

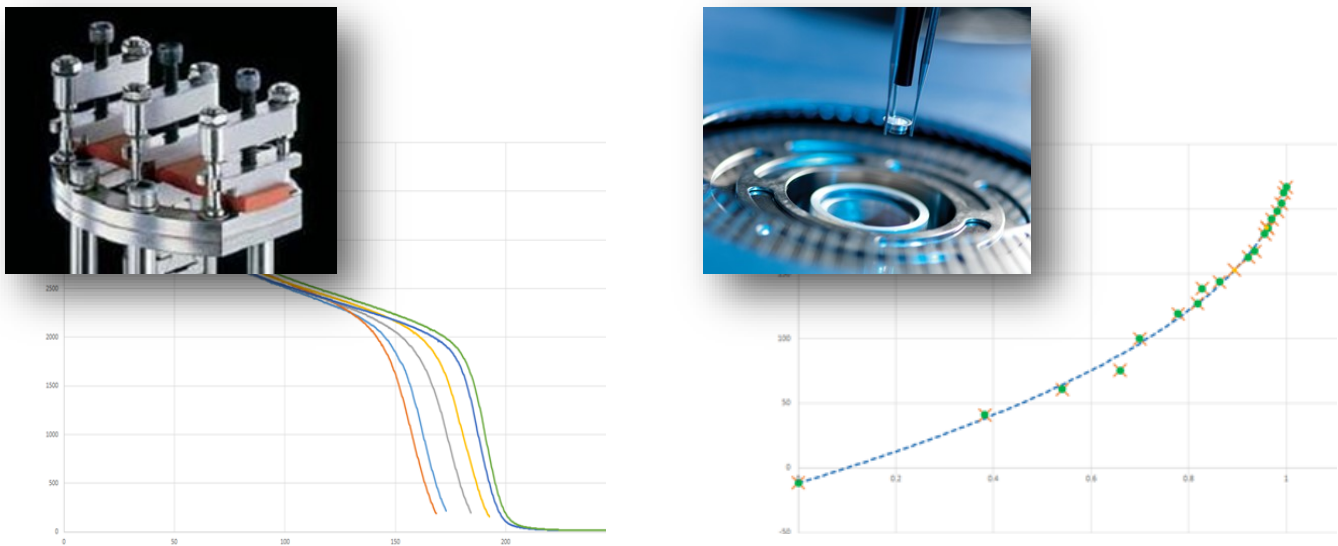
# Design of warp distortion compensated tooling for composite parts

Nominal shape tooling lead to significant distortions in highly-curved composite parts. We eliminate warp distortions by introducing a new concept of tooling design.

## Step 1 – Material model preparation

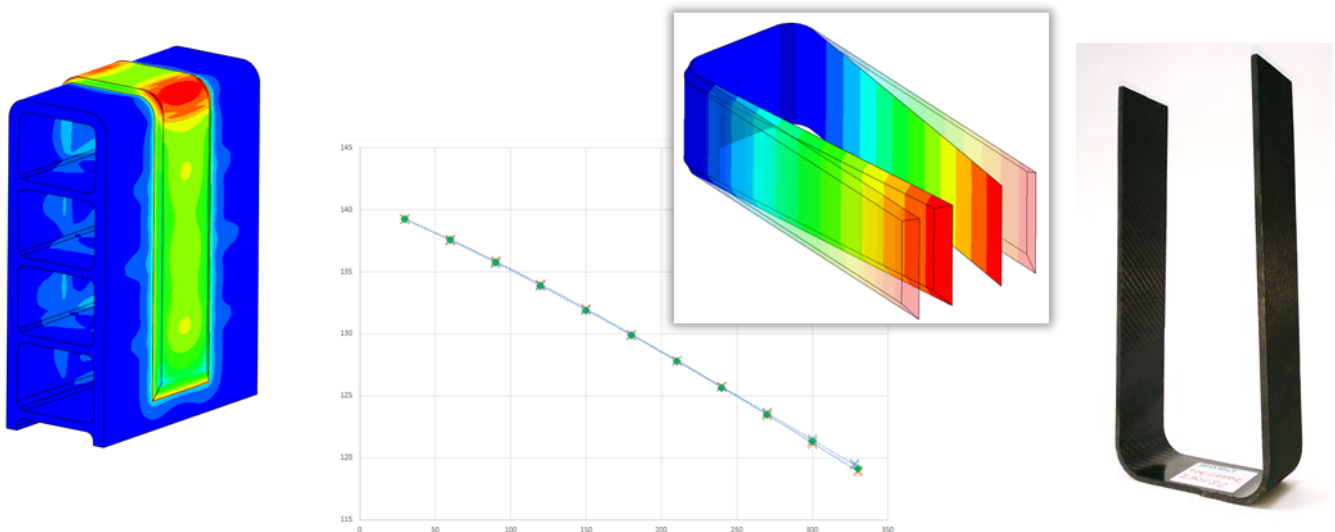
### Experimental measurements

are required to determine resin and ply characteristics that are the main causes of warpage.



### Model calibration

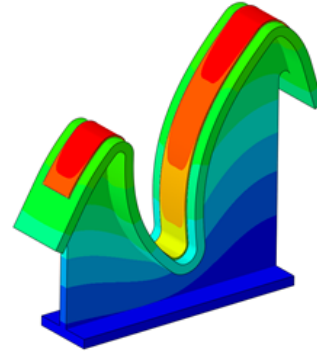
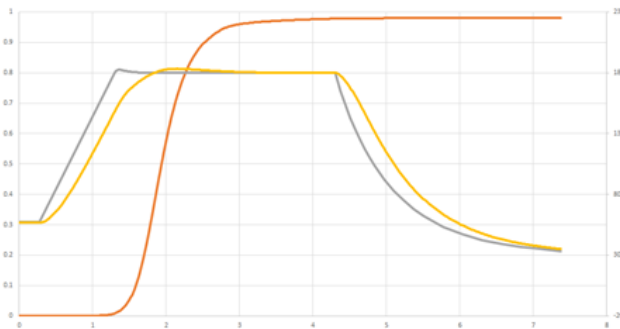
The U-shape samples are used to obtain precise mechanical solutions for the given material system.



## Step 2 – Optimizing the tooling shape

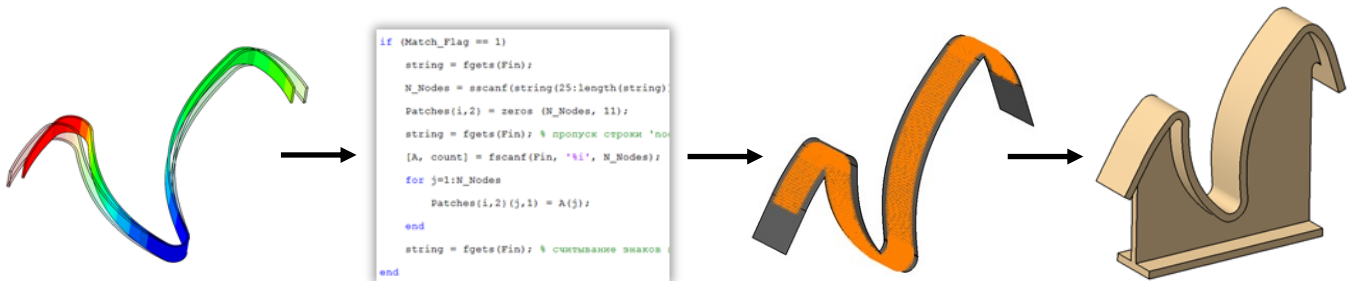
### Solution of thermal problem

gives distributions of temperature and degree of cure within the part which are required for mechanical calculations.



### Mechanical model

accounts for state-dependent part-to-tooling contact interaction and correctly deals with the liquid state of resin which is no more an issue.



### Tooling shape optimization procedure

involves in-house software for point cloud processing that gives connection from FEA to CAD.

## Use of compensated tooling allows

- Produce precise geometry composite parts
- High precision assembly
- Eliminate assembly stresses
- Avoid tooling adjustment or recut

