**White paper**

Simulation
enabling technologies

# Eliminating physical Clamping processes with the aid of Engineering Simulation

The physical Clamping process is a standard yet complex and demanding procedure, performed by most OEMs to ensure the quality of the produced parts. The Virtual Clamping tool comes to replace this process and same time reduce expenses, save time ,and enable more tests for new ideas, this time in the virtual world.

## Introduction

The physical Clamping process is a standard yet complex and demanding procedure, performed by most OEMs to ensure the measurement quality of the produced parts. During the stamping process, high forces are introduced to the initial material and large strains are produced by the process. For this reason the stamping result has shape differences with the designed model. In order to measure these differences, a standard procedure, performed by most OEMs, is to clamp the part in predetermined measuring mounts, and then measure it using 3D scanning to check the quality of produced parts. (Figure 1).
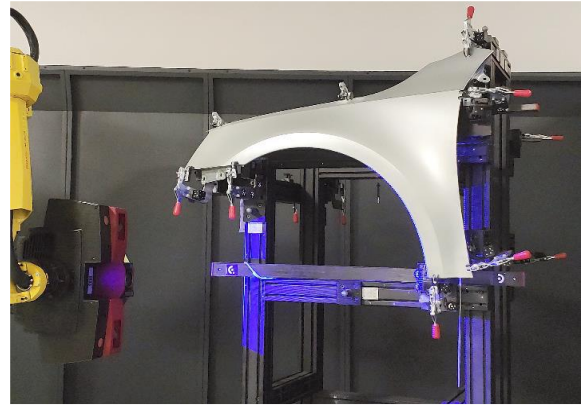


Figure 1: Clamping of a front Fender

Subsequently, a comparison is made between CAD and measured data. This approach requires a high level of expertise due to the complexity in parts' geometry, in the assembly process when positioning the part, and in the calibration of the tool. In addition, it demands an expensive measuring machine and a considerable amount of time consumed for each scan.

## The Virtual Clamping Process

These limitations urge the need to replace the complicated process with simulation. The proposed new tool, for this purpose, makes use of the capabilities of BETA CAE Systems' ANSA pre-processor, EPILYSIS solver, and META post-processor, making possible a new technique, named Virtual Clamping. In this technique, the stamped part is scanned in a free state and the clamping process is generated through a CAE simulation. A comparison is then run between the virtual results and the CAD data (Figure 2).
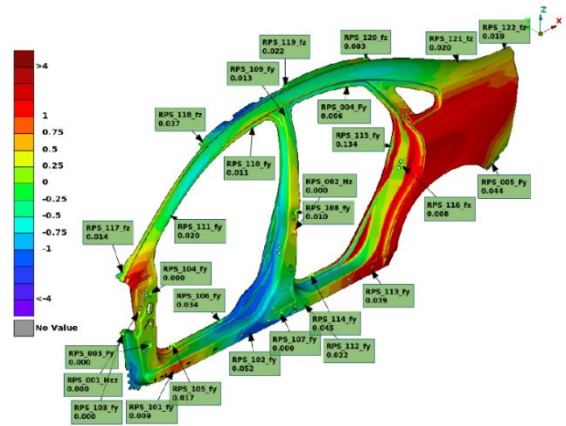
In the standard clamping process, the stamped sheet-metal parts are initially positioned in a dedicated device. The user clamps the part in predetermined mounting points and then measures the part using a 3D scanner. Then, a distance comparison is made between the initial CAD and the measured data.



Figure 2: Result of Virtual clamping process with separation color map and annotation on clamping points.

In the new Virtual Clamping Process, the stamped sheet metal part is positioned in a simple mount and scanned in an (unclamped) free-of-stress state, where only gravity affects the shape of the part.

The Virtual Clamping Process starts through the dedicated tool in ANSA, which imports the CAD data with all the necessary information on the clamping points. The user can then assign the material and the part's thickness (Figure 3).
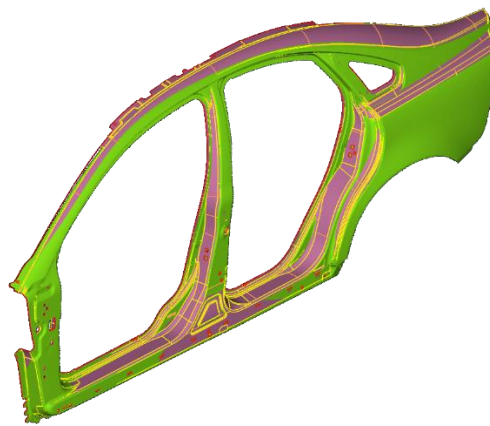


Figure 3: CAD Data input and STL input used in the tool.

If gravity produces a significant effect on the initial free scan of the model, then the user has the option to subtract the gravity effect. A simulation takes place, and the gravity is calculated on the initial CAD model. The next step of the process continues with the import of the free-state scan model in STL format, with or without the gravity effect accordingly. (Figure 4)
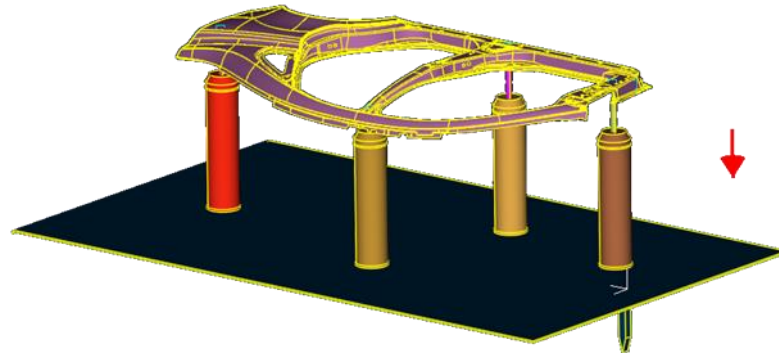
Figure 4: Input CAD file on the simple mount, used for the gravity calculation.

Then, all the predefined clamping points are listed within the tool providing to the user the capability to select which of these points will be used in the process. The final option is the selection of the simulation method of the clamping procedure.

There are 3 simulation methods that affect the accuracy and the speed of the result. In the first method, named "All together", all points are clamped together in a single simulation. The tool finds the projection of the point on the STL, measures the distance, and adds an enforced displacement in all points simultaneously. In the second method, called "All together with accuracy loop", all points are clamped in 2 simulation runs. After the initial measurement, 80% of the measured distances are applied to each clamping point, the projections are re-measured, and an additional simulation with the remaining distances occurs. In the most detailed method, named "One by one", the primary clamping points are initially solved and then a new simulation is run for each point. The sequence of the points plays an important role in this scenario, since the measurement for each point is performed after each step (Figure 5).
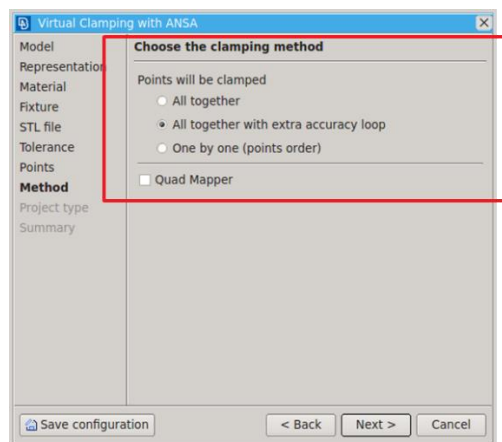


Figure 5: Run options.

By the end of the process, a resulting STL, a configuration file and a presentation are output. In the presentation a separation graph between the resulting STL and the initial CAD is included. The movement of each clamping point, the force that was used for each clamping point, and the tolerance value is given as well. The configuration file (.ini) has all the selections made by the user in the tool. If the user prefers to recalculate the same simulation, then the configuration file can be selected at the beginning of the process. All the steps will then be preset with the values of the configuration file.
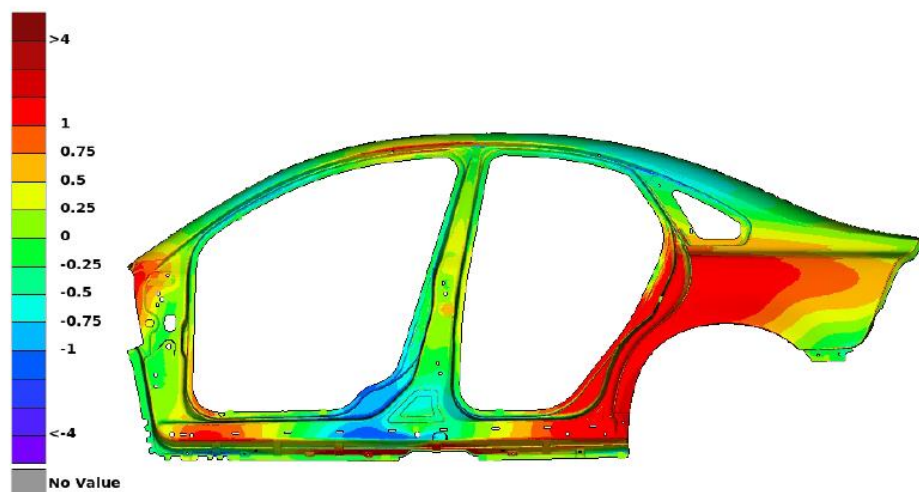


Figure 6 : Result of the Virtual clamping process, side view.

## Conclusion

Using the virtual clamping approach, expenses from the manufacturing of complicated measuring devices can be avoided. Furthermore, any scanner can be used to provide the input data. The number of the processed parts can be increased drastically, and multiple clamping scenarios can be tested for each scanned panel. Clearly, set-up time for multiple clamping scenarios is reduced since only one scan is necessary for each panel. All these can be achieved through a straightforward tool that needs no previous knowledge of the ANSA-META pre- and post- processors.

**About BETA CAE Systems International AG**

BETA is a simulation solutions provider, dedicated to the development of state of the art software systems for CAE. For almost 30 years, we have been developing tools and delivering services for the front-runners in numerous sectors by listening to their needs and taking up even the most demanding challenges. For more information on BETA CAE systems, our products, and our services, visit www.beta-cae.com

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