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Publication Date: December 2023



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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 <u>www.vitechcorp.com/online-resources/</u>.



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.



<u>Help Files</u>

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, that is included in the GENESYS Pro version, 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 in order 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 in order 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 in order 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 in 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.

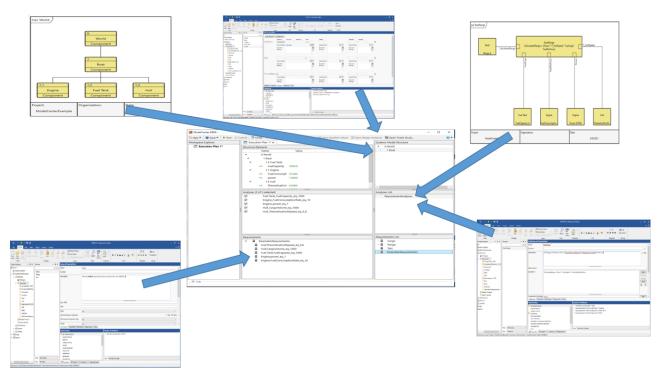


Figure 1 ModelCenter MBSE Connector Concept



button on the **Utilities** ribbon

To launch the ModelCenter MBSE connector, select the *ModelCenter* in GENESYS.

9.	C • 😋	9 🖬	0						GENESYS 2023 Pro			-		
File	Home	Data	Views	Project	Schema	Utilities							7	
Admin Tools	Job Monitor	Document Parser	Scripts	Reports	Export Team View		SBE Digital Thread	Import Export	Constraint Solver Exporter	Model Center				
Ma	nage		*	٣	Tools			DOORS	MATLAB	Ansys				

Figure 2 ModelCenter Command Location



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

🂔 ModelCenter Exporter		_			Х
Exports the model to ModelCenter.					
ModelCenter Exporter Step 1 of 5					
How would you like to export the model?					
• Full model					
○ Package					
○ Custom					
○ Existing file					
Can	ncel	<< Back	:	Next	>>

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**.

🌮 ModelCenter Exporter	_		\times
Exports the model to ModelCenter.			
ModelCenter Exporter Step 2 of 5			
Component export options Image: Component service			
How would you like Component names to appear in ModelCenter?			
 Entities represented by class alias, entity number, and entity name. 			
 Entities represented by entity number and entity name. Entities represented by entity name. 			
Cancel <	< Back	Next	>>

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.

ModelCenter MBSE - []		
🎦 New 🔻 💾 Save ▼ 🗼 Run 🗶 Ca	ancel 🎐 Undo 🔇 Redo 🖄 Export Execution Plan 💾 Save baseline values 🖽 Save design instan	ce 😧 🕇
Workspace Explorer	Execution Plan 1* ×	Systems Model Structure
Execution Plan 1*	Structure Elements	O Vehicle mass
	Name Value	numberOfWheels
	Drag and drop or right click a systems model to associate with this Execution Plan	stoppingDistance stopTime VehicleSpeed 1 Engine 2 Transmission E diameter speed 3.1 Brake torque 4 3.1.1 Caliper diameter
	Analyses	frictionForce
	Drag and drop or right click an analysis to associate with this Execution Plan	Analyses List Vehicle_Stop Distance Analysis Vehicle_Cost Analysis Vehicle_Cost Analysis P RequirementAnalyses
	0000	0000
	Requirements There are no requirements in this Execution Plan.	Requirements List P 1 Stopping Distance P 2 Stake Heating P 3 Stake Pad Life P 4 Vehicle Weight P 6 Rotor Diameter P 7 Pad Width P 8 Pad Center Length P 9 Pad Center Thickness P Parameter Requirements
(⊕ Log		

Figure 5 Exported Model in ModelCenter MBSE



SELECTING MODEL SEGMENT TO EXPORT

To make model analysis more manageable, GENESYS provides a 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.

🌾 ModelCenter Exporter		_		×
Exports the model to ModelCenter.				
ModelCenter Exporter				
Step 1 of 5				
How would you like to export the model?				
○ Full model				
Package				
⊖ Custom				
O Existing file				
Packages				
🕨 🐱 IPT 1				
L	Canad	e e Da al	NL	
	Cancel	<< Back	Next	>>

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' hierarchical structure or a folder in order 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.

🍀 ModelCenter Exporter	_		×
Exports the model to ModelCenter.			
ModelCenter Exporter Step 2 of 5			
Component export options			
How would you like Component names to appear in ModelCenter?			
 Entities represented by class alias, entity number, and entity name. 			
 Entities represented by entity number and entity name. Entities represented by entity name. 			
C Endes represented by endy home.			
Cancel	<< Back	Next	>>

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.

Pad asPrope							
Add / Re	move P sions						^
	Obje Minimum Ma	n Units	Design		Observed	Precision	
Cost (CO)	3.25 3.5	s					Ð
	Source Binding:	X	Source Binding:	×	Source Binding:	🗙	
	Dependent Bindings:	*	Dependent Bindings:	*	Dependent Bindings:	×	
Life ()	36015.78 35000.00000000	Cycles					Ð
	Source Binding:	×	Source Binding:	X	Source Binding:	X	
	Dependent Bindings:	+ ×	Dependent Bindings:	*	Dependent Bindings:	*	
Thickness ()	0.275 0.274 0.276	Inches					Ð
	Source Binding:	X	Source Binding:	- X	Source Binding:		0
	Dependent	•	Dependent		Dependent		
	Bindings:	×	Bindings:	*	Bindings:	×	
Attributes	Properties Parameters Diagnostics Views						~

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.

Þ	Vehicle Brake Demo_Stop Distance Arrysis Vehicle Brake Demo_Cost Anrysis RequirementAnalyses
2001	eees
	1 Stopping Distance
	2 Brake Heating
	3 Brake Pad Life
a	
6	4 Vehicle Weight
6	4 Vehicle Weight
	4 Vehicle Weight 5 Tires 6 Rotor Diameter
	4 Vehicle Weight 5 Tires
	4 Vehicle Weight 5 Tires 6 Rotor Diameter
	4 Vehicle Weight 5 Tires 6 Rotor Diameter 7 Pad Width

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*.

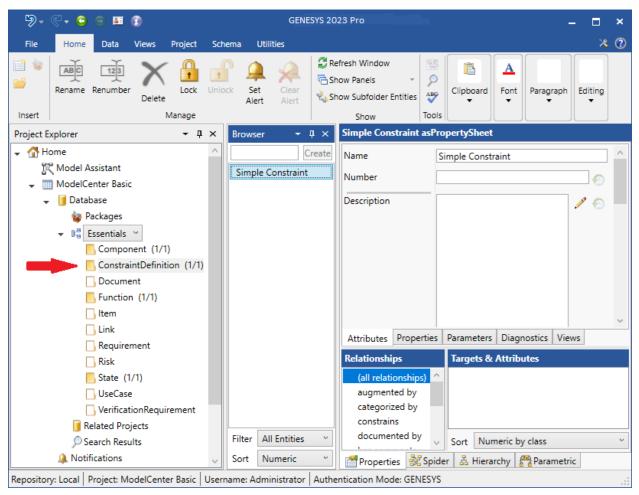


Figure 10 ConstraintDefinition folder in Project Explorer

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.



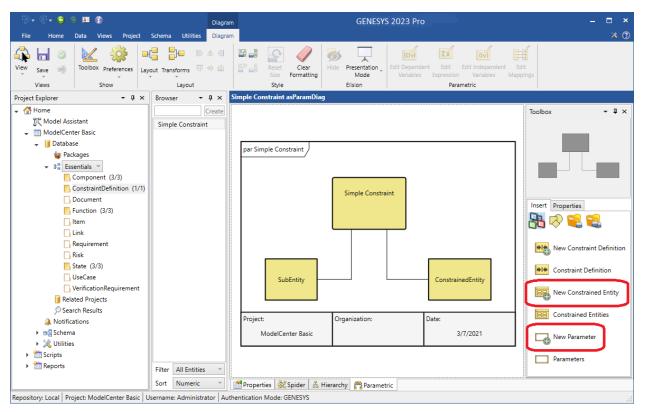


Figure 11 Simple Constraint Parametric Diagram

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.



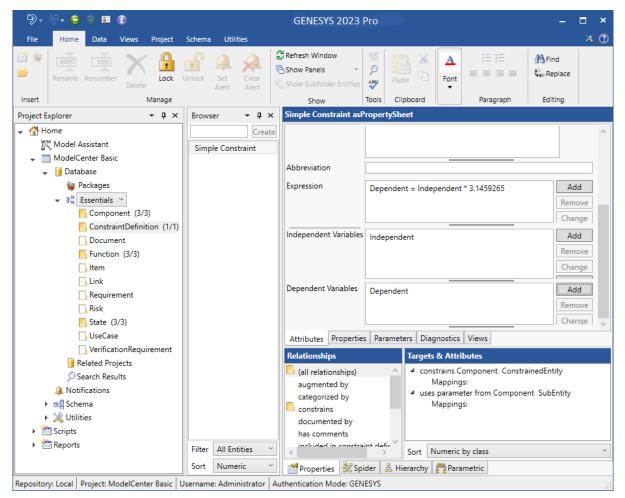


Figure 12 Simple Constraint Property Sheet

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

		SubEntity asProp	pertySheet			
File Home Views Image: Control of the second seco	Unlock Set Clear	Refresh Window Show Panels Show Subfolder Entities Show Tools	Paste Clipboard	v v A^ A [*] A v ≌ v	i≣ j≣ ≡ ≡ ≡ ≡ Paragraph	A Find Geo Replace
Add / Remove Permissions Objective Minimum Maxi DataParameter () Source Binding: Dependent Bindings:	imum Units	Design Source Binding: Dependent Bindings:		Observed Source Binding: Dependent Bindings:	Precision	
Attributes Properties Parameters Diagnostics Views						

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.

9• C• 😋 🖲 🖬 👔	Diagra	n GENESYS 2023 Pro	– 🗆 ×
File Home Data Views Project	Schema Utilities Diagra	n .	* 🕐
	yout Transforms IT & III	Image: Size Formatting Image: Size F	
Project Explorer - 🗜 🗙	Browser - 4 ×	Simple Constraint asParamDiag	
 Home Model Assistant Model Center Basic Jatabase Packages Component (3/3) ConstraintDefinition (1/1) Document Function (3/3) Item Link Requirement Risk State (3/3) UseCase VerificationRequirement Related Projects Search Results Notifications Search Results Notifications Scipts Meports 	Greate Simple Constraint	SubEntity ConstrainedEntity	E E
	Sort Numeric *	OK Cancel	
Repository Local Project: ModelCenter Basic			

Figure 14 Mapping SubEntity Parameter

Your parametric diagram should look like this:

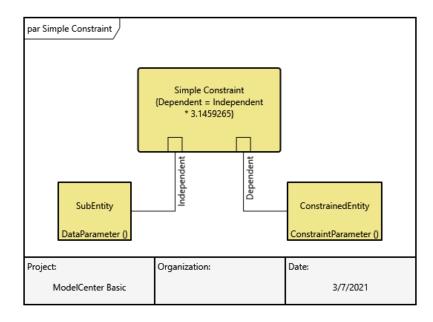


Figure 15 Simple Constraint Parametric Diagram



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.

🔁 New 🔻 💾 Save 👻 🕨 Run	🗙 Cancel 🏓 Undo ୯ Redo 🕇 🖄	Export Execution Plan	Save baseline values Save design	n instance	0
Workspace Explorer	StopDistance_A × 📼 S	topDistance_I ×		Systems Model Structure	
StopDistance_A StopDistance_Initial	Results	Initial Value Value	Completed: 6/18/2019 2:04:56 PM Change Delta Delta %	 O Vehicle mass numberOfWheels 	[
	← life ← torque ▲ 3.1.3 Rotor ← od	36016 36016 506.14 506.14 11.000 11.000 3200.0 3200.0	= 0.0 0.0 = 0.0 0.0 = 0.0 0.0 = 0.0 0.0	stoppingDistance stopTime VehicleSpeed 1 Engine 2 Transmission 3 Wheel	
	stopTime VehicleSpeed stoppingDistance numberOfWheels	5.0000 0.17920 65.000 65.000 5.0000 5.8241 4 4		diameter speed	

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.

orkspace Explorer	StopDistance_A x	StopDistance_L	×				
StopDistance_A StopDistance_Initial	Results			Co	mpleted	d: 6/18/2019 3	23:49 PN
Execution Plan Results save baselin	III	-	Yalue	Chang	ge Delta	Delta %	
Execution Plan Results save baselin	e		000	=	0.0	0.0	
2 values will be changed:			000	=	0.0	0.0	
* Vehicle stop Time changes to 0.179 * Vehicle stoppingDistance changes	2039 to 5.824128		000	=	0.0	0.0	
			000	=	0.0	0.0	
			000	=	0.0	0.0	
			00	=	0.0	0.0	
			1000	=	0.0	0.0	
			04	=	0.0	0.0	
			000	=	0.0	0.0	
			7500	=	0.0	0.0	
				=	0.0	0.0	
			.14	=	0.0	0.0	
			000	=	0.0	0.0	
		-	0.0	=	0.0	0.0	
			920	4	4.82	96.416	
Update GENESYS mo	del with these values? No	Yes					
Update GENESYS mo	del with these values? No	Yes	000	=	0.0	0.0	

Figure 17 List of Variables for Review



Source Binding:	Stopp.Time 0 5.0000000 s 0.175 Source Binding: X	Add / Remove	Permissions]				-		
Source Binding:	Source Binding:		Objective	Minimum	Maximum	Units	Design		Observed Precision	
Dependent Bindings: Stopping_Distance 0 50000000 Source Binding: Source Binding: Dependent Bindings: Dependent Bindings: Dependent Bindings: Dependent Bindings: Source Bindings: Dependent Bindings: Source Bindings: Source Bindings: Dependent Bindings: Dependent Bindings: Source Bindings: Dependent Bindings: Source Bindings: Source Bindings: Sou	Dependent Bindings: Stopping_Distance 0 50000000 (b. 5.834 Source Binding:	Stop_Time ()	5.0000000			5	0.179			0
Stopping_Distance 0 50000000 6.00000000 10 5.824 Image: Control of the stopping of	Stopping_Distance 0 50000000 6.00000000 ft 5.824 Image: Control of the stopping of		Source Binding:			X	Source Binding:	- ×	Source Binding:	×
Source Binding:	Source Binding:					×		+ ×		*
Source Binding:	Source Binding:	Stopping_Distance ()	5.00000000		6.00000000	B	5.824			
Dependent Bindings: Dependent Bindings: Dependent	Dependent Bindings: Dependent X Bindings: Dependent X Bindings: X		Source Binding:					- X	Source Binding:	
						×				×

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 of 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.

\sim	X Cancel 9 Undo C Redo 12 Export Execution Plan Save baseline values 13 Save	
Workspace Explorer	Execution Plan 1" ×	Systems Model Structure
Execution Plan 1*	Structure Elements	O Vehicle System Context
	Name Value	system context
	▲ 0 Vehicle	
	▲ 3 Wheel	E
	4 3.2 Tire	
	- diameter 0.90000	
	+= tireMU 0.90000	
	4 3.1 Brake	
	A 3.1.1 Caliper	
	ressure 1000.0	
	+= frictionForce 30.000	
	Analyses (1 of 1 selected)	Analyses List

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 of 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.



ModelCenter[®] MBSE for GENESYS Connector Guide

[] · · · · · · · · · · · · · · · · · · ·	Project Schema Utilities	c	GENESYS 2023 Pro			- □ × * 0
New New New Entity Folder Package Insert	Therefore the second se	Clear Alert	- Simulator Search	ABC Speli Check Clipboard	B I ∐ abs A A A A 2	i ⊟ } ⊒ A Find E ≝ ⊒ ■ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$
Project Explorer 🛛 👻 🕂 🗙	Browser - I ×	StoppingDistance_phx as	PropertySheet			
Home ^	Create StoppingDistance_phx	Name Number	StoppingDistance_phx			
ModelCenterExample Database Packages All Classes Category Change Request F Concern ConstraintDefiniti DefinedTerm Document (1/1) DomainSet Event		Description Document Number Revision Number Document Date	Decision to reduce pad thic	kness to .75" made to	cost analysis XYZ.	
Exit		External File Path	C:\tmp\StopDistance1_1.gnm			
FullPort		Туре	Trade Study			· .
Function		Attributes Properties F Relationships	Parameters Diagnostics View	vs Targets & Attribute	5	
Mitigation Activity Mode Organization Package PortDefinition Product		(all relationships) categorized by documents generates has comments impacted by packaged by referenced by	^	documents Com;	ponent 3.1.2 Pad	
ProgramActivity	Filter All Entities *	references	~	Sort Numeric by cl	ass	v
()	Sort Numeric ~	Properties 😽 Spider	🖁 🔏 Hierarchy 🖁 Requirem	ents		
Repository: Local Project: ModelCen	terExample Username: Administrator	Authentication Mode: GENE	SYS			

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.



🏀 ModelCenter Exporter			-		×
Exports the model to ModelCenter.					
ModelCenter Exporter Step 1 of 5					
How would you like to export the model?					
○ Full model					
O Package					
○ Custom					
Existing file					
					2
	Cancel	<<	Back	Nex	t>>

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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