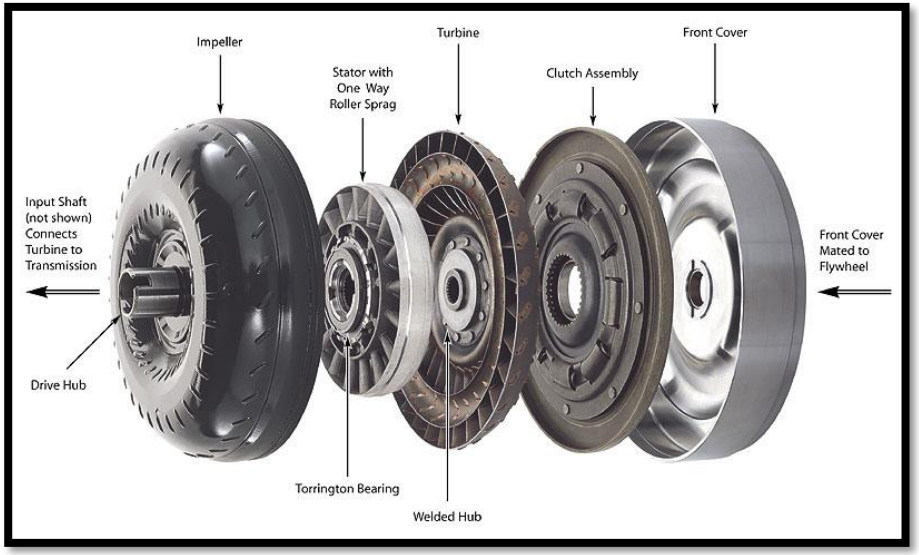
Automated Morphing and Optimization of Blade Assemblies

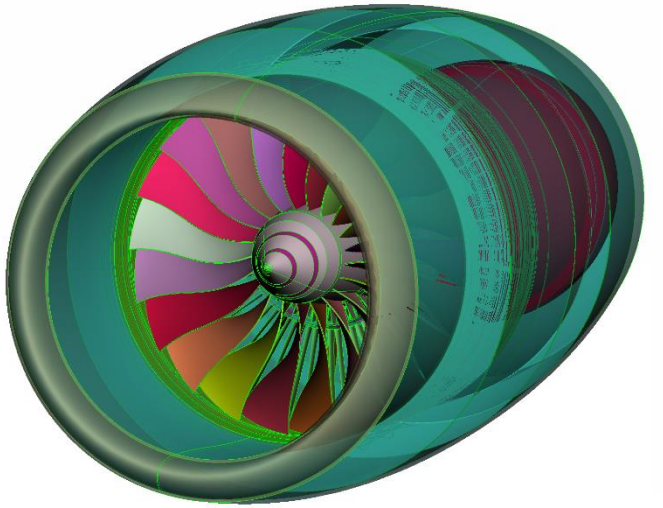
Automotive (Implemented at OEM's)

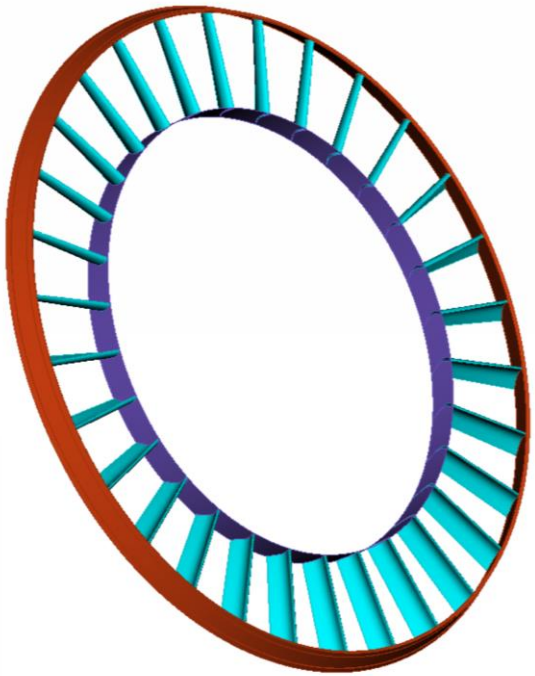


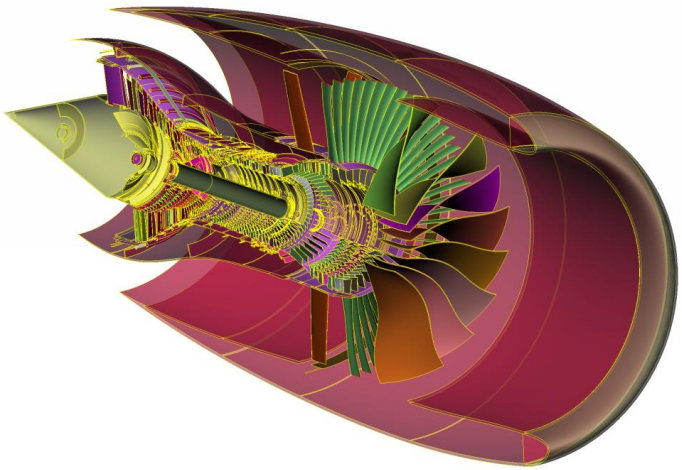
Torque Converter

This plugin can be used for 3D Ribs and Defrost Assembly (baffles/vanes) too.

Aerospace







Steps involved in the plugin

Entire process is automated using ANSA:

1. **Blade/Vane/Baffle** geometry is **trimmed** to accommodate assembly needs

2. **Morph** boxes fitting and shape changes

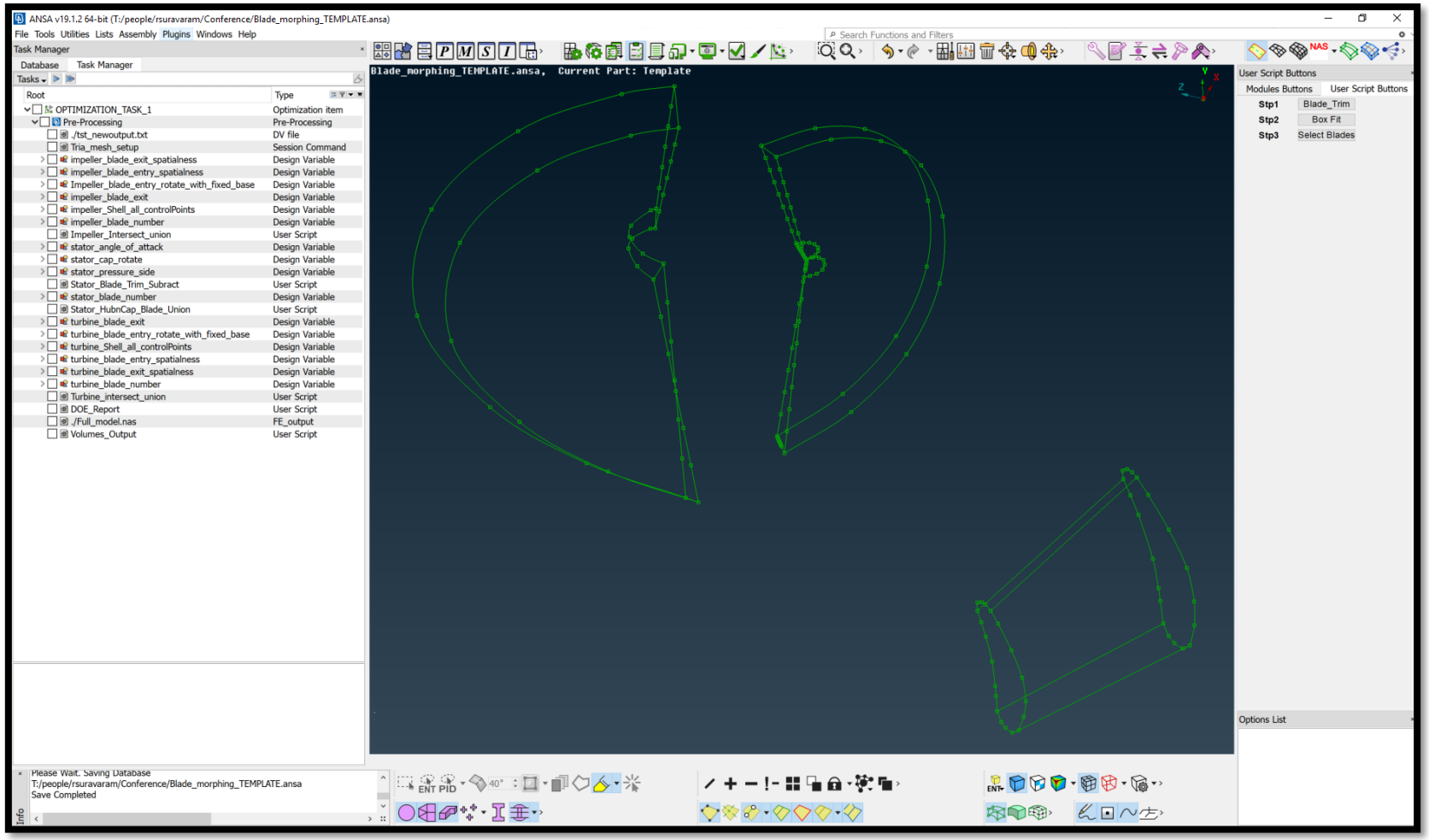
3. **Creating copies** of morphed geometry

4. **Intersecting** and **connecting** blades (**Boolean operation**) **to assemble**

5. **Volumes** Output

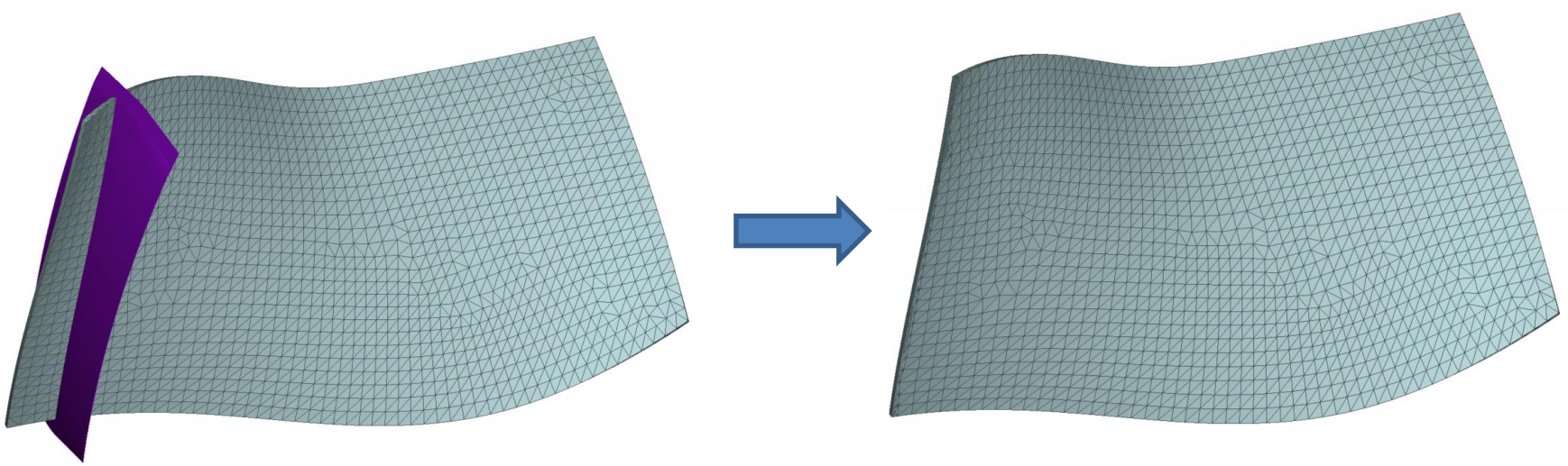
Template

- Ansa file template with **custom buttons**, **morph boxes** and **optimization task**
- **Any blade design** can be **imported** and **morphed** to obtain different designs



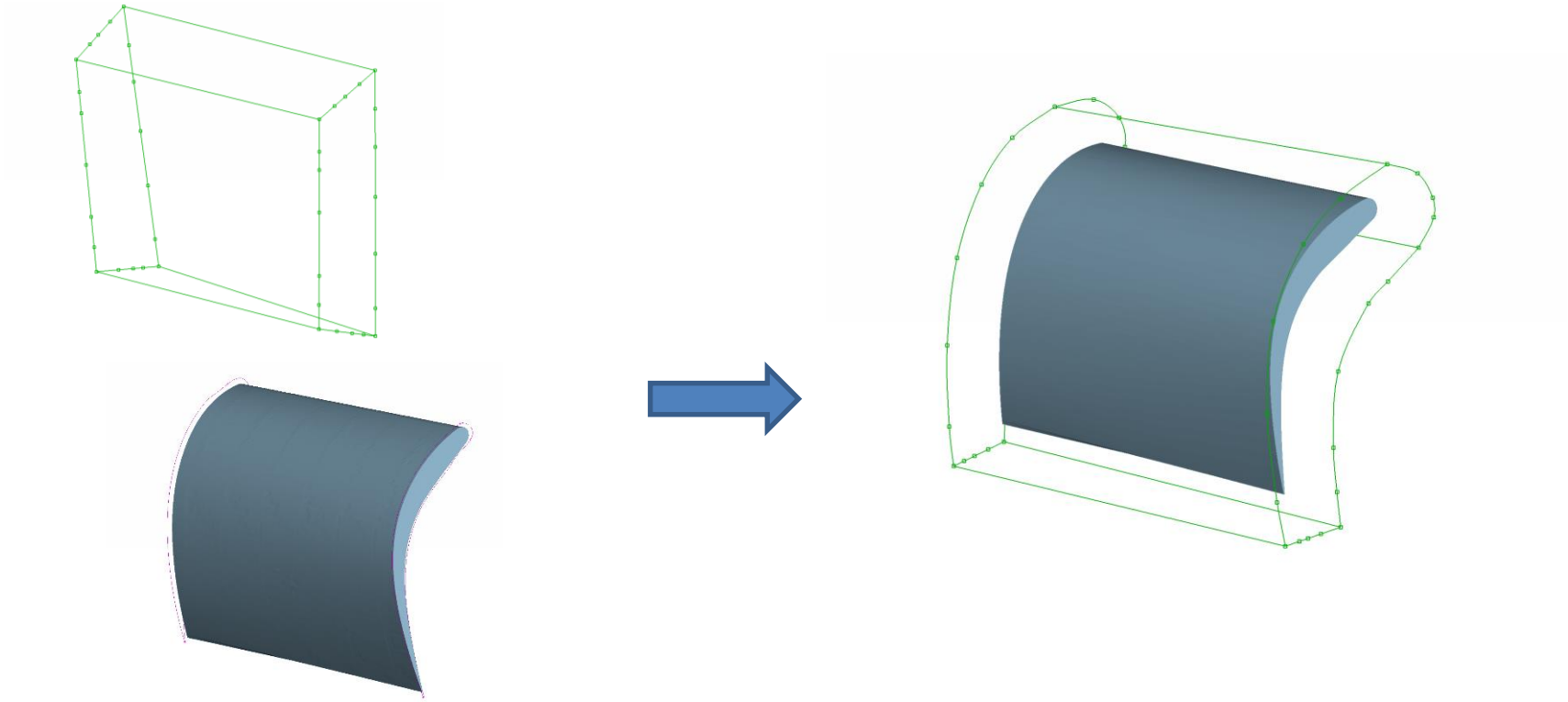
1. Blade Trim

- **Blades** are **trimmed** to prep for assembling purposes (Boolean operation)



2. Morph box edge fitting

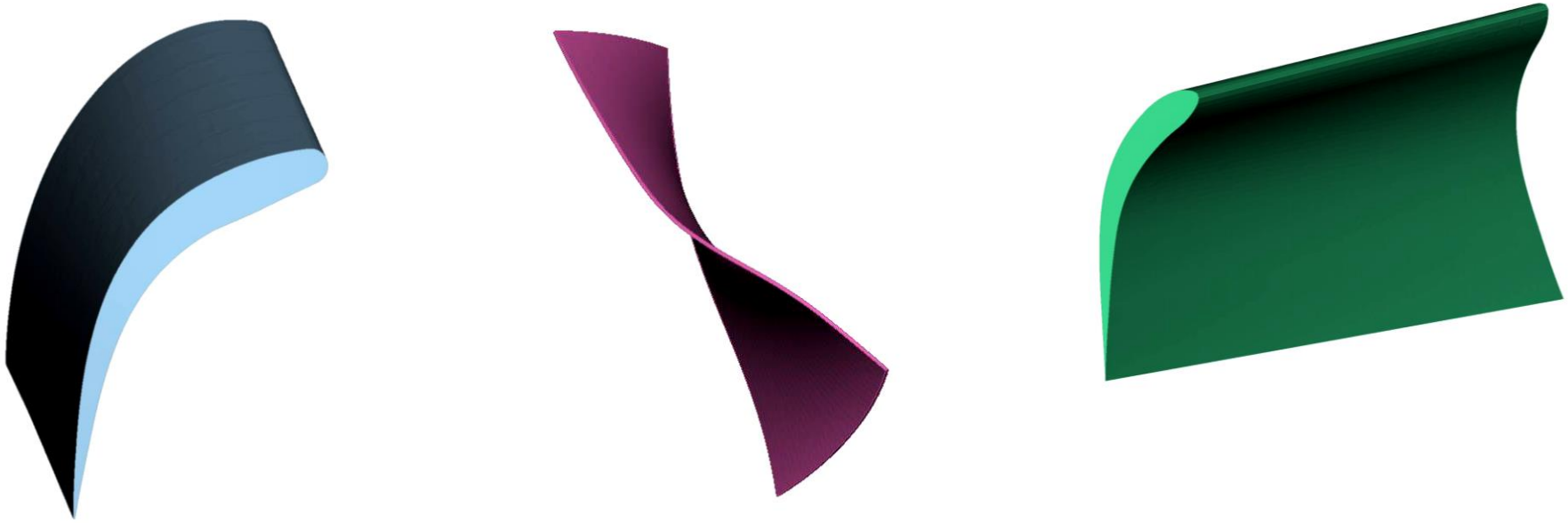
- Morph boxes (in the template) are **automatically fitted** to the new blades
  - The template morph boxes have **pre-defined morph parameters**
  - **Morph edges** and **curves** are assigned same **names**
  - Each morph edge fits to one curve based on name
  - Boxes are offset for capturing geometry to morph



Morph parameters applied

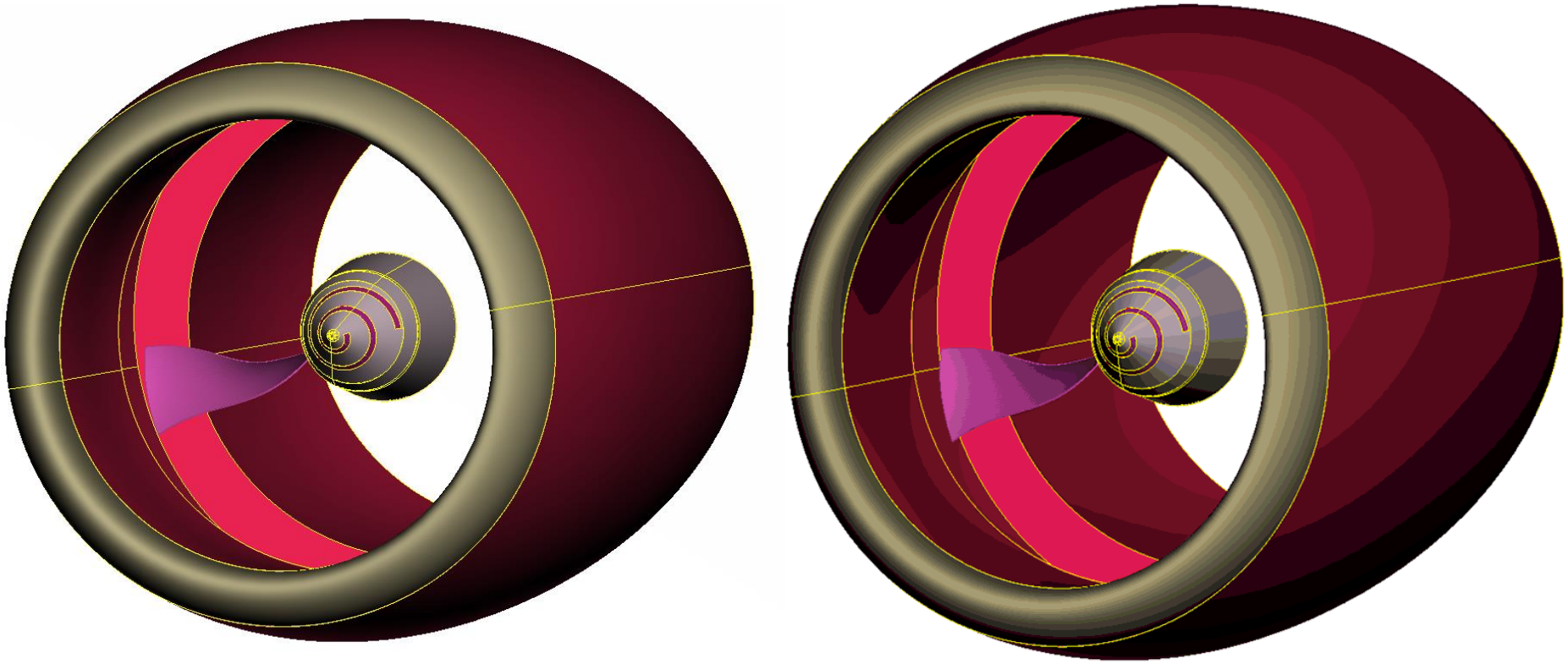
- **Pre-defined optimization task** drives the shape change of the blades based on the morph parameters defined

- More **Design change parameters (Design Variables)** can be **added** if needed



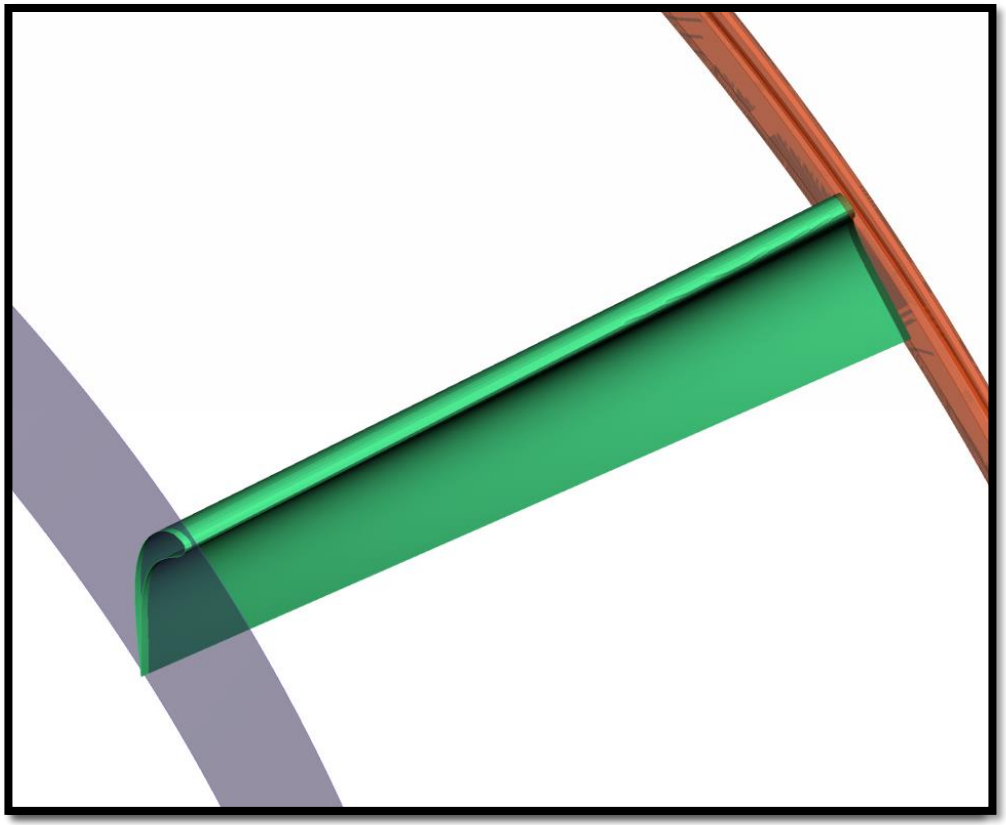
3. Creation of blade copies

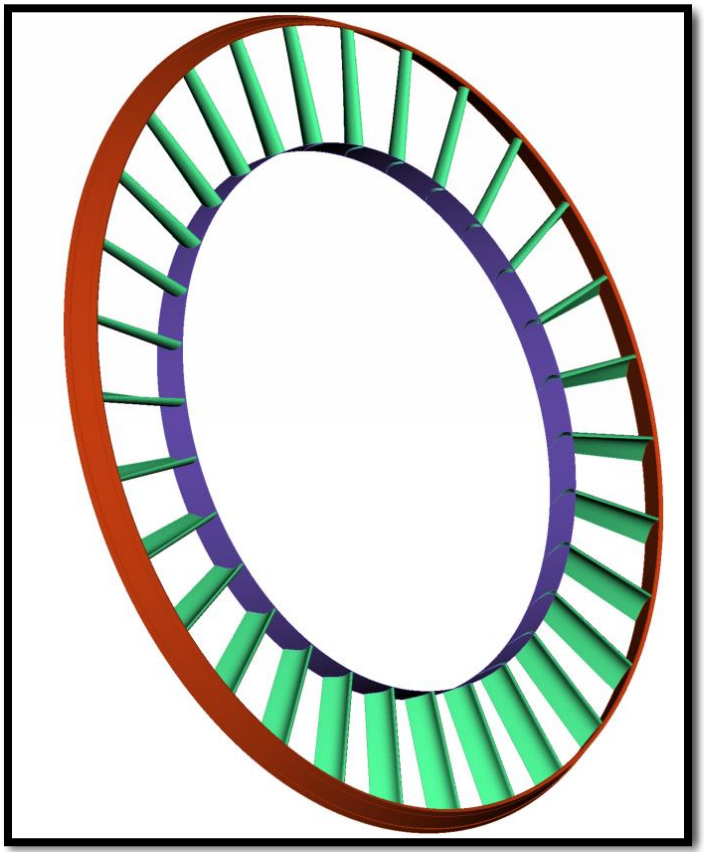
- After blade morphing is performed **copies** of them are created using script:
  - **Angle** or **Number of blades** can be used as a **design variable** for creating copies



4. Intersection and Connection

- **Blade copies** created are **connected** to **intersecting surfaces** by **Boolean operation**
  - Blades are intersecting the surface as shown (Left picture)
  - Picture on **right** shows the Boolean (Union) operation performed to **connect blades** to intersecting surfaces and **remove unwanted material**

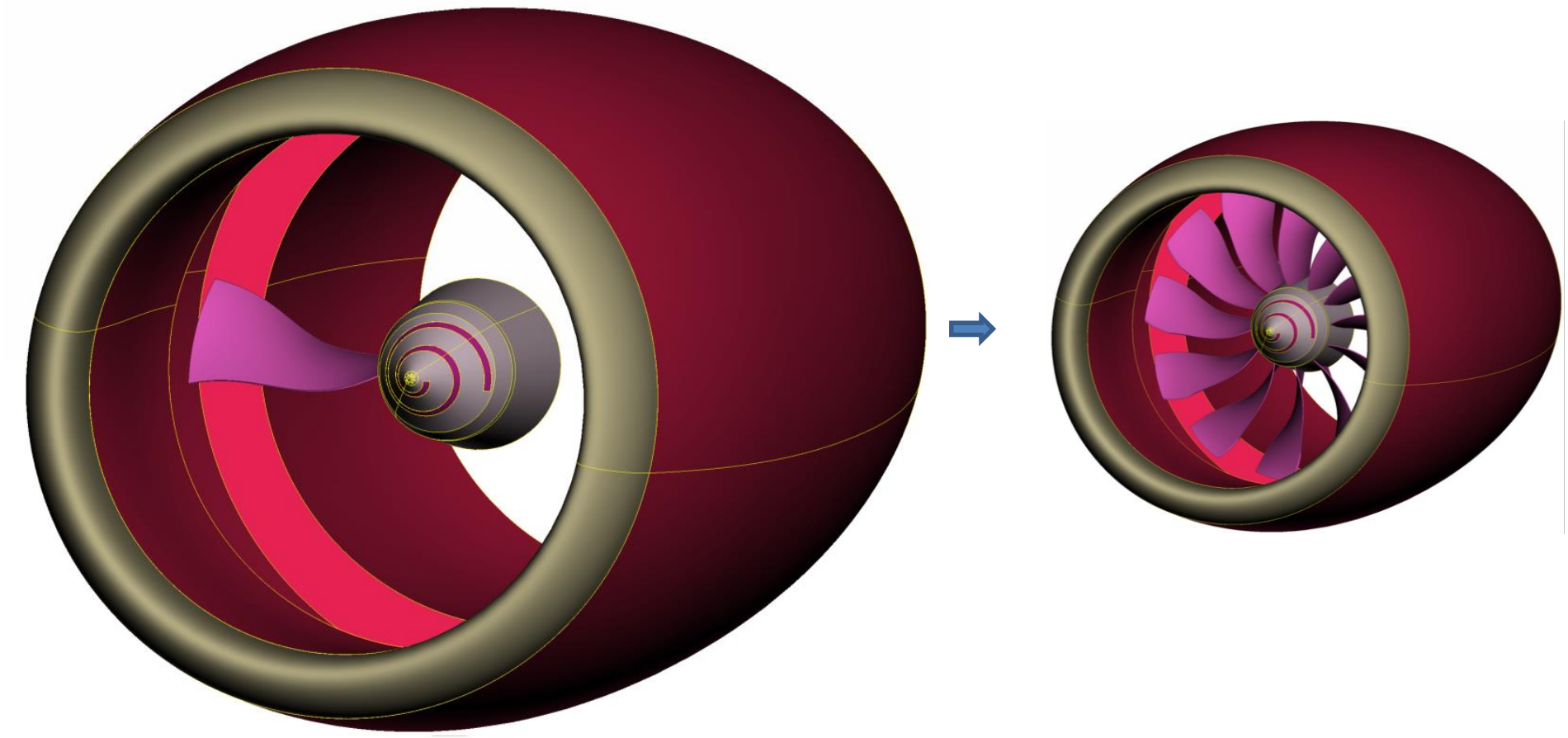




New Blade Designs by Chopping

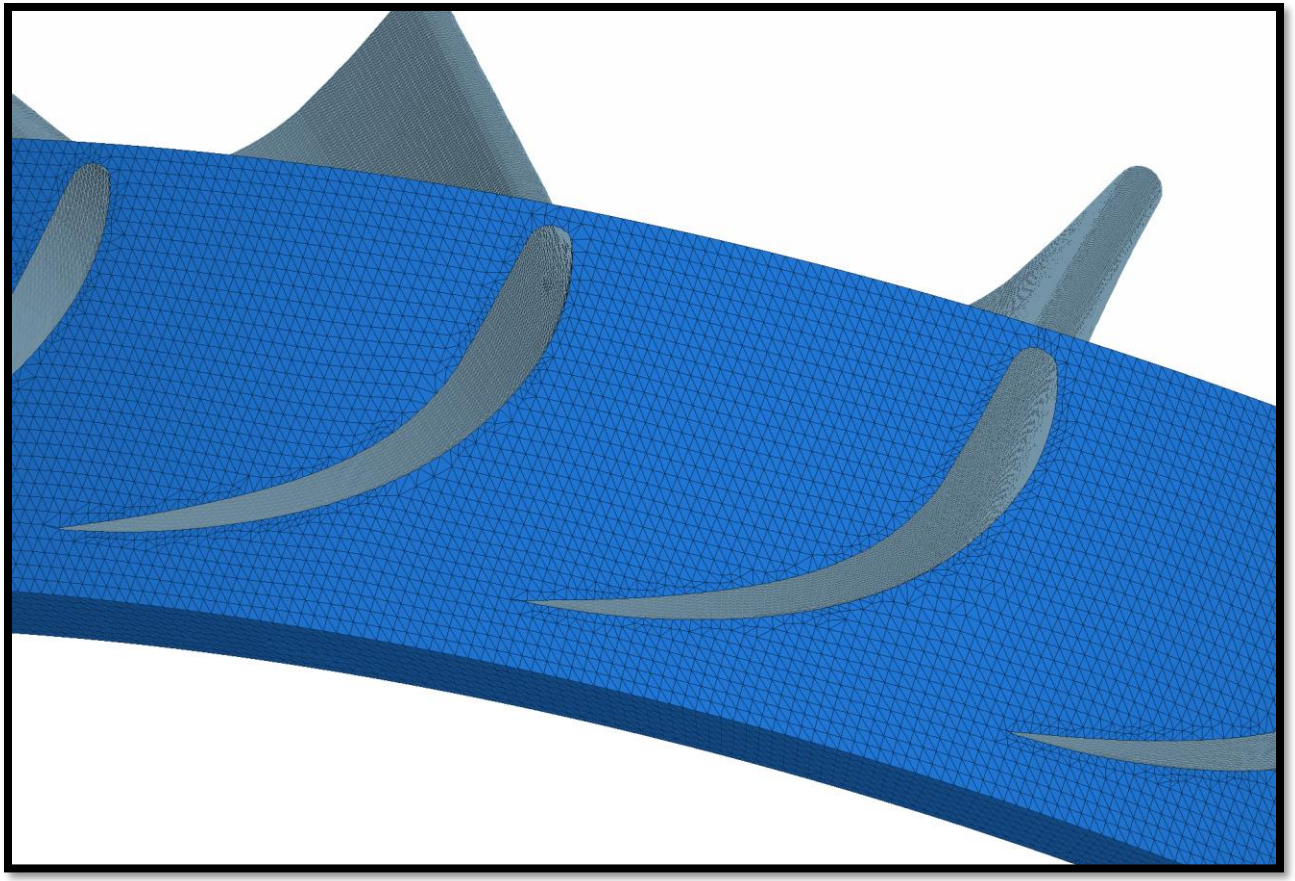
- A **plane surface** is used to **cut the blades** for obtaining **new complex blade design**

- **Multiple copies** of cut blade are made and **assembled to hubs**



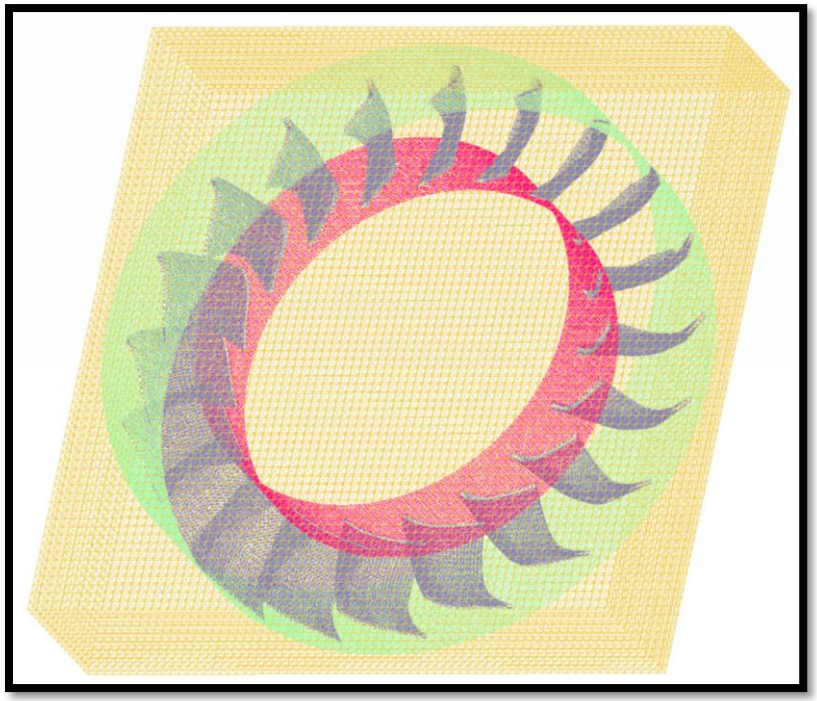
Blade Mesh Reconstruction

- **Mesh** at the connections and chopping region is taken care by **reconstruction** while Boolean operation is performed



5. Automated Blade Volumes Output and Volume Meshing

- **Specific assembly volumes** are identified
- These **volumes are written out separately** from the entire assembly with **specific names** (**Impeller, Stator, Turbine** in case of Torque Converter)
- **Batch mesh scenarios** are added to automate the volume meshing and layers generation (optional)



Name	Date modified	Type	Size
Full_model.nas	7/6/2017 10:00 AM	NAS File	334,578 KB
Impeller.nas	7/6/2017 9:59 AM	NAS File	81,830 KB
Stator.nas	7/6/2017 10:00 AM	NAS File	118,530 KB
Turbine.nas	7/6/2017 10:00 AM	NAS File	81,986 KB

Blade volume detection & Output

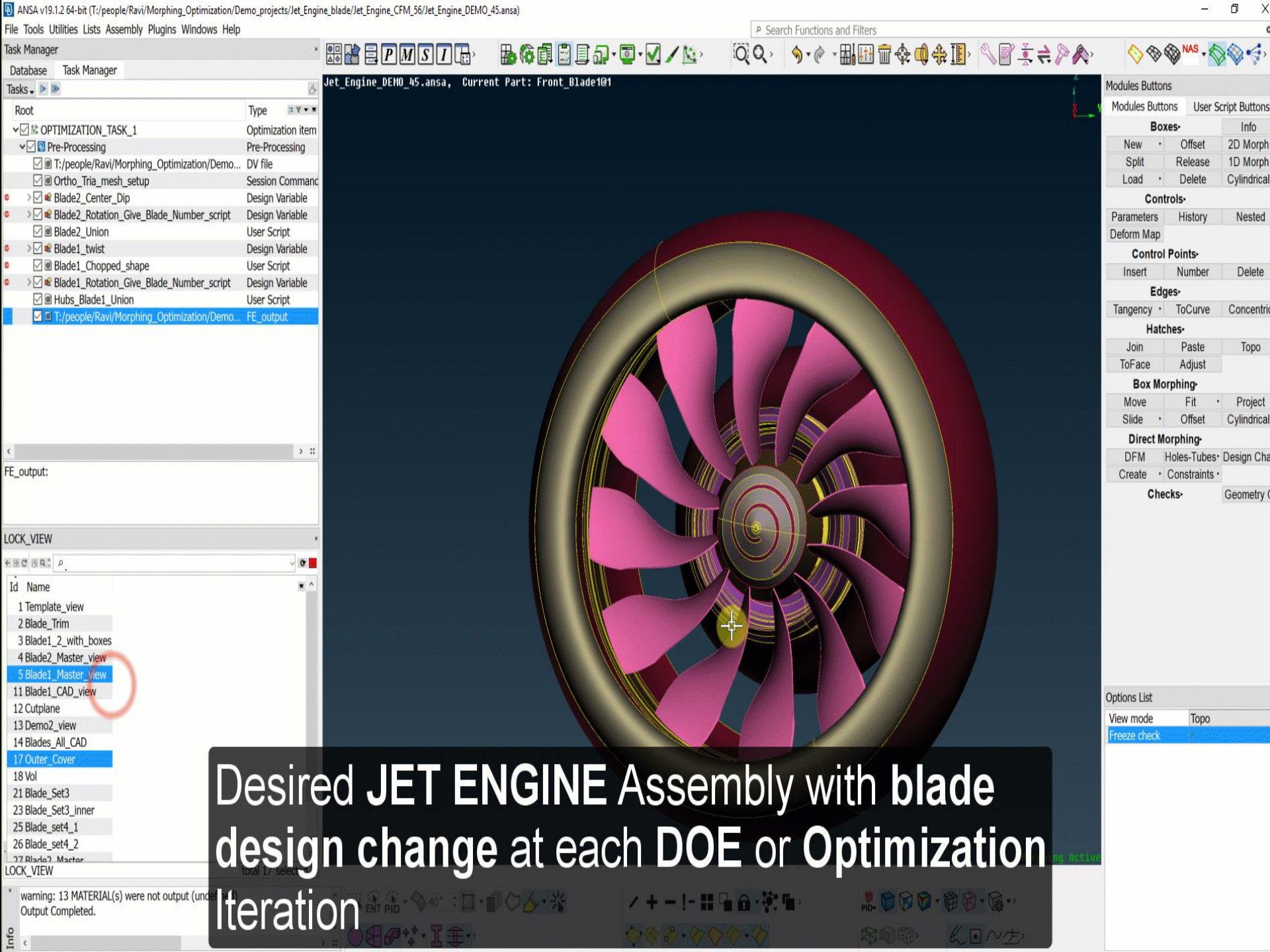
DOE Runs, Mesh Check and Report

- **DOE runs** to obtain designs for **analysis/optimization requires assurance** that the **volumes are good** for solid meshing and solving

- After assembling (Boolean operations) the blades **mesh check** assures whether the volumes can be used for analysis

- **DOE report (CSV file)** provides information about which **designs passed checks** and can be **used for analysis**

DOE Report for 150 designs


ANSA v19.1.2 64-bit (T:/people/Ravi/Morphing_Optimization/Demo_projects/Jet_Engine_blade/Jet_Engine_CFM_56/Jet_Engine_DEMO_45.ansa)
File Tools Utilities Lists Assembly Plugins Windows Help
Search Functions and Filters
Task Manager
Database
Task Manager
Tasks
Root
Type
OPTIMIZATION_TASK_1
Optimization item
Pre-Processing
Pre-Processing
T:/people/Ravi/Morphing_Optimization/Demo...
DV file
Ortho_Tria_mesh_setup
Session Commanc
Blade2_Center_Dip
Design Variable
Blade2_Rotation_Give_Blade_Number_script
Design Variable
Blade2_Union
User Script
Blade1_twist
Design Variable
Blade1_Chopped_shape
User Script
Blade1_Rotation_Give_Blade_Number_script
Design Variable
Hubs_Blade1_Union
User Script
T:/people/Ravi/Morphing_Optimization/Demo...
FE_output
FE_output:
LOCK_VIEW
Id
Name
1 Template_view
2 Blade_Trim
3 Blade1_2_with_boxes
4 Blade2_Master_view
5 Blade1_Master_view
11 Blade1_CAD_view
12 Cutplane
13 Demo2_view
14 Blades_All_CAD
17 Outer_Cover
18 Vol
21 Blade_Set3
23 Blade_Set3_inner
25 Blade_set4_1
26 Blade_set4_2
LOCK_VIEW
warning: 13 MATERIAL(s) were not output (unc
Output Completed.
Info
Jet_Engine_DEMO_45.ansa, Current Part: Front_Blade1@1
Modules Buttons
Modules Buttons
User Script Buttons
Boxes
Info
New
Offset
2D Morph
Split
Release
1D Morph
Load
Delete
Cylindrical
Controls
Parameters
History
Nested
Deform Map
Control Points
Insert
Number
Delete
Edges
Tangency
ToCurve
Concentric
Hatches
Join
Paste
Topo
ToFace
Adjust
Box Morphing
Move
Fit
Project
Slide
Offset
Cylindrical
Direct Morphing
DFM
Holes-Tubes
Design Cha
Create
Constraints
Checks
Geometry
Options List
View mode
Topo
Freeze check
Desired JET ENGINE Assembly with blade design change at each DOE or Optimization Iteration

What is the **value addition** using this plugin?

- **Automated template driven process**
- **Optimization setup in few hours** after model is merged with template
- **ANSA Morphing expertise not needed,** novice user can execute it
- **Any blade design can be handled (Flexible)**

Questions?