ModelCenter® MBSE for GENESYS Connector Guide

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CUSTOMER RESOURCE OPTIONS

Supporting users throughout their entire journey of learning model-based systems engineering (MBSE) is central to Vitech's mission. For users looking for additional resources outside of this document, please refer to the links below. Alternatively, all links may be found at www.vitechcorp.com/online-resources/.

Webinars

Immense, on-demand library of webinar recordings, including systems engineering industry and tool-specific content.

Screencasts

Short videos to guide users through installation and usage of GENESYS.

A Primer for Model-Based Systems Engineering

Our free eBook and our most popular resource for new and experienced practitioners alike.

Help Files

Searchable online access to GENESYS help files.

Technical Papers

Library of technical and white papers for download, authored by Vitech systems engineers.

Technical Support

Frequently Asked Questions (FAQ), support-ticket web form, and information regarding email, phone, and chat support options.

PREFACE

The ModelCenter® MBSE for GENESYS Connector, which is included in the GENESYS Pro edition, provides the ability to seamlessly export model segments from GENESYS™ projects into Ansys® ModelCenter® MBSE for GENESYS. After working with the model in ModelCenter MBSE, updated design values can then be imported back into the GENESYS model. The connector connects to ModelCenter MBSE for GENESYS version 14.5.

The connector gives the engineer a variety of ways to export three interrelated GENESYS classes which correspond to the Ansys model. Uses include:

- Verify constraint diagrams and definitions by executing them.
- Inform the systems model with the results of detailed design tools to do:
  - Model verification
  - Design verification
  - Requirements compliance
- Test the model in a variety of simulated environments to do:
  - Mission Analysis
  - Verify performance requirements at the systems level
- Mix and match different potential components to do:
  - Trade studies
  - Cost tradeoff studies

ASSUMPTIONS

This guide assumes that the reader has knowledge of Ansys ModelCenter MBSE, and a familiarity with model-based systems engineering. Since we will be working with a small slice of the GENESYS model, knowledge of the GENESYS STRATA™ methodology is recommended to understand the context of these operations and how they fit in an iterative systems design approach. It is also assumed that both ModelCenter MBSE and GENESYS are installed and operational.

THEORY OF OPERATIONS

The ModelCenter MBSE connector is designed to be flexible to allow the engineer to control which pieces of a model to send across. Three GENESYS classes, **Components**, **ConstraintDefinitions**, and **Requirements** map to Ansys Model Elements, Analyses, and Requirements, respectively. A systems model in GENESYS will generally be much larger than what would be used for detailed analysis, so several methods are provided to the engineer to limit the scope of the export to exactly what is desired.

Once the GENESYS model segment model has been exported, the full capabilities of ModelCenter MBSE are available to the engineer. After running the desired scenarios, information is sent back into GENESYS as design parameter values on their respective components. These scenarios can also be saved in ModelCenter and reloaded from or linked to GENESYS for documentation purposes.

NOTES

Components are a subclass of the abstract class **ImplementationUnit**. Since GENESYS has an extensible schema, any class the engineer derives from **ImplementationUnit** will be available for exporting. The term **Component** is used in this document and in the wizard text for brevity and clarity.

ModelCenter MBSE for GENESYS. Will hereafter be referred to as *ModelCenter MBSE* for the remainder of this document.

EXPORTING A MODEL TO MODELCENTER

The following diagram shows how the GENESYS entities map into ModelCenter MBSE elements.

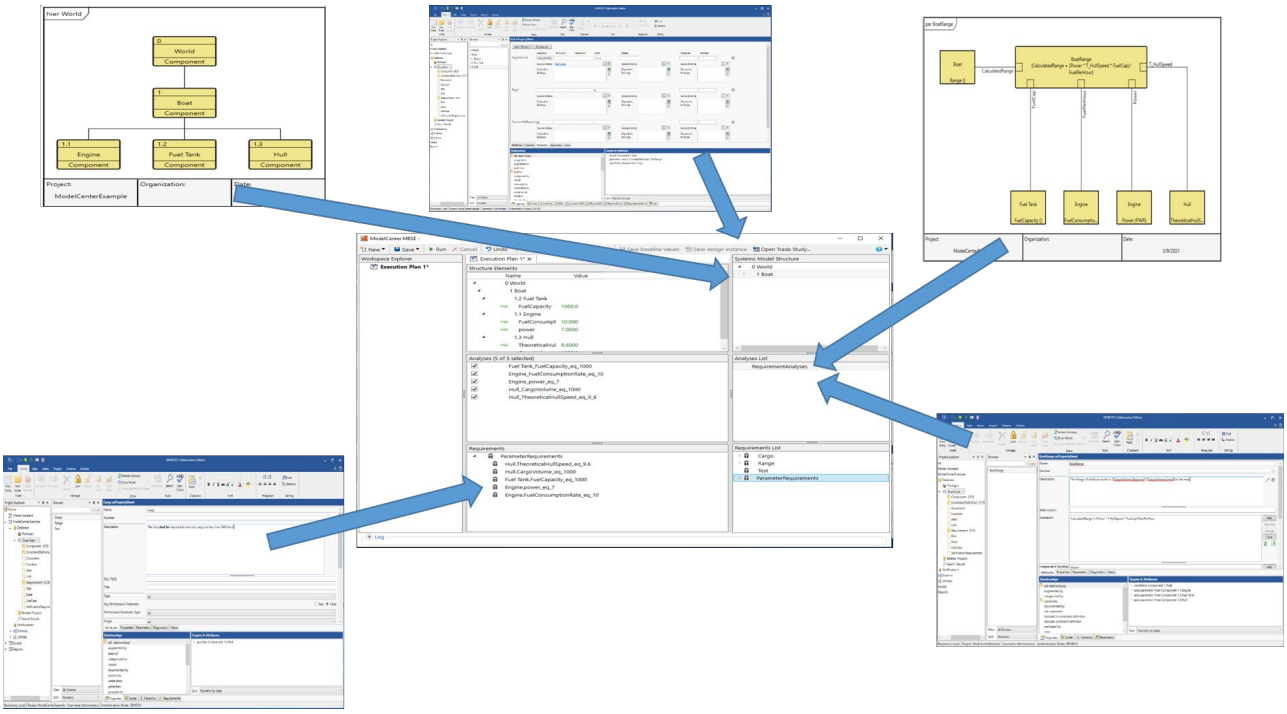

Figure 1 ModelCenter MBSE Connector Concept

To launch the ModelCenter MBSE connector, select the ***ModelCenter*** button on the ***Utilities*** ribbon in GENESYS.

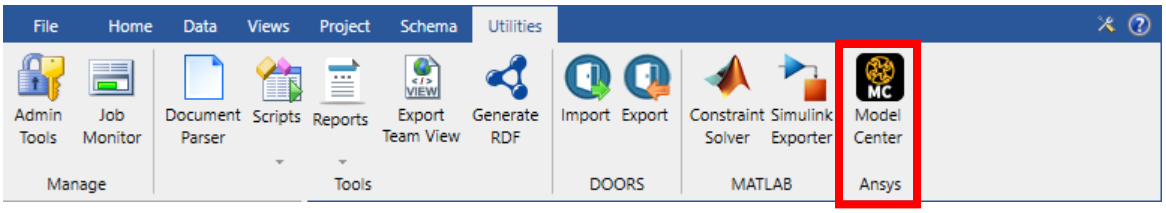

Figure 2 ModelCenter Command Location

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This will bring up the ModelCenter Exporter dialog. The default is to export all **Components**, relevant **ConstraintDefinitions**, and **Requirements** in the current project.

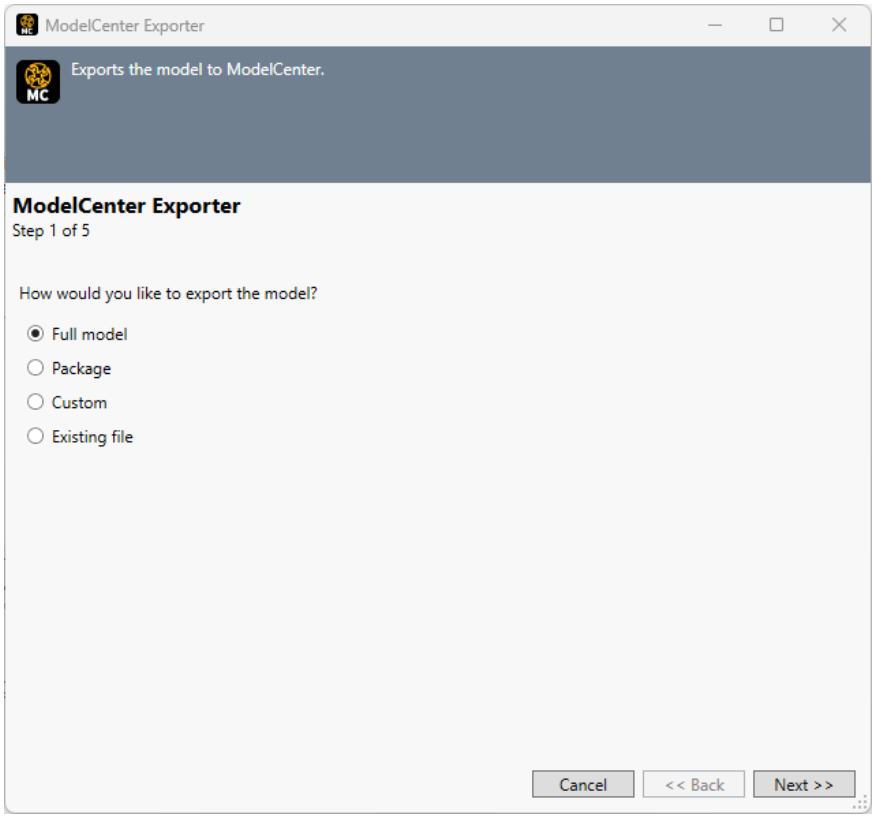

Figure 3 ModelCenter Exporter, Step 1

Subsequent pages of the wizard allow the engineer to unselect an entire class of entities; this will cause members of this class to not be exported.

If export is left checked, the engineer is presented with three options on how to name entities as they are exported into ModelCenter MBSE. A page is presented for each of **Components**, **ConstraintDefinitions**, and **Requirements**.

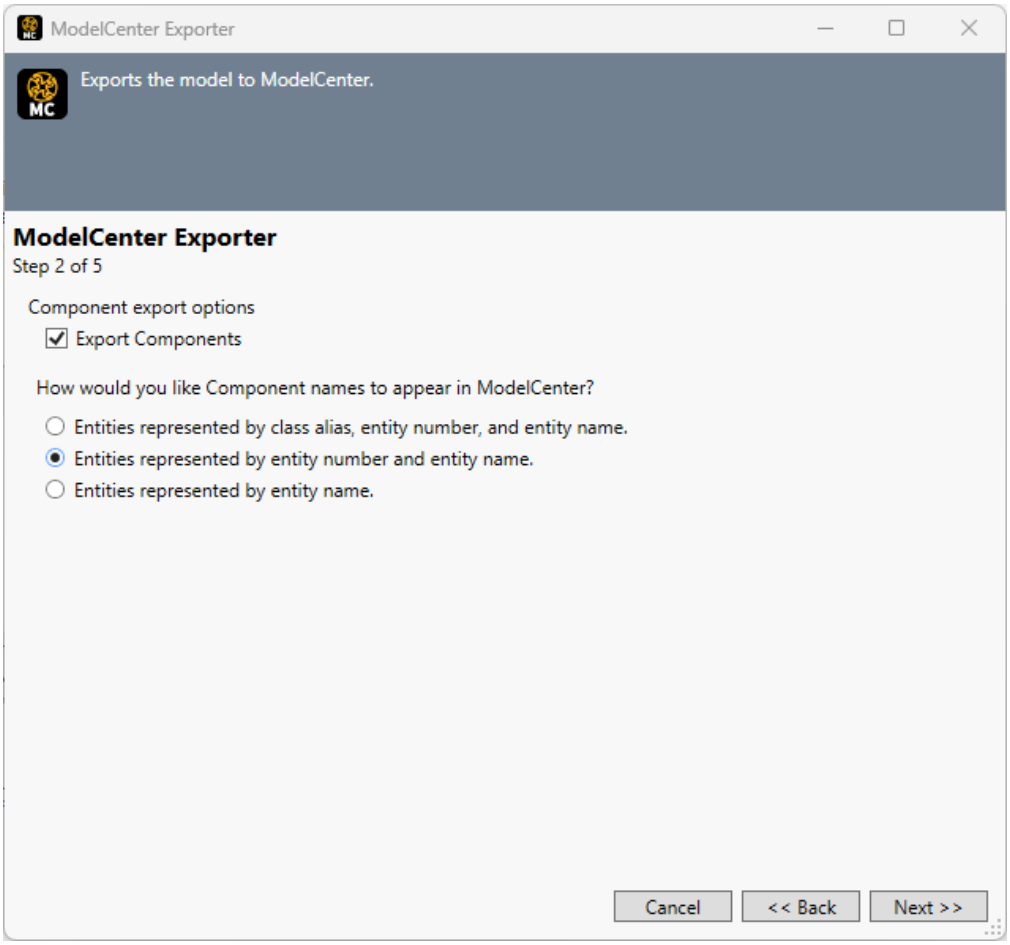

Figure 4 ModelCenter Exporter, Step 2

Once the engineer has completed the wizard, the ModelCenter MBSE pane will appear, fully populated with the selected entities.

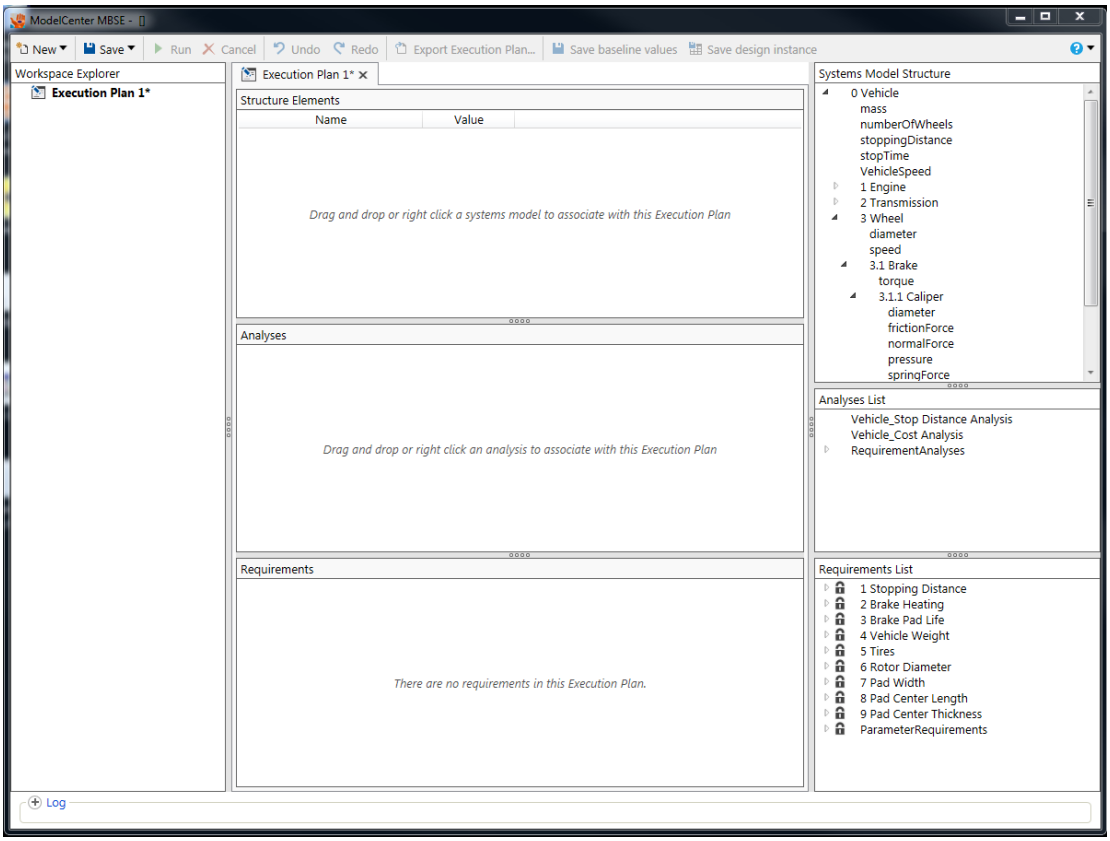

Figure 5 Exported Model in ModelCenter MBSE

SELECTING MODEL SEGMENT TO EXPORT

To make model analysis more manageable, GENESYS provides several ways to send a subsection of your model. The most explicit way of defining which entities to go is to create a package, add all **Components**, **ConstraintDefinitions**, and **Requirements** that you would like to send to ModelCenter MBSE, and then choose the package selection on the first page of the wizard.

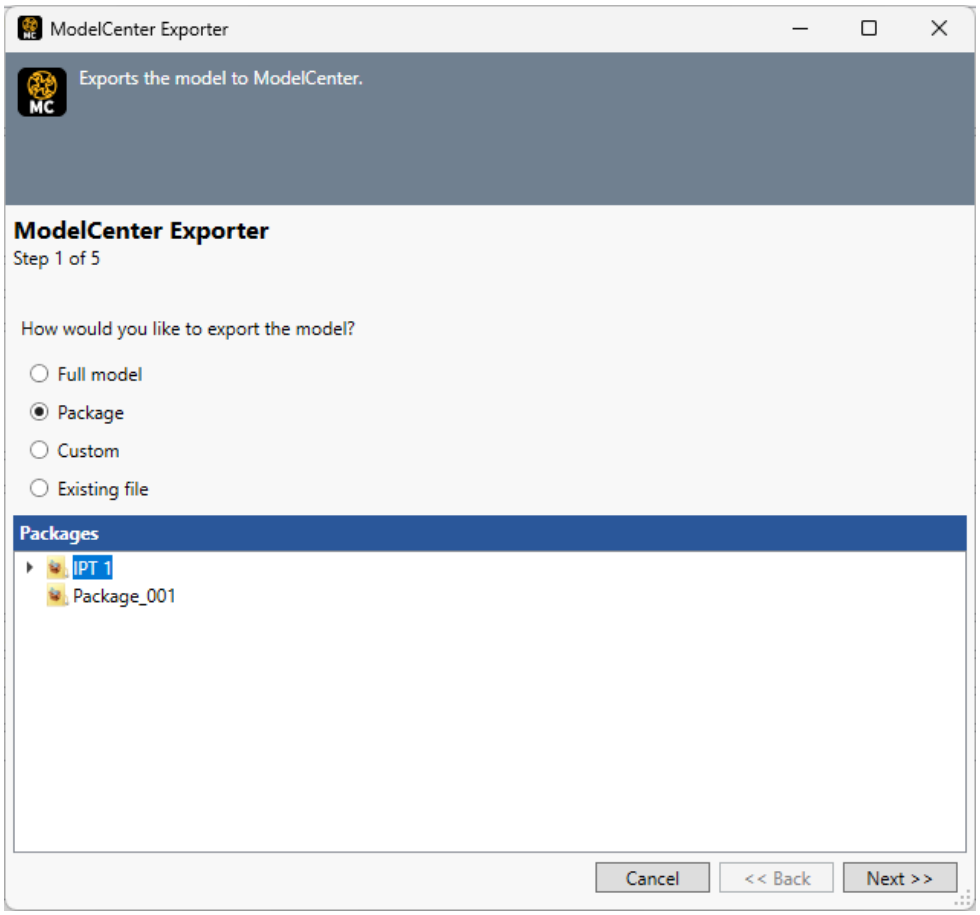

Figure 6 Sending a Group of Packaged Entities

The remaining pages of the wizard allow the engineer to configure how the model elements are displayed within ModelCenter MBSE.

If the following options appear on the window, use these guidelines. The “Custom” radio selection allows the engineer to use a Class’s hierarchical structure or a folder to limit what is sent over from each of the **Component**, **ConstraintDefinition**, and/or **Requirement** classes. Selecting the “Folder” radio button will allow the engineer to send over all instances of a class in a folder and its subfolders. Selecting the “Root Entity” radio button will send over the entire component tree of the selected Component.

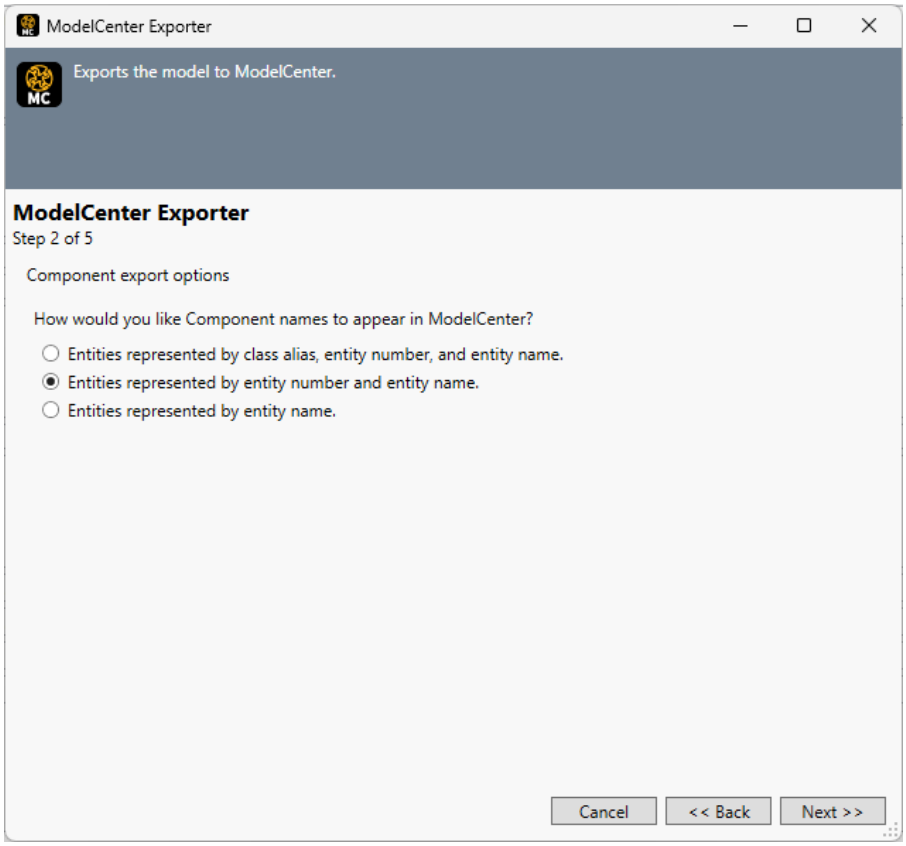

Figure 7 Custom Options for Exporter

EXPORTING COMPONENTS

GENESYS Components and their parameters are sent to ModelCenter MBSE as model elements. Components go over as parent elements; their parameters go over as leaf elements. The parameter’s objective value is assigned to its corresponding leaf element.

EXPORTING REQUIREMENTS

Some requirements in GENESYS are not explicitly called out in the **Requirements** class. The objective, minimum, and maximum values of an entity parameter work together to define a requirement. The example below (Fig. 8) shows the parameters on a brake pad **Component** which will generate three requirements: one requiring the pad's cost to be below or equal to $3.50; one requiring the pad's life to be equal or greater than 35000 cycles; and one requiring the pad's thickness to be between 0.274 and 0.276 inches inclusive.

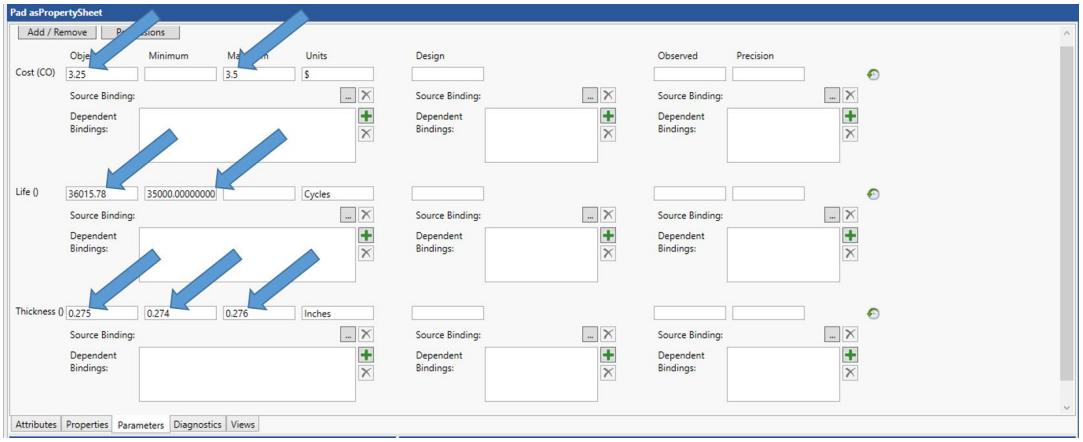

Figure 8 Implied Parameter Requirements

These requirements and their corresponding requirement analyses are sent over when the **Component** they describe is sent over. They appear in *ModelCenter MBSE* in two top level folders labeled "RequirementAnalyses" and "ParameterRequirements" in the "Analyses List" and "Requirement List" sections of ModelCenter MBSE, respectively.

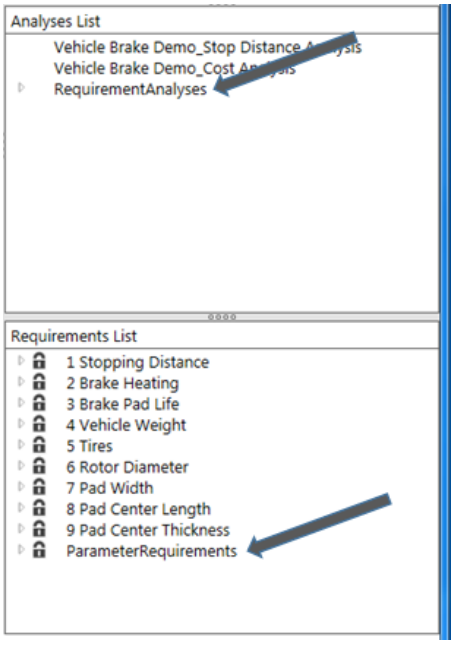

Figure 9 Location of Implied Requirements in ModelCenter MBSE

CREATING EXECUTABLE ANALYSES (CONSTRAINTDEFINITIONS)

The **ConstraintDefinition's** fully described parametric diagram will be sent over as an executable analysis. There are many ways to create the GENESYS model. The easiest way to construct this in GENESYS is on the diagram itself using the toolbar buttons.

The following section walks through creating the minimal Constraint Definition needed to describe an analysis in ModelCenter MBSE.

First, create a **ConstraintDefinition** entity named "Simple Constraint" by double-clicking the **ConstraintDefinition** folder in *Project Explorer*.

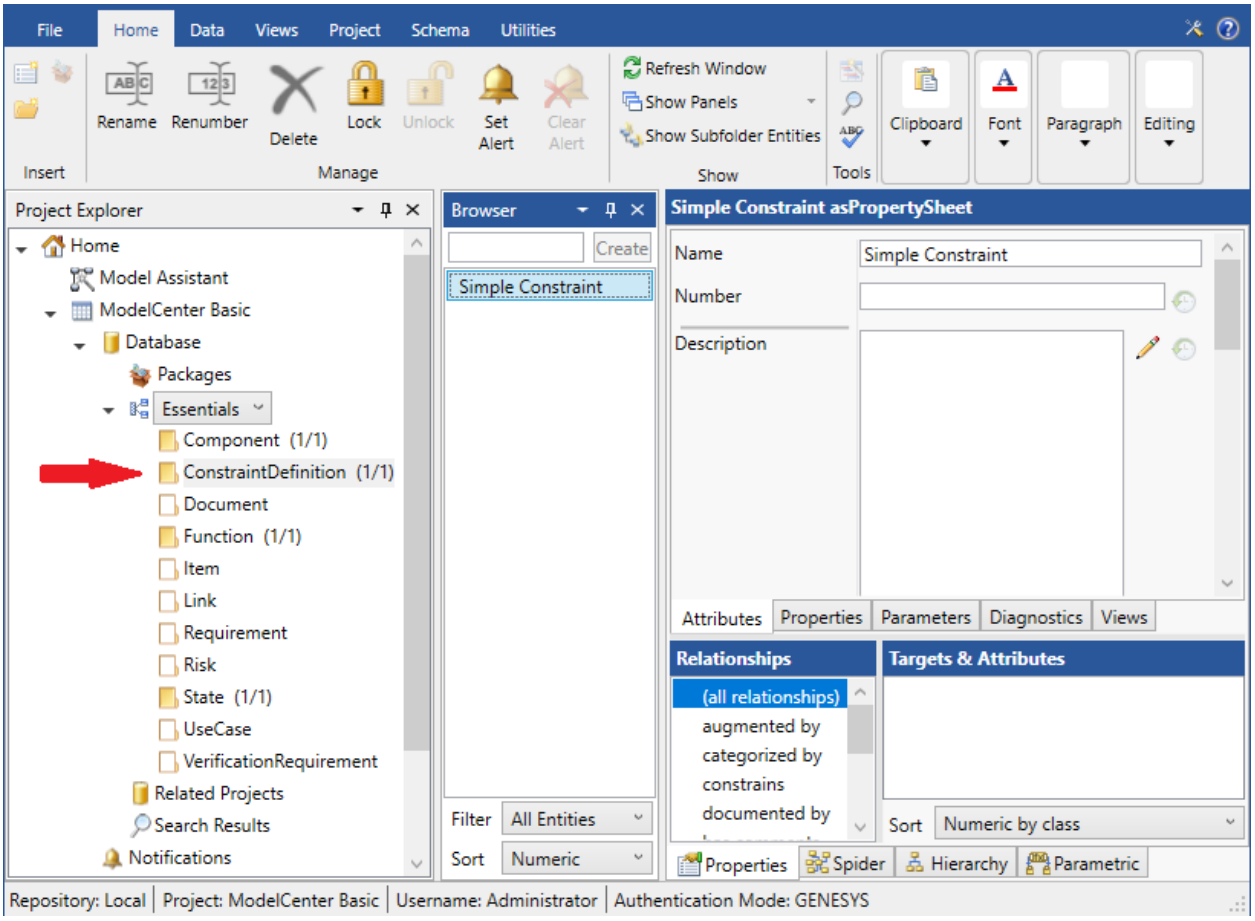

Figure 10 ConstraintDefinition folder in Project Explorer

Add a constrained entity called "ConstrainedElement" and a new parameter entity called "SubEntity" by dragging the appropriate entries from the toolbox onto the Simple Constraint node on the parametric diagram. You can rename an entity on the diagram by right clicking on it.

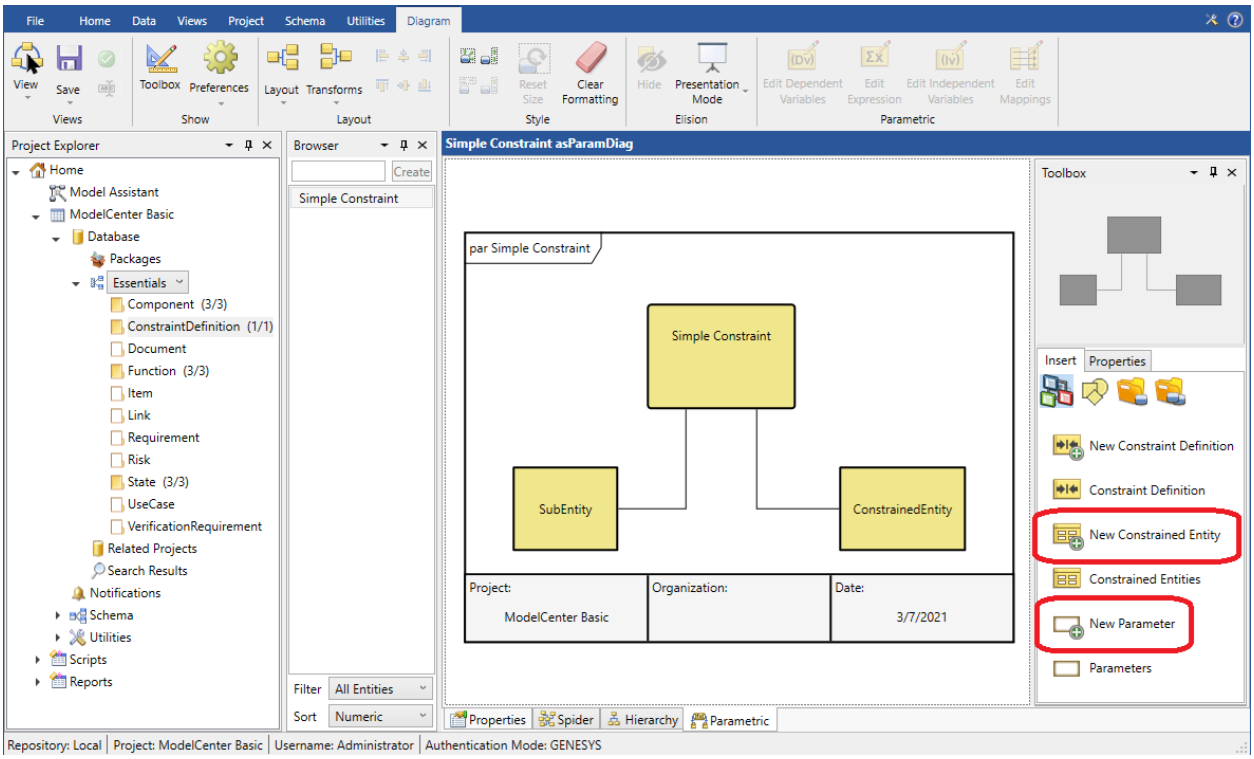

Figure 11 Simple Constraint Parametric Diagram

On Simple Constraint's property sheet, add a dependent variable called "Dependent", an independent variable called "Independent", and the equation "Dependent = Independent * 3.14159265".

Note that the connector uses Ansys script wrappers to create the analyses. See the Ansys documentation on creating script wrappers to determine how to format your **ConstraintDefinition** entity equations, and what mathematical functions are available for use.

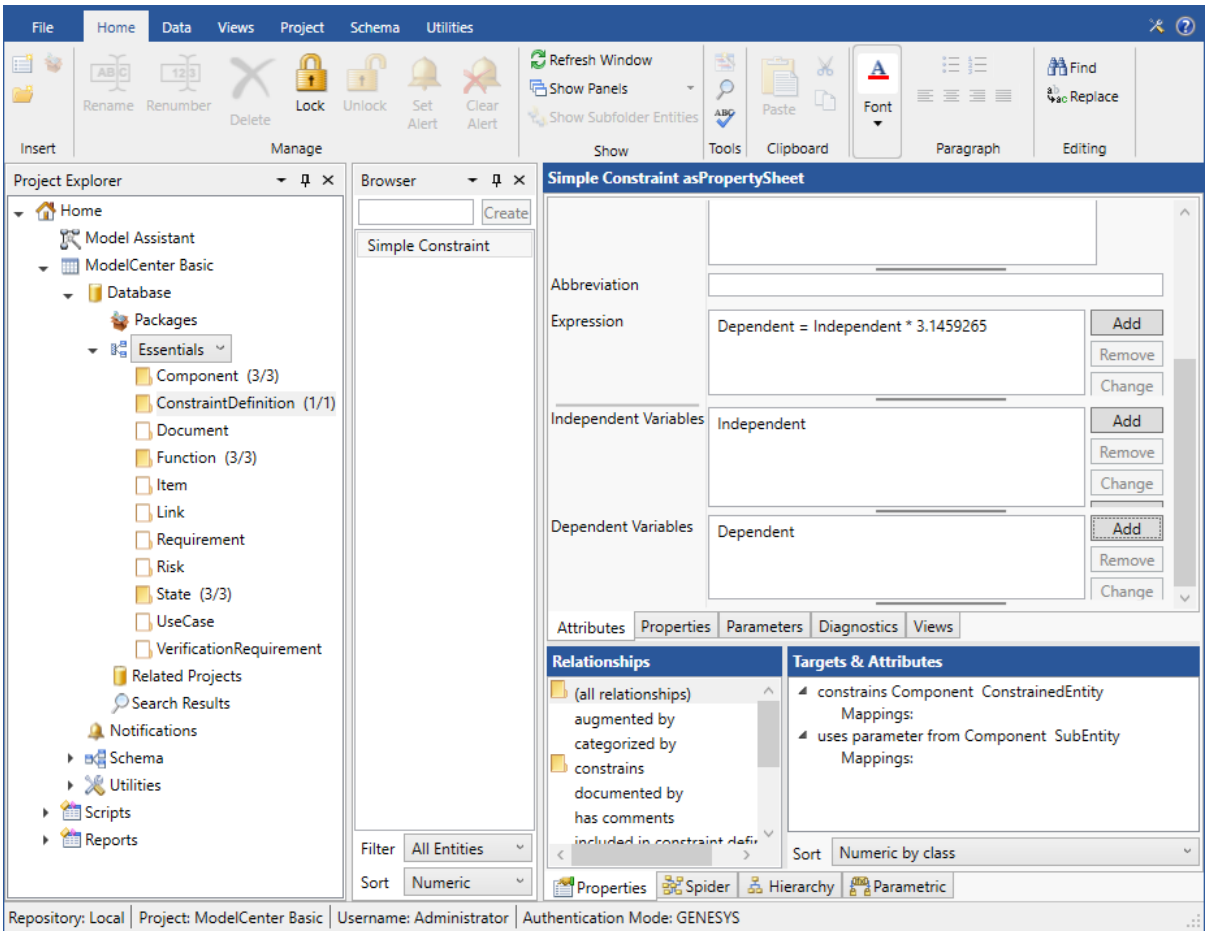

Figure 12 Simple Constraint Property Sheet

Select the **Component** folder in *Project Explorer*. Select **Component** SubEntity. Select the parameter tab. Add a new parameter called DataParameter.

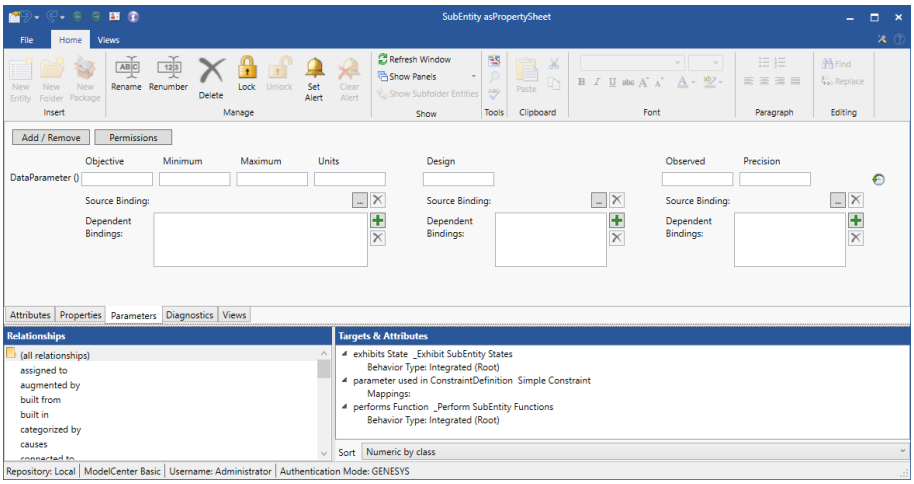

Figure 13 SubEntity Parameter Sheet

Select Component ConstrainedElement. Add a new parameter called ConstraintParameter.

On Simple Constraint's parametric diagram, map its dependent and independent variables to the appropriate parameters by selecting the lines between the entities, then select **Edit Mappings** from the ribbon. Use the resultant dialog to map parameters/variables as desired – in this simple case there is only one option for each.

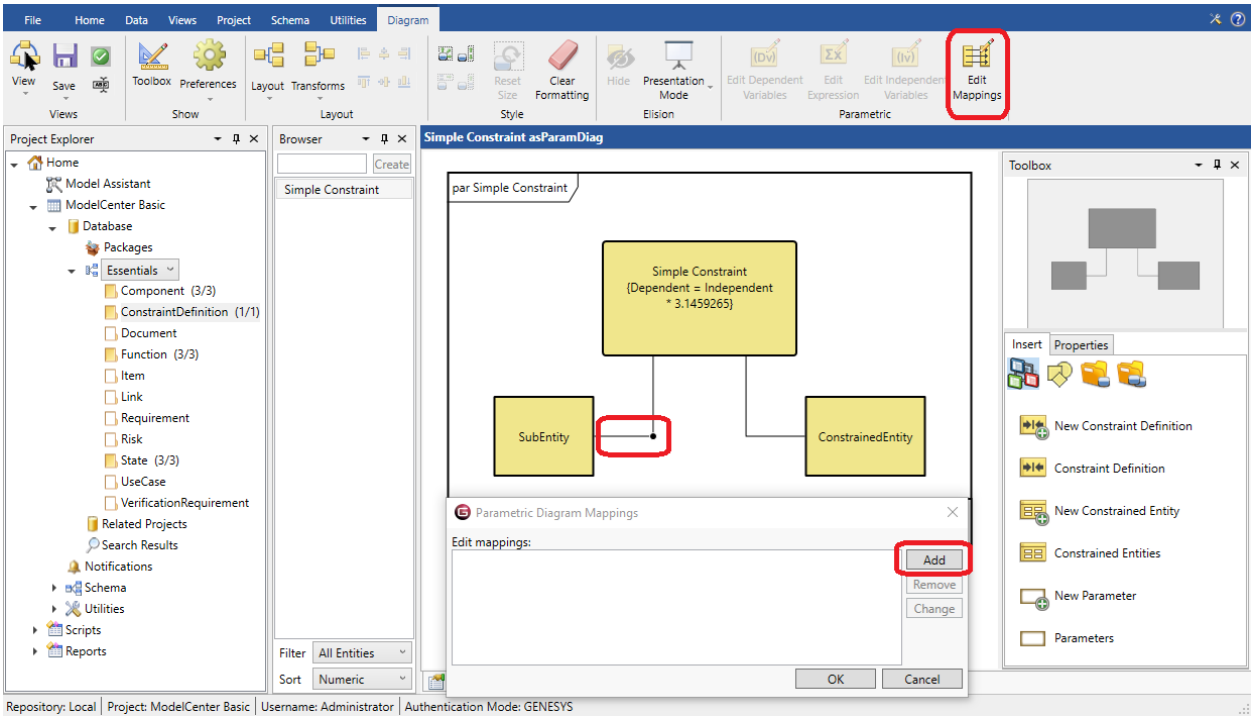

Figure 14 Mapping SubEntity Parameter

Your parametric diagram should look like this:

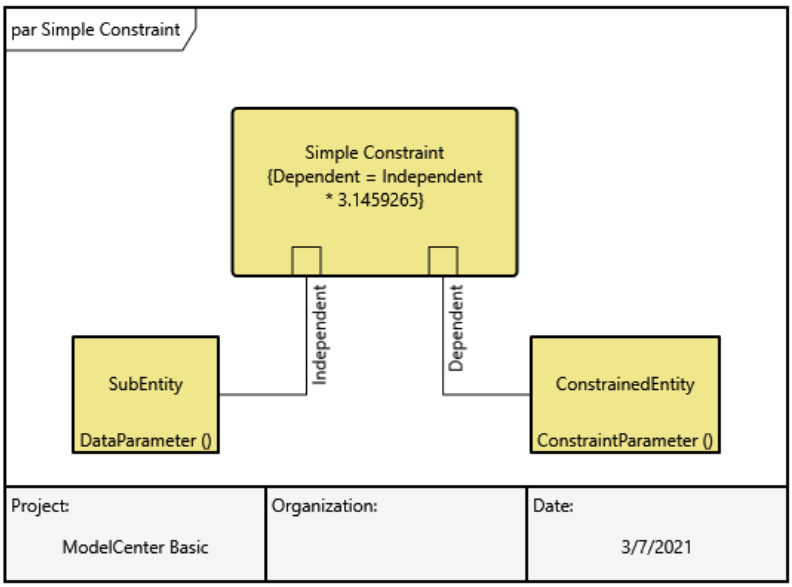

Figure 15 Simple Constraint Parametric Diagram

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Set the objective parameter value of the DataParameter (on **Component** SubEntity) to some value. Now the Simple Constraint is ready to send over to the Ansys ModelCenter MBSE.

Of course, you can use whatever analysis you want by adding it in the Ansys Analysis Server and connecting the analyses after you have exported the GENESYS model.

If you have imported leaf level components from Simulink, it is recommended you follow the Ansys documentation on how to import Simulink analyses into your Analyses Server.

UPDATING THE GENESYS MODEL

Once you have the execution plan set up the way you like and are satisfied with the execution plan results, save the parameter values back to your GENESYS model by selecting the “Save baseline values” button on the ModelCenter MBSE toolbar. Only values which have been calculated in the selected execution plan results and are different from the current GENESYS parameter design value will be sent back.

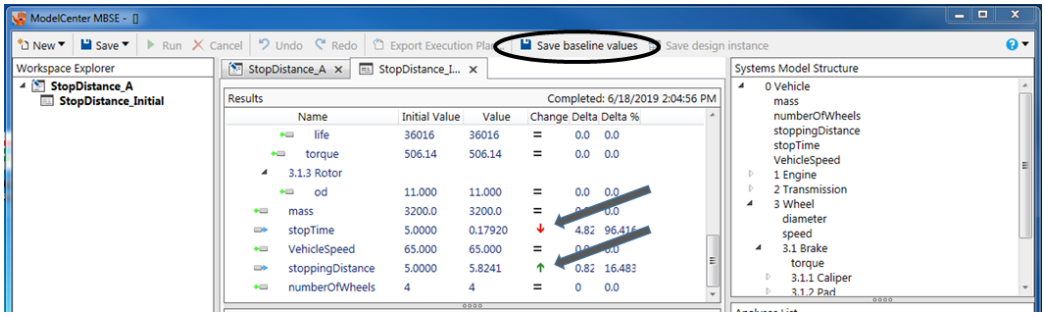

Figure 16 Calculated Variables

A list of these changes will be presented for the engineer to review. Verify these are the results you want to save and select “Yes” to complete the changes.

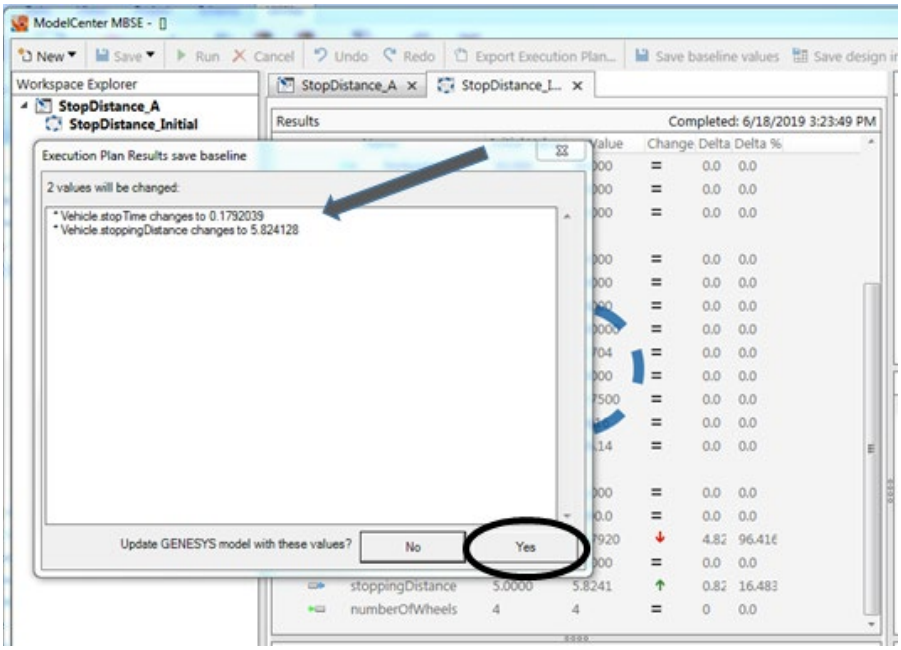

Figure 17 List of Variables for Review

These values will now appear in the design values of their respective parameters.

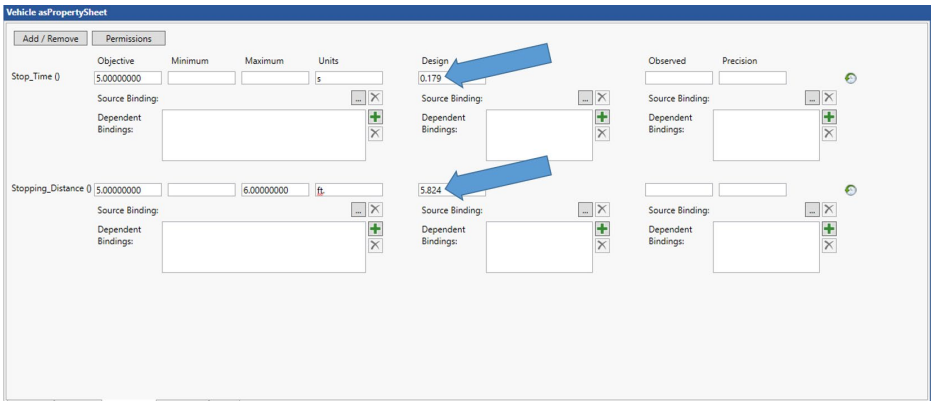

Figure 18 Location of Changed Values

DOCUMENTING DESIGN DECISIONS

There are several ways to document models and design decisions in GENESYS. Audit logs, reports, baselining, are a few – how a project and design choices should be documented is project specific and well beyond the scope of this guide, please see the relevant GENESYS documentation to explore all the tools available to you.

The following demonstrates how to document values derived from calculations run in ModelCenter MBSE and should be considered as only a part of a complete documentation solution.

Selecting the “Save” button in the ModelCenter MBSE toolbar will save the tab currently selected in the center pane.

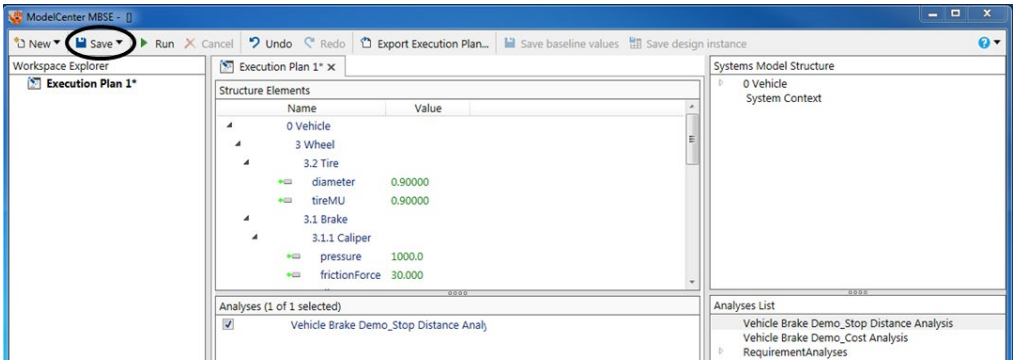

Figure 19 Saving Execution Plans

Execution plan results are saved with the execution plan from which they were run. Ensure that you have saved the execution plan along with each execution plan result you want to save. Any item on the left pane which has an asterisk beside it has not been saved.

Once you have saved the file in ModelCenter MBSE with all the results desired, create a corresponding GENESYS **Document** entity. Make sure that the description, date, and the external file path are filled in. Then simply create a *documents* relation to the **Component** entity from the analysis documents.

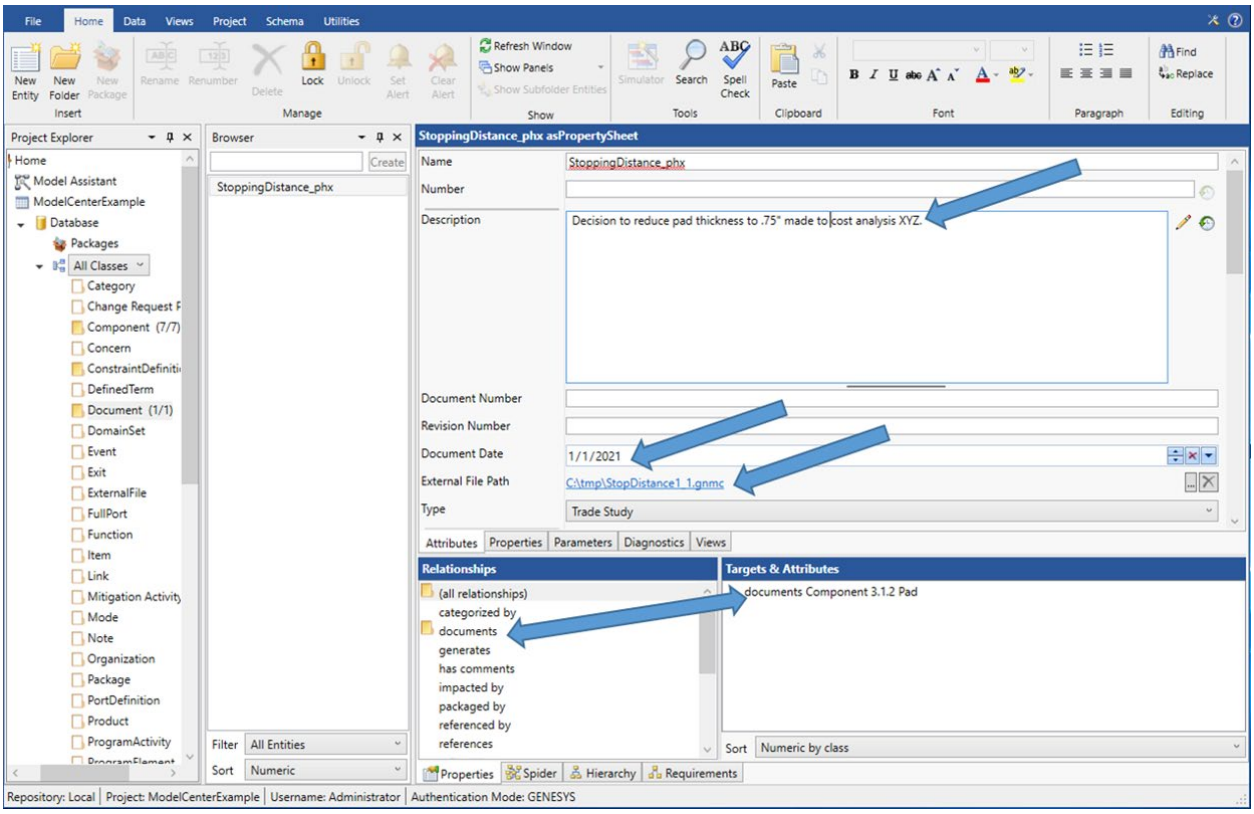

Figure 20 Creating a Document Entity

To reload the execution plan results, start the ModelCenter MBSE export wizard and select the “Existing file” radio option. Then browse to and select the desired GNMC file.

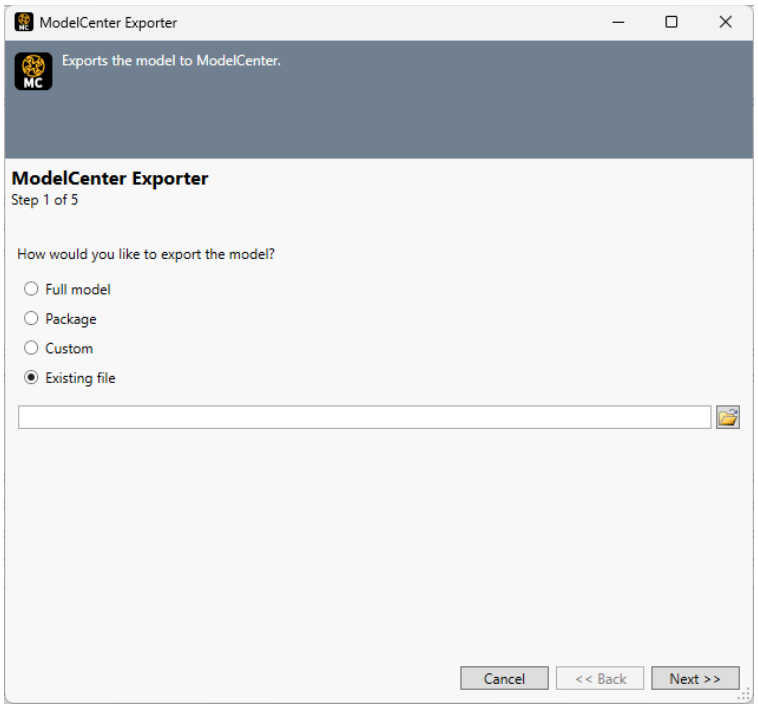

Figure 21 Loading a Saved Execution Plan

CAPABILITIES AVAILABLE IN MODELCENTER MBSE

ModelCenter MBSE contains a Design of Experiments (DOE) Tool, which simplifies the purposeful changing of inputs (design variables) in a model to observe the corresponding changes in outputs (response variables). A set of valid values for each design variable constitutes a design point. This tool collects the responses in the model to a set of predetermined design points. The provided tools graphically set up and conduct this experiment.

For more information on the Ansys ModelCenter MBSE go to the following link:

https://www.ansys.com/products/connect/ansys-modelcenter.

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