



PARTNERSHIP FOR
ADVANCED COMPUTING IN EUROPE

RBF Morph hands-on

Dr. Marco Evangelos Biancolini
University of Rome “Tor Vergata”



**PRACE Autumn School 2013 - Industry Oriented HPC Simulations, September 21-27,
University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana, Slovenia**

Outline

In this hands-on session, the following workshops will be carried out:

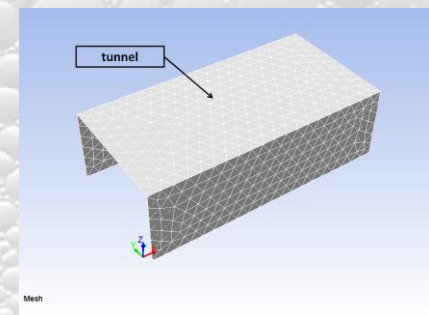
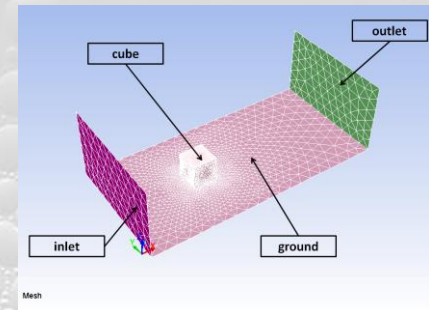
- Workshop 1: A 3D wind tunnel (tutorial 1+ tutorial 5)
- Workshop 2: Tube morphing (tutorial 4)
- Workshop 3: Adjust the position of a motorbike driver(tutorial 2)
- Workshop 4: Shape optimisation of an FSAE car airbox (tutorial 3)

Workshop 1 – Overview, objectives and procedure

The objective of the first tutorial is to provide the user with the guidelines for setting up and solving a morph study. The computational model is constituted of a cube with edges of 1m immersed in a virtual wind tunnel (10m long, 5m wide, and 3m high) located at 3m from the inlet and at 6m from the outlet.

The procedure foresees the following main steps:

- start RBF Morph;
- set up the RBF solution for the translation of the *cube* surface along $x+$ direction;
- set up the RBF solution for the rotation of the *cube* surface around the vertical $z+$ (2 approaches);
- set up a RBF multi-solution employing the earlier calculated solutions;
- set up the RBF solution to generate a fillet using STL target feature.



Workshop 1 – Acquired know how

This tutorial demonstrates how to do the following operations:

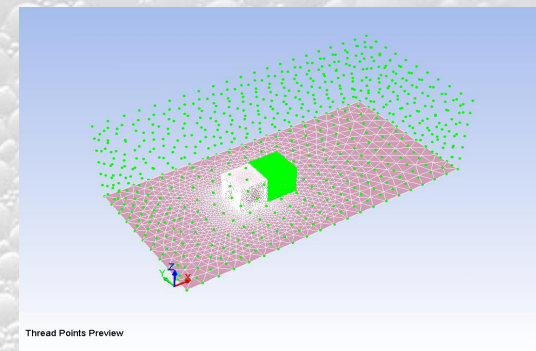
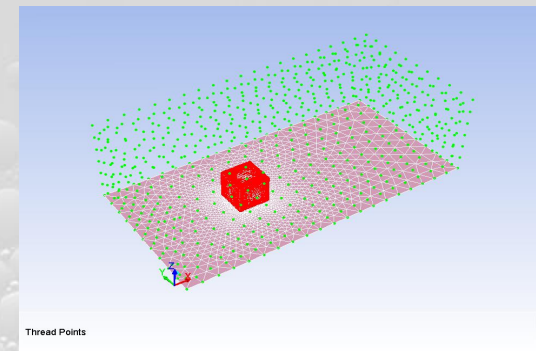
- define source points by means of different RBF Morph features (**Surfs** and **Encaps** panel);
- preview source points in both the baseline and morphed configuration;
- generate the RBF solution;
- preview the RBF solution effect on the mesh (qualitative evaluation check);
- load and adjust an existing solution;
- list the surfaces effectively involved by the encap (encapsulation) action;
- accomplish the morph testing (quantitative evaluation check);
- save the RBF solution;
- reset a solution set-up;
- set up a multi-morph solution;
- use of the STL feature of RBF Morph.

Workshop 1 – Cube translation solution

The cube translation will be accomplished by means of the features of the **Surfs** panel only. In particular, the set-up envisages that:

- all nodes of *cube* surface are utilized to define the first set of source points for prescribing a rigid movement (displacement of 1 m along x axis);
- all nodes of the *tunnel*, *inlet* and *outlet* surface are used to define the second set of source points constrained through a null movement.

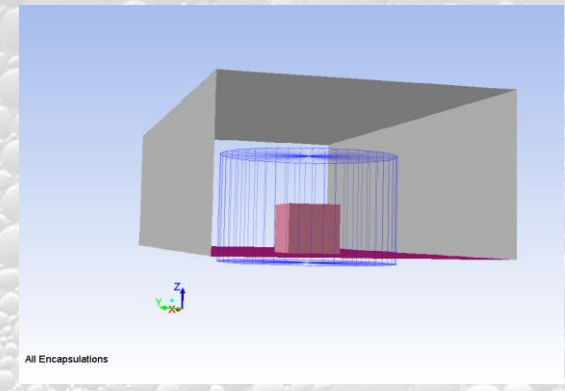
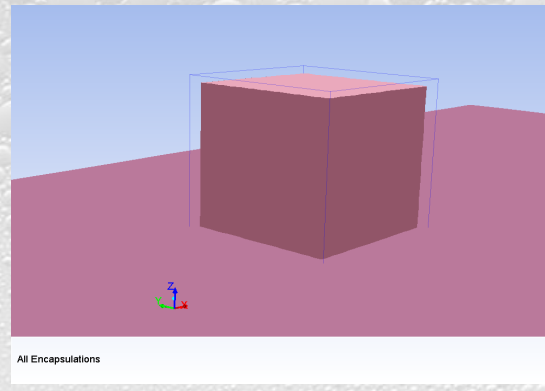
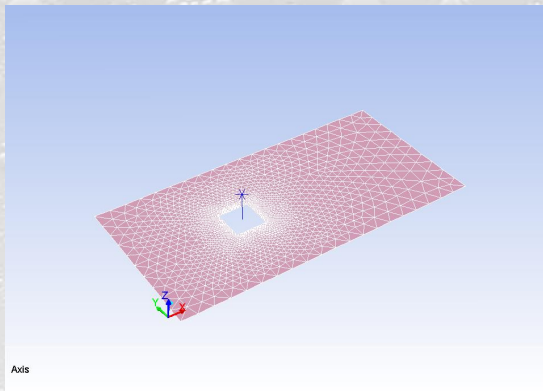
By default, all areas without a prescribed motion, namely the *ground* surface and the volume mesh, are left free to be smoothed by the morphing action.



Workshop 1 – Cube rotation solution

The cube rotation will be carried out adopting two strategies:

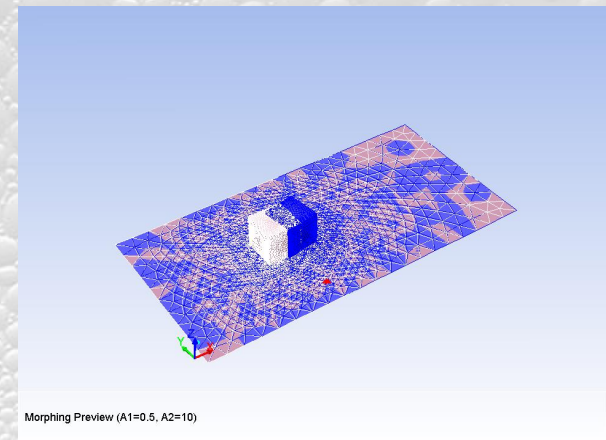
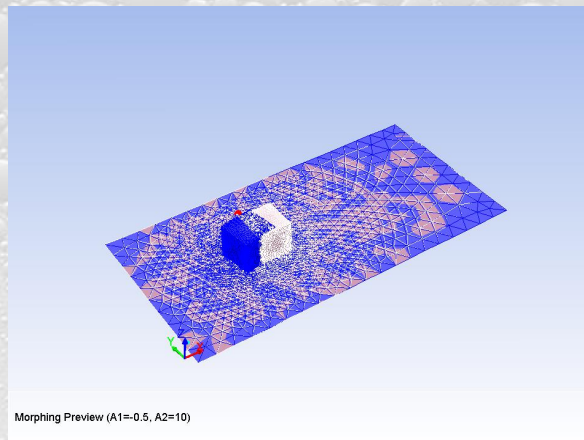
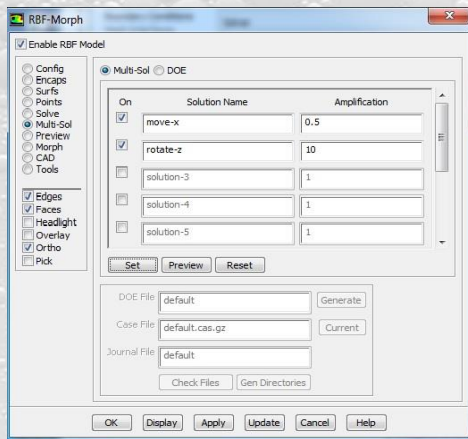
1. by properly adjusting the first surfs set of the previously obtained solution (*cube* translation) so as to impose to the nodes of *cube* surface a rotation of 10° around the vertical z axis;
2. using the feature provided by the **Encaps** (Encapsulations) panel. In particular, two encaps (one **moving** and one **domain** type) will be defined.



Workshop 1 – Solutions combination

Finally, the combination of RBF solutions will be performed in order to:

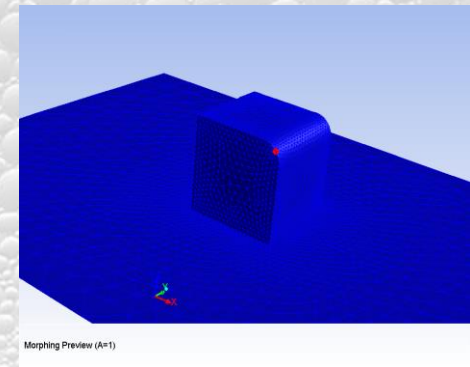
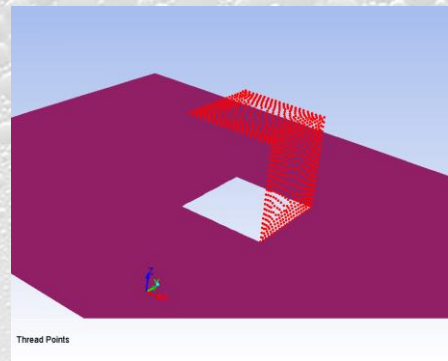
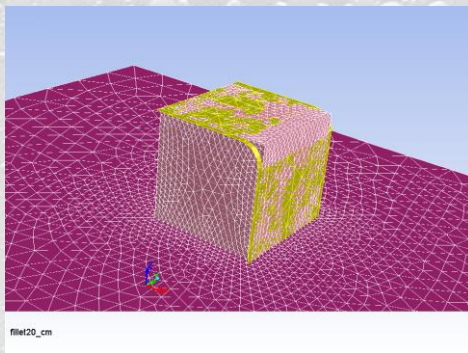
- evidence how different modifications can be applied, previewed and checked contemporaneously;
- describe how evaluating the constraints of the morphing action application (limits of the amplification coefficients) in the event that different modifications are needed to be considered at the same time.



Workshop 1 – STL target

The purpose is to generate a fillet on the cube by rounding one of its edges for two values of the rounding radius, namely 20 and 30 cm respectively. Considering the baseline configuration of the model, the top edge parallel to the y axis further from the inlet will be rounded by using available STL files as a target.

The rounding of the edge will be accomplished using one Surfs set coupled with a **selection** box-shaped encap will be generated in order to define a sub-portion of nodes which the target feature will be applied to, together with one box-shaped **domain** encap to limit the morphing action.



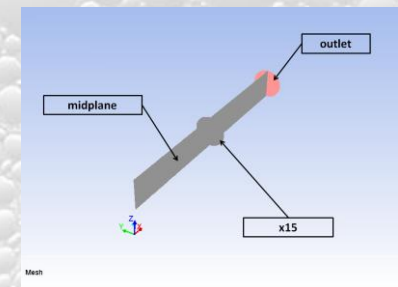
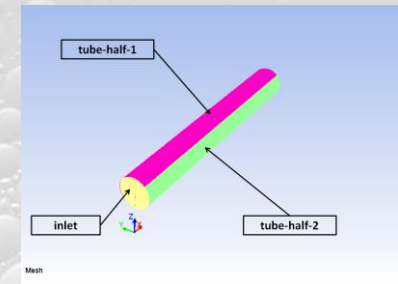
Workshop 2 – Overview, objectives and procedure

The second tutorial aims at supplying the guidelines for setting up and solving a morph study by means of the **Encaps** and **Points** features.

The computational model is a single vessel represented by a straight pipe with circular cross section. The pipe's length is 30mm and its diameter is 4mm.

Specifically, the procedure foresees the following steps:

- start RBF Morph;
- set up the RBF solution for imposing the displacement of 2 mm along z axis of the extremities of the tube mode (first solution);
- set up the RBF solution for the scaling of the central portion of the tube (second solution);
- set up of the tube morphing using the **Points** panel features (third solution).



Workshop 2 – Acquired know how

Through this tutorial the user learns the following operations:

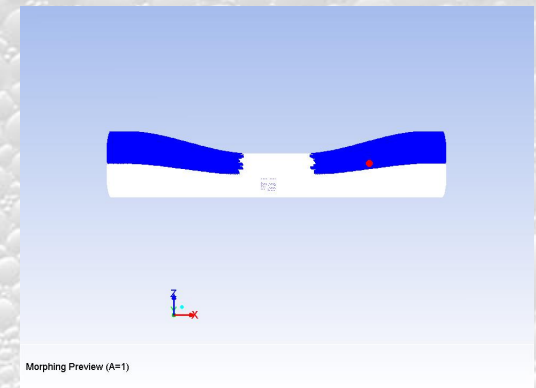
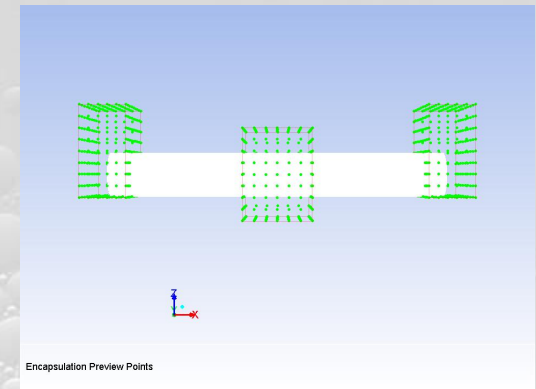
- morph a model using **moving** encaps only;
- employ the scaling feature;
- create an animation of the preview of the morphing action;
- save the frames of the animation sequence;
- generate **Points** utilizing the source points of a domain encap;
- morph a model using the **Points** feature;
- apply RBF functions with different order .

Workshop 2 – Middle section offset

The first solution foresees the translation of tube extremities along the z axis adopting the following RBF solution settings:

- both ends of the pipe are fixed using a **moving** encap with a rigid translation movement;
- the central domain of the pipe is wrapped by means of a **moving** encap with a null rigid movement.

Employing such a strategy, the model of the pipe will be accordingly deformed to accommodate the afore-listed displacements.

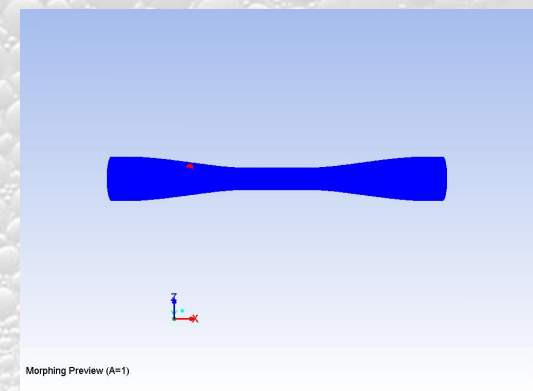
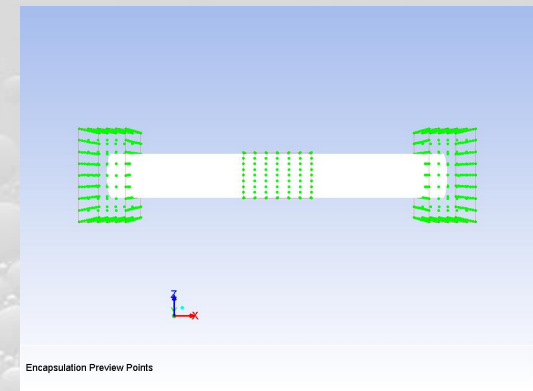


Workshop 2 – Middle section scaling

The second solution envisages the scaling of the central portion of the tube employing the following RBF solution set-up:

- both ends of the pipe are fixed using a **moving** encap with a null rigid movement;
- the central domain of the pipe is wrapped by means of a **moving** encap with a scaling action.

In such a manner, the pipe will then be deformed to accommodate the new shape of the throat.



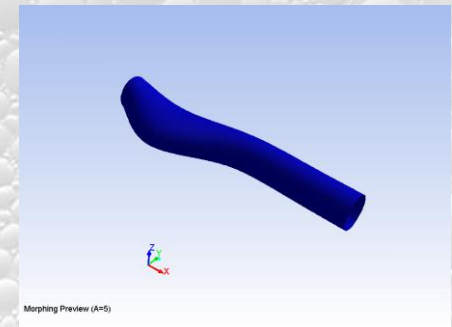
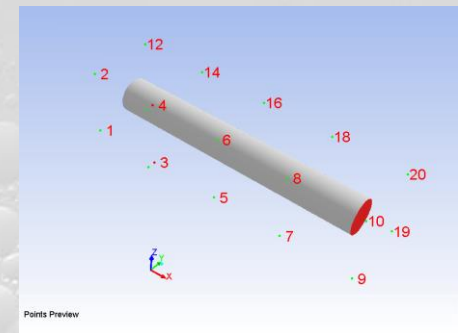
Workshop 2 – Tube morphing through Points

The third solution deforms the tube modifying the positions of **Points**. Points are special entities defined through source points generated in a **domain** encap by applying the **SP -> Points** feature of RBF morph.

For what stated, the steps to be done are listed below:

- definition of a **domain** encap with a suitable resolution;
- RBF solution achievement;
- generation of **Points** by source points extraction;
- **Points** displacement definition.

The RBF function order can be changed to improved surface smoothness.

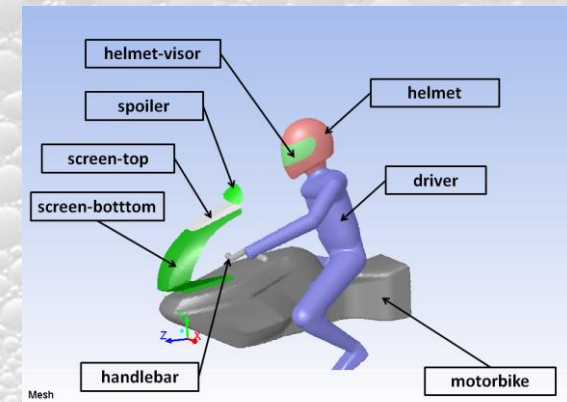
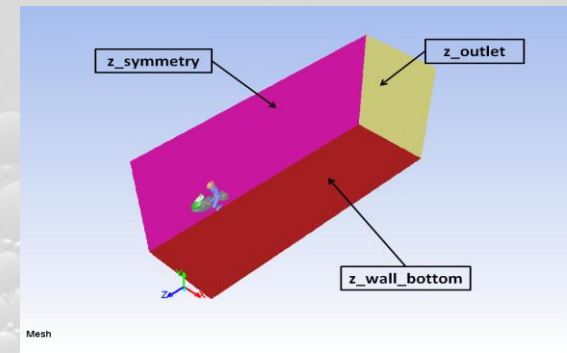


Workshop 3 – Overview, objectives and procedure

The principal objective of this tutorial is to show the user how loading previously computed RBF solutions to customize a combined solution.

The procedure foresees the following main steps:

- start RBF Morph;
- load the first solution dealing with the driver head rotation and browse through the GUI panels to acquire the knowledge of the RBF solution settings;
- redo the operations of the previous item for the second RBF solution;
- apply the multi-morph solution and evaluate the effects of smoothing on the mesh.



Workshop 3 – Acquired know how

Through this tutorial the user learns the following operations:

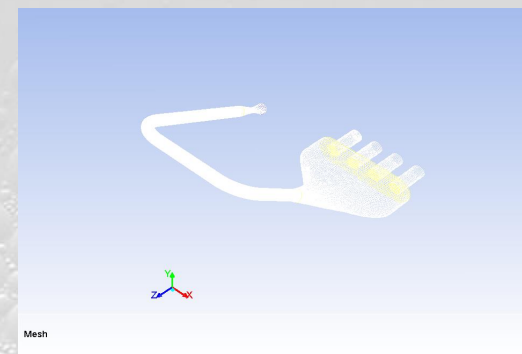
- acquire the knowledge about the use of .rbf and .sol files;
- fast select model surfaces through the **Pick** feature for morphing preview.

Workshop 4 – Overview, objectives and procedure

This tutorial aim is to supply the guidelines for setting up and executing an optimisation study of the divergent duct of a car aibox.

The procedure foresees the following main steps:

- start RBF Morph;
- load two RBF solutions in which the curvature of lateral walls of the divergent duct is reshaped through an external cylinder-shaped **moving** encap;
- generate the DOE (Desing Of Experiments) file for running the optimisation study;
- preview the action of combined modifications employing the DOE file.



Workshop 4 – Acquired know how

Through this tutorial the user learns the following operations:

- load solution data gained through a previous analysis;
- inspect the solution;
- set up and apply **moving** encaps;
- set up a DOE morphing analysis; ,
- preview the effects of the combinations defined through the DOE table.

Thank you for your attention!

Dr. Marco Evangelos Biancolini

E-mail: biancolini@ing.uniroma2.it

Web: www.rbf-morph.com

YouTube: www.youtube.com/user/RbfMorph