

Revit 2016 API News

Notes from the DevDays Online Revit 2016 API News presentation.

Revit Today

First, let's talk about where Revit is today.

Today, Revit can handle gigantic projects.

Cosmopolitan

- Las Vegas, Nevada
- \$3.9 billion
- 7000 m2 casino
- 28000 m2 retail
- 3700 m2 fitness
- 14000 m2 conference
- 1800 seat theatre
- 2995 rooms

Customer Models | Infrastructure LLC

A huge project, Revit puts it all together. What happens when we get into the next level of detail? We can handle all steel detailing, all the nuts and bolts.

Customer Models | Arup

This is The First Direct Arena in Leeds, UK, a multidisciplinary Revit coordinated project using Revit for Architecture, Structure, MEP, and links to Structural Analysis.

Customer Models | BAM Design

So, for an MEP model, how are we doing getting to a fabrication level of detail?

What are we doing to enable building bigger and bigger skyscrapers?

Revit 2016

Keep going as a great product and achieve the goals for expansion into new domains and levels of detail and complexity at the same time.

Scalability | API Changes

This year, we left the traditional split between 'rice' and 'wine' topics. This is the one and only 'rice' slide. All the rest of the topics affecting existing add-in are included in the following discussions the other new functionality. Many of the overviews of new functionality include changes to existing stuff as well. We are focusing on four areas of investment. One of them is scalability. This 'rice'

slide discusses APIs that have been affected by the scalability enhancements:

`CompoundStructure.SetLayers` now unsets the structural material layer index automatically. Code that needs this property to be set after changing layers will need to set it explicitly.

The behavior of `ReferenceIntersector` with the flag `ReferenceIntersector.FindReferencesInRevitLinks` set to true has been improved. Previously, an applied filter was ignored when returning elements encountered in Revit links, and any element encountered would be returned. Now the filter will be evaluated for the elements found in the links, and those elements returned only if they pass the filter. Note that results may not be as expected if the filter applied is geometric (such as a `BoundingBox` filter or `ElementIntersects` filter). This is because the filter will be evaluated for linked elements in the coordinates of the linked model, which may not match the coordinates of the elements as they appear in the host model. Also, `ElementFilters` that accept a `Document` and/or `ElementId` as input during their instantiation will not correctly pass elements that appear in the link, because the filter will not be able to match link elements to the filter's criteria. As before, if a list of target `ElementIds` is set, references in links will be returned only if the `ElementId` matches the id of the intersected `RevitLinkInstance`, and the ids will not be compared with the target list.

`NewFamilyInstance` overloads now throw an exception if family symbol is not active; Test by calling `FamilySymbol.IsActive`, and activate by calling `FamilySymbol.Activate`.

All methods marked deprecated in 2015 have been removed.

Revit 2016 | Areas of Investment

The main areas of key investment are scalability, collaboration, modelling and efficiency.

The heart of being smarter is about how to process data, only getting what we need.

Collaboration involves working with bigger models, bigger teams and requires heavy investments for large projects.

Both bigger models, and much more detailed design, which is also reflected in some API class and Revit element enhancements.

Last but not least: efficiency improvements.

Scalability

Regarding the scalability improvements, there are no new APIs associated. We invested a lot of development time and effort, and users in all areas should see noticeable performance enhancements.

Traffic Jam Example

"If you increase the number of highways in a city by one percent, it causes driving to also increase by one percent."

"As you add roads to a city those roads get filled up. There are people waiting to use that capacity."

The Fundamental Law of Road Congestion, Matthew Turner, University of Toronto

The world's largest traffic jam in history happened last year in China. It stretched more than 100 km (62 miles) from August 14 to 26, including at least 11 days of total gridlock.

Scalability is not a performance issue; it is a question of infrastructure. We need to process more data, on models that are getting bigger.

We are working on decoupling size from performance.

Scalability | Customer Experience Goals

- Model splitting only for business purposes
- Multiple disciplines in single models
- Unified MEP Systems
- Complex as-built buildings represented
- Easily derived documentation

We want to achieve total discipline consolidation, handling multiple disciplines together effectively in the same projects. There should never be a need to split projects up only for performance reasons.

Scalability | Projects

- Progressive Display
- Symbol Sharing – MEP System Families
- Symbol Sharing – Reinforcement
- Graphics Instancing
- Parallel Computation of colour fills
- Linked Model Performance
- Camera-based GRep Generation

Here are some projects supporting this that we are working on: GPU usage optimisation, process less data, parallel computation.

There is no one single solution, and we are going to have to keep on investing in this.

The main idea here is that the user can always continue working unimpeded. Revit has to keep up in the background.

Scalability | Linked Models

Here is an example video showing Revit 2015 versus 2016 driven by two journal files running side by side

demonstrating some of the enhancements in graphics, parallel processing and updating.

Scalability | Parallel Derived Data Update

- Objective: Return control to the user during derivative data update.
- Concept: Opportunistically update derived data with secondary CPU.
- Benefits: Interact with models before all calculations are complete.
- Framework for future asynchronous services.

Parallel derived data update is a new system framework for moving the processing of secondary data into a background process while the user can continue working in the foreground. Thus the user is not blocked. This system is currently only applied to colour fills. However, it is designed as a generic framework for use in many future areas.

Scalability | Progressive Display

- Objective: Allow model interaction during View update.
- Concept: Adopt Navisworks-like update of geometry and allow user interruptions during navigation
- Benefits: Fewer pauses during model navigation

On the progressive display: Revit updates the view progressively, and the user can interrupt the drawing while it is still updating.

Here is a video showing the side-by-side performance of Revit and Navisworks. NW is considered the performance standard among Autodesk products, handling large consolidated AEC models. As you see, the two systems show comparable performance. In some areas, Revit is faster, in others, NW. Revit now starts drawing some elements and enables user interaction with the model right away, before completing.

Collaboration

The next area is enhanced collaboration for Revit. You all heard of product Skyscraper?

Collaboration for Revit

Team:

- Single location
- Firewalled
- ✓ File Worksharing

Enterprise:

- Multiple locations
- Firewalled
- ✓ Revit Server and Vault

Project:

- Multiple companies
- Multiple locations

- Managed access
- ✓ A360 Services

Here is a brief overview of different levels of collaboration, paralleling its history in the Revit context.

We started with file-based worksharing based on one team in one office.

Revit server enabled concurrent work in multiple locations, still behind a firewall.

We are now moving to open project based collaboration involving multiple companies, multiple locations, based on a360, cloud based.

- Multi-firm collaboration within Revit
- Unified experience with Revit worksharing and Revit Server
- Access to associated model services
- Integration with A360 Professional
- No special APIs at this time

This enables full multi-firm and multi-discipline collaboration including unified worksharing, Revit server, and access to model services, A360.

From Revit's point of view, there is currently no dedicated API for this, but we are interested in hearing from you if you need anything specific.

How does this work? Here is a video showing how you can collaborate, upload a model and add collaborators. This ensures that everybody is informed and can add comments at any time. Suddenly, Revit is like an operating system, and there is no longer any need to switch to any other tools to collaborate.

Modelling

Next area: modelling.

Modelling | Direct Shape API

Referencing:

- DirectShape elements now support element references
- New property DirectShapeOptions.ReferencingOption defaults to true

RoomBouding:

- DirectShape elements can participate in room boundary calculation
- New property DirectShapeOptions.RoomBoudingOption defaults to false

Curves & Points:

- New class WireframeBuilder creates geometry from curves & points
- Curves and points are now valid inputs to SetShape and AppendShape methods

We added the DirectShape functionality in Revit 2015 to better support integration with IFC.

There is no end user UI for this.

It is much faster than creating background families on the fly and inserting instances of them in the project.

If you know exactly what geometry you need to create, use this instead of families.

You can now reference DirectShape elements, tag, host, dimension and use them for room boundaries; turn off references if not needed.

Besides faceted solids, you can now also create geometry based on curves and points or add them directly.

Referencing including dimensions, alignments, face hosting, and snapping.

Modelling | Geometry API

SolidUtils:

- Clone() | CreateTransformed() – create new Solid

CurveLoop:

- Transform() – transform original curve loop
- CreateViaTransform() – create new curve loop

BooleanOperationsUtils:

- CutWithHalfSpace() – create new Solid cut by input Plane
- CutWithHalfSpaceModifyingOriginalSolid() – cut Solid

Curve:

- SetGraphicsStyleId() – set graphics style id for the curve

GeometryCreationUtilities:

- CreateLoftGeometry() – create a solid or open shell geometry by lofting between curve loops

More geometry API enhancements: create new solids, curve loops, cut solid with plane, graphics style for curve, and loft between curve loops.

Modelling | IFC Improvements

Use linked IFC models as a reference for dimensions, alignment, snapping, and hosting of face-based families.

Linked IFC files are based on direct shapes, so they inherit all the new DirectShape functionality; here is the blurb on this from the user documentation:

IFC references and phases

When you link in an IFC model you can reference it for dimensions, alignment, snapping, and hosting of some face-based families in the Revit model. Also, when you link an IFC file, its elements are assigned to a default phase. For example, another team designed the architectural model, and you link its IFC file so that you can design the interior. You will not be able to make changes to the IFC model in Revit, but linking the IFC file allows you to see the model so you can continue your

design work in Revit. If you later change or update the original IFC file, the Revit model reflects the changes when you re-open it or reload the IFC file. The linked IFC files are read-only in a Revit model, but you can dimension to references of IFC elements. (These references apply to the faces of linked IFC geometry and not to centre lines, reference planes, or other non-geometry elements.) Snap to IFC-based elements, align Revit elements to IFC-based elements, and host some face-based families, such as conduit and some electrical devices. If the IFC file changes and you reload it into the Revit model, verify previously established references. Some changes to IFC geometry may make it difficult to maintain references in the Revit model.

Direct Shape + Geometry API Demo

Here is a DirectShape and solid geometry API demo. Open the 'Project to build loft element.rvt' and run the macro: AddRoadLoftWithSections. This demonstrates multiple new API steps: create a loft geometry including lines and faces, create a single DirectShape element representing a road from that, assign it to the Roads category and define two subcategories for stations and loft curves for it.

Modelling | Dynamo

Another hot modelling topic is Dynamo. It enables you or anyone else who want to create intelligent, complex designs without diving into the nitty-gritty coding details to exercise the full Revit API power without programming. It makes it easy to implement lots of support for smarter decisions about building design. Dynamo also includes the Autodesk DesignScript geometric programming and constraint management functionality. Every node in Dynamo has to be coded, e.g. in Python, providing lots of opportunity for developers and customizers. This was *the* hot Revit API topic at Autodesk University 2014. Dynamo is completely open source, and there is lots of public information available about it. If you have not taken a look at it yet, you absolutely must check it out!

Modelling | Custom Exporter

IExportContext is now a base class for two derived interfaces:

- IPhotoRenderContext processes elements visible in the Revit render command and is equivalent to the 2015 IExportContext.
- IModelExportContext processes elements visible in Revit 3D views and thus adds support for curves, polylines, points, and text.

The custom exporter was introduced last year. It enables you to pull out Revit geometry based on the faces generated by rendering a given view. Last year, it provided only one top-level export context for faceted faces. Now we added two derived classes: photo render context and model export context. The latter now gives

access to 0D and 1D elements like points, curves and text, as well as faces.

Modelling | MEP Fabrication Detailing

New user and API functionality supporting part-by-part placement of segments, fittings, and hangers.

Enable higher Level of Development (LOD):

- Detailed connectors
- Specification driven lengths
- Automatic couplings
- Grouped libraries
- Validation of size, shape, direction, orientation, connectivity

Includes part library and content with realistic behaviour, detail, and data to aid coordination modelling.

The MEP fabrication detailing provides a user interface for part-by-part placement of segments, hangers, and fittings. Look at a video attached. It includes a part browser, select parts, assemble piece by piece, full detailed design fabrication model. Revit correctly connects pieces. You can rotate them interactively as you go along. Just like everything added to Revit nowadays, this comes with full API support: every change to a product feature includes API support as well. You define a service, specify buttons, how it behaves, part type and part alignment.

Here is a video demonstrating the MEP fabrication detailing UI.

Modelling | MEP Fabrication Detailing API

New classes:

- FabricationService services available to create fabrication parts
- FabricationServiceButton defines service behaviour for given conditions
- FabricationPartType defines part types for given service buttons and conditions
- FabricationPart represents a fabrication component

New method:

- FabricationUtils.AlignPartByConnectors() – moves and aligns a FabricationPart

Fabrication Hanger Demo

Here is a fabrication API demo add-in that creates HVAC ducts with hangers. Note that all the hangers were automatically created and connected.

Modelling | Structural Section Properties

- New properties for detailing
- New Shape Types: Cold-formed Steel and Concrete
- Improved integration of Simulation, Code checking and Detailing products within BIM workflows

Structural sectional properties help define what structural sections are and their associated properties, integrated with code checking.

You can now assign parameters representing expected characteristics to structural framing and structural column families. This can present unreliable information to external analysis and code checking applications. By applying a section shape category to structural framing families, you can improve data integrity within BIM workflows and guarantee consistent parameters.

Bottom Line: This new functionality improves integration between Revit and Simulation products.

Modelling | Structural Connections

Careful: This may not be shipping in Revit 2016!

The new class StructuralConnectionHandler contains information about connected structural elements:

- Create() – Create new connection between given elements
- AddElementIds() – Add elements to connection handler
- RemoveElementIds() – Remove elements from connection handler
- GetConnectedElementIds() – Return connected elements
- GetOrigin() – Retrieve origin point of connection handler
- ConnectionName – Retrieves or changes the name

Modelling | Structural Analytical Model

Analytical model enhancements include LCS and definition of forces on stick elements.

Local Coordinate System (LCS):

- New method on AnalyticalModelStick + AnalyticalModelSurface
- GetLocalCoordinateSystem() – LCS at a specified point

New class MemberForces defines internal forces:

- New methods on AnalyticalModelStick elements to get, set, add, and remove member forces
- MemberForces.Position – position of force on element
- MemberForces.Force – translational force
- MemberForces.Moment – rotational force

Modelling | Structural Loads

The Load and LoadCombination classes have been significantly renovated:

- LoadBase – new base class for PointLoad, LineLoad and AreaLoad
- LoadBase subclasses have significant changes
- LoadCombination, LoadCase, LoadNature and LoadUsage also have significant changes

We have a significant revamp of loads. A new base class and many new and deprecated members were introduced, more changes than we can address here. More info is available in the documentation.

Modelling | Structural Path Reinforcement

The PathReinforcement class is equipped with new methods and properties:

- Create()
- GetOrCreateDefaultRebarShape() – return RebarShape that fulfils bending requirements
- SetDefaultRebarShape() – set RebarShape for primary and alternating bars
- PrimaryBarShapeId – RebarShape of primary bars
- AlternatingBarShapeId – RebarShape of alternating bars

The path reinforcement has also undergone a revamp, making it easier to create and define bar shapes inside it.

Modelling | Bent Fabric Sheets

Bent fabric sheets is an API only capability. A fabric sheet can be bent while creating it, but not afterwards. This should work with all structural elements, for both Cast in Place and Precast.

Specify a bend profile on a FabricSheet at creation:

- FabricSheet.Create(..., CurveLoop BendProfile)
- FabricSheet.SetBendProfile()

New enums: BentFabricBendDirection and BentFabricWiresOrientation.

This works with all structural elements.

You cannot convert between flat & bent sheets after creation.

Bent Fabric Sheet Demo

The bent fabric API demo is implemented in the createBFS.rvt model, defining a structural floor and creating a bent fabric sheet in it using the AddRoadLoftWithSections macro.

Efficiency

Efficiency | Productivity Enhancements in 2015 R2

Efficiency: everything in 2015 R2 is in Revit 2016 as well, so Revit 2015 and Revit 2015 R2 are reunited again into a common stream. R2 was a subscription only release, file format compatible. The new and enhanced features in Revit 2015 R2 include improvements to rendering, enhancements to documentation and schedules, performance improvements, etc. Here is a list of improvements:

Platform & Architectural enhancements:

- Batch wall join editing
- Schedules

- Shaft openings
- Perspective views Editing tools
- Reference other view
- View updates
- Select host for tags
- Annotate stair treads and risers

For Structural engineers:

- Rebar placement
- Reverse the orientation of structural framing elements
- Snapping to model lines
- Setback reference enhancements
- User interface for structural elements

For MEP engineers:

- Panel list search enhancement
- Most recently used panel list
- Circuit default to last used
- Move circuits in panel schedule enhancement
- Pressure loss table visibility

Efficiency | Workset API

The workset API was indeed a very long time coming. Until now, it was still read-only. Now we can also create a workset, rename and activate. Finally, Revit provides a fully capable workset API. Nice to have a feature that is fully completed .

Workset Creation:

- The new static method: `Workset.Create()`

Workset Modification:

- New method: `WorksetTable.RenameWorkset()`
- New method: `WorksetTable.SetActiveWorksetId()`

Efficiency | Reveal Constraints

The API defines a new enumeration value `TemporaryViewMode::RevealConstraints`

We added a new enumeration value in the view modes to reveal constraints. This enables you to view all constraints, to better understand how and why things are behaving the way they are.

Efficiency | Schedule API

The schedule API was expanded to control the title and header display. New Properties:

- `ScheduleDefinition.ShowTitle` indicates if a schedule displays title.
- `ScheduleDefinition.ShowHeaders` indicates if a schedule displays headers.

Efficiency | Datum Plane API

The datum plane was added as a new base class for level, grid and reference planes and now enables you to do everything you need, with full exposure of all level, grid and reference plane properties.

The new class `DatumPlane` is a base class for datum surfaces, i.e., Level, Grid and ReferencePlane. Now you can:

- Show and hide Level and Grid Heads
- Check view visibility
- Set 3D extents
- Maximize extents
- Set 2D extents
- Propagate 2D extents to other views
- Get and Set Leader information

Efficiency | Text Note API

The TextNote API has been revamped and expanded to provide full coverage. Some associated old methods were deprecated, obviously. Most of this functionality represents a change of existing possibilities rather than additions.

Efficiency | Dimension & Leader API

The dimension and leader API enhances documentation and exposes the ability to move the dimension text, adjust orientation and set leaders.

Dimension | DimensionSegment new properties:

- `Origin` (Dimension only) – return dimension origin
- `LeaderEndPosition` – position of leader end point
- `TextPosition` – position of the drag point
- `ResetTextPosition()` – reset to initial position

Leader new properties:

- `Anchor` – leader anchor point
- `LeaderShape` – geometric style of the leader

Dimension & Leader API Demo

The dimension and leader API demo shows two things: fully automate moving the dimension text, and use a manually picked point to define its location interactively. The two are defined as external commands by the `DimensionLeaderEnd` sample add-in. You can run it in the `DimensionLeadert.rvt` model.

Efficiency | PDF Export Enhancements

Here are a couple of useful end user PDF export enhancements with no associated API: hyperlinked table of contents, views and sheets. This works both when exporting individual sheets in the same folder or to a single file.

- Linked Table of Contents
- Link views and sheets
- Hyperlinks

Efficiency | Coincident Lines to CAD

Handling of coincident lines when exporting to CAD has been improved and made more flexible. Until now, the Revit export to CAD would eliminate all coincident lines. For instance, a desk touching a wall with aligned edges would drop some lines in the exported file. We now

enable keeping the duplicated lines. This can be important for derived work in the target CAD system or DWG. This is important unless it is use as a read-only, view-only visual reference.

BaseExportOptions defines a new property: PreserveCoincidentLines preserves coincident lines during export to DWG, DXF or DGN

Efficiency | Energy Analysis

Energy analysis is a very significant area of investment. This is much more than just seeing the model. It is critical to integrate well with energy analysis tools and provide simple visual real-time feedback to non-experts to enable significantly enhanced designs. The energy plus engine is now available for free in the cloud and runs ten times faster than on the desktop. Please talk with us if you are interested. You can see and create views and schedules of the Energy Analytical Model (EAM) elements directly in Revit. This enables accurate, consistent EAM creation from concept through to detailed design.

- Show the energy analytical model
- Use conceptual massing and building elements together
- Real time, interactive feedback
- Energy Plus engine in the cloud

Energy Range & Factors – Real time, interactive cause and effect feedback showing sensitivity and accuracy.

EnergyPlus running in the cloud – runs 10x faster than on the desktop and it's free. API access to most of the technology.

Building Information Modelling – BIM 2.0

Let's look at where BIM was yesterday and where we think it will go tomorrow.

We want to do all we can to make better buildings.

We want to enable smarter decisions and build better buildings.

Work on model behaviour rather than physical elements.

Avoid guessing and discovering mistakes later.

Put all information right into the model.

Expand to the fabrication level.

Expand what BIM means.

This leads towards the next generation of BIM – BIM 2.0.

- application – desktop
- locally collaborative – design level of detail
- limited building information – capturing design intent

- physical modelling – platform
- client – socially shared
- construction and fabrication ready – integrated simulation
- exploring design alternatives – behavioural modelling

Q+A

q: will Revit collaboration have all the functionality of Revit?

a: yes

q: will there be a requirement to own a Revit seat, or can you just get the collaboration license?

a: the collaboration service is built on top of Revit, so yes.

q: is modeless robustness improved?

a: no, a couple of small fixes, small internal change to enforce calls into main thread, more exception when violating that requirement.

q: scheduling API changes will be visible in parts list?

a: no changes, I think.

q: with dimension API enhancement, will be able to get into sub-elements for multi-segment dimensions?

a: yes.

q: trying to upload models for 3d printing, but solids had problems. Can I now export a Revit model as solids? e.g. OBJ?

a: yes, sure, Revit always worked with solids.

q: is it possible to do Booleans on the Revit model, use a plane to split the model, create two separate pieces?

a: Yes. The plane splits and removes one half. It gives you the half left over.

q: create radial dimension in families not projects?

a: that should be possible.

q: create ceilings? We can create floors but not ceilings.

a: we're working on it.

q: multi-thread processing is now closed off?

a: Revit was never legally multi-threaded, it causes instability, and we see crashes happening, so we had to close that off. We are thinking about how to open this up. The new multi-service framework is a step forward. We have to protect our users. The user experience of crashing is much worse than slower performance.