What's New in 2018

We are happy to announce the release of the Emulate3D 2018 Product Range.

These release notes cover the new features that have been added since the previous release.

Emulate3D (Controls Testing) and Sim3D include all Demo3D and Layout3D features. Demo3D includes all Layout3D features. The Ultimate edition contains all features.

Contents

Emulate3D 3

CAD Is The Model 3

CAD Is The Model – SOLIDWORKS Add-in 4

OPC UA Support 5

Siemens (Simatic Manager / TIA) Symbol Table Support 5

Siemens S7Online Support 5

Siemens PLCSIM Advanced V2.0 Support 6

Rockwell Operator Training Solutions (OTS) Support 6

Net Server Additional Protocols 6

Extended Addresses 7

User Defined Data Types (UDTs) Support 7

Tag Configuration and Tag Groups 7

Pulse Encoder Improvements and Gray Codes 7

Binding Interface (Controls Testing Catalog Support) 8

TwinCAT PROFIBUS/PROFINET Configuration Subslot Support 8

Wiring Diagram Emulation 9

Sim3D 10

Vehicle Framework Catalog Enhancements 10

Event List Window 10

Simulation Step Control 12

Distribution Editor 13

Demo3D 14

Visual Aspects 14

Visual Class 14

Mechanisms 15

Source Control Enhancements 17

C# 7.2 Scripting Support 17

Layout3D 18
CAD Update Feature 18
CAD Import Progress Bar 18
CAD Mouse/Keyboard modes 19
View Cube 20
Invert Selection 20
Plan View Rulers 21
Snap Mode 22
Dimension Tool Enhancements 22
VR Static Analyzer 23
VR Lights 24
VR Point Clouds 24
Web Server Shortcut 25
Print to Scale 25
Rack Configurator Catalog 26
Viewers 28
Windows Mixed Reality Headsets 28
HoloLens Remoting 28
General 29
Universal License Server (ULS) 29
Web Store Updates 29
Cloud Rendering Updates 29

Emulate3D

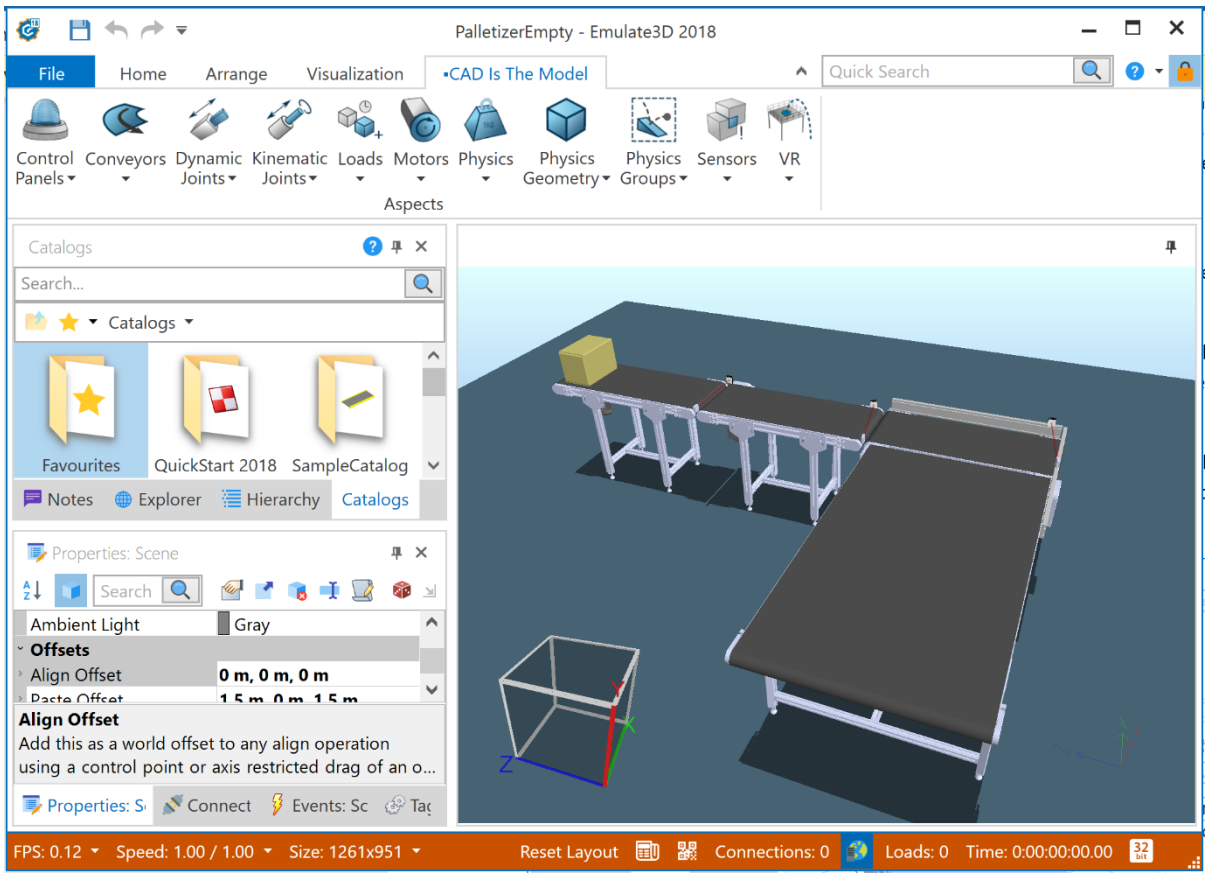
CAD Is The Model

CAD Is The Model is a new set of features to allow CAD to be marked up with “Aspects” to create Dynamic Digital Twins for virtual commissioning. These Aspects represent things like conveyors, joints, physics geometry, sensors, etc. This is a new approach to turning CAD into usable emulation and simulation models of machines or layouts with as few additions as possible.

The default Aspects are Controls Testing ready, so you can generate PLC Tag IO points directly from the Aspects that have been configured with no change to the original CAD hierarchy and no need to add extra Visuals overlaid by CAD.

The workflow allows the CAD to be modified and updated while retaining all the Aspects that have been added, allowing continuous iteration of machine designs in CAD and the PLC code that controls them.

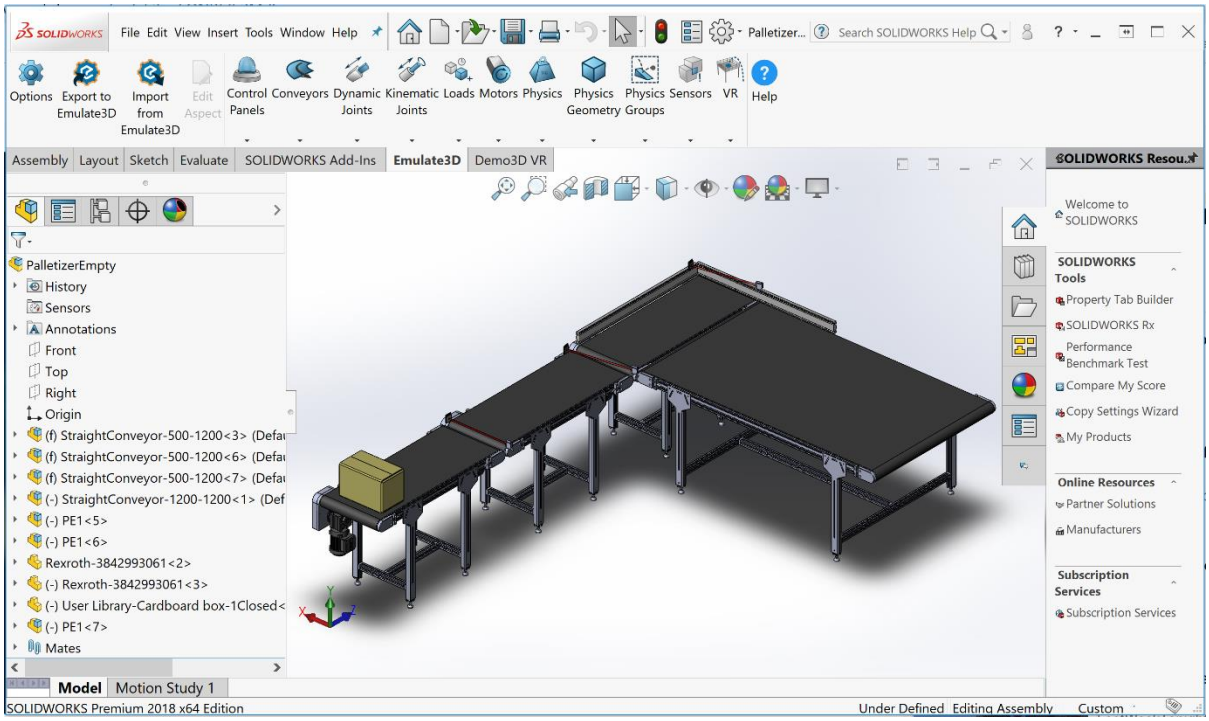
A new catalog has been created which holds a default set of Aspects and a Plugin which gets added to the User Interface when the catalog is loaded. User-defined Aspects can easily be added using custom C# scripts in the same way that existing scripts are written.



CAD Is The Model – SOLIDWORKS Add-in

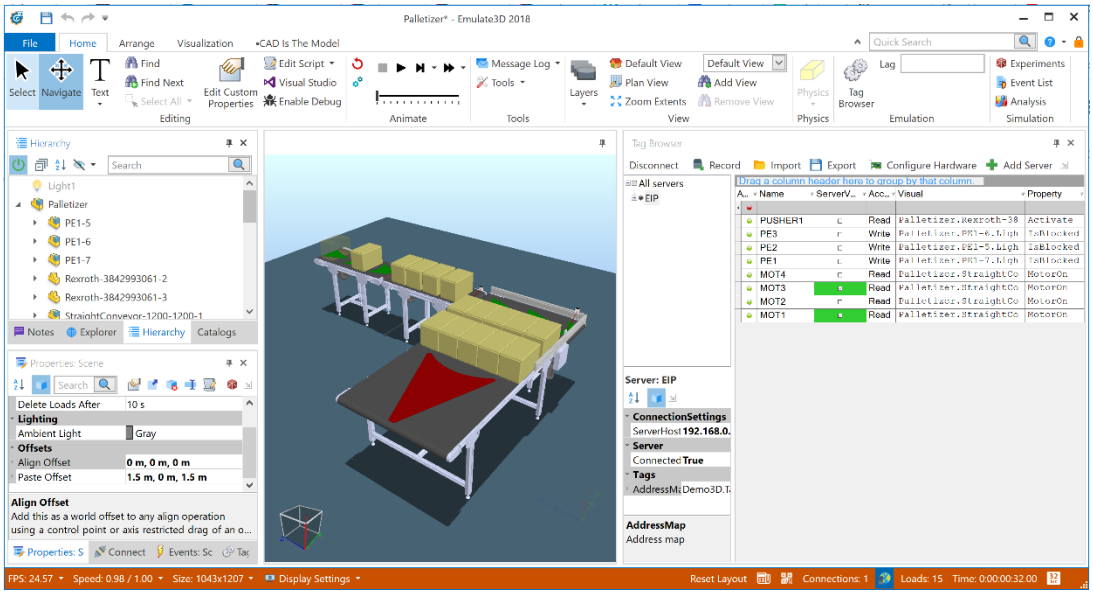
The catalog Plugin inside Emulate3D has also been created for SOLIDWORKS as an Add-In. This allows the CAD to be marked up with Aspects directly inside SOLIDWORKS and the properties of those aspects are stored within the SOLIDWORKS part and assembly files.

These Aspects stay within the CAD files when using a PDM solution such as SOLIDWORKS Manage.



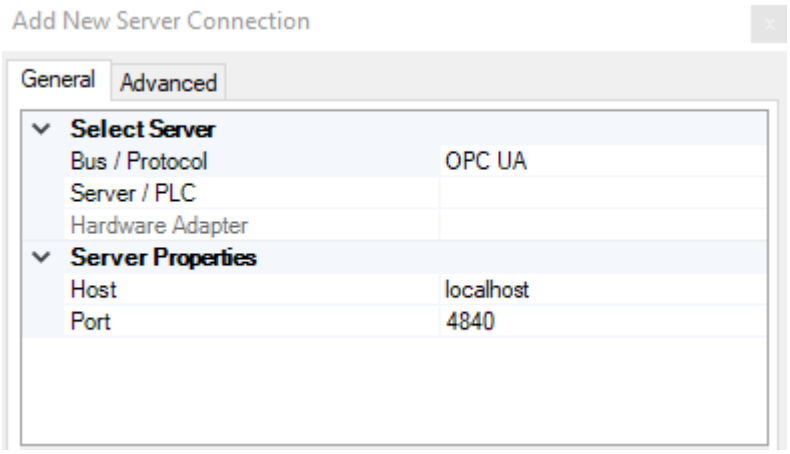
The CAD model marked up with Aspects can be Exported to Emulate3D where it can be simulated and connected to a PLC to test control logic.

Changes to these Aspects can be made in Emulate3D and then Imported back into SOLIDWORKS and stored again within the CAD file. This allows the entire simulation and controls testing model to be stored in the CAD files and regenerated in Emulate3D as needed.



OPC UA Support

Emulate3D has full support for OPC UA. OPC UA is the new vendor-neutral communication standard for PLCs, HMIs, SCADA, etc. It moves away from OPC Classic and the COM legacy to a modern cross-platform stack, based on internet technologies. It also includes enhanced data modeling capabilities allowing for richer data sets to be manipulated.



Increasingly, modern PLCs are supporting OPC UA either directly or via optimized middleware servers. OPC UA is favored over OPC Classic for its speed and security, especially for PLCs that support it natively (such as Beckhoff and the latest Siemens PLCs). Support for OPC UA gives Emulate3D another avenue for connecting to a large range of PLCs.

Siemens (Simatic Manager / TIA) Symbol Table Support

Emulate3D can now extract the Symbol Table directly from a TIA project. Setting the **TagDefinitionPath** in the Tag Server properties directs Emulate3D to use TIA to import the Symbol Table.

A Symbol Table can also be imported from a Siemens .asc, .seq or .sdf file (exported from Simatic Manager).

Using symbols in a Controls Testing model (instead of memory addresses) provides extra resilience for projects, especially where editing the PLC program changes the tag memory locations.

Siemens S7Online Support

S7Online provides access to the Siemens Virtual Backplane used by all the Simatic Manager and TIA versions of PLCSIM. With support for PROSIM being discontinued by Siemens, S7Online is now the only way to connect to the versions of PLCSIM shipped with TIA.

Siemens PLCSIM Advanced V2.0 Support

PLCSIM Advanced is a separate product to PLCSIM. It offers a more faithful Siemens S7-1500 emulator, and furthermore can operate in concert with Emulate3D as a co-simulation partner. In this mode, the clocks within Emulate3D and PLCSIM Advanced tick forward in shared virtual time – meaning that communication overhead is eradicated, and fluctuations in simulator speed and performance have no detrimental effect on the fidelity of the emulation.

By using synchronized shared virtual time, the simulation can be run faster than real-time, in slow-motion, or be paused altogether. (PLCSIM Advanced can run up to 10 times faster than the real PLC.) This allows controls engineers to get to a problem point in the control code quickly and then safely step though it to debug problems, knowing that while the model is paused, the PLC program and the timers within the softPLC are all paused as well.

Emulate3D supports the latest version 2.0 of PLCSIM Advanced.

Rockwell Operator Training Solutions (OTS) Support

Support has been added for Rockwell's Studio 5000 Emulate (OTS) softPLC. Like Siemens' PLCSIM Advanced, Rockwell's OTS acts as a co-simulation partner with Emulate3D.

Net Server Additional Protocols

All existing communication protocols are now implemented in the Demo3D.Net framework. Sharing a common code base for implementing caching, buffering, pulse encoders, etc. allows for optimizations to all protocols at the same time, accelerating improvements across the breadth of protocols. (The only exception being Ethernet/IP CIP class 3 which is in progress but didn't quite make the 2018 deadline.)

New protocols include:

- Internal Loopback. Replaces the internal SoftPLC and allows loopback communication to all internal virtual PLCs and embedded logic controllers in the emulation model.
- Rockwell CSP. Connects to older Rockwell PLCs, e.g. the SLC5/05.
- Mitsubishi SLMP. Native protocol for Mitsubishi PLCs.
- OPC UA.
- Siemens S7Online. Support for all versions of PLCSIM.
- EtherCAT (via TwinCAT).
- TwinCAT ADS now exposes the entire PLC symbol table and includes support for all program data types.
- Simulation Unit (SIMIT Unit) direct memory protocol, and support for Profibus/Profinet acyclic messages.

The Demo3D.Net framework also allows for customized protocols and communication libraries to be added in C# scripting. Simplified APIs, and a wealth of built-in support to optimize data traffic, make adding custom protocols easy. Example protocol implementations are given in the online API documentation.

Extended Addresses

Some servers (PLCs and OPC servers) provide access to named tags only, forcing cumbersome scripts or tag expressions to access individual bits within an integer, or individual elements of an array.

Emulate3D Extended Addresses allow you to extend the tag name artificially with ".X" or "[X]", automatically and efficiently extracting or inserting the data you need.

User Defined Data Types (UDTs) Support

Support has been added for tags which represent more complex data structures than simple bool/int/float types. It also allows arrays of basic types or arrays of UDTs to be bound to in a virtual commissioning model.

Tag Configuration and Tag Groups

It's often desirable to configure individual tag characteristics (scan rate, cache control, etc.). Alternatively, for convenience, it may be helpful to put tags together in a group for common configuration. Support has been added for both configuration styles.

Pulse Encoder Improvements and Gray Codes

Hardware pulse encoders offer extremely high-fidelity pulse signals to the PLC, immune from fluctuations in simulation speed. Alternatively, model-based encoders offer signals that are precisely accurate with the current state of the model. Each has its advantages, and Emulate3D offers both. For hardware-in-the-loop, hardware-based pulse encoders are a good choice. But for co-simulation, the model-based pulse encoders are extremely accurate.

New pulse generators in Controls Testing 2018 can now run entirely as hardware pulse encoders, without the need to switch back to model-based encoders during acceleration and deceleration, etc. The new generators are optimized to handle multi-frequency pulses, and especially to work with large numbers of motors that switch on/off periodically (e.g. power saving).

Both Pulse State and Pulse Count are supported by the hardware pulse encoders. Pulse Count can be configured with a maximum and minimum count, and further configured to expose a Gray code encoded counter.

Pulses with widths as small as 1ms are supported.

Binding Interface (Controls Testing Catalog Support)

A Visual can now have a set of BindableItem(s) or CustomProperty(s) that represent the IO points/interface to that piece of equipment. This Binding Interface can be controlled dynamically based on the values of other properties, allowing for a "ControlMode" to be added to equipment to describe the IO required to control that equipment. E.g. for a Conveyor it could be as simple as an On/Off Boolean, or as complicated as a Variable Frequency Drive.

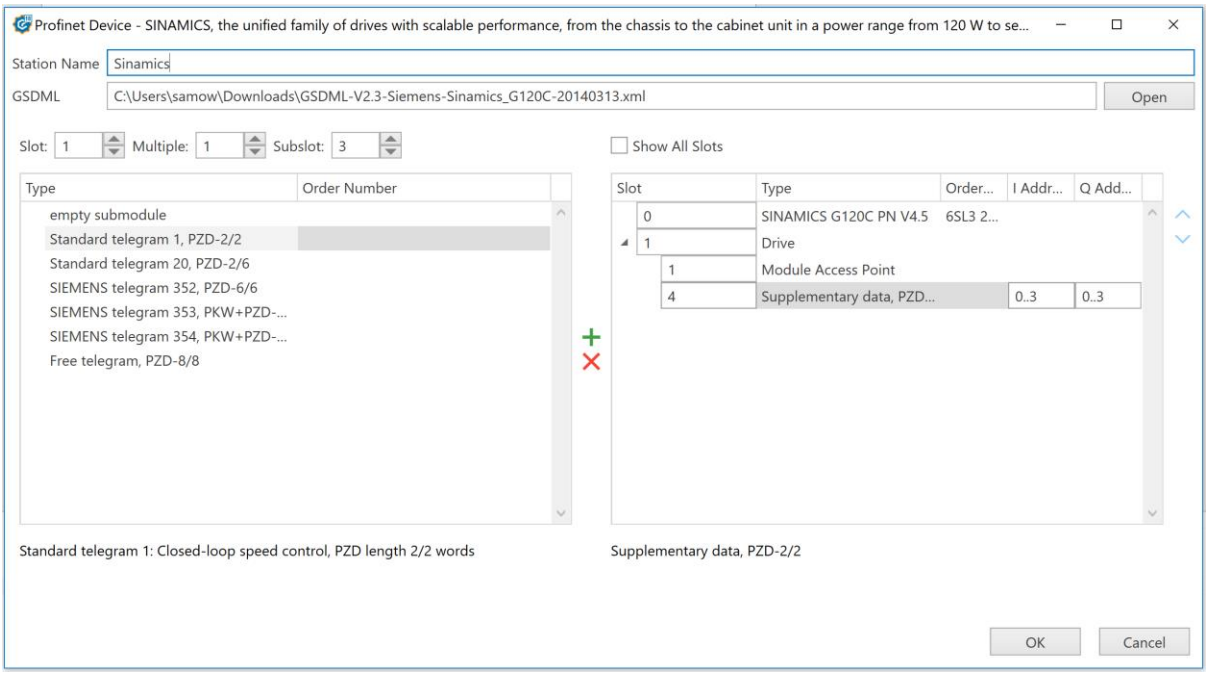
The Binding Interface is stored with a Visual when it becomes a catalog element so adding one to a scene will automatically create the Server Tags in the Tag Browser that are needed to drive that piece of equipment given its current configuration.

A complete Controls Testing model built from such a catalog will present all the IO points that need to be exposed from the PLC to control that model. These can then be bound to a specific PLC/Server, or set of PLCs/Servers, for testing.

Before connecting to a PLC, the tags' **Model** value can be driven by hand to test out the basic IO interface of the machine/layout. Axes can be driven to their extents, conveyors turned on and off and loads generated, all using the Tag Server Window as the control API.

TwinCAT PROFIBUS/PROFINET Configuration Subslot Support

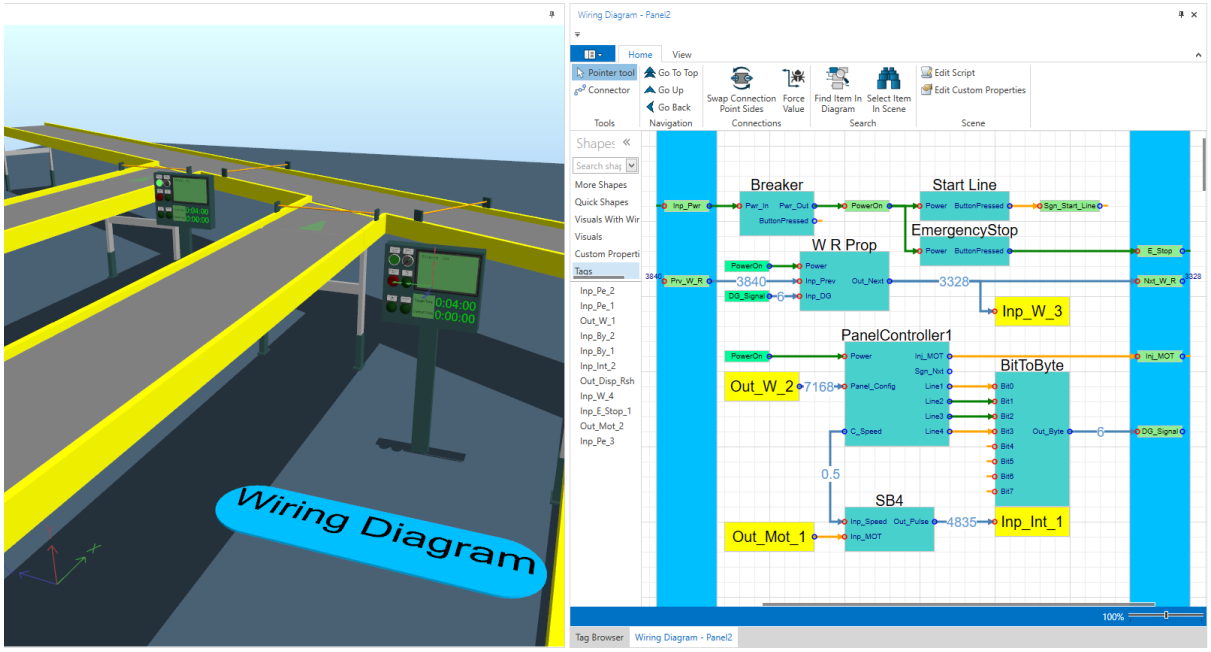
Configuring TwinCAT to correctly emulate PROFIBUS or PROFINET devices can be complicated and error-prone. The existing feature has been enhanced with support for modules with subslots, and 4K monitor support to try to minimize the work needed to set up TwinCAT by TwinCAT project that would normally have to be created by hand.



Wiring Diagram Emulation

In addition to testing PLC logic by reading/writing to PLC IO Tags, a new Plugin now allows you to use Wiring Diagrams to model the additional connections which interface those PLC connections. This often means buttons, switches, motors etc. which are rarely wired directly to a PLC tag and more likely via circuit to a device which then talks to the PLC.

- Use a 2D editing environment to create, visualize, and debug the connections between a PLC and the model, and internally between visuals.
- Add diagram items which can represent items within the model or on a connected PLC.
- Create bindings by drawing connection arrows between I/O points.
- Connection arrows update in real time to visualize signal propagation in the system.
- Force the value of connections to see how the system responds.
- Nest diagram items within each other to create a structured hierarchy of layers.
- Drag and drop items to configure the inputs and outputs of each layer.
- Data storage allows straightforward re-use of components from catalogs.



Sim3D

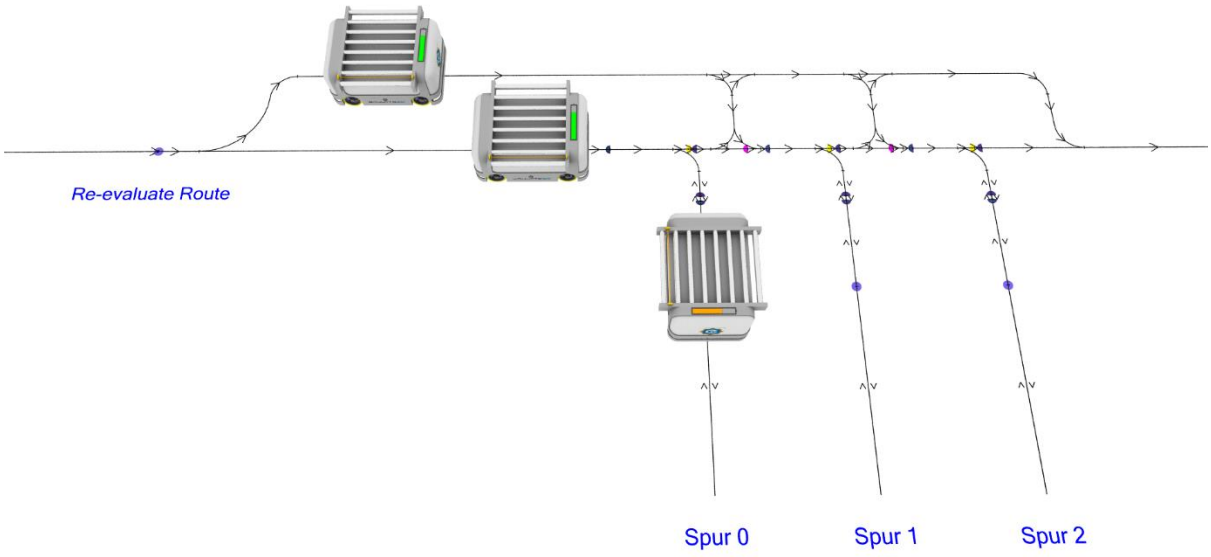
Vehicle Framework Catalog Enhancements

The Vehicle Framework has experienced a wide range of improvements and new additions since the release of Demo3D 2017. Key improvements include:

- Enhanced Vehicle detection and collision avoidance for all track-based vehicles.
- Improved performance of models with many ground-based Vehicles and large track systems.
- Vehicle utilization tracking: Accurately track time spent during Pickup/Dropoff/Charge/Idle for any Vehicle.
- Other improvements have been made to areas including path building, Dual LHD AGVs, TrackSwitches, Zone Management and more.

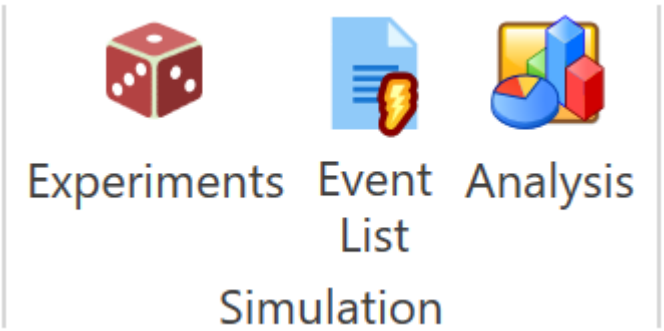
New features include:

- Dynamic path weighting to avoid stationary vehicles. Can be toggled on a per-vehicle basis.
- Create and use Bi-Directional lifts as shuttles for TrolleyVehicles. Apply speed profiles to lifts.
- PickupJobCombiner component added (for use with Dual LHD AGVs). Loads may be picked up from either a single conveyor or two adjacent conveyors.
- Choose which motor to carry through a merge.
- Enable/disable job dispatching for vehicles: Maintain zones where vehicles cannot start a new Pickup/Dropoff/Charge job.
- Opportunistically charge vehicles while parked.
- Motor visualization: Display a visual overlay on all track sections to show whether their corresponding motor is enabled/disabled.

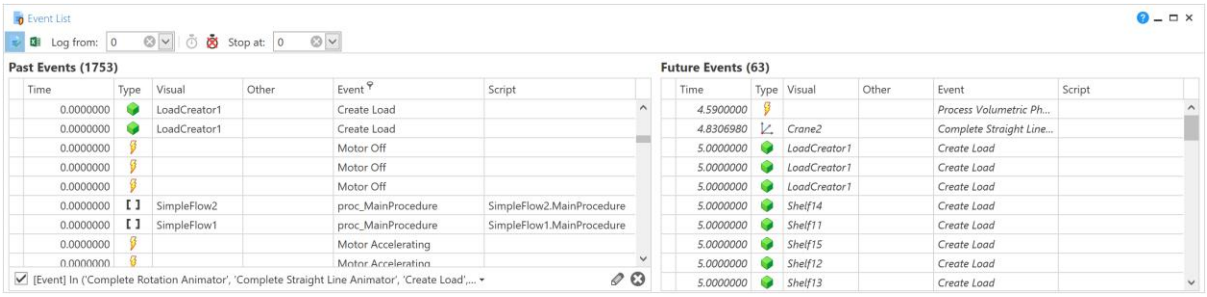


Event List Window

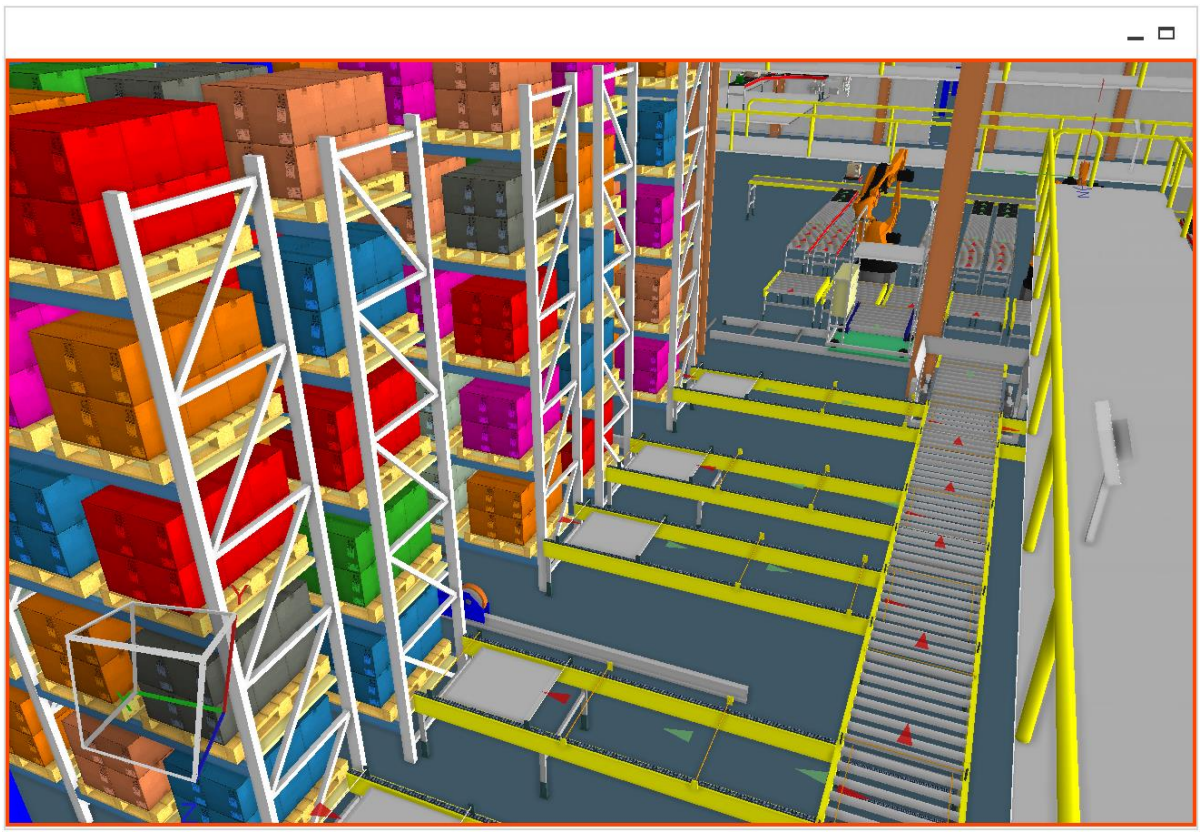
To assist with diagnosing issues with simulation models, a new window has been added to Sim3D/Ultimate that can record every event that has occurred in the simulation, the time it happened (model time) and any Visuals involved such as loads, conveyors, etc.



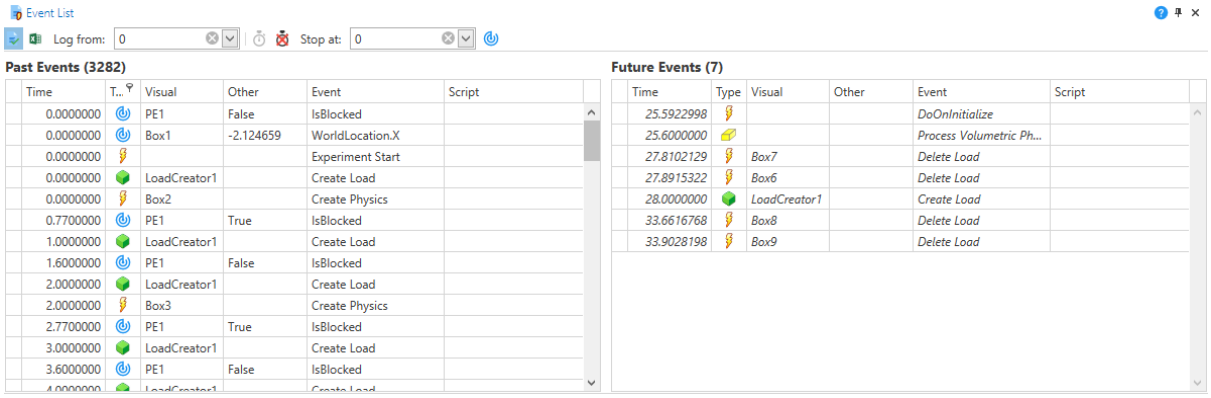
There are features to stop at a specific time, log events to a file and see a list of future scheduled events and select one to stop at.



Logging events can add a small **performance overhead** so to indicate when events are being logged a **red outline** is added to the main scene view as a reminder that there is a potential performance loss.

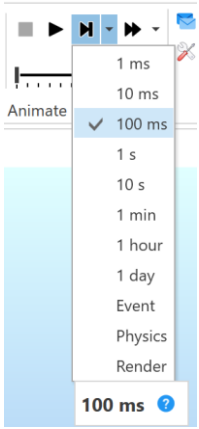


As well as logging events, properties of any visual in the scene can be tracked via the Event List Window. These are configured by selecting the Edit Tracked Properties button. Once set up, when a tracked property changes, an event will be logged to the Event List. Property changes can be tracked three different ways, when an event is logged, when an OnPropertyChanged event occurs or by polling the scene at a configurable interval.



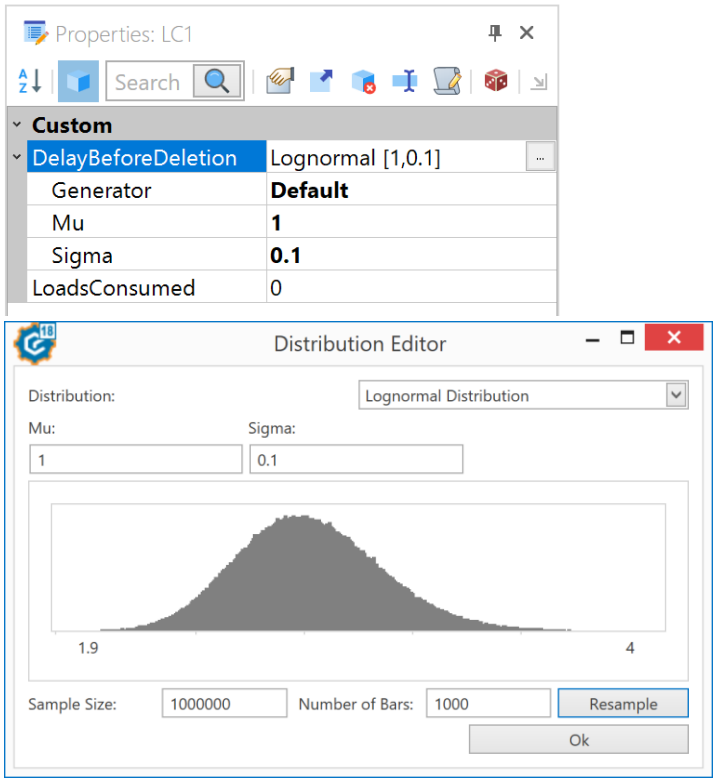
Simulation Step Control

The time duration that the Simulation Step button now advances the simulation can be controlled with options for different periods of milliseconds or seconds, or to the next Simulation Event, Physics Step, or Render Event.



Distribution Editor

Custom Properties which generate random numbers from distributions now have a new editor which shows how the parameters control the profile of the distribution based on a random set of samples.



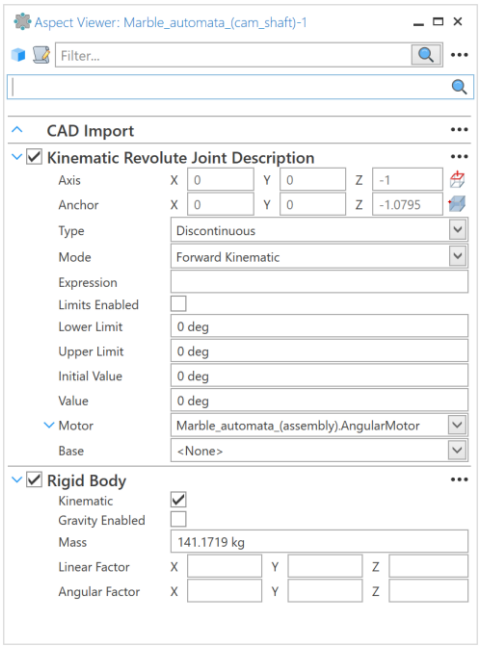
Demo3D

Visual Aspects

A VisualAspect is a component that can be added to a Visual. It's like a combination of custom properties and C# scripts, but unlike C# Scripts, multiple aspects can be added to a single visual.

A VisualAspect is defined using a C# class that derives from the Demo3D class **VisualAspect**. It has methods that can be overridden to perform certain functions at different points in its lifetime and it can call out to all existing C# APIs for manipulating **Visuals**, the **Document** and the **App**.

There is a new Aspect Viewer window available which can be used to edit visual aspects in a more advanced way, as well as, in some cases, enable or disable them dynamically.



The aspect properties are also shown in the traditional Property Grid.

Visual Class

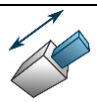
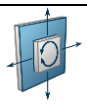
The class Visual itself was previously abstract but it can now be created. A vanilla Visual has only a few properties such as a location, rotation and parent and a name and is intended to be extended by using Visual Aspects.

This Visual class has no physics or graphics associated with it and uses a low amount of memory and has a low runtime overhead.

All imported CAD in 2018 uses this base Visual class to be as lightweight as possible.

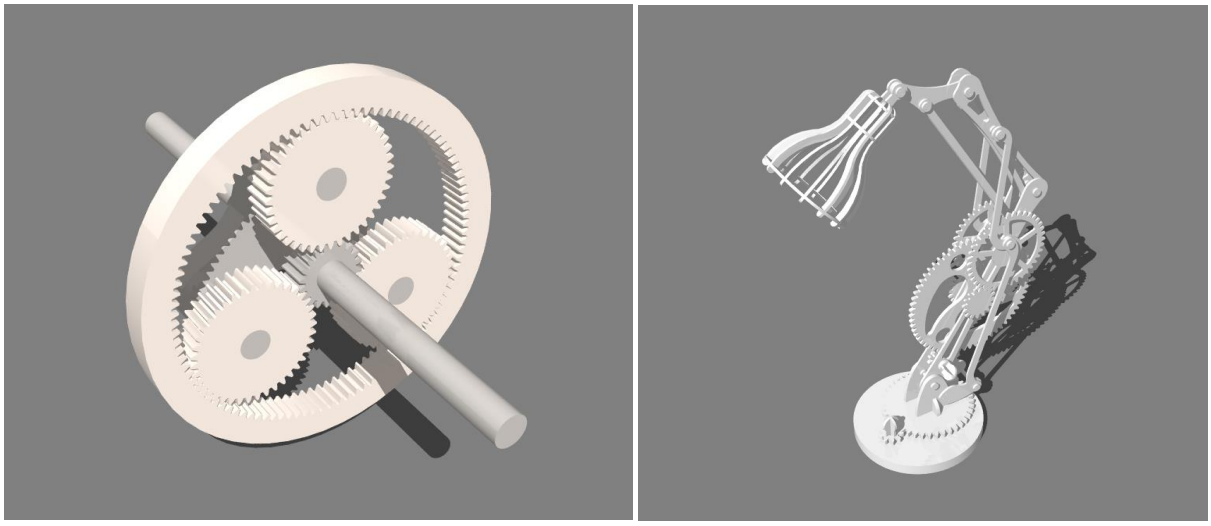
Mechanisms

Construct kinematic mechanisms from several different joint types, each of which has 1-3 parameters that constitute the degrees of freedom of the joint:

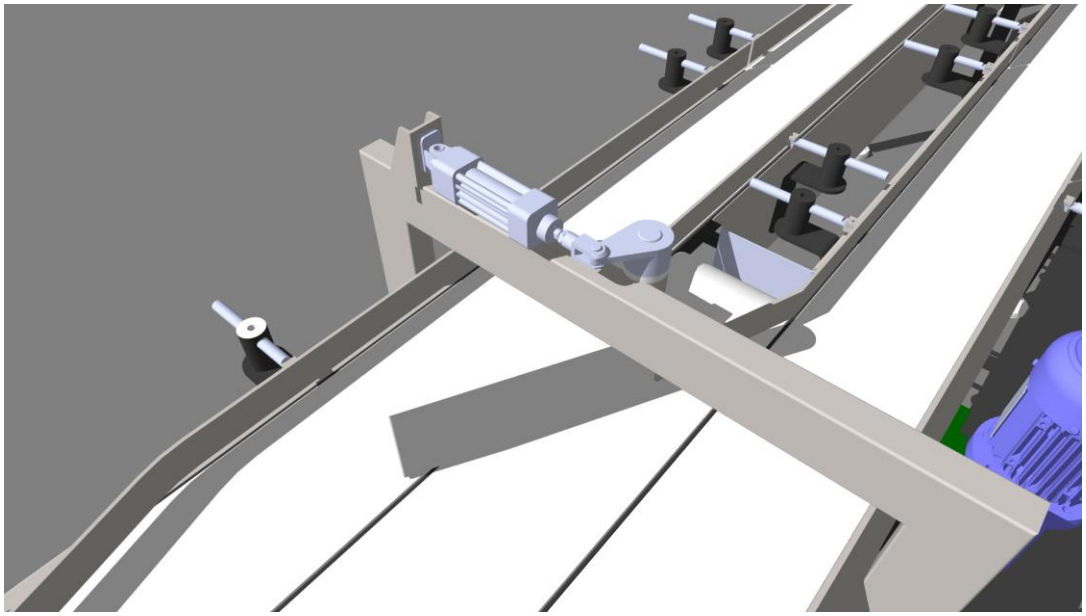
Icon	Joint Name	Parameters	Description
	Revolute	Angle	Revolute joints permit one link to rotate relative to another about an axis. Note that this axis need not be located at the origin of either link. The joint parameter is the directed angle between the two links about the axis.
	Prismatic	Distance	Prismatic joints permit one link to translate relative to another along an axis. The joint parameter is the signed distance between the two links along the axis.
	Helical	Displacement	Helical joints permit one link to translate and rotate relative to another along and about a single axis. The joint parameter is a dimensionless value from which both the signed distance and directed angle are derived. The translation and rotation are then intrinsically linked.
	Cylindrical	Angle Distance	Cylindrical joints permit one link to translate and rotate relative to another along and about a single axis. The first joint parameter is the directed angle between the two links about the axis. The second joint parameter is the signed distance between the two links along the axis.
	Planar	Angle1 Distance1 Distance2	Planar joints permit one link to translate and rotate relative to another along a plane. The first joint parameter is the directed angle between the two links about the normal of the plane. The second and third joint parameters are the signed distances between the two links along two orthogonal axes in the plane.
	Spherical	Angle1 Angle2 Angle3	Spherical joints permit one link to rotate relative to another about three orthogonal axes. The three joint parameters are the three directed angles between the two links about the three orthogonal axes.

In addition, there is a special ‘Fixed’ joint type which has no parameters and removes all degrees of freedom.

Joint parameters can operate in one of three modes: **forward kinematic**, **inverse kinematic** and **passive**. Forward kinematic parameters can be set directly by the user or indirectly via a motor. Inverse kinematic parameters are solved efficiently to satisfy loop closure and any user-specified goals or interactions. Passive parameters provide a method for simulating complex or hidden mechanical couplings, such as gears.

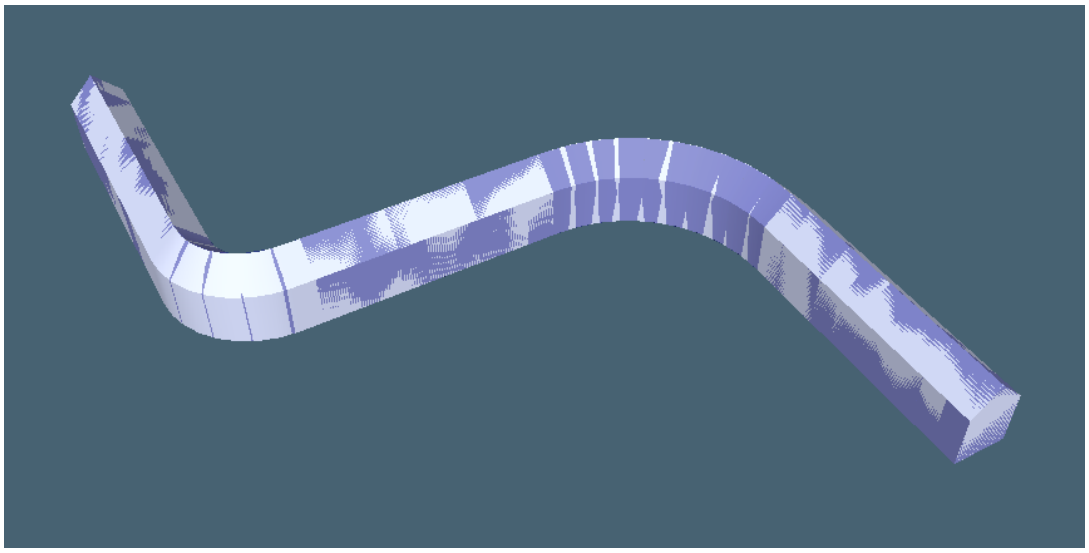


Kinematic mechanisms do not suffer from physics jitter or instability. Mechanisms of almost any scale can be simulated efficiently without significant loss of accuracy. Non-contact based interactions between links mean that fast moving objects do not suffer tunneling or large de-penetration forces, leaving you confident in the results. Loop closure and goal constraints can be solved down to an extremely small user-specified tolerance, yielding realistic and precise movements in real-time simulations.



Convex Extrusion Physics Geometry

It is common to have geometry formed from an extrusion of a convex profile along a non-convex path. Such extrusions can generate highly concave geometry, which are challenging to automatically decompose into a set of convex-hulls in reasonable time. Convex extrusion geometry performs a manual decomposition by stepping the convex-hull of a specified face along a line or curve. This efficiently generates accurate solid physics geometry, resulting in greater contact stability and inertia tensor accuracy.



Source Control Enhancements

The source control format for meshes has changed slightly in the 2018 release to reduce the number of times 3D models that haven't changed are written out.

C# 7.2 Scripting Support

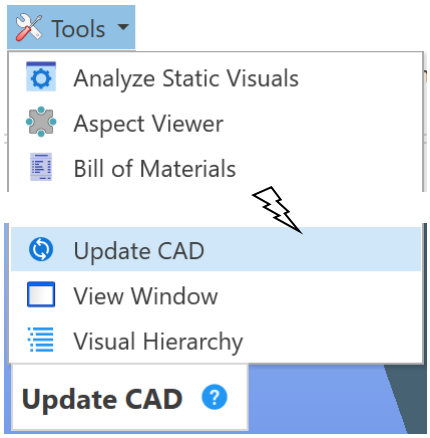
The new C# Roslyn compiler and associated toolchain is now embedded into Demo3D and is used when compiling C# scripts to DLLs internally. The C# language level supported in 2018 is 7.2, where previously it was C# 5.0.

For more detailed information on the extra features available please refer to the Microsoft C# Language Features documentation.

Layout3D

CAD Update Feature

CAD imported in 2018 retains the original path to the CAD files that were used to create that visual tree. This information is used by the new **Update CAD** button which re-imports the original CAD files but preserves any changes that were made that aren't related to the CAD, such as additional child visuals or Visual Aspects that were added. This allows CAD to be upgraded in-place in an existing model.

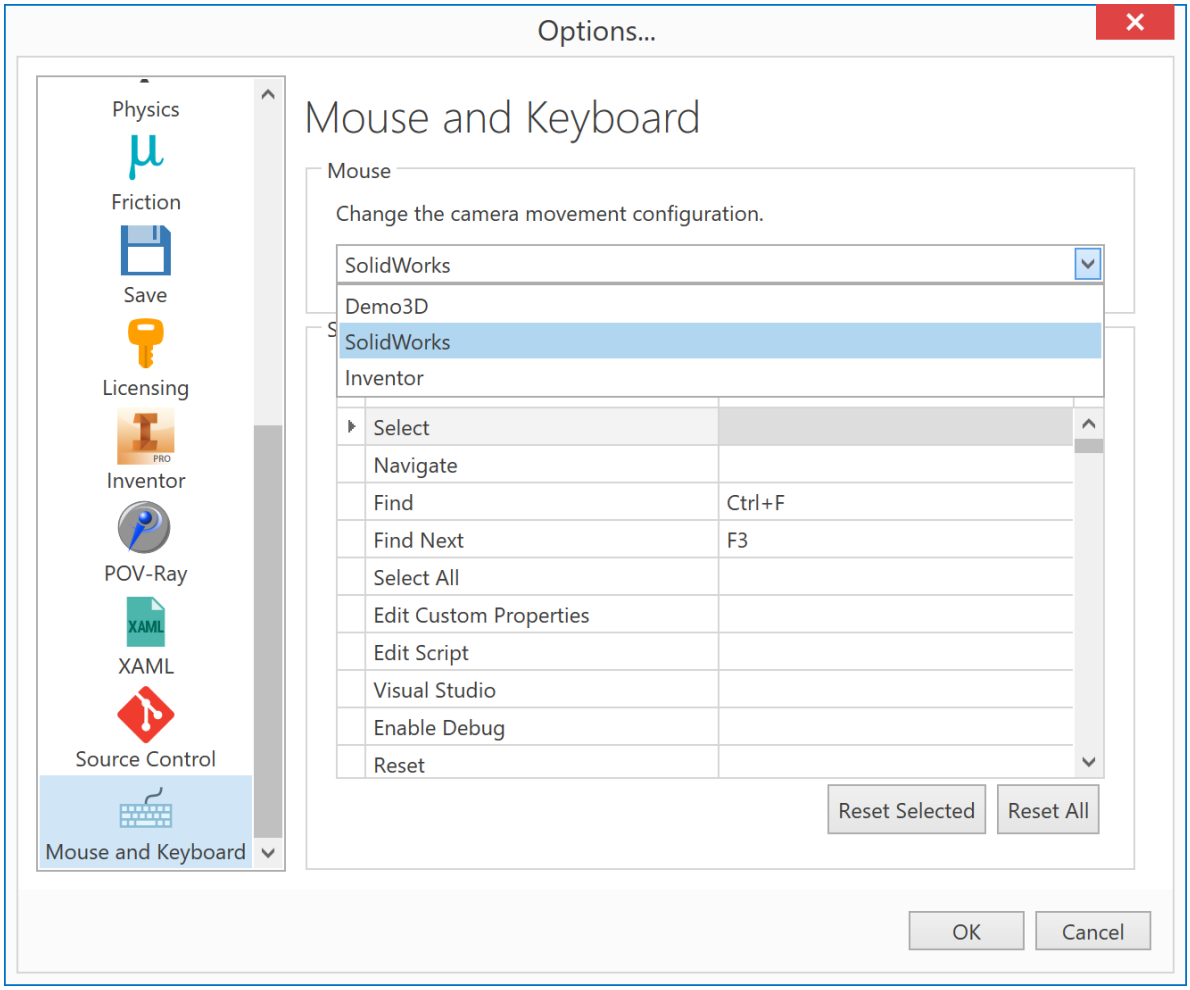


CAD Import Progress Bar

A progress bar now shows when importing CAD files to give an indication of how much more there is to do during the import process.

CAD Mouse/Keyboard modes

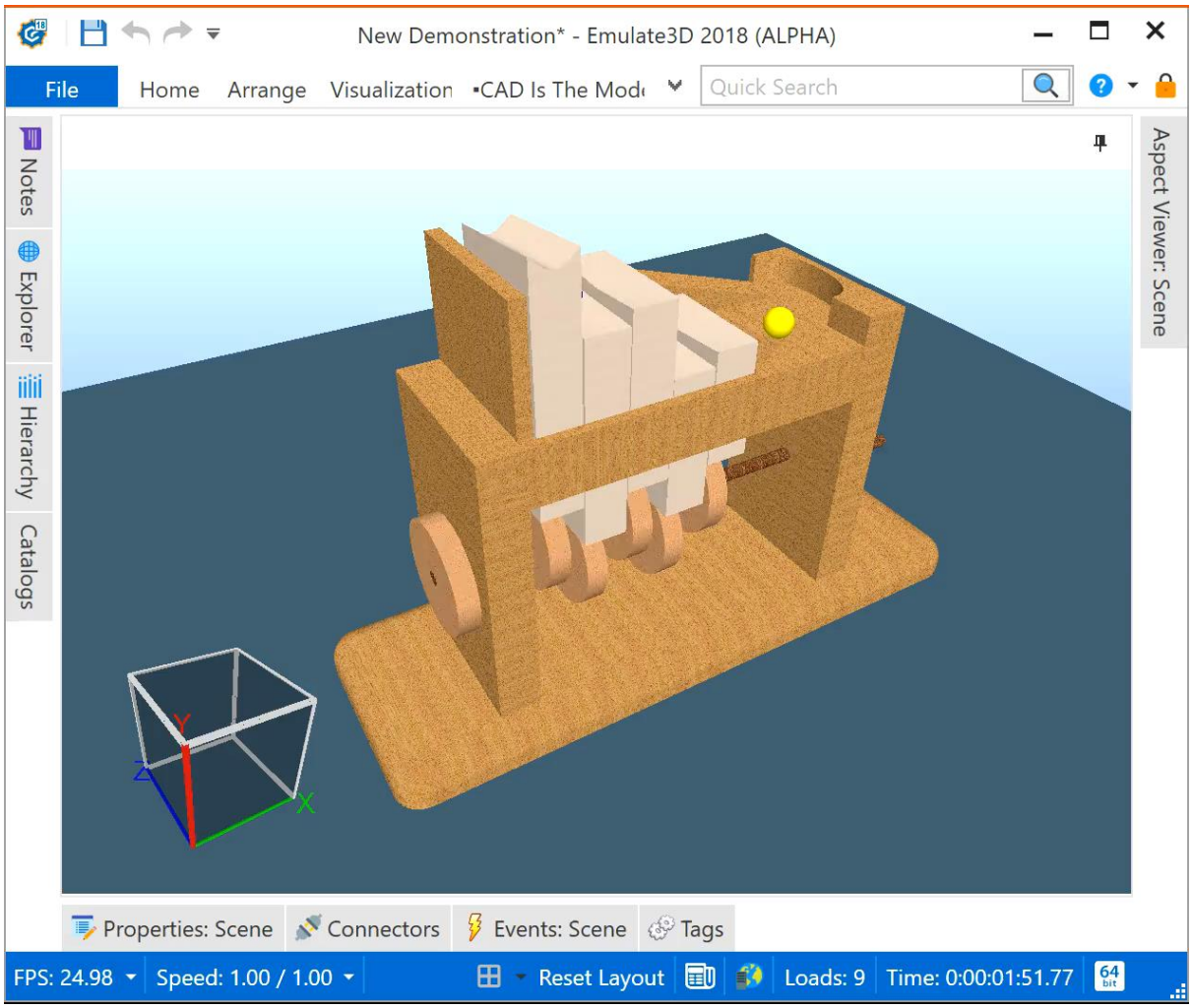
To make it easier for existing CAD users to pick up and use the Demo3D range we've added mouse and keyboard bindings for SOLIDWORKS and Autodesk Inventor.



View Cube

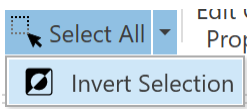
To move the camera to a parallel (or perspective) side, front/back or plan view there is now a new View Cube feature on the bottom left of the main window.

- Clicking on a face of the view cube will align the current camera view to that face.
- Clicking on an edge of the view cube will align the camera halfway between the two faces.
- Clicking on a corner of the view cube will align the camera between the adjacent three faces.
- Double clicking on the view cube switches between parallel and perspective views.
- The view cube can also be rotated by dragging it into a given position.



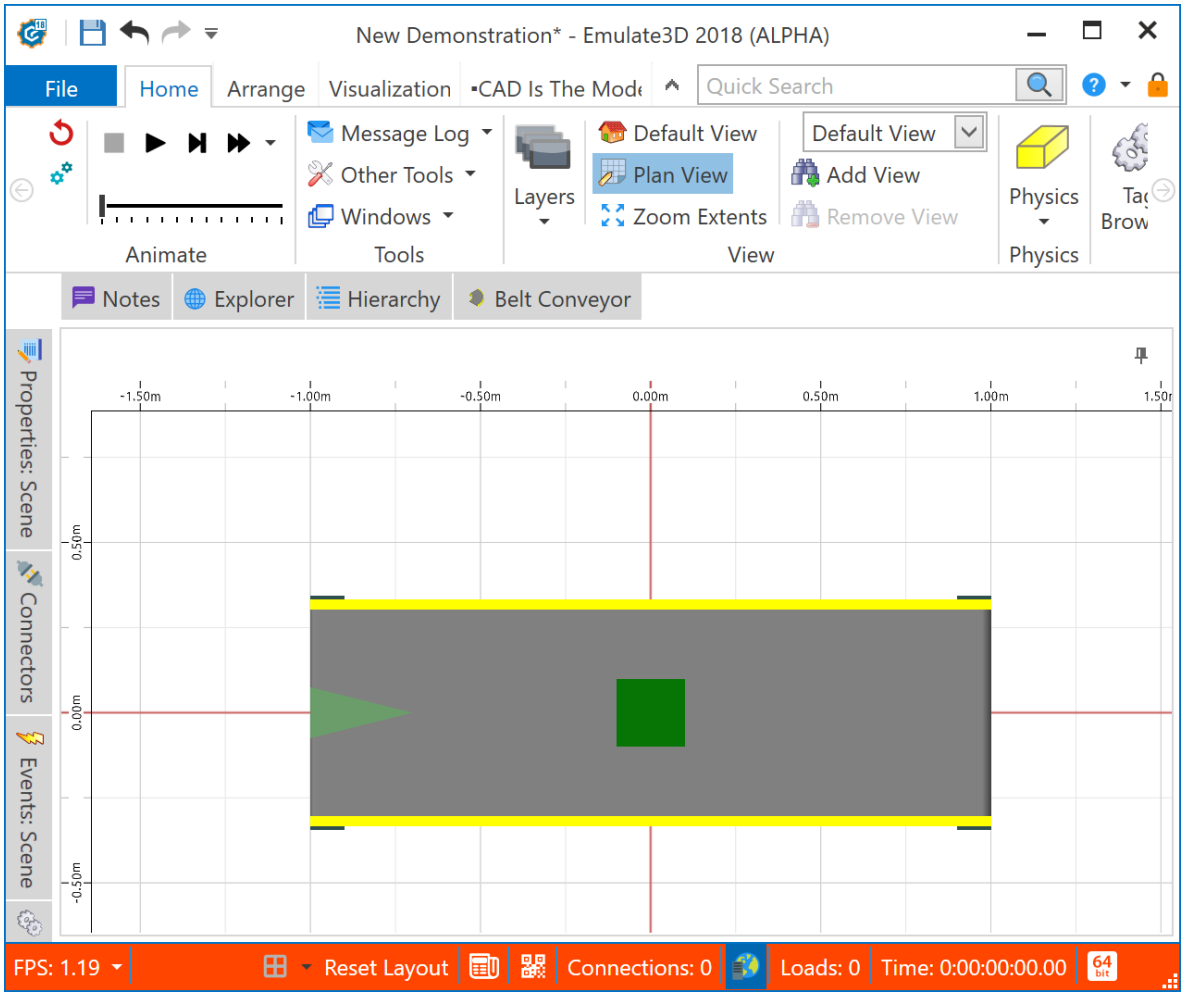
Invert Selection

To be able to extract a Visual or a selection of Visuals from a scene the ability to invert the current selection and select everything that is visible, but not currently selected, has been added.



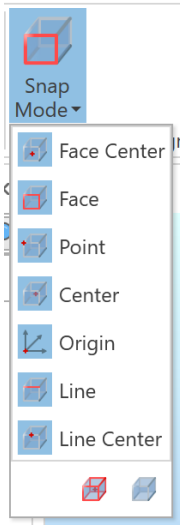
Plan View Rulers

To help with alignment and dimensions while in plan view, rulers now appear on the top and side of the view that show the distance between two points. The rulers' zero point is the scene origin.



Snap Mode

The Align To/Select dropdowns have been replaced with a Snap Mode dropdown. Which features can be selected and aligned to are controlled by the same menu. The feature select mode is always enabled and the Align To is now invoked by holding down the ALT key when clicking on, or dragging to, the target feature to align to. This includes the floor which can now be aligned to from any existing feature.

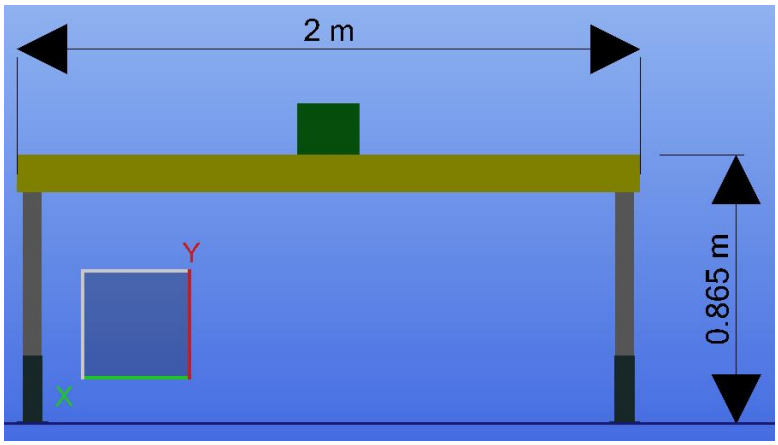


Dimension Tool Enhancements

The dimension tool has been updated to make it easier to use. Dimensions can be placed by:

- Selecting a **single edge** of a Visual
- Selecting **two different points** on the same or different Visuals (including the floor)

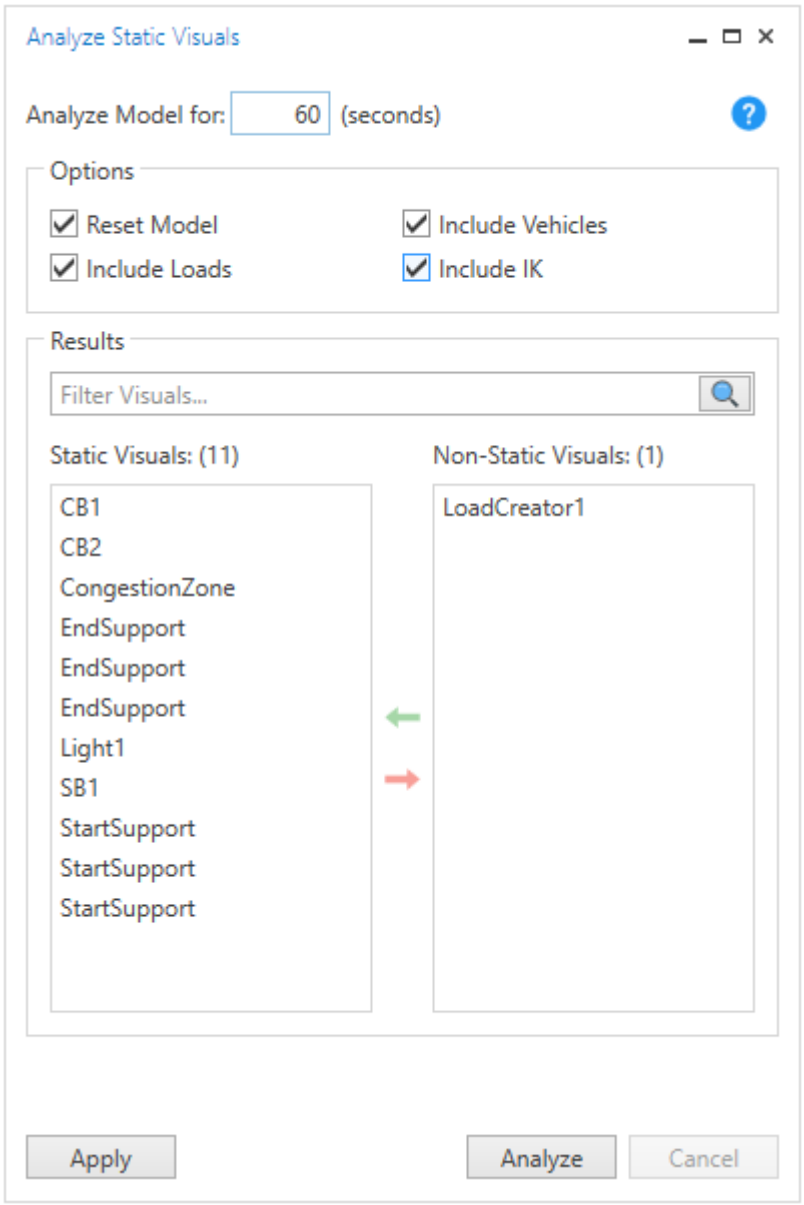
Once the bounds of the dimensions have been selected, the position of the dimension text can be changed by moving the mouse.



Dimensions are also automatically aligned to face towards the nearest axis that the camera is looking along. Dimension text can be flipped by pressing the Alt Key during the positioning of the dimension. The View Cube can be used to align the view precisely to any given axis/plane.

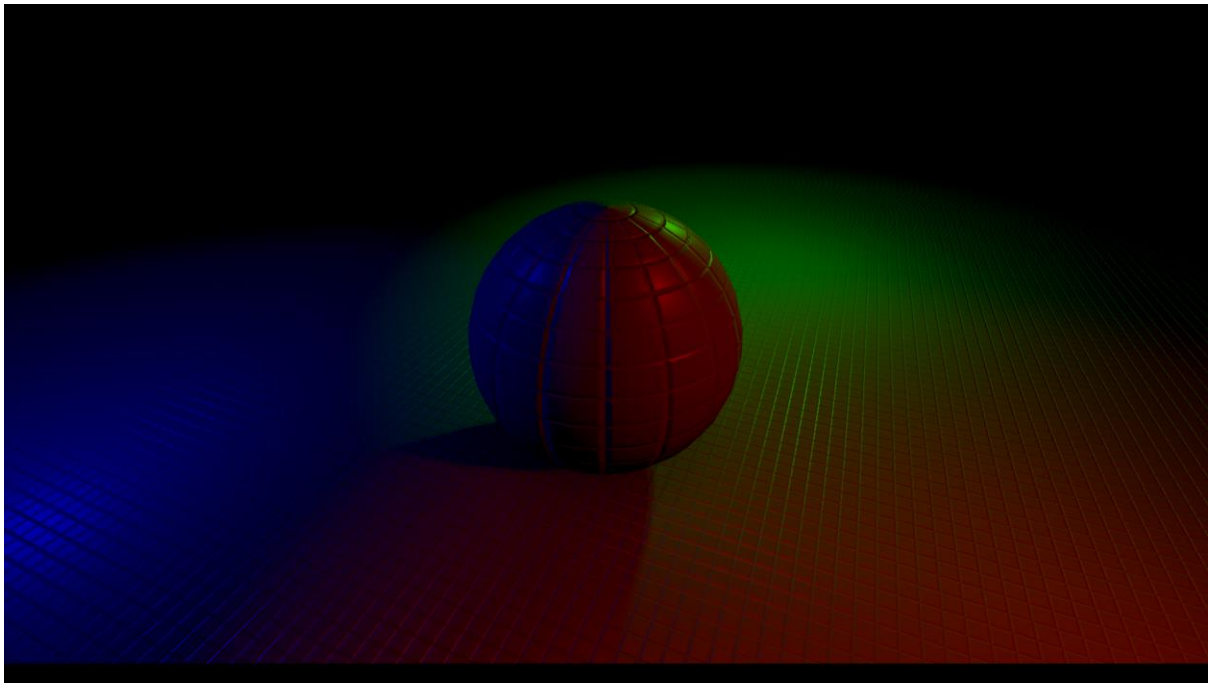
VR Static Analyzer

The Static Analyzer has been added to help users determine which Visual can be made static. This helps in improving performance, especially for VR-orientated models. The tool runs the model for a predetermined amount of time and then displays a report of all the Visuals in the scene that can be made static, or a reason why the Visual cannot be made static, e.g. the Visual moved during the model run. From the report you can choose to make a Visual static or not. On selecting apply, all the Visuals in the 'Static Visual' column will be made static.



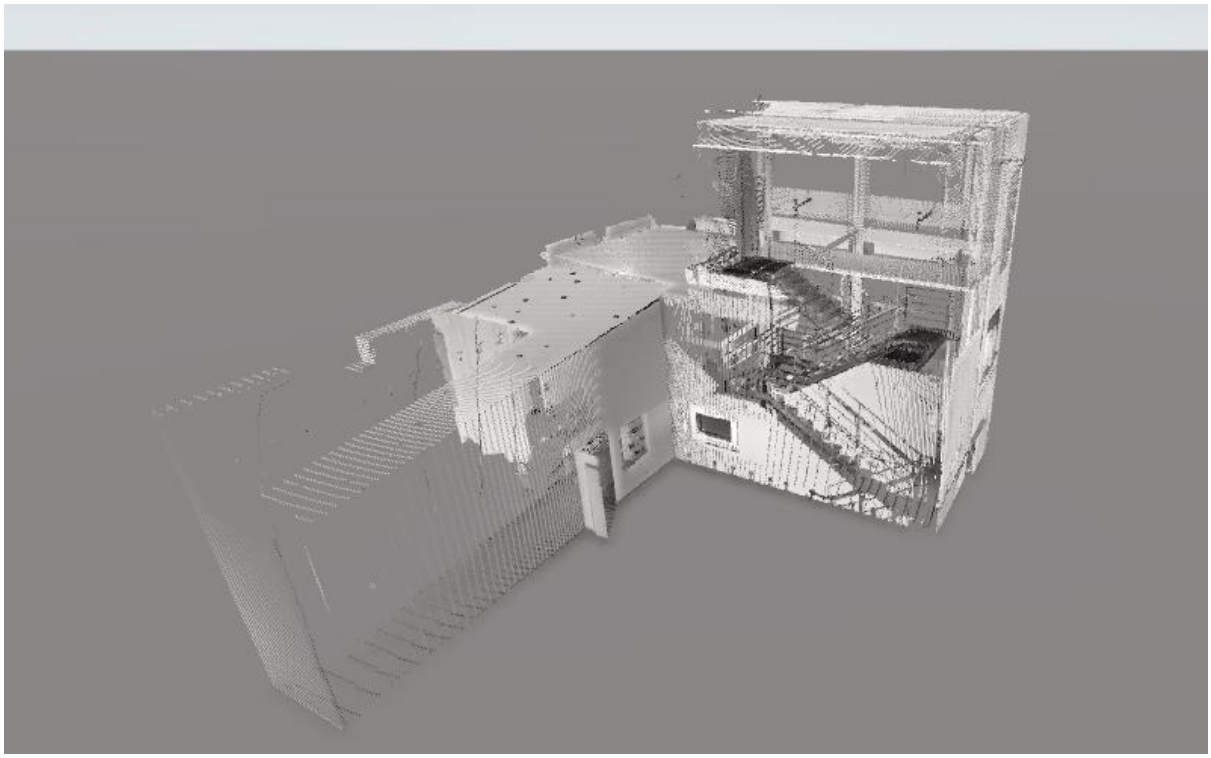
VR Lights

The default lighting in VR can now be overridden to use custom lighting from inside Demo3D. These lights can be configured individually and can be set to cast shadows.



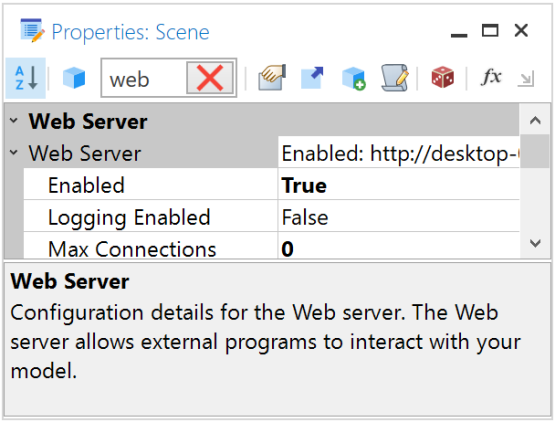
VR Point Clouds

Massively improved performance of Point Clouds in VR.



Web Server Shortcut

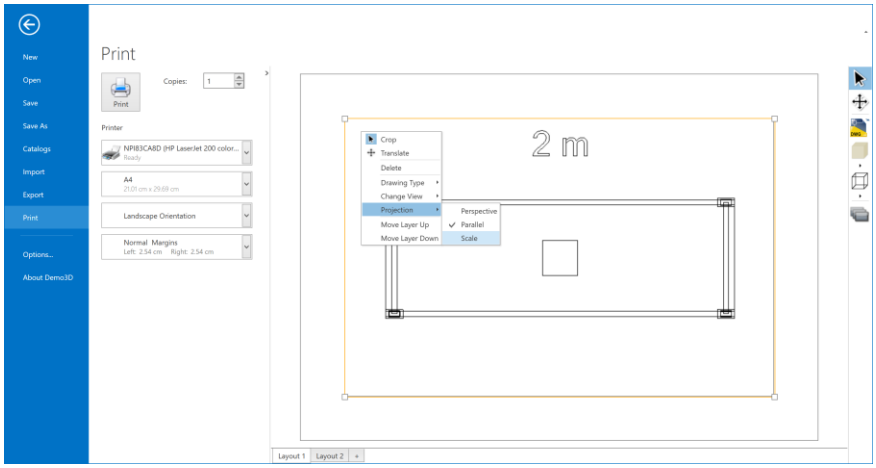
The CAD Is The Model Add-Ins for CAD packages such as SOLIDWORKS use the Web Server feature in Demo3D to connect to an existing Demo3D session and insert or update the CAD in the currently loaded model.

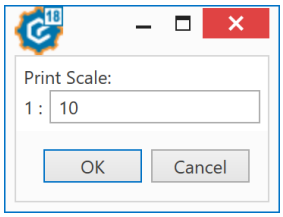


To make it easier to enable the web server we've added a new shortcut button on the bottom status bar of the main window. When the web server is enabled (or connections have been made) the status bar will turn orange as shown here with the Web Server button highlighted in blue:

Print to Scale

A new option for printing to scale is available for in the print/plot view for the scene:

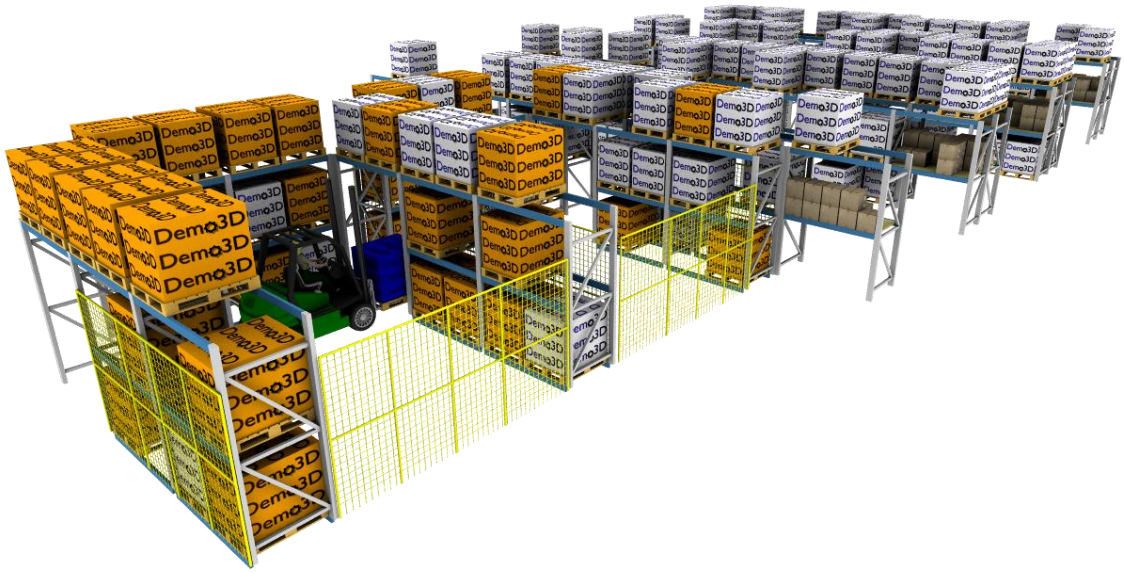




Rack Configurator Catalog

The QuickLogic Rack Configurator can create customized racking layouts using QuickLogic procedures with these key features:

- Define racks with mixed shelf types and tunnels.
- Use QuickLogic procedures to build complex rack arrangements.
- Implement custom addressing, prioritization and zoning.
- Includes an internal SRM and Rack Populator.
- Generate reports for the racking system.
- Use a single Rack Configurator for all racking within the model



Improved rack customization allows:

- Definition of different shelf and rack and types.
- Inclusion of multiple different types of shelves, tunnels and referenced objects (such as custom CAD) within a single rack.
- Definition and customization of aisle arrangements, which contain multiple racks and can be imported from tables.

QuickLogic construction allows:

- Placement of racks, aisles, and referenced objects by using a cursor system.
- Movement of the cursor system to any location in the scene, allowing flexible object placement.
- Assigning custom addressing to bin locations on racks.

Custom addressing and zoning allow:

- Regions of the racking to be defined as a zone by filtering standard or custom addressing.

- Pre-population of separate zones.
- Storage and retrieval in a random or structured order.
- Streamlined storage and retrieval of loads within zones, including options for prioritization, exclusions and zone-specific interactions.

Reporting API allows information to be presented for:

- The floor space and shelf space of the racking system, individual zones, and defined types of rack.
- The capacity, current usage, and available space for the racking system, individual zones, and defined types of rack.
- The number and types of loads stored within the system and individual zones.

Viewers

Windows Mixed Reality Headsets

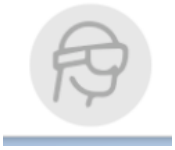
Support has been added for the range of Windows Mixed Reality Headsets, and the associated controllers, made by companies such as Dell, Samsung, ASUS, Acer, and HP:

These Virtual Reality headsets have the benefit of using the spatial tracking software from the HoloLens, meaning there are no external lighthouses or sensors needed (as is the case with the HTC Vive and the Oculus Rift). They are very easy to setup and use and they interface to Demo3D using SteamVR in the same way other VR headsets do.

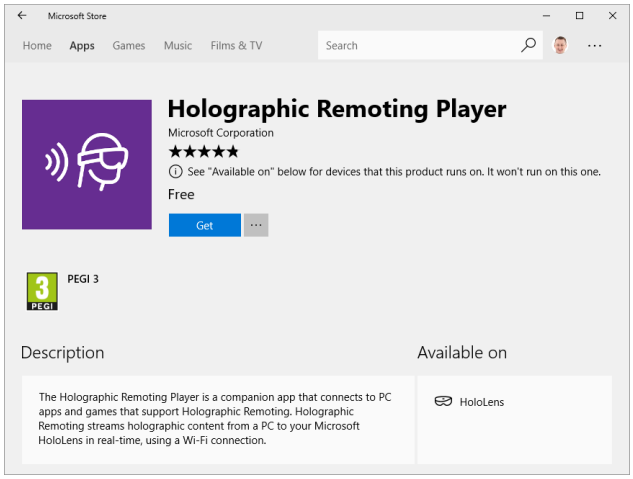
HoloLens Remoting

The Demo3D Windows Store App now has support for Microsoft's Holographic Remoting Player App for the HoloLens. This allows the HoloLens graphics to be rendered on a remote PC and then streamed to the HoloLens via Wi-Fi. The remote PC can use high-end graphics cards to render larger scenes with more detail than the Standalone HoloLens is able to.

Click on this icon in the Demo3D Viewer app from the Windows App Store on your PC:



Install the Holographic Remoting Player app on your HoloLens and then follow the instructions in the Demo3D manual for Holographic Remoting.



General

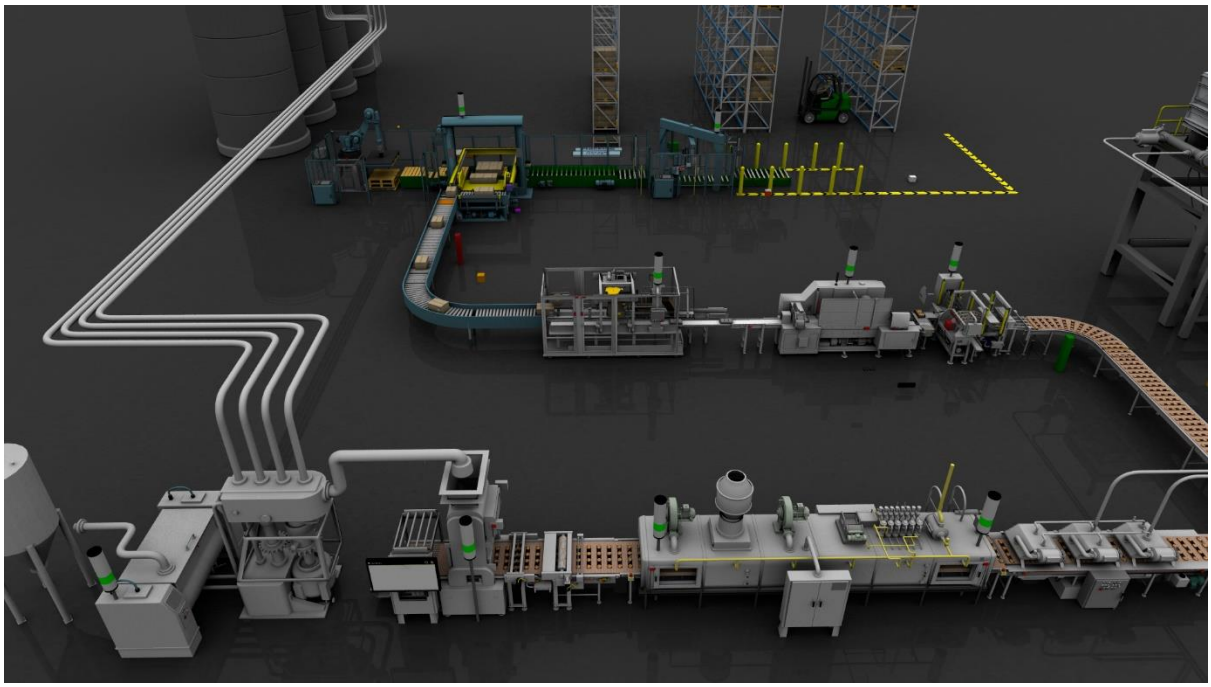
Universal License Server (ULS)

A new Internet-based NLS service is now available. This provides NLS level of service without the need to host an NLS Server machine with a dongle locally. Please contact your local distributor for more information on pricing and availability.

Web Store Updates

The Help system and Web Store have now been combined into a single service with enhanced search capabilities.

Cloud Rendering Updates

Previously our cloud rendering service used a slightly different version of the POV-Ray generation code than the local Demo3D client. This was in part because we were running POV-Ray on Linux on the cloud, whereas it was running on Windows locally.

These differences have now been removed and the cloud version of the renderer uses the same code as the local version. This should make local previews more accurate representations of cloud-based renders of the final image.