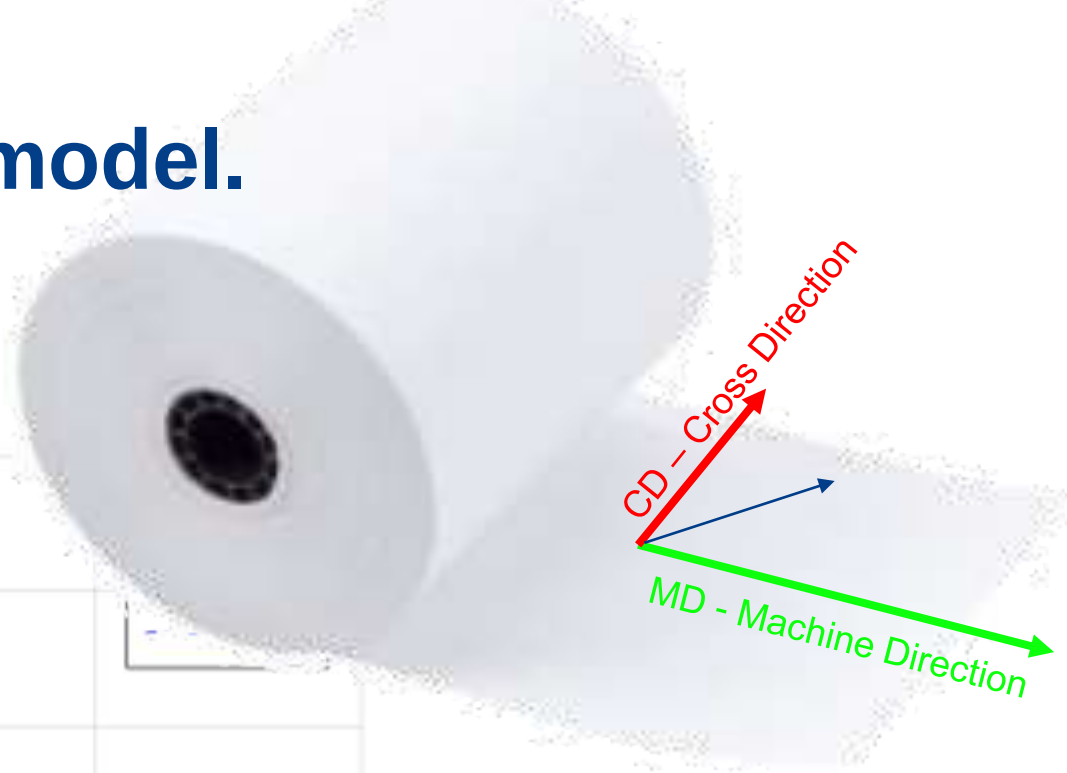
GEMELLO ENGINEERING

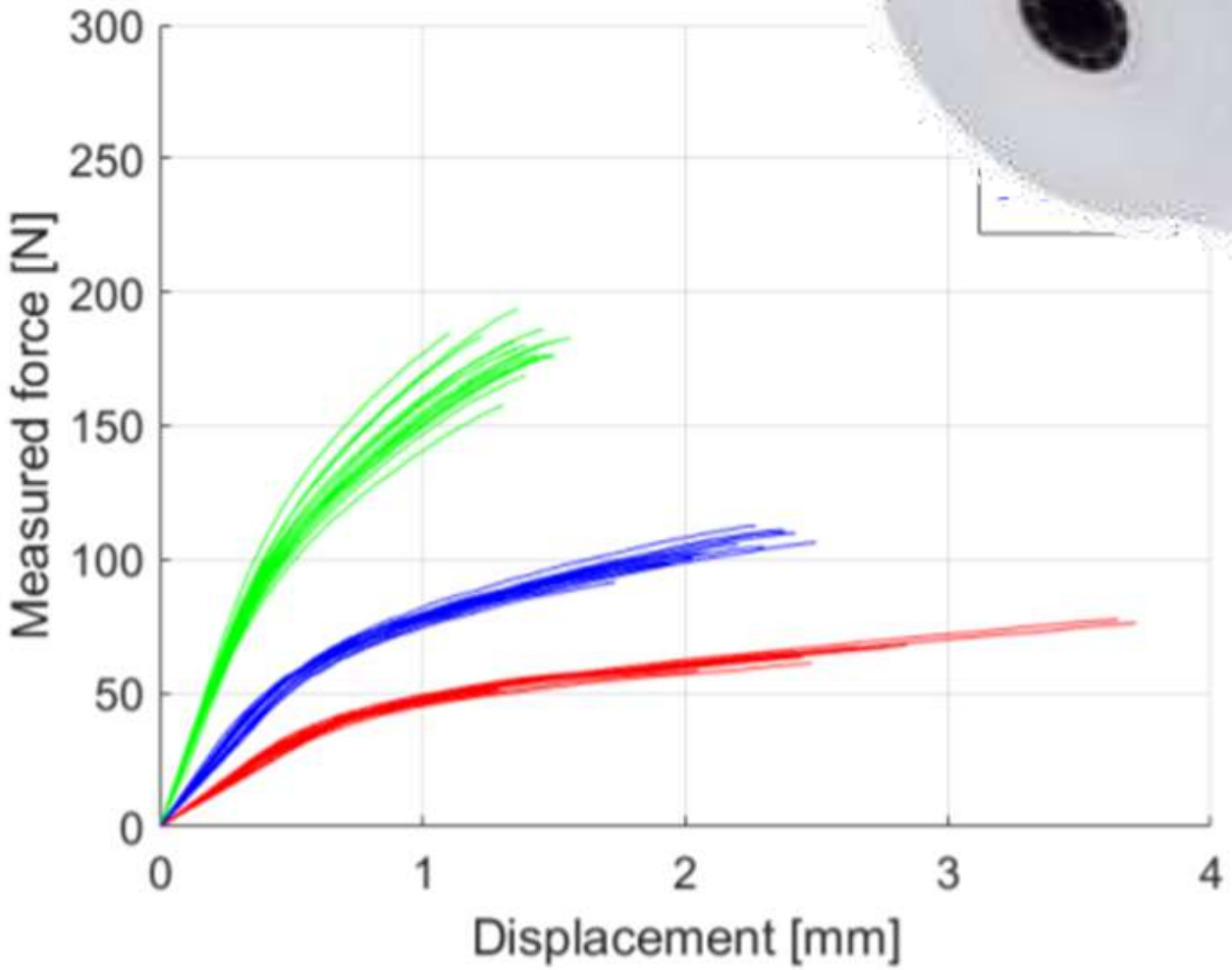
Making Food and Packing is not Exactly Rocket Science, or is it?



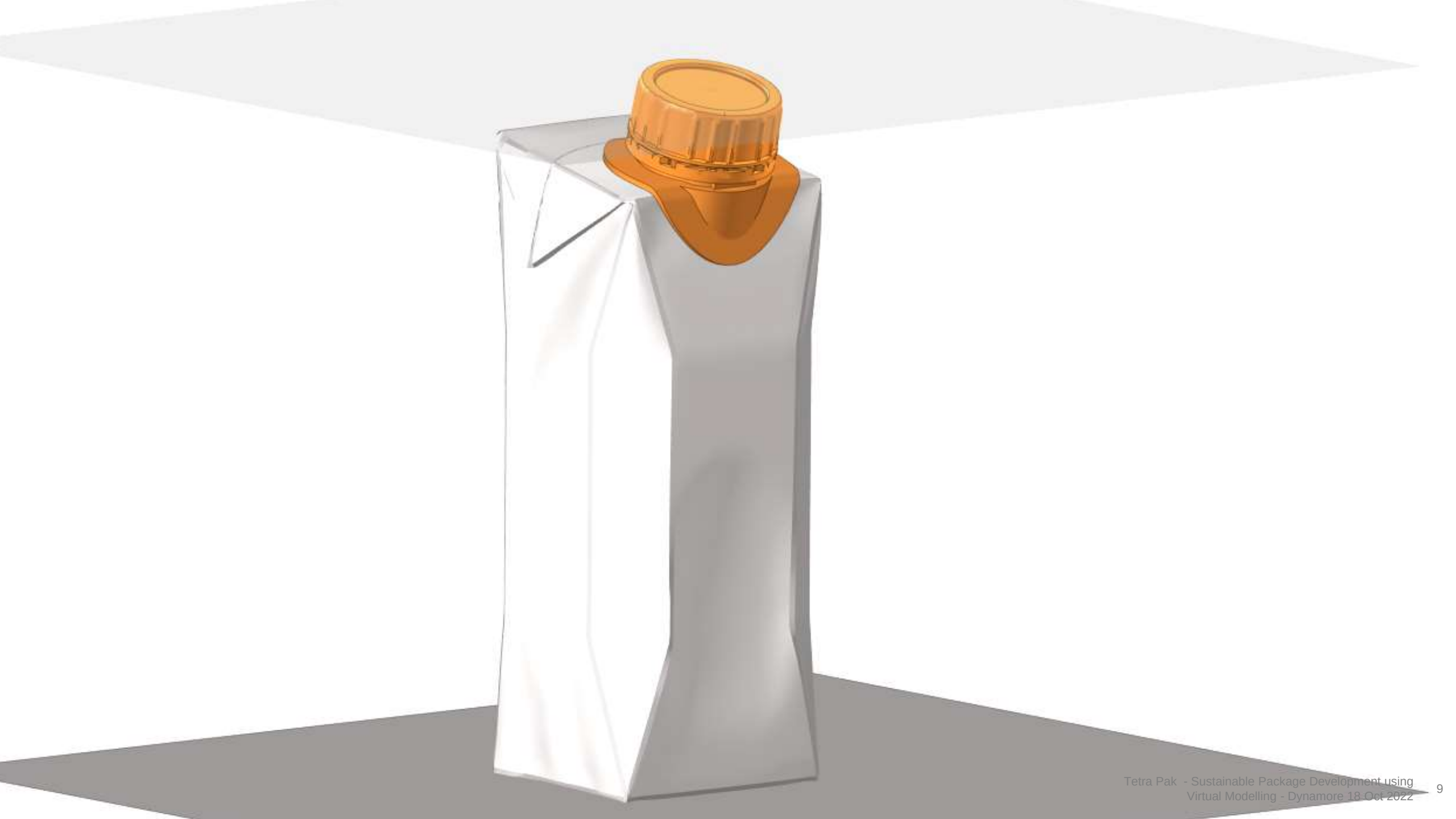
Well not exactly, but in fact, rockets is a spin off from butter making!

Paper Material is hard to model.



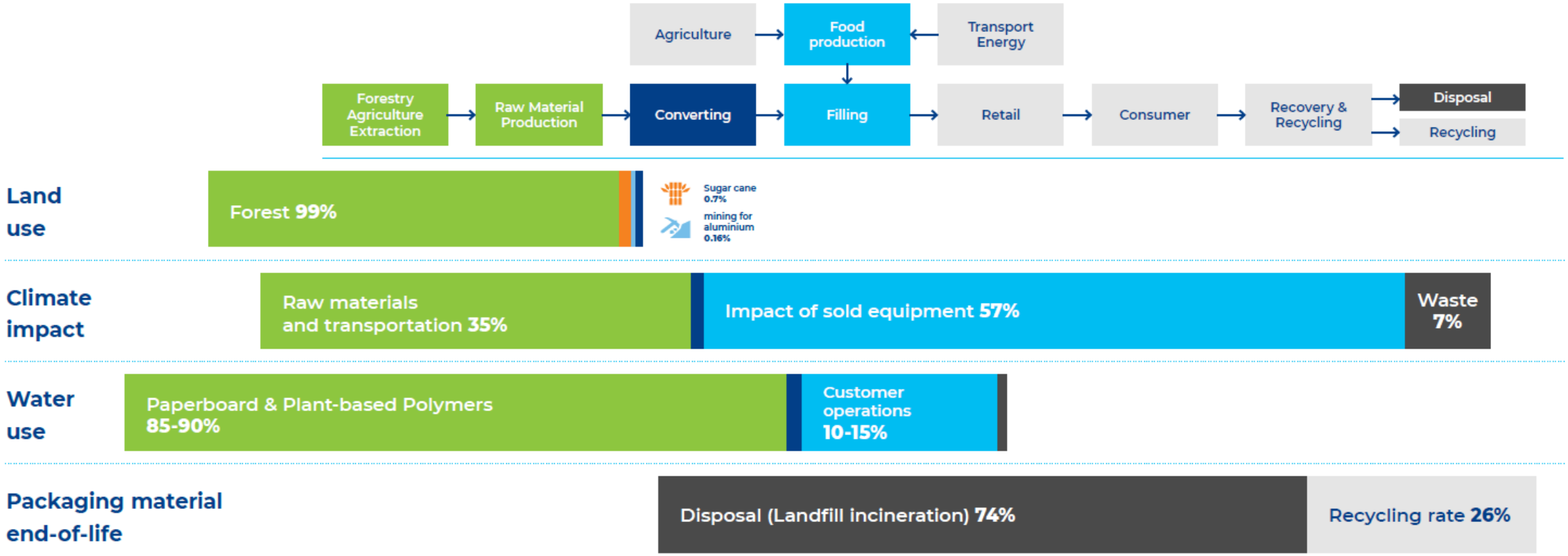


highly anisotropic and has far from a linear relationship.



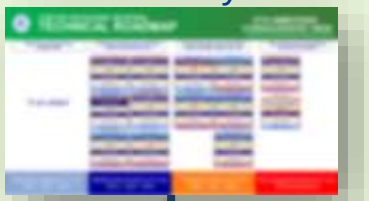
Impact on Nature

Impact on nature – Tetra Pak's value chain[34]




LEAD THE SUSTAINABILITY TRANSFORMATION
INTEGRATE AND OPTIMISE CUSTOMER OPERATIONS
DELIVER FOOD SAFETY AND THE BEST QUALITY
INNOVATE FOR CUSTOMER GROWTH
STRATEGY 2030
DYNAMIC
PRODUCTIVE
CAPABLE

PM Sustainability roadmap

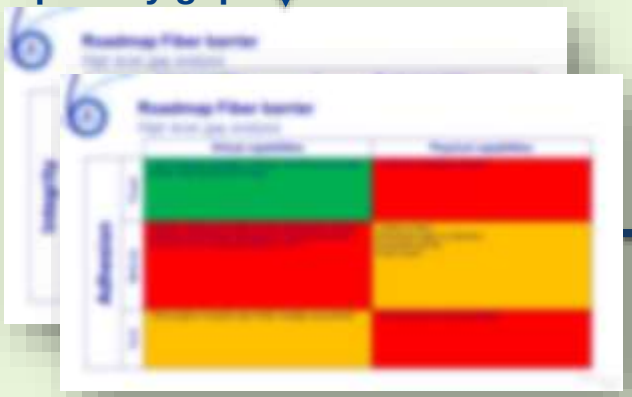


O&C technical roadmap

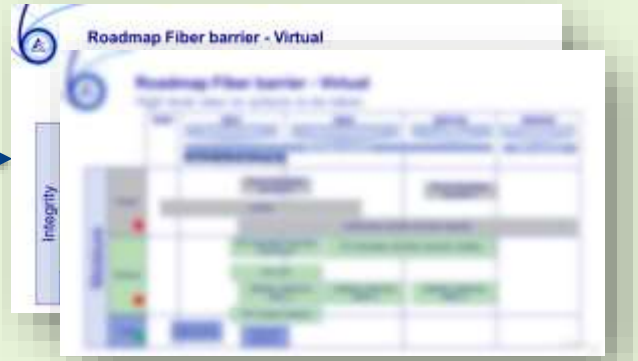
PM Quality roadmap

Virtual & Physical Capabilities

Virtual & Physical Capability gaps



Virtual Capability roadmap/plan



Physical Capability roadmap/plan

3 -5 yr plan:

- Competence development
- Recource needs
- Technology Specialist plan
- TKH needs
- Collaborations
- Study participation
- Investments

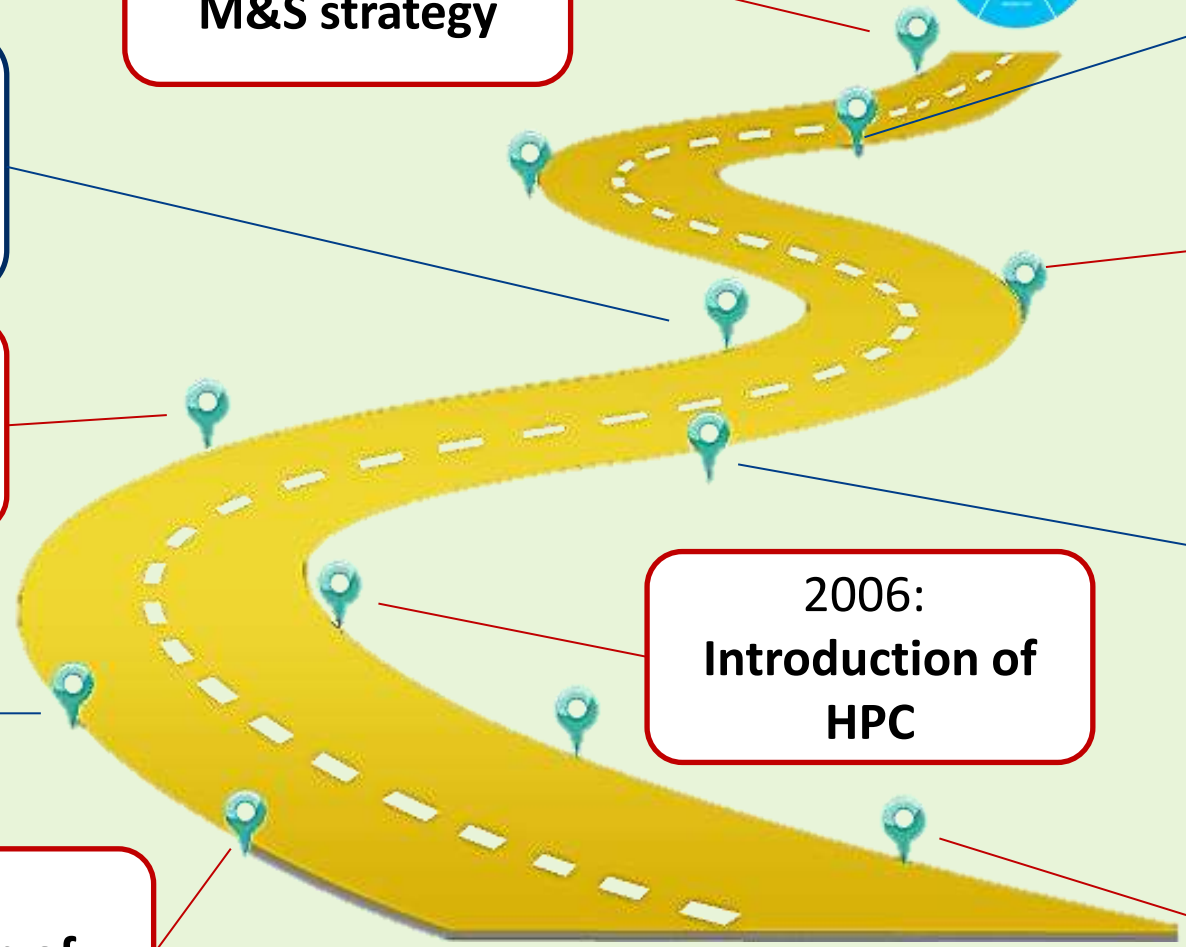
Capability roadmap

Gains

- Secure the Required Simulation Capabilities in Due Time
- Reduce Time to Market
- Increase Quality
- Proper prioritization
- Adress external partnership and competence centres

History of Simulation at Tetra Pak

The journey to simulation driven development



2019+2022:
M&S strategy

2017-2020:
“Industrialization" of M&S

2011-2016:
M&S take a clear role in the V&V

2012:
Central support started for advanced infrastructure

2010:
M&S strategy

2004-2010:
Advanced simulation takes off (full time specialized users)

<2003:
Explorations of simulation areas and disciplines

2006:
Introduction of HPC

1990:
Introduction of Moldflow and CFD

1984:
Introduction of FEM

Simulation Method Readiness Level

Common maturity scale for simulation

SMRL 5: Certification and warranties, No physical test required

SMRL 4: System verification (all load cases), Ready for external field test

SMRL 3: Concept selection (comparison studies)

SMRL 2: Concept/Design support

SMRL 1: Idea generation, probability studies

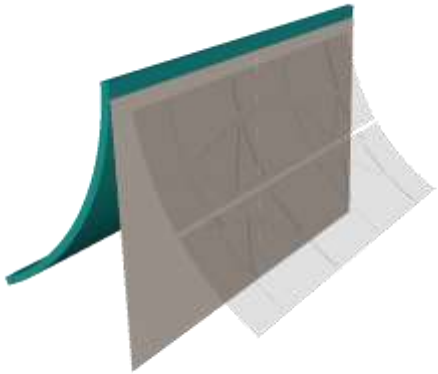
Virtual Converting

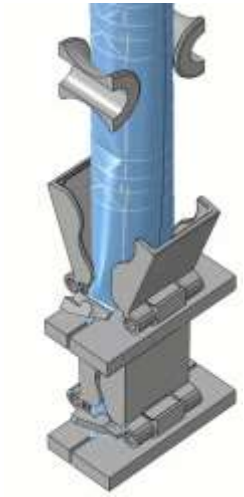
Virtual Filling

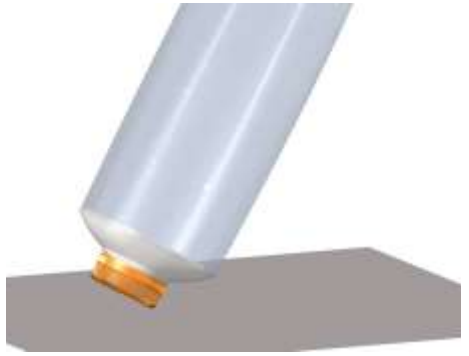
Virtual Package

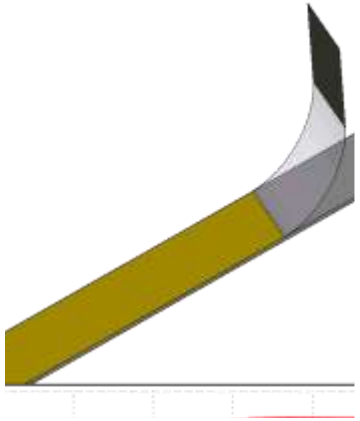
Virtual Consumer

Virtual Recycling





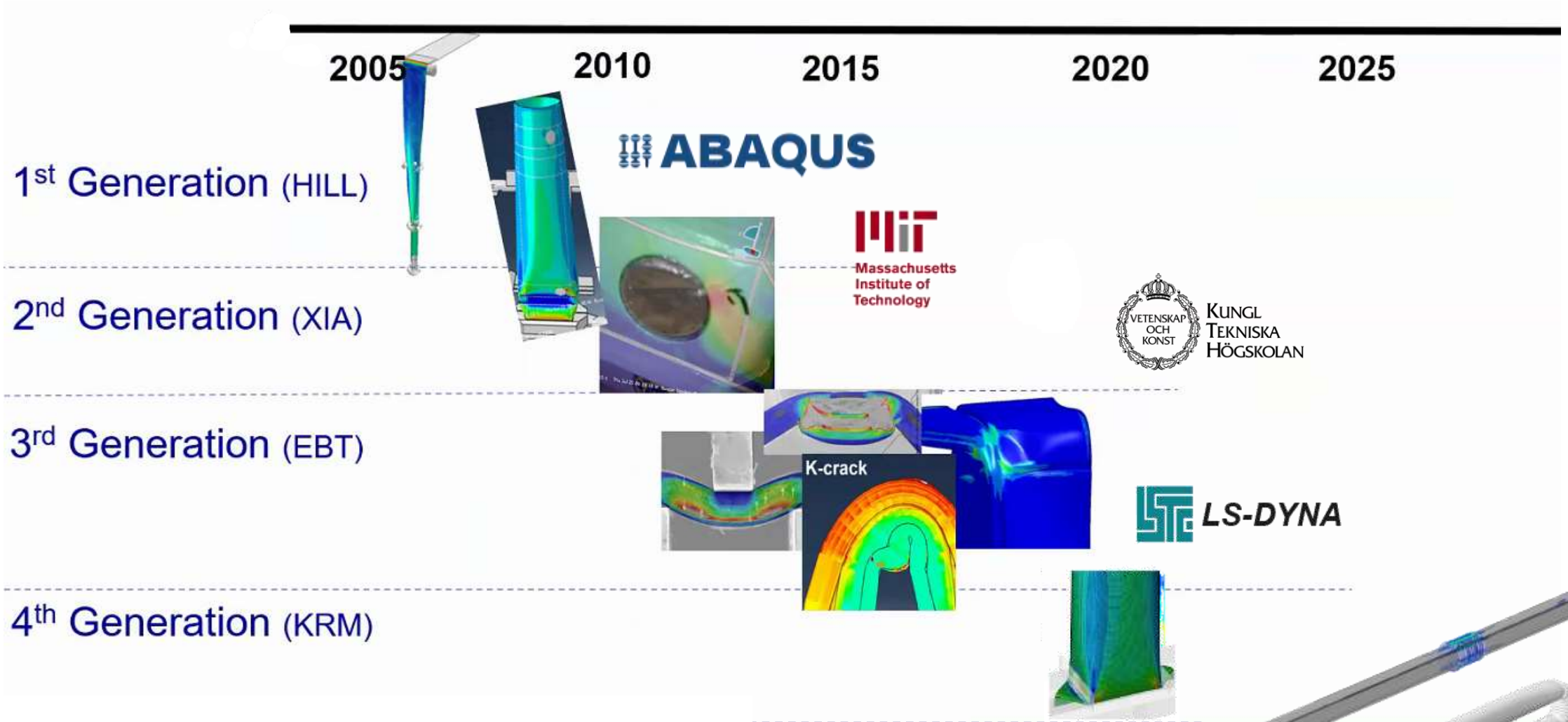




Collaboration Partners in Modelling & Simulation

- Experimental devices and tools for studying processes (in-situ)
- Thorough understanding and material characterisation of PM
- Verification and validation of the simulation models

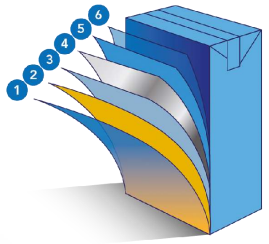
Developing Improved Paper Material Models every 5 year



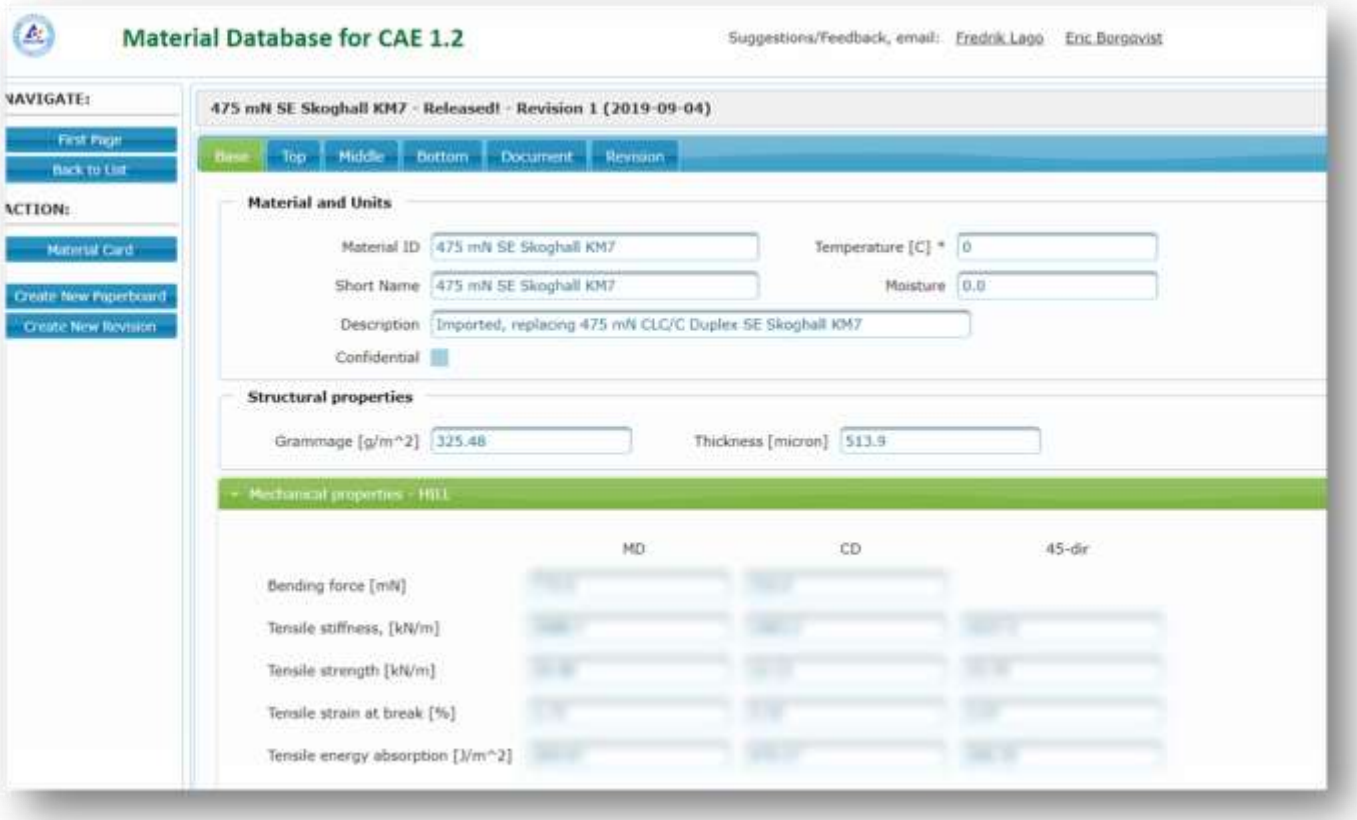
5th Next Generation (NEO)

Material database

Self developed application



1	Polyethylene - protects against outside moisture
2	Paper - for stability and strength
3	Polyethylene - adhesion layer
4	Aluminium foil - oxygen, flavour and light barrier
5	Polyethylene - adhesion layer
6	Polyethylene - seals in the liquid



- Specifically developed to handle packaging material properties
- Support for different CAE tools
- Properties covering multiple key technologies (forming, sealing etc.)

The need for standardized and common infrastructure increases with a growing community!

Implementation of it all – Capping fast

Tetra Top Flipcap

One cap for two different package systems

Replace

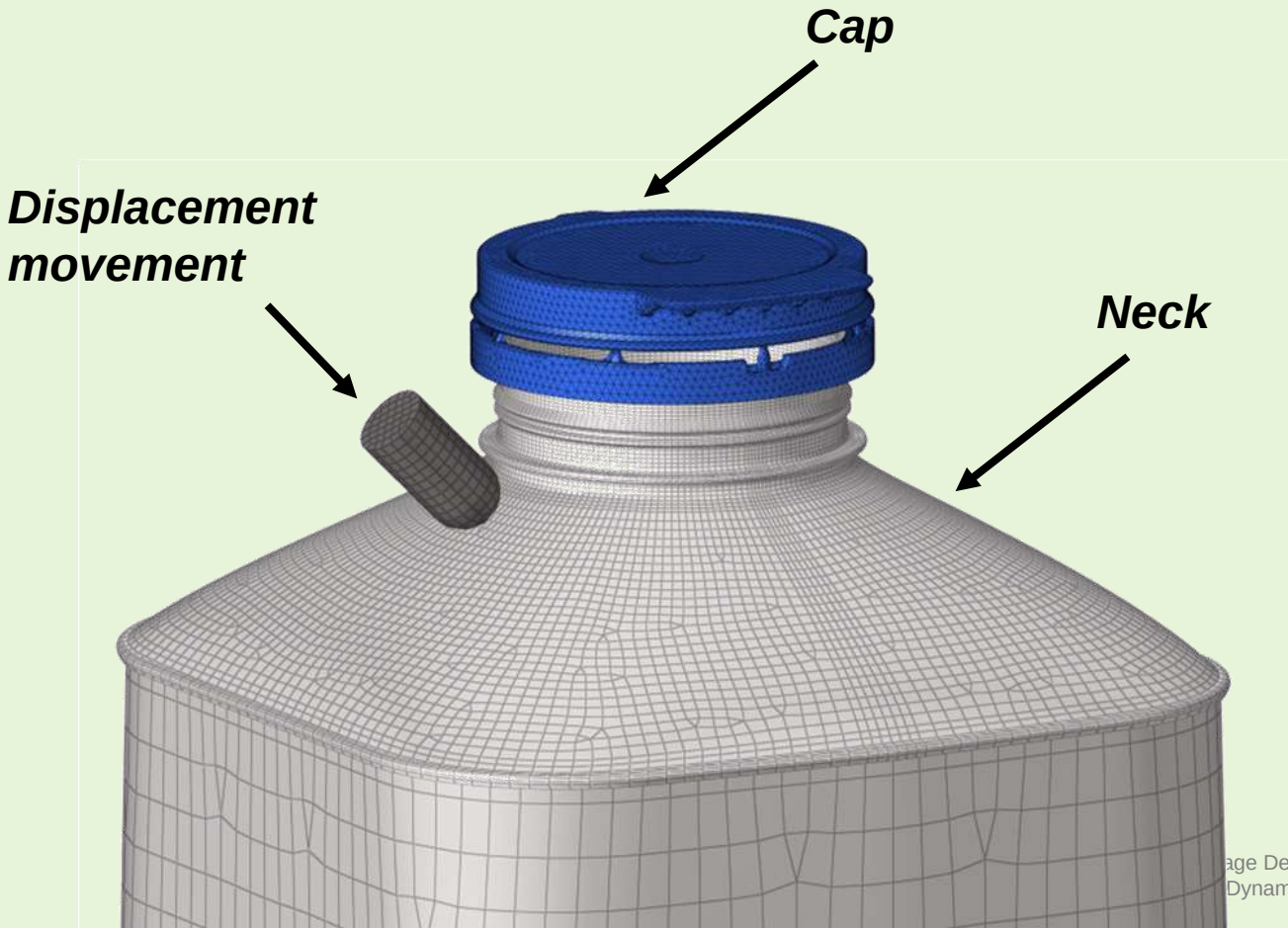
screw cap

with

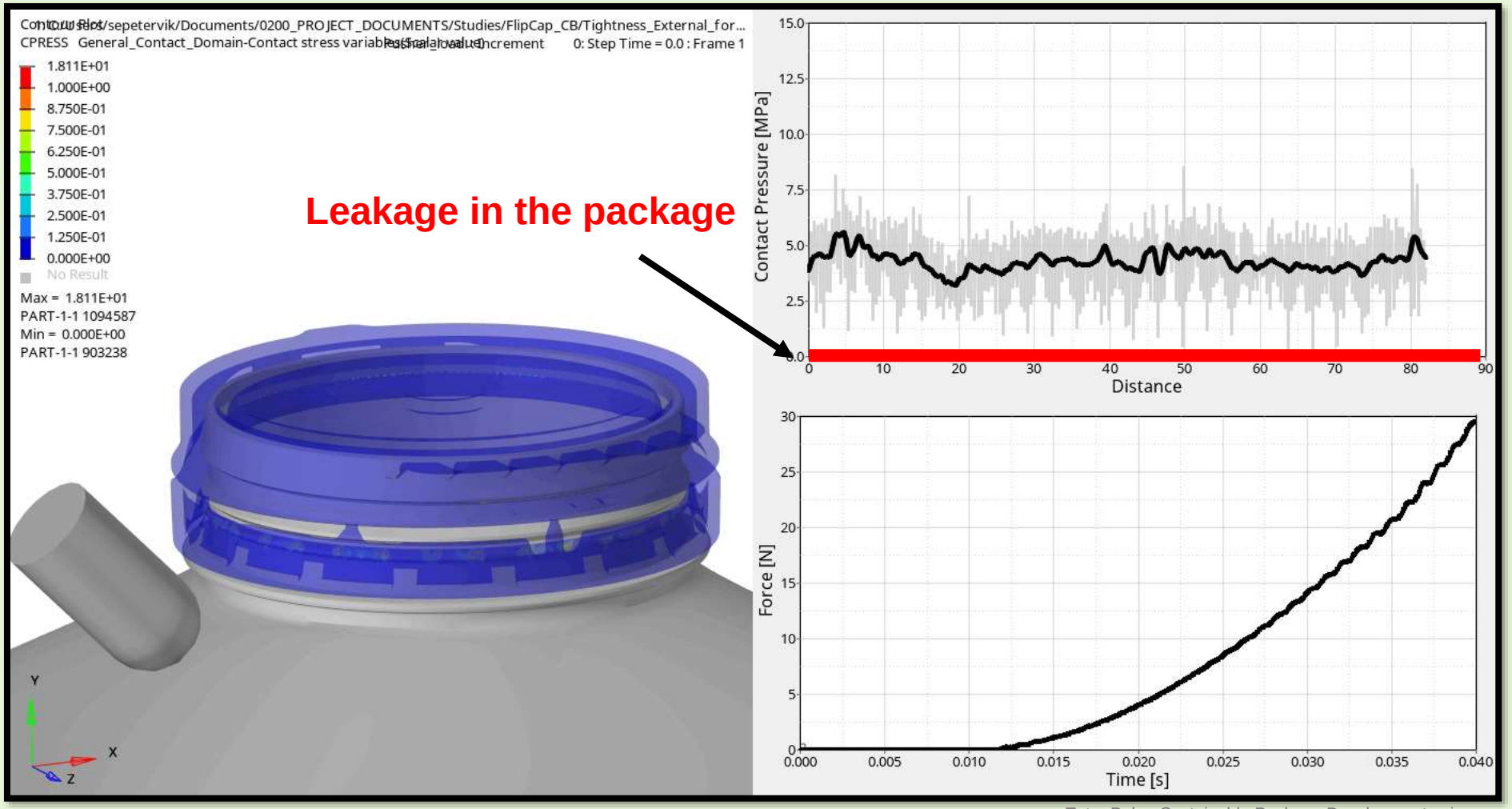
flip cap

Fast model building

- Reusing materials and models
- Very fast model setup!



Results from original model



Fast exploration of different scenarios

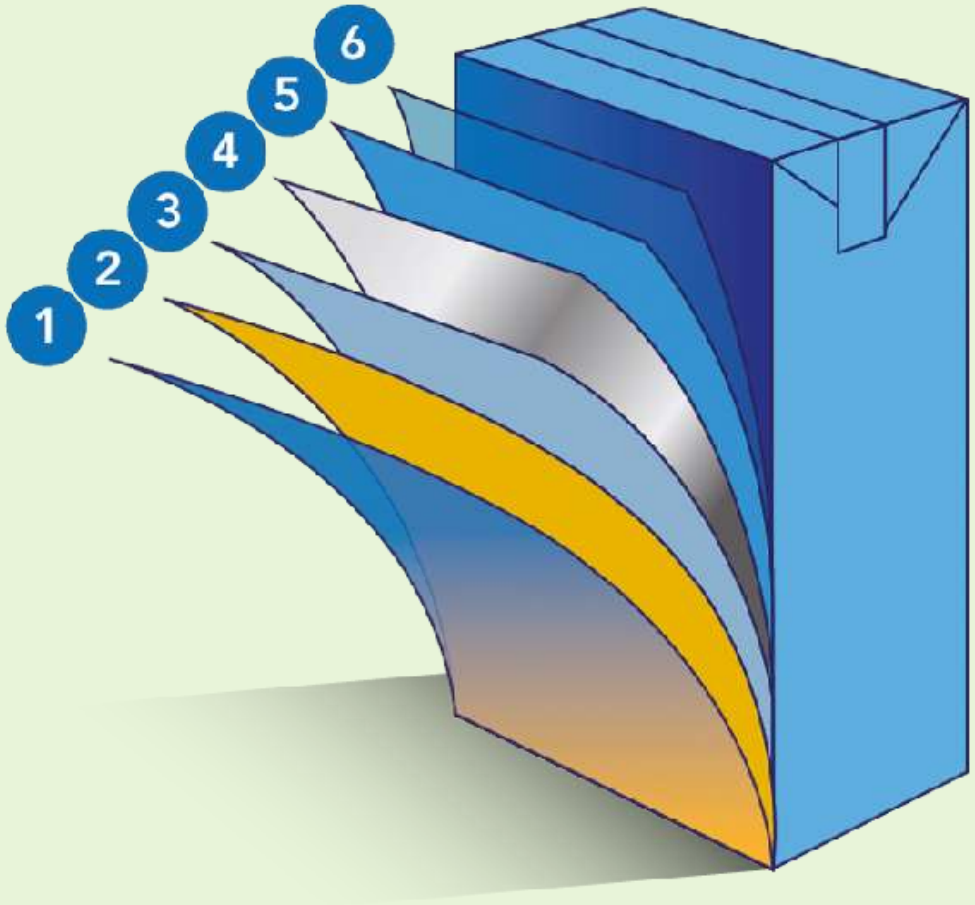
Comparison with existing screw cap

Deliver results, presentation and new design in two days

Implementation of it all – Pushing modelling to the extreme

Complex folding

Material structure



Outside

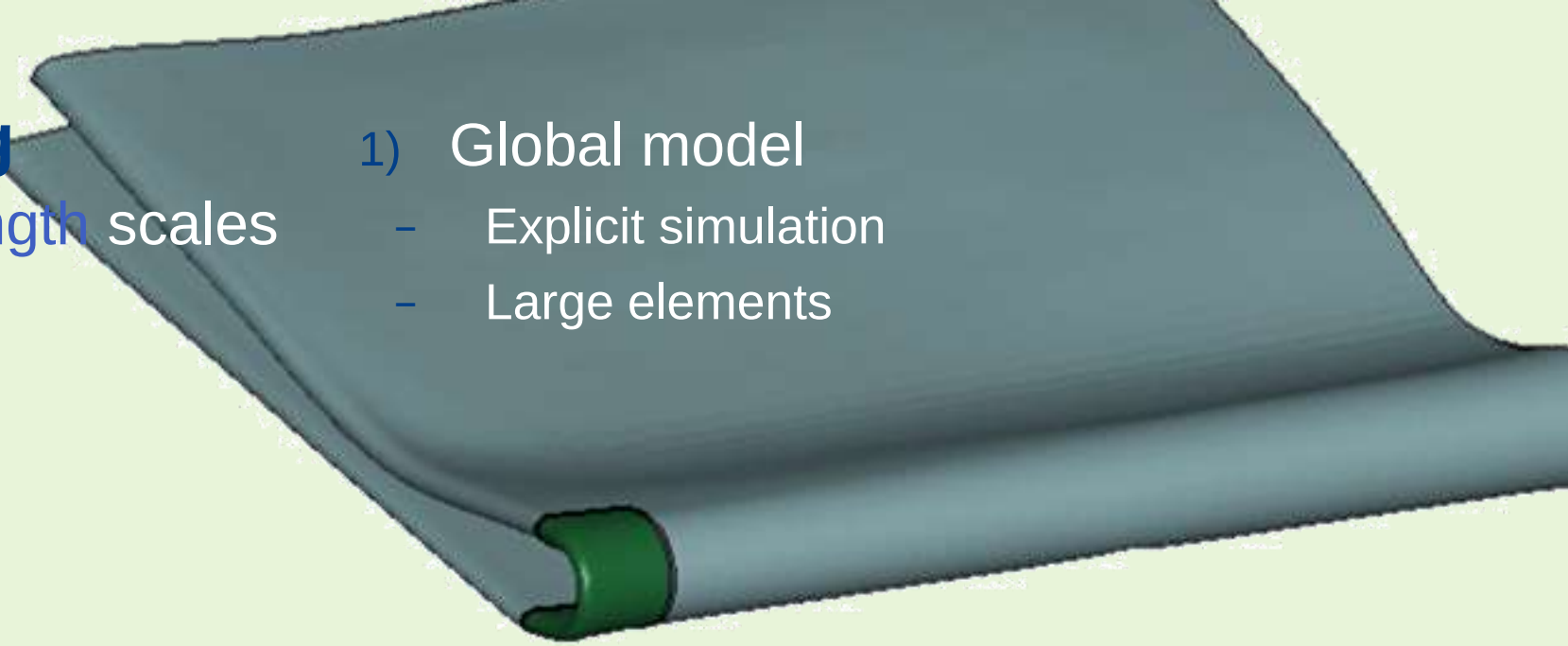
1	Polyethylene - protects against outside moisture
2	Paper - for stability and strength
3	Polyethylene - adhesion layer
4	Aluminium foil - oxygen, flavour and light barrier
5	Polyethylene - adhesion layer
6	Polyethylene - seals in the liquid

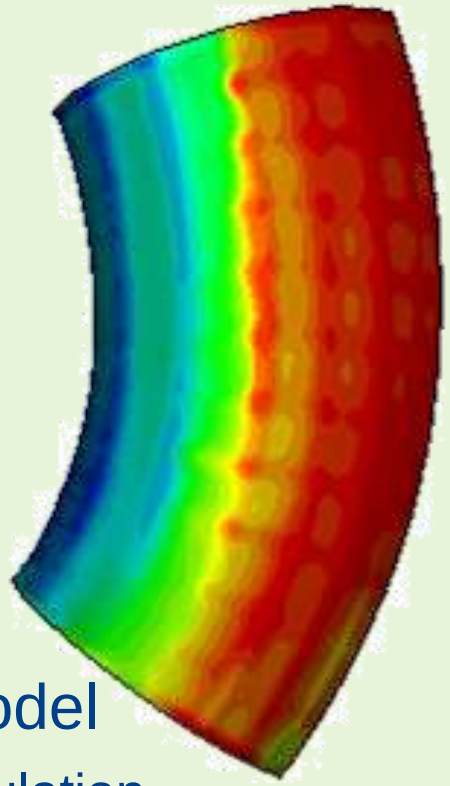
Inside

Complex folding

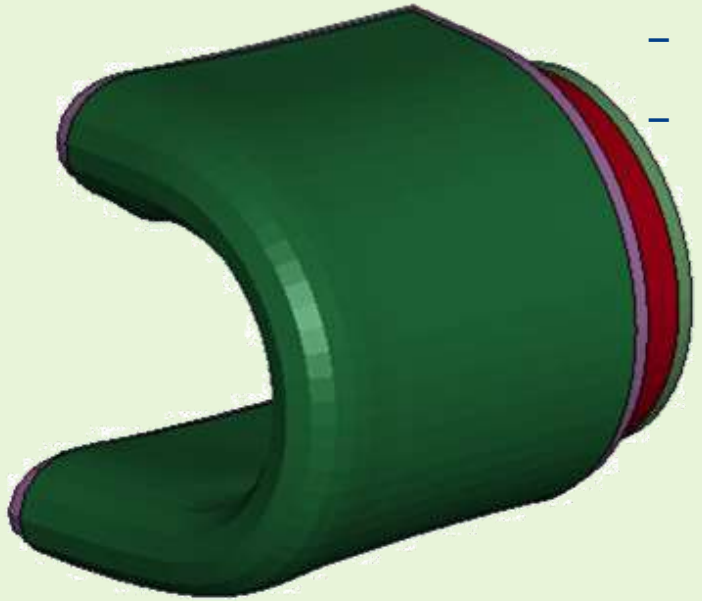
Utilizing different length scales

1) Global model
   - Explicit simulation
   - Large elements



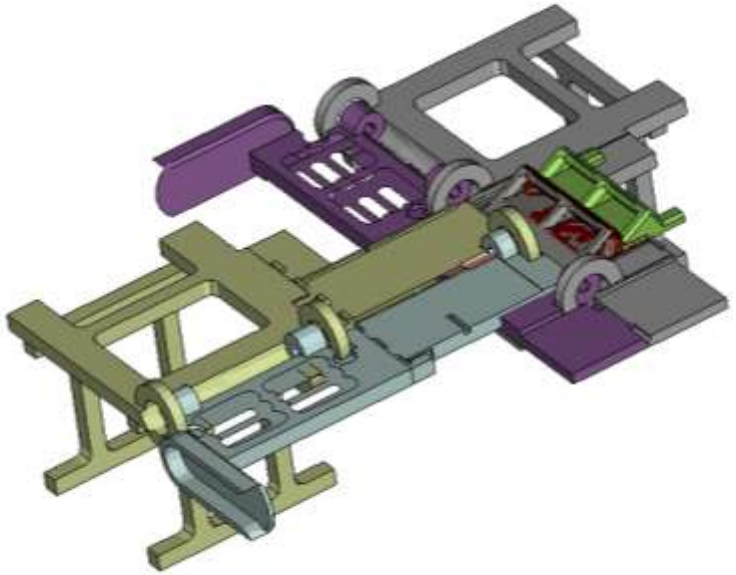


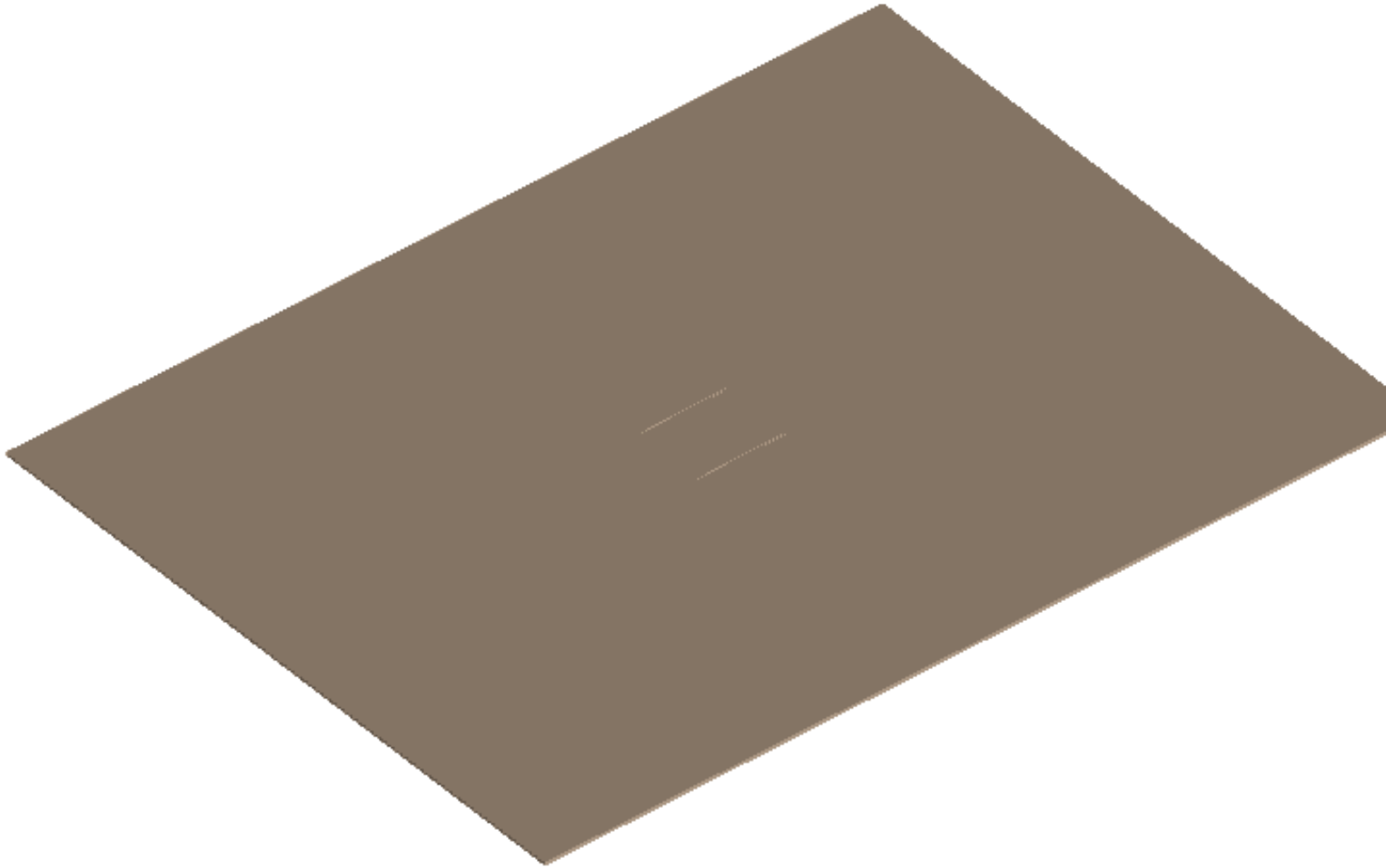
2) Sub-model
   - Implicit simulation
   - Intermediate element size



3) Sub-sub-model
   - Implicit simulation
   - Small elements

Double Folding of Layered Packaging Material

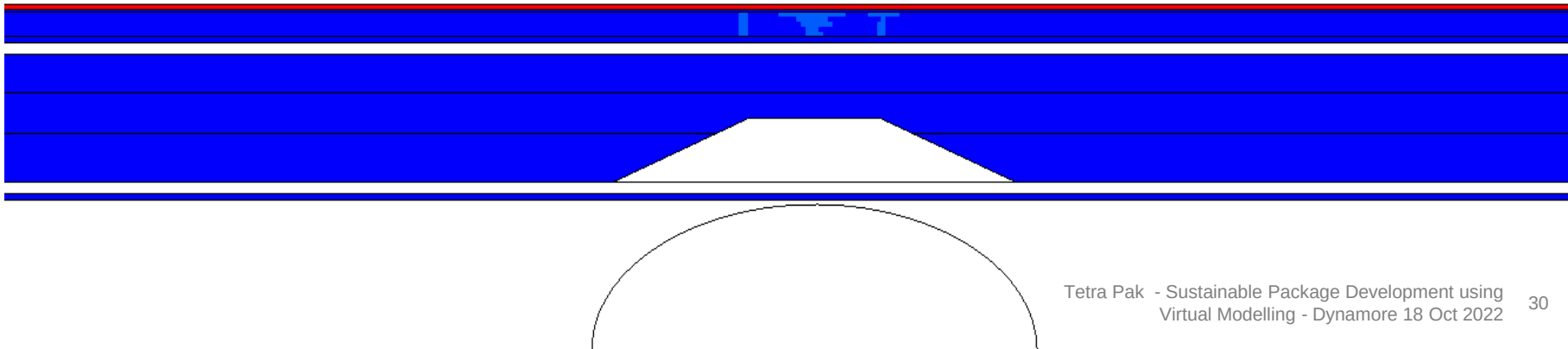




Focus on package integrity

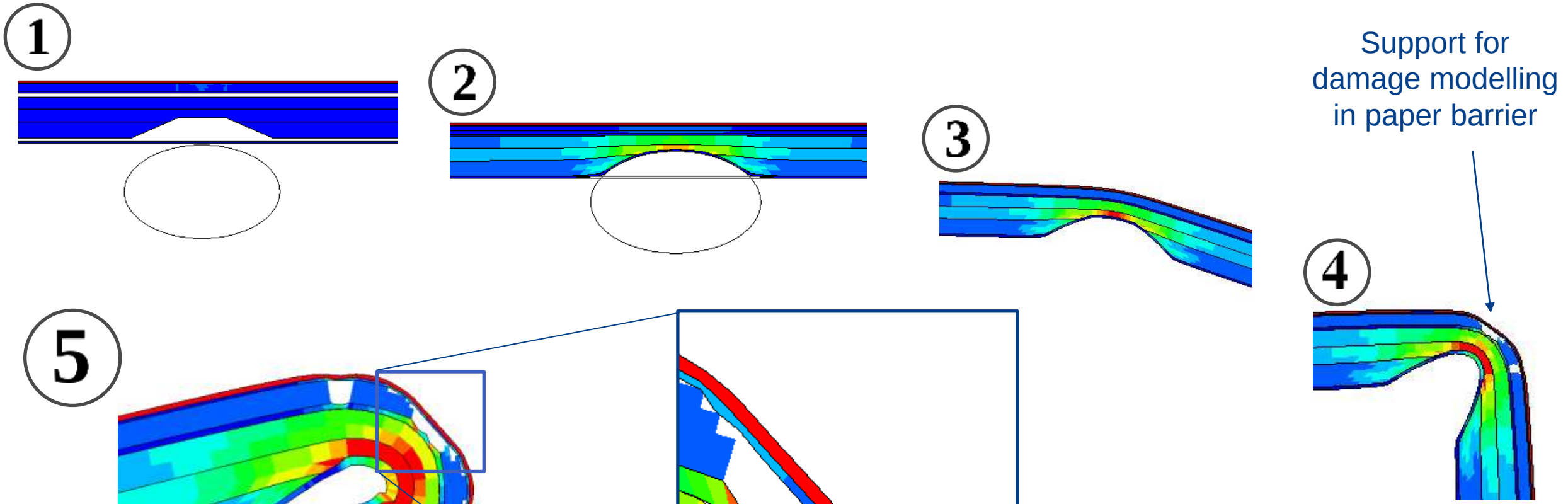
Folding of Layered Packaging Material

Adding a Slit

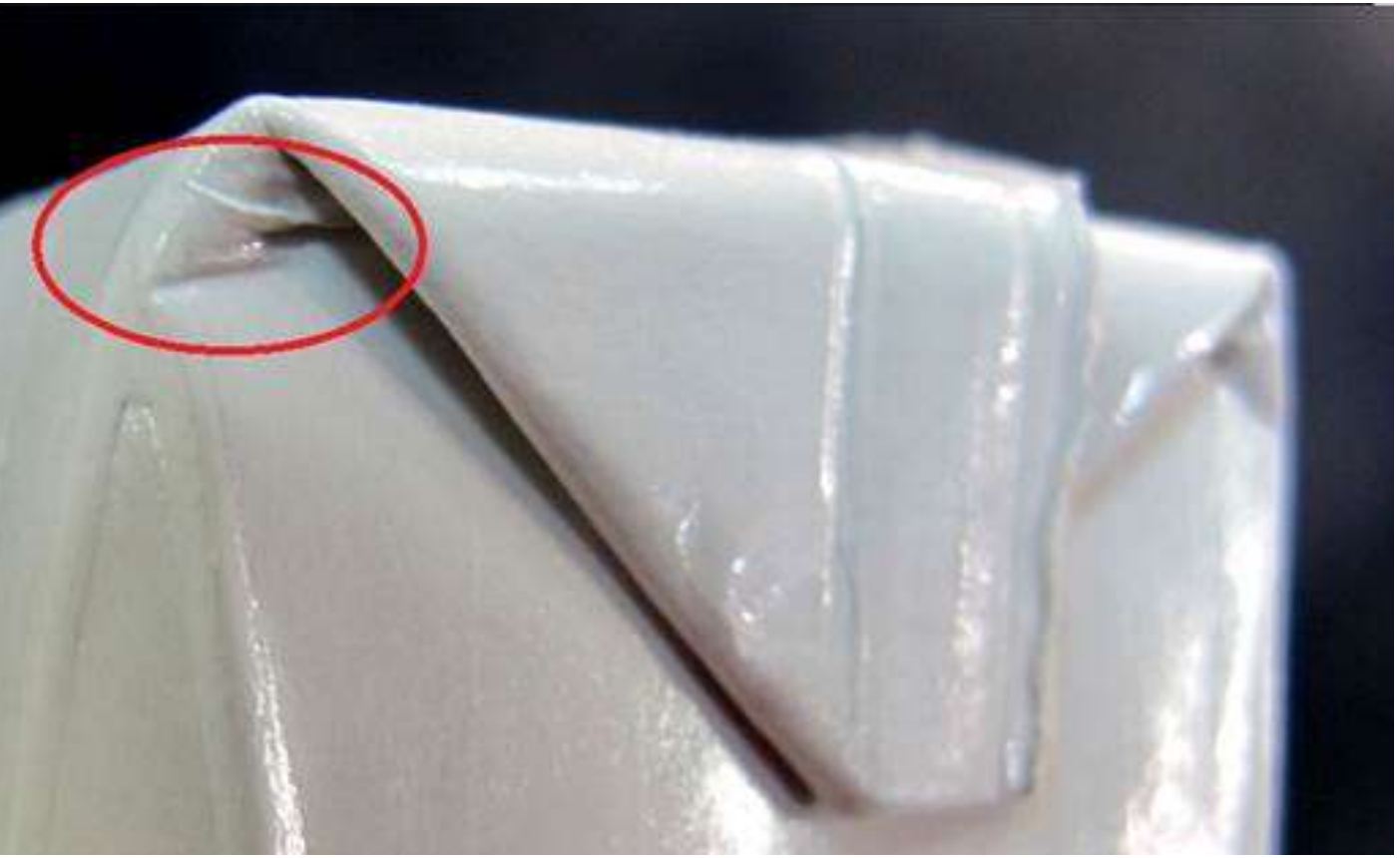


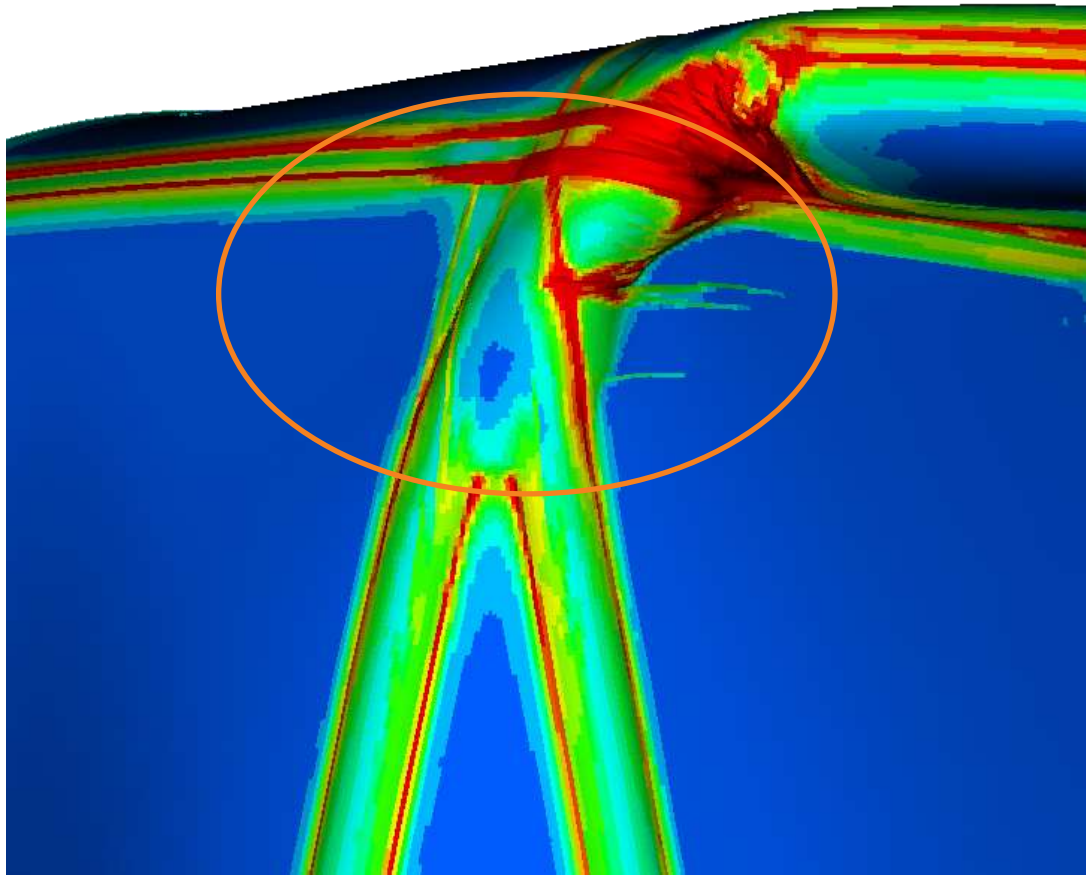
Folding of PM including slit in paperboard

Lamination and folding



Simulating Corner Dents is Possible



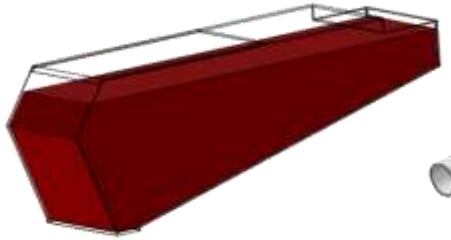


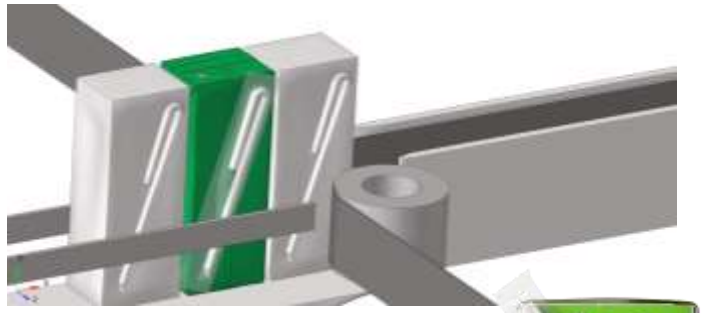
Implementation of it all – Single-Use Plastics

Simulation Driven Paper Straw Development

Capabilities have been used to simulate the whole value chain

Paper models

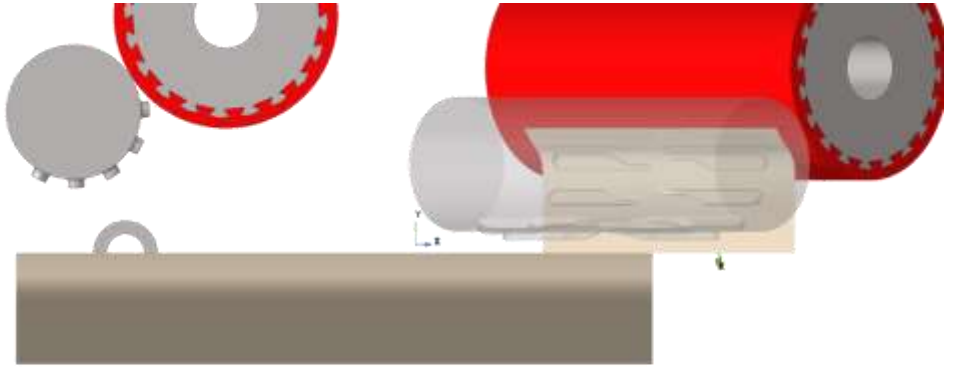


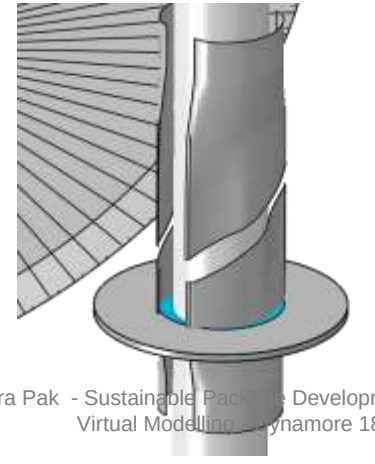


Material | **Straw forming** | **Corrugation U-straw** | **Distribution Equipment**

Storage | **Production interface** | **Straw wrap** | **Consumer**

Glue models



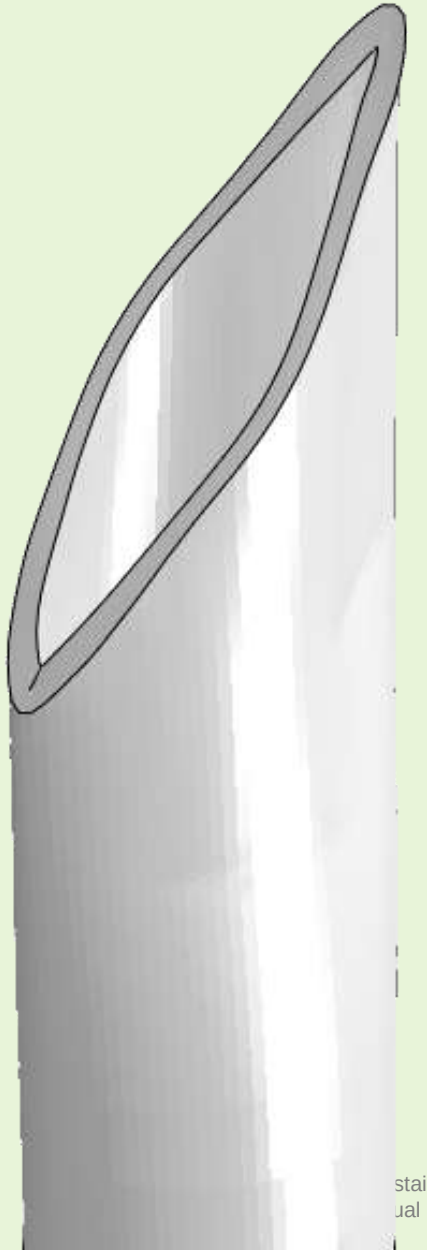


Focusing on the tip

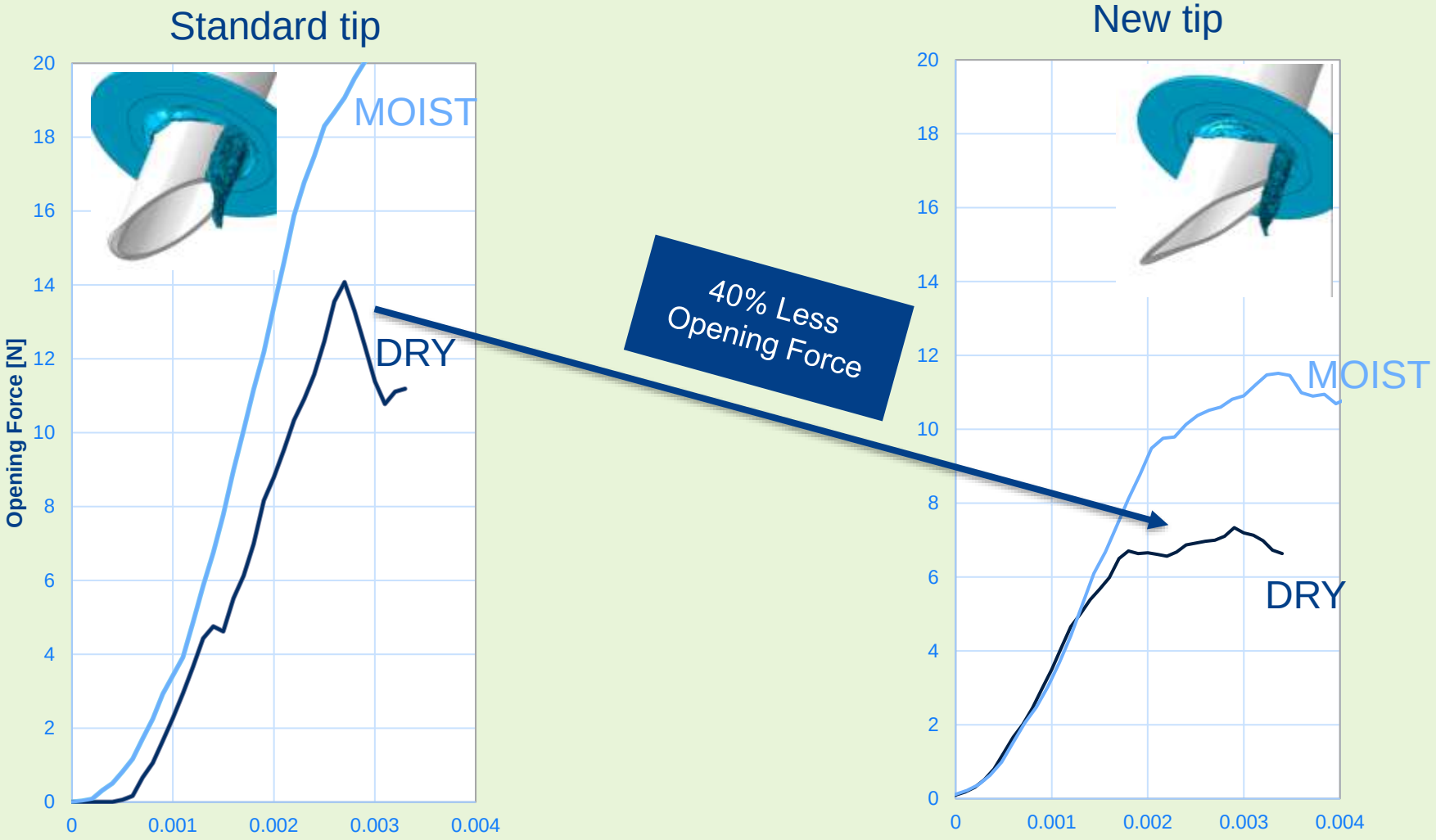
A small change with a big impact

- New sustainable barrier **is tougher to open.**
- With a Paper Straw it is **even worse**!
- Simulations and testing has solved the problem!

→ Improved product

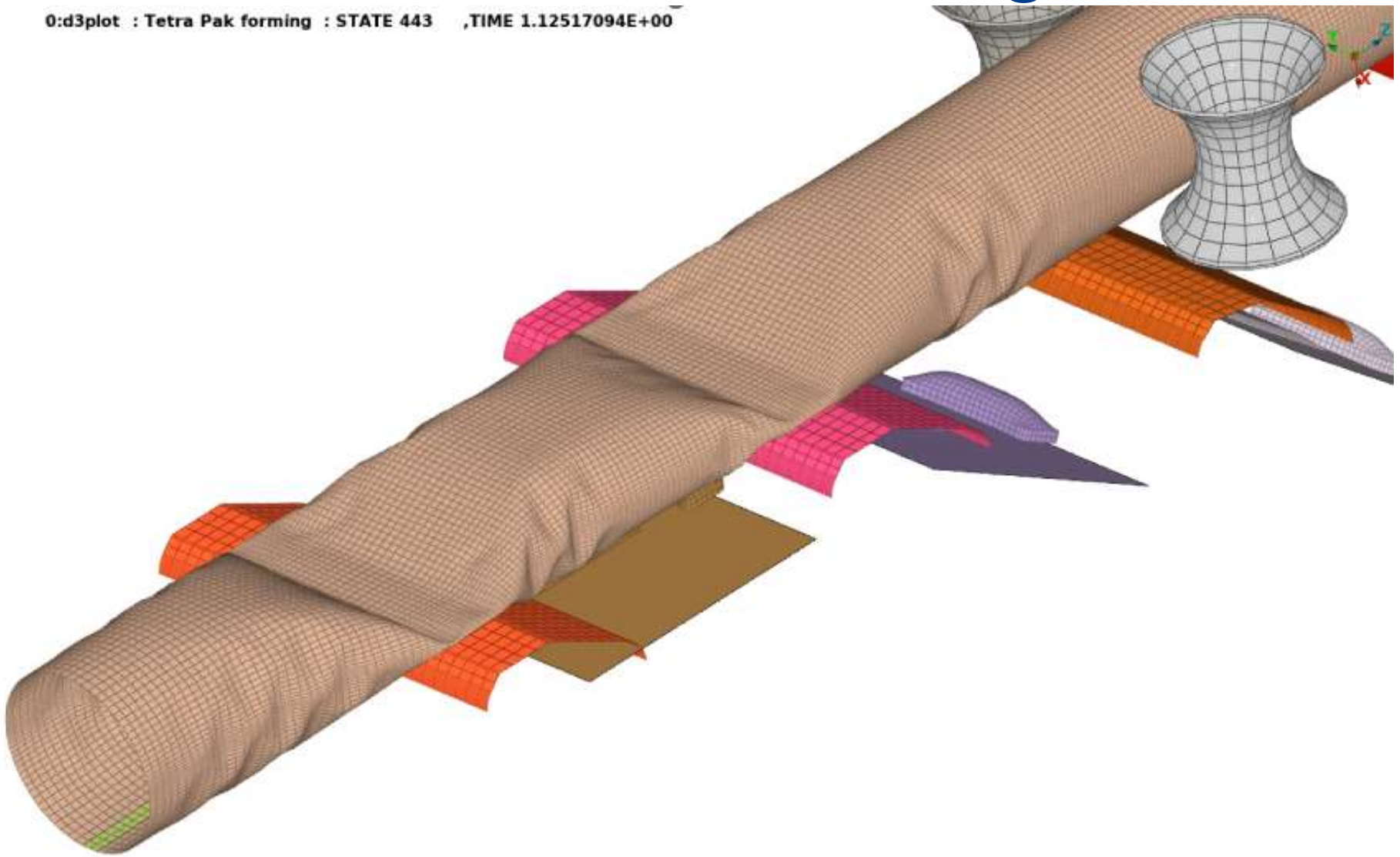


Simulated Opening Forces – New tip design

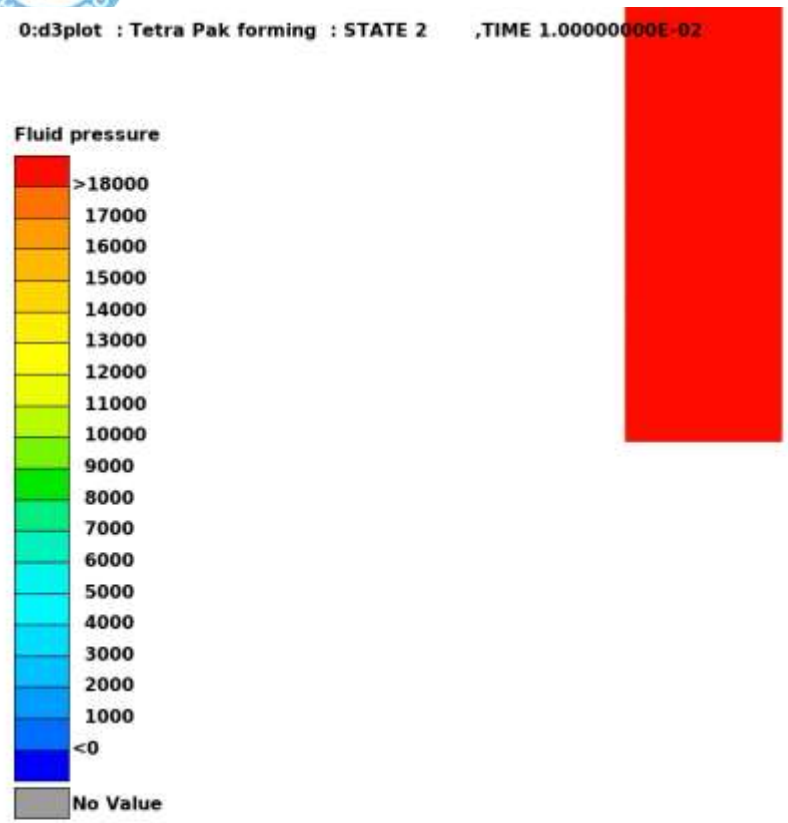


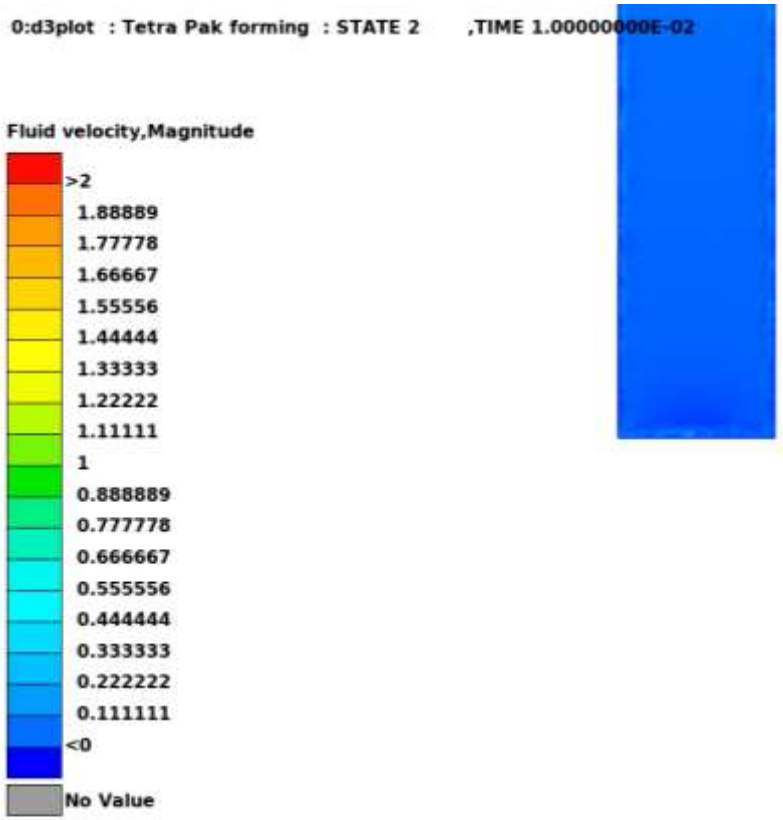
Collaboration with Dynamore

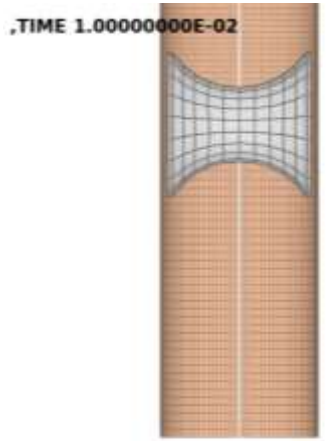
Fluid Structure Interaction - Filling



Pressure, velocity and deformation

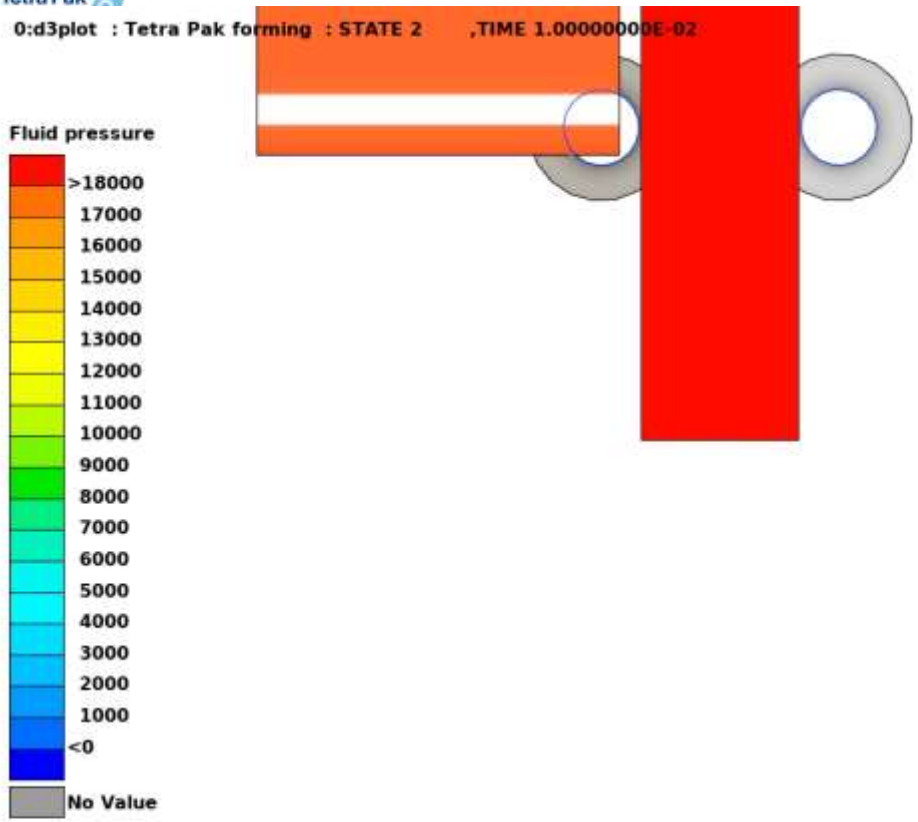


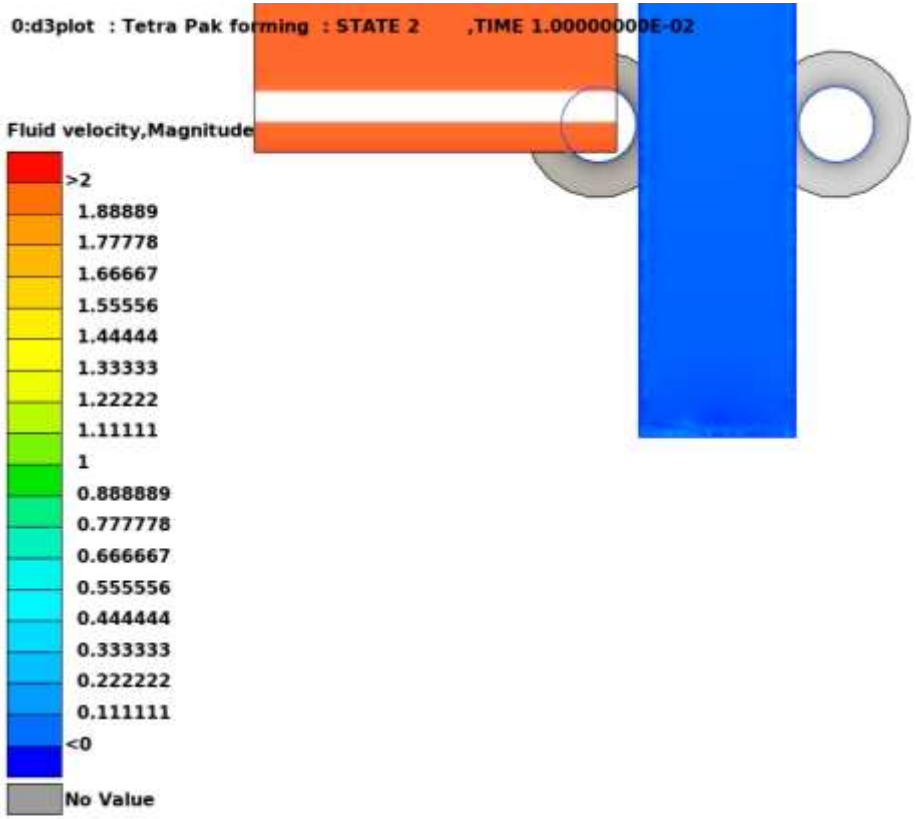


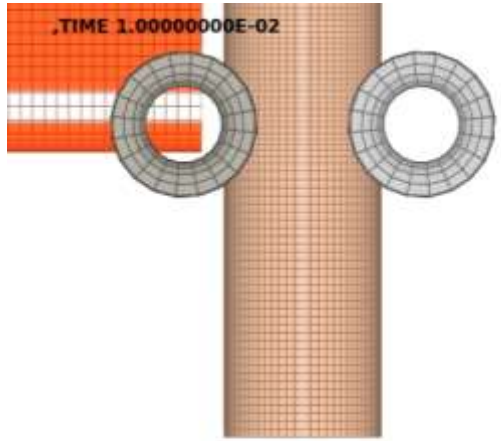


Pressure, velocity and deformation

View 2







Collaboration with Dynamore

- Support from Dynamore is fast and skilled
- LS-Dyna is efficient in parallelisation
- Vert robust, leading to increased productivity.

- → Future activities

Take-Aways

- Tetra Pak is maximising our positive impacts on nature and society using modelling and simulation as a tool
- We continue to push the limits promoting a culture of sustainability everywhere.

With Great Ability Comes Great Responsibility!

Tetra Pak®

PROTECTS WHAT'S GOOD

Thank you!

Questions?