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AEC Generative Design and Dynamo

Product Briefing

Lilli Smith and Sol Amour
AEC Computational Design and Automation

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@solamour
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Learning Objectives

AEC Generative Design and Dynamo

1. Discover the value of Dynamo, Dynamo Player, and Generative Design in Revit.
2. Discover three examples of how customers are using these tools.
3. Learn about the driving principles for future prioritization.
4. Discover the future direction of the product and road map.

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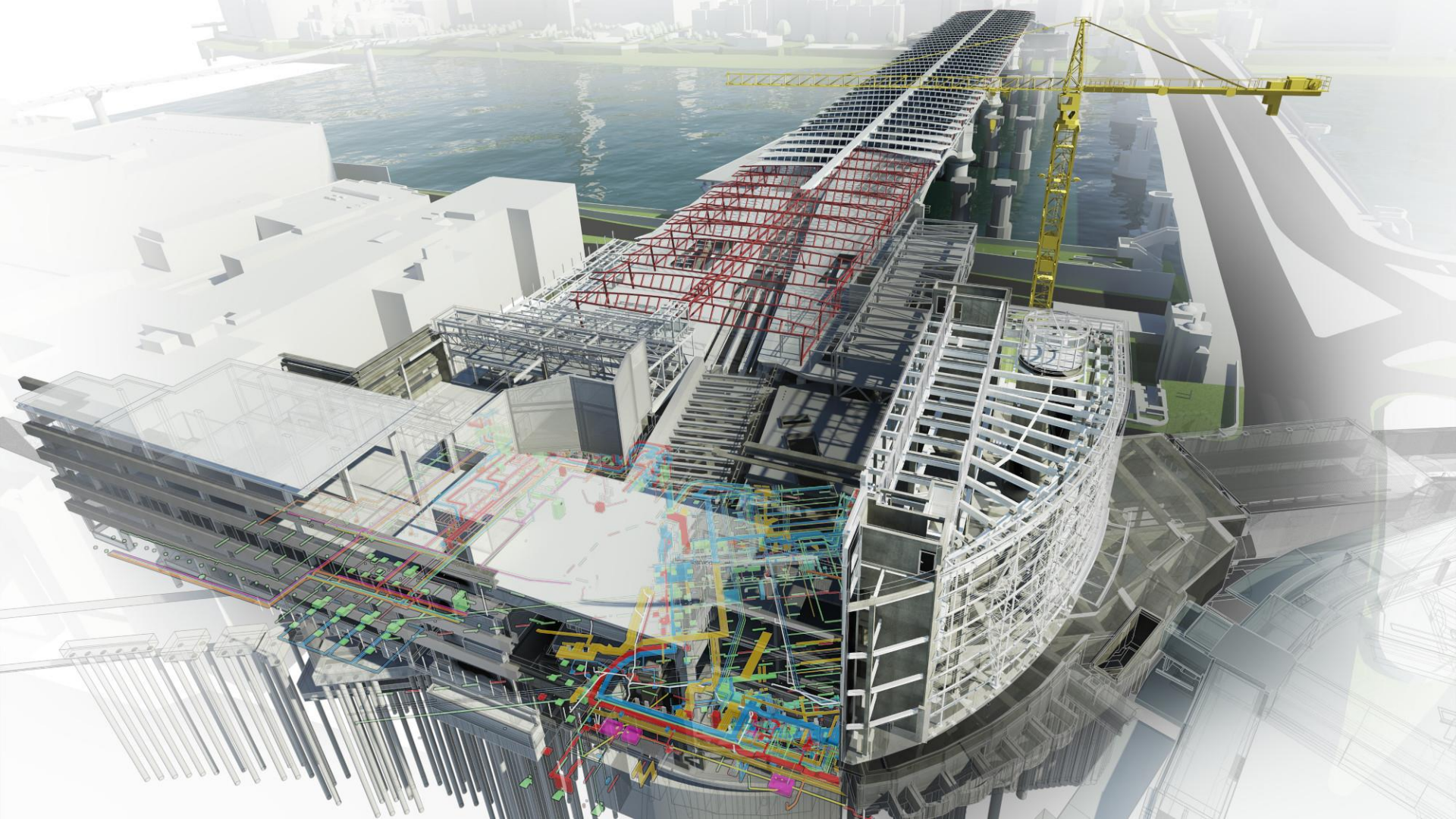
Why?

Computational and Generative Design

THE FUTURE IS A DESIGN CHALLENGE

Solving tomorrow's challenges with automation and generative design

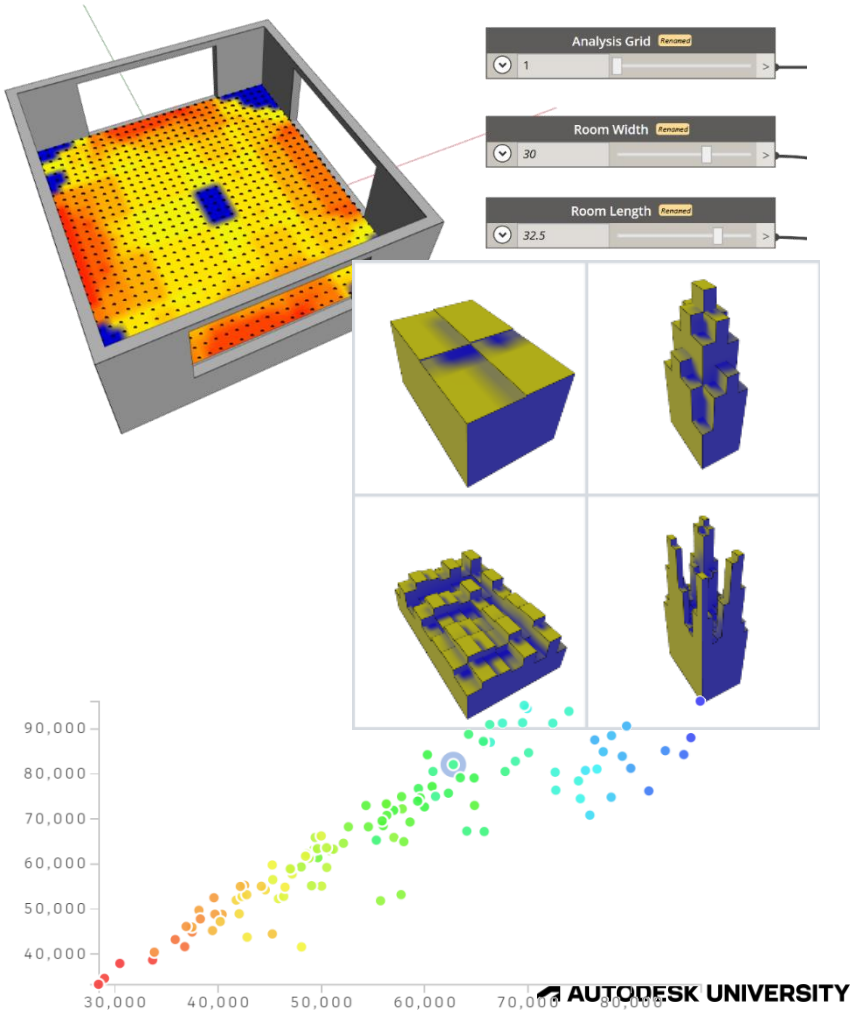

BEDROOM
12.4 mp/14.45m
parchet+zugraveli
HALL
1.9 mp/5.6m
parchet+zugraveli
LIVING ROOM + DINING
39.5 mp/59.58m
parchet+zugraveli
KITCHEN
8.9 mp/12.5m
gresie + faianta
HALL
2.6 mp
parchet
zugraveli
STAIR WELL
16.7 mp
GR SANIT.
2.4 mp/6.6m
gresie + faianta
BATH ROOM
5.8 mp/10.1m
gresie + faianta
KITCHEN
9.5 mp/12.3m
gresie + faianta
+15.10
+11.70
+8.30

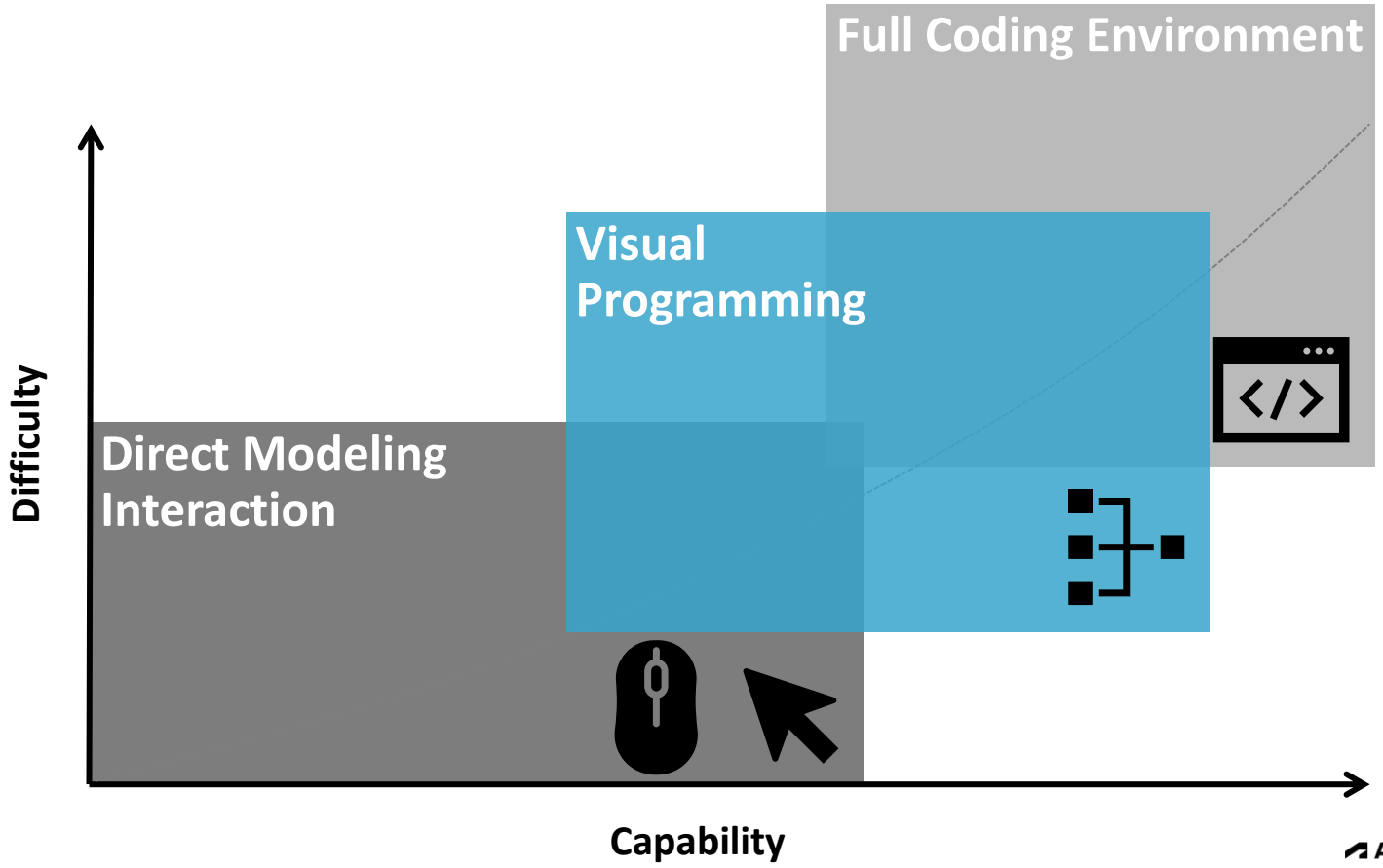



HANSENYUNCKEN
HANSENYUNCKEN

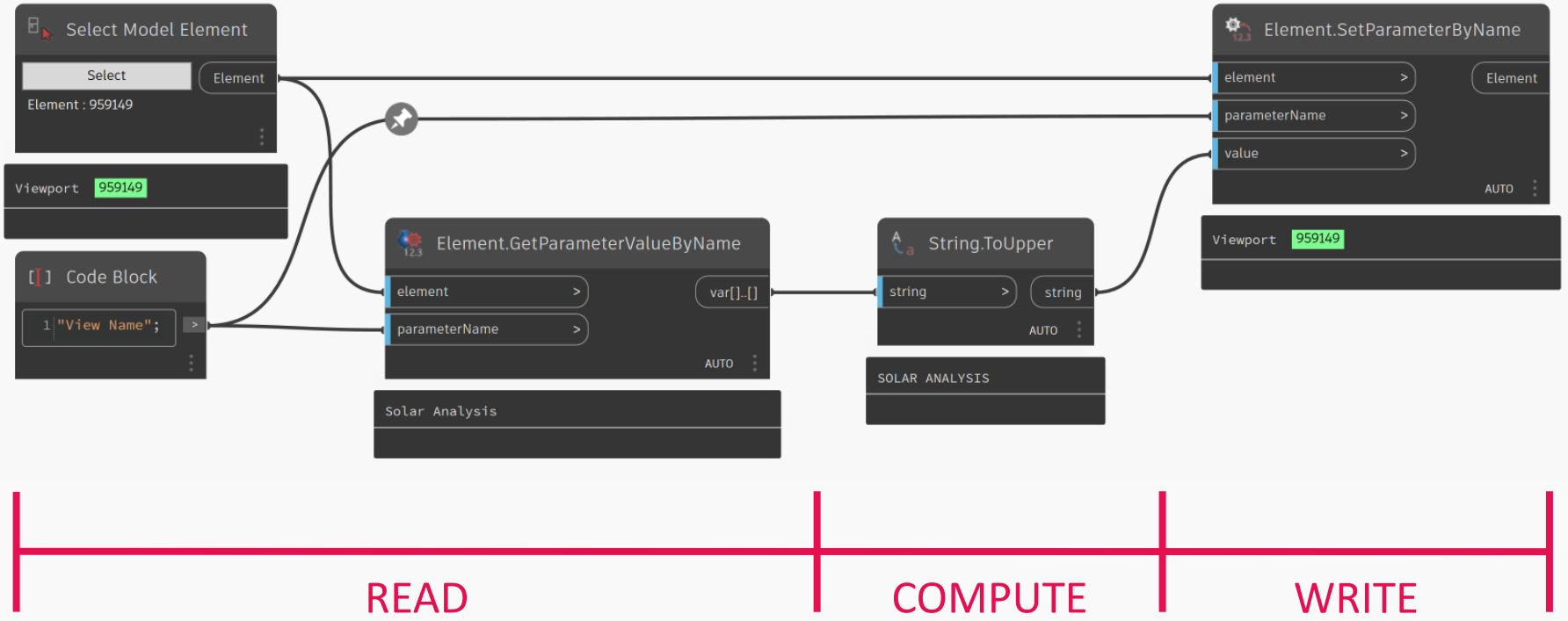
Computational Design and Automation

Provide simple, coherent, and capable tools for encoding AEC goals and constraints to assist design and analysis with automation




Full Coding Environment
Visual
Programming
Direct Modeling
Interaction
Difficulty
Capability

Dynamo Visual Scripting



Where can I find Dynamo?

Dynamo Sandbox

Revit

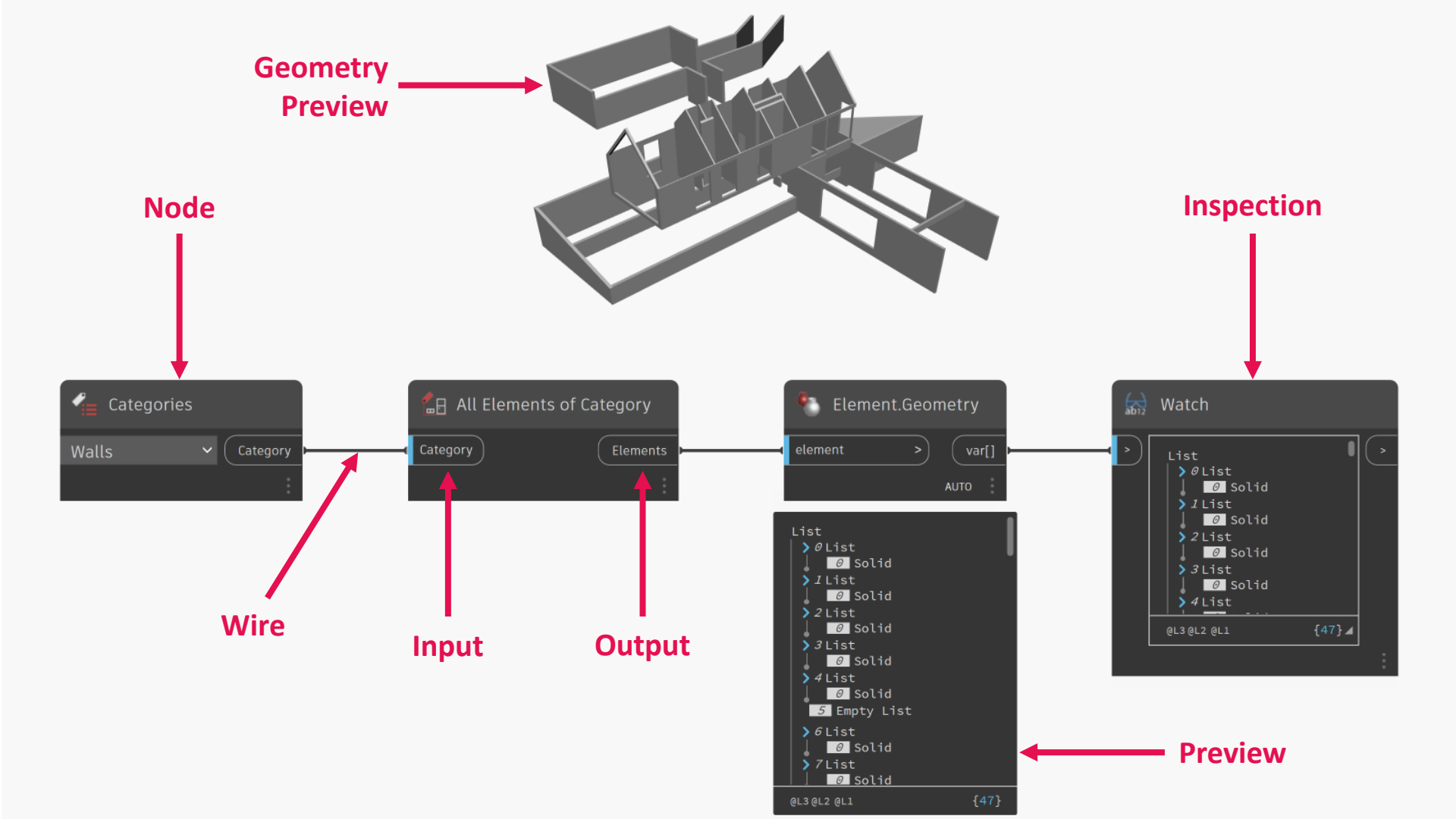
Civil 3D

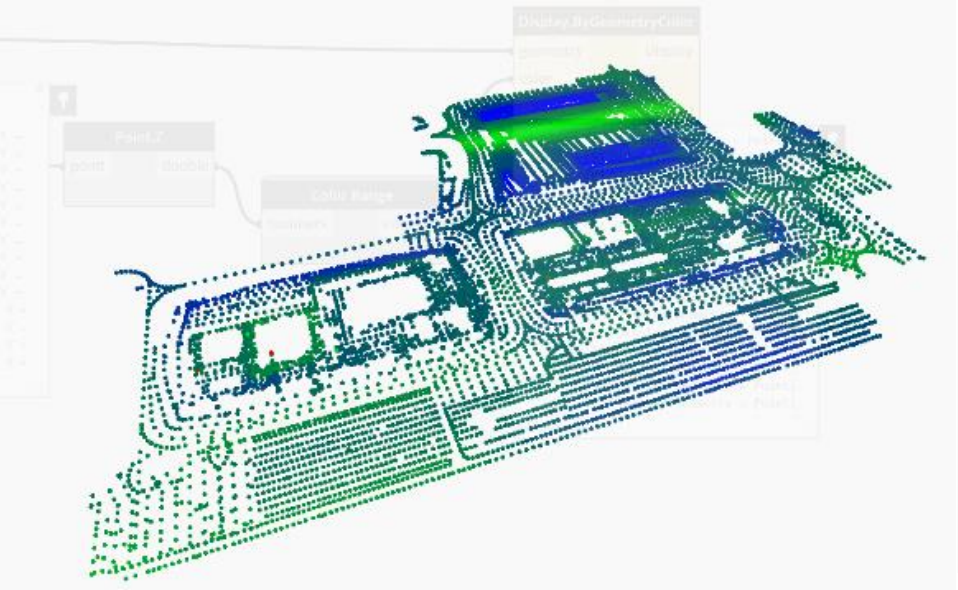
Robot Structural Analysis

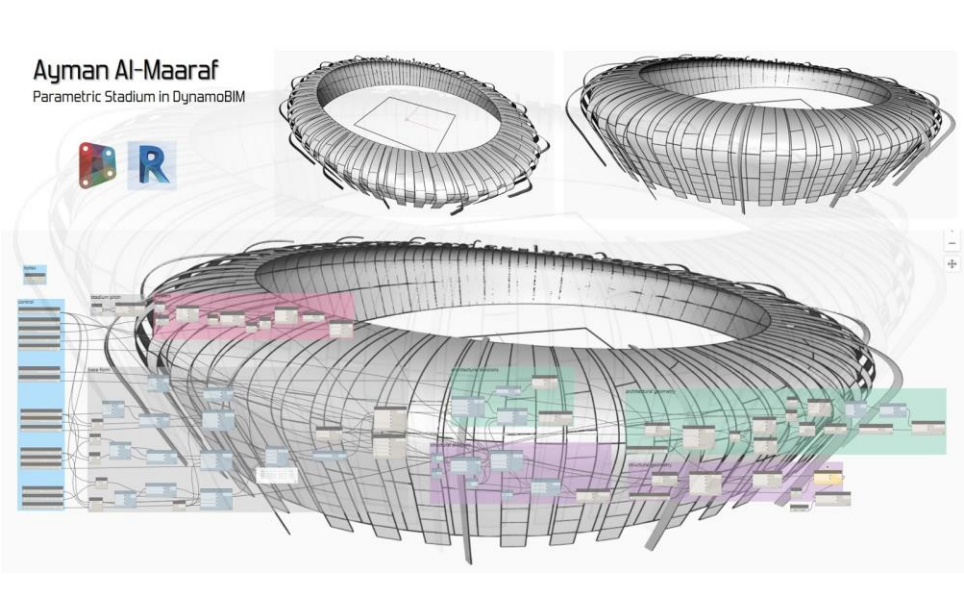
FormIt

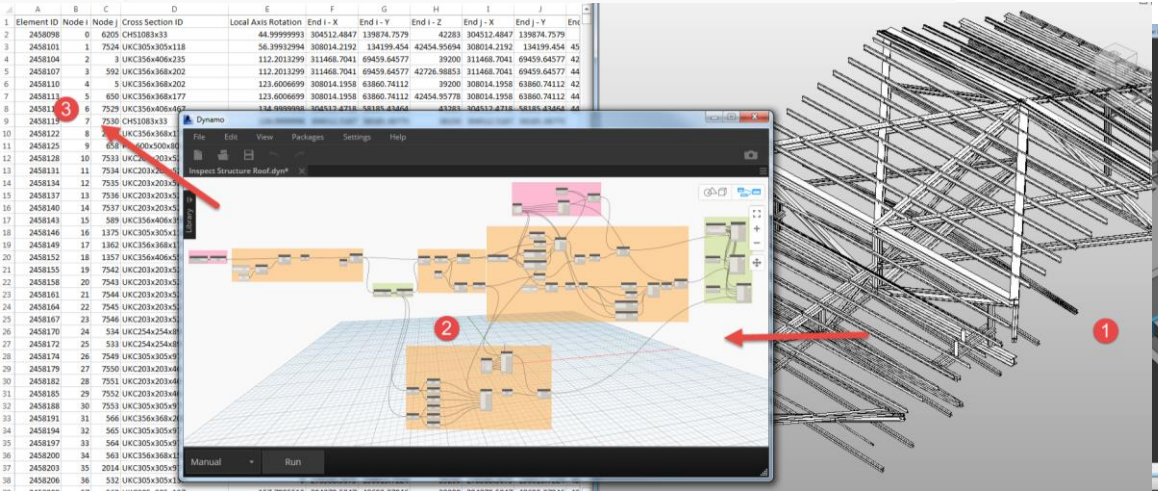
Alias

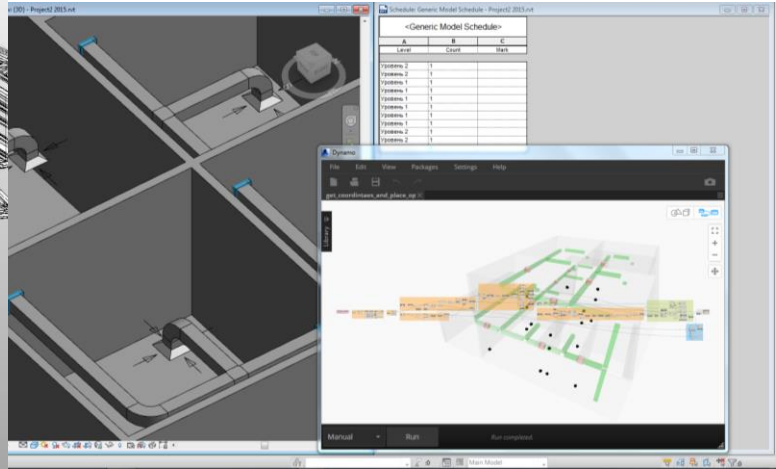
Advance Steel


Geometry Preview
Node
Inspection
Categories
Walls
Category
All Elements of Category
Category
Elements
Element.Geometry
element
var[]
AUTO
Watch
List
0 List
0 Solid
1 List
0 Solid
2 List
0 Solid
3 List
0 Solid
4 List
0 Solid
5 Empty List
6 List
0 Solid
7 List
0 Solid
@L3 @L2 @L1
{47}
Wire
Input
Output
Preview

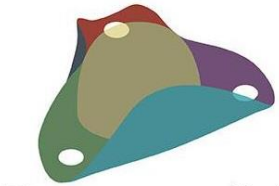


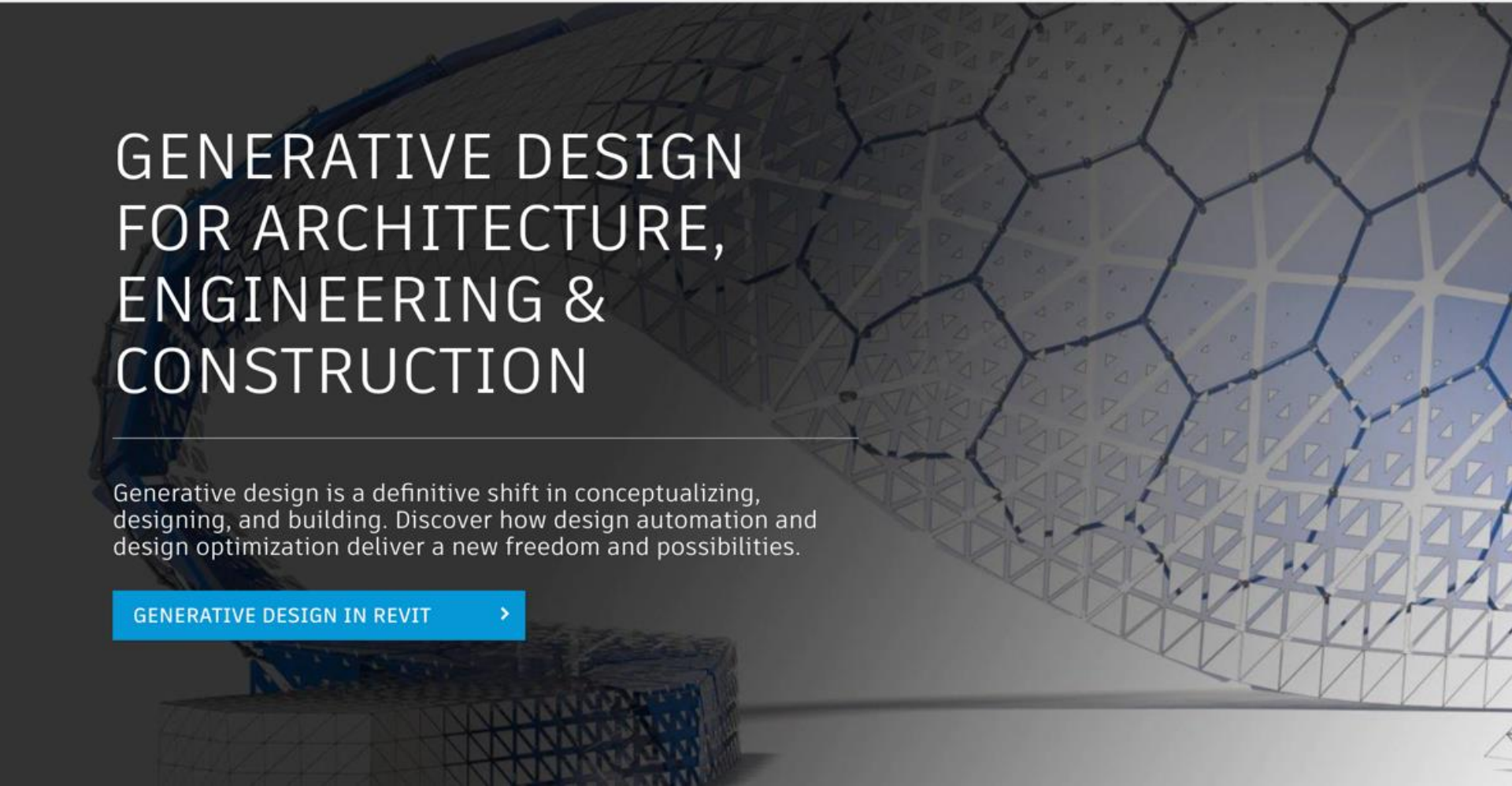

Ayman Al-Maaraf
Parametric Stadium in DynamoBIM


Element ID
Node i
Node j
Cross Section ID
Local Axis Rotation
End i - X
End i - Y
End i - Z
End j - X
End j - Y
Dynamo
File
Edit
View
Packages
Settings
Help
Manual
Run
1
2
3


<Generic Model Schedule>
Dynamo
Manual
Run

Dynamo User Groups

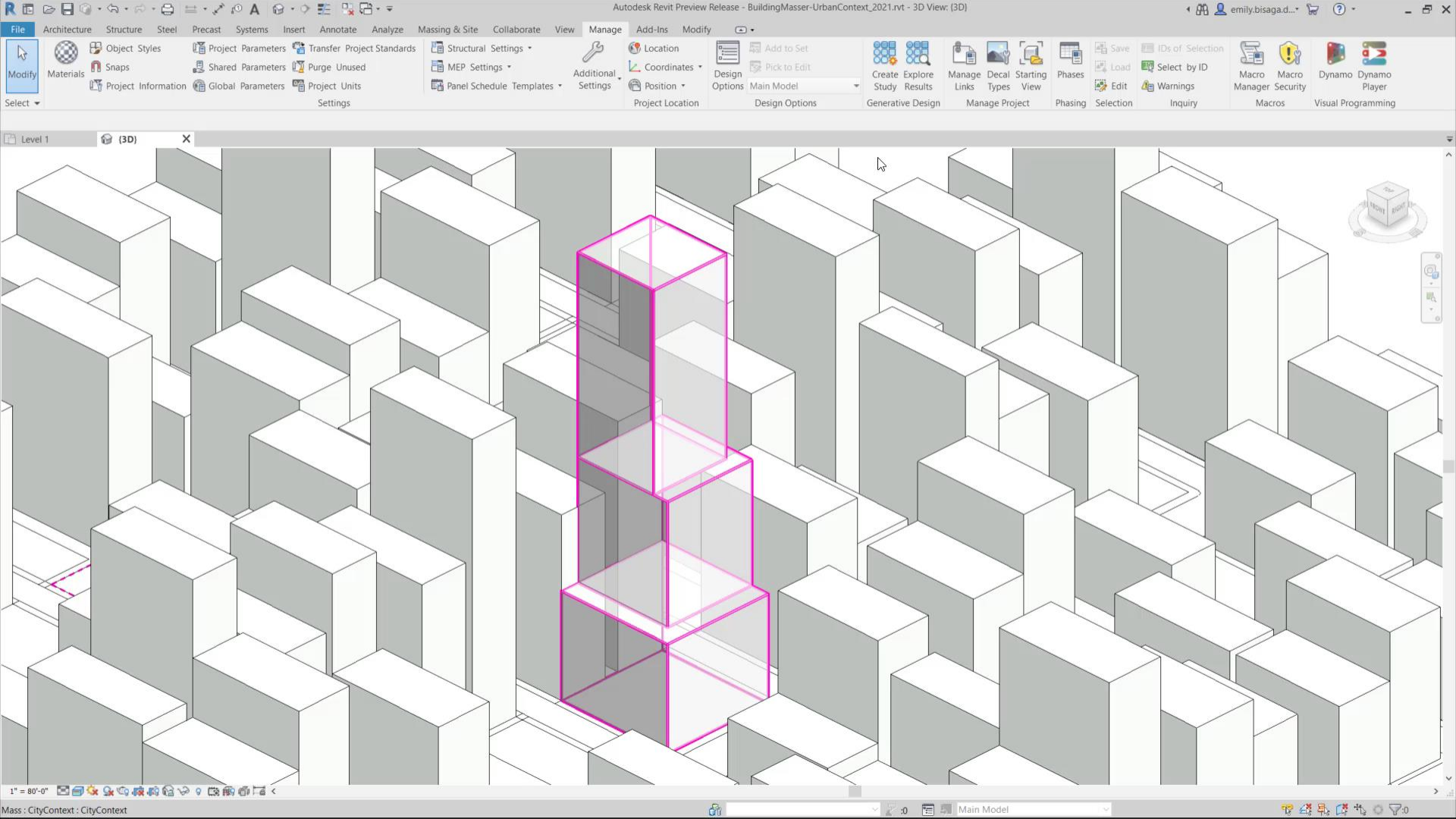




GENERATIVE DESIGN FOR ARCHITECTURE, ENGINEERING & CONSTRUCTION

Generative design is a definitive shift in conceptualizing, designing, and building. Discover how design automation and design optimization deliver a new freedom and possibilities.

GENERATIVE DESIGN IN REVIT ›


Autodesk Revit Preview Release - BuildingMasser-UrbanContext_2021.rvt - 3D View: {3D}
File
Architecture
Structure
Steel
Precast
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Modify
Select
Materials
Object Styles
Snaps
Project Information
Project Parameters
Shared Parameters
Global Parameters
Transfer Project Standards
Purge Unused
Project Units
Settings
Structural Settings
MEP Settings
Panel Schedule Templates
Additional Settings
Location
Coordinates
Position
Project Location
Design Options
Add to Set
Pick to Edit
Main Model
Design Options
Create Study
Explore Results
Generative Design
Manage Links
Decal Types
Starting View
Manage Project
Phases
Phasing
Save
Load
Edit
Selection
IDs of Selection
Select by ID
Warnings
Inquiry
Macro Manager
Macro Security
Macros
Dynamo
Dynamo Player
Visual Programming
Level 1
{3D}
1" = 80'-0"
Mass : CityContext : CityContext
Main Model

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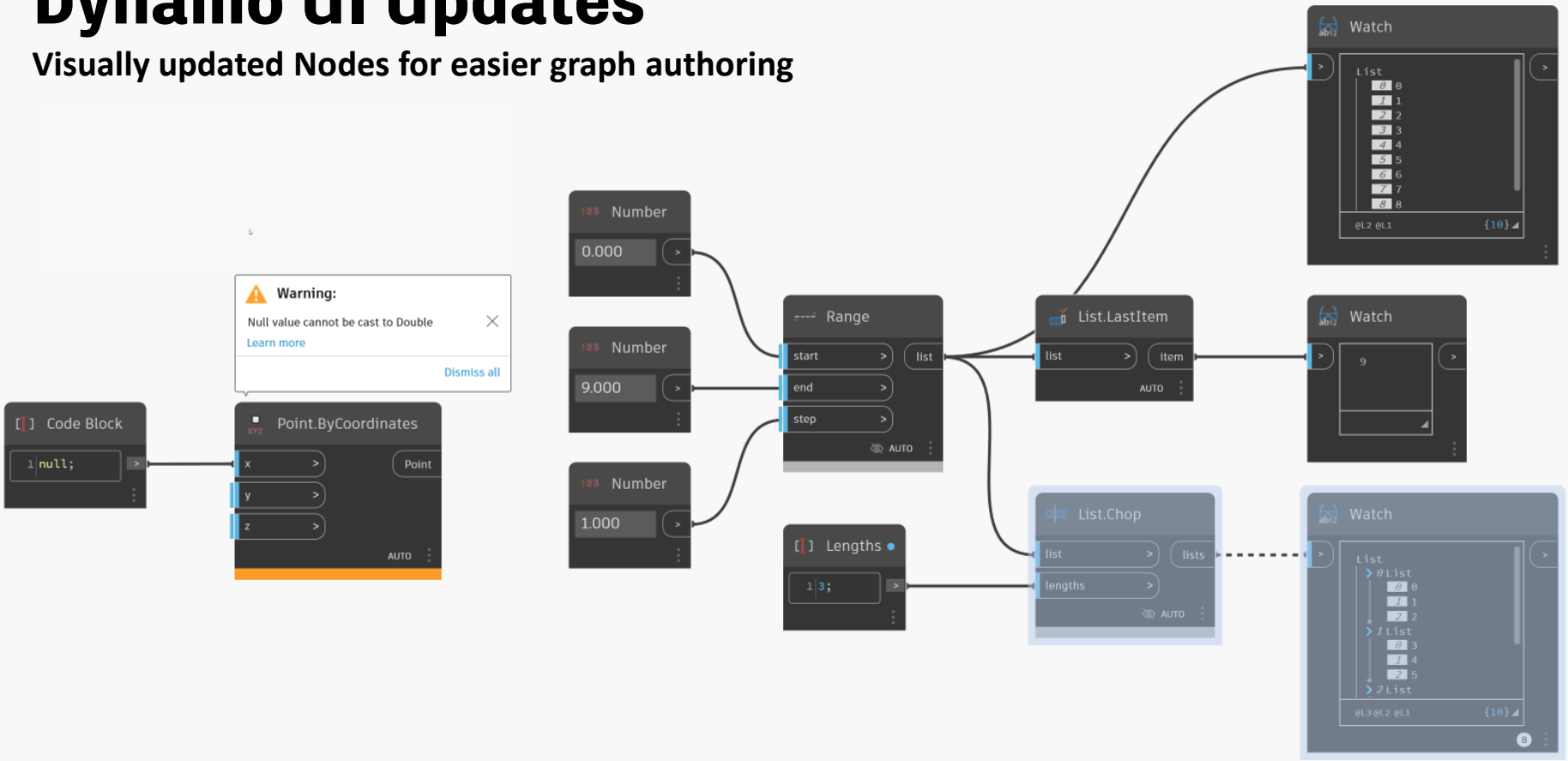
What’s New?

Dynamo 2.13+ and Dynamo tools in Revit 2023

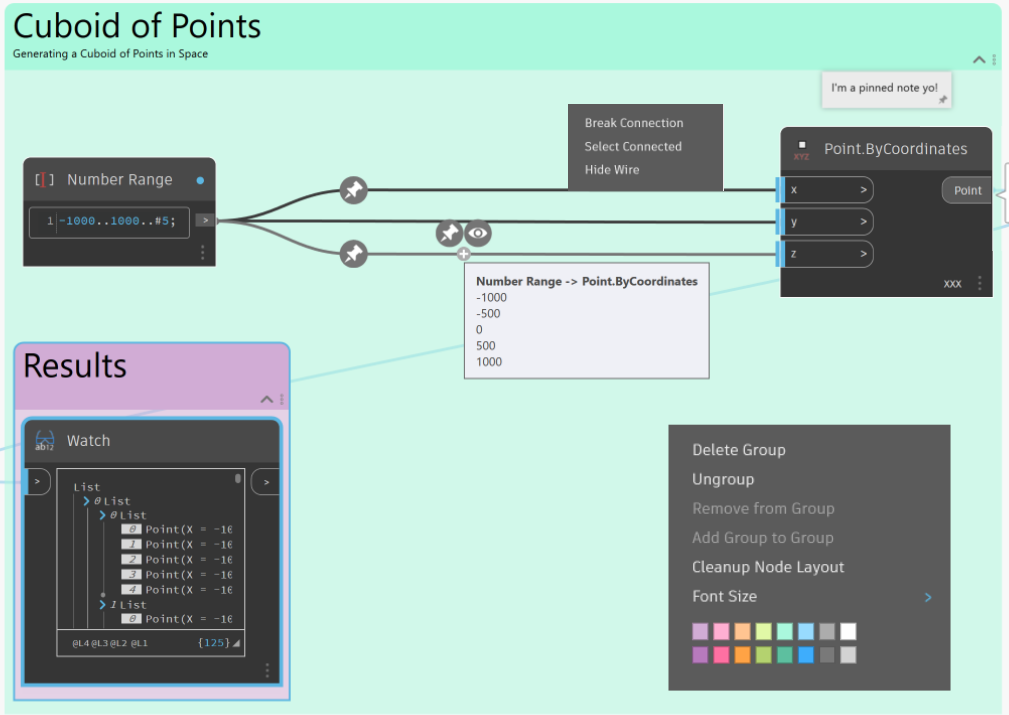
Dynamo UI Updates

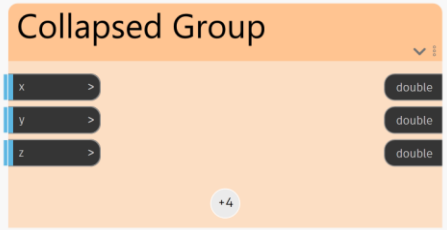
Visually updated Nodes for easier graph authoring



Dynamo Authoring Tools

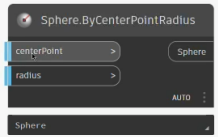
New authoring tools to help you organize your graph





Dynamo Node Auto-complete

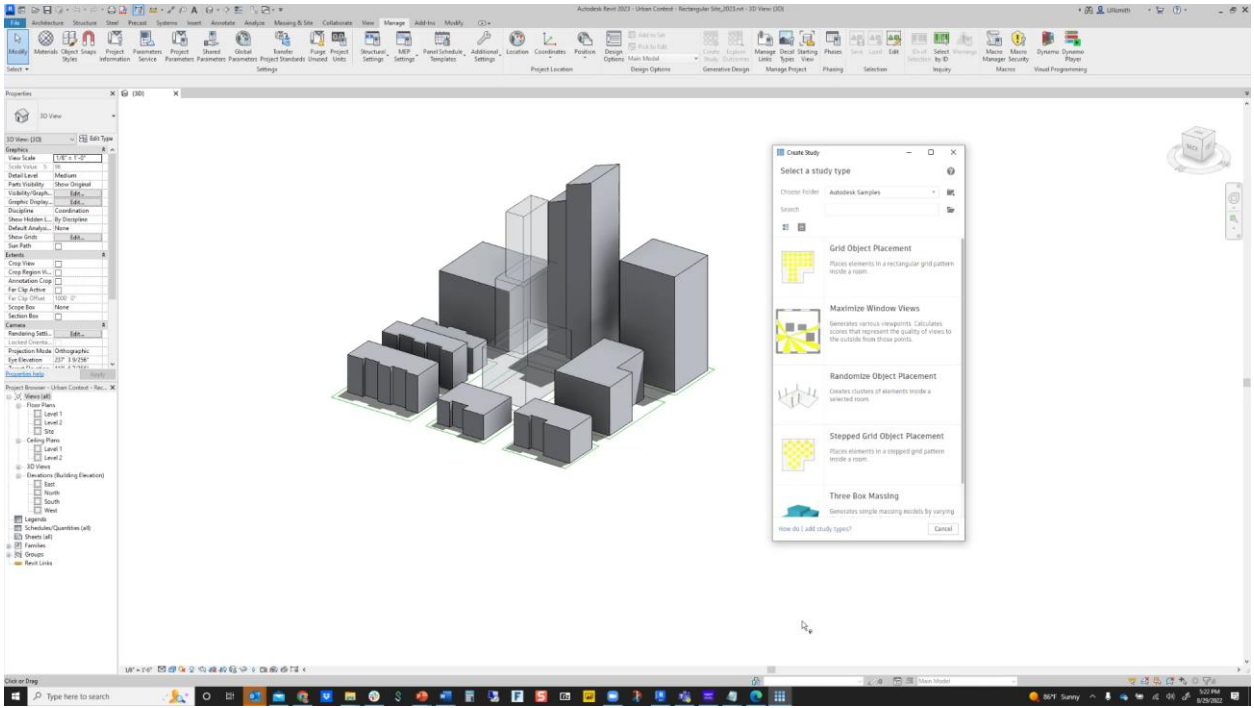
More effective and efficient graph authoring



GenDesign – Create Study Improvements

Revit 2023

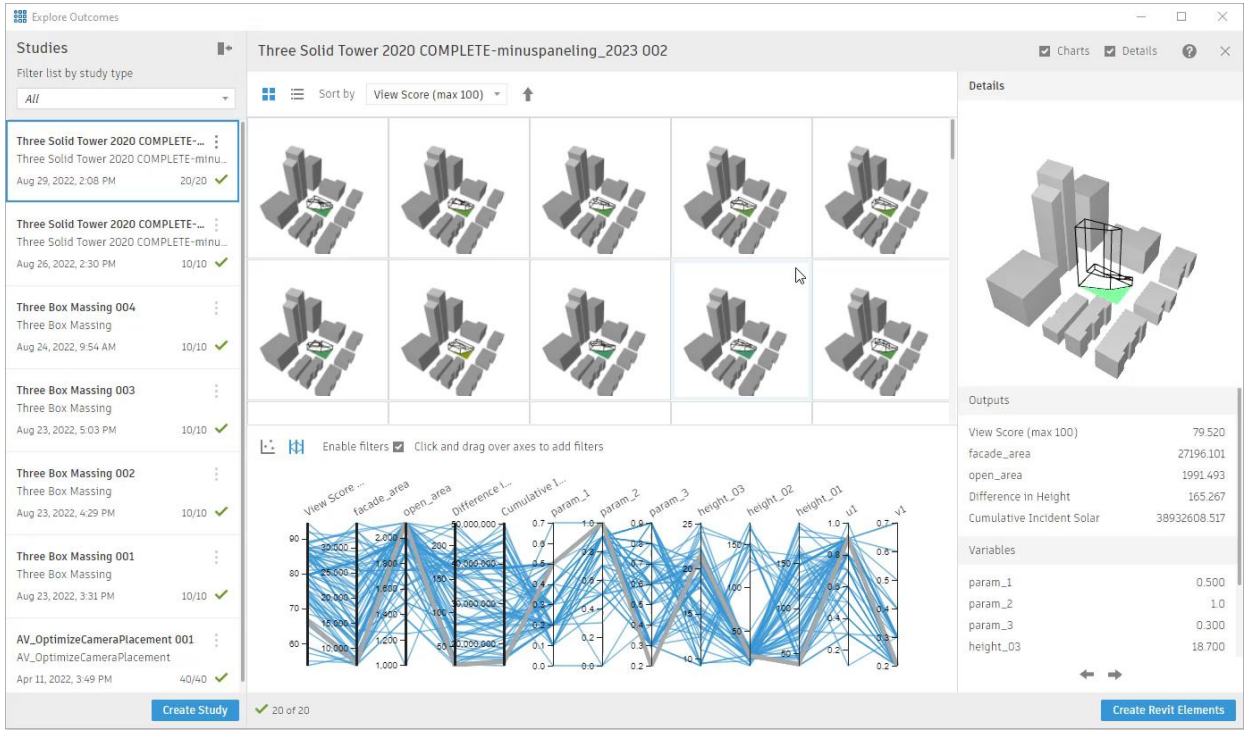
- Keyboard navigation
- New input types
- Detailed information links
- Renamed and better explained option generation methods



Gen Design - Explore Improvements

Revit 2023

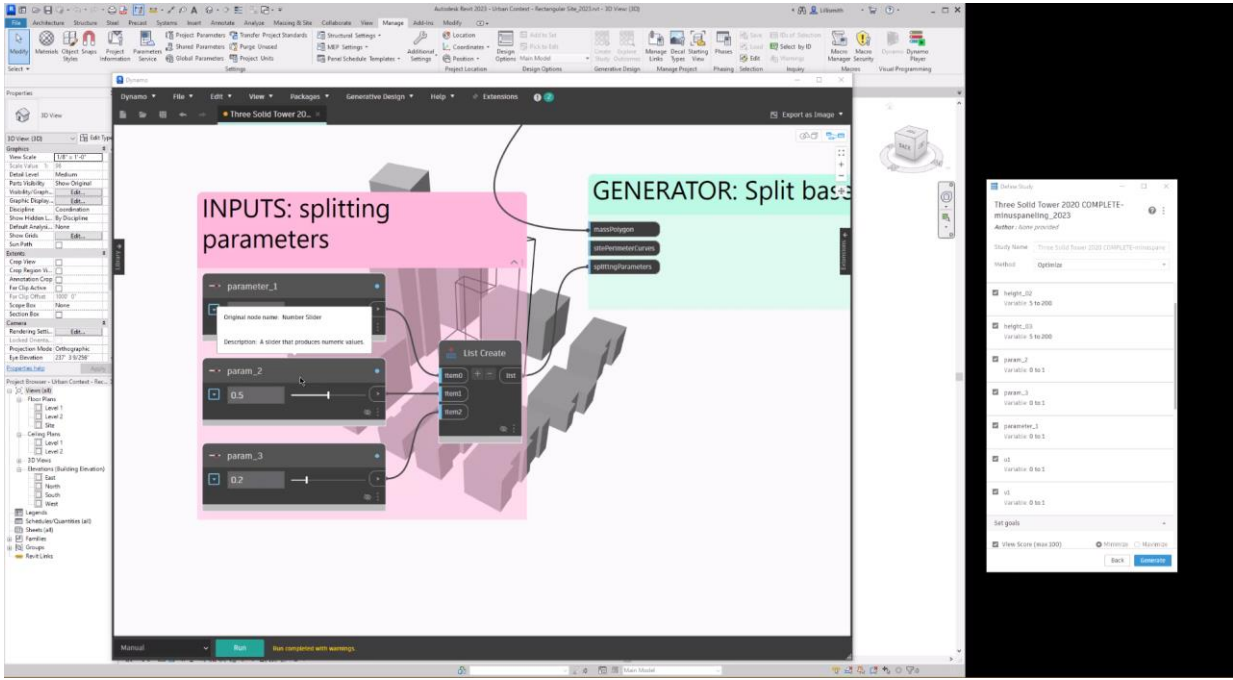
- See more than 10 outcomes at once
- Export outcomes (including thumbnails and rejected options)



Gen Design/Dynamo Improvements

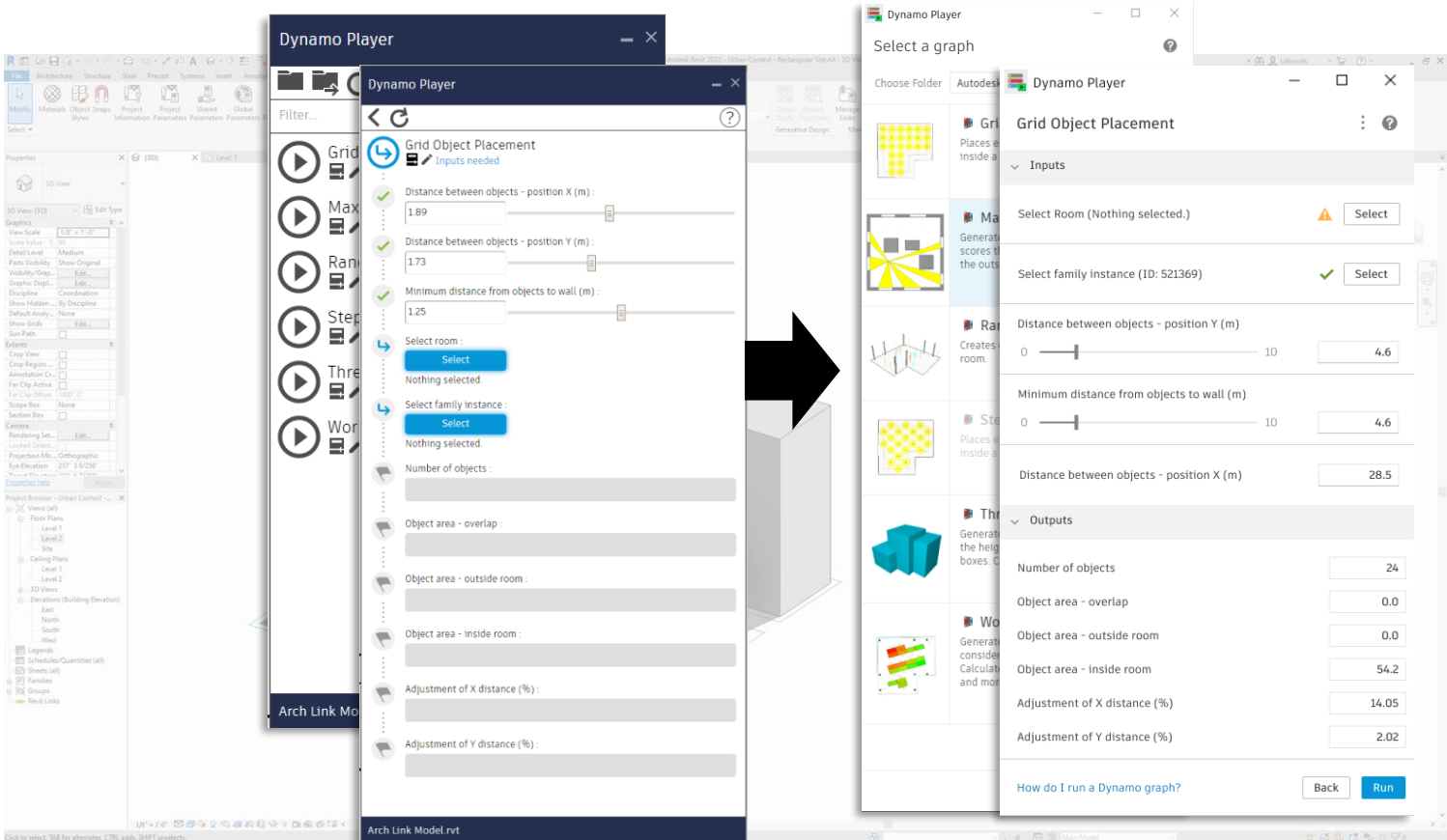
Revit 2023

- Work in Dynamo without having to close Dynamo Player.
- Set graph type to generative design
- Show/edit graph properties



Dynamo Player UI Updates

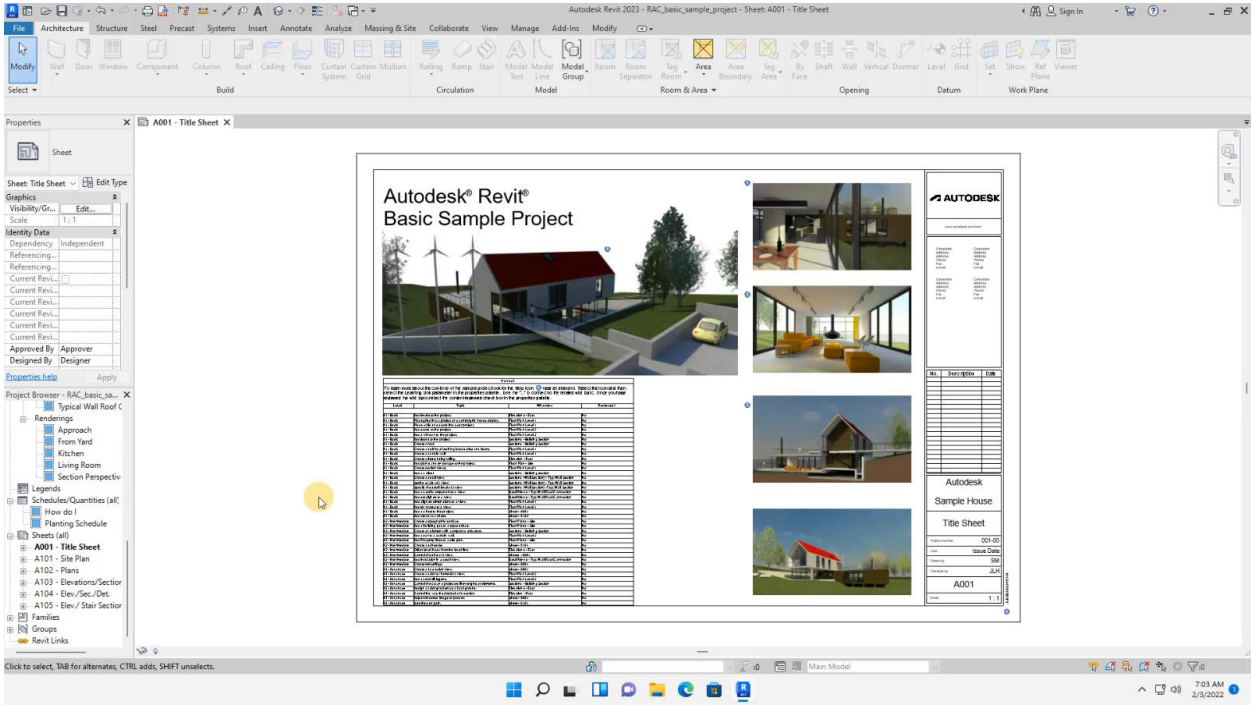
Revit 2023



Dynamo Player Improvements

Revit 2023

- UI consistent with Generative Design
- Manage and save folder locations
- Add descriptions and thumbnails to graphs
- Add links to more detailed information
- Add a description and author information to the graph



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Use Cases

Subtitle

Special Guests

Computational Design Practitioners

Karam Baki
Senior Principal
AECedx
Turkey

Dana De Filippi
Computational Designer
Smith Group Architects
Washington DC

Edgar Pestana
BIM Engineer
Basler & Hofmann
Lucerne Switzerland

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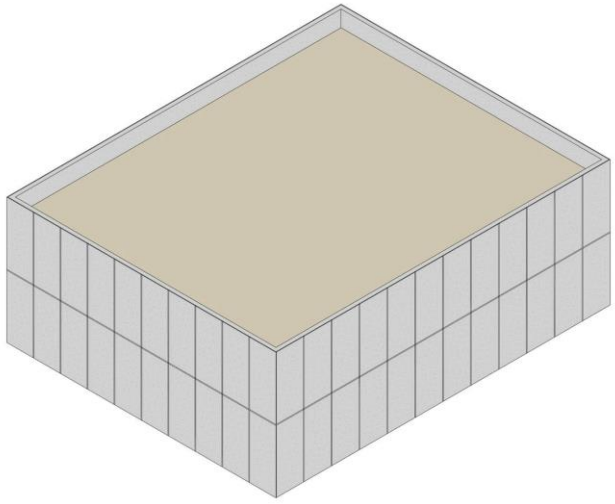
Karam Baki

KaramBaki
Senior Principal | **AECedx**
Turkey

Multi-Discipline Geometry Coordination

AECedx For Education And Consultation

Synchronize Actual Geometry Between Linked Revit Files to Produce Better Drawings And More Accurate Material Take-offs.



Inputs

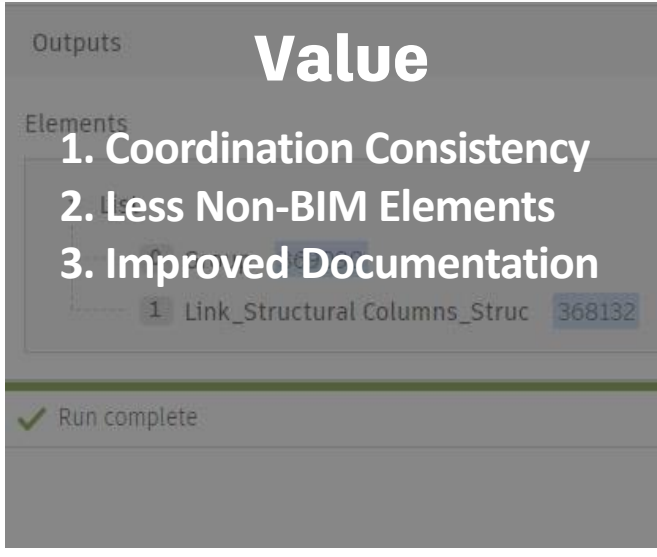
1. Link Name
2. Filter By Parameter (?)
3. Create Model Group
4. Create Void Family

Goals

1. Minimize Workarounds
2. Increase MTO Precision
3. Minimize Drafting Efforts

Value

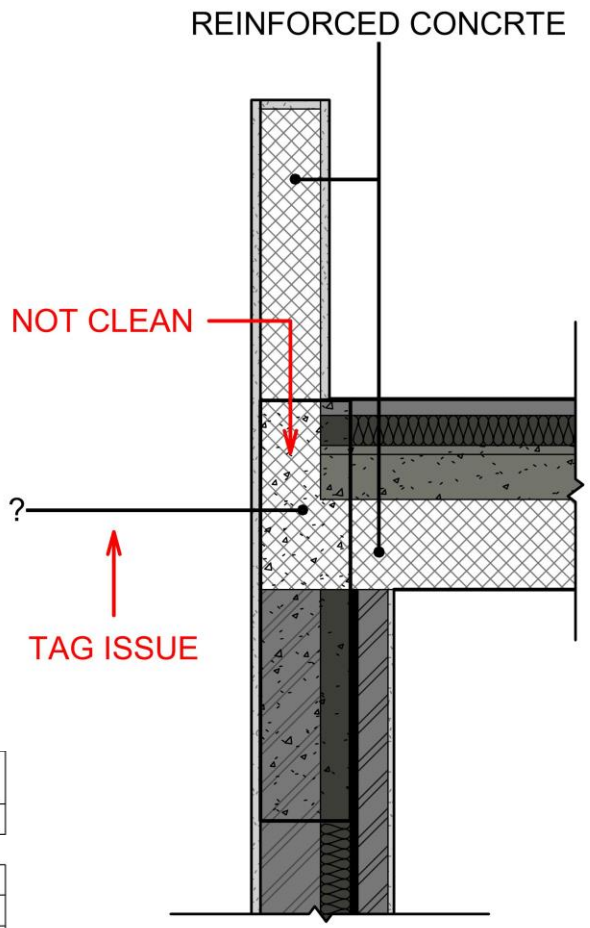
1. Coordination Consistency
2. Less Non-BIM Elements
3. Improved Documentation



Problem

- When using multiple linked Revit files. There are always geometrical issues related to Boolean operations (Cutting/Joining)

- These problems cause inaccurate Material Take-offs and require manual drafting elements to be placed in order to produce neat drawings and deliverables.



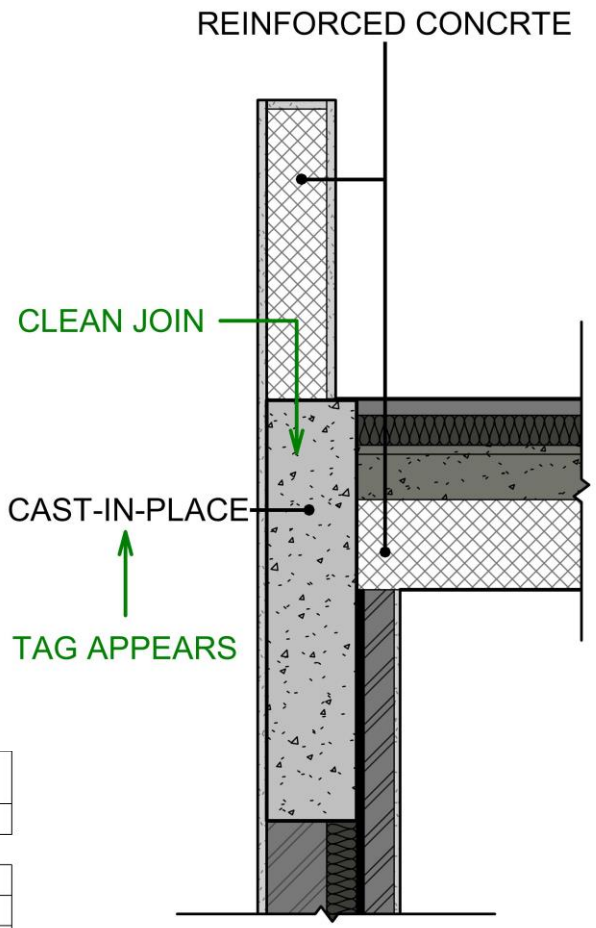
NOT ACCURATE

Material Takeoff	
Material: Description	Material: Volume
SLOPED FOAM CONCRETE	51 m³
HOLLOW CONCRETE BLOCK 10	39 m³
HOLLOW CONCRETE BLOCK 20	78 m³
REINFORCED CONCRTE	156 m³
	323 m³

Solution

- Extract geometry of structural elements from the link, and at the same time, generate a void family out of them.
  *Geometry can be refreshed

- Cut Voids with Element Types or any other selection criteria via (Void.Auto Cut) scripts.
  *Void cutting is only needed once



ACCURATE

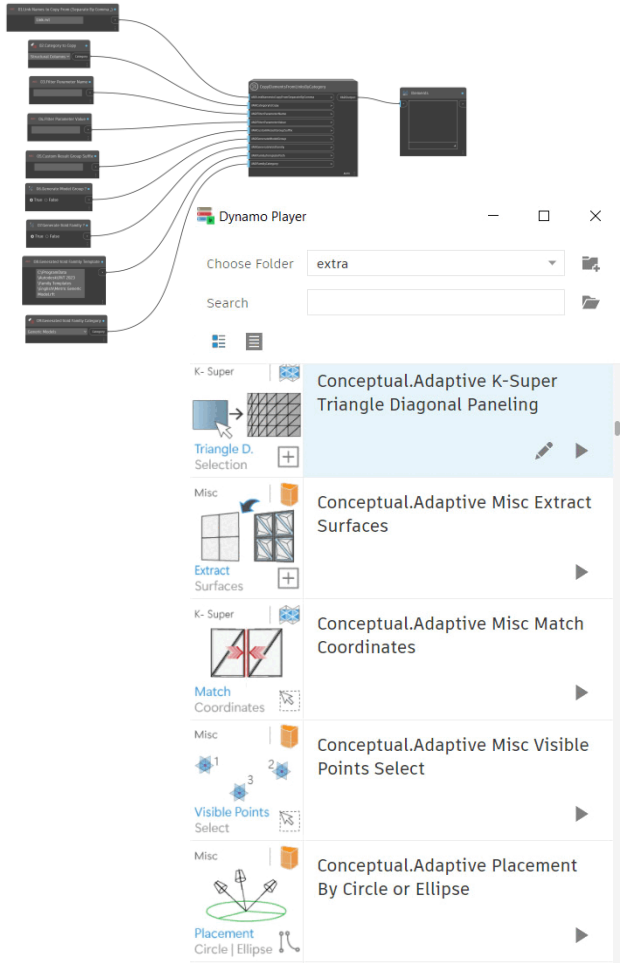
Material Takeoff	
Material: Description	Material: Volume
SLOPED FOAM CONCRETE	45 m³
HOLLOW CONCRETE BLOCK 10	32 m³
HOLLOW CONCRETE BLOCK 20	59 m³
REINFORCED CONCRTE	141 m³
	278 m³

Conclusion

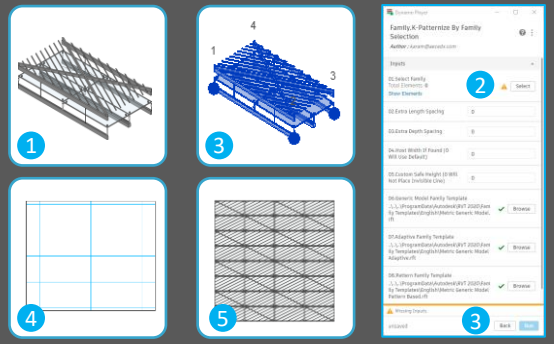
- Not only Dynamo helped us to automate the solution, but rather it allowed us to access to API tools that are not accessible from the UI.

- And because Dynamo ships with Revit, we have easily deployed this solution to different team members using Synthesize toolkit package.

- Furthermore, the new Dynamo Player allows all non-Dynamo users to use any script with minimal knowledge in programing.

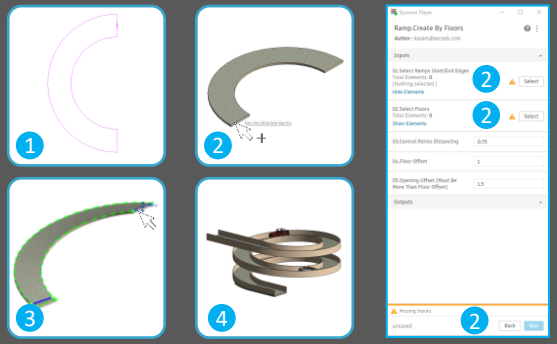


K- Patternize



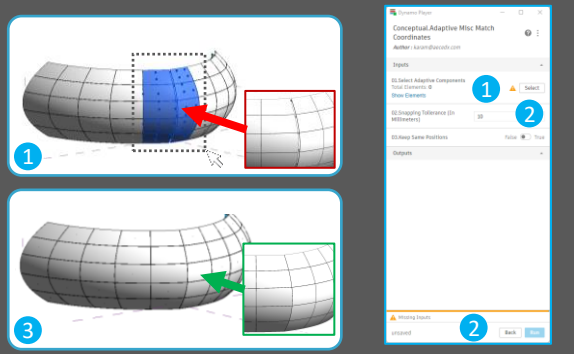
1. Create or import any family.
2. Use K- Patternize and select the family.
3. Click on run and you can place the adaptive family.
4. Select the divided surface and assign the pattern.
5. Final result , and you adjust size or rotation.

Ramp. Create By Floors



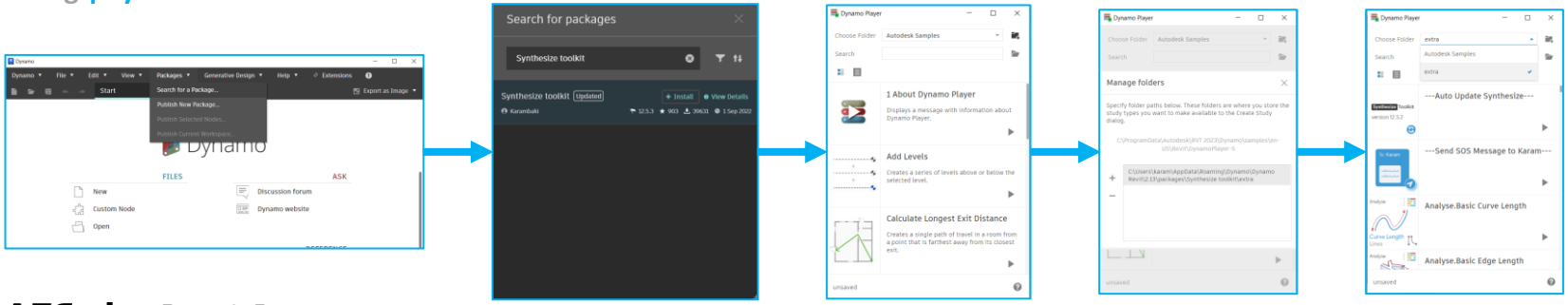
1. Create Floor  .
2. Using ‘Ramp.Create By Floors’ Select Ramp Start/End Edges and select floors and click on run.
3. Adjust heights using ‘modify Sub Elements ’  .
4. Final result , and you duplicate to multi levels.

Adaptive. Match Coordinates



1. Using ‘Match Coordinates’ select Adaptive Components.
2. Adjust Snapping Tolerance or leave its default value and click on run.
3. Final result.

Installing | Synthesize Toolkit



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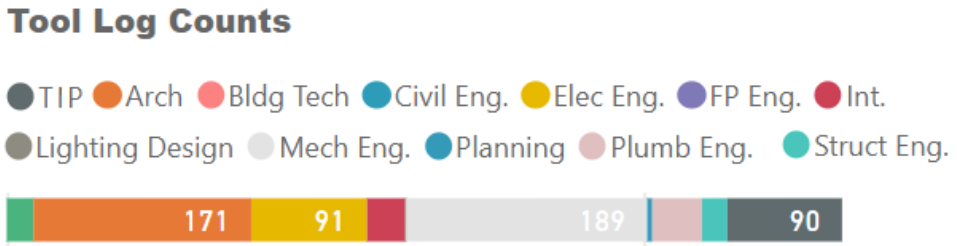
Dana De Filippi

DanamoBIM
Computational Leader | SMITHGROUP

Workset Creation

SmithGroup

Integrate standard worksets, and global visibility settings, per discipline upon model collaboration.



Inputs

1. “Resource Toggles”
2. Discipline
2. “Optional” worksets in addition to default

Goals

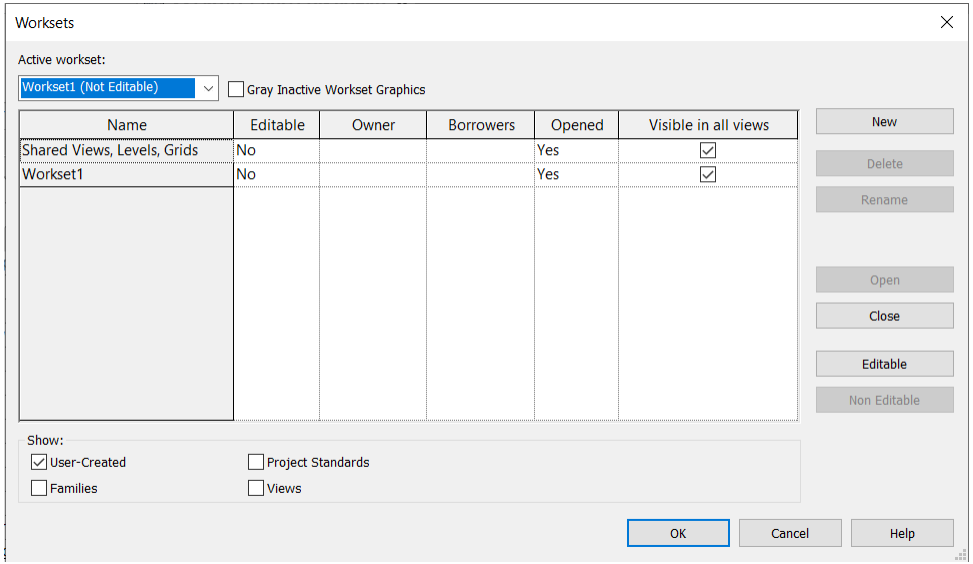
1. Ensure incorporation of company standards
2. Eliminate manual transcription
3. Save time / increase efficiency

Value

1. ALL Revit models benefit
2. ~30 seconds saved / workset created
3. Standards alignment / future workflows with workflow requirements

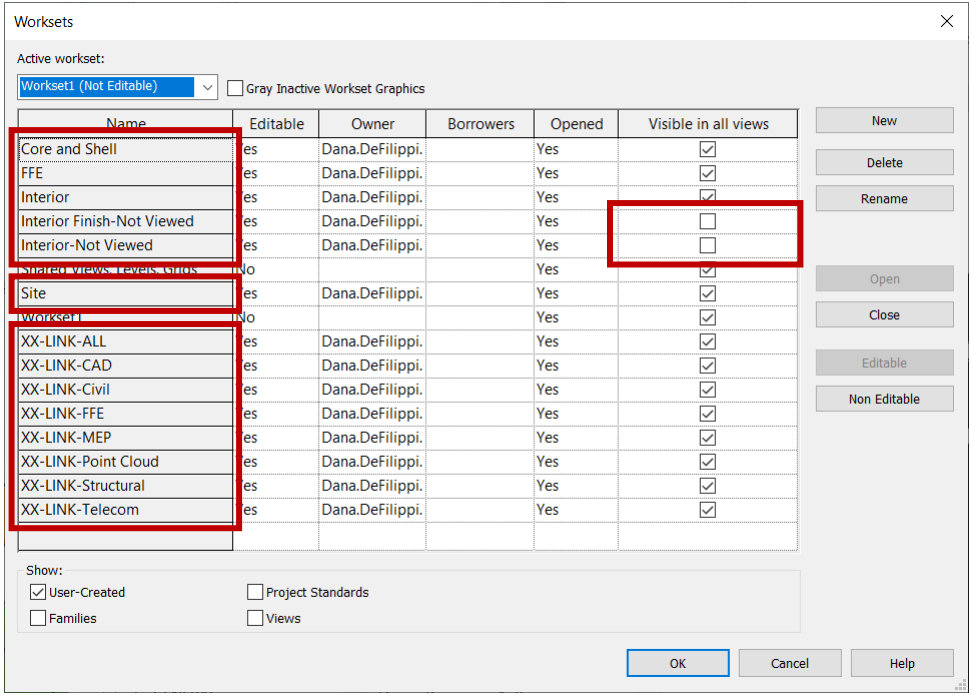
problem

1. Incorporation of SmithGroup standard worksets across all Revit models by discipline

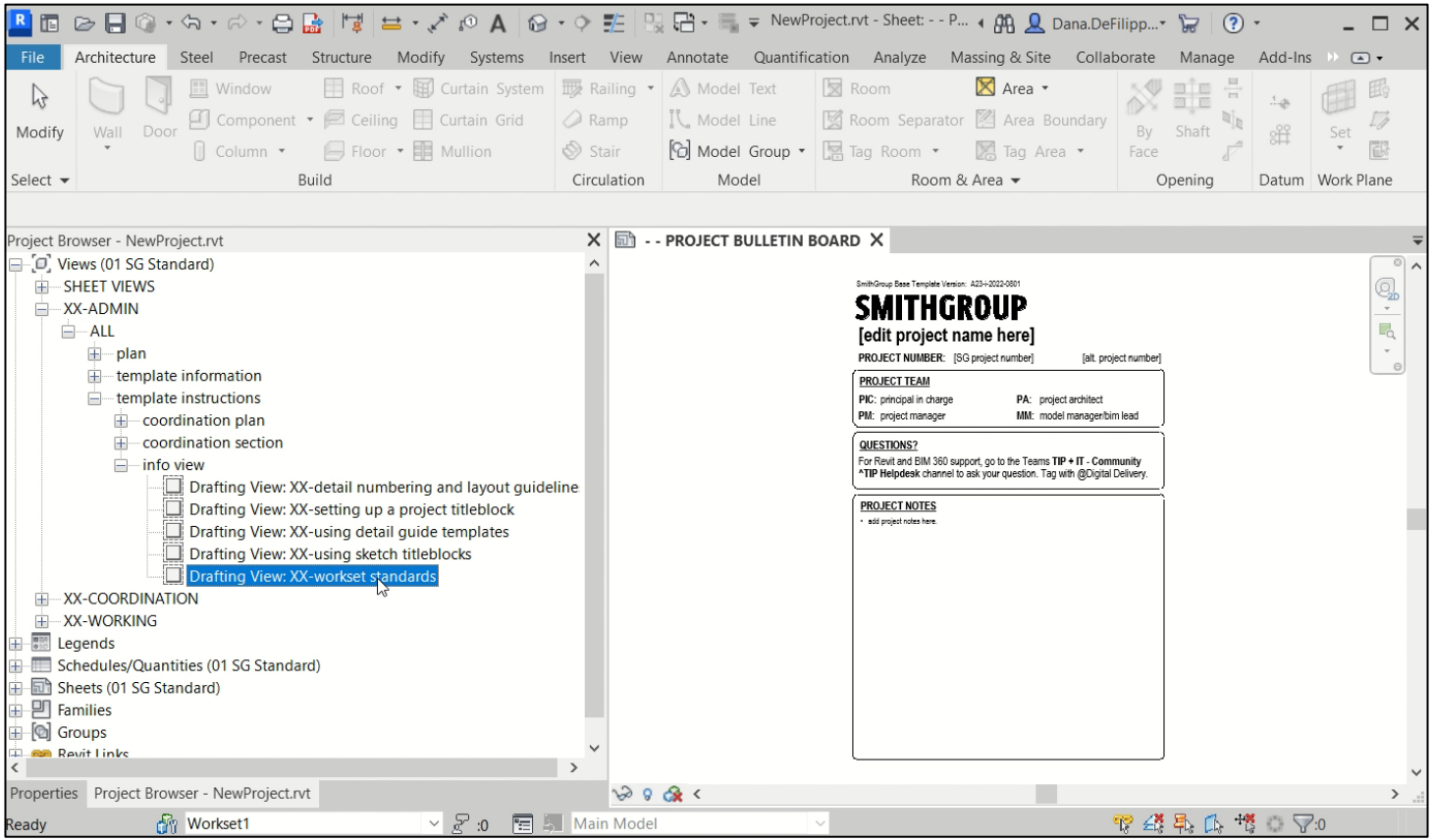


considerations

1. Naming conventions to match
2. Default visibility settings applied
3. Build efficiency / save time in creation process
4. Eliminate manual transcription



workset standards



worksets by discipline

Architectural Model
Architectural Baseline Worksets

NAME	DESCRIPTION
Shared Levels and Grids	Contains all existing levels, grids and reference planes. Created by default when worksharing is enabled
Workset1	Initially contains all existing model elements in the project when worksharing is enabled. Reassign elements from Workset1 into the appropriate workset(s). It is recommended that Workset1 is left as a placeholder workset, since it cannot be deleted. **Do not rename!**
XX-LINK-ALL	Type parameter of ALL Linked Revit Models
XX-LINK-Structural	Linked Structural Revit model
XX-LINK-MEP	Linked MEP Revit Model
XX-LINK-Civil	Linked Civil site DWG or Revit site model
XX-LINK-CAD	For linked CAD files linked into the model NOT using Current view only. Uncheck the **Visible in all views** box. (a separate workset for each intrinsically related DWG file may be advisable)

Optional Worksets, depending on the project scope

NAME	DESCRIPTION
Core and Shell	Shell elements: Exterior walls, Floors, Roofs, Shaft walls not part of core (exterior/perimeter stairs). Core elements to the building, elevator shafts, stairs, vertical circulation, etc. (Can be separate worksets for Shell and Core)
Interior	Walls, doors, windows and other building elements interior to the shell and not included in the core or FFE worksets
FFE	Furniture, Fixtures, and Equipment
Site	Site elements, toposurfaces, parking, planting, hardscape, etc.
XX-LINK-FFE	Furniture, Fixtures and Equipment (if FFE is in a separate model)
XX-LINK-Telecom	Telecommunications Revit model
XX-LINK-Point Cloud	Point Cloud data sets

Mechanical Model
Mechanical Baseline Worksets

NAME	DESCRIPTION
Shared Levels and Grids	Contains all existing levels, grids and reference planes. Created by default when worksharing is enabled.
Workset1	Automatically created when you activate Worksets
M-Equipment	Mechanical equipment with power demands should be placed on this workset.
M-Fire Protection	Fire Protection piping and associated non-powered mechanical equipment should be placed on this workset.
M-HVAC	HVAC ductwork, air terminals, and non-powered mechanical equipment should be placed on this workset.
M-Not Viewed	Elements on this workset will not be visible to other disciplines. Uncheck "Visible in all Views" when creating.
M-Piping	HVAC piping and associated non-powered mechanical equipment should be placed on this workset.
MEP Common	Match lines, scope boxes, and reference planes should be placed on this workset.
MEP Spaces	Spaces associated with documentation should be placed on this workset.
XX-LINK-CAD	All referenced CAD should be on this workset.
XX-LINK-REVIT	All linked Revit models should be placed on this workset (it's also good practice to put each model on its own workset to assist in unloading links if necessary).

Electrical Model
Electrical Baseline Worksets

NAME	DESCRIPTION
Shared Levels and Grids	Contains all existing levels, grids and reference planes. Created by default when worksharing is enabled.
Workset1	Automatically created when you activate Worksets
E- Electrical	Electrical items should be placed on this workset.
E-Not Viewed	Elements on this workset will not be visible to other disciplines. Uncheck "Visible in all Views" when creating.
E-Site	Uncheck "Visible in all views" when creating.
MEP Common	Match lines, scope boxes, and reference planes should be placed on this workset.
MEP Spaces	Spaces associated with documentation should be placed on this workset.
XX-LINK-CAD	All referenced CAD should be on this workset.
XX-LINK-REVIT	All linked Revit models should be placed on this workset (it's also good practice to put each model on its own workset to assist in unloading links if necessary).

Plumbing Model
Plumbing Baseline Worksets

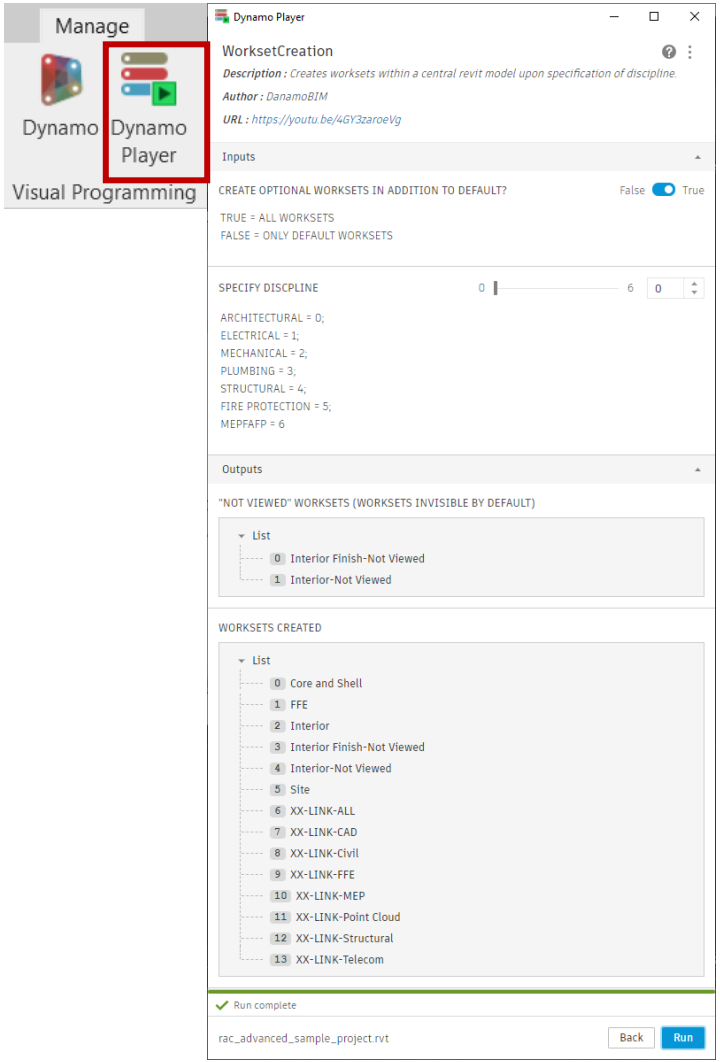
NAME	DESCRIPTION
Shared Levels and Grids	Contains all existing levels, grids and reference planes. Created by default when worksharing is enabled.
Workset1	Automatically created when you activate Worksets
MEP Common	Match lines, scope boxes, and reference planes should be placed on this workset.
MEP Spaces	Spaces associated with documentation should be placed on this workset.
P-Plumbing	Plumbing fixtures, piping, and non-powered mechanical equipment should be placed on this workset.
XX-LINK-CAD	All referenced CAD should be on this workset.
XX-LINK-REVIT	All linked Revit models should be placed on this workset (it's also good practice to put each model on its own workset to assist in unloading links if necessary).

Structural Model
Structural Baseline Worksets

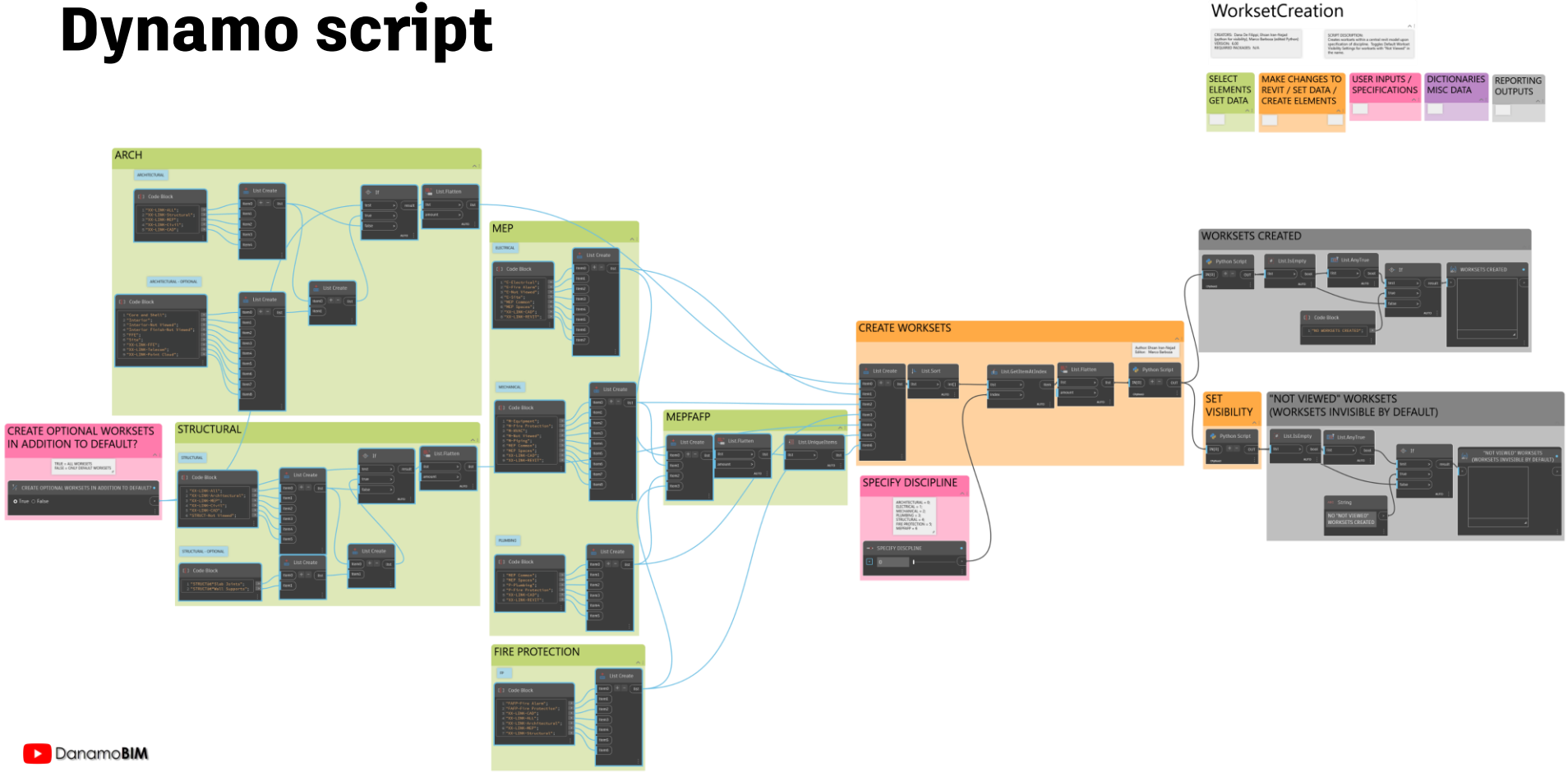
NAME	DESCRIPTION
Shared Levels and Grids	Contains all existing levels, grids and reference planes. Created by default when worksharing is enabled.
Workset1	Initially contains all existing model elements in the project when worksharing is enabled. Reassign elements from Workset1 into the appropriate workset(s). It is recommended to Workset1 is left as a placeholder workset, since it cannot be deleted. **Do not rename!**
STRUCT – NOT VIEWED	Items in the model not to be viewed by other disciplines
XX-LINK-REVIT	All linked Revit models should be associated with this workset using the linked model's type parameters.
XX-LINK-CAD	For CAD files linked into the model NOT using "Current view only." Create workset to not be visible in all views. A separate workset for each intrinsically related DWG file may be advisable.

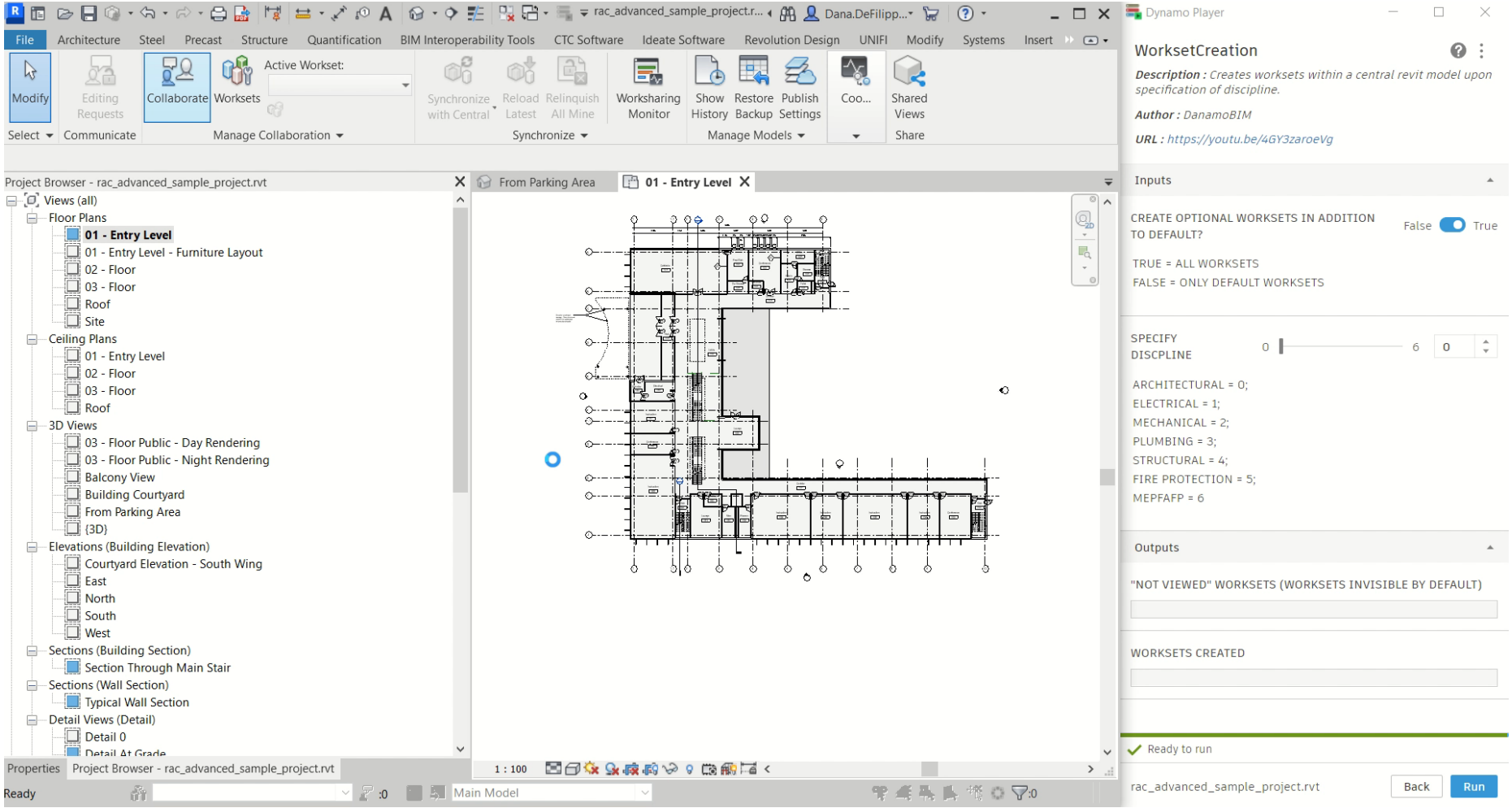
solution

1. Dynamo Player script

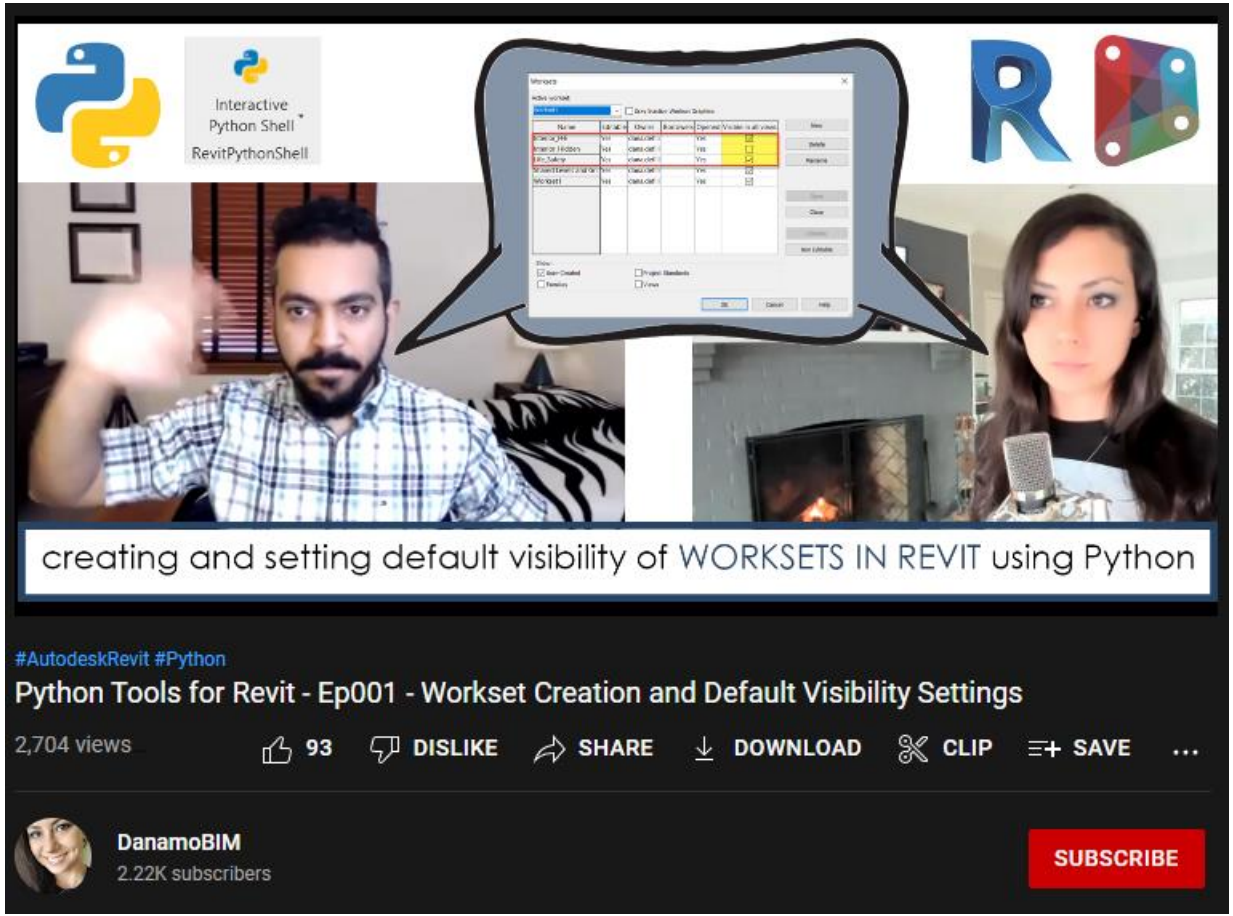


Dynamo script

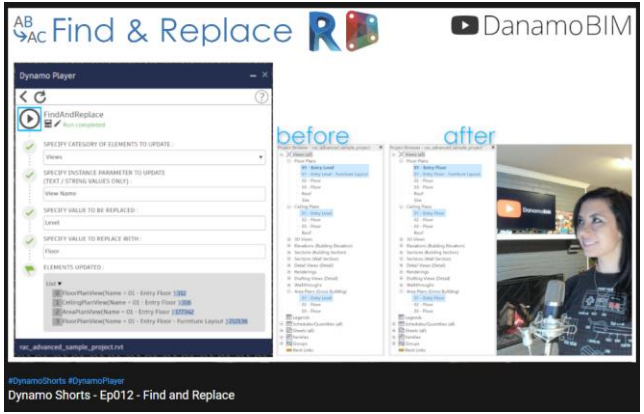



File
Architecture
Steel
Precast
Structure
Quantification
BIM Interoperability Tools
CTC Software
Ideate Software
Revolution Design
UNIFI
Modify
Systems
Insert
Modify
Editing Requests
Collaborate
Worksets
Active Workset:
Synchronize with Central
Reload Latest
Relinquish All Mine
Worksharing Monitor
Show History
Restore Backup
Publish Settings
Shared Views
Select
Communicate
Manage Collaboration
Synchronize
Manage Models
Share
Project Browser - rac_advanced_sample_project.rvt
Views (all)
Floor Plans
01 - Entry Level
01 - Entry Level - Furniture Layout
02 - Floor
03 - Floor
Roof
Site
Ceiling Plans
01 - Entry Level
02 - Floor
03 - Floor
Roof
3D Views
03 - Floor Public - Day Rendering
03 - Floor Public - Night Rendering
Balcony View
Building Courtyard
From Parking Area
{3D}
Elevations (Building Elevation)
Courtyard Elevation - South Wing
East
North
South
West
Sections (Building Section)
Section Through Main Stair
Sections (Wall Section)
Typical Wall Section
Detail Views (Detail)
Detail 0
From Parking Area
01 - Entry Level
1 : 100
Properties
Project Browser - rac_advanced_sample_project.rvt
Ready
Main Model
Dynamo Player
WorksetCreation
Description : Creates worksets within a central revit model upon specification of discipline.
Author : DanamoBIM
URL : https://youtu.be/4GY3zaroeVg
Inputs
CREATE OPTIONAL WORKSETS IN ADDITION TO DEFAULT?
False
True
TRUE = ALL WORKSETS
FALSE = ONLY DEFAULT WORKSETS
SPECIFY DISCIPLINE
0
6
0
ARCHITECTURAL = 0;
ELECTRICAL = 1;
MECHANICAL = 2;
PLUMBING = 3;
STRUCTURAL = 4;
FIRE PROTECTION = 5;
MEPFAFP = 6
Outputs
"NOT VIEWED" WORKSETS (WORKSETS INVISIBLE BY DEFAULT)
WORKSETS CREATED
Ready to run
rac_advanced_sample_project.rvt
Back
Run

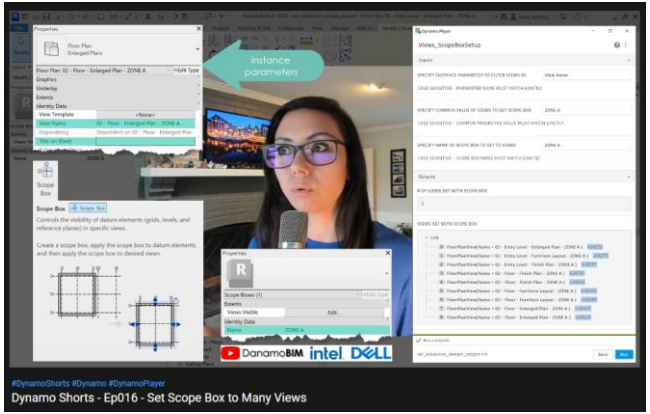
DanamoBIM


Interactive
Python Shell
RevitPythonShell
creating and setting default visibility of WORKSETS IN REVIT using Python
#AutodeskRevit #Python
Python Tools for Revit - Ep001 - Workset Creation and Default Visibility Settings
2,704 views
93
DISLIKE
SHARE
DOWNLOAD
CLIP
SAVE
DanamoBIM
2.22K subscribers
SUBSCRIBE

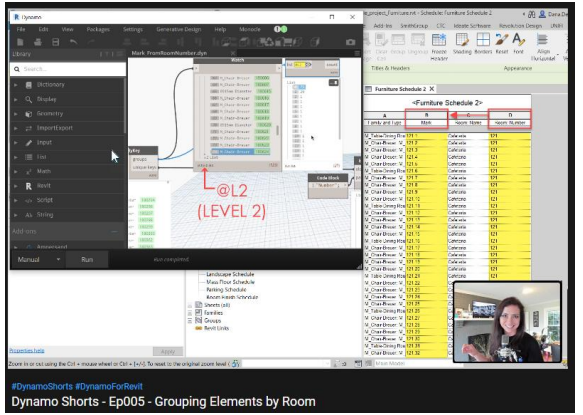
DanamoBIM



#DynamoShorts #DynamoPlayer
Dynamo Shorts - Ep012 - Find and Replace

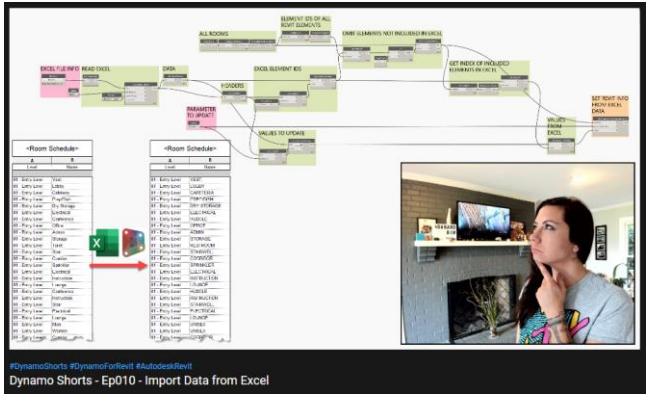


#DynamoShorts #Dynamo #DynamoPlayer
Dynamo Shorts - Ep016 - Set Scope Box to Many Views

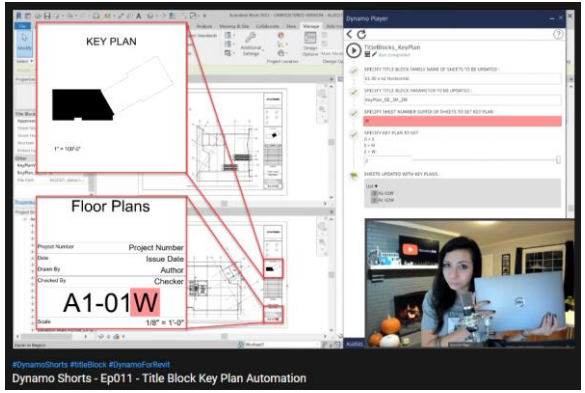


#DynamoShorts #DynamoForRevit
Dynamo Shorts - Ep005 - Grouping Elements by Room

#DynamoShorts #DynamoForRevit
Dynamo Shorts - Ep002 - Numbering Elements



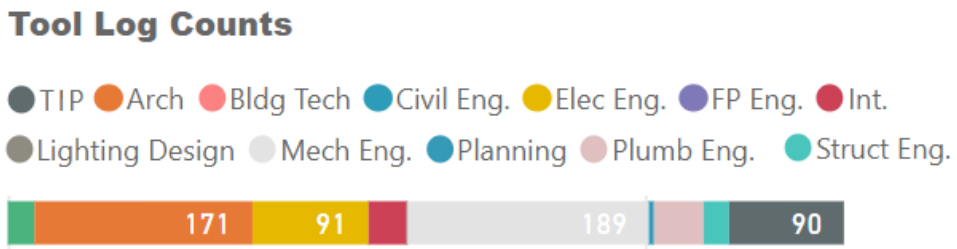
#DynamoShorts #DynamoForRevit #AutodeskRevit
Dynamo Shorts - Ep010 - Import Data from Excel



#DynamoShorts #TitleBlock #DynamoForRevit
Dynamo Shorts - Ep011 - Title Block Key Plan Automation

use

varied across disciplines



AUTODESK UNIVERSITY

Edgar Pestana

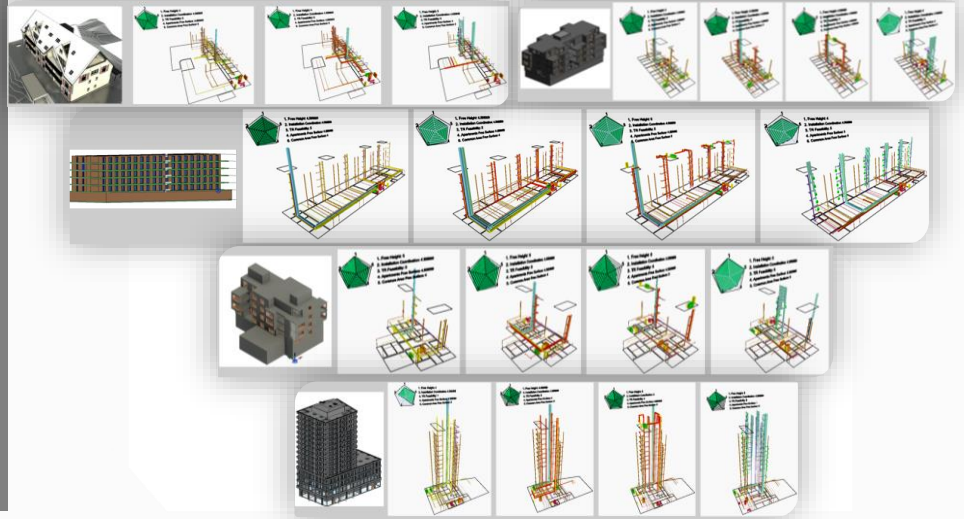
BIM Engineer| **Basler & Hofmann**, Lucerne
Switzerland

spacing

Basler & Hofmann AG, Switzerland

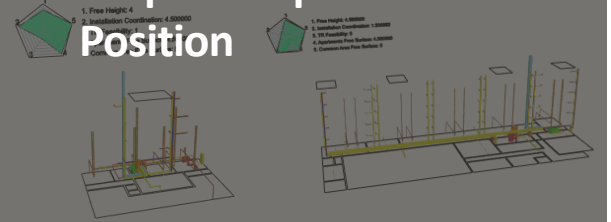
MEP Design Optimization

Minimizing technical space while ensuring feasibility of mechanical systems installation



Inputs

1. Architect. Layout (.ifc)
2. SIA & VDI Standards
3. MEP System Types
4. Proposed Spaces and Position



Goals

1. Minimize the Technical Space Used

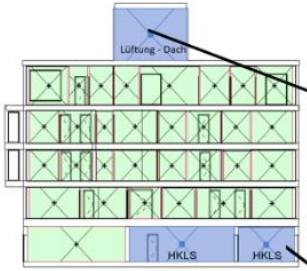
2. Ensure Technical Installation Feasibility

Value

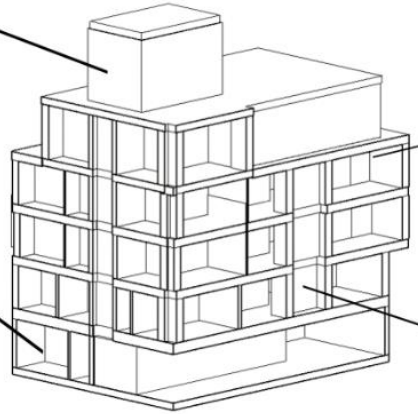
1. 60% Time Savings
2. Evaluate Multi-Variant Solutions
3. Improve Design Communication
4. Decision-making aids

Many specialized plans are based on standards.
We convert standards into algorithms and thus enable specialized planning «at the click of a mouse».
Parameterization will open up new degrees of freedom for architectural design.

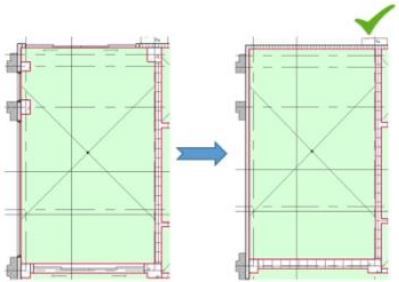
What are the model inputs?



Name technical rooms
as IfcSpace

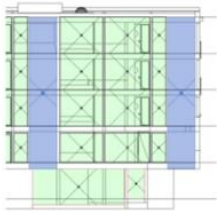


Apartment defined
as IfcZone

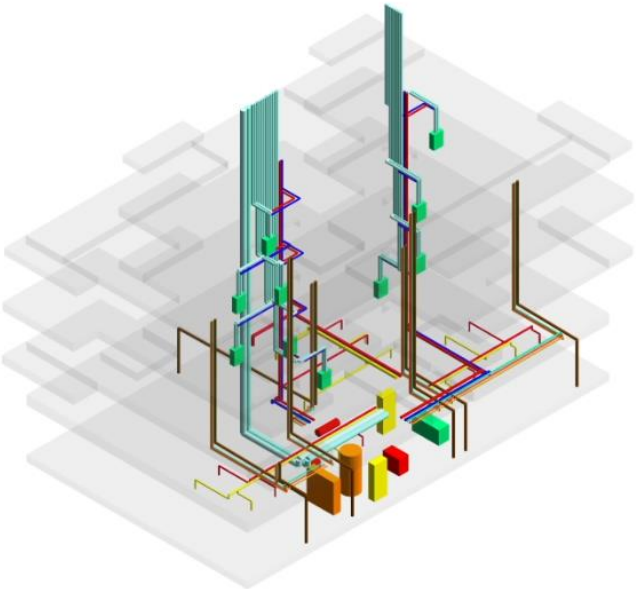


Example of a simplified
technical room (floor plan)

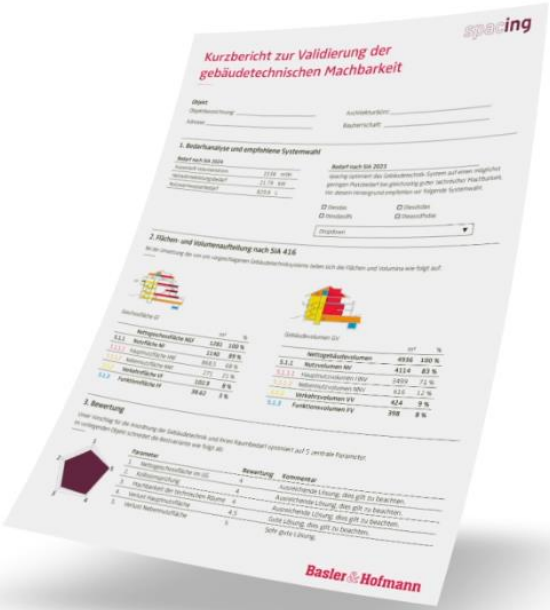
Shafts defined as IfcSpace
and modeled in all floors



What are the results?



.ifc model



Report

Our design goals

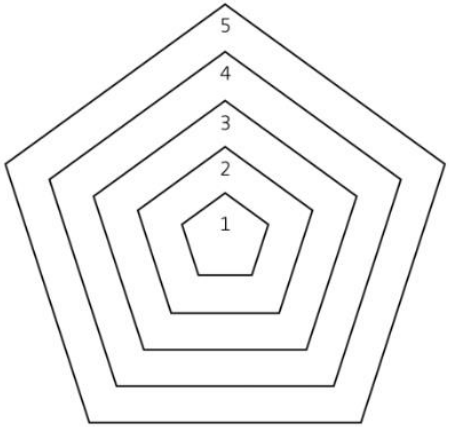
1 Free height
achieved through minimizing the installations

2 Collision detection
this function is minimized in the algorithm

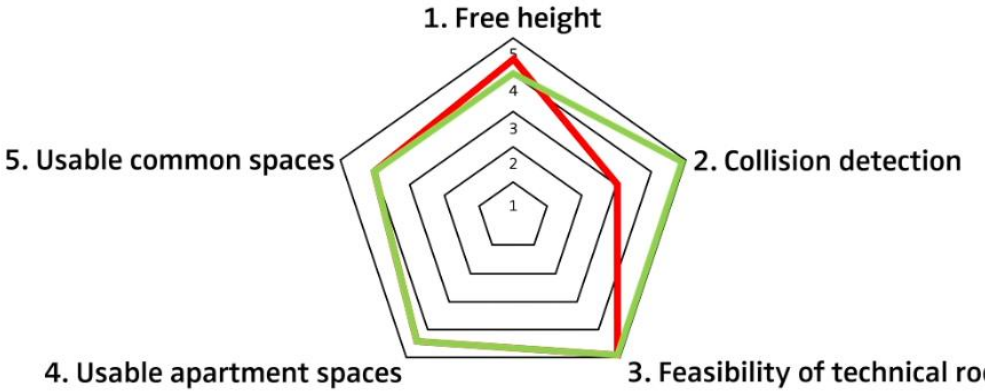
3 Feasibility of technical rooms
this is a critical parameter and is maximized

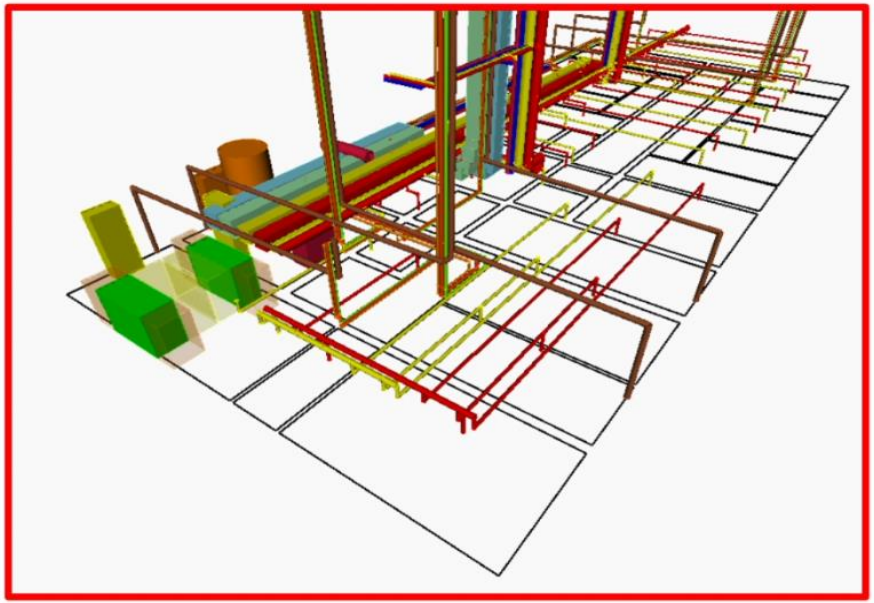
4 Usable apartment spaces
direct rentable floor area for an architect – maximized

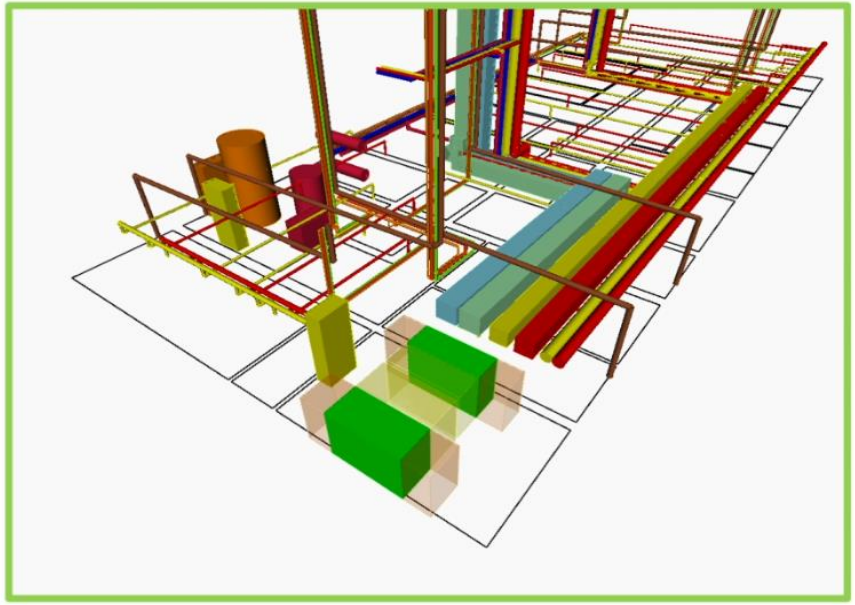
5 Usable common spaces
parking, laundry, bicycle parking etc. – maximized



Example – Collision detection


1. Free height
2. Collision detection
3. Feasibility of technical rooms
4. Usable apartment spaces
5. Usable common spaces
1
2
3
4
5





What is behind?

Explore Outcomes

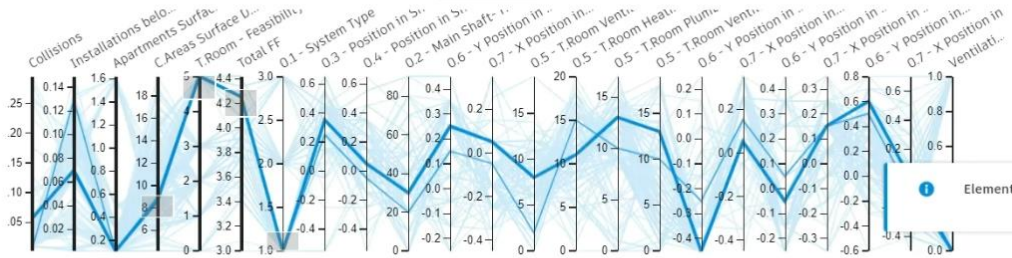
Studies

A

Charts Details

Collisions↑	Installations below headroom	Apartments Surface Deducted	C.Areas Surface Deducted	T.Room - Feasibility	Total FF	0.1 - System Type	0.3 - Position in Sh
0.005	0.129	0.108	8.995	5.0	4.250	1	0.2
0.056	0.070	0.108	8.649	5.0	4.250	1	0.3

Enable filters Click and drag over axes to add filters Clear filters

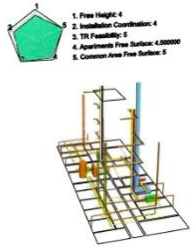


Element creation completed

40 of 40

Create Revit Elements

Details

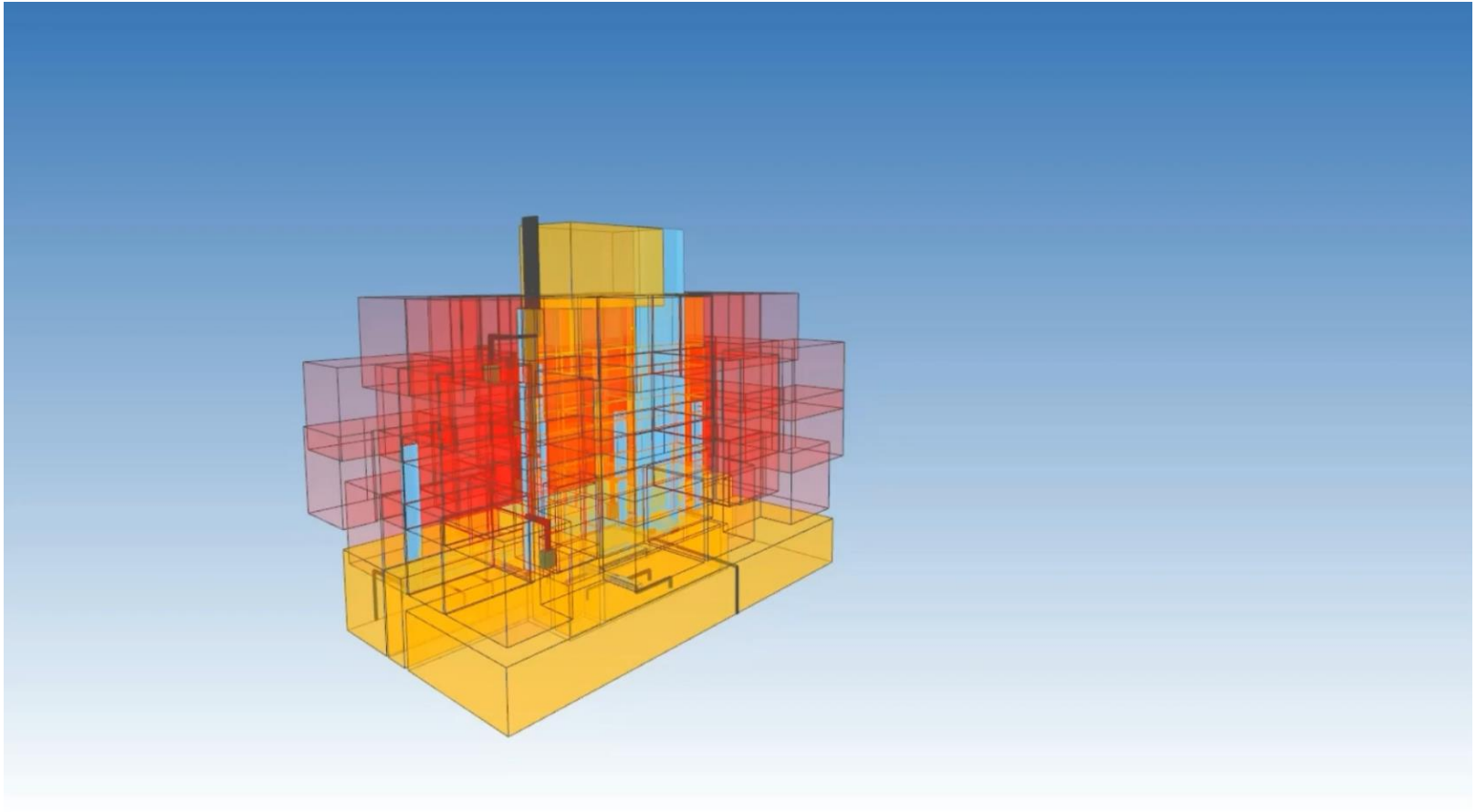


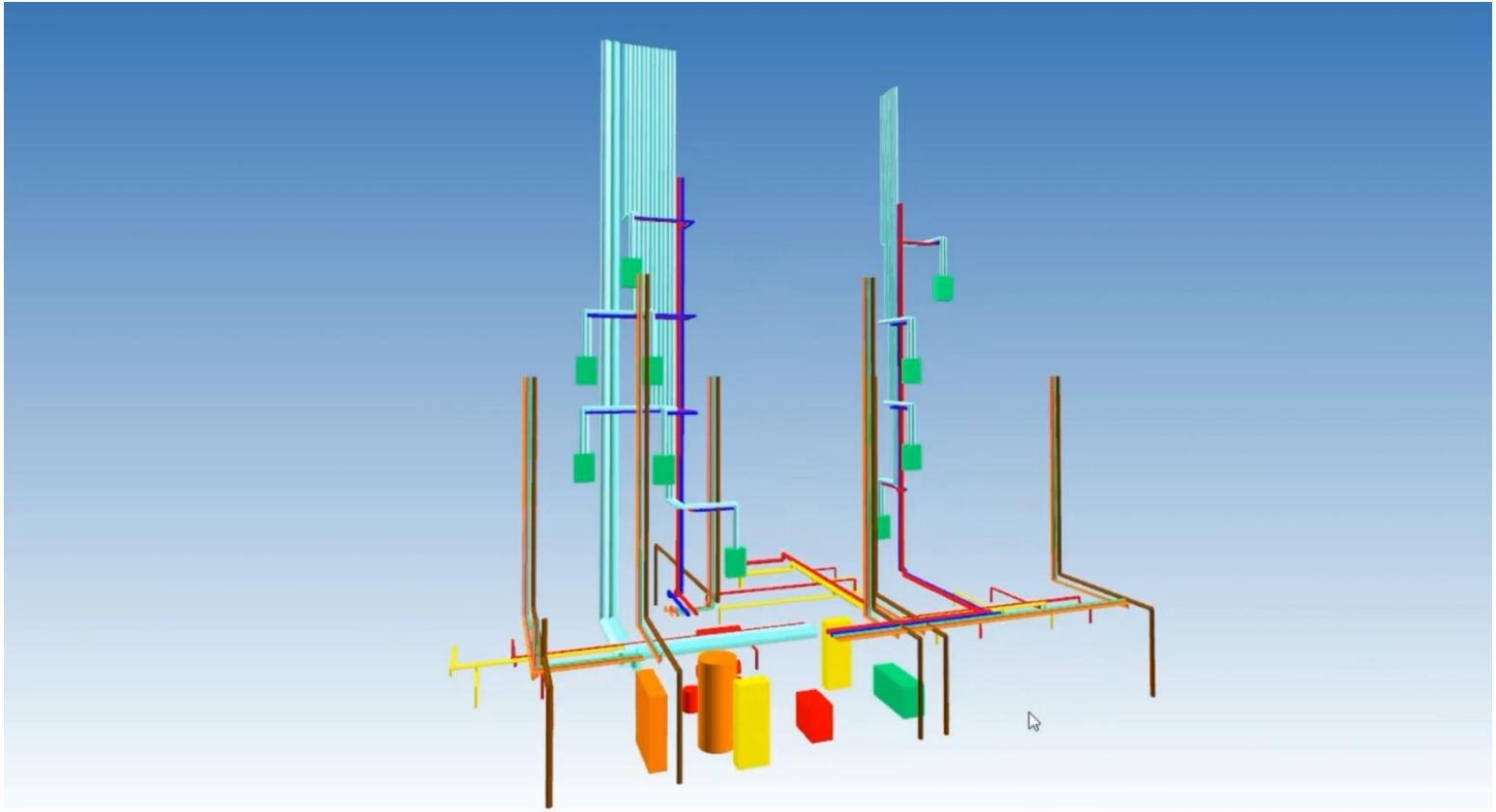
Outputs

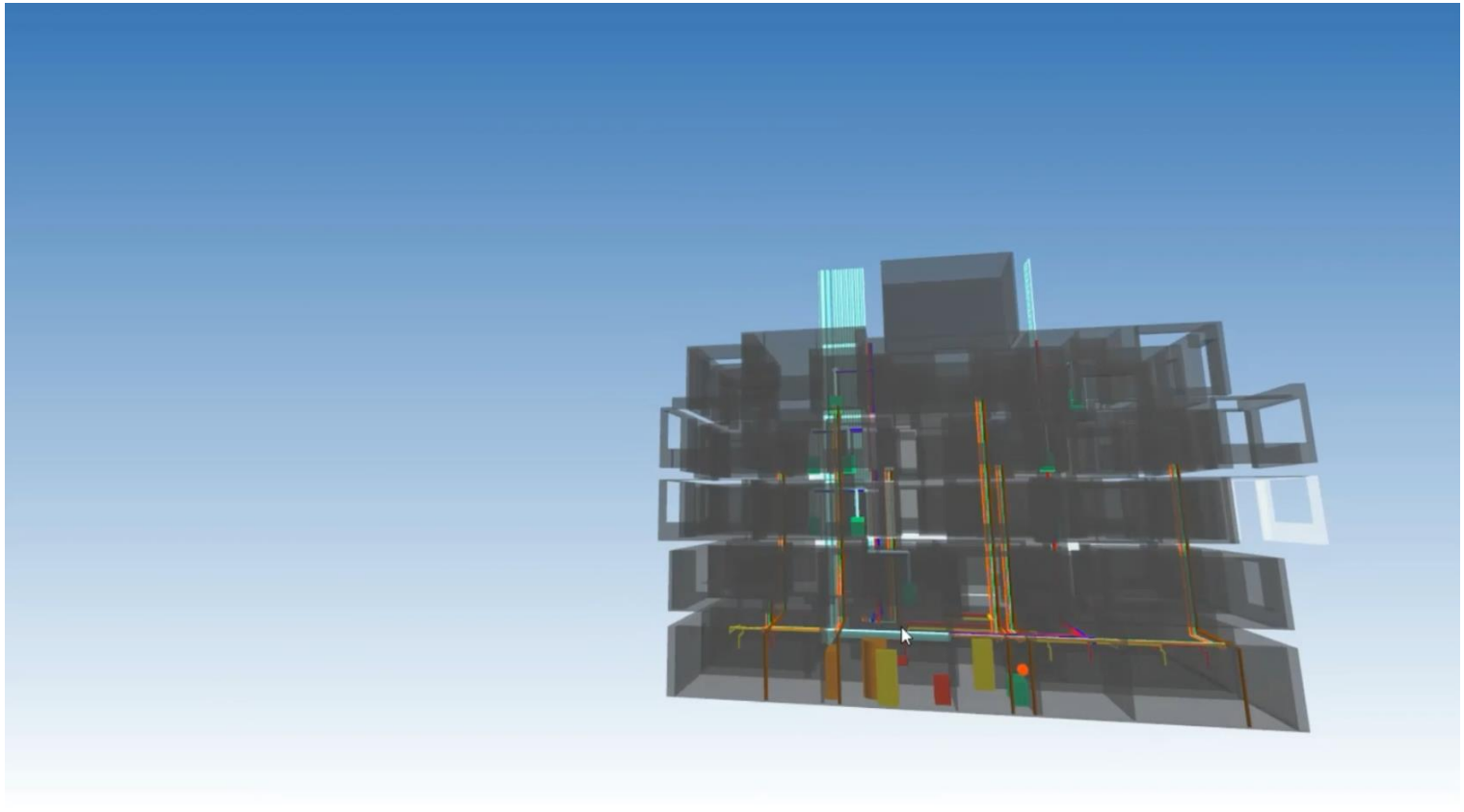
Collisions	0.056
Installations below headroom	0.070
Apartments Surface Deducted	0.108
C.Areas Surface Deducted	8.649
T.Room - Feasibility	5.0
Total FF	4.250

Variables

0.1 - System Type	1
0.3 - Position in Shaft - X	0.350
0.4 - Position in Shaft - Y	0.050
0.2 - Main Shaft- FA and E	30







spacing helps you decide and design better.

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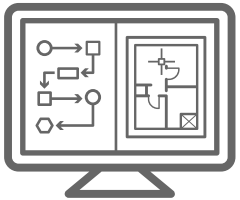
What’s Next?

Subtitle

Focus Areas

Computational Design and Automation Roadmap



Accessibility

Make Dynamo easier for new users to learn. Make it easier for more people to use Dynamo automation routines.

Sharing

Make it easier to share and collaborate on Dynamo files inside and outside of your firm.

Performance

Make Dynamo faster and less prone to missing dependency problems.

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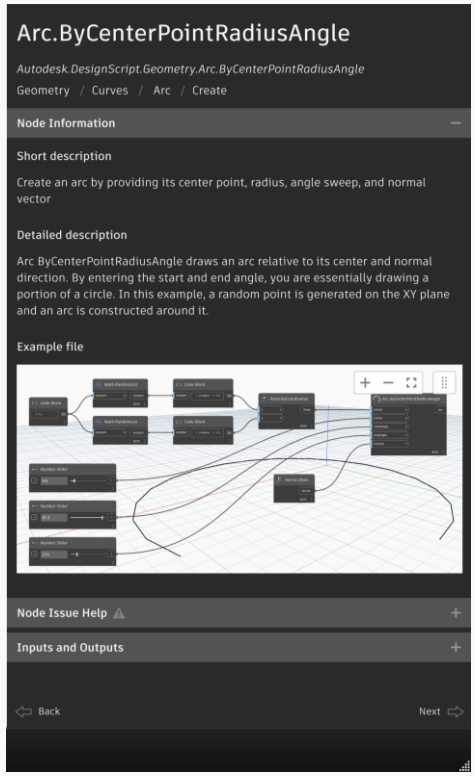
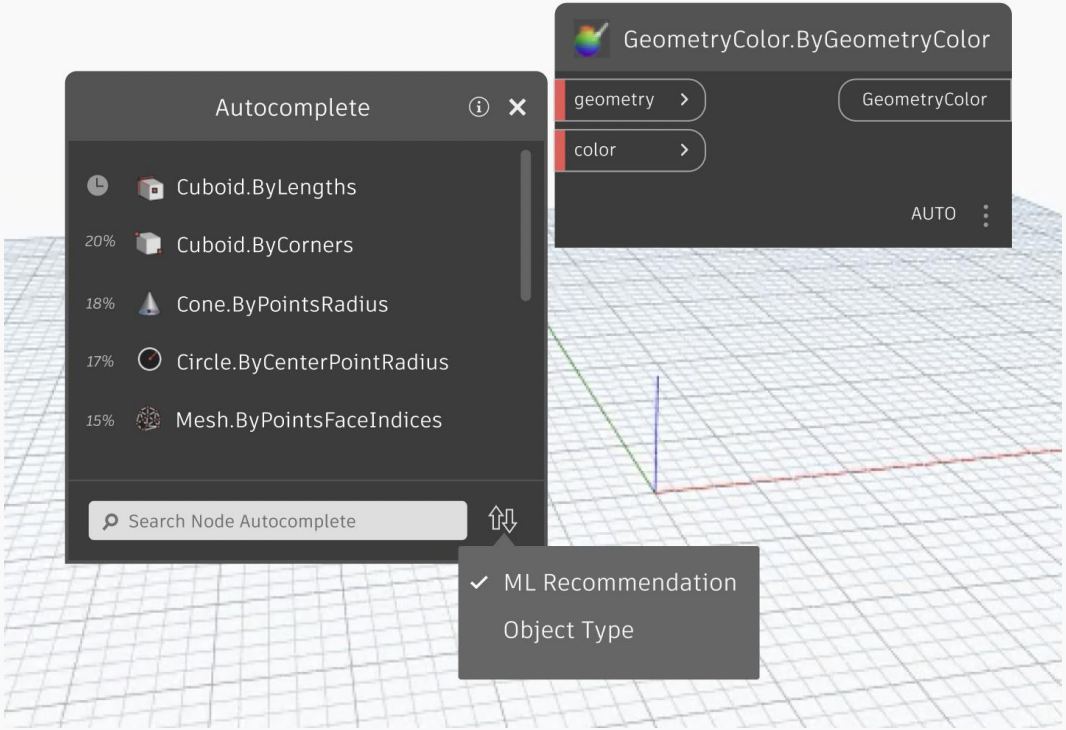
Improve Accessibility

Subtitle

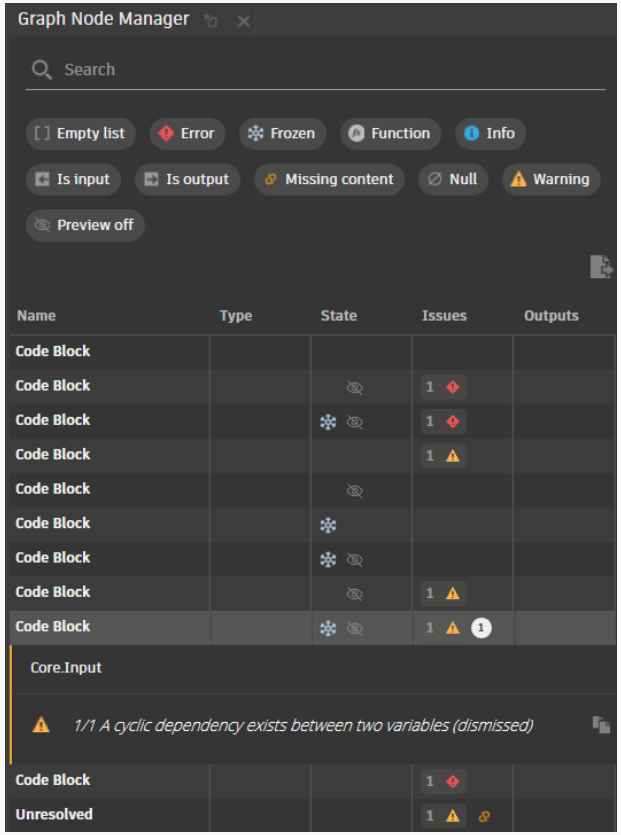
Dynamo Extended Node Help & Documentation Browser update

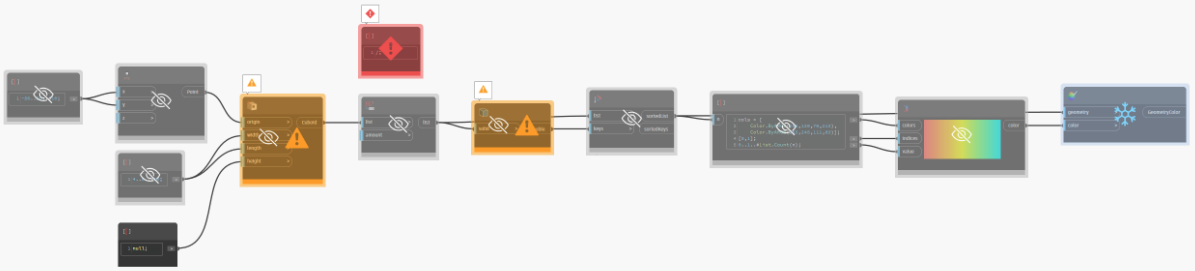


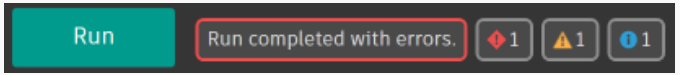
Empower Node-Autocomplete with Machine Learning



Swiftly understand Graph Node States







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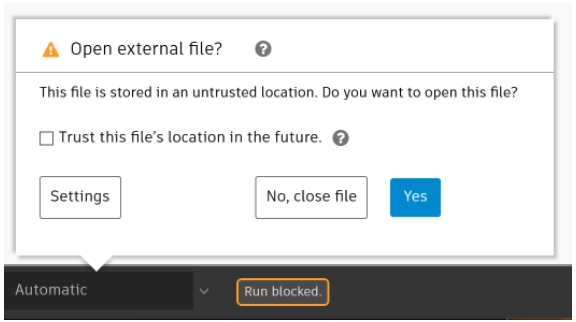
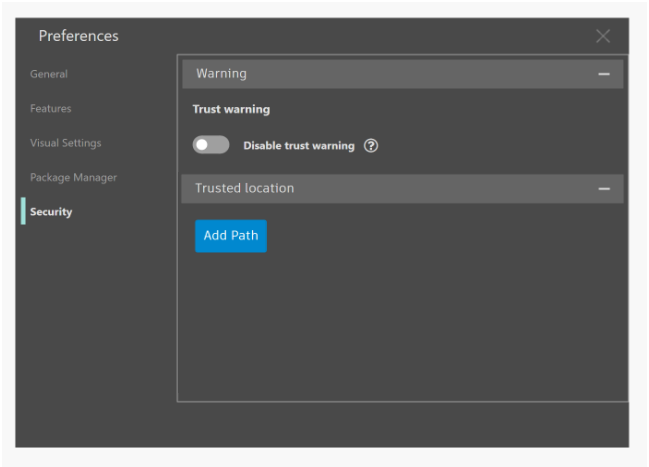
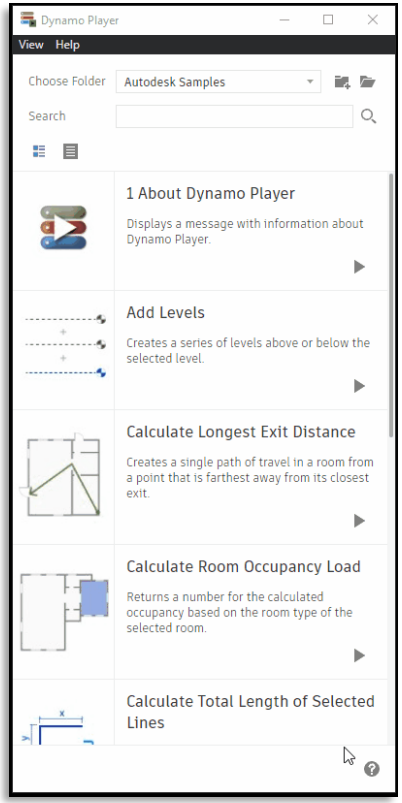
Better Sharing

Subtitle

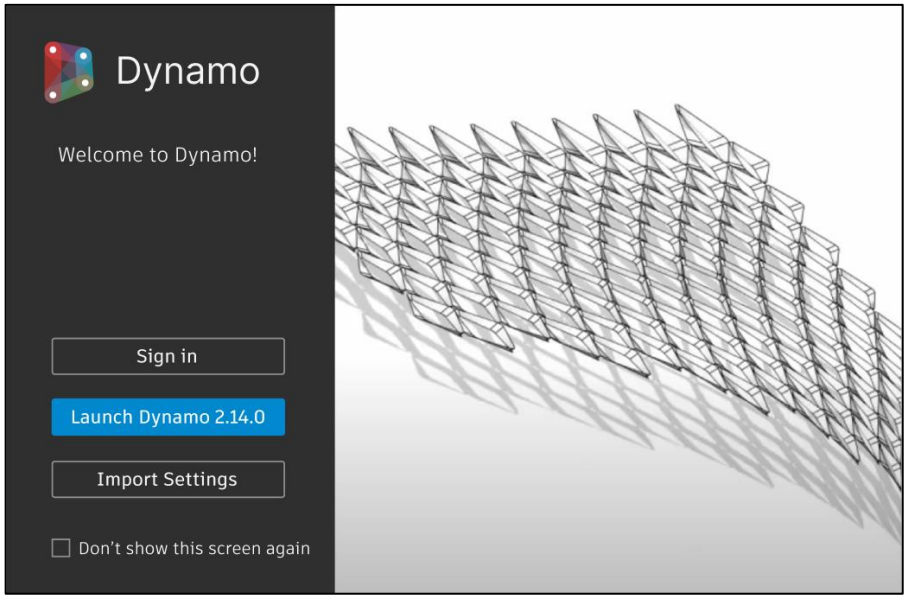
Bringing Trusted Locations to Dynamo

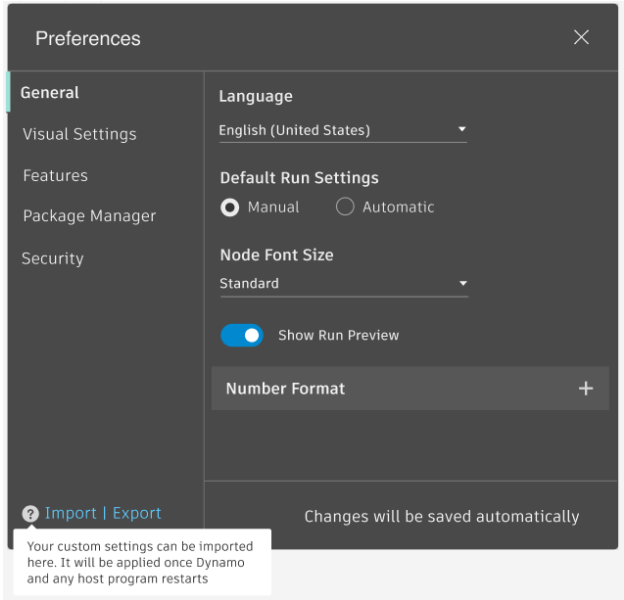






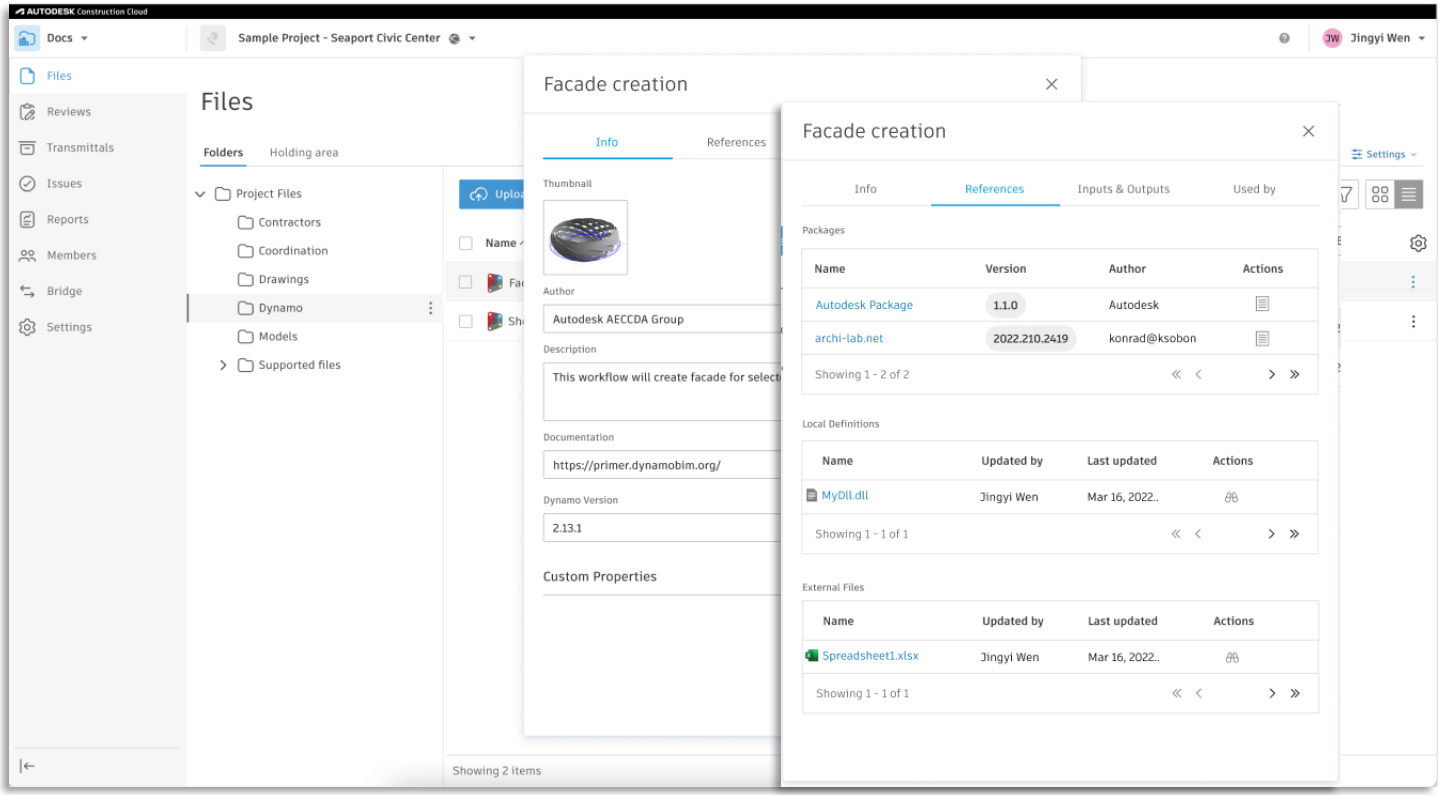
Dynamo Settings Deployment & Splash Screen





Dynamo file info on Autodesk Docs

Share Dynamo files and see more information about them online



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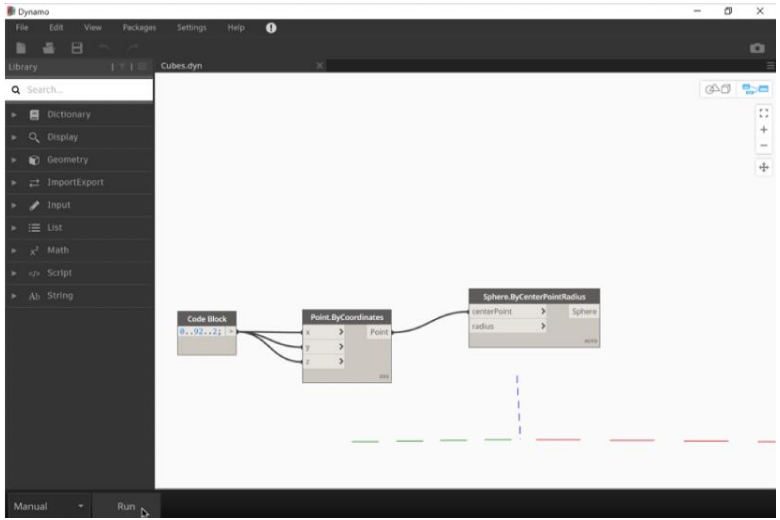
Better performance

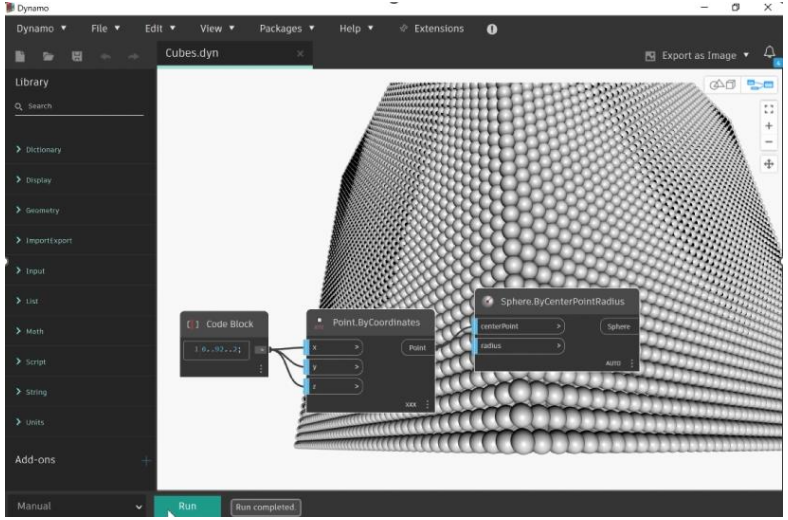
Subtitle

Dynamo Performance Enhancements

Creation of 103,823 Spheres



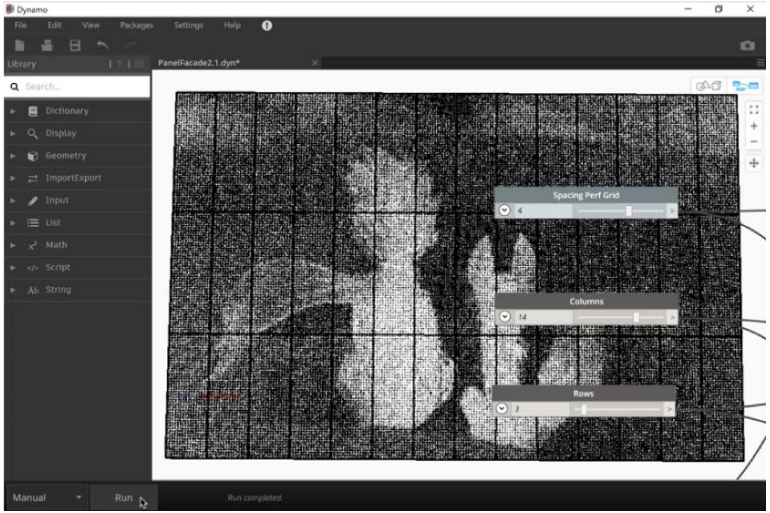
Dynamo 2.1:
ran out of memory before completing the graph

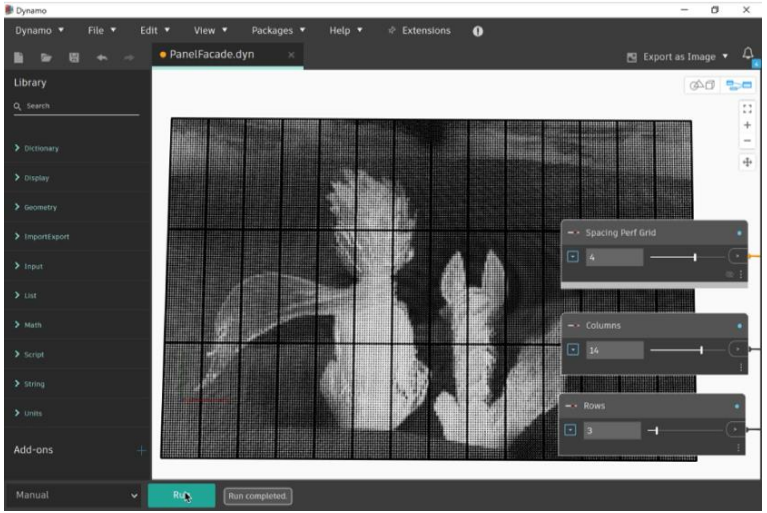


Dynamo in Development:
5.4 seconds to complete

Dynamo Performance Enhancements

Rendering a pattern of perforations



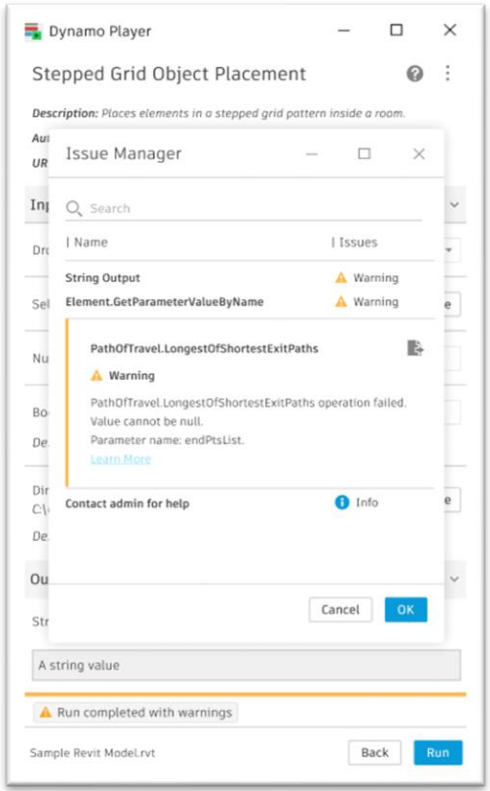


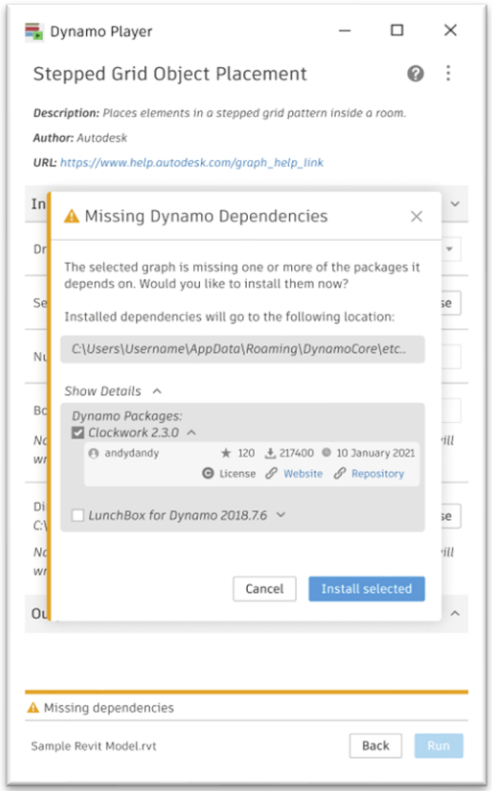
Dynamo 2.1:
7.51 seconds for first run
4.54 seconds to update a slider
1.2GB memory usage

Dynamo in Development
2.55 seconds for first run (3x faster)
1.19 seconds to update a slider (4x faster)
500MB memory usage (reduced by half)

Dynamo Player/GD Dependency Manager

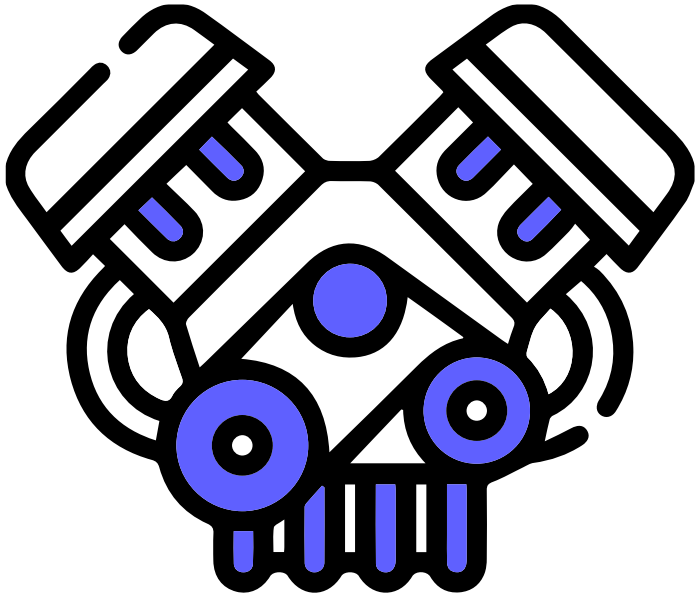
Resolve package issues and get warnings in Dynamo Player





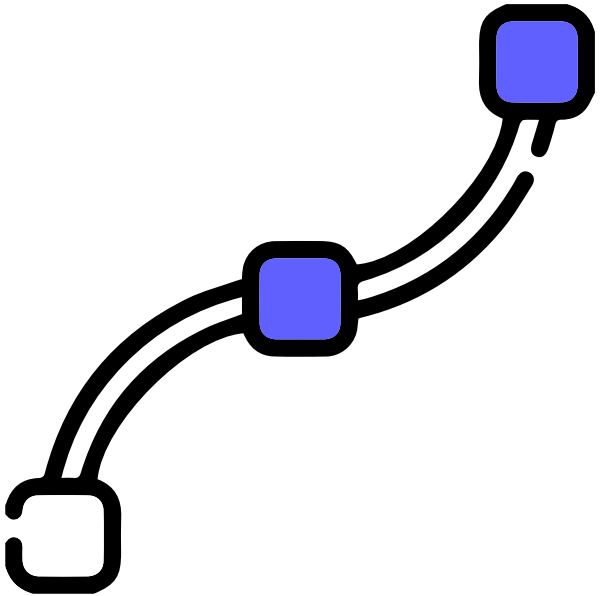
Dynamo Engine Refactor

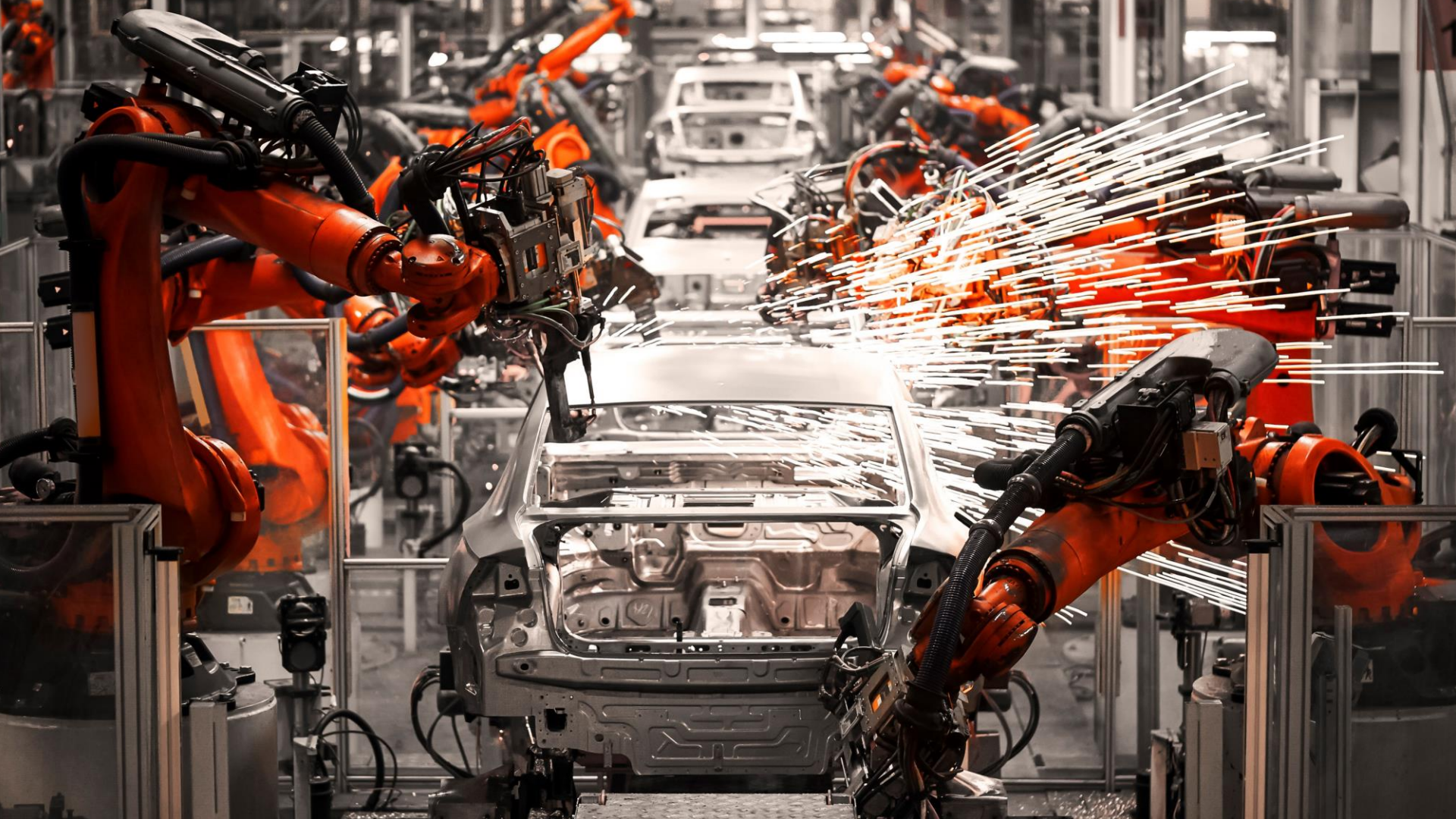
Ensuring that Dynamo’s graph execution is performant, efficient and robust



Dynamo Native Polycurves

Native C++ PolyCurve support that is robust, performant and plays well with the rest of Dynamo's Geometry






002·B1·L2·T11
73-7 3/8
002·B1·L4·T10
FIRE
FIRE
CINTAS

Images courtesy of How Things Are Manufactured @fastworkers6

Thank you inspirational Dyna-leaders!