DIGITAL ENGINEERING SUMMIT

16-17 June 2025

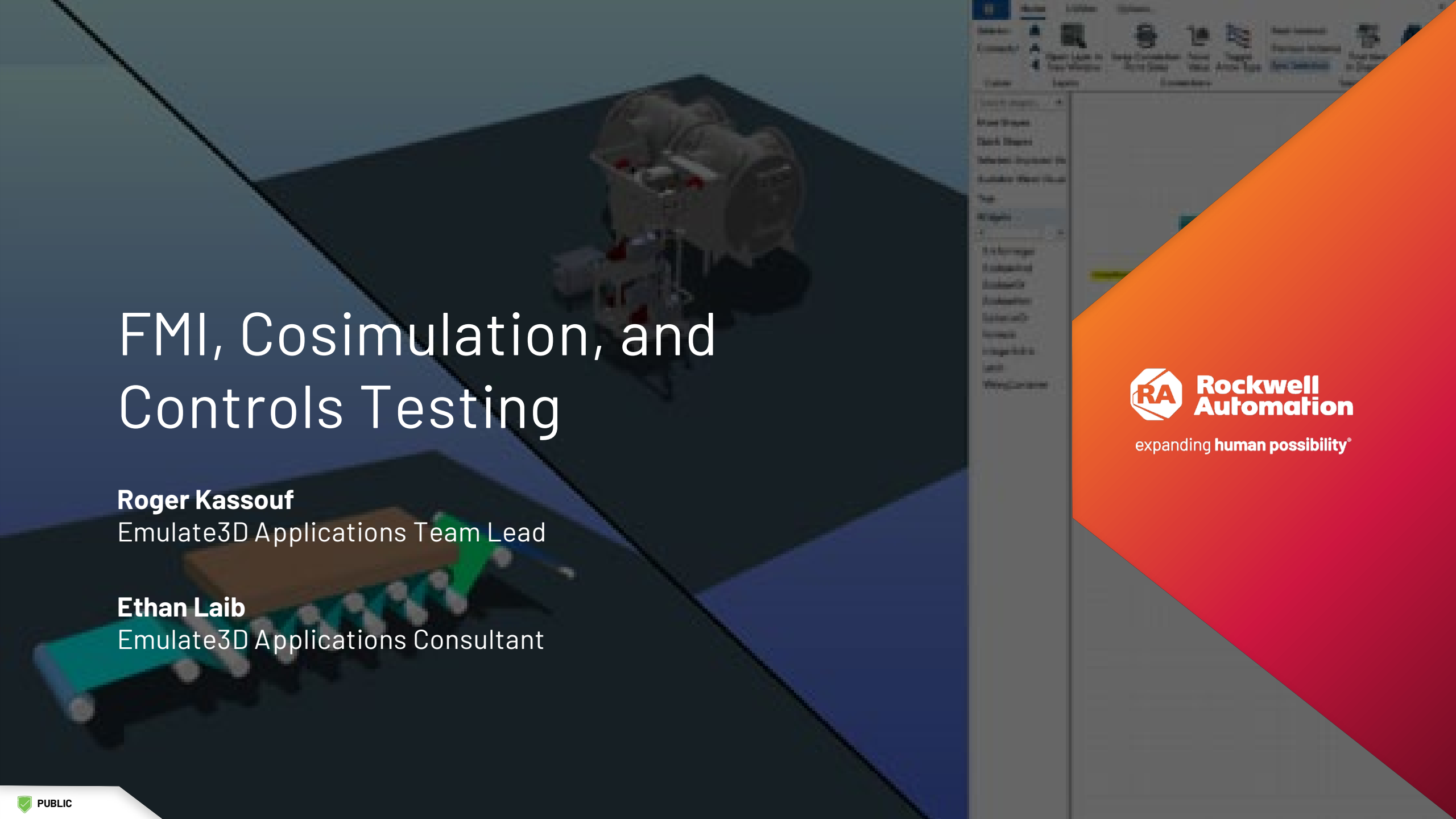
Rome Marriott Park Hotel, Italy

EMULATE3D

by ROCKWELL AUTOMATION

ROK LIVE EMEA

Creating the Future of INDUSTRIAL OPERATIONS



FMI, Cosimulation, and Controls Testing

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Emulate3D Applications Team Lead

Ethan Laib
Emulate3D Applications Consultant

Rockwell Automation

expanding **human possibility**®

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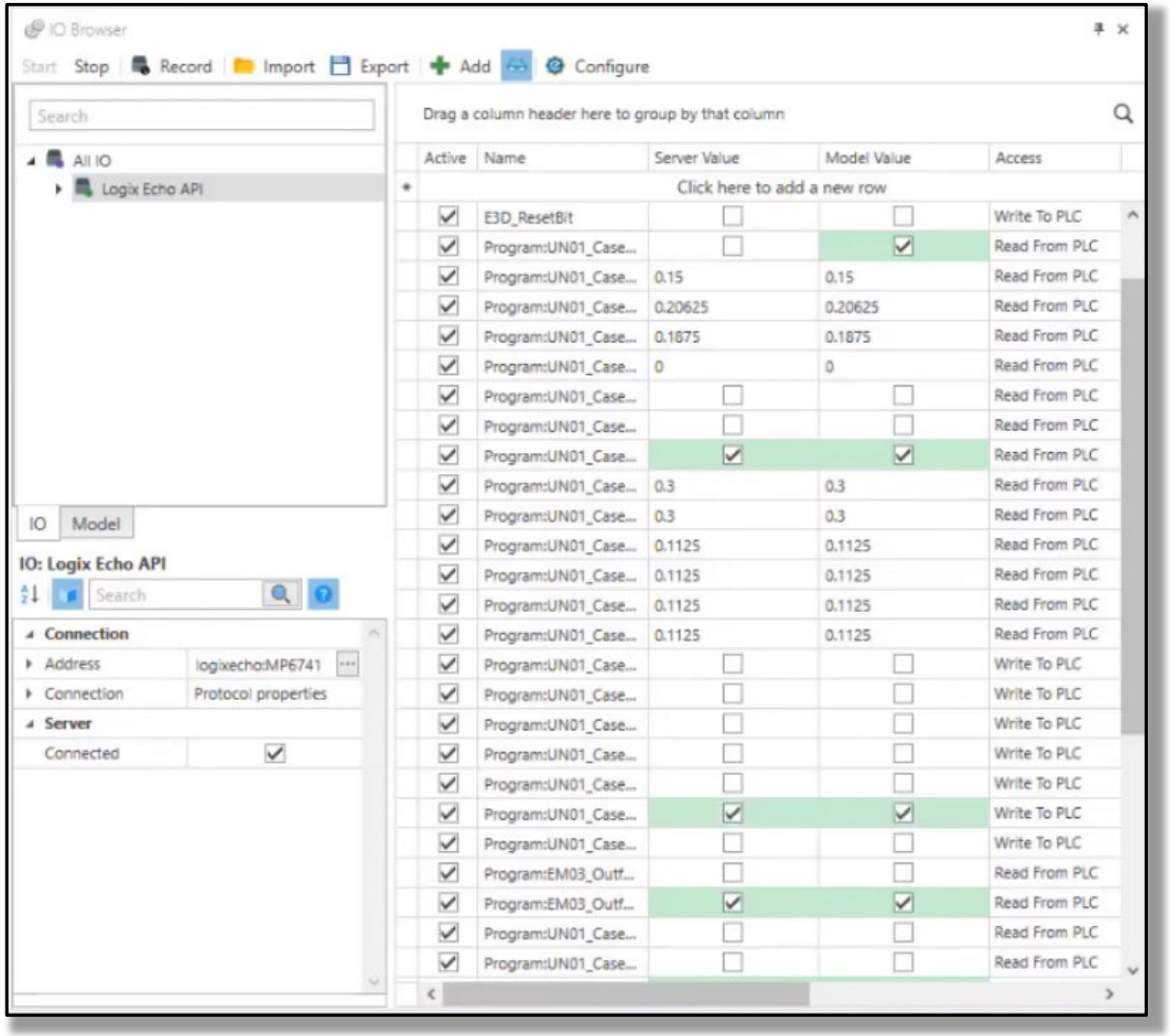
Co-simulation Enhancements

- Rework of co-simulation engine, separating out the co-simulation master from Emulate3D
- Performance and stability benefits for all existing co-simulations, including:
  - Logix Echo
  - PLCSIM Advanced
  - SIMIT
  - Robot co-simulation
- Future potential for use in Multi Model simulations!
- Laid the groundwork for FMI



New PLCSIM Advanced Protocol
(Available now in public preview)

Brand new PLCSIM Advanced implementation using Siemen's updated runtime API.
Separate protocol to ensure continued support of older projects and PLCSIM Advanced versions.

The two completely different protocols have these main differences:

Protocol	PLCSIM Advanced (legacy)	PLCSIM Advanced S7-PSA (new)
Version Support	All versions, including v5 and before	Only supports v6/v7 + (released Dec 2024)
Performance	Good	Greater
Maximum Scale	Good	Greater
Access	Tag Access or Memory Access	Tag Access only
UDTs and Arrays	Parsed as symbol branches only	Implicit support for UDTs & Arrays
Co-simulation	Synchronization at cycle control point	Customizable synchronization points
Program Updates	Must disconnect before downloading	Stay connected during download
Remote connection	Single remote connection	Multiple remote connections

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PLCSIM Advanced S7-PSA

Tag Access

Memory access is **no longer recommended** by Siemens

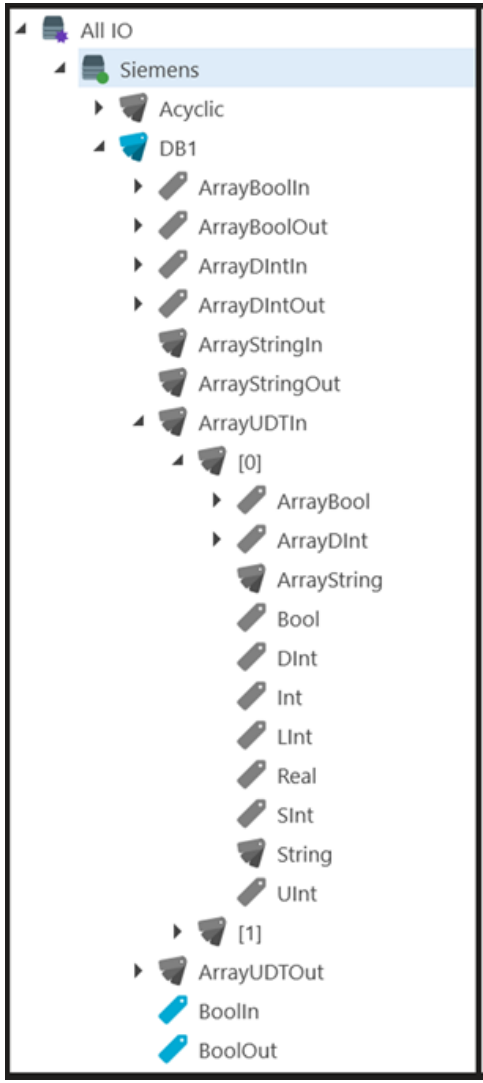
The new protocol only offers tag access

This new protocol allows the following advantages:

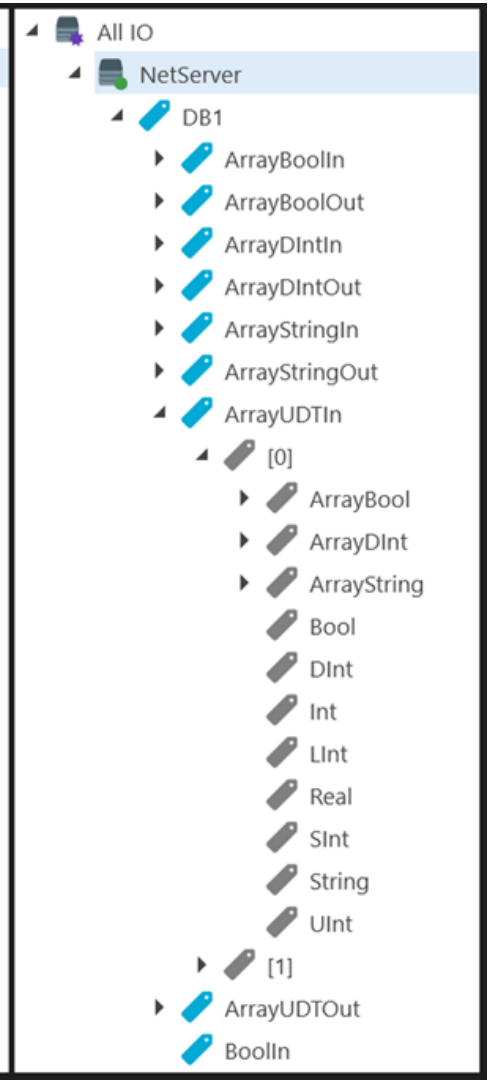
- Improved batching of IO requests, for faster data exchange
- Removed risk of writing to unintentional areas of storage
- Implicit support of UDT structs, arrays, and strings
- Resolved potential issues with writing to safety tags
- Selective filtering of tags, mitigating the 500,000 entries limit

Tag List	
DataBlockFilterList	
IsHMIVisibleOnly	☐
TagListDetails	IOMCTDB
CT	☑
DB	☑
IO	☑
M	☑

Legacy UDT



New UDTs



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PLCSIM Advanced S7-PSA

The new API provides us with new options, allowing the following in Emulate3D:

Remote Connections

- Connect a single Emulate3D model to multiple remote instances of PLCSIM Advanced
- A preview tester successfully connected Emulate3D to five PLCs using the new protocol

Live Tag Configuration

- Stay safely connected during downloads using the new protocol
- The old protocol provided no notifications, and risked crashes

Co-Simulation

- Define synchronization points at which the instance freezes simulation and signals to Emulate3D that it's ready to exchange tag data
- Previously, co-simulation freeze & data exchange would occur at the cycle control point

This protocol will become the default in the future

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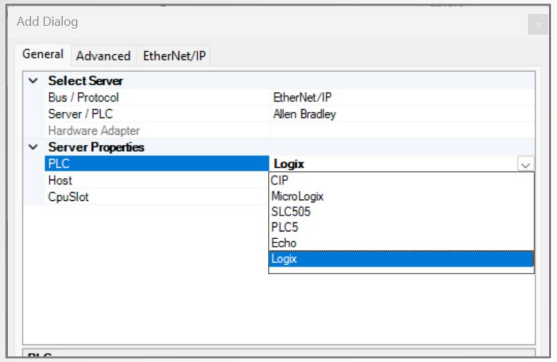
Logix Tag Server

Improvements to connectivity with Allen-Bradley PLCs and Rockwell software.

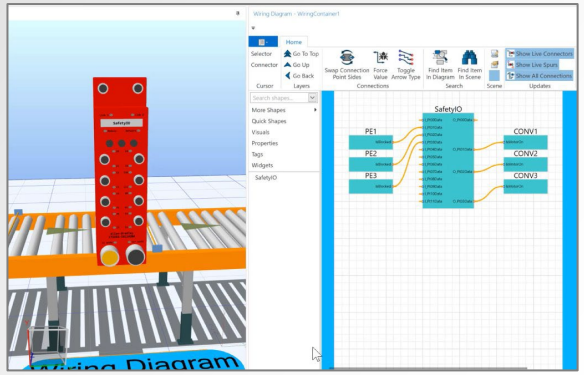
New Logix Server Type

- New server type encompasses CIP Class 1, CIP Class 3, and Logix Echo API
- Users can then choose the protocol at any time in the Tag Sever and Tag settings



Module Emulators

- Module emulators are now supported by CIP Class 3 and Echo API in addition to the previously supported CIP Class 1
- Internal logic of the device is emulated for all Logix protocols



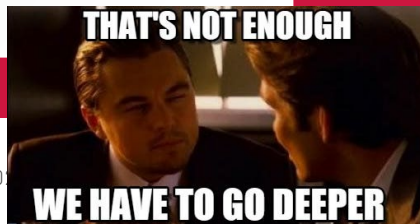
Overall Improvements

Many improvements, including:

- Improved tag merging optimizations for the Logix Echo API connection
- Faster connection establishment speed for complex IO trees
- Clearer configuration of co-simulation step
- Configuration of continuous task fidelity, allowing for faster co-simulations

Additional Data type support for Logix (and for Omron), including:

- Strings from an array of strings
- Strings in a UDT
- A UDT which is composed of strings and array string tags



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LS Electric, Omron, and other protocols

Emulate3D remains controller agnostic, connecting to far more than just Allen-Bradley

LS ELECTRIC

- Support coming in version 18.0.2
- Ability to connect with hardware
- Full co-simulation with XGSIM

OMRON Industrial Automation

- Faster connection speed for NX, NJ, and CJ series controllers
- Additional data type support
- Plans for Omron co-simulation with Sysmac Studio Simulator

KEYENCE

CODESYS AND MORE!

Our team is targeting to support more controller connections, including Keyence and CODESYS

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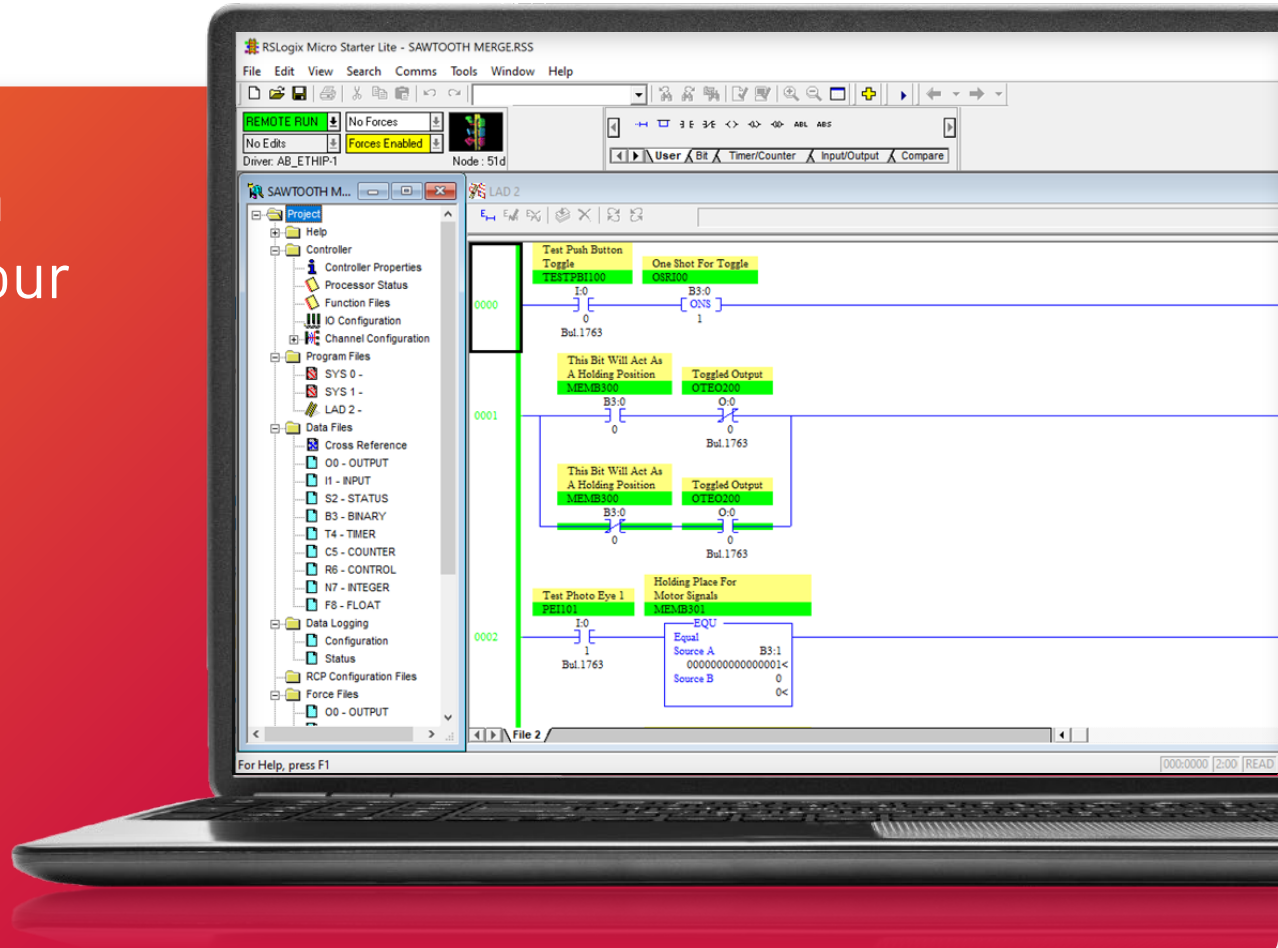
MicroLogix 1100 Emulator

A successor to the Emulate3D internal Ladder Logix Editor

Use the MicroLogix 1100 Emulator a **free, fully contained** SoftPLC for your Emulate3D projects and demos

- Program PLC projects for free using RSLogix Micro Starter Light
- Easily add the controller your model through the catalog
- Co-simulation support for time synchronization



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What's coming for Emulation?

UDT Configuration Wizard

- No need for scripting
- Define UDTs via a user interface
- Similar to how the Telegrams interface to make Higher level Emulation easier

Controls Testing Advisor

- Looks for tags and bindings that could be made simpler
- Advises on data types to use, scan intervals, tag merging, etc.

Controls Testing Profiler

- Looks at IO queue lengths
- Reports on round trip times
- Advises on things CT Speed related

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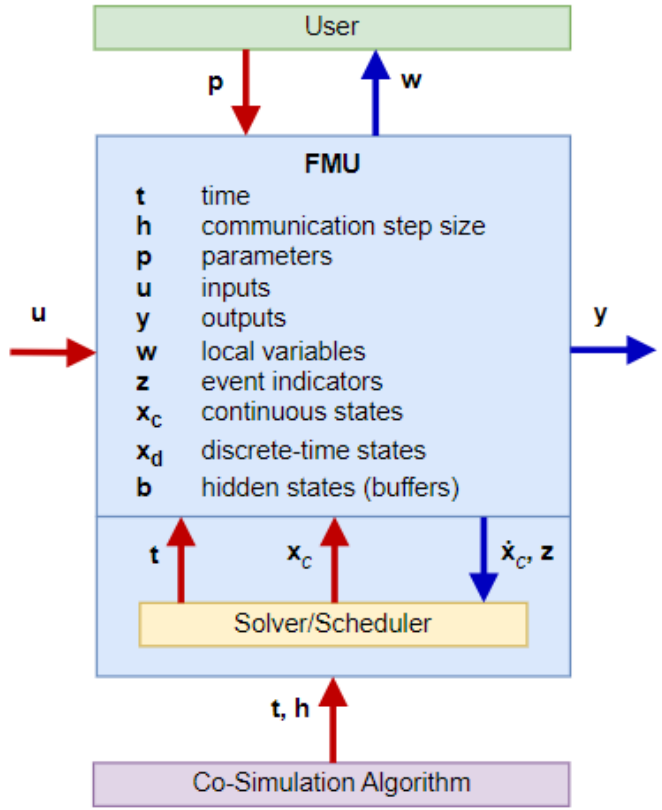
What is FMI?

- The Functional Mockup Interface (FMI) is an open standard for exchanging dynamical simulation models between different tools in a standardized format
- This standard format is called a Functional Mockup Unit, also known as an FMU
- Maintained by the Modelica Association through a steering committee with membership across various companies

Functional Mock-Up Interface



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Why support FMI in Emulate3D?

Multi-Physics

High fidelity modelling for:

- Mechatronics
- Web Handling
- Thermodynamics
- Chemical Processes

...and many more!

Single Interface

Single connection for:

- MATLAB/Simulink
- MapleSim
- Ansys

...and many more!

Scalable co-simulation

Emulate3D is the co-sim master:

- Allows clock synchronization with multiple FMUs and other co-simulators (Logix Echo, PLCSIM Advanced)
- Run faster/slower than real-time
- Future – FMI for Multi-Model

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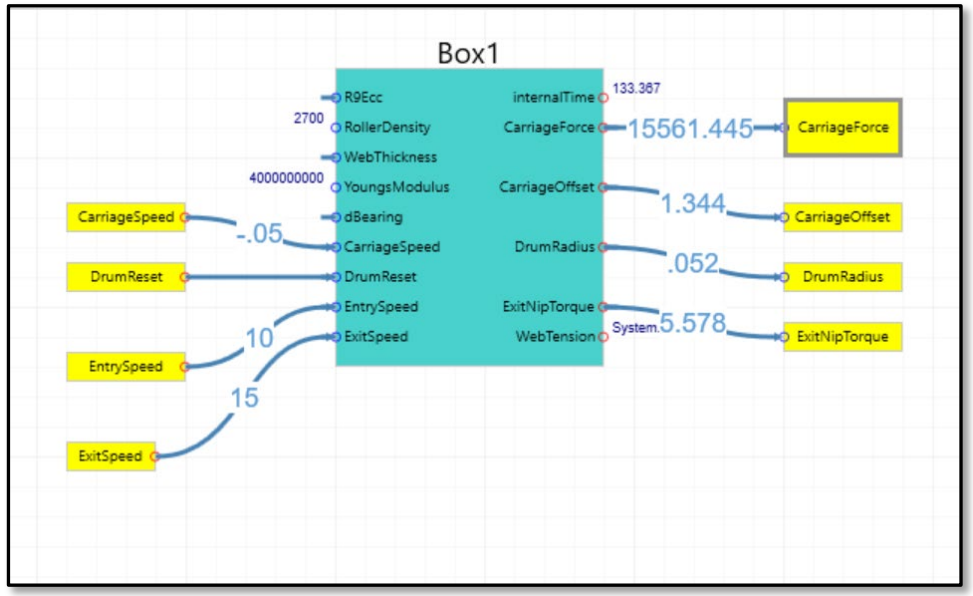
What have we done?

- Major overhaul of the co-simulation framework
- Full support of imported v2 & v3 co-simulation FMUs
- Treated the same as co-simulations, like Logix Echo, PLCSIM Advanced, and SIMIT RCI
- Compatible with the wiring diagram
- Scripting support via API, including full co-simulation control for advanced cases



Using the FMI Standard

Use a wide range of simulation tools to model systems in high fidelity

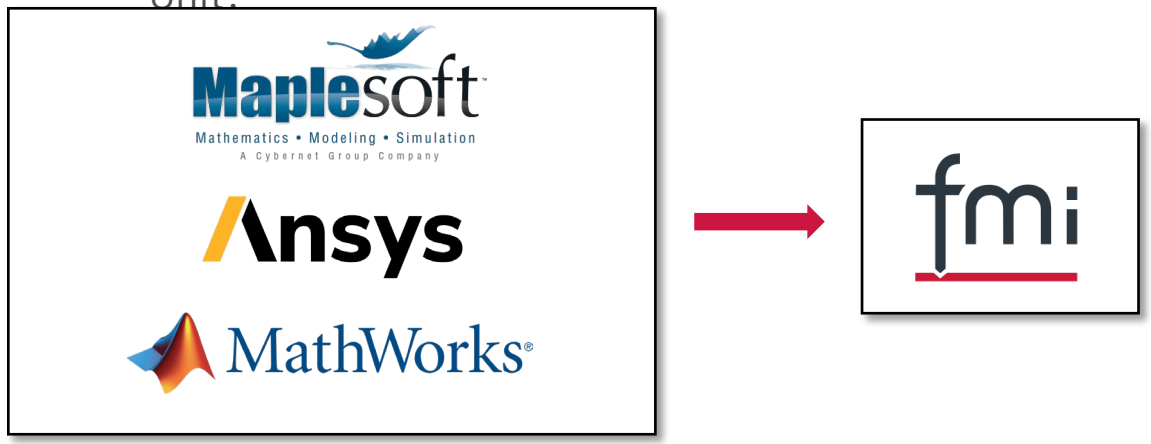
The typical FMI approach follows these stages:

- A modelling environment describes a system through equations
- Generate and export the component in an FMU in the tool
- Import the FMU in another environment to execute

Follow this process to import models into Emulate3D from a growing list of over 200 tools including:

- Matlab/Simulink
- Ansys
- MapleSim

Export your model as a Functional Mock-up Unit:



Import the Functional Mock-up Unit to Emulate3D:

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FMU Export

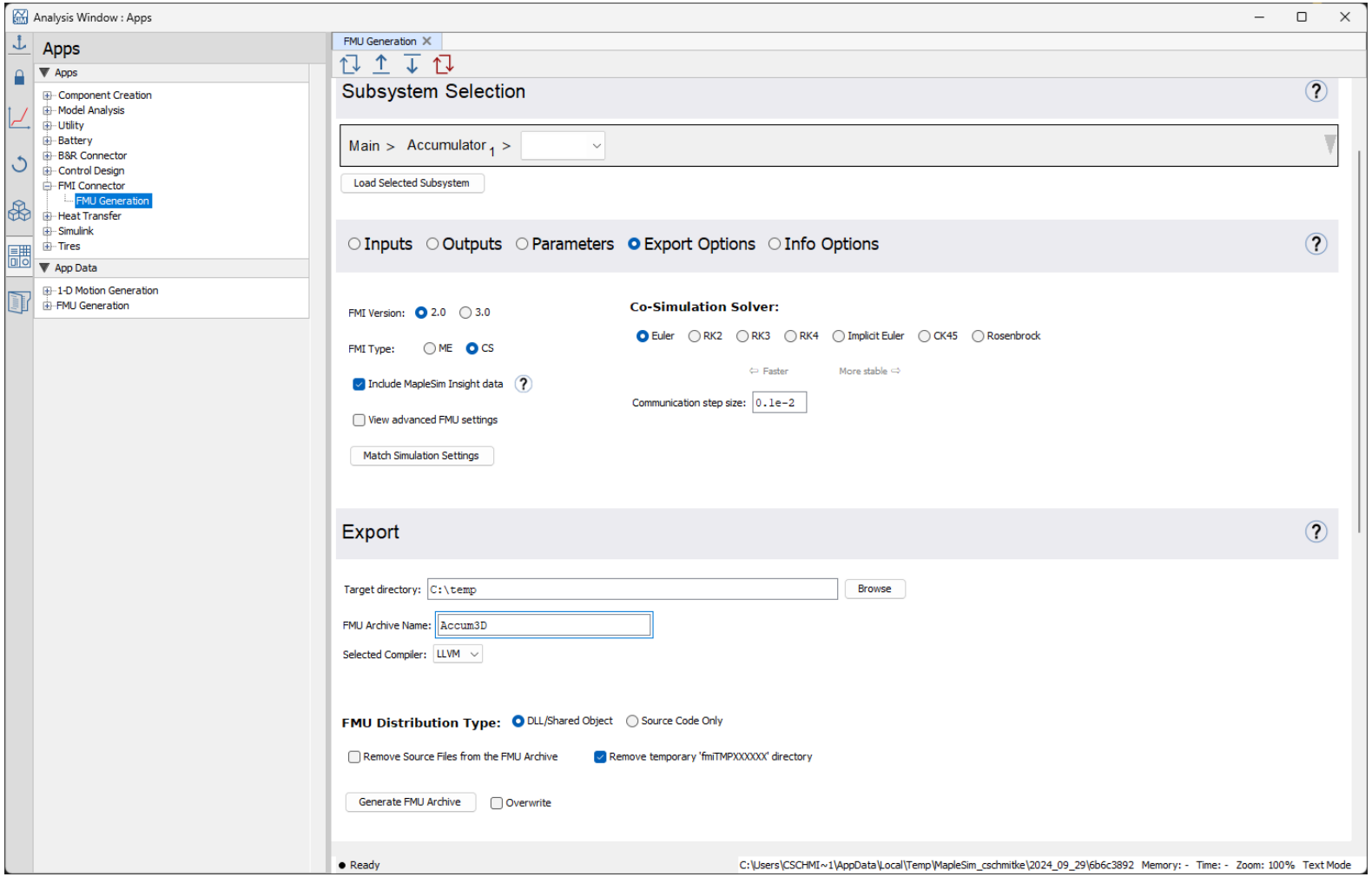
Export a cosimulation ready Functional Mock-up Unit

FMU contains:

- Variable definitions
- Equations used by the model
- Additional optional data

The importing tool:

- Sets the FMU inputs
- Asks the FMU to step forward
- Runs internal solvers
- The FMU updates its outputs



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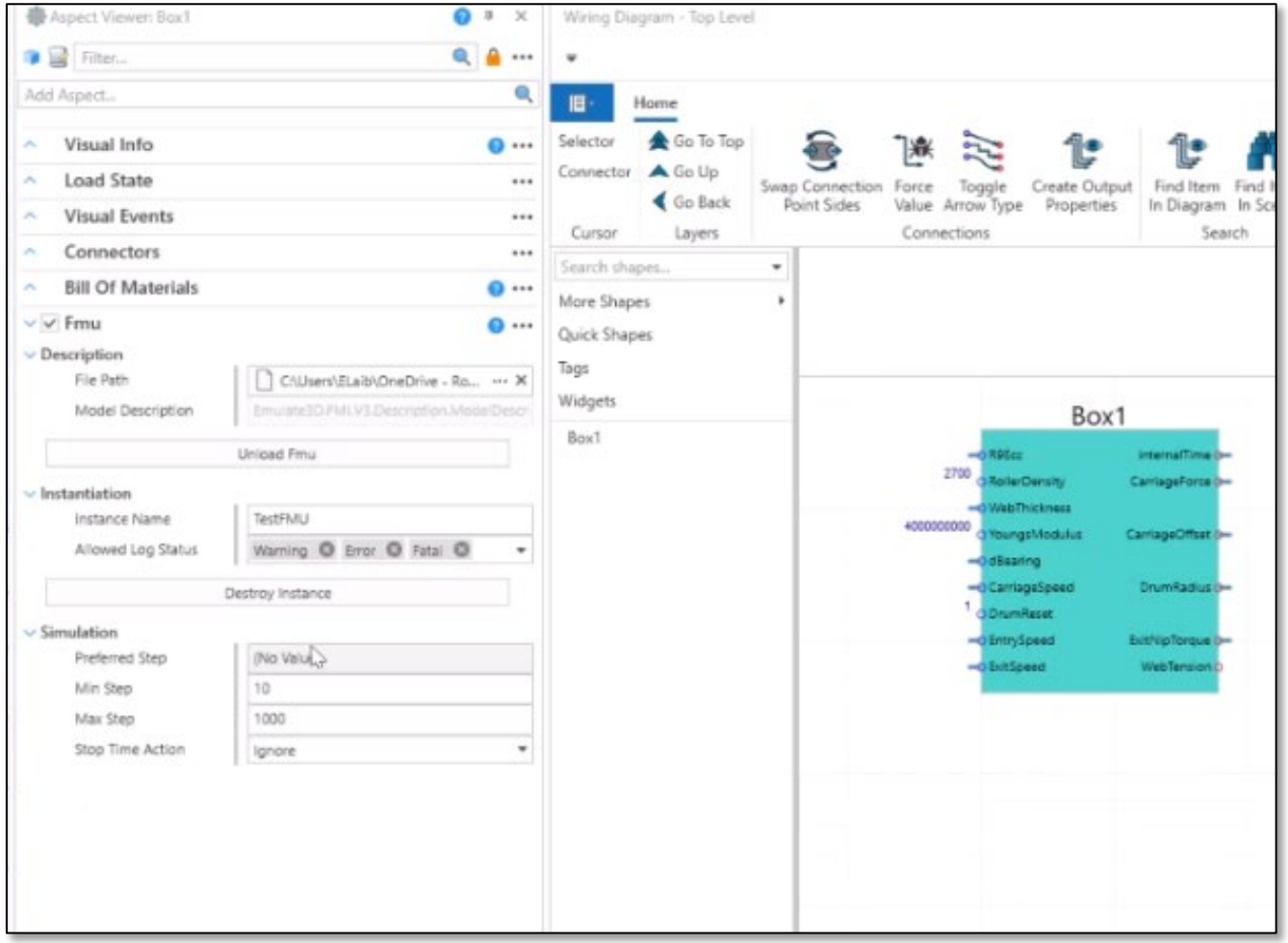
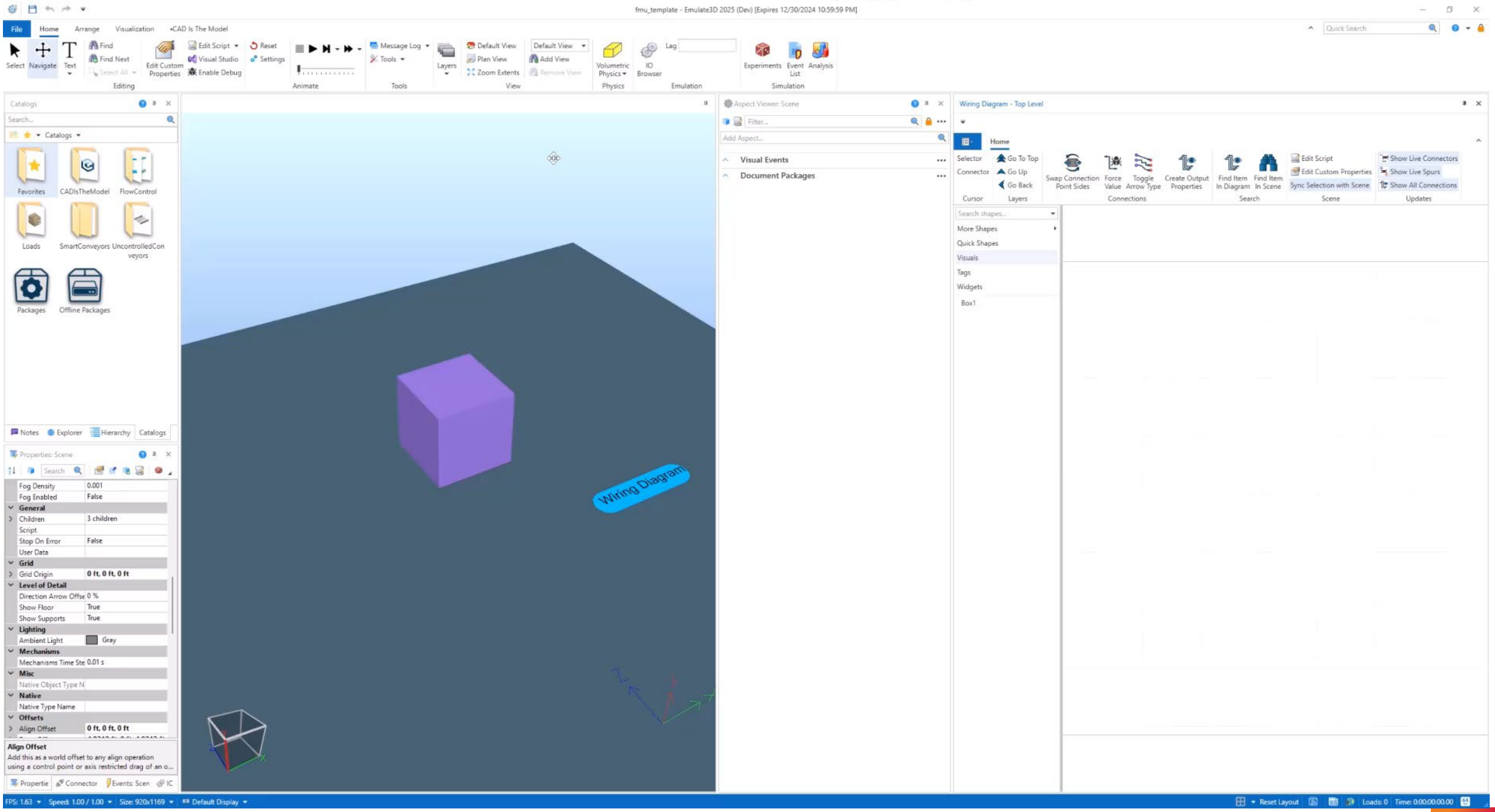
FMI Import and Configuration in Emulate3D

Think of an FMU like a Black Box:

- Import FMUs to any visual using an aspect. (A motor, a mixer, a robot, a box…)
- See input and output properties for the FMU
- Use these in QuickLogic, in Scripting, or bind to properties and PLC tags with the Wiring Diagram.
- The model and FMU advance together according to the step size, reading inputs and updating outputs




fmu_template - Emulate3D 2025 (Dev) [Expires 12/30/2024 10:59:59 PM]
File
Home
Arrange
Visualization
•CAD Is The Model
Quick Search
Select
Navigate
Text
Find
Find Next
Select All
Edit Custom Properties
Edit Script
Visual Studio
Enable Debug
Reset
Settings
Editing
Animate
Message Log
Tools
Layers
Default View
Plan View
Zoom Extents
Add View
Remove View
View
Volumetric Physics
Physics
IO Browser
Lag
Emulation
Experiments
Event List
Analysis
Simulation
Catalogs
Search...
Favorites
CADIsTheModel
FlowControl
Loads
SmartConveyors
UncontrolledConveyors
Packages
Offline Packages
Notes
Explorer
Hierarchy
Catalogs
Properties: Scene
Search
Fog Density
0.001
Fog Enabled
False
General
Children
3 children
Script
Stop On Error
False
User Data
Grid
Grid Origin
0 ft, 0 ft, 0 ft
Level of Detail
Direction Arrow Offse
0 %
Show Floor
True
Show Supports
True
Lighting
Ambient Light
Gray
Mechanisms
Mechanisms Time Ste
0.01 s
Misc
Native Object Type N
Native
Native Type Name
Offsets
Align Offset
0 ft, 0 ft, 0 ft
Align Offset
Add this as a world offset to any align operation using a control point or axis restricted drag of an o...
Propertie
Connector
Events: Scen
IC
Wiring Diagram
Aspect Viewer: Scene
Filter...
Add Aspect...
Visual Events
Document Packages
Wiring Diagram - Top Level
Home
Selector
Connector
Cursor
Go To Top
Go Up
Go Back
Layers
Swap Connection Point Sides
Force Value
Toggle Arrow Type
Create Output Properties
Connections
Find Item In Diagram
Find Item In Scene
Search
Edit Script
Edit Custom Properties
Sync Selection with Scene
Scene
Show Live Connectors
Show Live Spurs
Show All Connections
Updates
Search shapes...
More Shapes
Quick Shapes
Visuals
Tags
Widgets
Box1
FPS: 1.63
Speed: 1.00 / 1.00
Size: 920x1169
Default Display
Reset Layout
Loads: 0
Time: 0:00:00:00.00

Bringing Vacuum Carburizing to Emulate3D™

What is Vacuum Carburizing:

- The process of diffusing carbon into iron or steel to make it harder
- Requires complex systems due to the number of processes involved in maintaining vacuum pressure

The Challenge:

- Systems are large and difficult to test
- Stops client's production
- Requires short timelines

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CES_FeatureSpotlight* - Emulate3D 2025 (RC) [Expires 5/1/2025 12:59:59 AM]

File | Home | Arrange | Visualization | Help | •CAD Is The Model

Quick Search

Select | Navigate | Find | Find Next | Select All | Navigation
Edit Custom Properties | Aspect Viewer | Edit Script | Visual Studio | Enable Debug | Version Control | Editing
Reset | Settings | Animate
Message Log | Immediate Window | Tools | Tools
Layers | Default View | Plan View | Zoom Extents | Default View | Add View | Remove View | View
Volumetric Physics | Physics
IO Browser | Emulation
Experiments | Event List | Analysis | Test Runner | Simulation

Hierarchy
Search
- Box1
- FlowControl1
- Group1
  - CES
    - Area_Cell
    - Area_Pirani
    - Area_Pump
    - Area_Seal_Supply
    - BUTOIR ANTI ROTATION BAUMER Z119.041-1
    - BUTOIR ANTI ROTATION BAUMER Z119.041-2
    - CES 06H-025-1
    - CES 06H-050-1
    - CES 06H-055-1

Note | Explore | Hierarch | FMU_Catalo

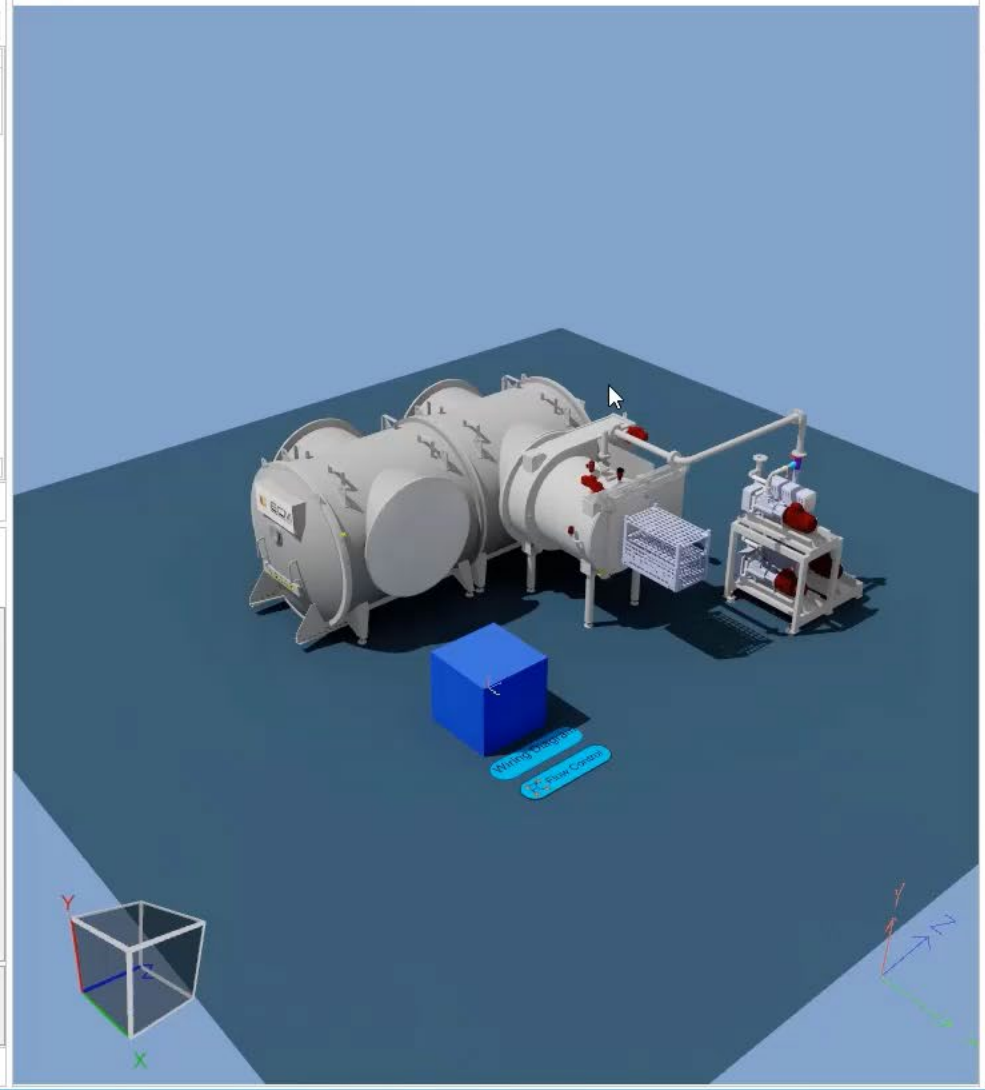
Properties: Box1
Search

Custom	
E3D_PressureCell	0
E3D_PressureExternal	0
E3D_PressureInternal	0
Dimensions	
Depth	1 m
Height	1 m
Width	1 m
General	
Name	Box1
Materials	
Color	RoyalBlue
Position	
World Location	0.3848 m, 0.5 m, -0.9517

Name
A non-unique name used when defining actions for this object.

Properties | Connecto | Events: Box1 | IC

Scene



Aspect Viewer: Box1
Filter...
Add Aspect...

- Visual Info
- Load State
- Visual Events
- Connectors
- Bill Of Materials
- FMU
  - Description
    - Model Descript... | Emulate3D.FMI.V3.Description.Mode
  - Unload Fmu
  - Instantiation
    - Instance Name: CES
    - Platform: Default
    - Enable Logging: ☑
    - Allowed Log St...: Warning, Error, Fatal
    - Allowed Log C...:
    - Allowed Causal...: Input, Output
    - Allowed Variabi...: Tunable, Discrete, Continuous
    - Allowed Initial: Exact, Approx, Calculated
  - Create Instance
  - Simulation
    - Preferred Step: 10
    - Min Step: 10
    - Max Step: 10
    - Current Step: -1
    - Stop Time Acti...: Continue
    - OK Action: Continue
    - Warning Action: Continue
    - Discard Action: Continue

Wiring Diagram
Home | Utilities | Options...
Selector | Connector | Cursor
Open Layer in New Window | Layers
Swap Connection Point Sides | Force Value | Toggle Arrow Type | Connections
Next Instance | Previous Instance | Sync Selection | Searc

Search shapes...
More Shapes
Quick Shapes
Selected Unplaced Visuals
Available Wired Visuals
Tags
Widgets

Box1
Group1.CES.CES 06H-080-1.
Group1.CES.CES 06H-080-1.
Group1.CES.CES 06H-142-1.
Group1.CES.CES 06H-147-1.
Group1.CES.Purge_Pumps1.(
Group1.CES.Purge_Pumps1.(
Group1.CES.Purge_Pumps1.(
Group1.CES.Seal_Vv_Group.(
Group1.CES.Seal_Vv_Group.(
Group1.CES.Seal_Vv_Group.(
Group1.CES.Seal_Vv_Group.(

Wiring Diagram | MainProcedure on FlowControl1 | OnResetLogic on FlowControl1

FPS: 59.98 | Speed: 1.00 / 1.00 | Size: 657x809 | Default Display | World Location | X 0.385 m | Y 0.5 m | Z -0.952 m | Reset Layout

FMU Import - Vacuum Carburizing Application

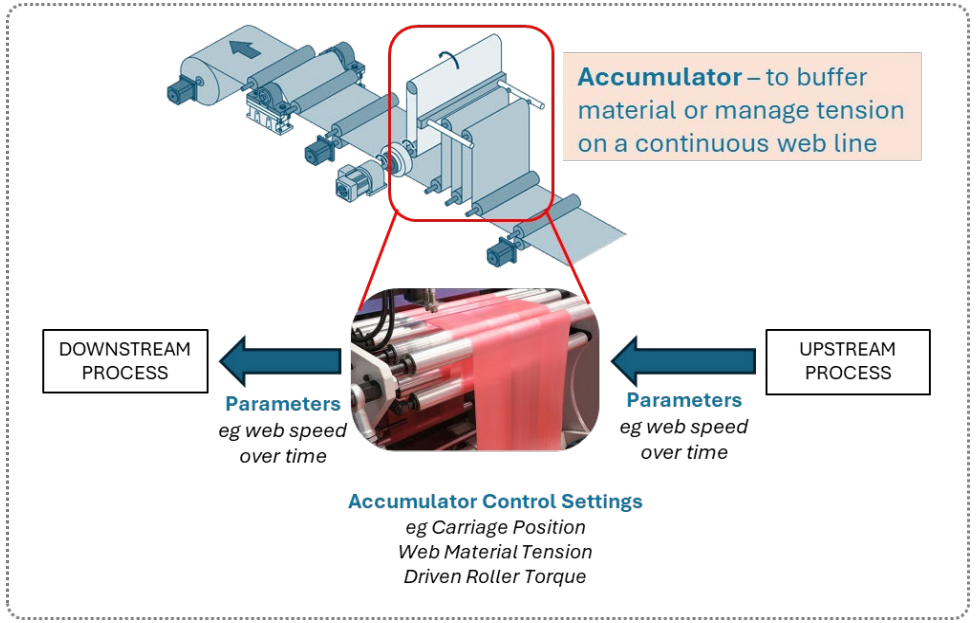
EMULATE3D by ROCKWELL AUTOMATION

Bringing Web Handling Management to Emulate3D™

THE CHALLENGE

Materials passing through web handling and converting processes:

- Have complex dynamics and tension fluctuations
- Are affected by UPSTREAM processes
- Impact DOWNSTREAM steps

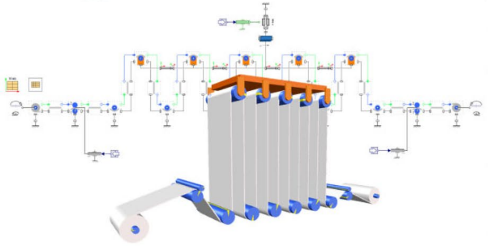


THE SOLUTION

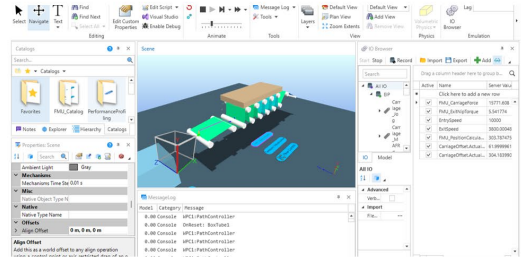
MapleSim™ models of web handling systems can:

- Capture web handling process dynamics
- Visualize tension and torque over time
- Integrate with Emulate3D™ via FMI to provide enhanced line simulations

MapleSim™



EMULATE3D by ROCKWELL AUTOMATION



USE SIMULATION TO **MAINTAIN PRODUCT QUALITY** AND **AVOID DOWNTIME** WHEN MAKING CONTROL AND MACHINE CHANGES

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MapleSim_Demo_VelocityBased_DemoWD_V0.4* - Emulate3D 2025 (Dev) [Expires 12/30/2024 10:59:59 PM]

File | Home | Arrange | Visualization | Help | •CAD Is The Model

Quick Search

Select | Navigate | Text | Find | Find Next | Select All | Edit Custom Properties | Edit Script | Visual Studio | Enable Debug | Reset | Settings | Message Log | Tools | Layers | Default View | Plan View | Zoom Extents | Default View | Add View | Remove View | Volumetric Physics | IO Browser | Lag | Experiments | Event List | Analysis

Editing | Animate | Tools | View | Physics | Emulation | Simulation

Catalogs

Search...

Catalogs

Favorites | FMU_Catalog | PerformanceProfiling | WiringCatalog | SmartConveyors | UncontrolledConveyors | FlowControl | Packages | Offline Packages

Notes | Explorer | Hierarchy | Catalogs

Properties: Box1

Search

Constant	False
Continuous	False
Discrete	False
Fixed	False
Tunable	False
General	
Name	**Box1**
Materials	
Color	**SkyBlue**
Position	
World Location	**-0.9142 m, 0.5 m, 1.4474**
Wiring	
DiagramInformation	4 items

Name
A non-unique name used when defining actions for this object.

Properties: Bc | Connect | Events: Bo | I

Scene

Wiring Diagram

Home | Utilities | Options...

Selector | Connector | Cursor | Open Layer in New Window | Layers | Swap Connection Point Sides | Force Value | Toggle Arrow Type | Connections | Next Instance | Previous Instance | Sync Selection | Find Item In Diagram | Find Item In Scene | Search | Edit Script | Edit Custom Properties | Debug Refresh View | Scene

Search shapes...

More Shapes
Quick Shapes
Selected Unplaced Visuals
Available Wired Visuals
Tags
Widgets

Wiring Diagram | IO Browser

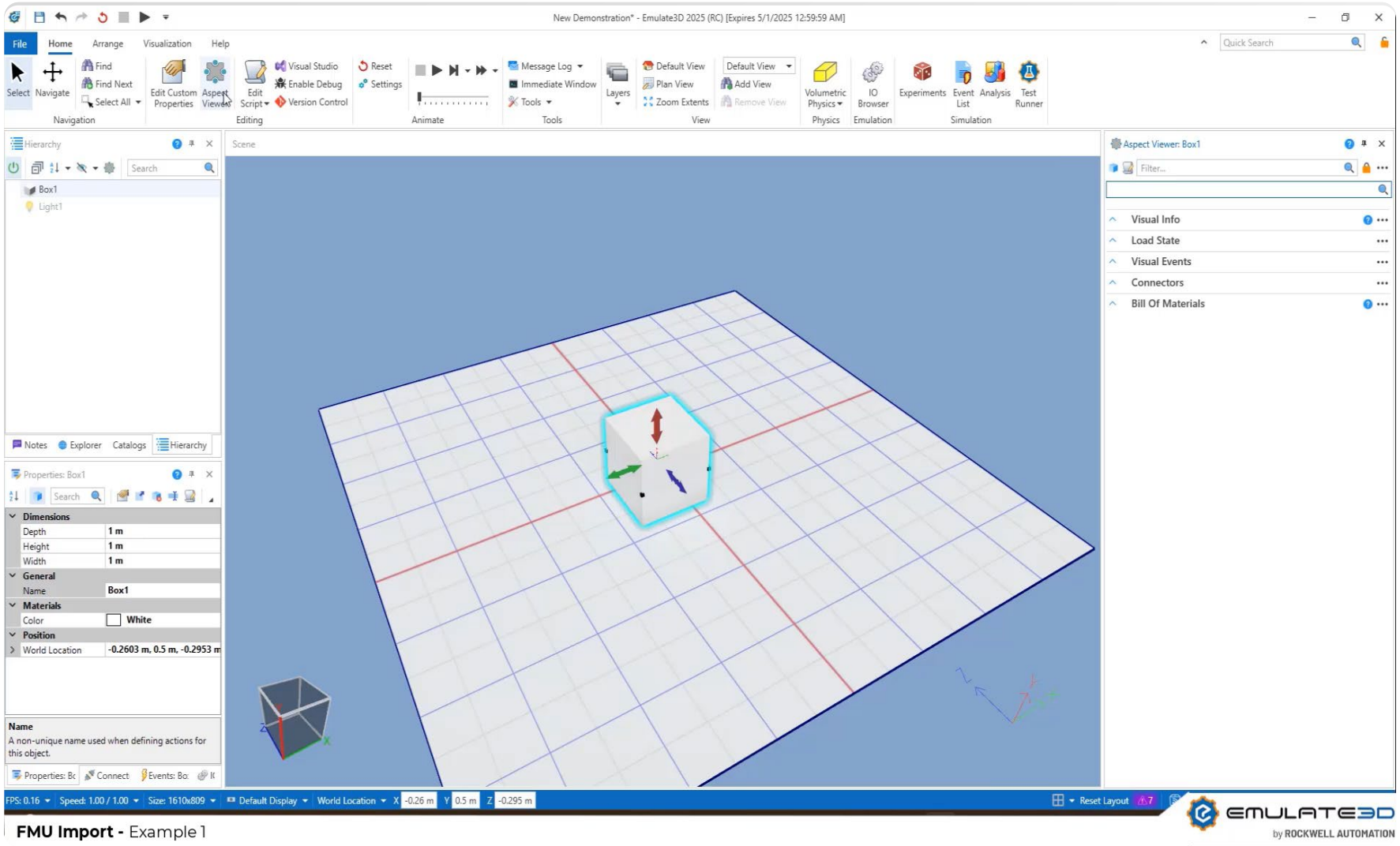
FMU Import - Web Handling Application

EMULATE3D by ROCKWELL AUTOMATION

| Tip – Connect an FMU to another FMU

In Emulate3D, FMUs can be linked together to **create larger models**

- Connect the FMUs using the wiring diagram
- Create larger, higher fidelity systems



FMU Import - Example 1

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This is just the beginning

FMI can be used to bring in high fidelity simulations across many applications

Pharmaceutical

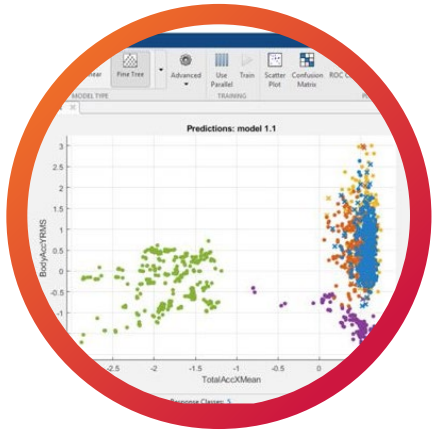
Bioreactors and Cleanroom HVAC systems

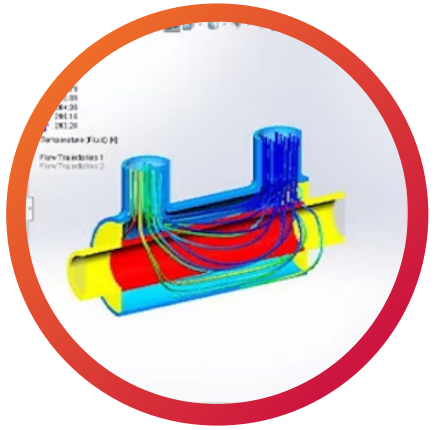
Data Centers

Thermodynamics for temperature control

Advanced Analytics

Use analytics toolboxes to gain insights on your model



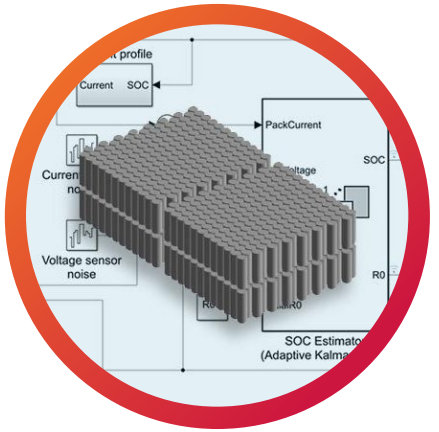


Chemical and Fluid systems

Higher fidelity pumping stations and mixing tanks

Electrical and Power Systems

Battery systems or devices



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What is Device Emulation?

There are two parts to Device Emulation:

1. **Device Network Emulation** emulates the low level **CIP Class 1 communication** with the PLC. This layer of emulation is only enough to establish data communication with the PLC, exchanging uninterpreted data.

2. **Module Emulation** emulates the logic inside the device/ module. This might include any CIP Class 3 Objects that the module supports, and any Smart logic that it offers.

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Why Device Emulation within Emulate3D?

No PLC Code Changes

Don't need to Inhibit Allen-Bradley Modules

Communicate via CIP Class 1 with supported devices using Device Network Emulation layer

Enables automated testing of your controls code and CI/CD workflows

Write to Safety IO

E3D creates the CIP Class 1 connection on the specified IP

The PLC thinks it's talking with the real hardware module, and Status bits are satisfied

IO can be freely exchanged (Logix Firmware 35+)

Comprehensive Testing

Module configuration errors can be discovered & resolved

With Module Emulators, internal logic is emulated with highly accurate behavior

Fault testing can be performed virtually

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What Module Emulators are available?

AB Digital IO Modules

AB Velocity Drives (standard)

Armor PowerFlex (future)

Create your own! APIs and Tutorials for Device Network Emulation.

1732ES ArmorBlock Guard I/O Ethernet/IP Safety Modules

IB16, IB12XOBV2, IB12XOB4, IB8XOBV4, IB8XOB8

1734 Point I/O Digital Modules

IB8S, OB8S, 8CFG, IA2, IB2, IM2, IV2, IA4, IB4, IM4, IV4, IB8, IV8, OA2, OB2, OW2, OX2, OB2E, OB2EP, OV2E, OA4, OB4, OW4, OB4E, OV4E, OB8, OB8E, OV8E

1756 Control Logix EtherNet/IP Digital I/O Modules

IA16I, IB16I, IA16, IB16, IC16, IH16I, IM16I, IN16, IV16, IG16, IB16D, IA32, IB32, IV32, OA8, OB8, ON8, OC8, OH8I, OX8I, OB8I, OB8EI, OA16I, OB16I, OW16I, OG16, OA16, OB16E, OV16E, OB32

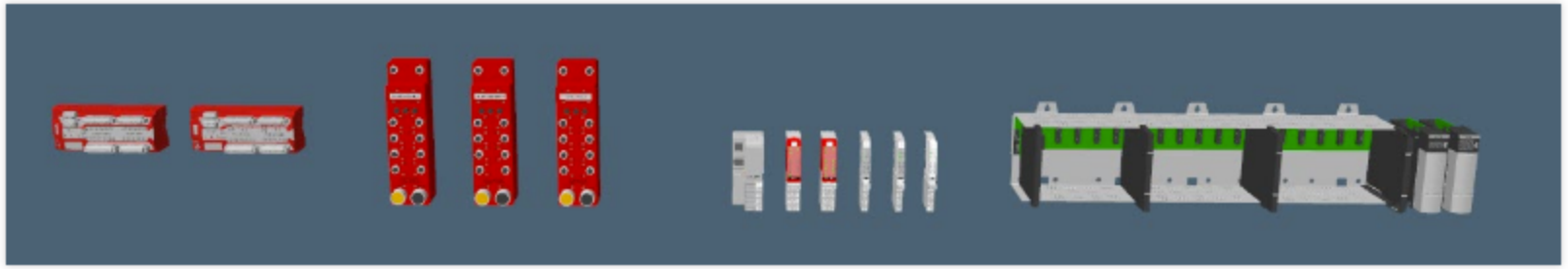
1791ES CompactBlock Guard I/O Ethernet/IP Safety Modules

IB16, IB8XOB4

Velocity Drives

ArmorStart 284E, PowerFlex 525, PowerFlex 753, PowerFlex 755, and PowerFlex 755T

See Allen-Bradley Velocity Drives Catalog for more details.



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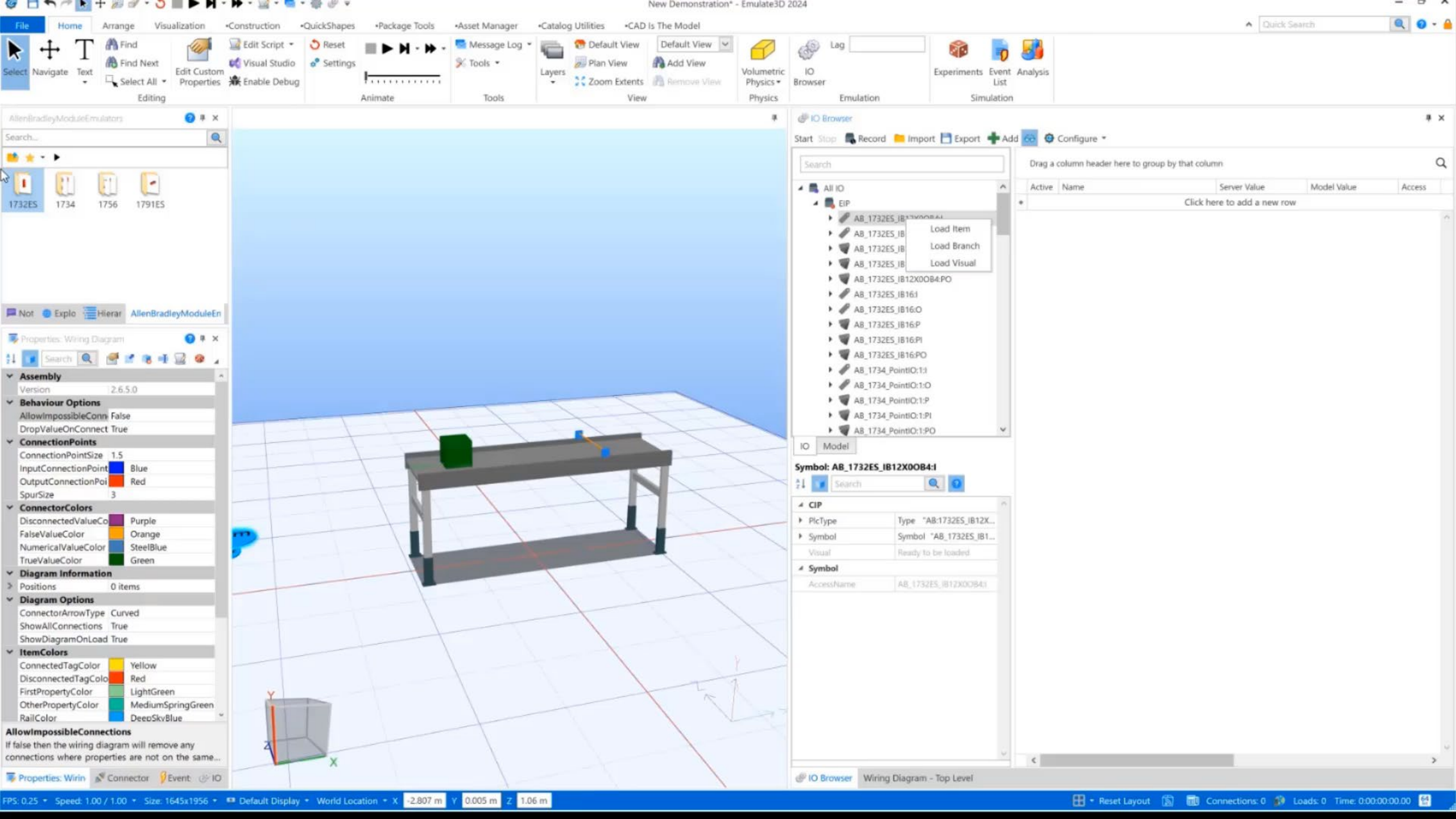

New Demonstration* - Emulate3D 2024
File
Home
Arrange
Visualization
Construction
QuickShapes
Package Tools
Asset Manager
Catalog Utilities
CAD Is The Model
Quick Search
Select
Navigate
Text
Find
Find Next
Select All
Editing
Edit Custom Properties
Edit Script
Visual Studio
Enable Debug
Reset
Settings
Animate
Message Log
Tools
Layers
Default View
Plan View
Zoom Extents
Add View
Remove View
View
Volumetric Physics
Physics
IO Browser
Lag
Emulation
Experiments
Event List
Analysis
Simulation
AllenBradleyModuleEmulators
Search...
1732ES
1734
1756
1791ES
Properties: Wiring Diagram
Assembly
Version 2.6.5.0
Behaviour Options
AllowImpossibleConn False
DropValueOnConnect True
ConnectionPoints
ConnectionPointSize 1.5
InputConnectionPoint Blue
OutputConnectionPoi Red
SpurSize 3
ConnectorColors
DisconnectedValueCo Purple
FalseValueColor Orange
NumericalValueColor SteelBlue
TrueValueColor Green
Diagram Information
Positions 0 items
Diagram Options
ConnectorArrowType Curved
ShowAllConnections True
ShowDiagramOnLoad True
ItemColors
ConnectedTagColor Yellow
DisconnectedTagColo Red
FirstPropertyColor LightGreen
OtherPropertyColor MediumSpringGreen
RailColor DeepSkyBlue
AllowImpossibleConnections
If false then the wiring diagram will remove any connections where properties are not on the same...
IO Browser
Start
Stop
Record
Import
Export
Add
Configure
Search
All IO
EIP
AB_1732ES_IB12X0OB4:PO
AB_1732ES_IB16:I
AB_1732ES_IB16:O
AB_1732ES_IB16:P
AB_1732ES_IB16:PI
AB_1732ES_IB16:PO
AB_1734_PointIO:1:I
AB_1734_PointIO:1:O
AB_1734_PointIO:1:P
AB_1734_PointIO:1:PI
AB_1734_PointIO:1:PO
Load Item
Load Branch
Load Visual
IO
Model
Symbol: AB_1732ES_IB12X0OB4:I
CIP
PlcType
Symbol
Visual
Ready to be loaded
Symbol
AccessName
Drag a column header here to group by that column
Active
Name
Server Value
Model Value
Access
Click here to add a new row
Properties: Wirin
Connector
Event
IO
IO Browser
Wiring Diagram - Top Level
FPS: 0.25
Speed: 1.00 / 1.00
Size: 1645x1956
Default Display
World Location
X -2.807 m
Y 0.005 m
Z 1.06 m
Reset Layout
Connections: 0
Loads: 0
Time: 0:00:00:00.00

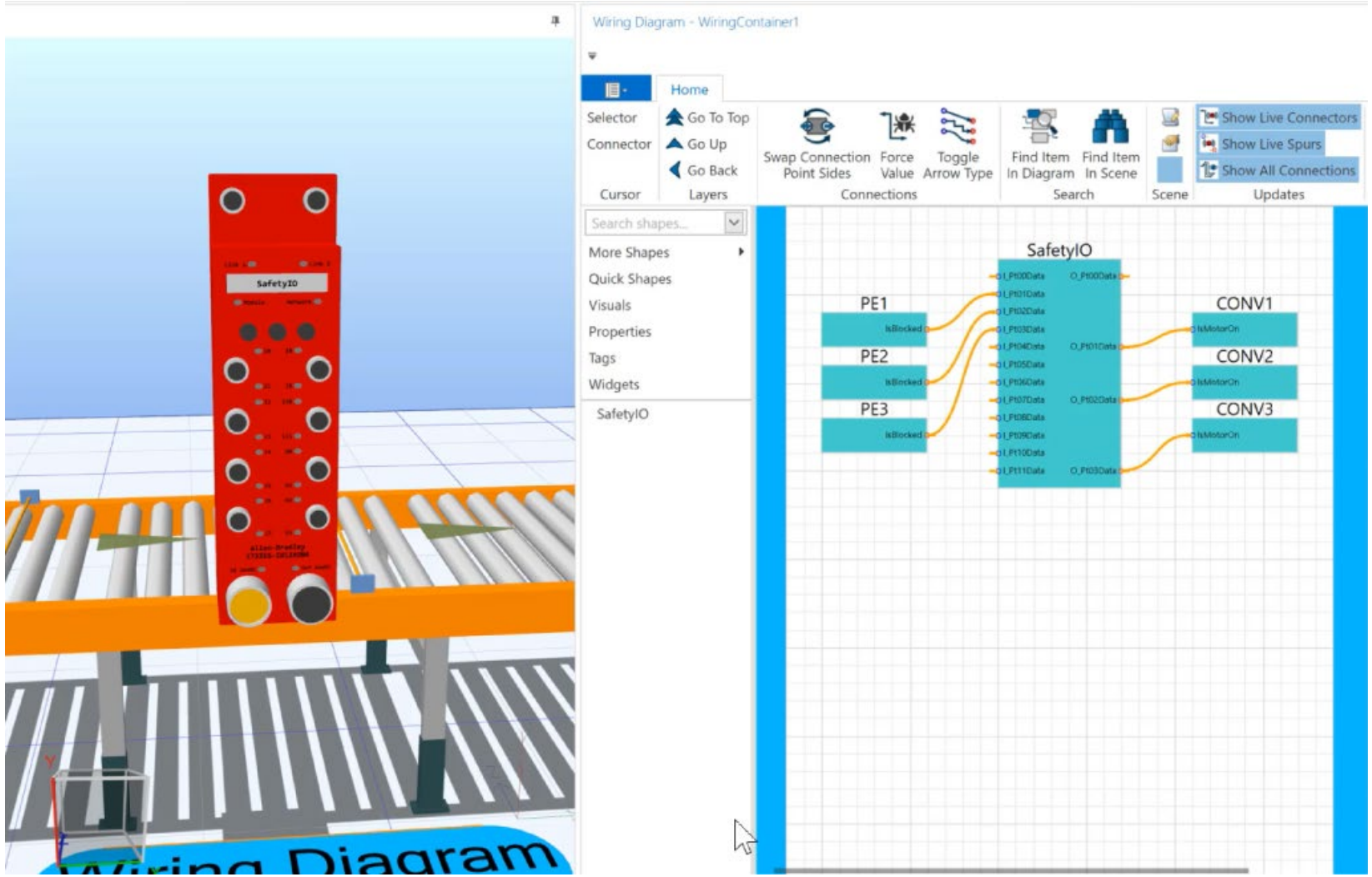
Allen-Bradley Module Emulators Catalog

Add the catalog item into the model to automatically generate the module emulation logic

Highly parametric with many configurations modelled

Single binding in IO browser

Easily bind inputs and outputs to E3D properties via IO Browser, Wiring Diagram or scripting



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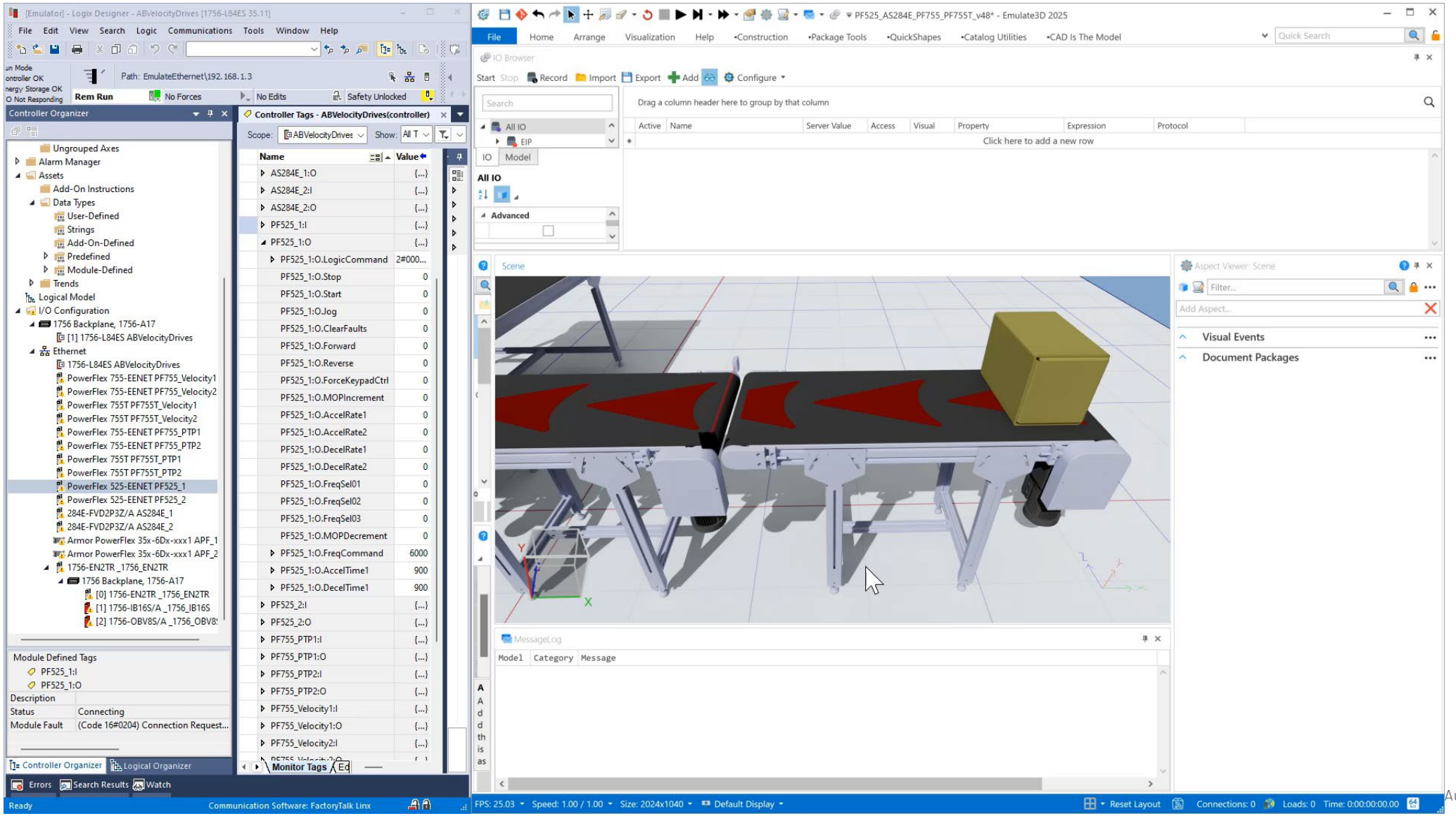
Allen-Bradley Velocity Drives Catalog (in-progress improvements)

IO Browser bindings automatically generated



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Thank you

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