
Linking System Requirements with Product Performance

Tom Tecco

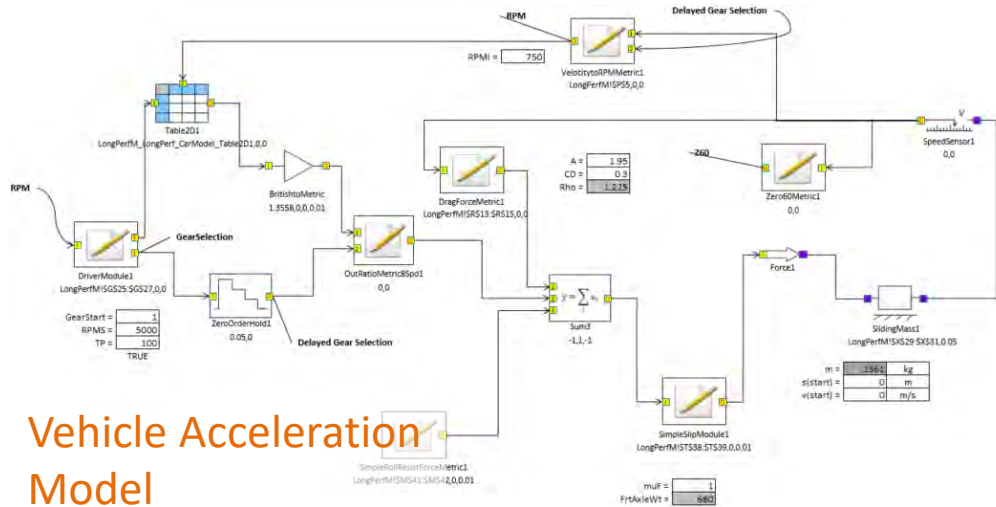
XLDyn

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XLDyn, LLC

XLDyn is an intuitive and easy to use, enterprise system engineering tool that is fully integrated with simulation



Vehicle Acceleration
Model

XLDyn = XLSE + XL1D

XLSE – For authoring OMG SysML
compliant system models

XL1D - For authoring/simulating
detailed 1D multi-physics
systems models



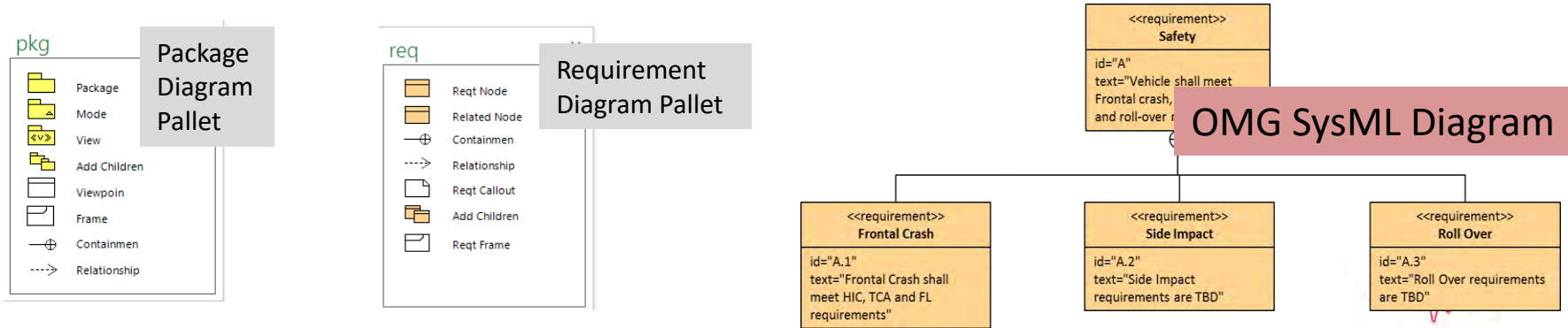
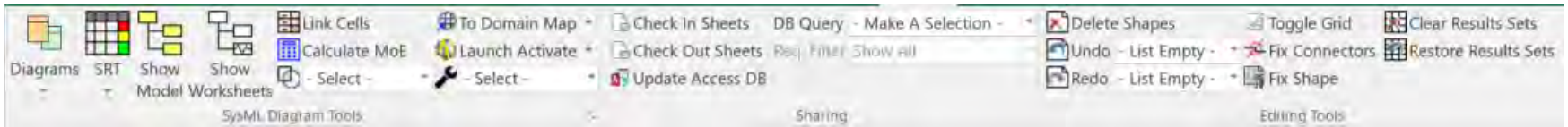
XLDyn = Enterprise Solution to MBSE



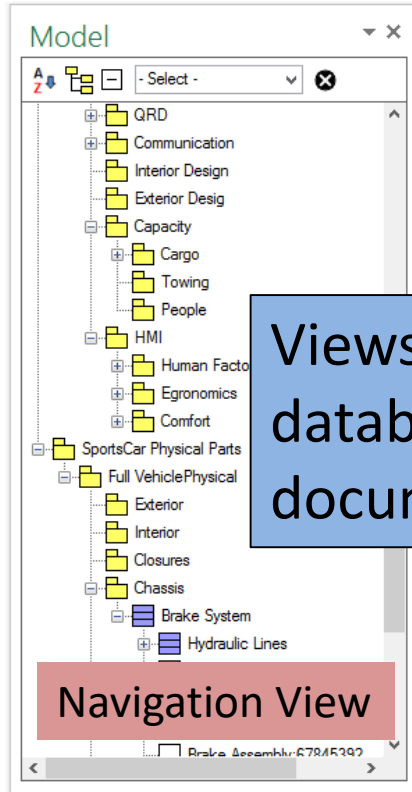
- XLDyn is an **actionable** tool for engineers to develop, balance, and track designs
- XLDyn supports all verification methods
- Program status is easily available to everyone
- Documentation is byproduct of the development process
- Documentation is critical for team communication
- **XLDyn is easy to use: Systems Engineering for everyone**

XLSE Overview

- XLSE is a Model Based Systems Engineering Tool
 - Provides design balance tools to develop optimal designs
 - Manages requirements status throughout the design cycle
 - Can be used at system, subsystem, or component level
 - Model is fully synchronized when adding/editing requirements or BoM parts



XLSE Overview



ID	Name	Text	Procedure Name	Target	Actual	Method
A	Safety	Vehicle shall meet Frontal crash, side	Ad hoc			
A.1	Frontal Crash	Frontal Crash shall meet HIC, TCA ar	Ad hoc			
A.1.1	Head Injury Criterion	Head Injury Criterion(HIC<1000) - F	Ad hoc	HIC<1000	342.8	
A.1.2	Thoracic Chest Acceleration	Thoracic Chest Acceleration(TCA<60	Ad hoc	TCA<60	45.1	
A.1.3	Femur Load	Femur Load(FL<7560) - Femur load	Ad hoc	FL<7560	4513	
A.1.4	Star Rating	Star Rating (Star=5) – The NHTSA fr	Ad hoc	4.75<Star<5	5.00	
A.2	Side Impact	Side Impact requirements are TBD	Ad hoc			
A.3	Rollover	Vehicle shall meet all rollover requir	Ad hoc			
A.3.1	Static Stability Factor	Static Stability Factor (SSF>1.45) – T	Ad hoc	SSF>1.45	1.198	
					42.0	
					31.09	
					35.2	
					423	
						ality requirements while
					7.96	
C.2	Deceleration	The vehicle shall meet an decelerati	Ad hoc			
C.2.1	Stopping Distance	Stopping Distance(Distance<60) – Tl	Ad hoc	Distance<60	55.2	
C.3	Handling	The vehicle shall meet all of the follo	Ad hoc			
C.3.1	Turning Radius	Turning Radius(TurnRad<8.6) – The	Ad hoc	TurnRad<8.6	8.69	
C.3.2	Axle Weight Balance	Axle Weight Balance (FrtAxle=50) – T	ad hoc	47.5<FrtAxle	50.0	CAT/CAE
D	Capacity	Capacity is c				, cargo both weight and volume, and towing.
D.1	Passengers	Passengers (able to carry 4.75<NumPass<5.25
D.2	Cargo	Cargo capac				volume measures
D.3	Towing	Vehicle towing capacity is comprised of trailer weight and tongue weight.				
E	QRD					

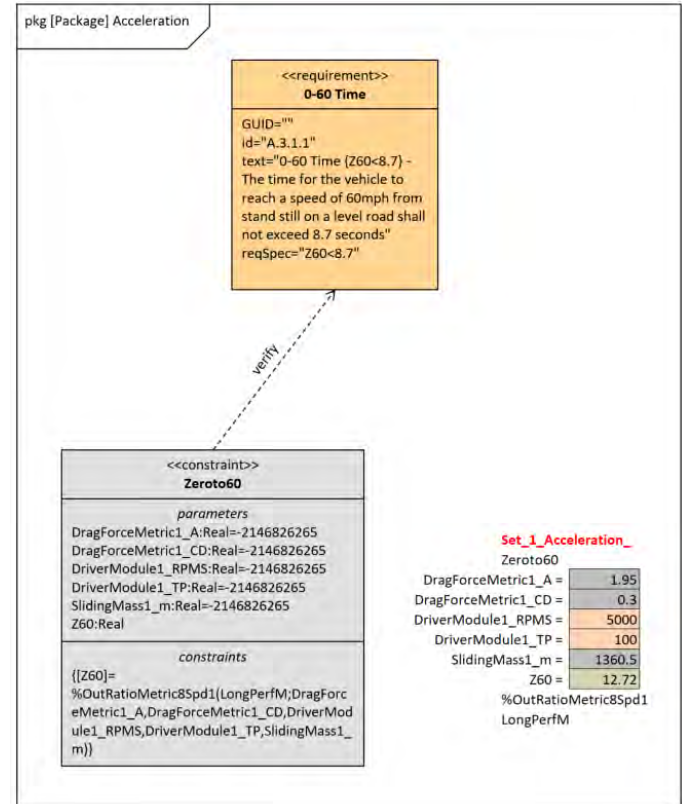
Views are created automatically from the database or imported Microsoft Word® documents, including IBM DOORS®

Table View



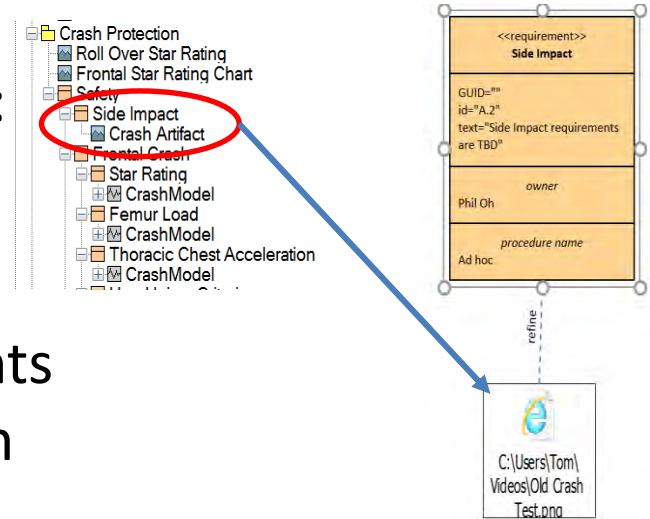
XLSE Overview

- XLSE includes the following SysML diagrams:
 - Package (*pkg*)
 - Block Definition (*bdd*)
 - Internal Block (*ibd*)
 - Parametric (*par*)
 - Activity (*act*)
 - Requirement (*req*)
 - State Machine (*stm*)
 - Use Case (*uc*)
- XLSE's Parametric, Activity, and State Machine diagrams are **actionable**. Change parameters and run simulations directly from the diagrams



XLSE Overview

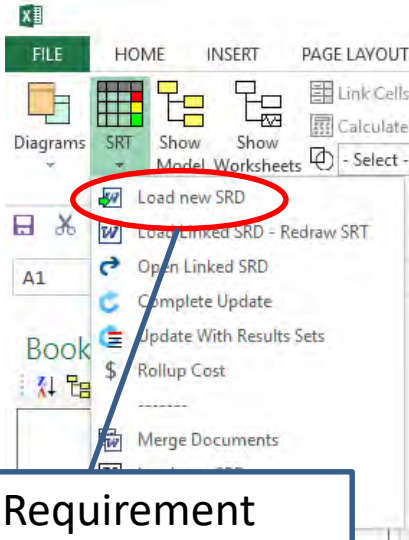
- Document your work by attaching objects to the diagram blocks including:
 - Word Documents, PowerPoint,
 - Excel, Visio, Video, PDF, etc.
- XLSE automatically updates requirements status with verifier results in the System Requirement Table (SRT)



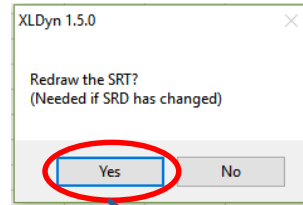
ID	Name	Text	Procedure N	Target	Actual	Target Wt	Actual Wt	Change Hist	Comments	Method	Owner	Assigned To	Notified	Due Date	Last Updated
A.3.2	Deceleration	Deceleration – The vehicle shall meet all deceleration requirements													
A.3.2.1	Stopping Distance	Stopping Distance(Distance<60) – The vehicle shall Distance<60			56.4										
A.3.3	Handling	Handling – The vehicle shall meet all of the following handling criteria.													
A.3.3.1	Turning Radius	Turning Radius(TurnRad<8.6) – The vehicle turning TurnRad<8.6			8.23										
A.3.3.2	Axle Weight Balance	Axle Weight Balance (FrtAxle=50) – TI CAE 50	47.5	<FrtAxle	49.0					CAT/CAE Request		thomas.tecc	Jul 21, 2017	Jul 31, 2017	21-Jul-17
A.3.4	Ride Quality	Ride Quality – Vehicle shall be best in class for smooth and rough road ride metrics													
A.4	Capacity	Capacity – Capacity is comprised of number of passengers, cargo both weight and volume, and towing.													
A.4.1	Passengers	Passengers (NumPass==5) – The vehicle must be a NumPass==5													
A.4.2	Cargo	Cargo – Cargo capacity is comprised of both weight and volume measures													
A.4.2.1	Cargo Volume	Cargo Volume (CargoVol>1.0) – Avall:ad hoc	CargoVol>1.0		1.100					CAT/CAE Request		thomas.tecc	Jul 20, 2017	Jul 30, 2017	20-Jul-17

Model Creation: 'One Click'

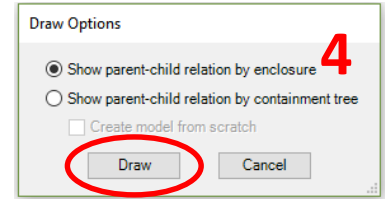
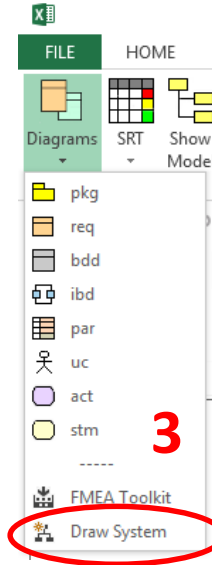
- Model Creation Steps



System Requirement Document (SRD) **1** includes Requirements and BoM

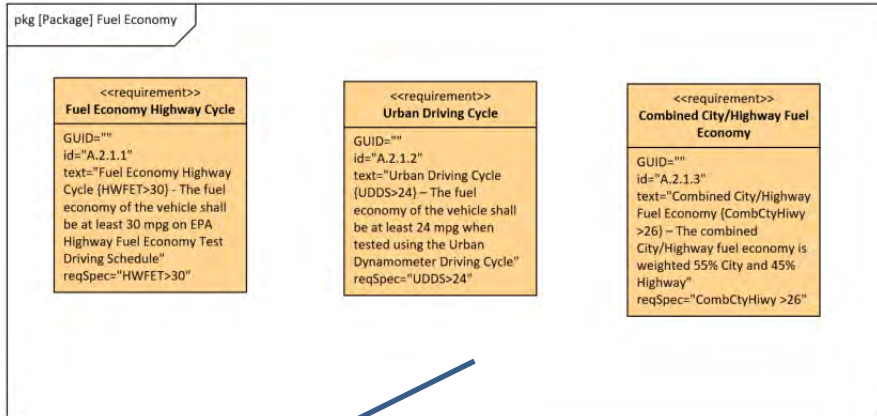


Yes to create the System Requirements Table (SRT). SRT provides a summary of **2** requirements status



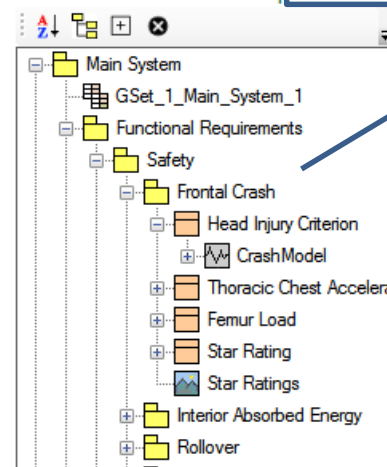
Model Creation: 'One Click'

- XLDyn® 's patented method creates SysML requirement, BoM, and Activity diagrams for the *entire* system



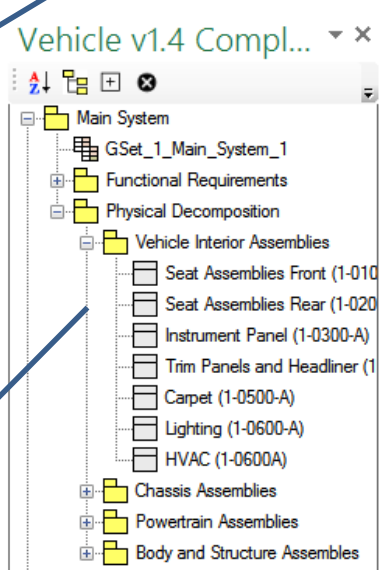
SysML Requirement nodes created

Vehicle v1.4 Compl...



Physical Tree Structure: BoM Assemblies and Parts

Functional Tree Structure: Packages and Requirements



Requirements Verification

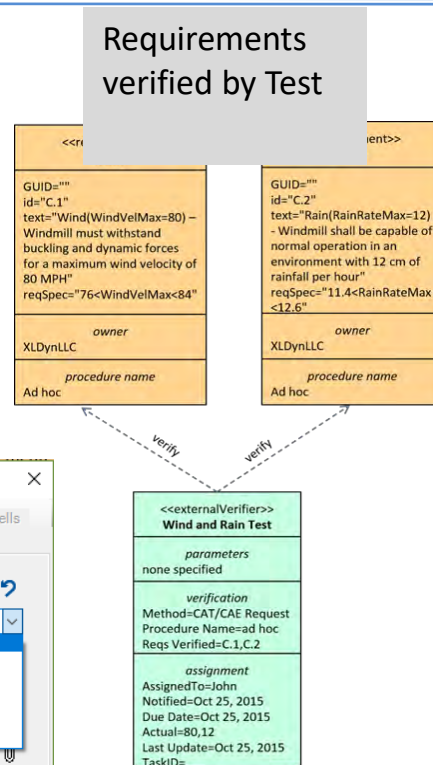
- Verification checks if requirements are met for a given set of design parameters and operating conditions
- XLSE has two classes of verifiers:
 - Internal: Perform simulations or retrieve test data directly from the diagram view. *3rd Party simulation tools can be easily added.*
 - External: Generate and track work request for test or large scale simulation
- Multiple verifiers for a requirement:
 - Verification methods can change over the life of a product program
 - Simple models, design rules followed by detailed simulation and test
 - XLSE allows engineers to change verifiers and track the history of the methods and values

XLDyn[®] Verification Methods

Verification methods supported by XLDyn[®]

- *Cell Equations* – Simple equations or Macros
- *Worksheets* – Link the input/output cells of a worksheet to the results set
- *CAT/CAE Request*¹ – Automated e-mail request for a test or simulation. Automatic updated to SRT when work is completed
- *Observation*¹ – Automated e-mail request to make a simple observation, e.g. verify label is installed

¹ Requires Microsoft Outlook



Create Verifier

Configuration Parameters

Node Name: externalVerifier2

Verification Method: CAT/CAE Request

Node Location: CAT/CAE Request

Procedure Name: act Diagram

Owner: XLDynLLC

Attachment:

Due Date: May 29, 2017

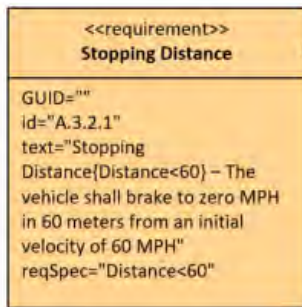
Actual Value: TBD

XLDyn[®] Verification Methods

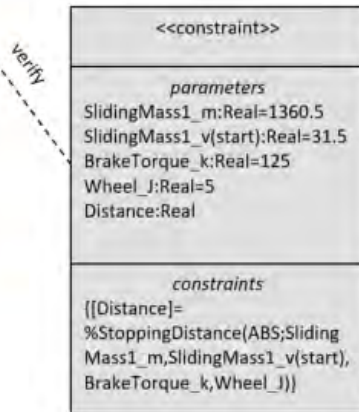
Verification methods supported by XLDyn[®]

- *XL1D Model*² – Use a XL1D model including reliability
- *Activate Model*³ – Use a *solidThinking Activate* model.
- *Modelica Model*⁴ – Use a Modelica model
- *act Diagram*⁵ – Calculate process time using an activity diagram
- *stm Diagram*⁶ – Determine system state for different parameters and conditions

- Radius
 - Force
 - Friction
- $T > 90 \text{ Nm}$



Requirement verified
by XL1D simulation



```
Set_1_Deceleration_
Brake Model ABS
SlidingMass1_m = 1360.5
SlidingMass1_v(start) = 31.5
BrakeTorque_k = 125
Wheel_J = 5
Distance = 56.4
%StoppingDistance
ABS
```

Simulation run from
Diagram View

- ² Requires XL1D model in workbook
- ³ Requires Activate models in Activate model library
- ⁴ Requires OpenModelica solver and Modelica models in Modelica model library
- ⁵ Requires Activity diagram in workbook
- ⁶ Requires State diagram and XL1D mode.

Creating An Activate Verifier

Requirement Node:

```
<<requirement>>  
Stopping Distance  
GUID=""  
id="C.2.1"  
text="Stopping  
Distance(Distance<60) – The  
vehicle shall brake to zero  
MPH in 60 meters from an  
initial velocity of 70 MPH"  
reqSpec="Distance<60"
```

Context Menu:

- Style
- Fill
- Outline
- Fix Shape
- Add/Change Verifier
- Add uc/act/stm
- Add Children
- To SRT
- To Model Tree
- EditBlock

Add/Change Verifier Dialog:

Node Name	sTconstraint1
Verification Method	Activate Model
Node Location	Deceleration_ISCS25
Procedure Name	ad hoc
Assigned To	Tom
Attachment	
Due Date	May 31, 2017
Actual Value	TBD

Select Model Dialog:

Model
Select A Model
HSVS_Demo_water tank.scm
nonlinear_ABS5 TCT.scm
nonlinear_ABS5 v speed.scm
nonlinear_ABS5.scm
nonlinear_ABS9.scm
temp.scm

Creating An Activate Verifier

The screenshot displays the SolidThinking Activate 2016 software interface. The main workspace shows a simulation model of an ABS controller. A 'Configure Activate Model' dialog box is open, showing a list of parameters and their values. The 'Vehicle_Speed' parameter is highlighted with a red box and a callout 'Select Model'. The 'Max over interval' parameter is also highlighted with a red box and a callout 'Click draw to view model'. The 'bd.txt' parameter is highlighted with a red box and a callout 'Select checkmark to draw verifier'. The 'Vehicle_Speed' parameter is also highlighted with a red box and a callout 'Select MOE and parameters'. The 'Vehicle_Speed' parameter is also highlighted with a red box and a callout 'Select Model'.

Click draw to view model

Select checkmark to draw verifier

Select Model

Select MOE and parameters

Simple ABS controller that varies braking torque based on wheel s

Event time(s) time_final

Braking Distance 57.8126

bd.txt

Braking distance scope

Max over interval

vehicle speed

Fix to zero

Wheel slip scope

Mu scope

Wheel Slip - Lambda

Tire adhesion coefficient - Mu

Vehicle states

Tire adhesion coefficient - Mu

Vehicle state rates

Braking Torque

Vehicle

ABS Controller

Torque scope

Wheel rotational speed

Detect zero wheel speed

Fix to zero wheel speed

Parameter Value Note

Parameter	Value	Note
<input type="checkbox"/> Saturation up...	1	
<input type="checkbox"/> Saturation lo...	-1	
<input type="checkbox"/> Saturation.zc	1	
<input checked="" type="checkbox"/> m	1189	kg, mass vehicle
<input type="checkbox"/> rho	1.202	kg/m ³ , air density
<input checked="" type="checkbox"/> Cd	0.5	drag coefficient
<input checked="" type="checkbox"/> A	1.95	m ² , frontal cross-section area
<input type="checkbox"/> g	9.81	kg-m/s ² , acceleration gravity
<input type="checkbox"/> Theta	0.0	rad, road grade angle
<input type="checkbox"/> bw	0.0	kg-m/s, wheel damping, friction
<input type="checkbox"/> f	0.01	coefficient for rolling friction
<input type="checkbox"/> uw	0.0	m/s, wind velocity
<input type="checkbox"/> fw	0.0	m, friction arm, wheel
<input type="checkbox"/> lw	0.65	kg-m ² ; wheel inertia
<input checked="" type="checkbox"/> rw	0.31	m; wheel radius
<input type="checkbox"/> Fz	3560.0	N
<input type="checkbox"/> rg	9.5285	gear ratio
<input type="checkbox"/> le	0.0	engine inertia, 0 in braking, non-zero for acceleration
<input type="checkbox"/> Nw	4	number of wheels applying torque (e.g., 2 for acceleration, 4 ...
<input type="checkbox"/> c	[-68.5937, 23...	
<input checked="" type="checkbox"/> Vehicle_Speed	31.5	

Model has been loaded

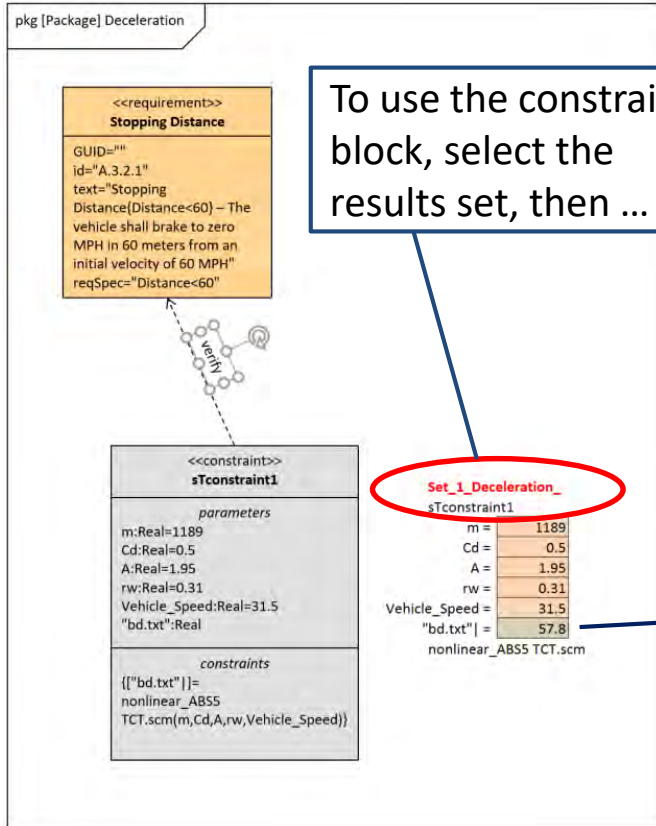
Property Editor

Name Value

General

Name nonlinear_ABS5 TCT

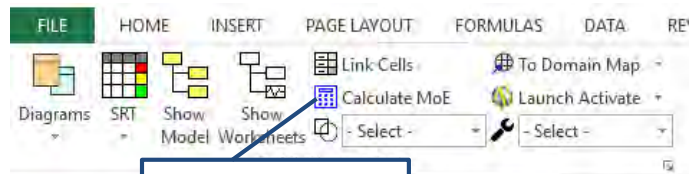
Using an Activate Verifier



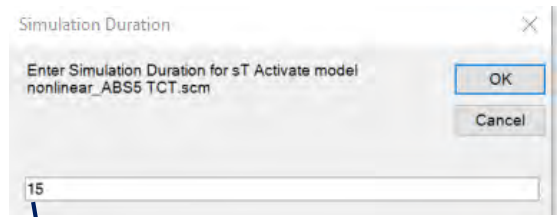
To use the constraint block, select the results set, then ...

Set_1_Deceleration_ sTconstraint1

m =	1189
Cd =	0.5
A =	1.95
rw =	0.31
Vehicle_Speed =	31.5
"bd.txt" =	57.8
nonlinear_ABS5 TCT.scm	



... click here



XLDyn ask for simulation time and results posted to MoE

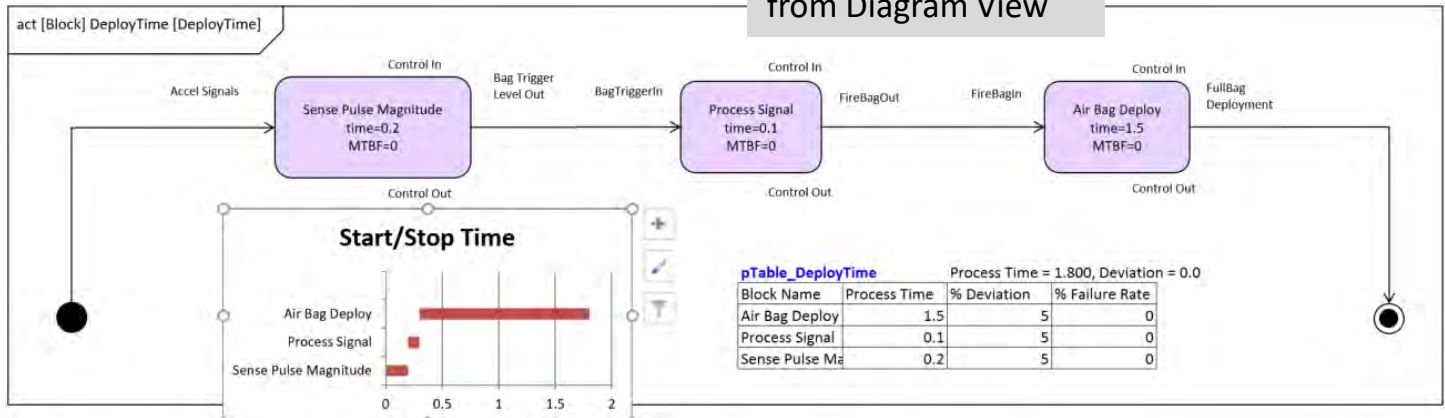
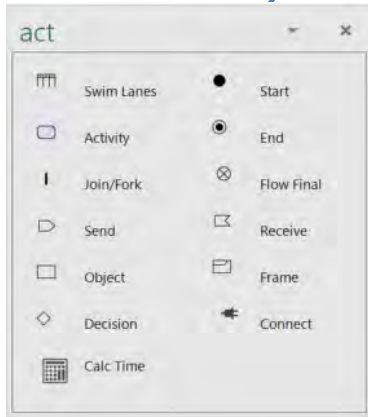
XLSE Activity Diagram

- Activity diagrams are graphical workflows of stepwise activities and actions.
- In XLDyn, Activity diagrams can be created from a library or manually from the pallet

act pallet

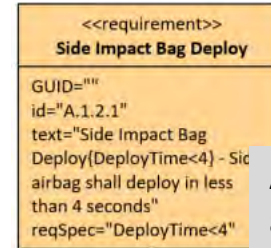
Choose act

Air Bag Deployment Time Simulation run from Diagram View

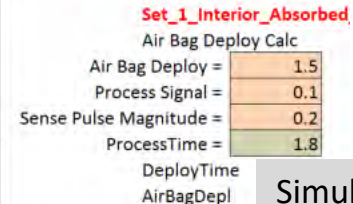
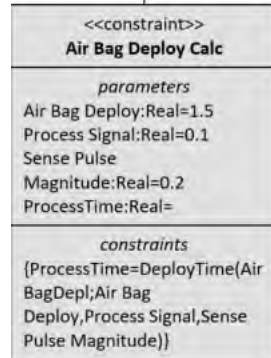


XLSE Activity Diagram

- Activity diagrams can be used as a verifier, design parameters can be varied and simulations performed
- Monte Carlo or Reliability simulations can also be performed



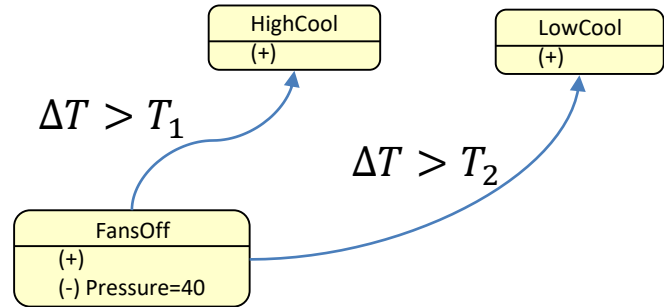
Activity Diagram
as Verifier



Simulation run
from Diagram View

XLDyn State Diagram

- A state transition machine diagram, or *state diagram* for short, is used in dynamic system models as well as SysML models
- A state diagram shows the conditions that causes a system to change its state
- In this example, a simple cooling system has three states, and the system will shift from *FansOff* to *HighCool* or *LowCool* depending on the temperature difference ΔT



XLDyn State Diagram

```

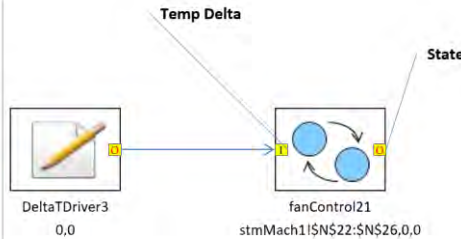
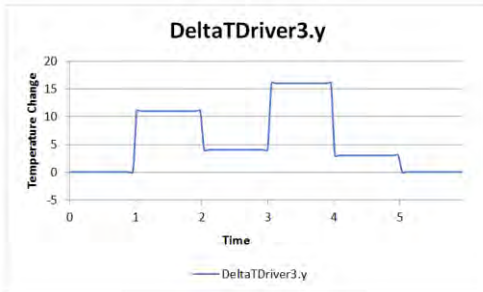
State FansOff
  OnEntry
  End OnEntry

  Active
    y1 = 1
    if DeltaT > T_high then goto highcool
    if DeltaT > T_Low then goto lowcool
  end Active

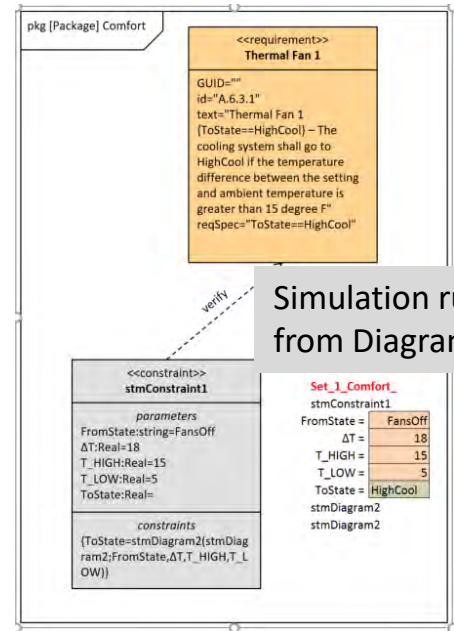
  OnExit
    Pressure=40
  End OnExit
end State

State LowCool
  OnEntry
  end OnEntry
  Active
    y1 = 2
    if DeltaT > T_high then goto 3
    if DeltaT < T_Low then goto 1
  end Active
end state
    
```

- Start with easy to write script
- Use script to create the XL1D state machine
- Determine states based on inputs



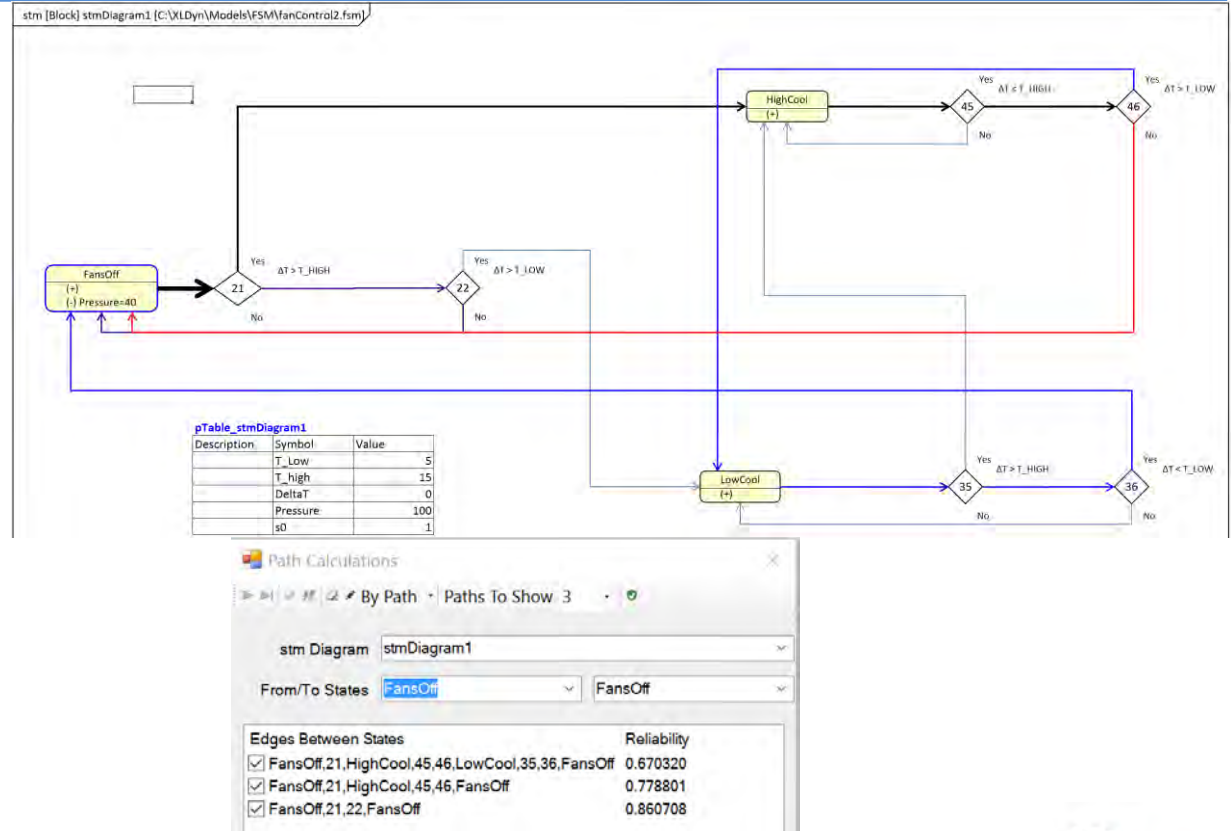
State Machine used to verify requirement



Simulation run from Diagram View

XLDyn State Diagram

- Use same script to create SysML diagram
- Find possible transition paths
- Animate transition during simulation
- Determine reliability



XLSE Use Case Diagrams

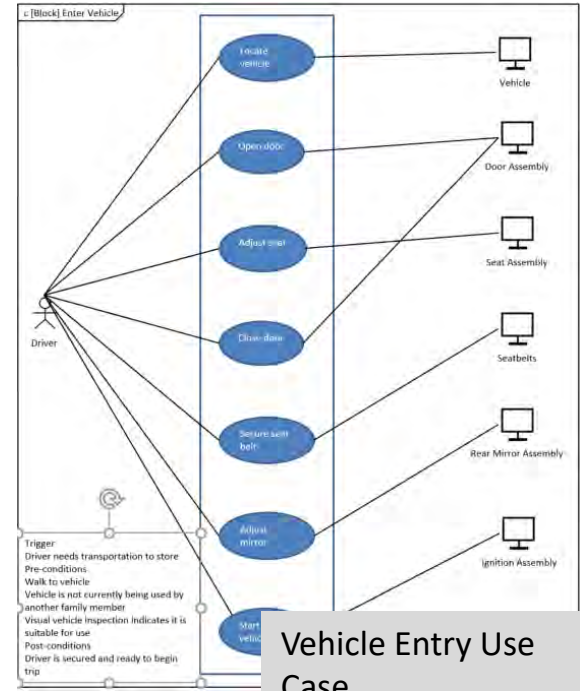
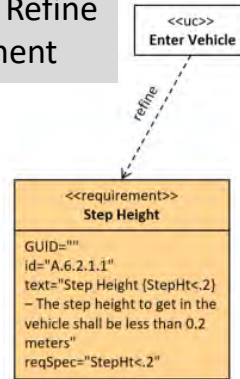
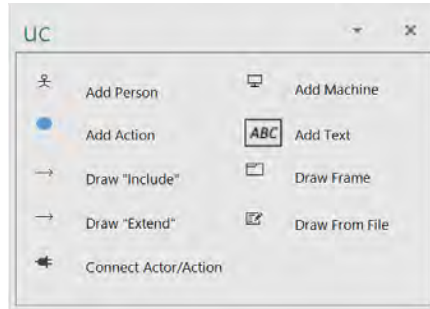
- Use Cases can be imported from a Word document or created directly in XLDyn
- Use Cases can be associated with other diagrams such as requirements
- Use Cases can be linked: (parent/child)

Word Document

HPV

- A Enter Vehicle
- A.1 Description – Enter vehicle and prepare for riding
- A.2 Pre-conditions
- A.2.1 Proper vehicle has been located
 - A.2.2 Vehicle is not currently being used by someone else
 - A.2.3 Visual vehicle inspection indicates it is suitable for use
- A.3 Post-conditions
- A.3.1 Gear is stowed and secured
 - A.3.2 Passenger is ready to begin trip
- A.4 Trigger
- A.4.1 Passenger needs transportation
- A.5 Actors
- A.5.1 Passenger
 - A.5.2 +Door Assembly
 - A.5.3 +Rear Mirror Assembly
 - A.5.4 +Seat Assembly
 - A.5.5 +Cargo Compartment
- A.6 Activities
- A.6.1 Stow cargo
 - A.6.2 Open door
 - A.6.3 Adjust seat
 - A.6.4 Close door
 - A.6.5 Adjust mirror

Use Case to Refine Requirement



Vehicle Entry Use Case

Schematic Diagrams with Reliability

- Create schematic diagrams from part list with defined connector types
- Show connectivity and flow
- Select components then calculate reliability

Schematic Diagram Menu

- Select -
- Select -
- Connect Parts
- Draw Parts
- Add Legend
- Calculate Reliability

Draw Parts

- Transmission Assembly (3-0500-A)
- Hybrid Drive (3-0600-A)
 - Generator
 - Drive Motor
 - Inverter
 - Li Ion Battery
 - Heat Exchanger
- Sensors (3-0700-A)
 - Pressure Sensors (3-0710-A)
 - Air Pressure Sensor
 - Brake Vacuum Sensor
 - Speed (3-0720-A)
 - Transmission Speed Sensor
 - Steering Angle Rate Sensor
 - Temperature Sensors (3-0730-A)
 - Outside Air Temp Sensor
 - Engine Temp Sensor
 - Engine Oil Temp Sensor
 - Transmission Oil Temp Sensor
 - Intake Air Temp Sensor
 - Position Sensors (3-0740-A)
 - Brake Pedal Position Sensor
 - Crankshaft Sensor
 - Throttle Position Sensor
- Controllers (3-0800-A)
 - Engine Control Module

Pin Connector

Transmission Speed Sensor	Trans Control Module
<input type="checkbox"/> Pin 1	<input type="checkbox"/> Pin 1
<input type="checkbox"/> Pin 2	<input type="checkbox"/> Pin 2
<input checked="" type="checkbox"/> Pin 3	<input checked="" type="checkbox"/> Pin 3
<input type="checkbox"/> Pin 4	<input type="checkbox"/> Pin 4

Schematic Diagram

Components: Transmission Speed, Transmission Oil Temp, Engine Oil Temp Sensor, Throttle Position Sensor, Trans Control Module, Engine Control Module, Li Ion Battery, Drive Motor, Heat Exchanger.

Legend:
High Voltage: Red
High Speed LAN: Green
Fluid: Blue
Low Voltage: White

Calculate Reliability

Exposure: 1 Sys. Reliability: 0.847831766

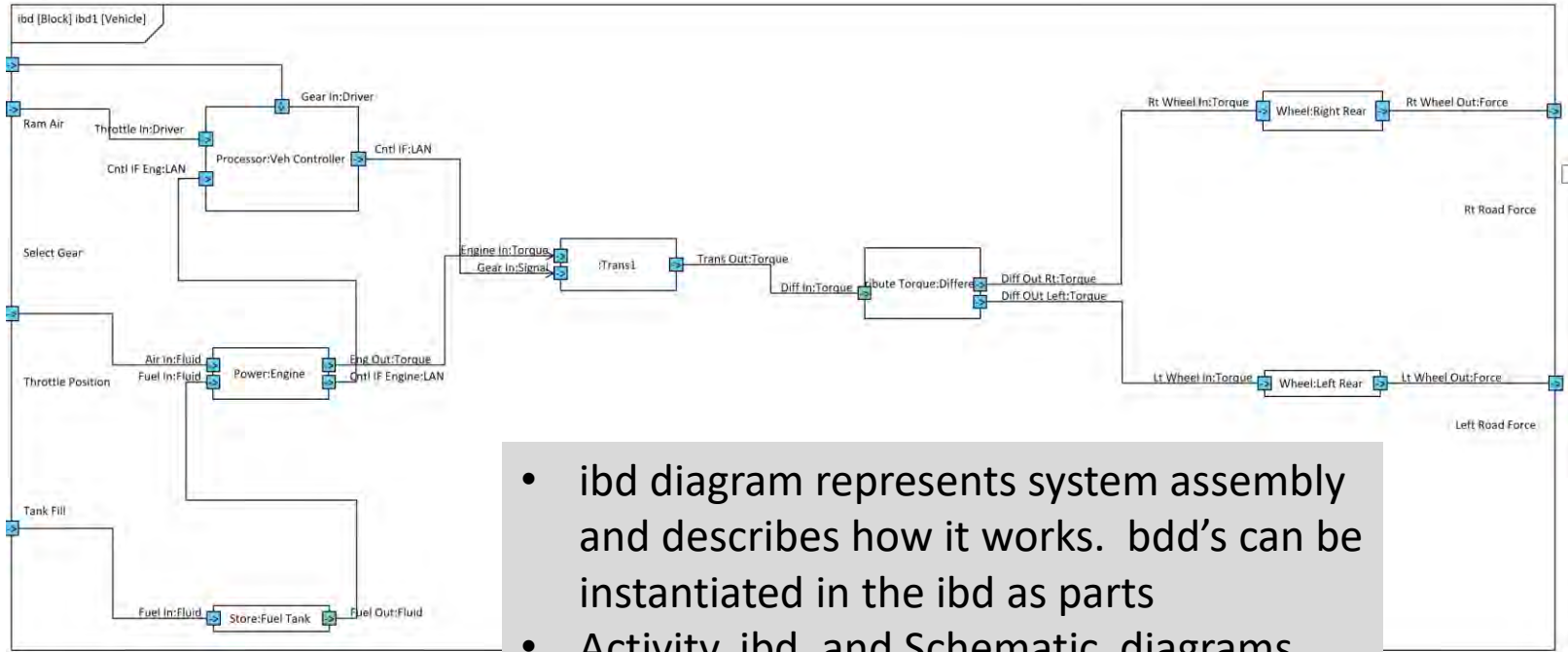
Paths Definition: MTBF Data

Chains	Reliability
<input type="checkbox"/> Engine Oil Temp Sensor Engine Control Module Li Ion Battery	0.47575...
<input checked="" type="checkbox"/> Trans Control Module Engine Control Module Drive Motor	0.70973...

Drag Parts to Pallet and Connect

Select Components, Calculate Reliability

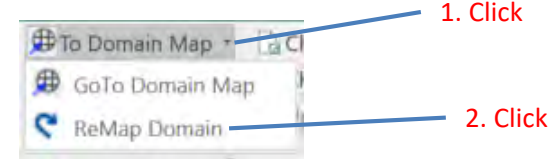
Internal Block Diagram (ibd)



- ibd diagram represents system assembly and describes how it works. bdd's can be instantiated in the ibd as parts
- Activity, ibd, and Schematic diagrams can have parent/child relationships to expand detail

Domain Mapping

- XLDyn automatically maps the requirements to the parts using the tree structure of the model
- Add relationship strength directly to table
- Use for peer reviews and to create DFMEA



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
		B Physical Det...	B.1 Vehicle Interior Assembl	B.1.1 Seat Assemblies Fro	B.1.2 Seat Assemblies Res	B.1.3 Instrument Panel (1	B.1.4 Trim Panels and Hel	B.1.5 Carpet (1-0500-A)	B.1.6 Lighting (1-0600-A)	B.1.7 HVAC (1-0600A)	B.2 Chassis Assemblies	B.2.1 Brake Assemblies (2	B.2.2 Rear Axle Assembly	B.2.3 Front half shafts As	B.2.4 Drive Shaft Assembl	B.2.5 Chassis Control Mod	B.2.6 Tires and Wheels (2	B.2.7 Front Suspension As	B.2.8 Rear Suspension As	B.3 Powertrain Assemblies	B.3.1 Engine Assembly (3	B.3.2 Fuel System (3-020	B.3.3 Air Intake (3-0300-A
1																							
56	A.6.1.3	Vehicle Operation Controls																					
57	A.6.1.4	Vehicle Operation Transaction Times																					
58	A.6.2	Ergonomics																					
59	A.6.2.1	Entry Egress																					
60	A.6.2.1.1	Step Height															5	4	4				
61	A.6.2.1.2	Door Close Force																					
62	A.6.2.1.3	Door Open Force																					
63	A.6.2.2	Cargo Access																					
64	A.6.3	Comfort																					
65	A.6.3.1	Thermal																					5
66	A.7	NVH																					

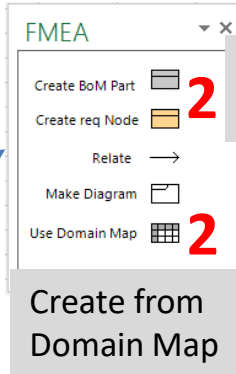
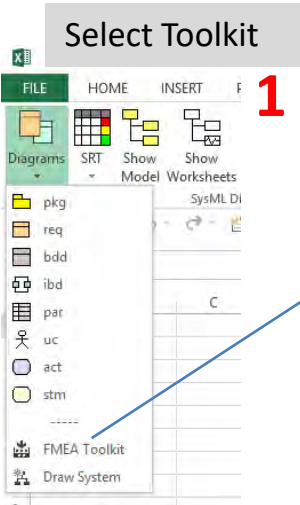
4. Add Relationships

	A	B	C	N	AF	AG	AH	AI	AJ	AK	AL	AM	A
		0. Physical Decomposition	1. Body & Structure	1. Chassis & Power Transfer	1. interior, Electrical & Clim:	2. Seat Assembly (3-0100-	2. Upper Steering Assem:	2. Headlamp Harness Assr	2. Taillamp Harness Assen	2. Handlebar Turn Indicat	2. Front Indicator Harness	2. Rear Indicator Harness	
1													
2	0.	Functional Requirements											
3	1.	Load/ Unload											
19	1.	Move											
31	1.	Steer											
34	1.	Brake											
37	1.	Signal											
40	1.	Safetv											

3. Domain Map created with empty cells

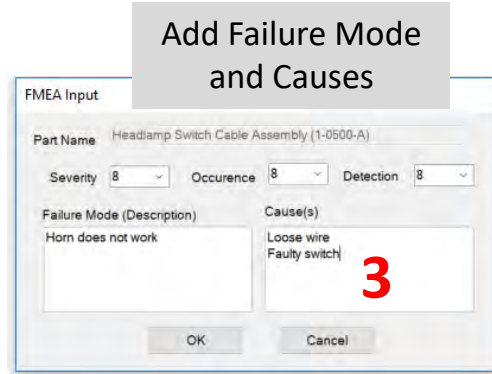
DFMEA Process

- DFMEA is a representation of:
 - What can go wrong in a part or subassembly
 - Its cause(s) and effects
 - Importance or ranked priority



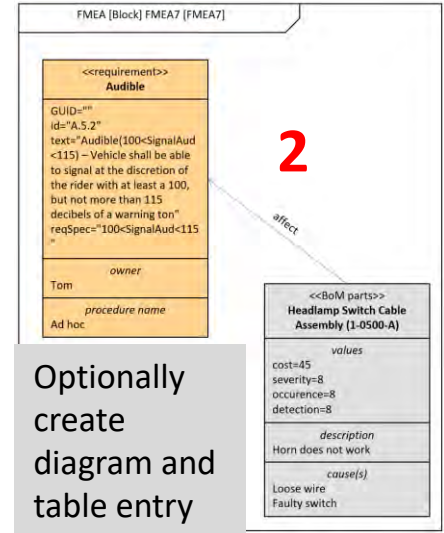
Optional Diagram

Create from Domain Map



Add Failure Mode and Causes

3



Optionally create diagram and table entry

Item	Potential Failure Mode	Requirements impacted	Potential Cause(s)	Symtoms/Detection	SEV	OCC	DET	RPN	Recommended actions	Assigned To	Target Date
Headlamp Switch Cable Assembly (1-0500-A)	Horn does not work	Audible[100<SignalAud<115] - Vehicle shall be able to signal at the discretion of the rider with at least a 100, but not more than 115 decibels of a warning ton	Loose wire Faulty switch		8	8	8	512			

4

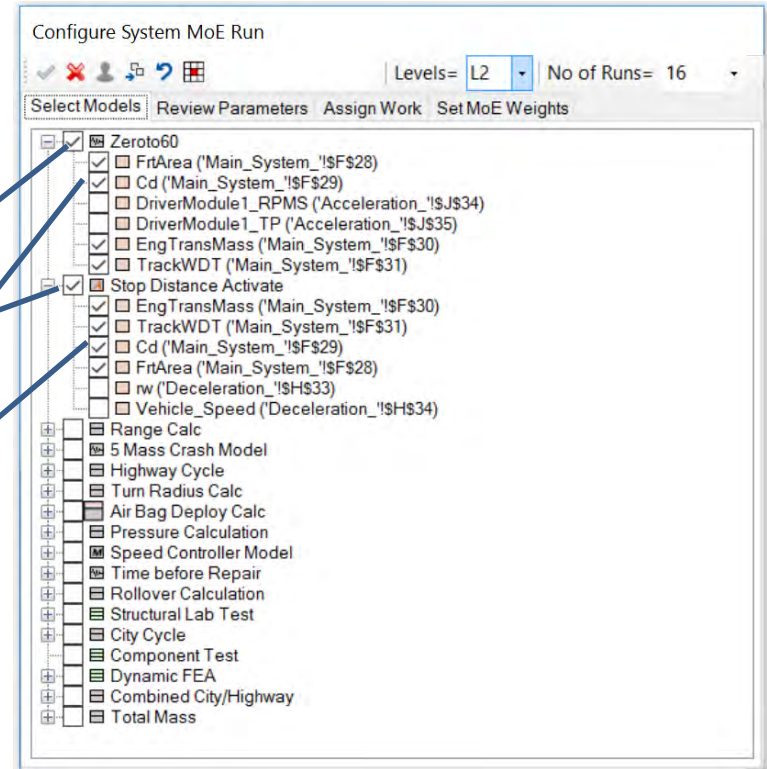
Table Entry Generated

Configuring A System Level DoE

- XLDyn can easily configure a system level Design of Experiments (DoE)
- All verifiers in the model can be used including tests data

First, select the MoE's you want to include.

Select the parameters to include in the study. Some parameters are common



System Level DoE Results

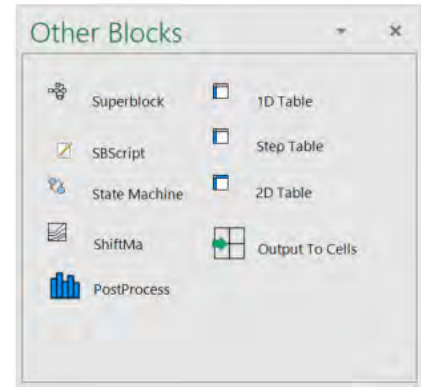
Run	FrtArea	Cd	EngTransMass	TrackWDT	Z60 =	"bd.txt"	CombCtyHiwy =	Current, Z60 =	Current, "bd	Current, CombCtyHi	Total_Deviation
1	1.755	0.27	166.25	135.9	6.90	55.6	38.5	9.17	59.5	33	0.43251
2	1.755	0.27	166.25	166.1	12.12	58.7	31.30	9.17	59.5	33	0.40669
3	1.755	0.27	183.75	135.9	7.29	56.3	37.9	9.17	59.5	33	0.39642
4	1.755	0.27	183.75	166.1	12.72	57.7	30.90	9.17	59.5	33	0.46449
5	1.755	0.33	166.25	135.9	6.90	55.3	36.7	9.17	59.5	33	0.38782
6	1.755	0.33	166.25	166.1	12.12	58.6	30.13	9.17	59.5	33	0.39414
7	1.755	0.33	183.75	135.9	7.29	56.3	36.2	9.17	59.5	33	0.35027
8	1.755	0.33	183.75	166.1	12.72	57.7	29.76	9.17	59.5	33	0.45453
9	2.145	0.27	166.25	135.9	6.90	55.3	36.7	9.17	59.5	33	0.38782
10	2.145	0.27	166.25	166.1	12.12	58.6	30.13	9.17	59.5	33	0.39414
11	2.145	0.27	183.75	135.9	7.29	56.3	36.2	9.17	59.5	33	0.35027
12	2.145	0.27	183.75	166.1	12.72	57.7	29.76	9.17	59.5	33	0.45453
13	2.145	0.33	166.25	135.9	6.90	55.2	34.8	9.17	59.5	33	0.34031
14	2.145	0.33	166.25	166.1	12.12	58.5	28.81	9.17	59.5	33	0.38339
15	2.145	0.33	183.75	135.9	7.29	56.0	34.3	9.17	59.5	33	0.30219
16	2.145	0.33	183.75	166.1	12.72	57.6	28.47	9.17	59.5	33	0.44653
Main Effects	-0.2277	-0.228	0.09243	0.450826							

The *Main Effects* row ranks the effect of system parameters on *Total Deviation*. To improve your design, *Track Width* is the parameter to adjust

Total Deviation is shows the combination of parameters that yields the best design.

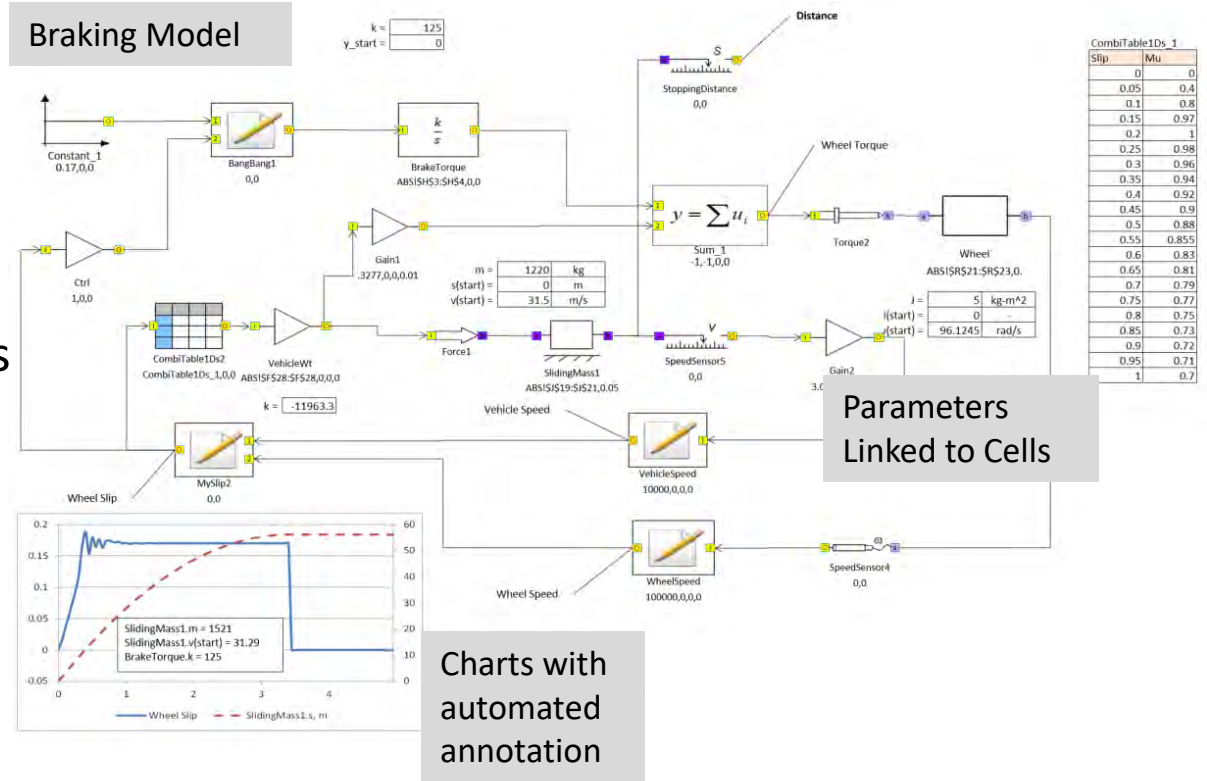
XL1D Features

- Static, transient, and frequency domain analyses
- Supports continuous and discrete time simulation
- Powerful scripting language (without 3rd party compiler)
- Finite state machines using scripts
- Transfer Function blocks with custom labels



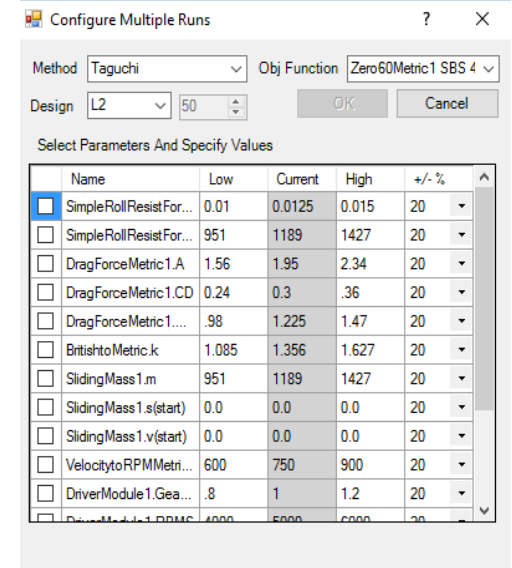
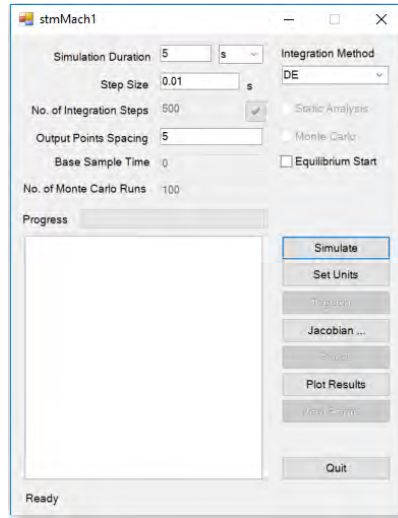
XL1D Features

- Automated chart creation with Excel functionality
- Built-in Units Management
- Links system parameters to Excel cells
- Run Monte Carlo to calculate performance variations, component properties have built in variation specification



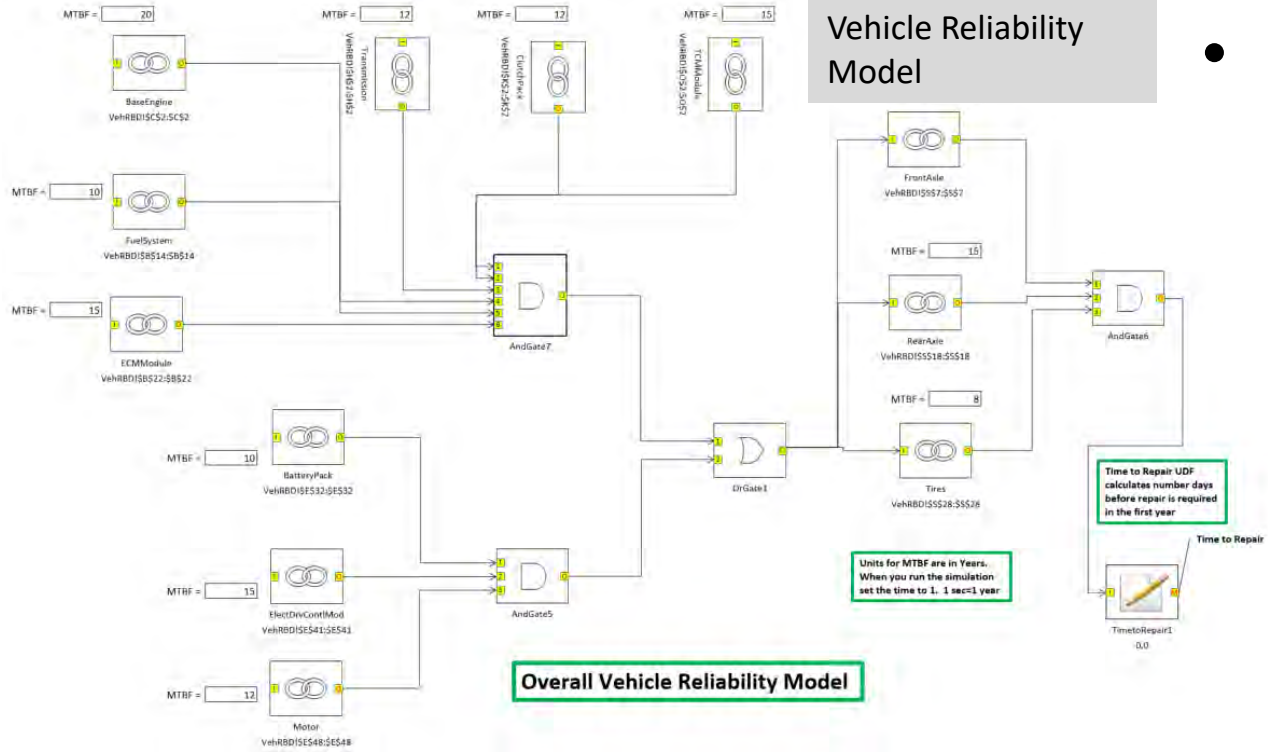
XL1D Features

- Easily configures DoE studies
- Automatically connects components across worksheets (superblocks)
- Completely integrated with XLSE for requirements verification and parametric studies



XL1D Features

Vehicle Reliability Model



- Fault Tree and Reliability Block Diagrams

Reliability Blocks

Start	OrGate
Maintai	AndGate
Repair	FaultTree Node
Failure Link	KofN
Unertainty Link	Exponential Event

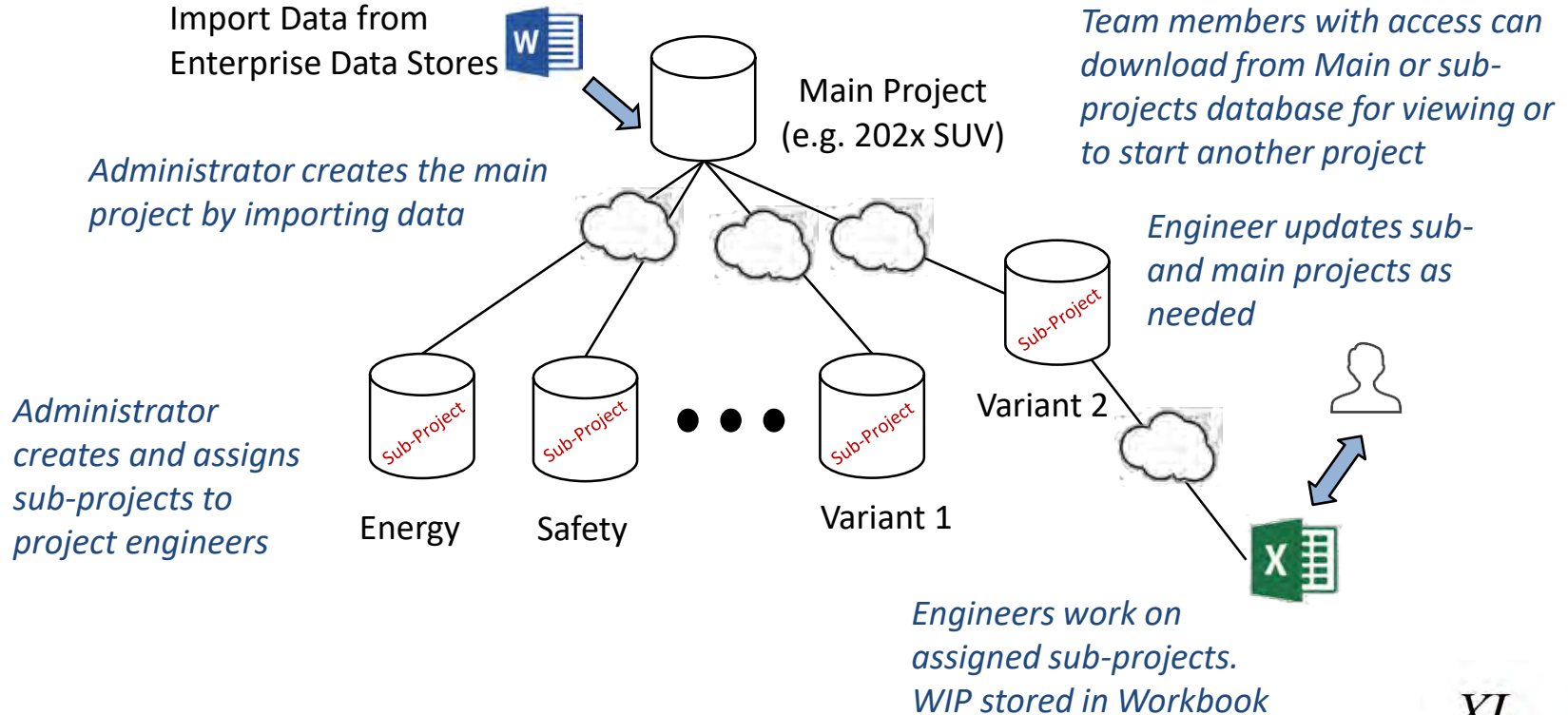
Units for MTBF are in Years.
When you run the simulation
set the time to 1. 1 sec=1 year

Overall Vehicle Reliability Model



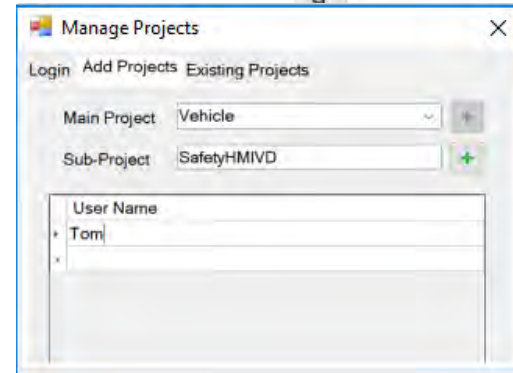
XLDyn v2.0 Overview

- XLDyn v2.0 adds a database to version 1.5

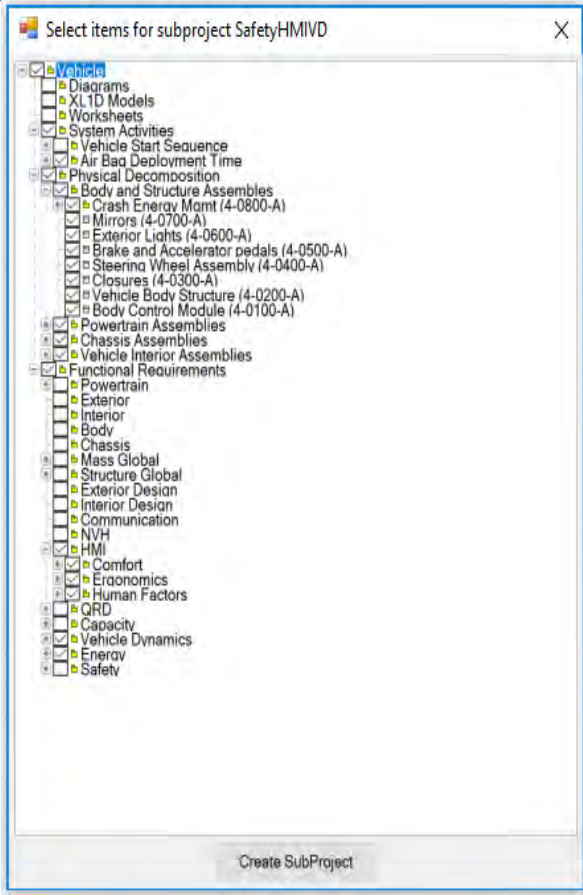


XLDyn v2.0 New Features

- ❑ Includes v1.5 functionalities with the addition of enterprise data management
- ❑ **All** system artifacts are stored in the database:
 - ❑ Requirements, verifiers, parts, diagrams, domain maps, DFMEA, State Machines, XL1D models, user defined models, change history, relationships, etc
- ❑ Highly scalable – only hardware limited
- ❑ Authorized users can view any subset of a project



XLDyn v2.0 New Features



- Configure a Main project from imported data
- Configure a model from existing database and save as new database
- Create an Ad Hoc model and save to new database
- One Click model creation from database
- Add, Delete, and Rearrange model content
- Copy content from other workbooks

XLDyn v2.0 New Features

- ❑ Workbook stores Work in Progress (WIP) until owner updates Sub-project and/or Main databases
- ❑ Perform Variant Analysis
 - ❑ Select Common Core Requirement set
 - ❑ Define BoM and Parameters for Variants 1-N
 - ❑ Perform Analysis
 - ❑ Compare results

The screenshot shows the 'Compare Variants' window with a table of variant metrics and two tree views of variant composition and parameters.

MoE				
Variant	Z60	ProcessTime	FitAxle	Stopping Distance
suv_safety	9.69	1.8		
suv_vehdyn			50.0	TBD

Variant Composition

- Main System
 - suv_safety
 - Vehicle Interior Assemblies
 - HVAC (1-0600-A)
 - Lighting (1-0600-A)
 - Carpet (1-0500-A)
 - Trim Panels and Headliner (1-0400-A)
 - Instrument Panel (1-0300-A)
 - Seat Assemblies Rear (1-0200-A)
 - Seat Assemblies Front (1-0100-A)
 - suv_vehdyn
 - Chassis Assemblies
 - Rear Suspension Assembly (2-0800-A)
 - Front Suspension Assembly (2-0700-A)
 - Tires and Wheels (2-0600-A)
 - Chassis Control Module (2-0500-A)
 - Drive Shaft Assembly (2-0400-A)
 - Front half shafts Assembly (2-0300-A)
 - Rear Axle Assembly (2-0200-A)
 - Brake Assemblies (2-0100-A)

Variant Parameters

- Main System
 - suv_safety
 - DragForceMetric1_A=1.95 (from XLconstraint1)
 - DragForceMetric_CD=0.3 (from XLconstraint1)
 - SlidingMass1_m=1360.5 (from XLconstraint1)
 - Air Bag Deploy=1.5 (from actConstraint1)
 - Process Signal=0.1 (from actConstraint1)
 - Sense Pulse Magnitude=0.2 (from actConstraint1)
 - suv_vehdyn
 - a=50 (from constraint1)

Summary

- Balance designs at the system, subsystem and component level
- Import requirements from and export updates to enterprise systems
- All requirements and verifiers managed in a single application
- XLDyn's SysML diagrams are actionable
- Easy access "project status view" including on mobile devices
- XLDyn's ease of use and integration makes MBSE a way to do your work, not document what you did
- XLDyn requires minimal training so **ALL** engineers can use it

Backup Slides

Adding Requirements and Parts

- Requirements and BoM parts are added directly to diagrams and synchronized in all views and added to the SRD

Requirement Node

Specifications GUID & Names

*Node Name: Lift Over Height

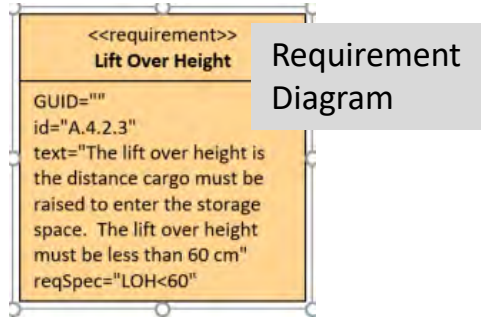
Target Spec: LOH<60

Req ID: A.4.2.3

Edit Requirement Text

The lift over height is the distance cargo must be raised to enter the storage space. The lift over height must be less than 60 cm

Define Requirement

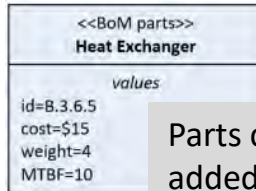


- A.4.2 **Cargo** – Cargo capacity is comprised of both weight and volume measures
- A.4.2.1 **Cargo Volume** {CargoVol>1.0} – Available volume for passenger cargo shall be at least 1 square meter
- A.4.2.2 **Cargo Weight** {CargoWt>50} – Cargo compartments must be able to carry at least 50 kg
- A.4.2.3 **Lift Over Height** {LOH<60} – The lift over height is the distance cargo must be raised to enter the storage space. The lift over height must be less than 60 cm

Added to System Requirement Document (SRD)

A.4.2	Cargo	Cargo – Cargo capacity is comprised of both weight and volume measures	
A.4.2.1	Cargo Volume	Cargo Volume {CargoVol>1.0} – Available volume for passenger cargo shall be at least 1 square meter	CargoVol>1.0 1.100
A.4.2.2	Cargo Weight	Cargo Weight {CargoWt>50} – Cargo compartments must be able to carry at least 50 kg	CargoWt>50
A.4.2.3	Lift Over Height	The lift over height is the distance cargo must be raised to enter the storage space. The lift over height must be less than 60 cm	LOH<60

Added to System Requirement Table (SRT)



Parts can be added also