

# Iterative Design Process with Abaqus for CATIA V5

During product development, design engineers often have the freedom to modify size, shape, orientation, and material properties of their product. However, each modification requires validation to ensure that the maximum stresses remain below the acceptable limit for all load cases. This article outlines two analysis approaches with Abaqus for CATIA V5 to evaluate a product design and achieve significant productivity gains.

The first approach uses CATIA's Knowledgeware capability to define parametric studies to assist in making engineering decisions. With this approach, geometry and load parameters can be captured in a design table to simplify model modifications.

The second approach makes proven analysis methods available in analysis templates that can be reused to analyze design variations efficiently with minimal effort. This approach facilitates the replacement of an entire geometric component in the analysis with another design from a different vehicle (Figure 1).

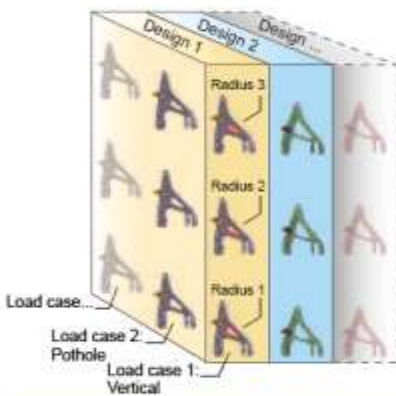


Figure 1: Using design tables and analysis templates to analyze multiple designs under various load cases.

## Suspension Control Arm Assembly

For this example a suspension control arm is modeled with four geometric parts: the control arm, the shock absorber bracket, and two bolts (Figure 2). The control arm connects the steering knuckle to the chassis and allows the knuckle to pivot on a lower ball joint. The shock absorber, which controls vertical movement, connects to the control arm through the bracket.



Figure 2: Suspension system assembly and control arm.

Rubber bushings are used for both the front and rear attachments to the chassis. The rear bushing is modeled using a linear spring in the axial direction and a nonlinear spring in the radial direction to simulate the bushing's carefully-tuned behavior.

The two bolts connect the bracket to the control arm. The stress in the control arm at the location of this connection is particularly important. Therefore, the effects of pre-tensioning the bolts using bolt-tightening connections must be modeled accurately. Defining contact properties between two surfaces helps ensure accurate results. In this analysis, the contact between the bracket and the control arm is modeled without considering friction effects.

## Load Cases & Geometric Parameters

In a traditional design analysis process, the suspension model would be subjected to a variety of load cases, such as braking, accelerating, and driving over a pothole. To simplify this example, only pothole and vertical load cases are considered. These load cases consist of forces and moments applied at the chassis and at the lower ball joint's attachment points (Figure 3). In total, 15 load case parameters are implemented in the analysis: 9 force components and 6 moment components.

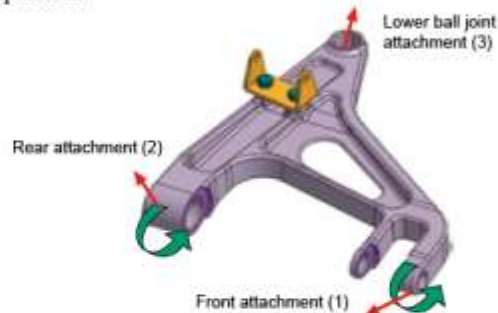


Figure 3: Load and moment locations.

The size of the control arm pocket can be a factor in weight and cost. Therefore, it is important to evaluate the effect of pocket dimension variations on the stress results. In this example three pocket radii are evaluated: 7 mm, 10 mm, and 12.5 mm.

## Approach 1: Controlling parameters through a design table

A design table provides the designer with a tool to create and manage sets of model parameters. Design tables drive the parameters of a CATIA-based model from external values. These values are stored in a table in either a Microsoft Excel file or a tabulated text file. Each column in the table corresponds to a model parameter, and each row contains a set of parameters to be considered together as a group. These sets are called configurations (Figure 4).

Line	Config.	Arm/Pocket_Radius	FB_Fx	FB_Fy	FB_Fz	FB_Mx
<1>	VerticalLoad+R1	12.5mm	50N	5600N	-3200N	24.3Nm
2	Pothole+R1	12.5mm	30N	8400N	-2500N	24Nm
3	VerticalLoad+R2	10mm	50N	5600N	-3200N	24.3Nm
4	Pothole+R2	10mm	30N	8400N	-2500N	24Nm
5	VerticalLoad+R3	7mm	50N	5600N	-3200N	24.3Nm
6	Pothole+R3	7mm	30N	8400N	-2500N	24Nm

Figure 4: Design table.

In this study six configurations are defined: each pocket radius value is tested against each of the two load cases. Each time a new configuration is selected, the model is updated automatically. The design engineer steps through the design table to obtain the results needed for each configuration (Figure 5). Alternatively, a Visual Basic script can be used to cycle through the various design configurations and run the analyses.

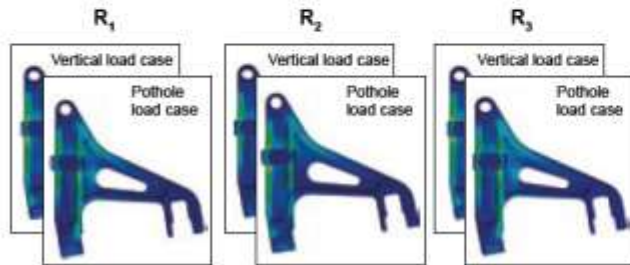


Figure 5: Von Mises stress result images.

## Approach 2: Reusing Analysis Models with Analysis Templates

The second approach reuses the analysis model with geometry from another vehicle (Figure 6). The same stress evaluations can be conducted on different vehicle programs, allowing for great gains in efficiency with little effort.

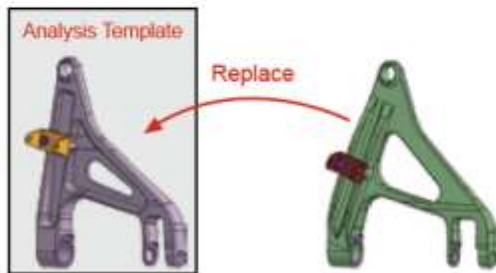


Figure 6: Different geometry evaluated using the same analysis template.

The CATIA publication capability is used to create an analysis template. Using this approach, a geometric entity (face, edge, point, etc.) is associated with a unique and descriptive name called a publication. For example, the lower ball joint attachment surface is associated with the “LowerBallJoint” publication. Bolt tightening connections, springs, contact definitions, and loads are created based on publications.

Figure 7 and Figure 8 illustrate the difference between the standard (non-publications) approach and the analysis template approach (with publications). Using the standard approach, analysis attributes are associated directly with the geometry. On the other hand, using the analysis template approach, all analysis attributes are applied to publications rather than to the geometry. The ability to abstract the analysis attributes from the geometry is a fundamental requirement for creating analysis templates.

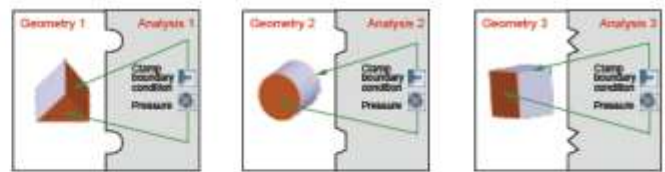


Figure 7: Standard approach. Analysis attributes are applied to the geometry.

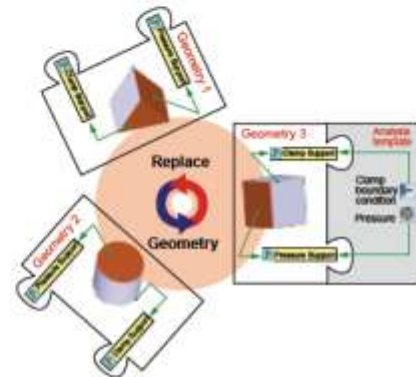


Figure 8: Analysis template approach. Publication objects are generated from geometric entities, and analysis attributes are applied to the publications.

Applying analysis attributes to publications instead of to the geometry enables a design engineer to modify or replace the geometry while maintaining full associativity between analysis attributes and geometry. Various designs can be tested using the same analysis model, provided that each design uses the same publication names.

Once an analysis is defined, it can be used as a template for other design evaluations. In this case the control arm and the bracket are replaced by a new design, while the analysis model and the design table remain the same. All analysis attributes update automatically to associate with the new geometry. The design engineer only needs to re-run each analysis for the new suspension system design. Results can be compared quickly to determine whether the design configurations meet the appropriate stress requirements.

## Conclusion

Abaqus for CATIA V5 provides the capabilities to easily perform analyses and obtain accurate results, including nonlinear effects during the design process. The application also enables design engineers to iterate efficiently on an analysis, using tools such as design tables and publications, resulting in important time savings. If an alternate design must be considered, an analysis template with an updated design can be used to obtain the necessary validation.

To Download the Complete Tech Brief, Visit:  
[simulia.com/techbriefs](http://simulia.com/techbriefs)

EDS Technologies in strategic partnership with Dassault Systemes plays a vital role in implementing Dassault Solutions, in India across various industry segments.

More information: [www.edstechnologies.com](http://www.edstechnologies.com)