

Make FEA more Flexible with Mesh Morphing

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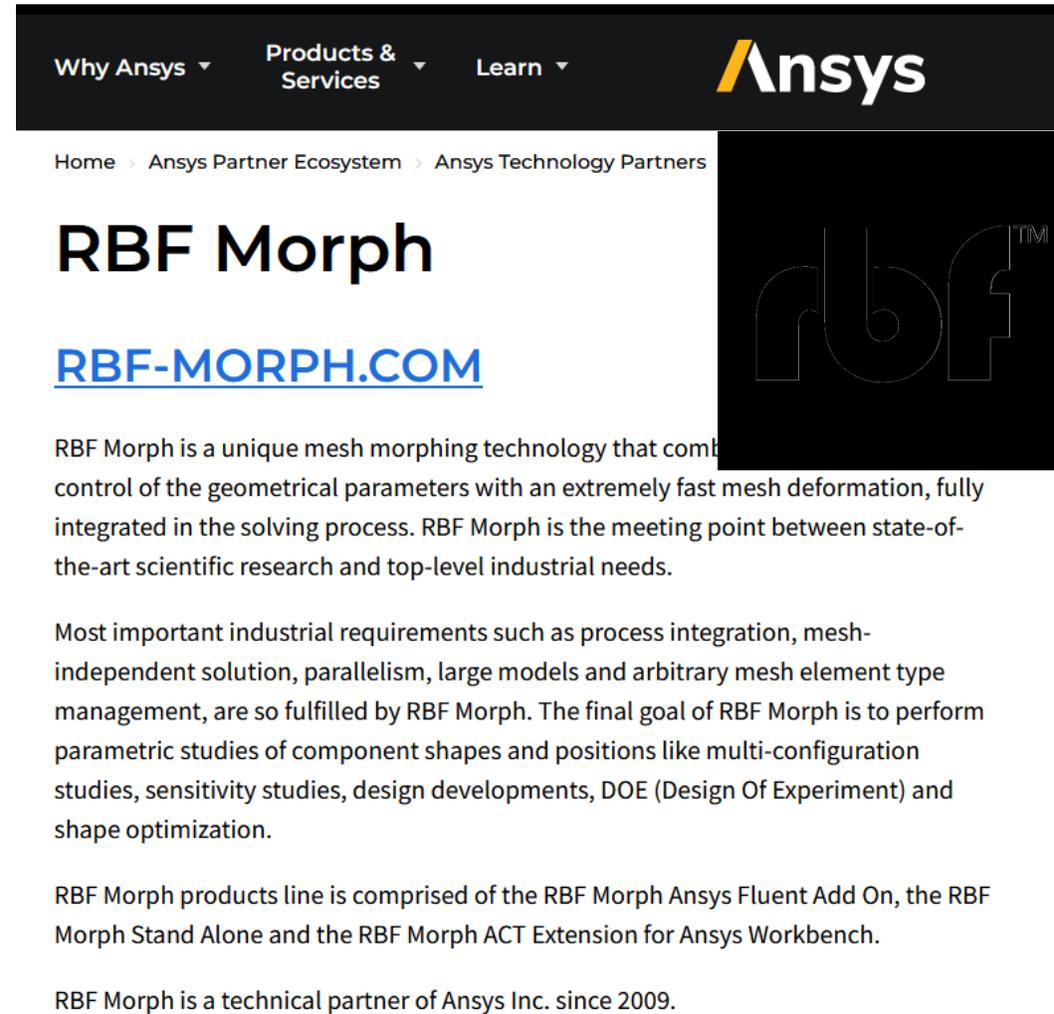


/ Agenda

- RBF Morph **Five Ws** introduction
- Parameter based mesh morphing
 - Shape optimization
 - Digital twins
- Parameter free mesh morphing
 - Self designing structures?
- Mesh morphing hands-on
- An advanced example: the update onto the as mounted shape of flexible PCB
- Take home message

RBF Morph Five Ws introduction: **Who?**

- RBF Morph is an **Italian company** providing advanced mesh morphing software and expertise
- We are **partner of Ansys** since 2009
- We have a long experience in advanced **CAE workflow**



The screenshot shows the RBF Morph website page on the Ansys Partner Ecosystem. The page features the Ansys logo in the top right corner and navigation links for 'Why Ansys', 'Products & Services', and 'Learn'. The breadcrumb trail reads 'Home > Ansys Partner Ecosystem > Ansys Technology Partners'. The main heading is 'RBF Morph' with the website URL 'RBF-MORPH.COM' below it. A large image of the RBF Morph logo is on the right. The text describes RBF Morph as a unique mesh morphing technology that combines control of geometrical parameters with fast mesh deformation, fully integrated in the solving process. It highlights its role as a meeting point between state-of-the-art scientific research and top-level industrial needs. The page also lists industrial requirements fulfilled by RBF Morph, such as process integration, mesh-independent solutions, and large model management. Finally, it details the RBF Morph product line, including the Ansys Fluent Add On, Stand Alone, and ACT Extension for Ansys Workbench, and notes that RBF Morph has been a technical partner of Ansys Inc. since 2009.

Why Ansys ▾ Products & Services ▾ Learn ▾ **Ansys**

Home > Ansys Partner Ecosystem > Ansys Technology Partners

RBF Morph

RBF-MORPH.COM

RBF Morph is a unique mesh morphing technology that combines control of the geometrical parameters with an extremely fast mesh deformation, fully integrated in the solving process. RBF Morph is the meeting point between state-of-the-art scientific research and top-level industrial needs.

Most important industrial requirements such as process integration, mesh-independent solution, parallelism, large models and arbitrary mesh element type management, are so fulfilled by RBF Morph. The final goal of RBF Morph is to perform parametric studies of component shapes and positions like multi-configuration studies, sensitivity studies, design developments, DOE (Design Of Experiment) and shape optimization.

RBF Morph products line is comprised of the RBF Morph Ansys Fluent Add On, the RBF Morph Stand Alone and the RBF Morph ACT Extension for Ansys Workbench.

RBF Morph is a technical partner of Ansys Inc. since 2009.

RBF Morph Five Ws introduction: **What?**

- We offer mesh morphing solution fully embedded in Ansys
- **RBF Morph Fluids** – an Add On for Fluent
- **RBF Morph Structures** – an ACT extension for Mechanical



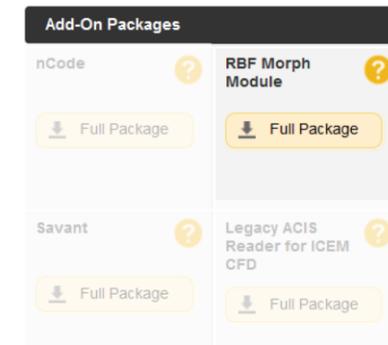
(rbf-morph)

**RBF Morph ACT
Extension for
Mechanical**

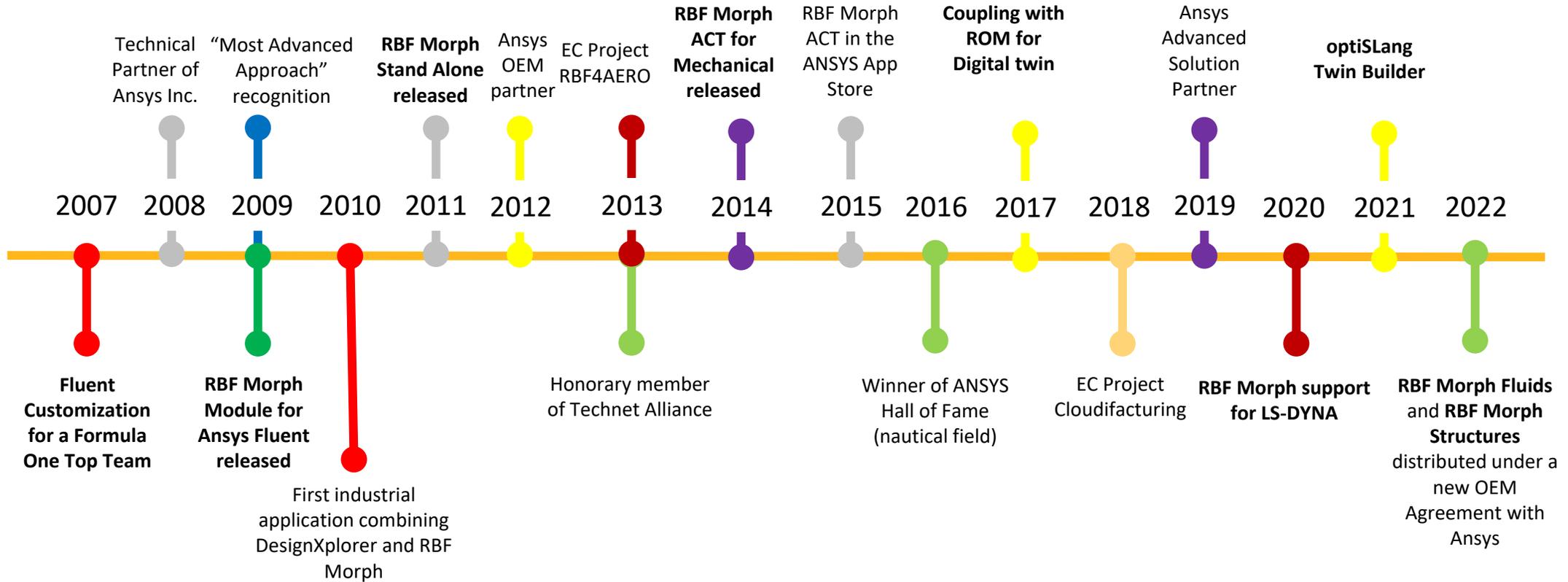
Target Application:
Meshing



Fast RBF mesh morphing technology that makes the mesh shape parametric with a few clicks. Basic and hierarchical shape modifications defined in the tree. Automatic shape optimisation now included.

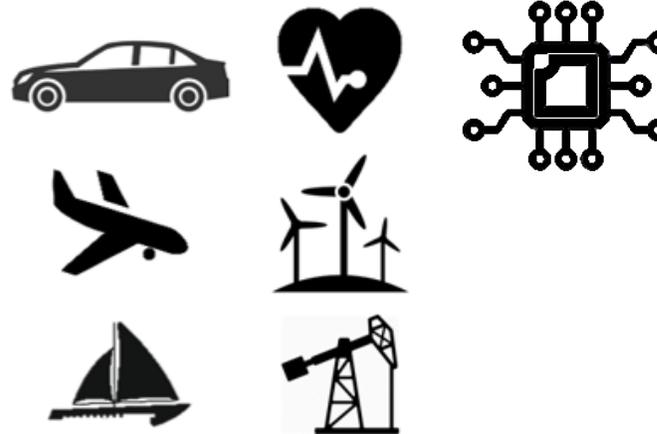


RBF Morph Five Ws introduction: **When?**



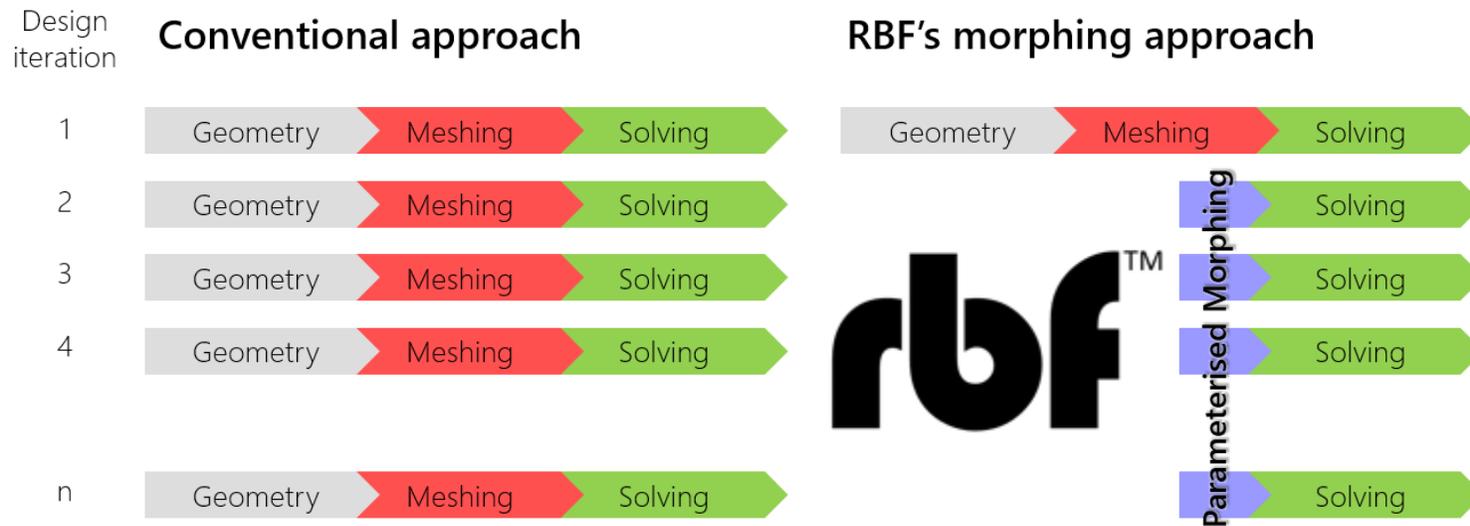
RBF Morph Five Ws introduction: **Where?**

- RBF Morph is serving **industry** and research
 - Automotive
 - Aerospace & Defense
 - Naval & Nautical
 - Healthcare
 - Energy
 - Oil & Gas
 - **Electronics**
 - ...



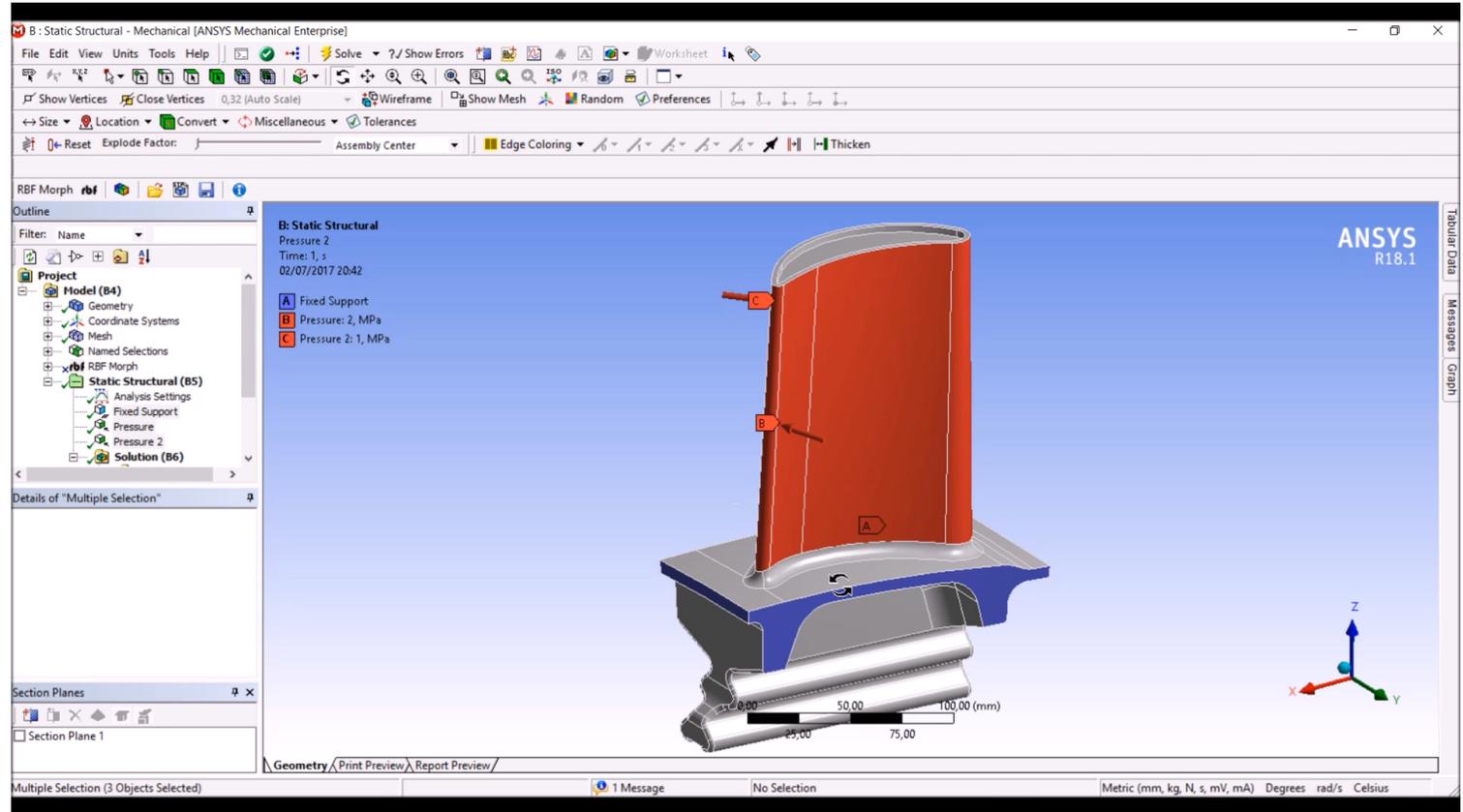
RBF Morph Five Ws introduction: **Why?**

- Morphing is a **key enabler** for optimization and Digital Twins
- The turnaround time of the optimization is usually **reduced by a factor five** (weeks becomes days)



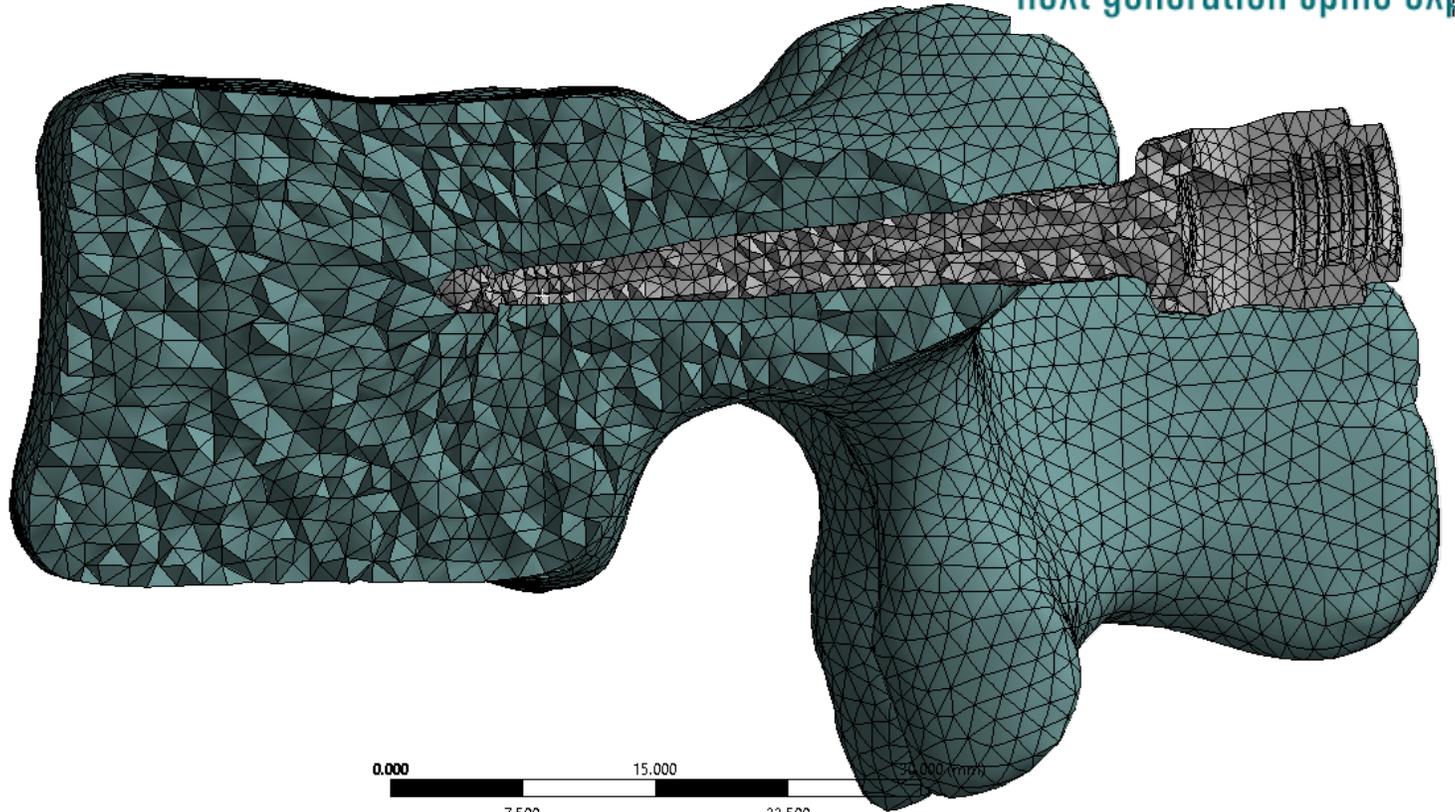
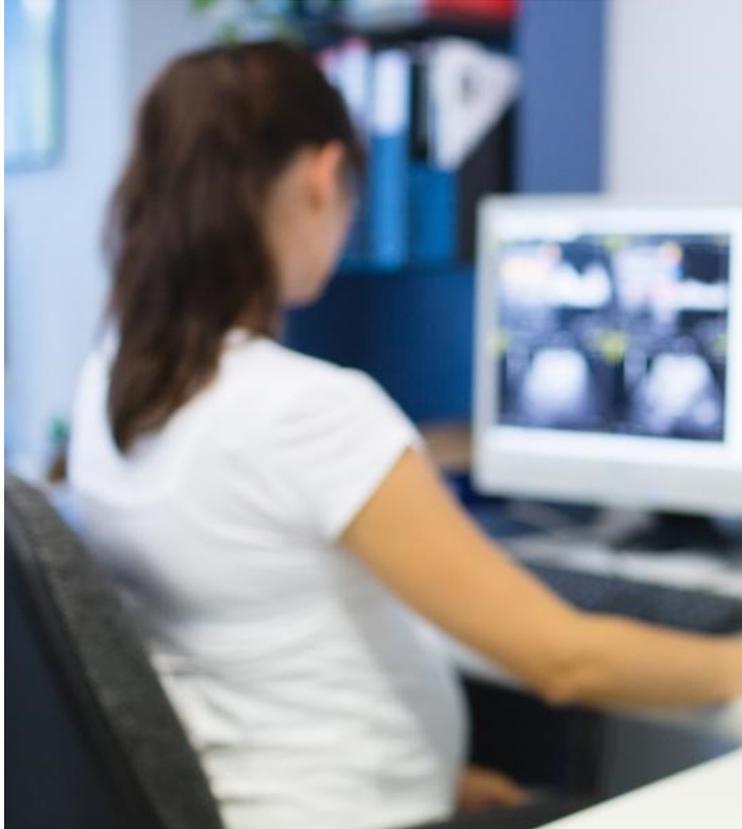
Parameter based mesh morphing (design points/snapshots)

- **Morphing regions** are identified and added in the tree (volume mesh)
- The shape is controlled acting on **surfaces**
- Surface control in this example is achieved by controlling two loops of **curves**
- The **two parameters** are steered to get the optimal design



Spine surgery Digital Twin

spinner
next generation spine experts

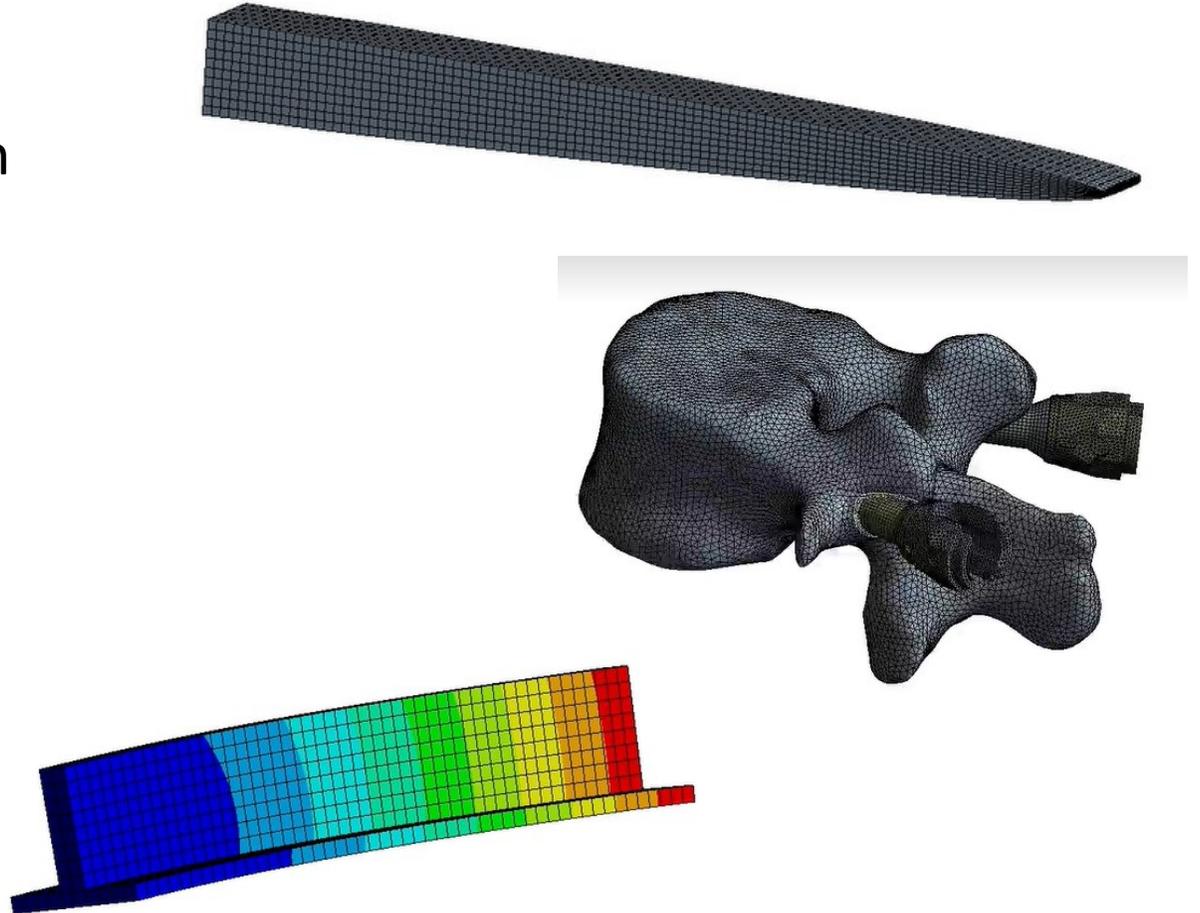


HOW A TREE TRUNK REACTS TO STRESSES

- The “Biological Growth method” BGM is adopted on the **morphing region**
- **Surfaces to be optimized** are selected prescribing the driving function (stress, cumulated plasticity, ...) and constraints (minimum thickness, packaging)
- Surfaces to be preserved are **constrained**
- DPs are populated with the BGM growth sequence

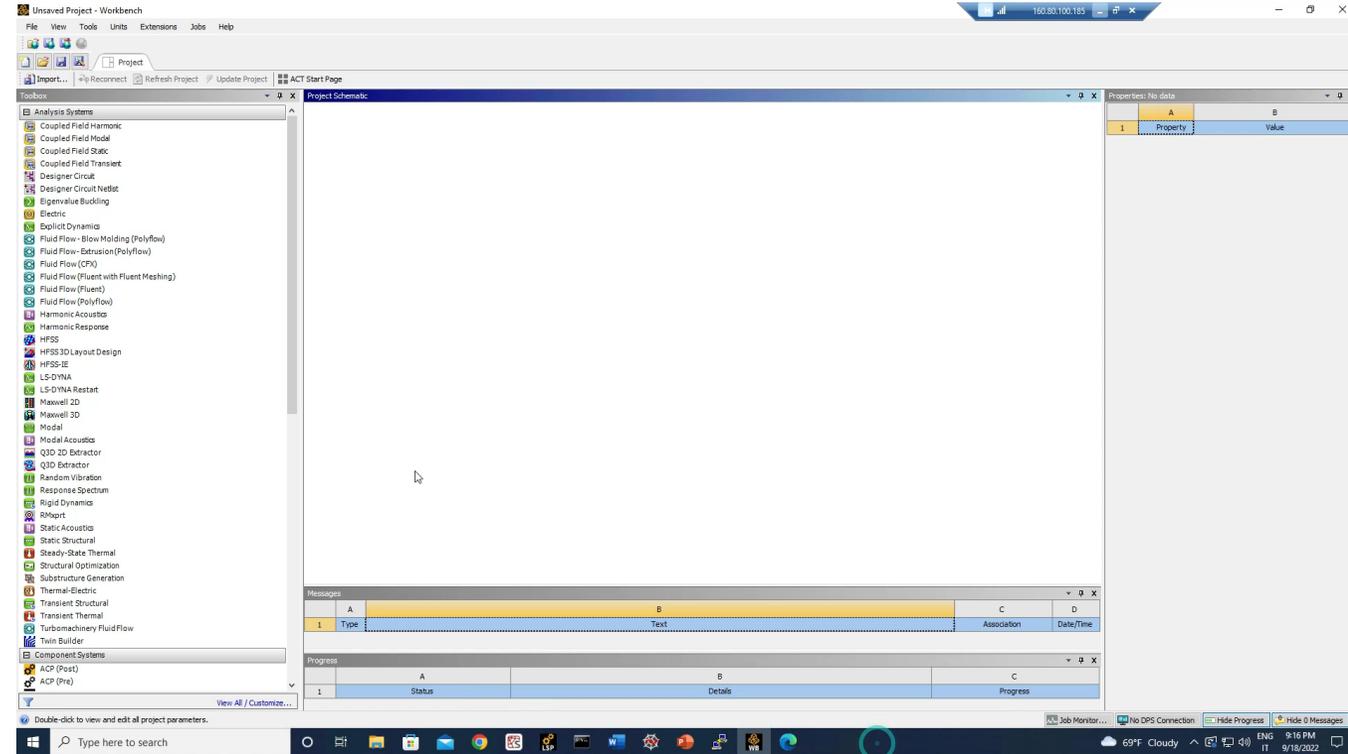
Mesh morphing hands-on

- **Parameter less** shape optimization with **BGM**: a cantilever beam going into the parabolic shape
- Creating the digital twin of the **spine** surgery with **Twin Builder**
- **Parameter based** optimization with **optiSLang**: a simple T-Beam



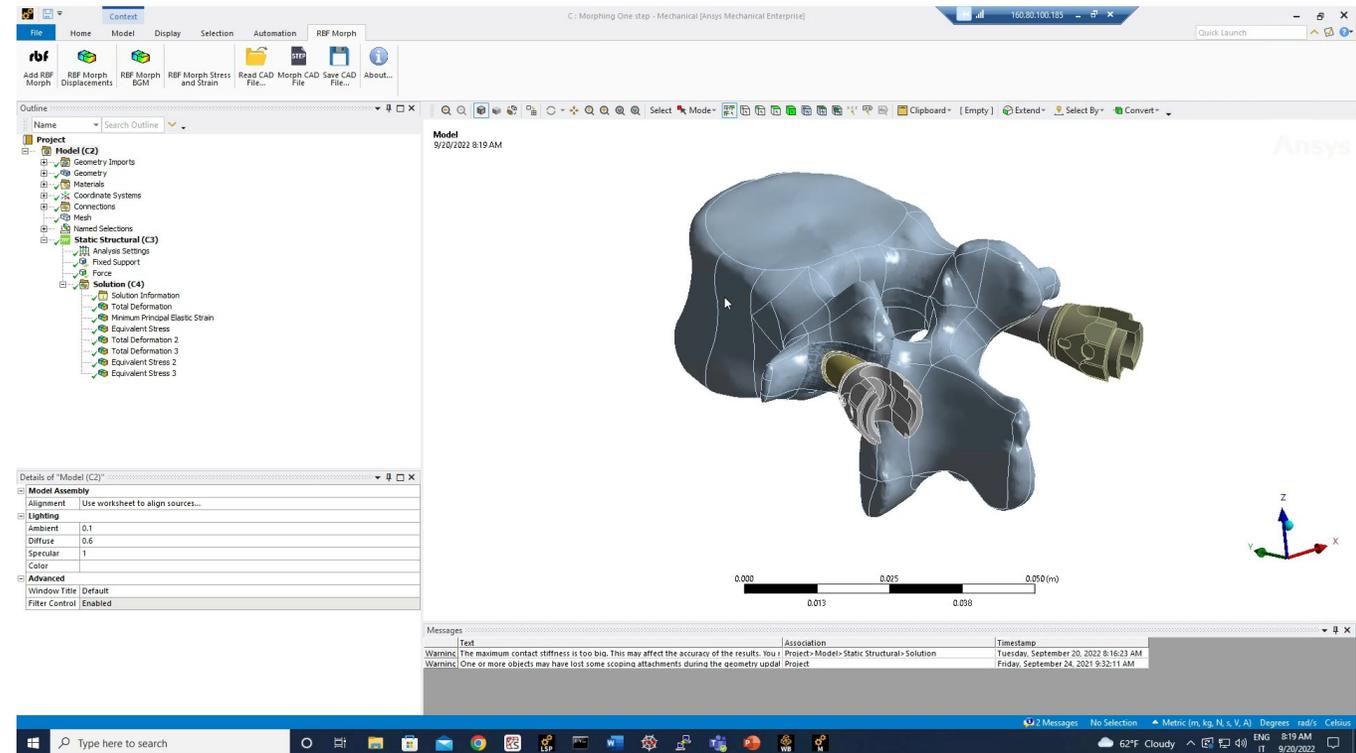
Mesh morphing hands-on

- **Parameter less shape optimization with BGM:** a cantilever beam going into the parabolic shape



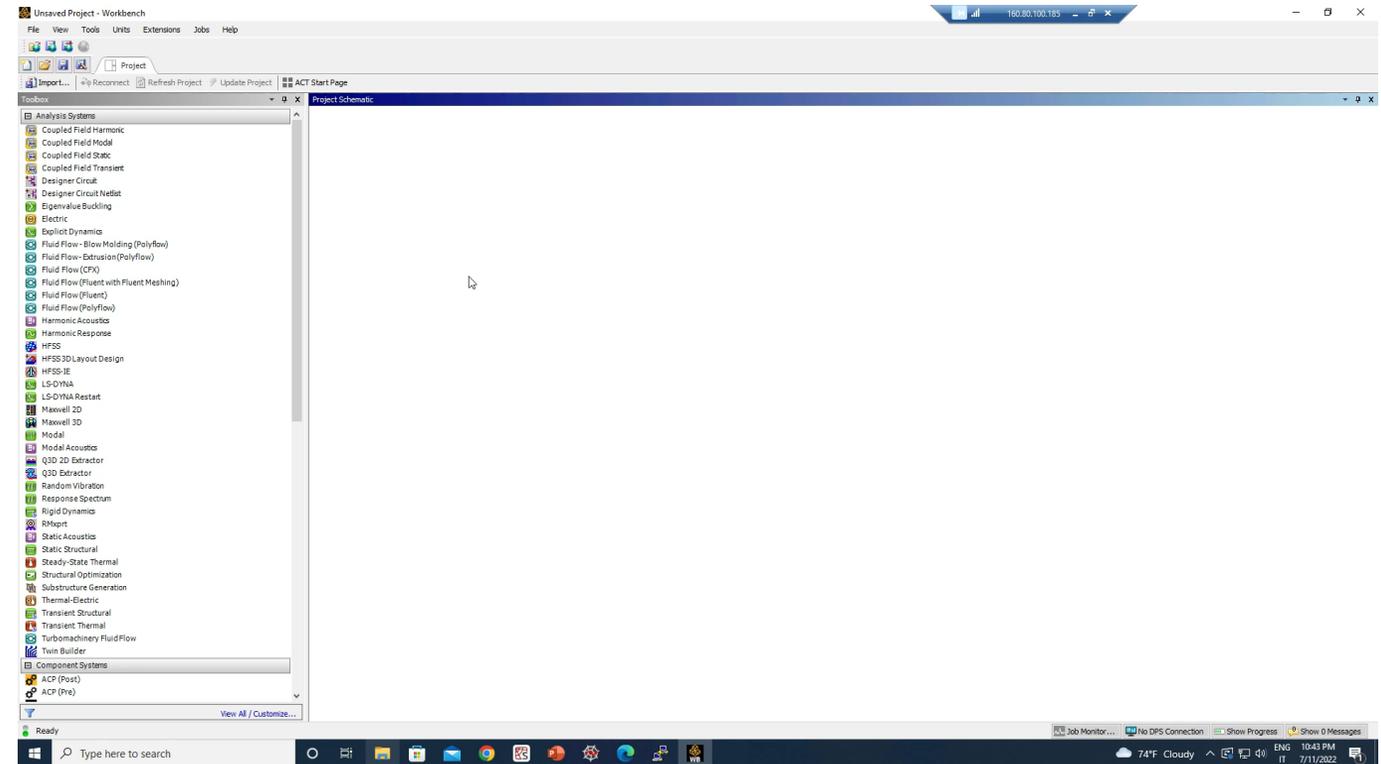
Mesh morphing hands-on

- Creating the digital twin of the **spine surgery** with **Twin Builder**



Mesh morphing hands-on

- **Parameter based optimization with optiSLang: a simple T-Beam**



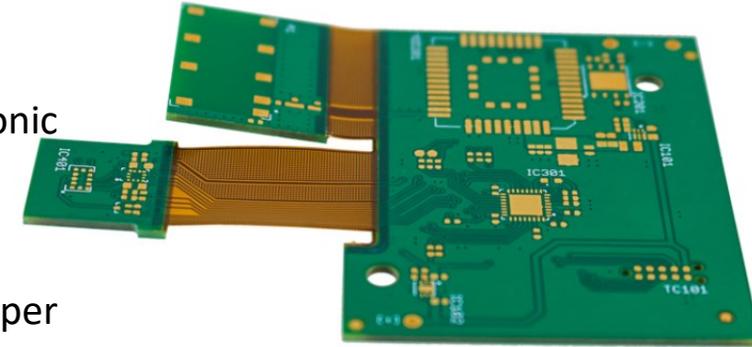
Update onto the as mounted shape of flexible PCB

Workshop by Sandeep Medikonda and Amogh Shejwal

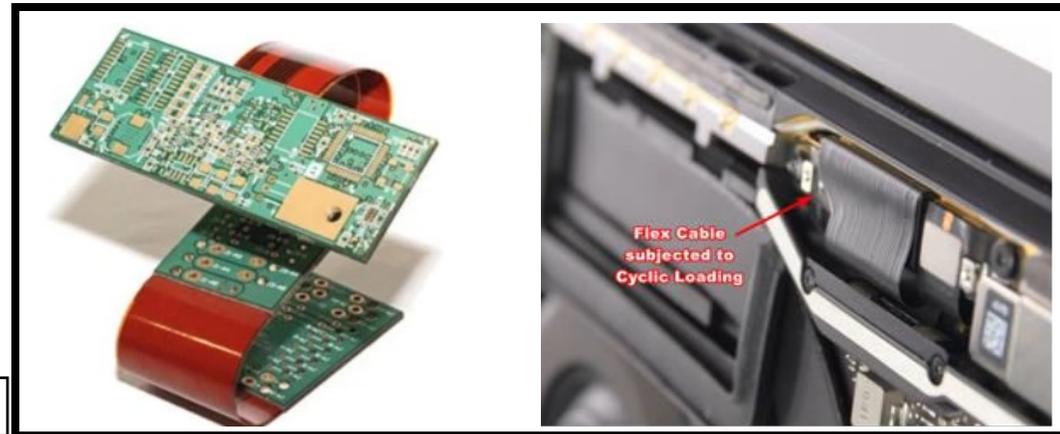


PCBs- Introduction

- As electronic devices have become smaller and more ubiquitous, the printed circuit boards (PCBs) and components that drive them face evermore complexity. To ensure product reliability and performance, accurate and detailed analysis methodologies are necessary
- A PCB is a multi-layer and multi-material component used in a vast number of electronic applications
- A Flexible PCB majorly comprises very thin (in the range of microns) circuit patterns of copper embedded in a non-conductive polymer layer (mostly polyimide)
- Flexes enable the circuitry to be designed to fit the electronic device or product as opposed to building the device to conform the circuit board



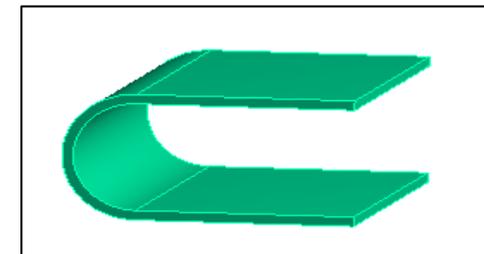
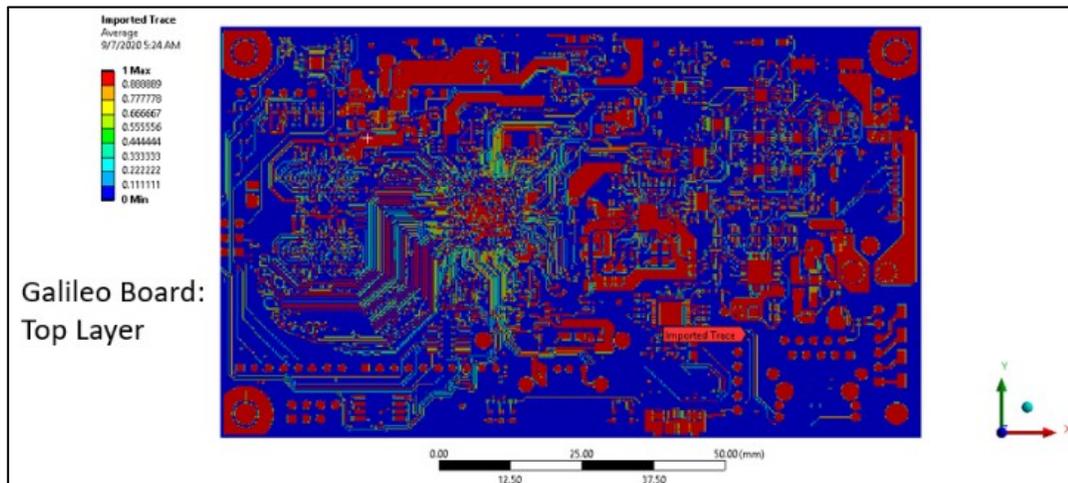
PCBs
Source: Epectec.com



Flexible PCBs

PCBs – Modeling Challenges and Goals

- The detailed design is typically only available **on a flat shape (ECAD)** and
 - the boards are built with layered materials
 - traces have a complex configuration
 - complexity of modelling ranges from **shell structures with traces mapped** up to **solid models** with traces full represented
- Numerical modeling of such structures requires a full nonlinear analysis to **deform the structure onto the installation shape** (hours of simulation on HPC)
- There is a **need for a clear and simple methodology** to adapt the FEA mesh onto the curved shape while preserving the trace mapping and trace modeling typically used while working with Electronic-CAD files
- In this study we explore the potential of **advanced mesh morphing** based on **Radial Basis Functions**



Deformed Shapes of Galileo Board

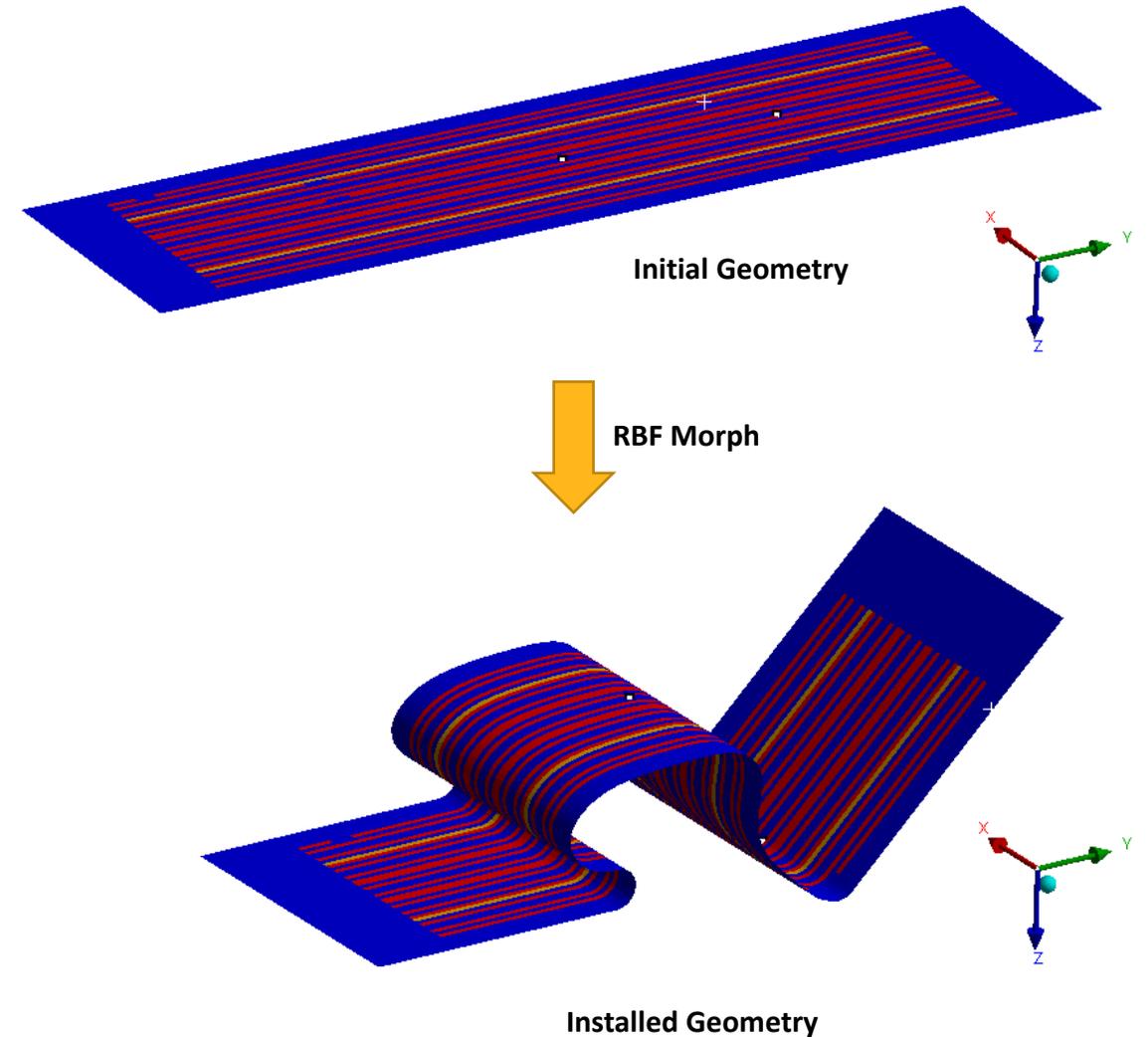
Workshop: FCB Cable

Goal:

- To morph the mesh from a flat FCB cable to its installed state

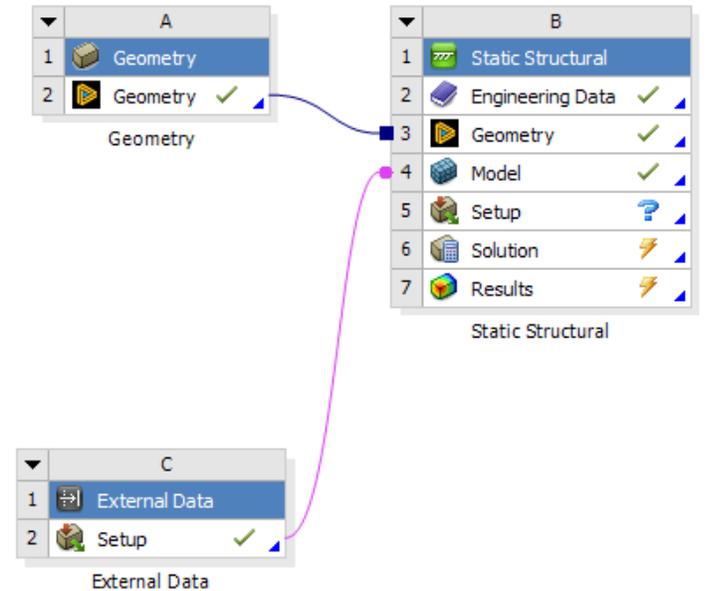
Model Description:

- FCB cable is a single layer 100 microns thick geometry
- The base or flat board is meshed with **shell elements**
- **Tracemapping** is used to represent the ECAD data
- The target geometry is installed state of the FCB



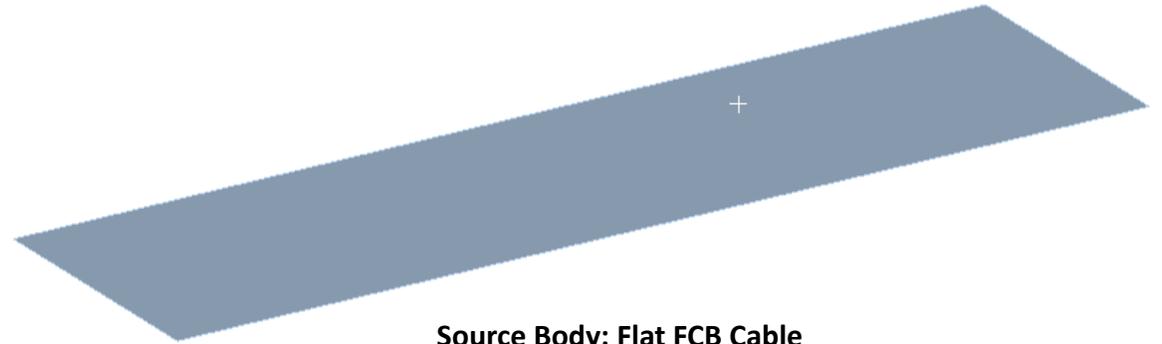
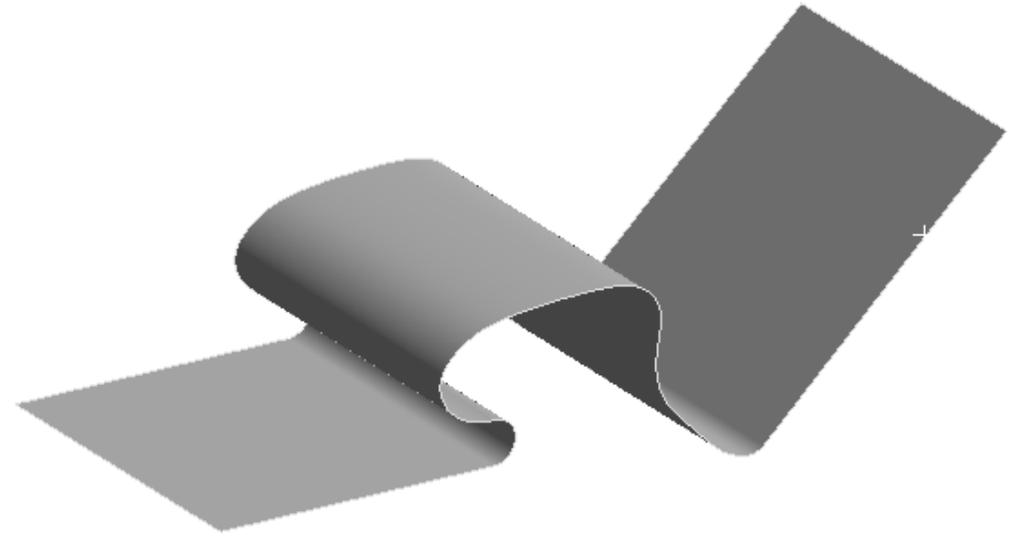
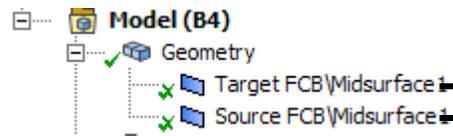
STEP 1: Opening the model in Ansys WB

- Launch Ansys V2021R2 or beyond from windows start button
- Once Ansys WB is opened, install the RBF Morph ACT. Installation directions are specified in the ACT download (Ansys store download link: [RBF Morph](#))
- Next, open the ***RBF_Morph_Shell_Tracemapped_FCB.wbpz*** file
- “Save As” the above file as ***RBF_Morph_Shell_Tracemapped_FCB.wbpj*** in the appropriate location
- Project Schematic should look like the image shown on right
- Double click on the Model cell to launch Mechanical



STEP 2: Geometry

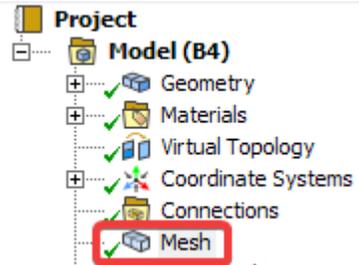
- In Mechanical, verify the following geometries:



STEP 3: Mesh and Tracemapping

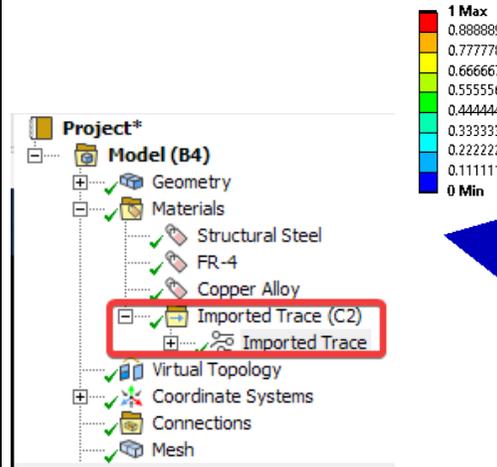
- The model shared with this document is meshed and tracemapped
- Verify the mesh and tracemapping settings

Mesh settings

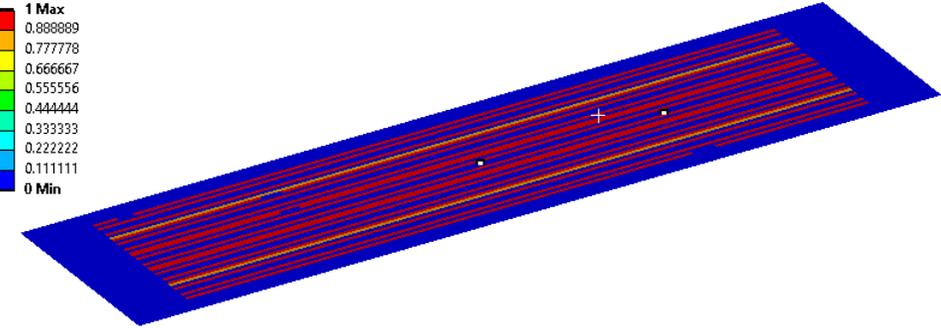


Details of "Mesh"	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
<input type="checkbox"/> Element Size	0.25 mm
Sizing	
Quality	
Inflation	
Batch Connections	
Advanced	
Statistics	

Tracemapping setting

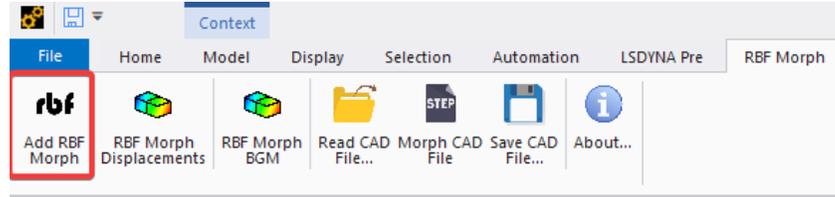


Details of "Imported Trace"	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Type	Imported Trace
Suppressed	No
External Data Identifier	File1
Shell Offset	Middle
Graphics Controls	
Layer	M1
Component	Average
Display Source Points	Off
Settings	
Legend Controls	
Named Selection Creation	
Material	
Modeling	Averaged
Discretization	
<input type="checkbox"/> X-Discretization	200
<input type="checkbox"/> Y-Discretization	200

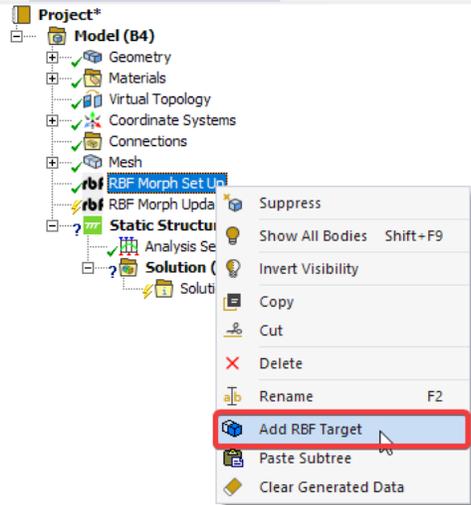


STEP 4: RBF Morph Setup

- Add RBF Morph from the top ribbon



- Right click on *RBF Morph Set Up* and *Add RBF Target*



Details of "RBF Target"

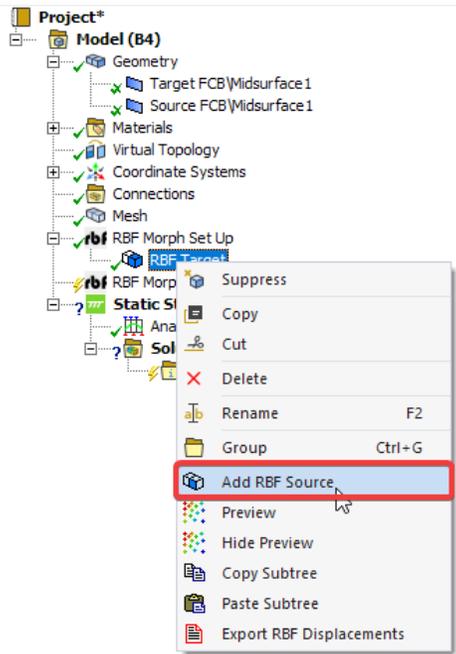
Node Selection	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Transformation	Translation
Translation Definition	Manual
<input type="checkbox"/> Delta x	0 mm
<input type="checkbox"/> Delta y	0 mm
<input type="checkbox"/> Delta z	0 mm
RBF Function	
Degree	1
Combine Select	
Acting On	Undeformed
If Selected Nodes Overlap	Override
<input checked="" type="checkbox"/> Coord Filtering	Yes
Coordinate System	Global Coordinate System
Locked Coordinate	x
<input type="checkbox"/> Locked Coordinate Value	0 mm
RBF Problem	
<input type="checkbox"/> Source	201
<input type="checkbox"/> Target	10251



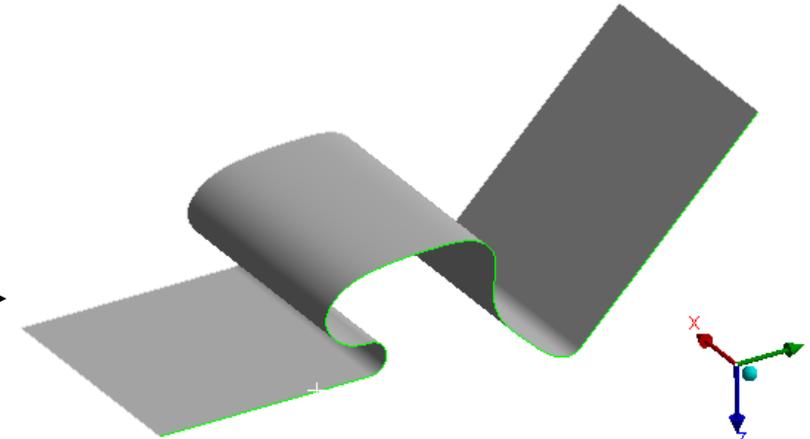
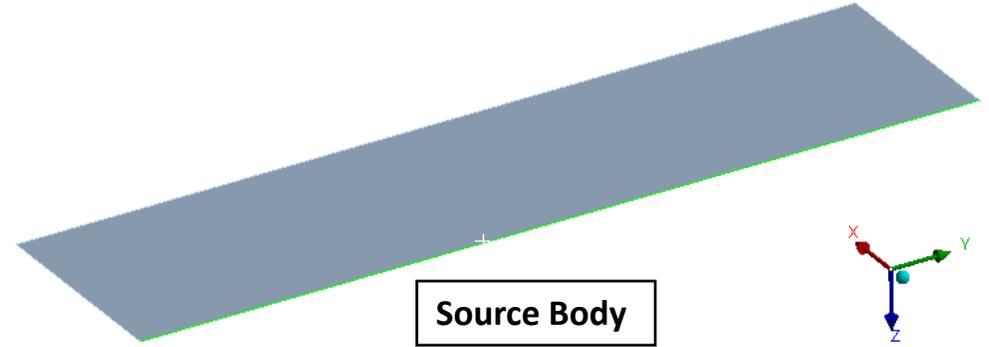
- Select Source FCB under geometry Scoping
- Turn on the *Coord Filtering* option and choose Global Coordinate System
- Lock the X axis of the Coordinate system

STEP 4: RBF Morph Setup

- Right click on *RBF Target* and *Add RBF Source*

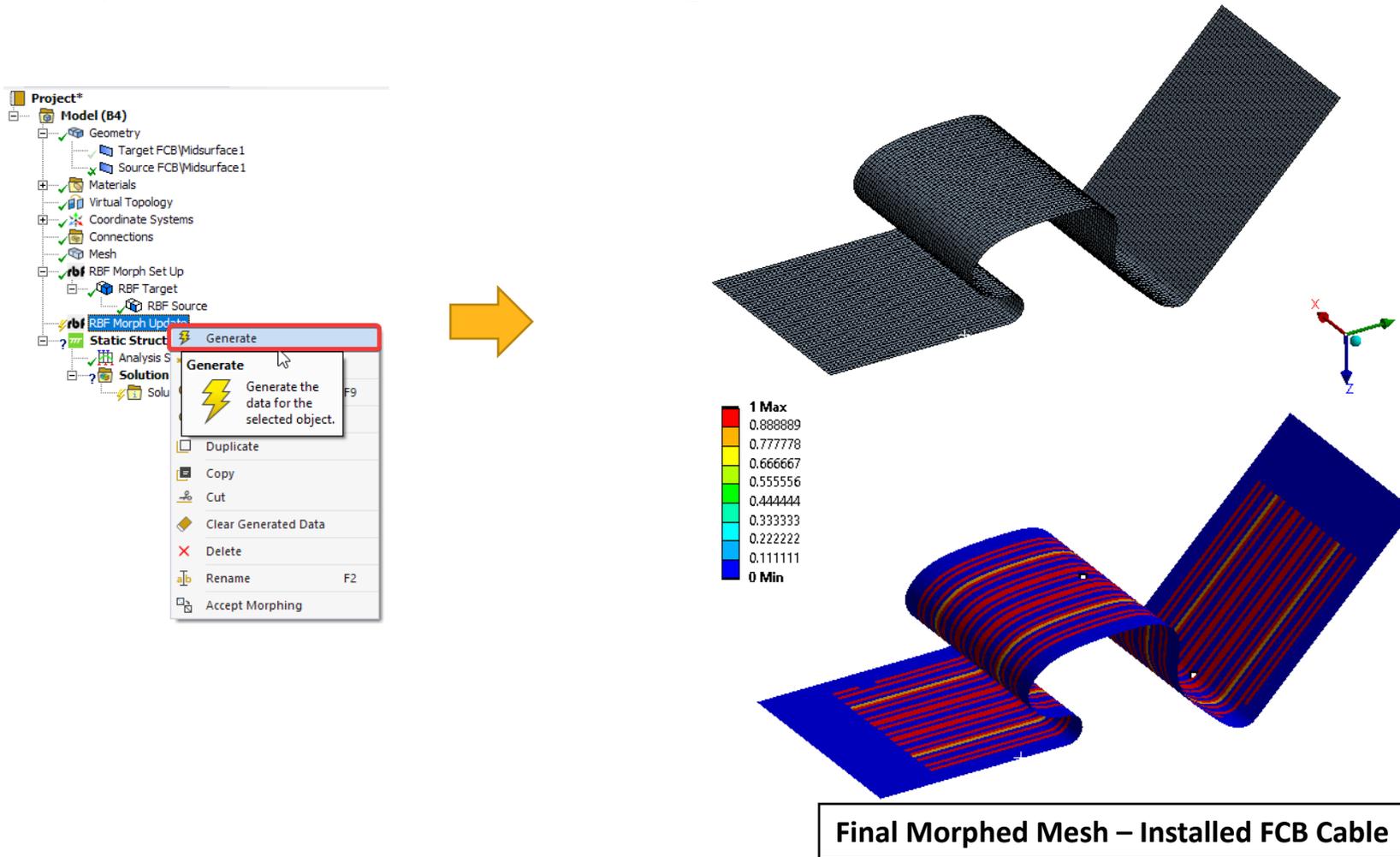


Details of "RBF Source"	
Node Selection	
Scoping Method	Geometry Selection
Geometry	1 Edge
Definition	
Transformation	Curve Targeting
Percentage	1
Invert	Yes
Method	Segment-wise
Geometry Selection	
Scoping Method	Geometry Selection
Geometry	1 Edge
RBF Function	
Degree	1
Combine Select	
Acting On	Undeformed
If Selected Nodes Overlap	Override
Coord Filtering	No
RBF Problem	
<input type="checkbox"/> Source	0
<input type="checkbox"/> Target	201



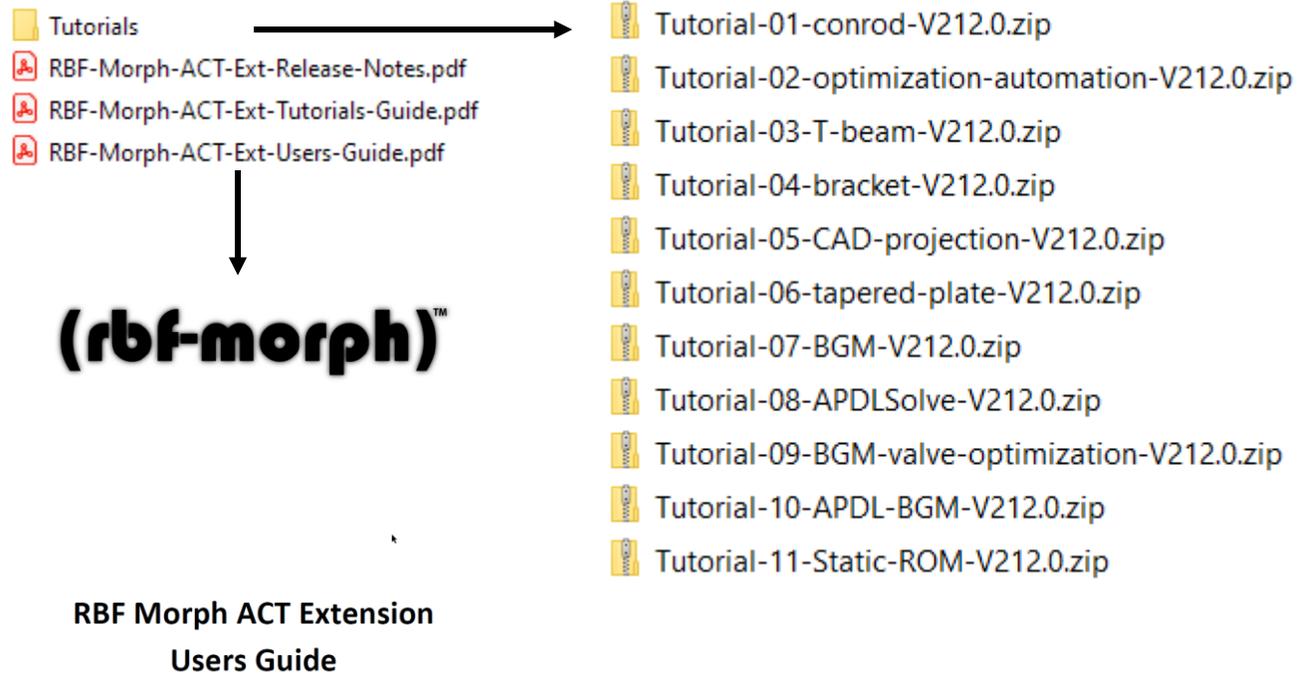
STEP 4: Generate Morphed Mesh

- Right click on *RBF Morph Update* and *Generate*. This will generate the morphed data
- A tracemapped FCB cable in installed state will be generated



Additional Resources

- In addition to the examples in this presentation, RBF Morph has comprehensive User Guide and extensive set of tutorials included in the ACT download



- Open Access technical paper on *“Modeling flexible/curved PCBs using RBF mesh morphing”* [Link](#)

/ Take home message

- Advanced **mesh morphing** with RBF Morph has been demonstrated for **Mechanical** applications
- Shape optimization, **parameter based or parameter less**, is available within Mechanical (and MAPDL with our CDB morphing tool)
- Snapshots for **reduced order models** and digital twin definition can be easily generated using as input shape parameters
- Mesh morphing can also be used for **morphing onto a prescribed target** (a new CAD variation, the actual manufactured shape captured by 3d scan)
- To learn more about the technology and how it can help your design visit our website
 - www.rbf-morph.com

/ Thank you!



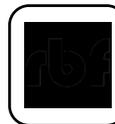
marco.biancolini@rbf-morph.com



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[youtube.com/user/RbfMorph](https://www.youtube.com/user/RbfMorph)



rbf-morph.com

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