Finally Working Together, Civil 3D and Dynamo

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Autodesk AEC Technical Specialist

AUTODESK. UNIVERSITY

Agenda

1. Computational vs. Generative Design
2. What is Dynamo?
3. How to download & install it
4. User Interface and terminology
5. Live Demo
6. Use cases and workflows
7. *Productivity Toolkit* Package
8. *CivilConnection* Package
9. Project Refinery!
10. Learning + Q&A

About the Speaker

Mohammad Abou Assali

Autodesk AEC Technical Specialist (Infrastructure focus)

Based in Dubai, United Arab Emirates

Responsible for **Infrastructure Solutions** like:

Civil 3D, Vehicle Tracking, Geotechnical, InfraWorks, Navisworks, 3ds Max & BIM 360.

Bachelor Degree in **Civil Engineering** (AUB)

PMP certified (PMI)

Diploma in Supply Chain Management (SCM)

Masters in Neuro Linguistic Programming (NLP)

Certified Consulting Hypnotist (NGH)

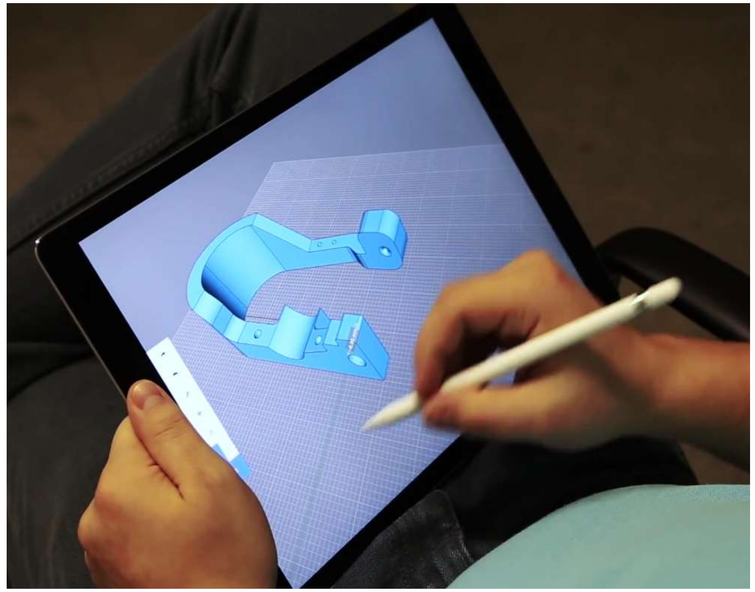
12 years of AEC industry experience

- 6 years in civil construction projects
- 6 years with Autodesk

Computational vs. Generative Design Intro

What about today?

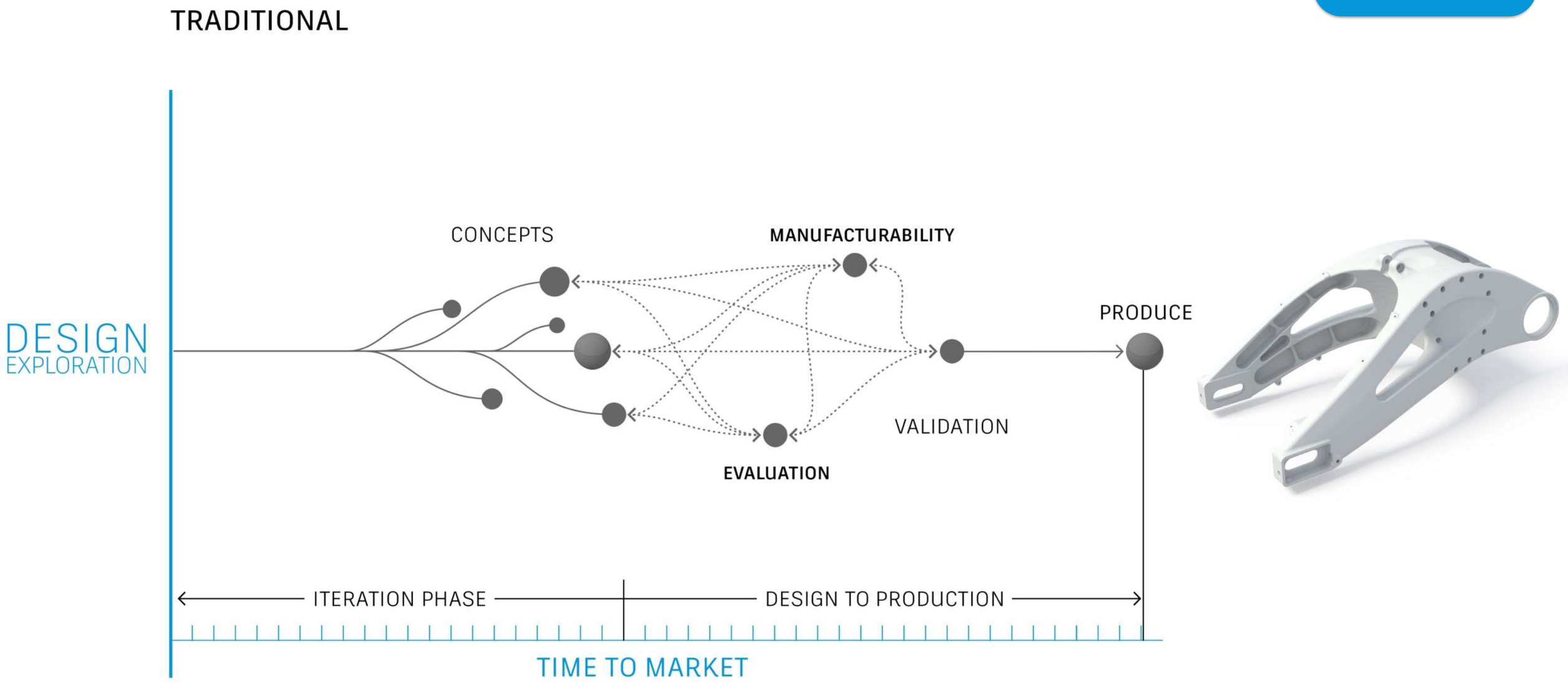
The “**Augmented Age**”



Passive → **Generative**

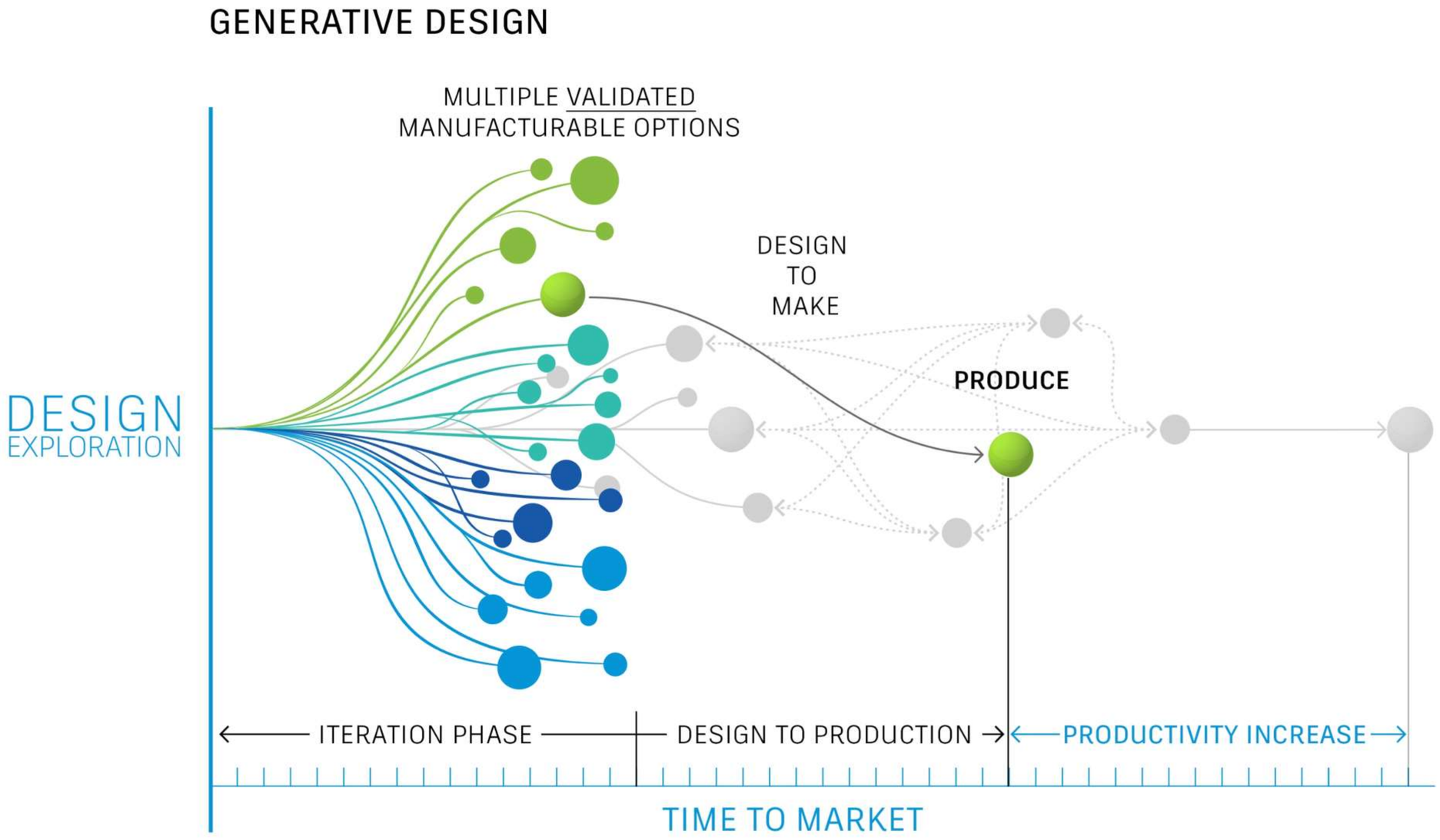
HOW DOES AUTODESK GENERATIVE DESIGN HELP THE PRODUCT DEVELOPMENT PROCESS

Passive

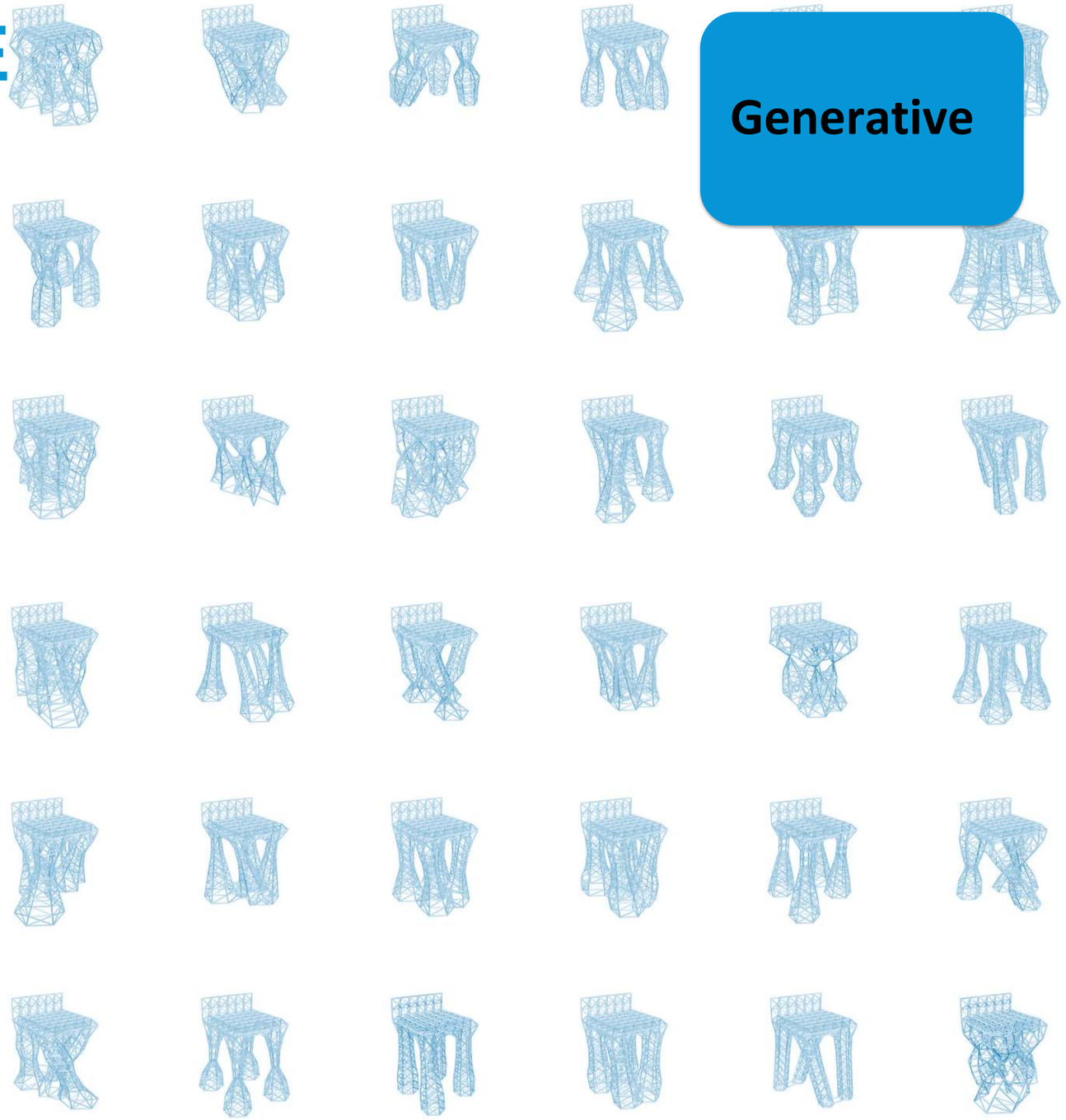


HOW DOES AUTODESK GENERATIVE DESIGN HELP THE PRODUCT DEVELOPMENT PROCESS

Generative



AUTODESK GENERATIVE DESIGN



Generative

Autodesk generative design is a “**design exploration technology”**.

Simultaneously generate multiple CAD-ready solutions based on:

1. *real-world manufacturing/construction constraints*

    &

2. *Product/**design** performance requirements*.

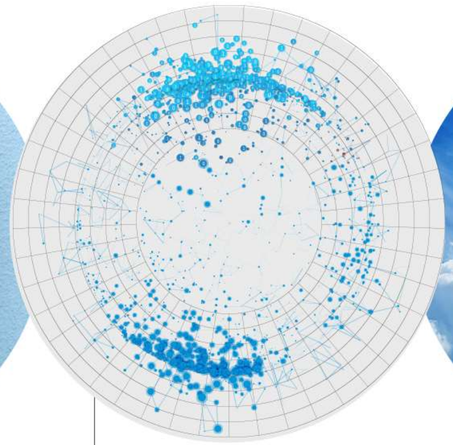
Generative

THE NEW WAY

Computer and designer/engineer unite as co-creators

one human

+

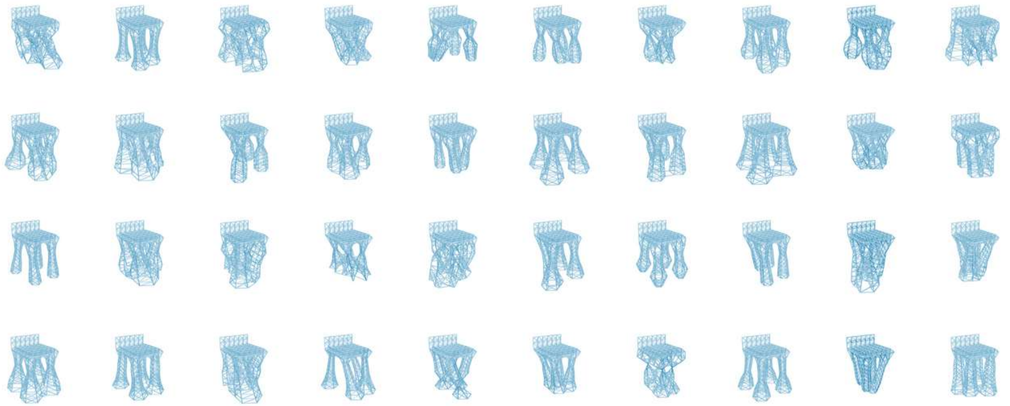


machine learning algorithims

+

unlimited cloud-computing power

=

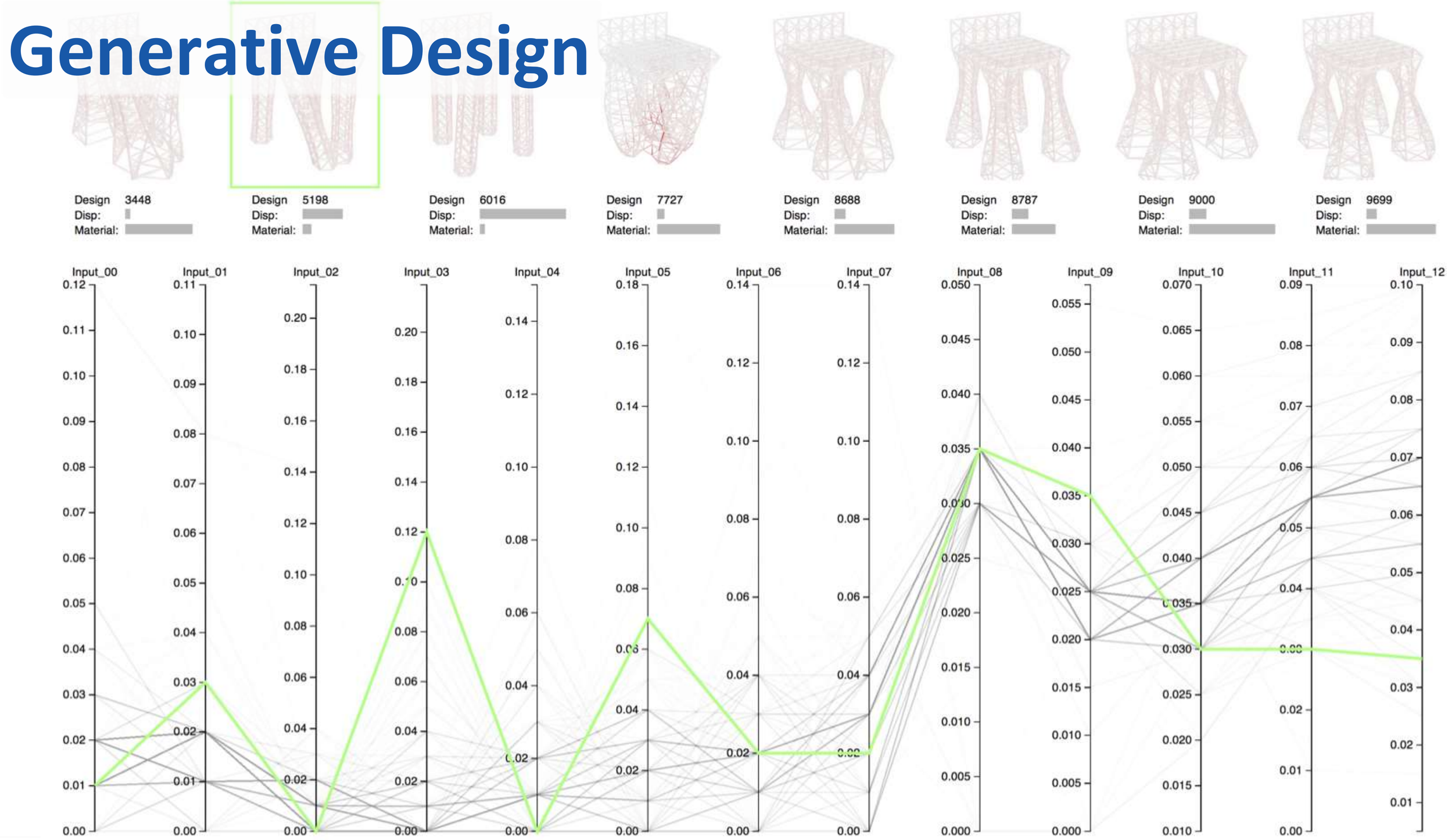


100s to 1000s of design options

Generative

THERE ARE
MULTIPLE PRACTICAL OUTCOMES
FOR A DESIGN PROBLEM

Generative Design



AUTODESK.

The Journey

Traditional Design

Recording decisions

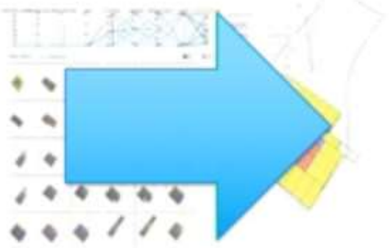
Generative Solutions

Describing goals + constraints for computation

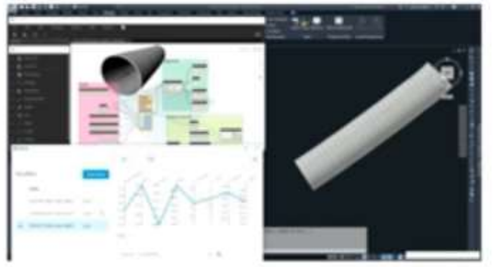
Parametric Modeling

Visual Programming

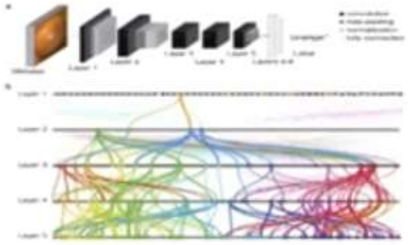
Option Generation



Design Optimization

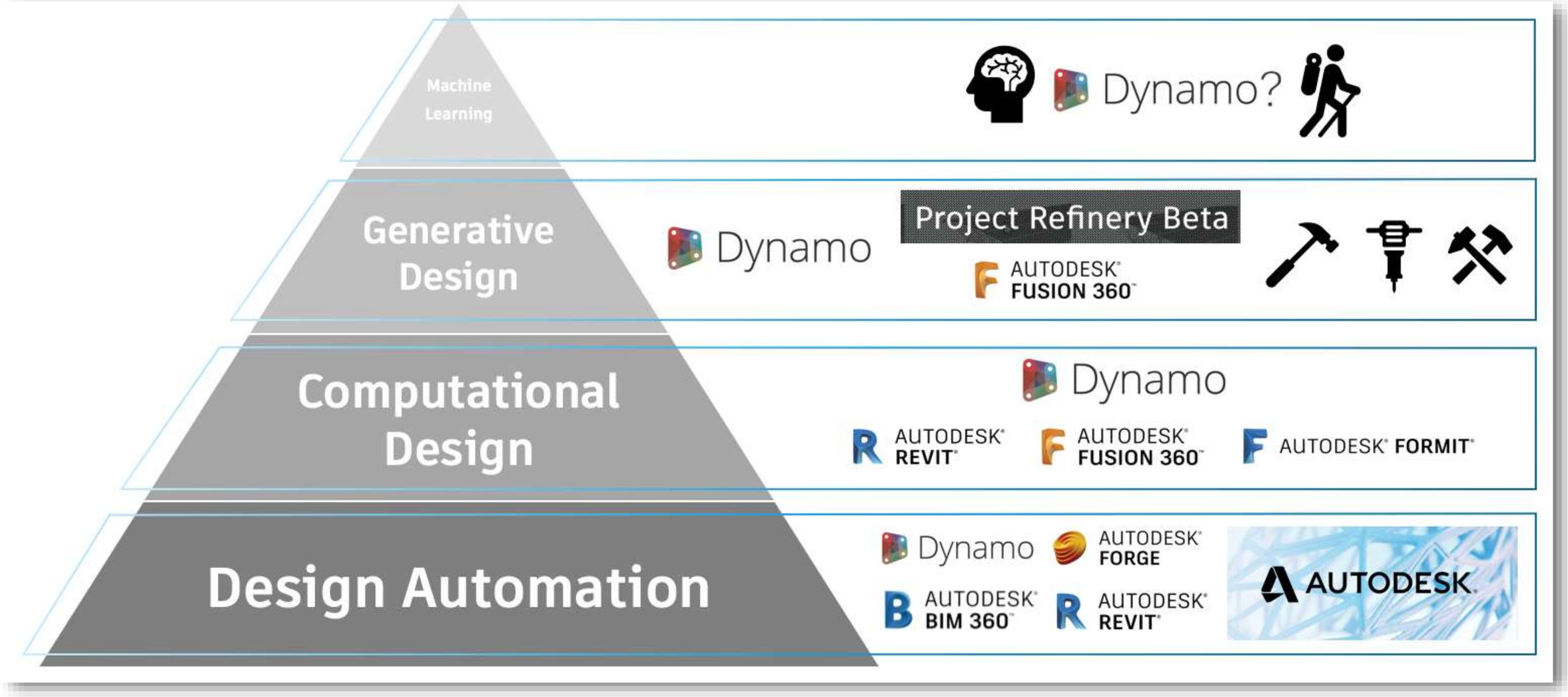


Machine Learning

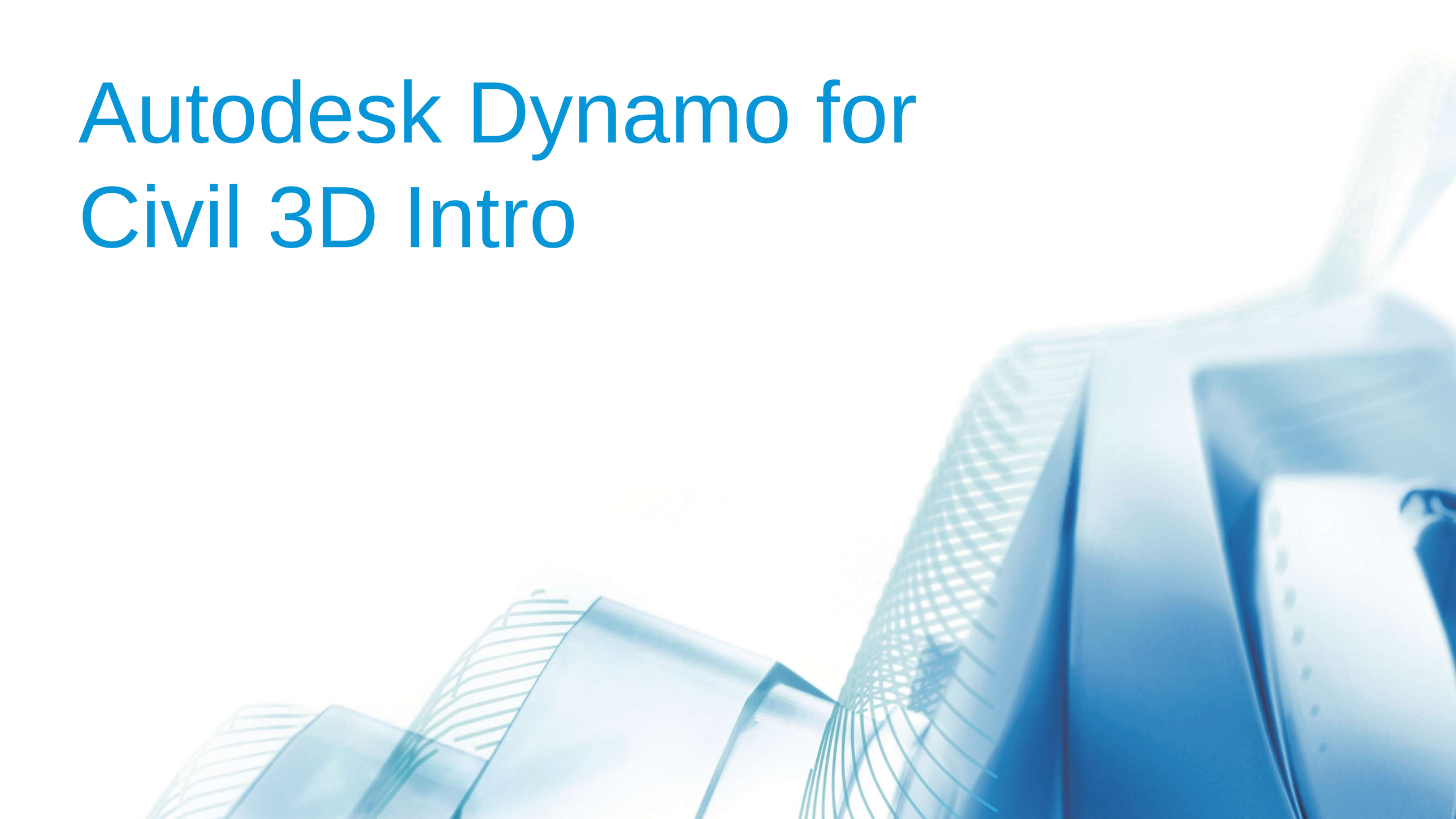


Dynamo for Civil 3D

Technology Positioning



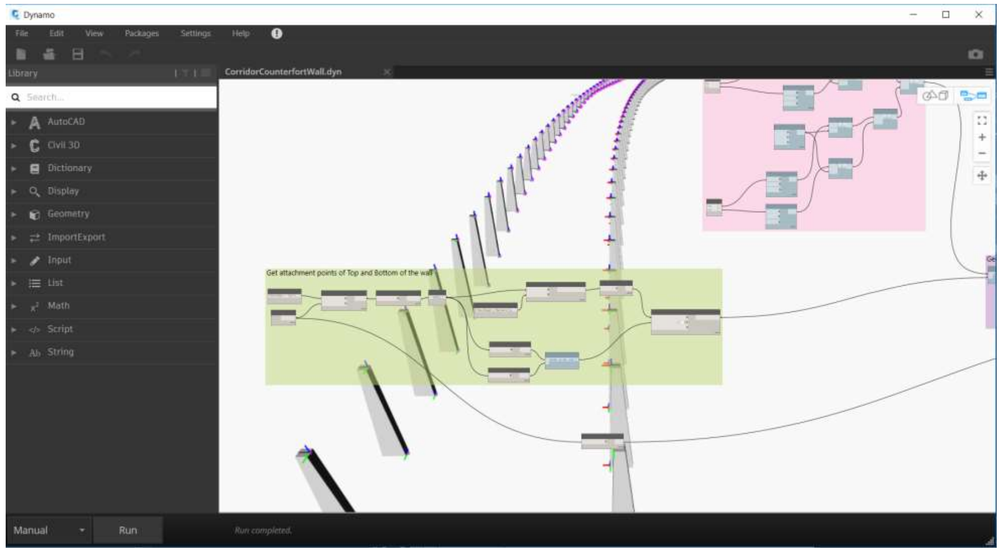
Autodesk Dynamo for Civil 3D Intro



Dynamo for Civil 3D

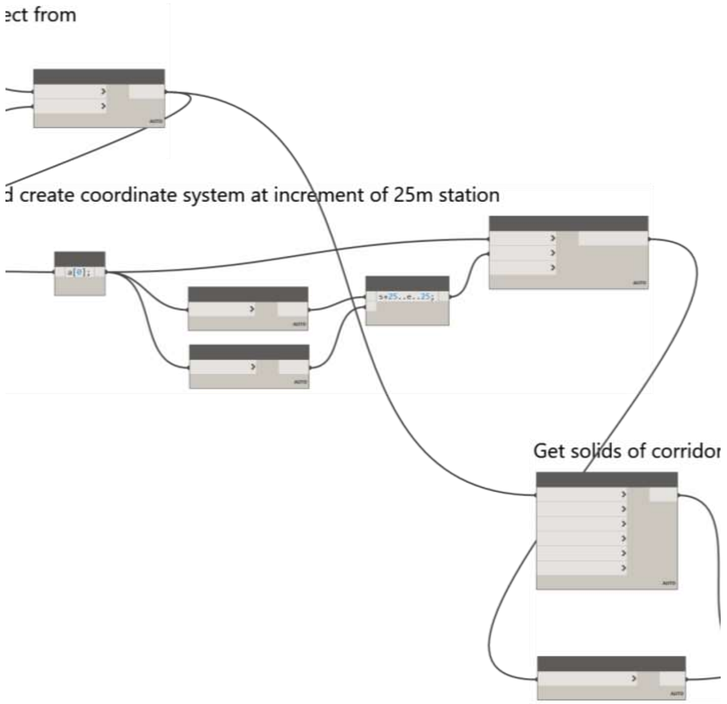
What is it?

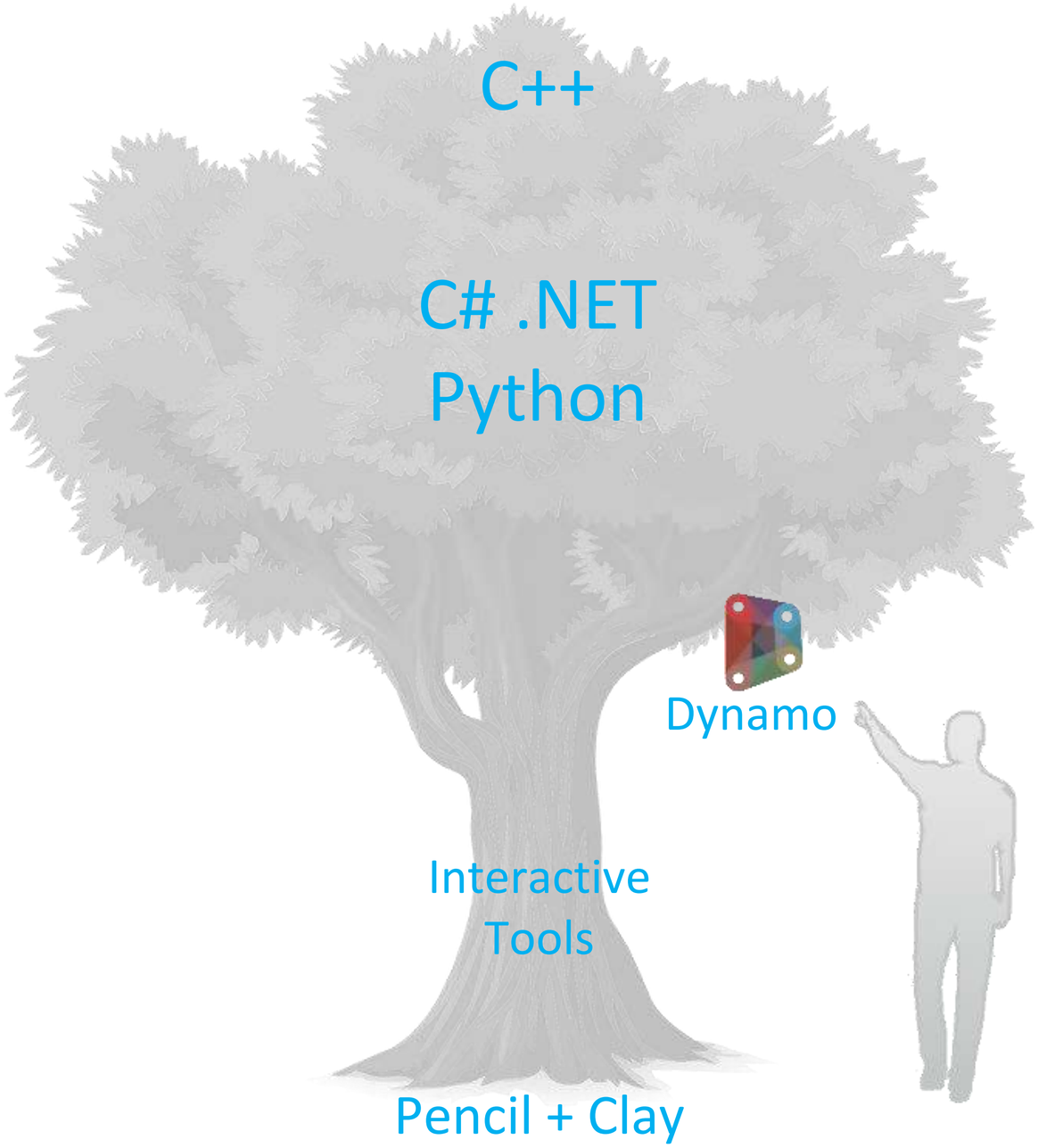
- Open-source programming platform
- Visual interface to construct logic routines
- Geometry creation
- Workflow automation
- **Interface for multiple software*



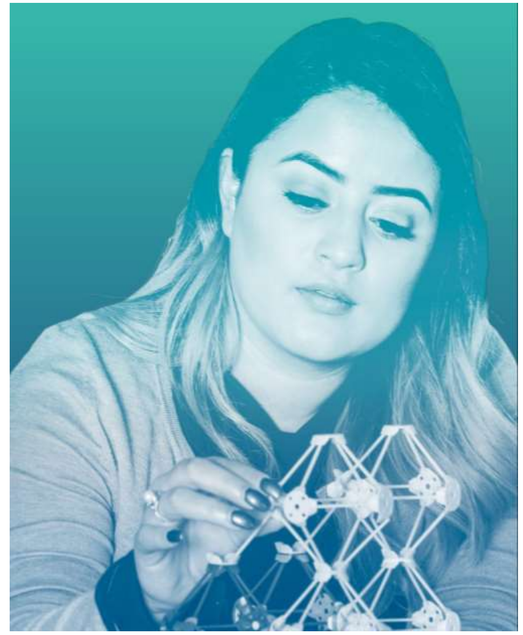
Dynamo for Civil 3D

Complex Modeling | **More**
Model Data Consistency | **Better**
Automate Repetitive Tasks | **Less Effort**





Dynamo for Civil 3D



What's in it for our customers?

- **Automation** :
  - ✓ Reducing man hours
  - ✓ Ensure Data completeness
  - ✓ Improve the efficiency of existing workflows and create new ones
  - ✓ Improve the collaboration
  - ✓ Enhance technology adoption …

Who is it for?

- ✓ Engineers and designers who process ***repetitive or time consuming design workflows***. Dynamo for Civil 3D gives users the ability to visually script behavior, define custom pieces of logic, and script using various textual programming languages. With its simple interface, this feature can be easily accessible to both non-programmers and programmers alike.

Dynamo for Civil 3D – Myths & Truths

- Don’t need to know how to code to use Dynamo
- Dynamo is only for modeling
- Dynamo = Civil API
- Once you go .NET you never go back
- Need to understand how to build logical structures
- Dynamo geometry engine is very powerful but it can be used for data mining also
- The more one knows the better
- Broader choice of tools to work with
- Dynamo is Generative Design
- Dynamo is computational design and a precursor to Generative Design

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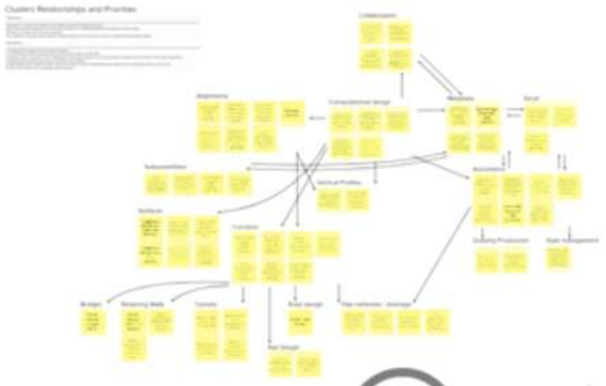
Dynamo for Civil 3D



September 2018
CRUX team develops a POC

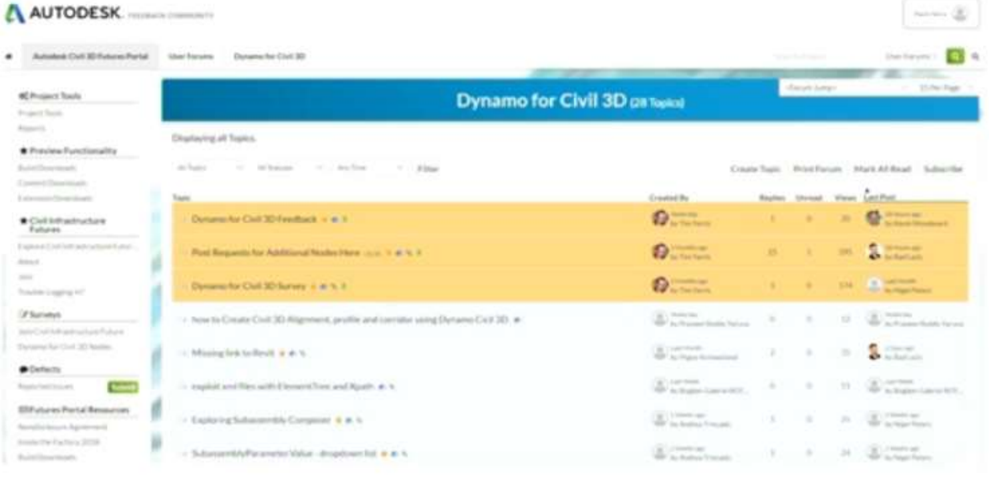
October 2018
Consulting shared CivilConnection use cases with product team

November 2018
Dynamo for Civil 3D is announced at Autodesk University

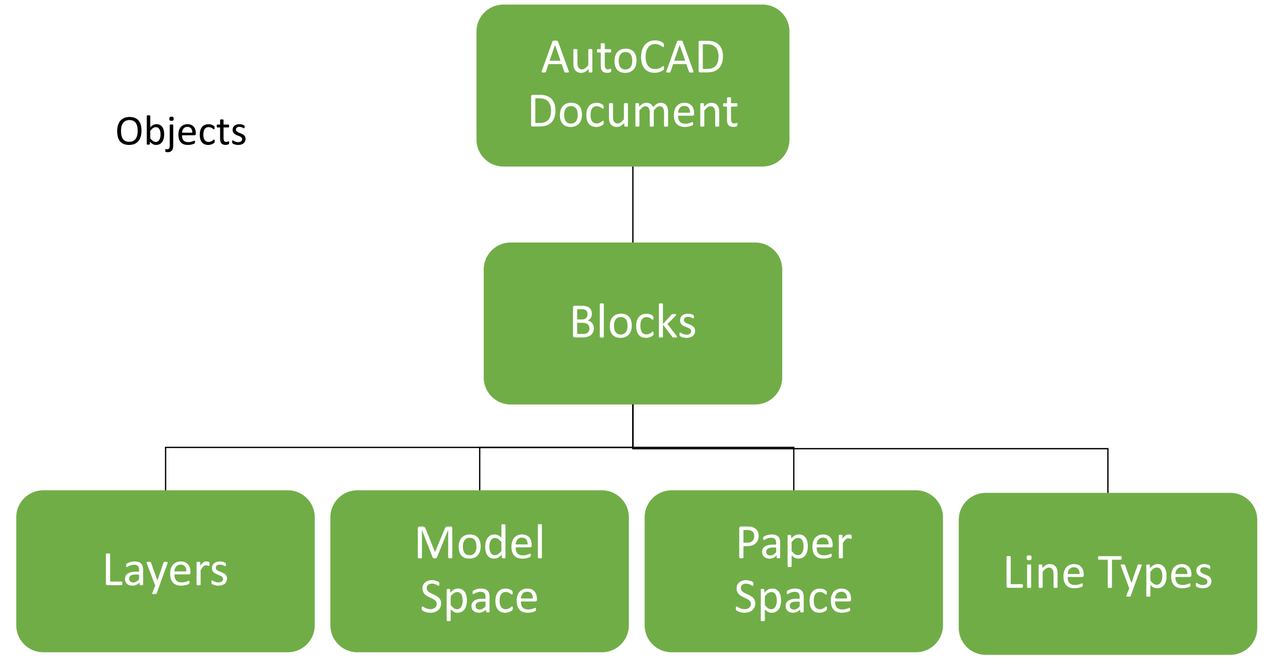
December 2018
Nigel Peters and CRUX Team in China start development

February 2019
Dynamo for Civil 3D is launched on the Beta website

April 2019
Dynamo is available at product global launch

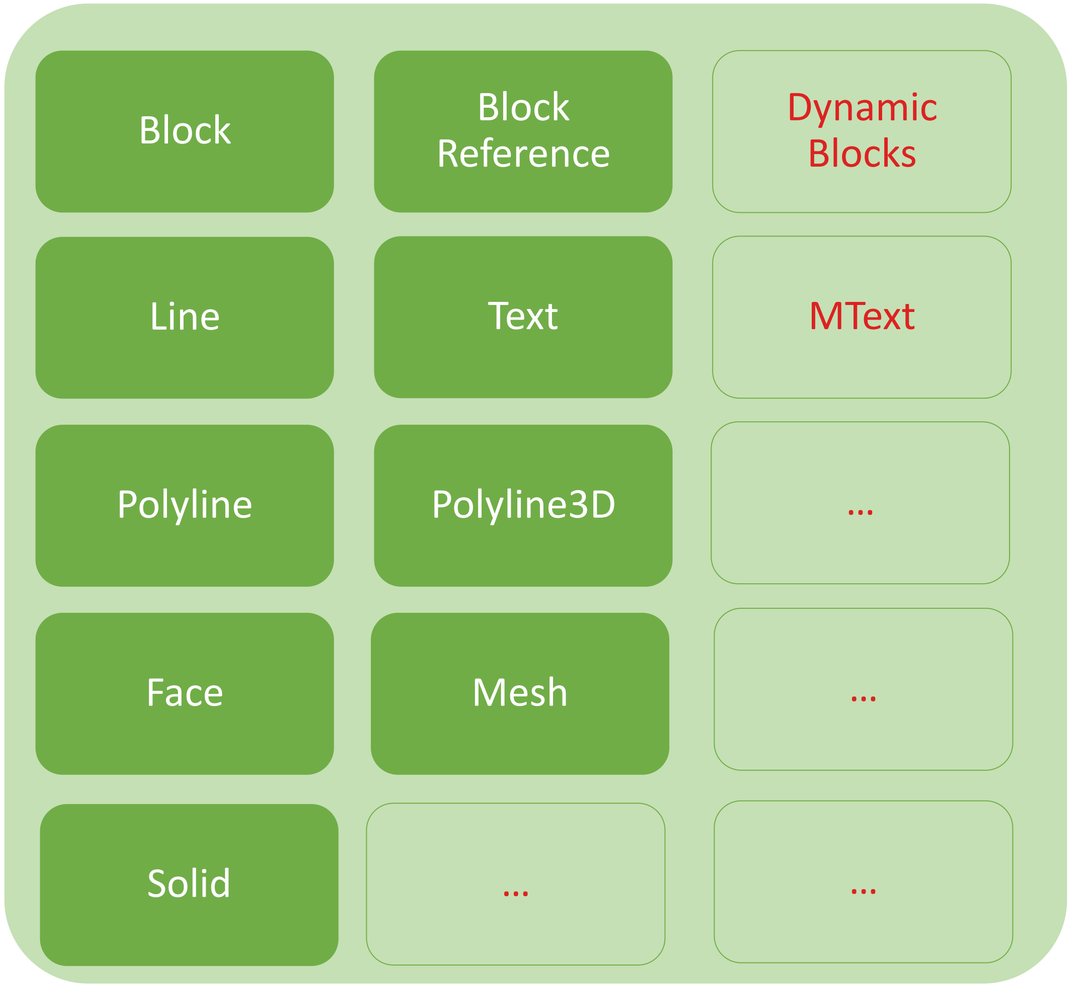


Dynamo for Civil 3D | AutoCAD Nodes



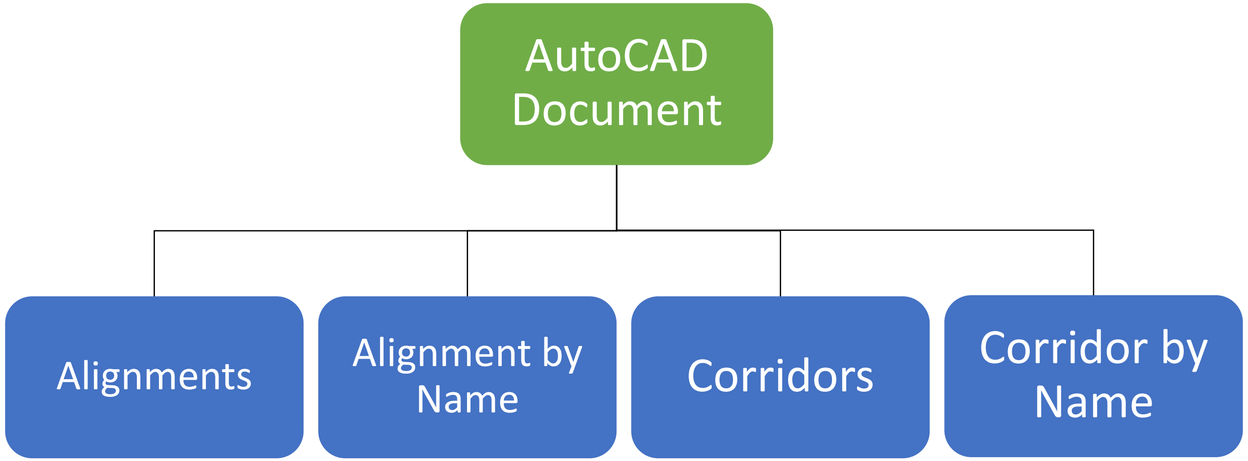
Document

Selection



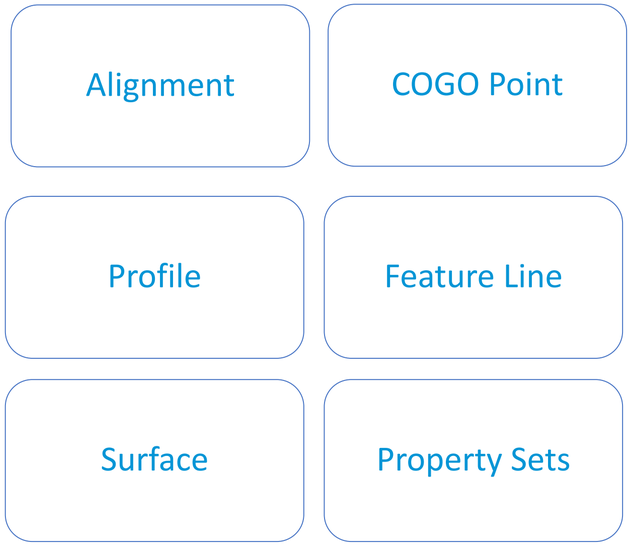
Object Model

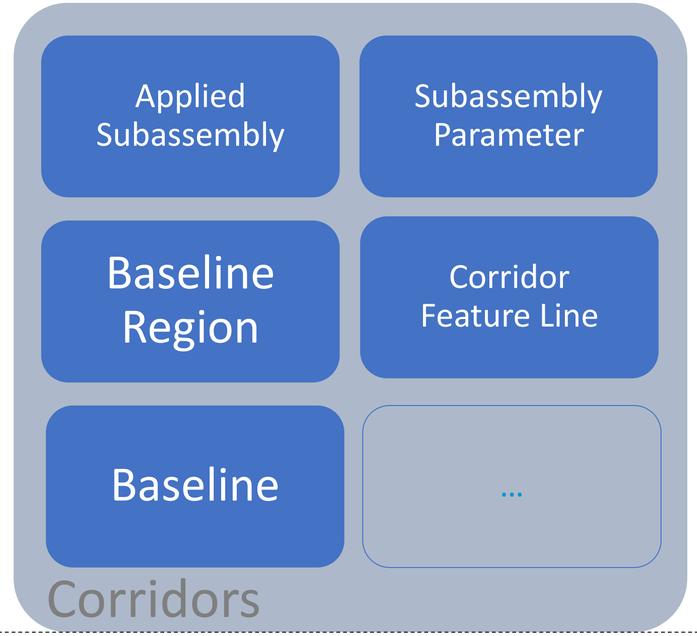
Dynamo for Civil 3D



Selection

Object Model





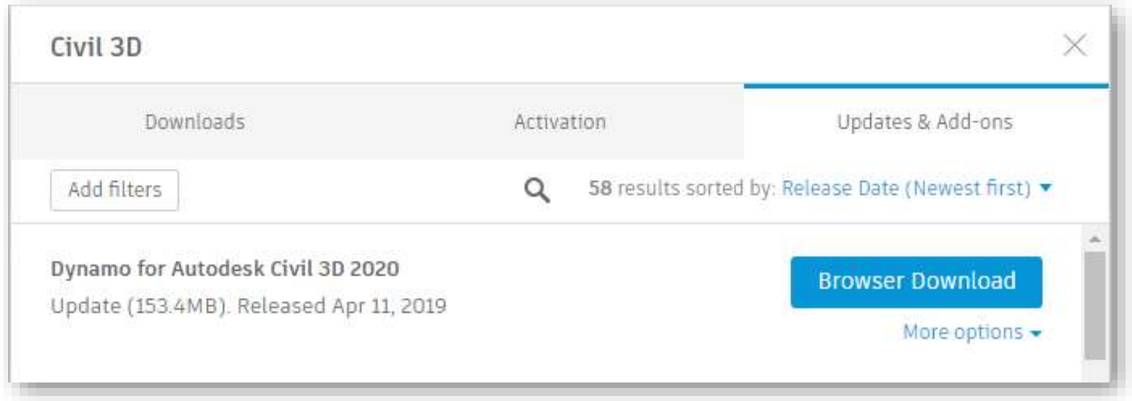
Dynamo for Civil 3D
Download and Installation

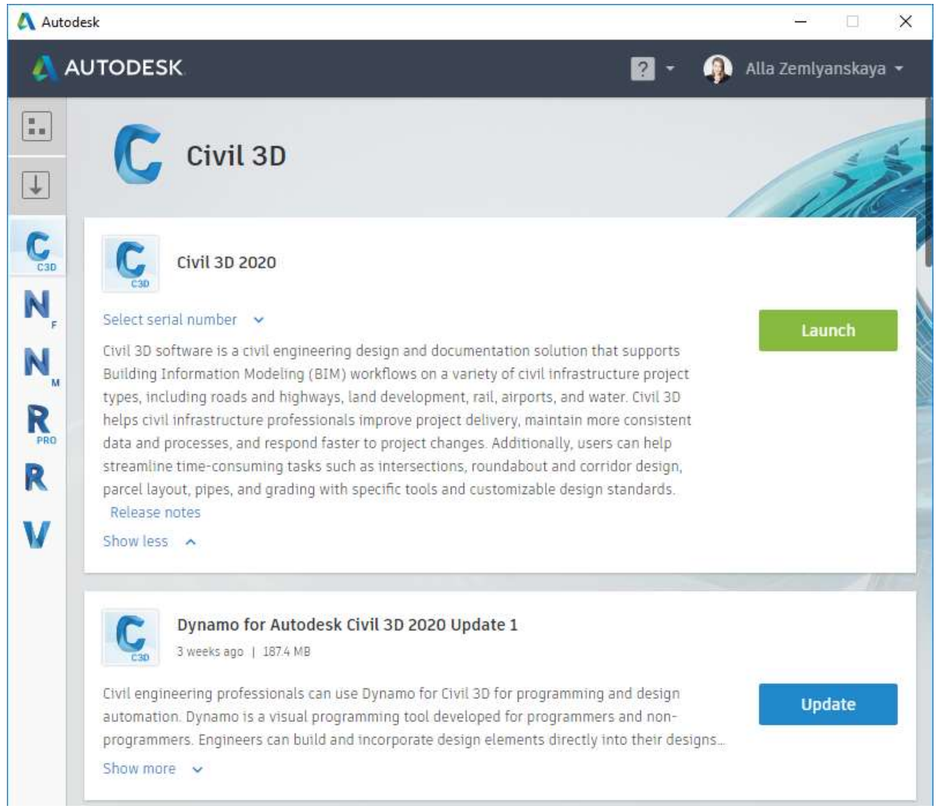
Dynamo for Civil 3D

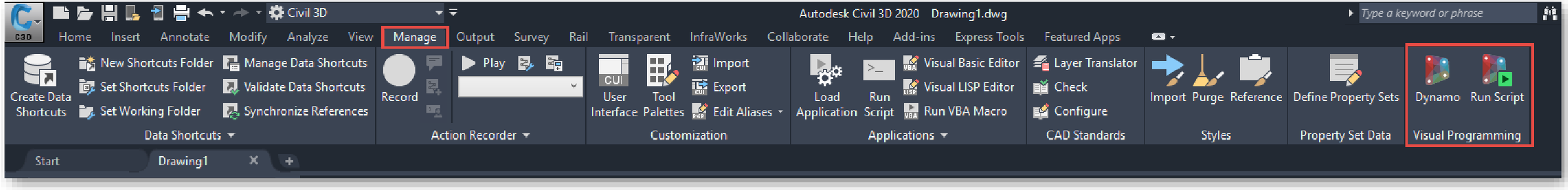
Download & Installation

- Separate installer
- New panel in the ribbon

  Manage > Visual Programming







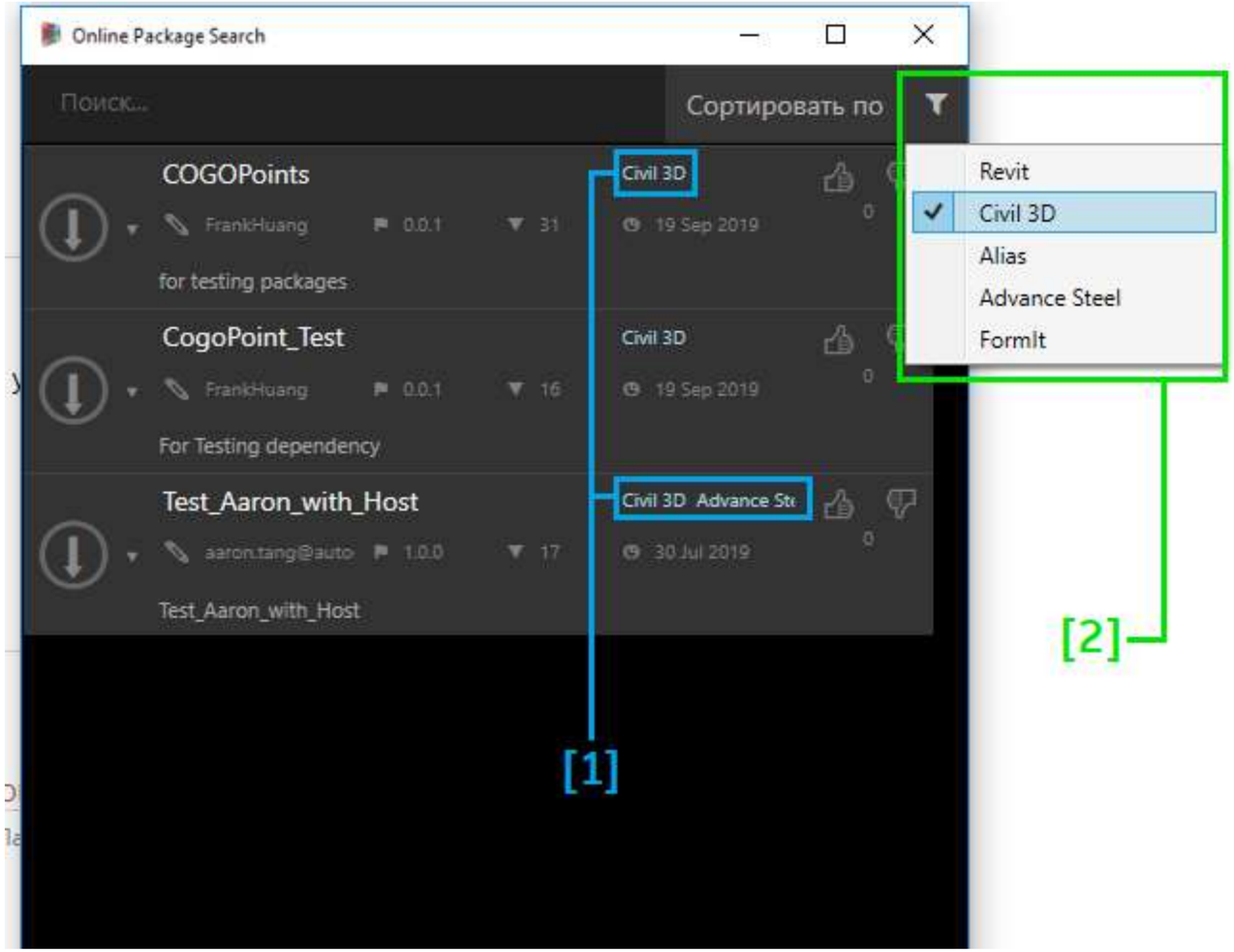
Dynamo for Civil 3D 2020 Update 1

Update to Dynamo 2.4

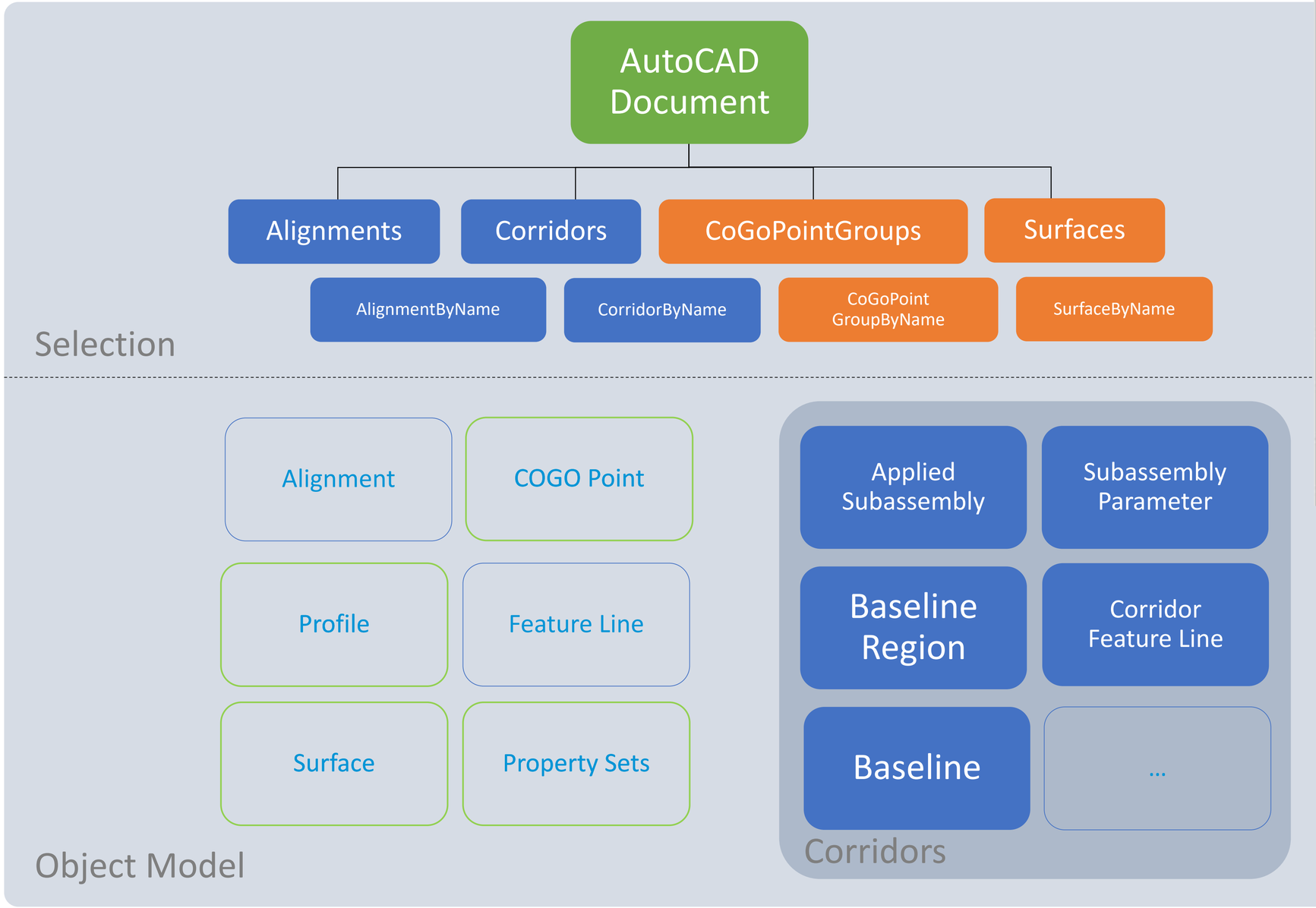
- Updated Python version
- Product Classification for Published Nodes

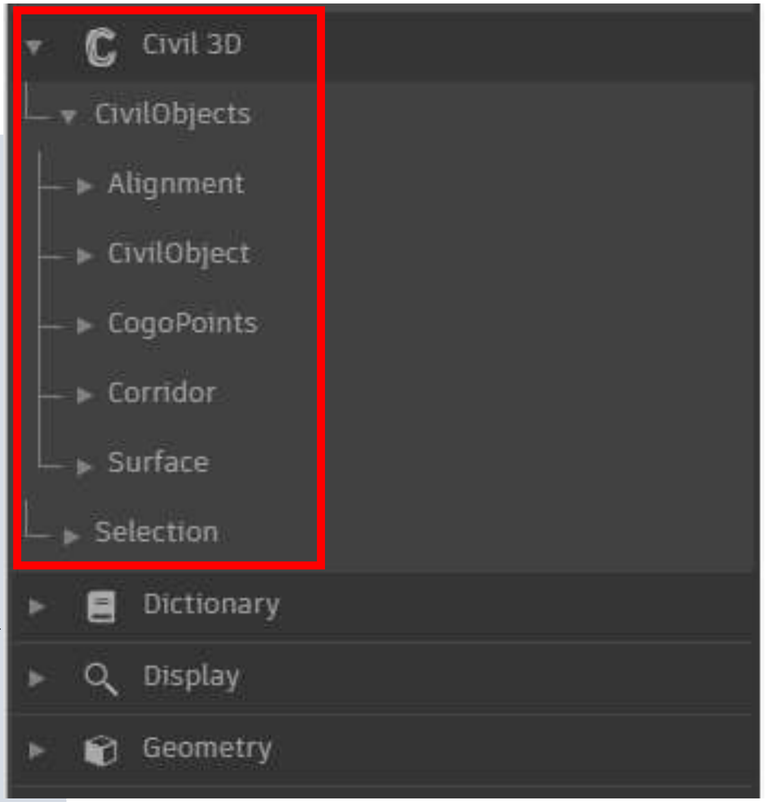
  [1] Host application dependency tags
  [2] Filter for host applications
- Performance Enhancements
- ….

[Link to updates](#) as of Dec. 6



Dynamo 2.4 with Civil 3D





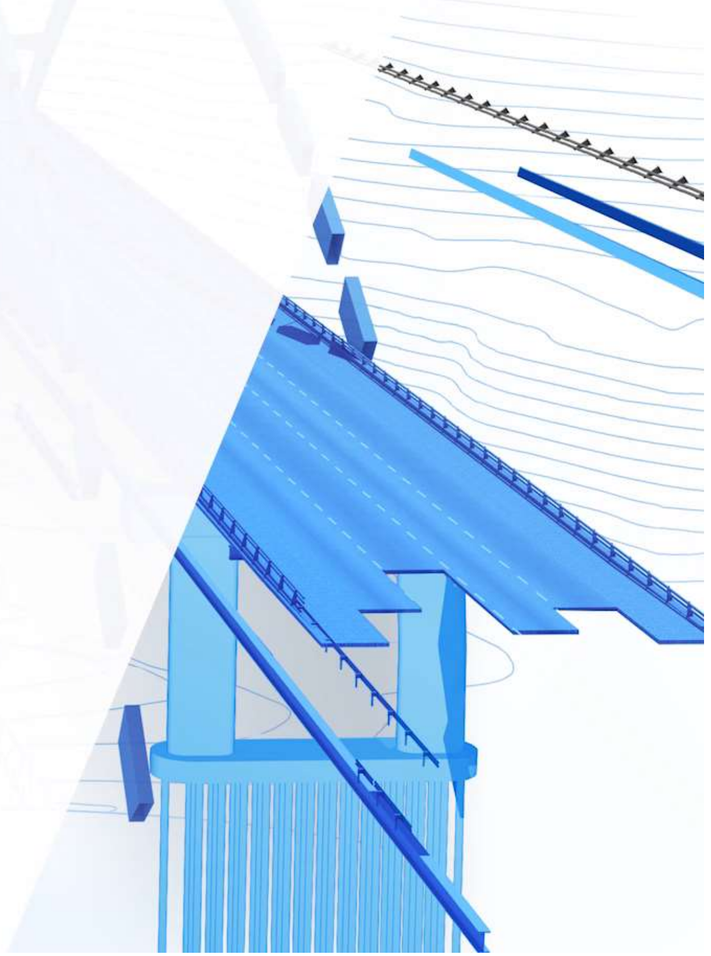
Dynamo for Civil 3D
User Interface & Terminology

Getting Started with Dynamo

AUTODESK® ARCHITECTURE, ENGINEERING & CONSTRUCTION COLLECTION

Dynamo for Civil 3D

Getting Started



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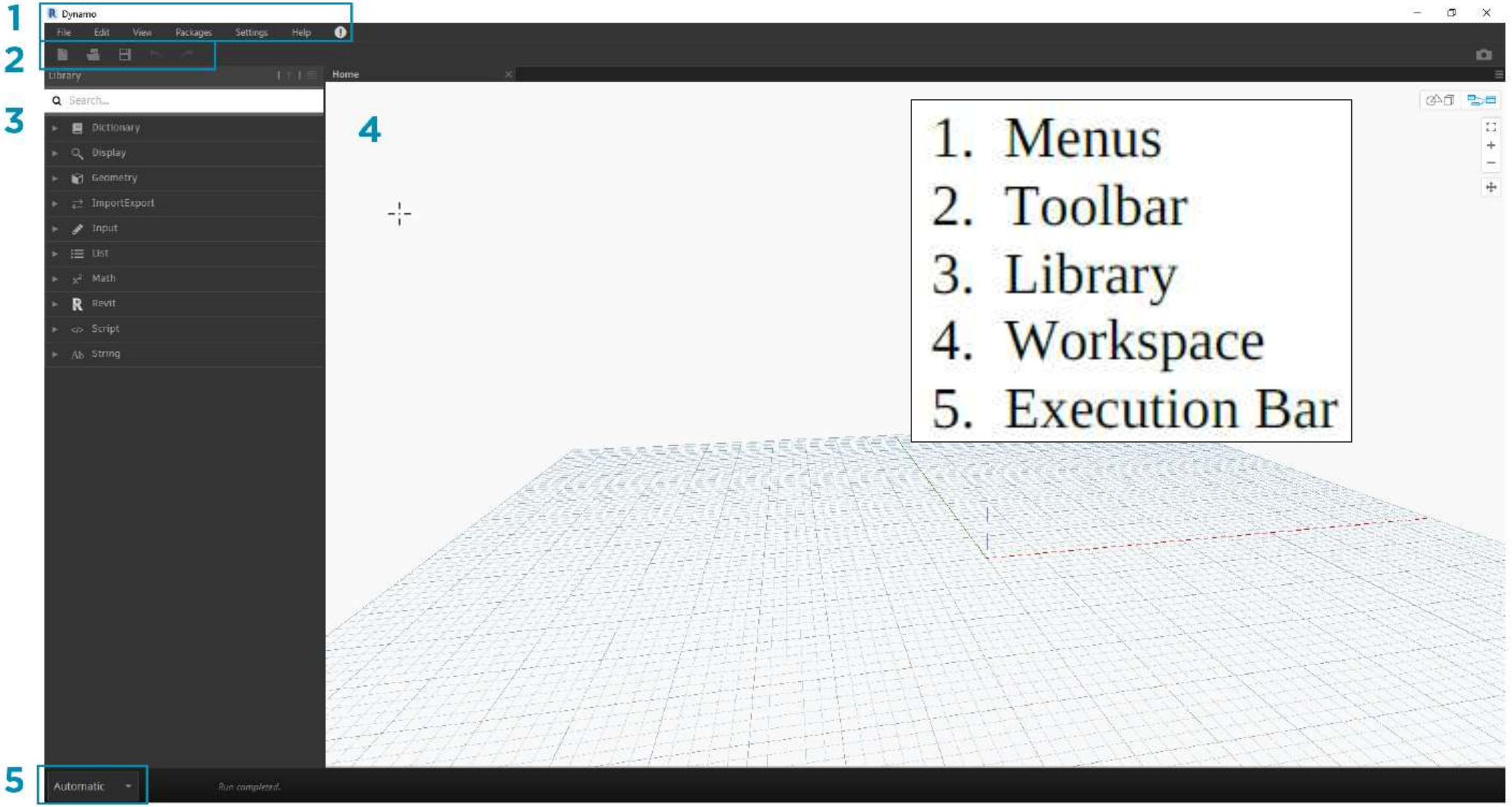
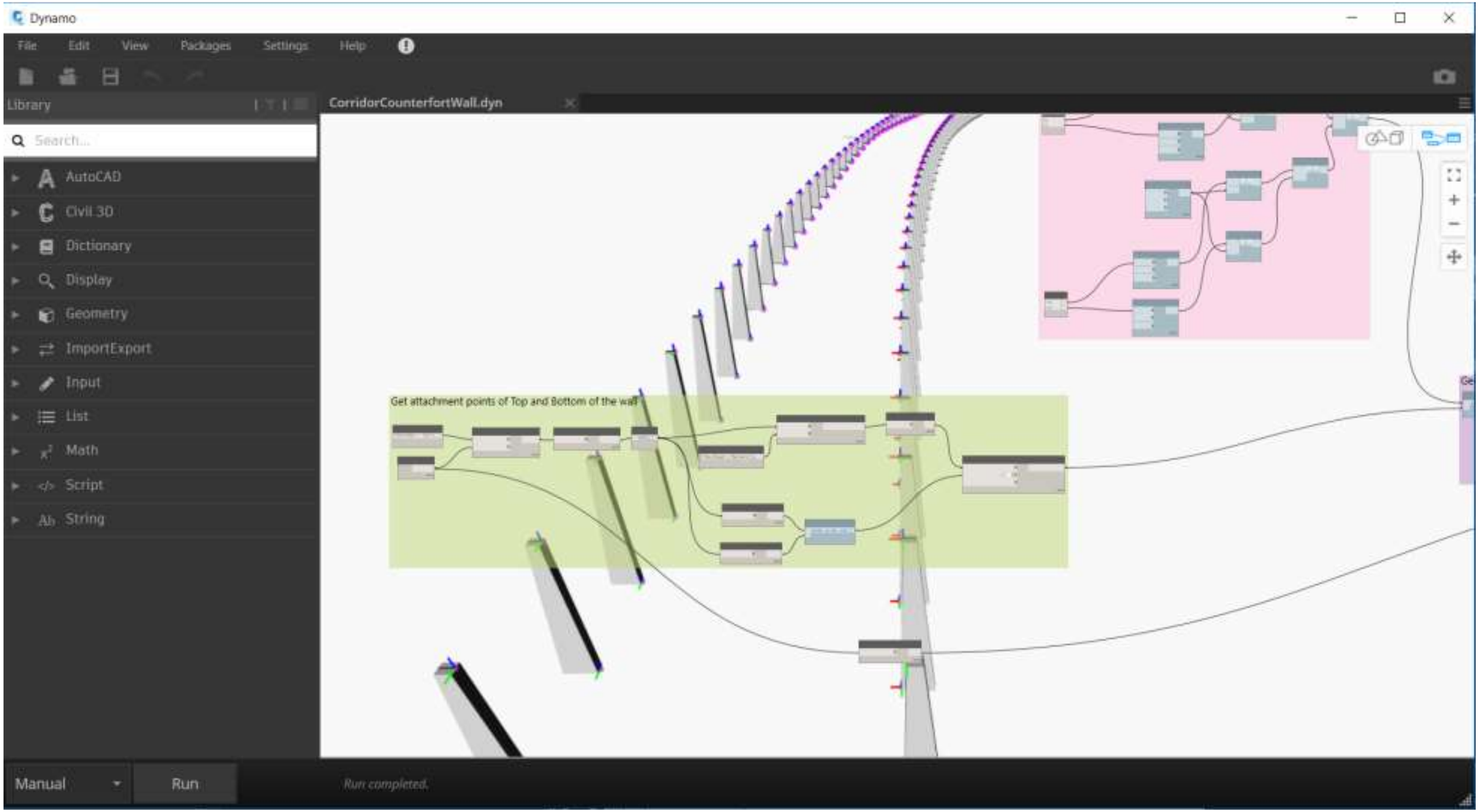
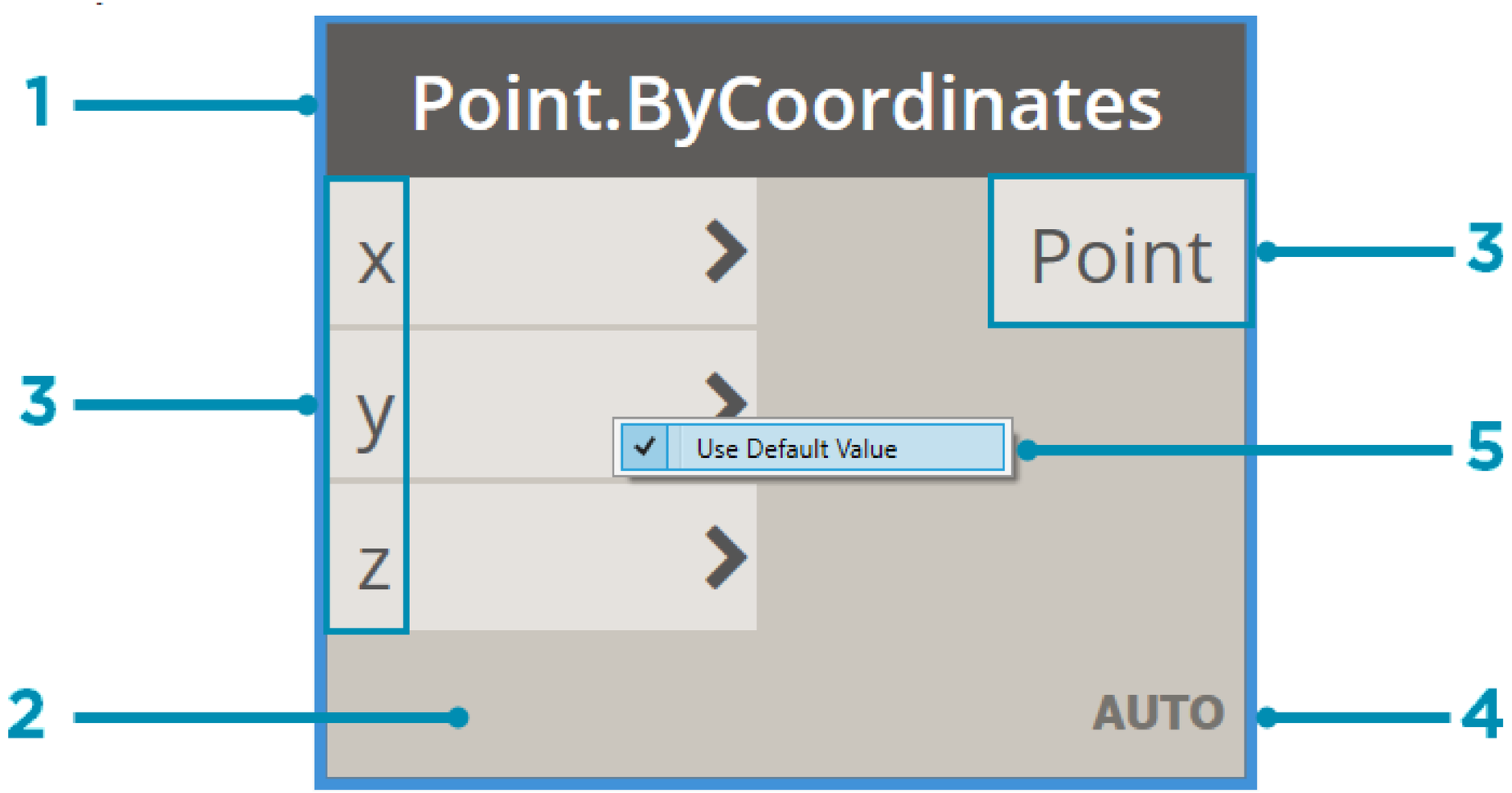
Dynamo User Interface



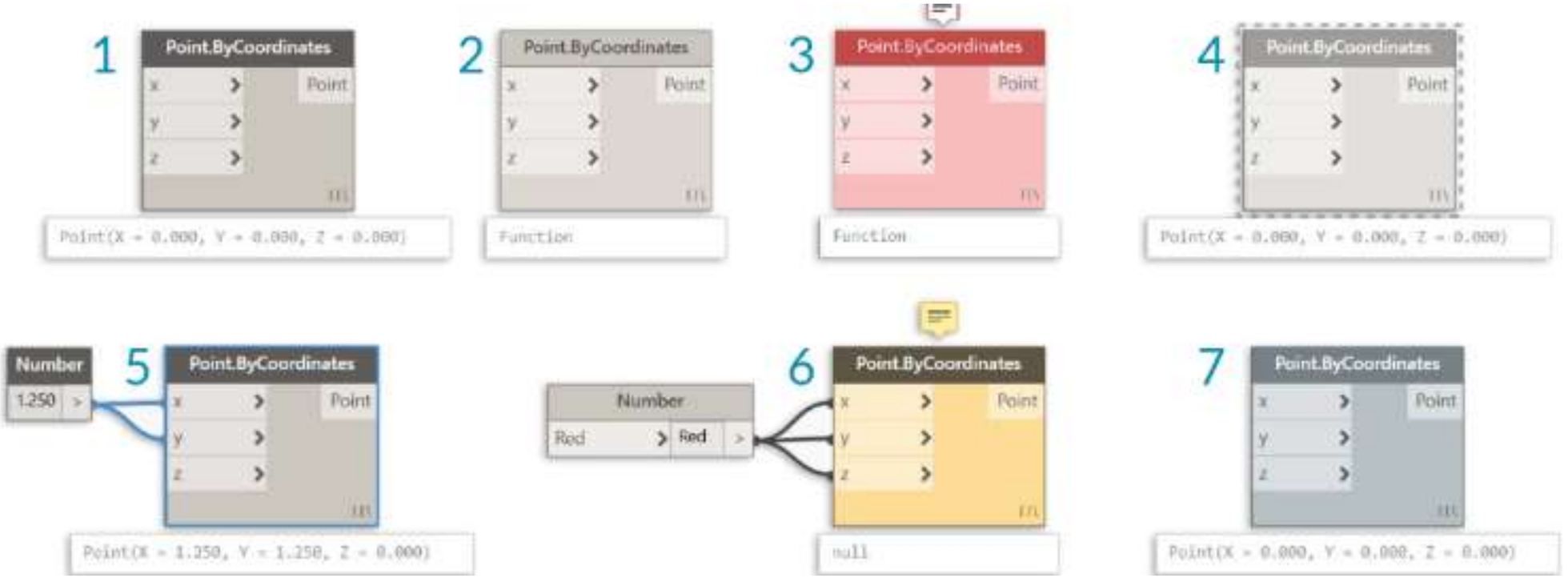
Dynamo User Interface



Dynamo Node Anatomy

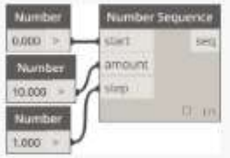
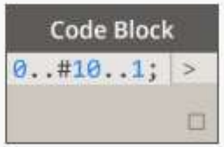
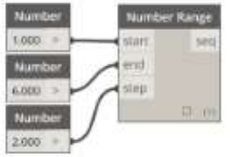
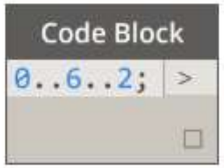
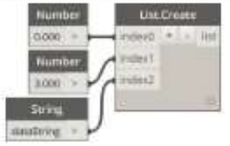
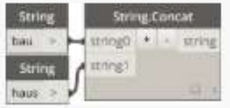


Dynamo Node States

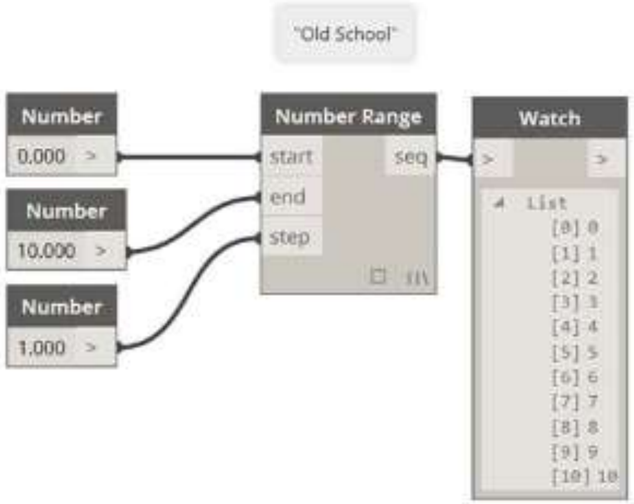


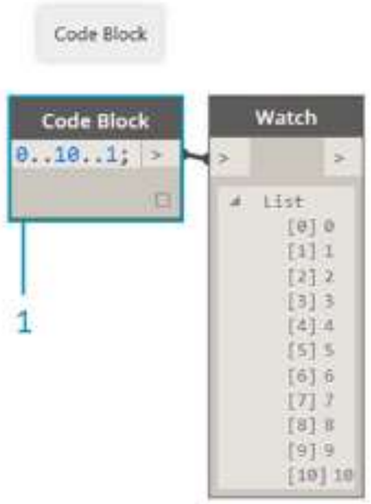
1. Active - Nodes with a Dark Grey Name background are well-connected and have all of their inputs successfully connected
2. Inactive - Grey Nodes are inactive and need to be connected with Wires to be part of the Program Flow in the active Workspace
3. Error State - Red indicates that the Node is in an Error State
4. Freeze - A Transparent node has Freeze turned on, suspending the execution of the node
5. Selected - Currently selected Nodes have an Aqua highlight on their border
6. Warning - Yellow Nodes are in an Warning state, meaning they may have incorrect data types
7. Background Preview - Dark Grey indicates that the geometry preview is turned off

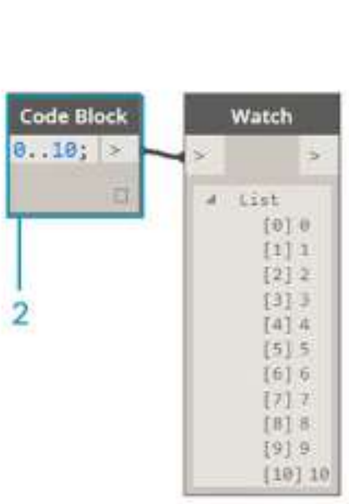
Dynamo Code Blocks

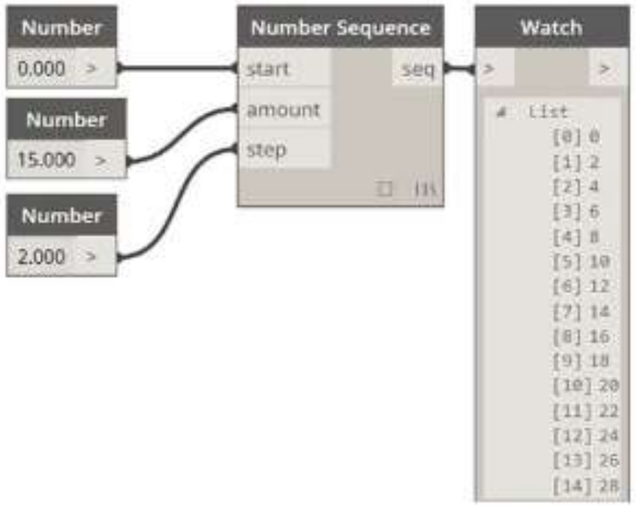
Data Type	Standard Dynamo	Code Block Equivalent
Numbers		
Strings		
Sequences		
Ranges		
Get Item at Index		
Create List		
Concatenate Strings		
Conditional Statements		

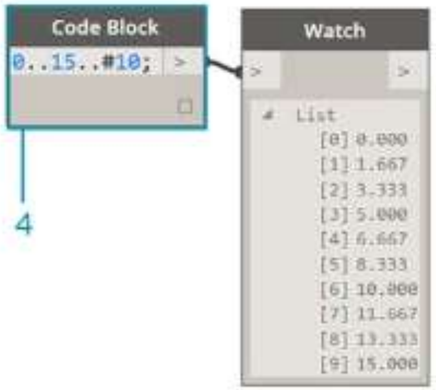
Dynamo Ranges / Sequences





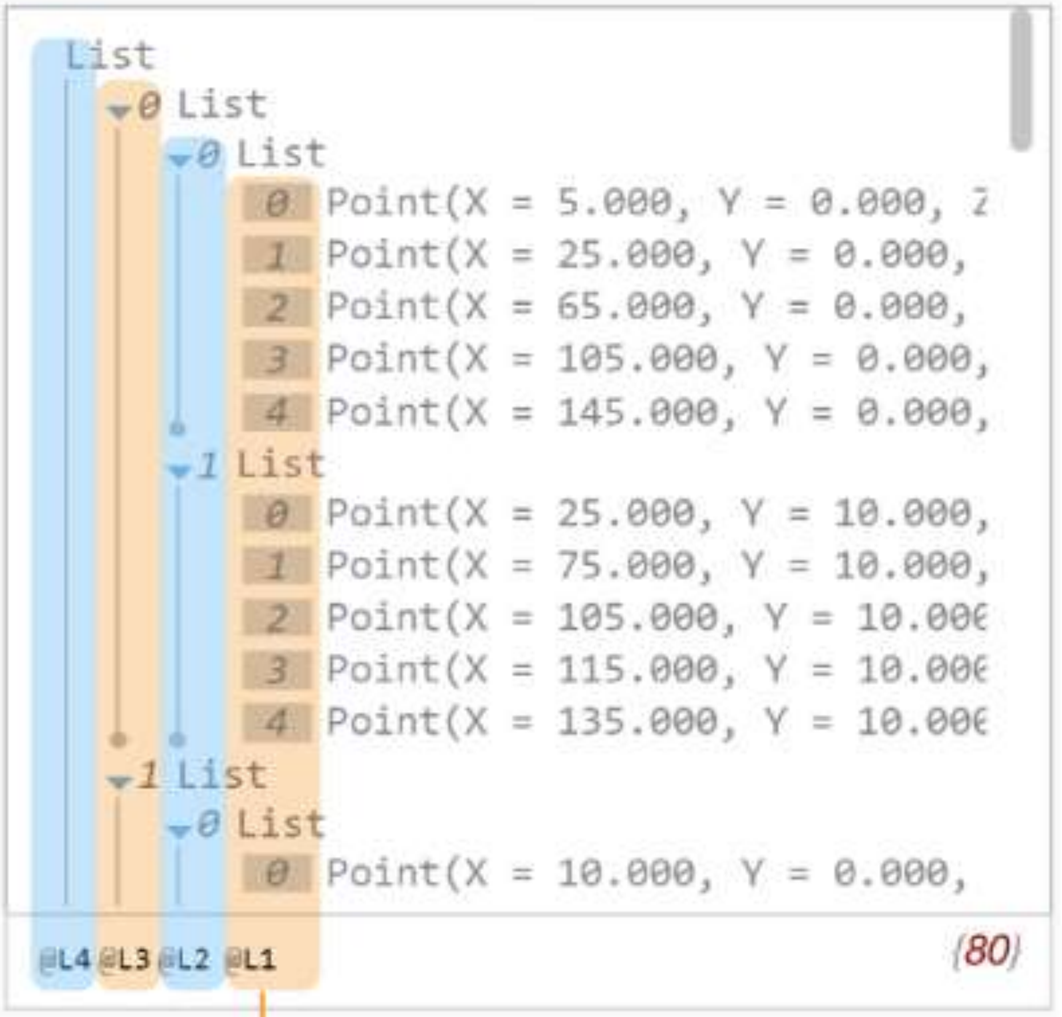






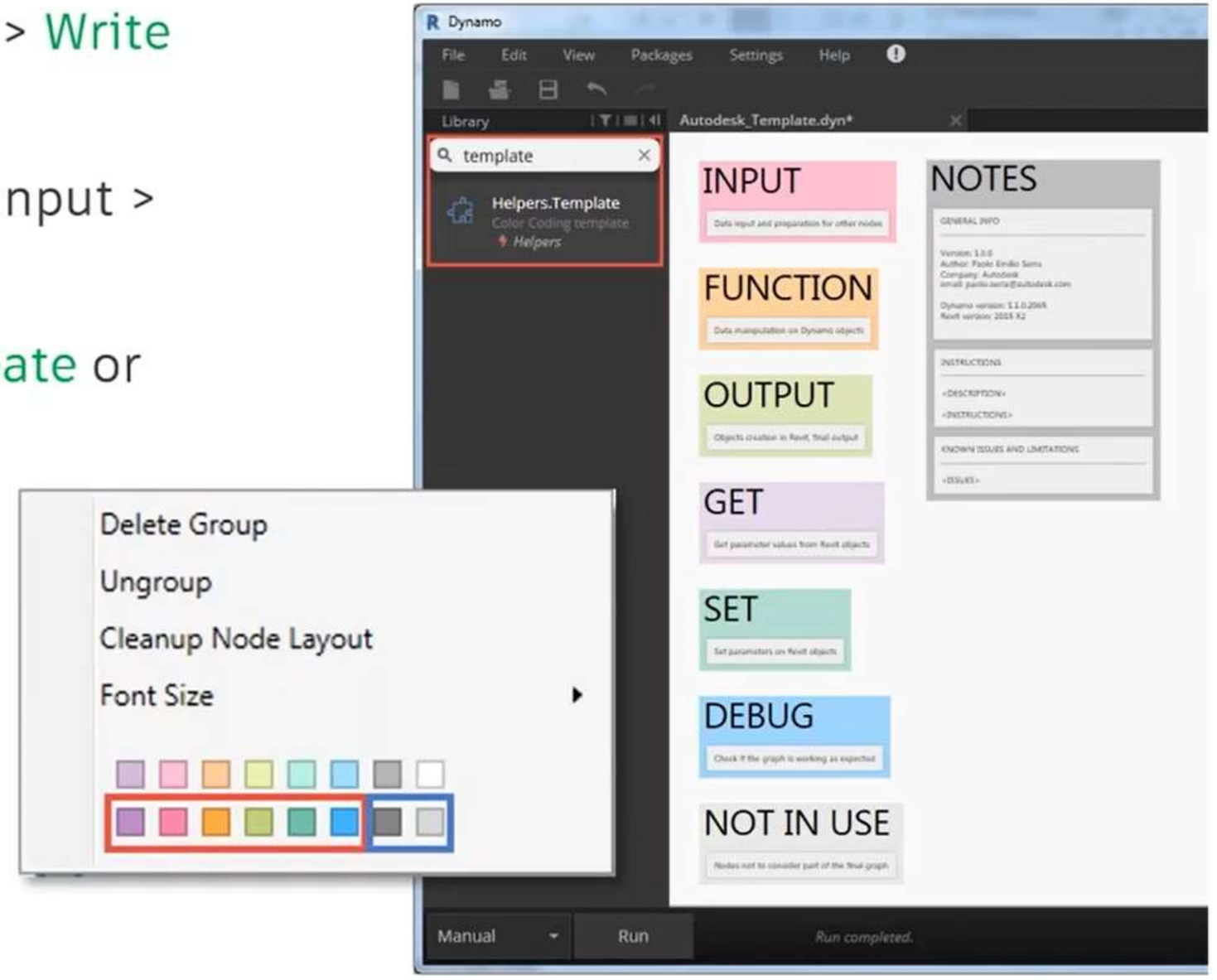
Dynamo List Levels @L1, @L2,…

To determine which level to use, just follow the lines up from the List@Level notation at the bottom of the preview bubble or watch node



@L1 contains a flat list of all the items

- Select objects > Get properties > Write values to an external file
- Select objects > Read external input > Modify object properties
- Input data > Process data > Create or Update objects




LIVE
DEMO

Sample Dynamo Scripts for Civil 3D

Link

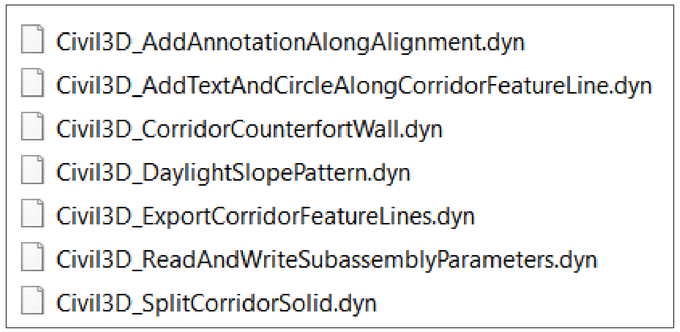
Autodesk Dynamo for Civil 3D provides several sample scripts that automate workflows in Civil 3D. The following Dynamo scripts and supporting files are provided to learn and understand how Dynamo automates workflows for efficiency.

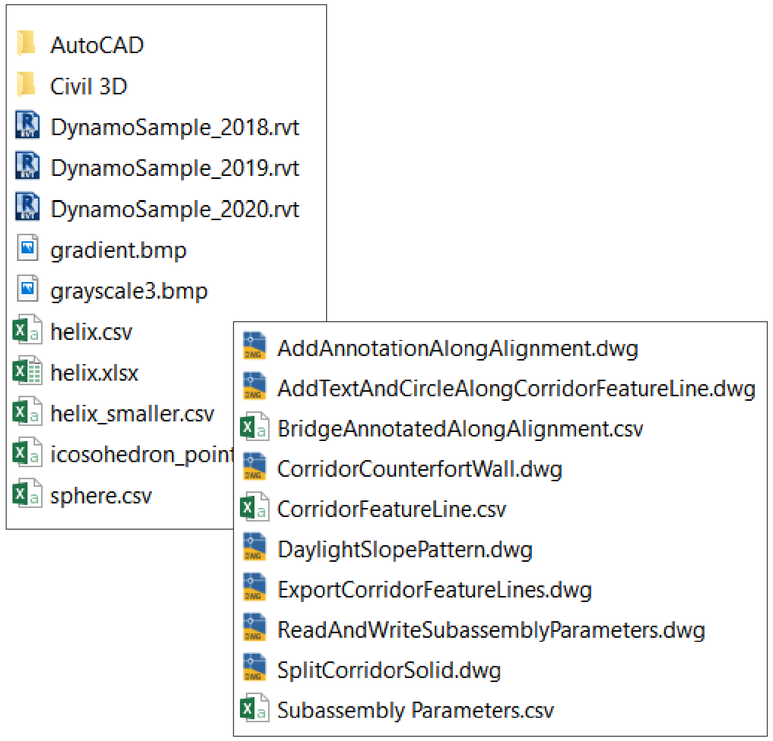
They are installed in the following folders by default:

- **Dynamo Scripts**.
  C:\ProgramData\Autodesk\C3D 2020\Dynamo\Samples\en-US

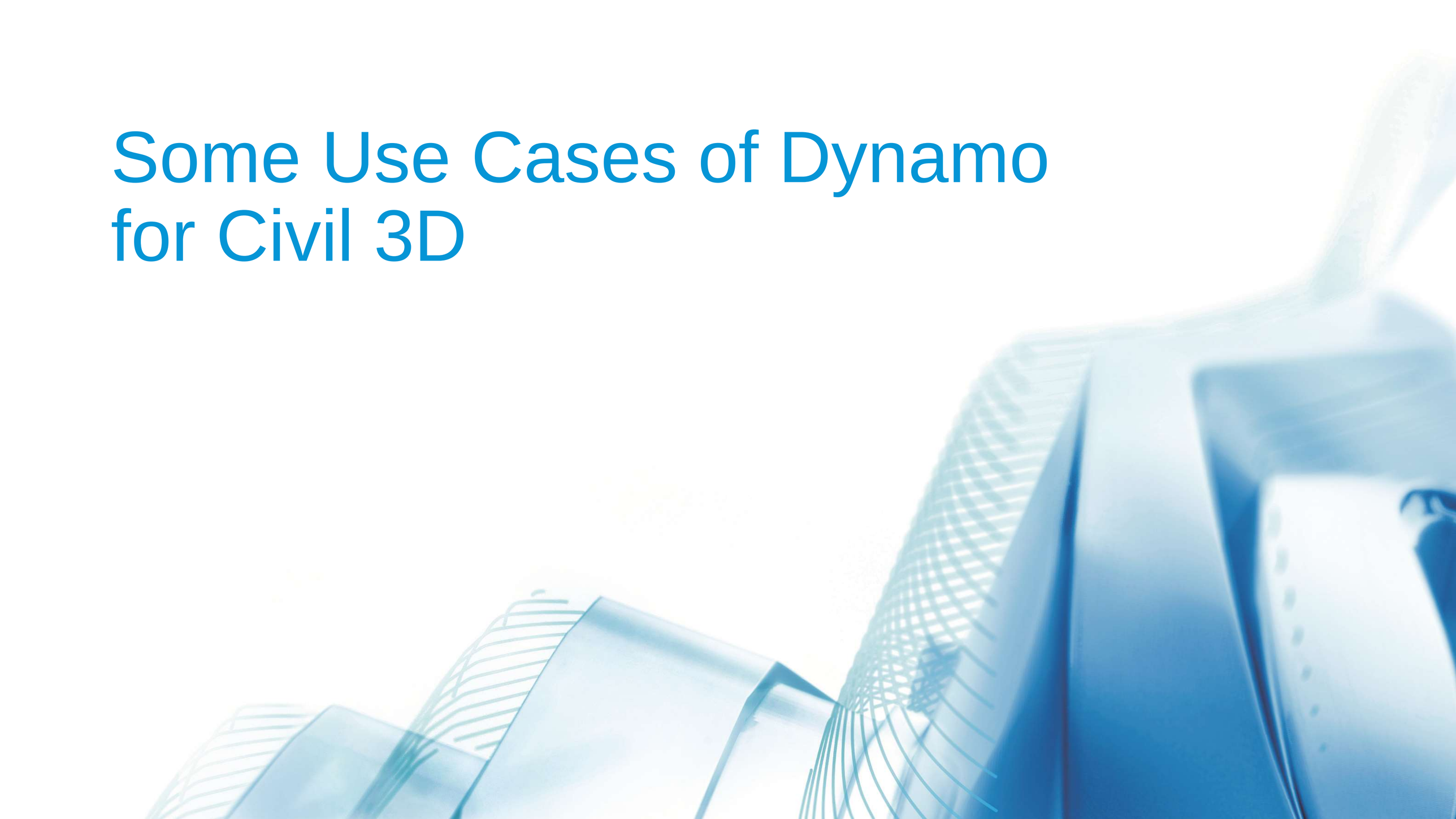
- **Drawings and associated files**.
  C:\ProgramData\Autodesk\C3D 2020\Dynamo\Samples\Data

- **API Dynamo Samples and files**.
  C:\ProgramData\Autodesk\C3D 2020\Dynamo\API Samples



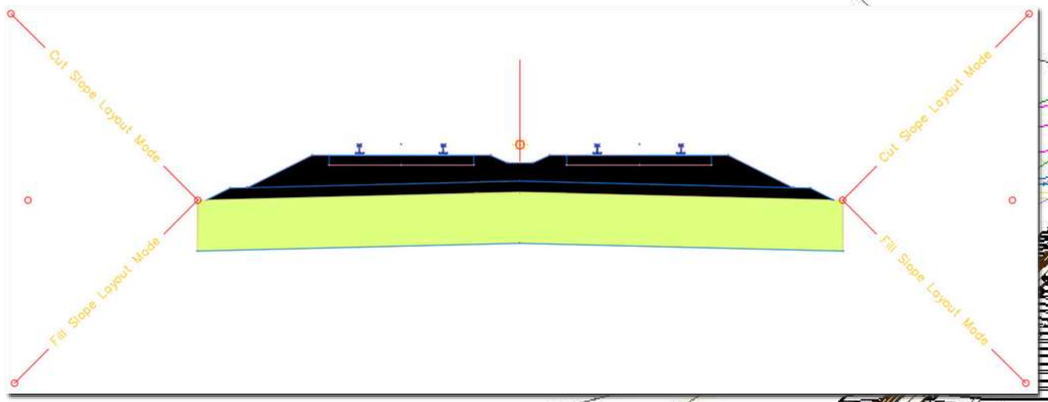


Some Use Cases of Dynamo for Civil 3D



Rail Workflows

Coordination Model



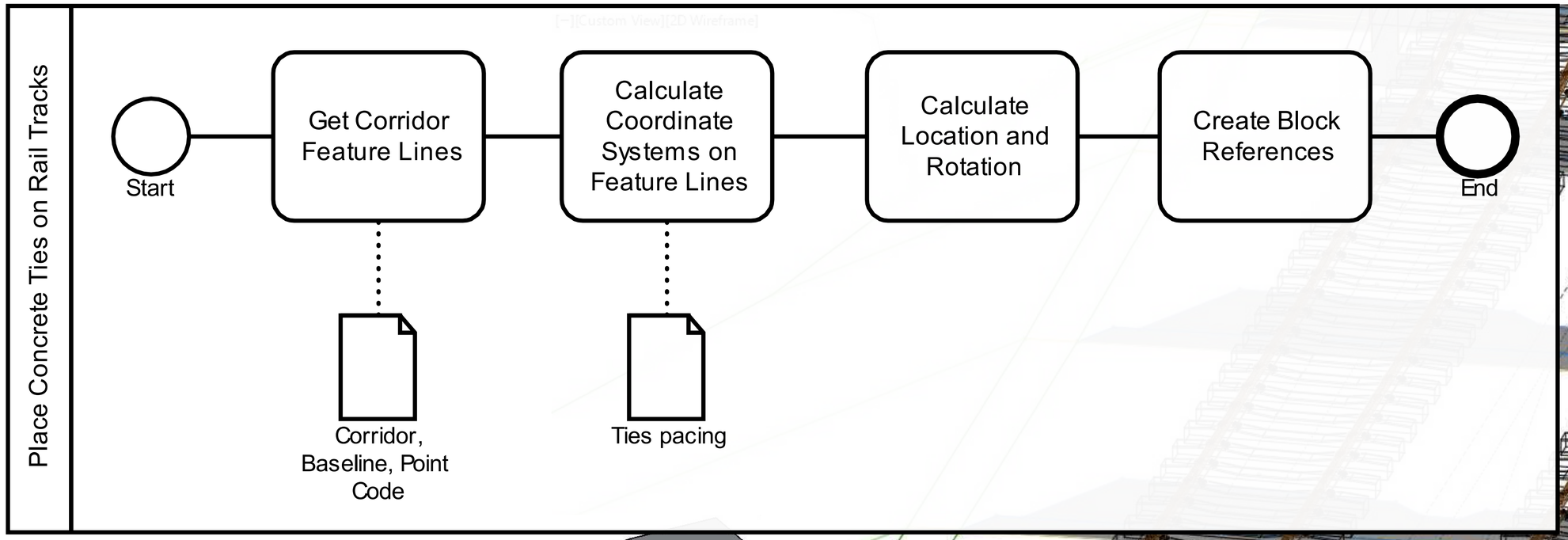
OCS Cables

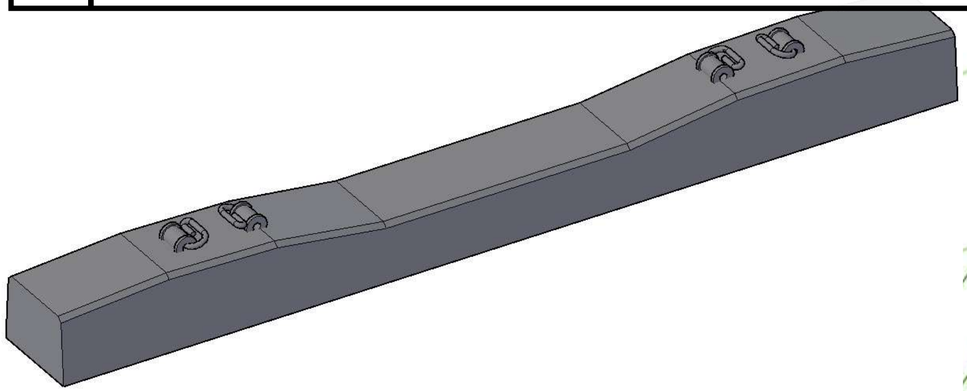
OCS Poles

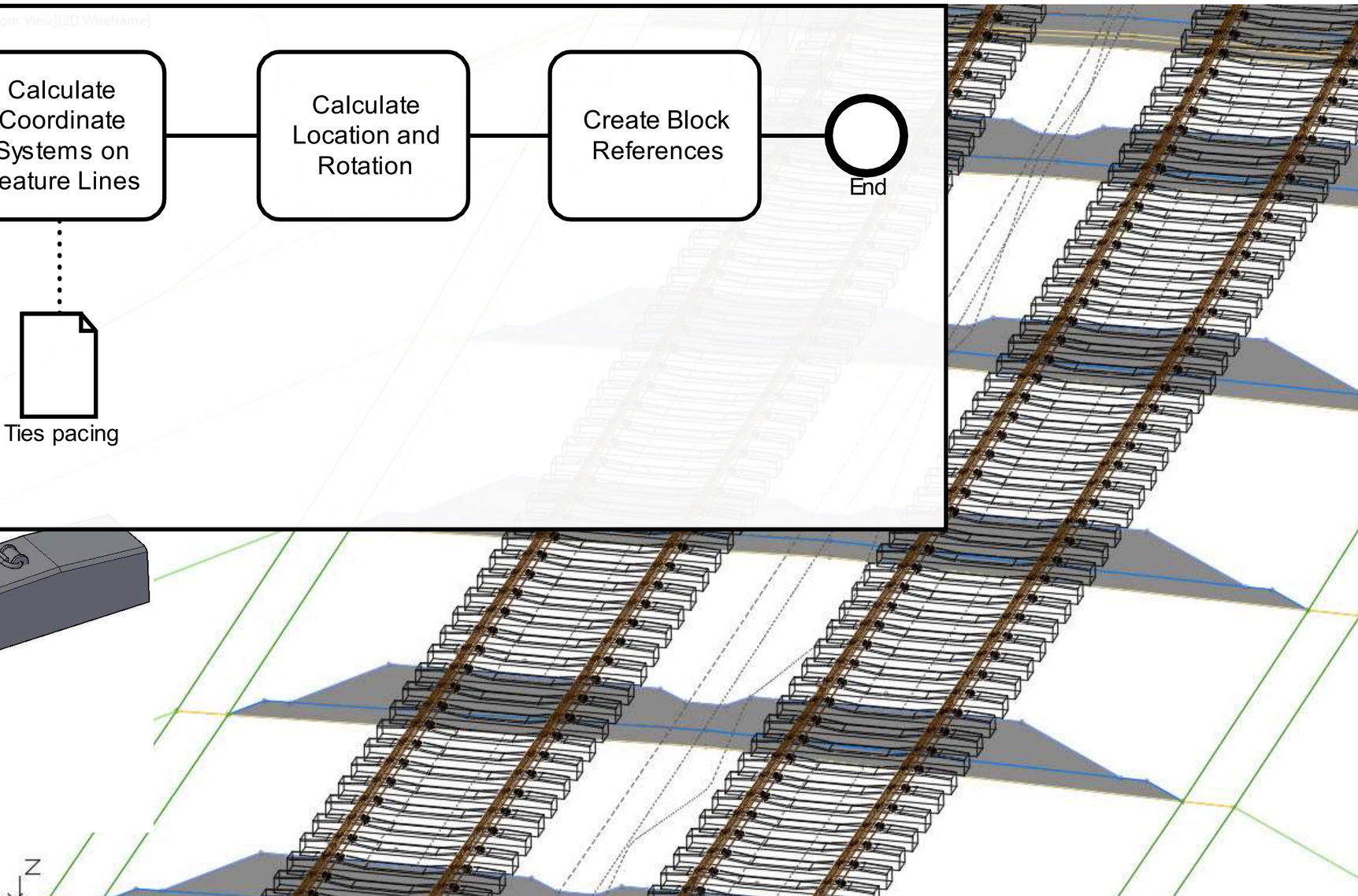
Concrete Ties

Rail Workflows

Concrete Ties

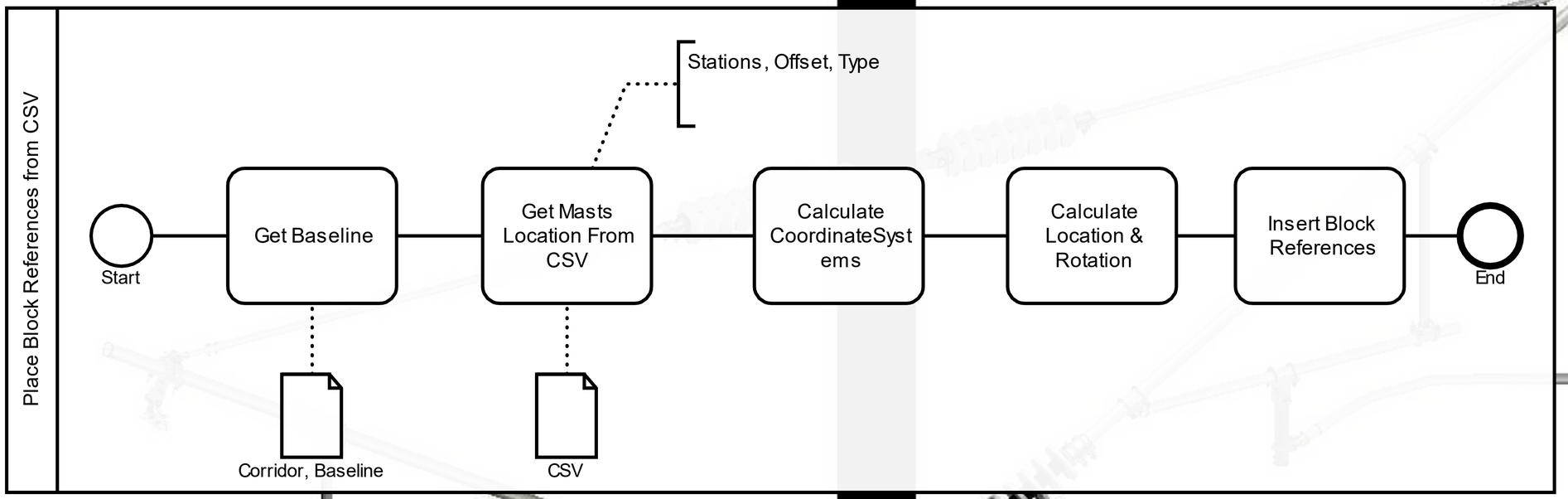


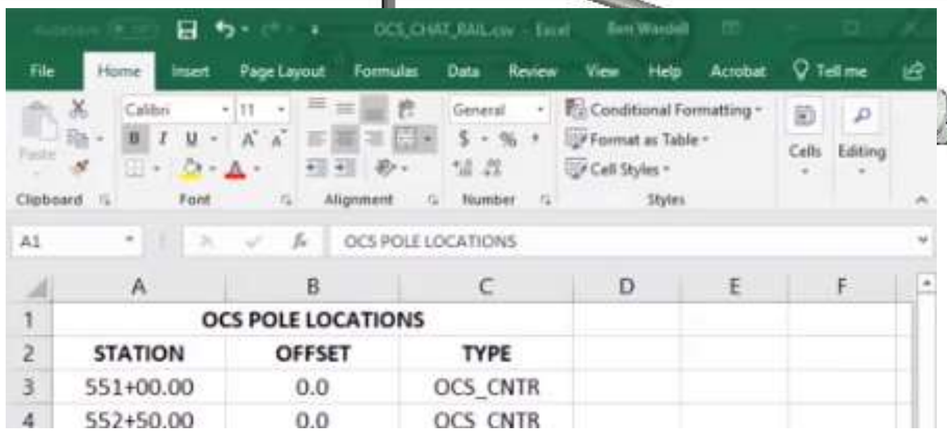




Rail Workflows

OCS Masts





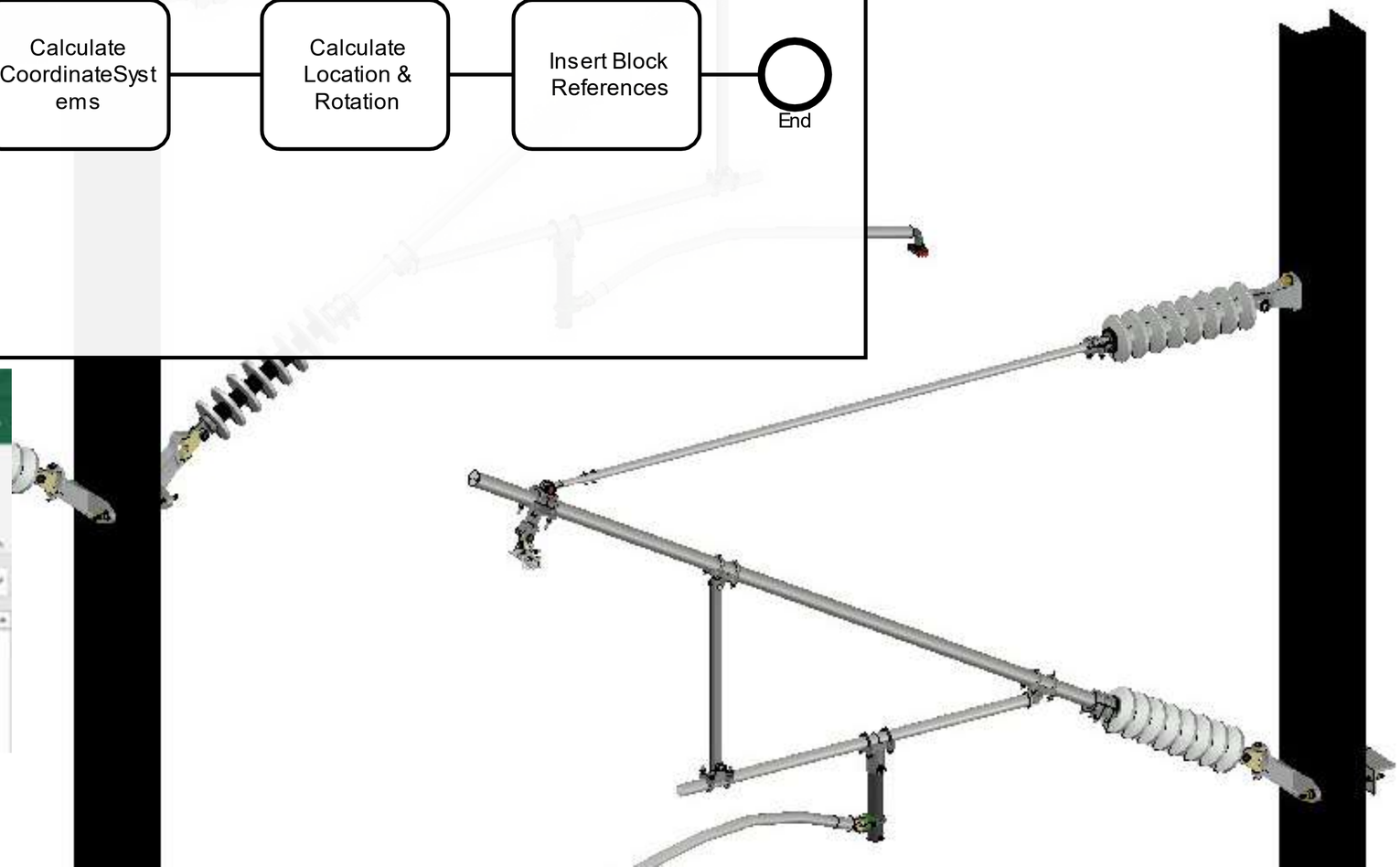
OCS_CHAT_RAIL.csv - Excel

File Home Insert Page Layout Formulas Data Review View Help Acrobat Tell me

Clipboard Font Alignment Number Styles Cells Editing

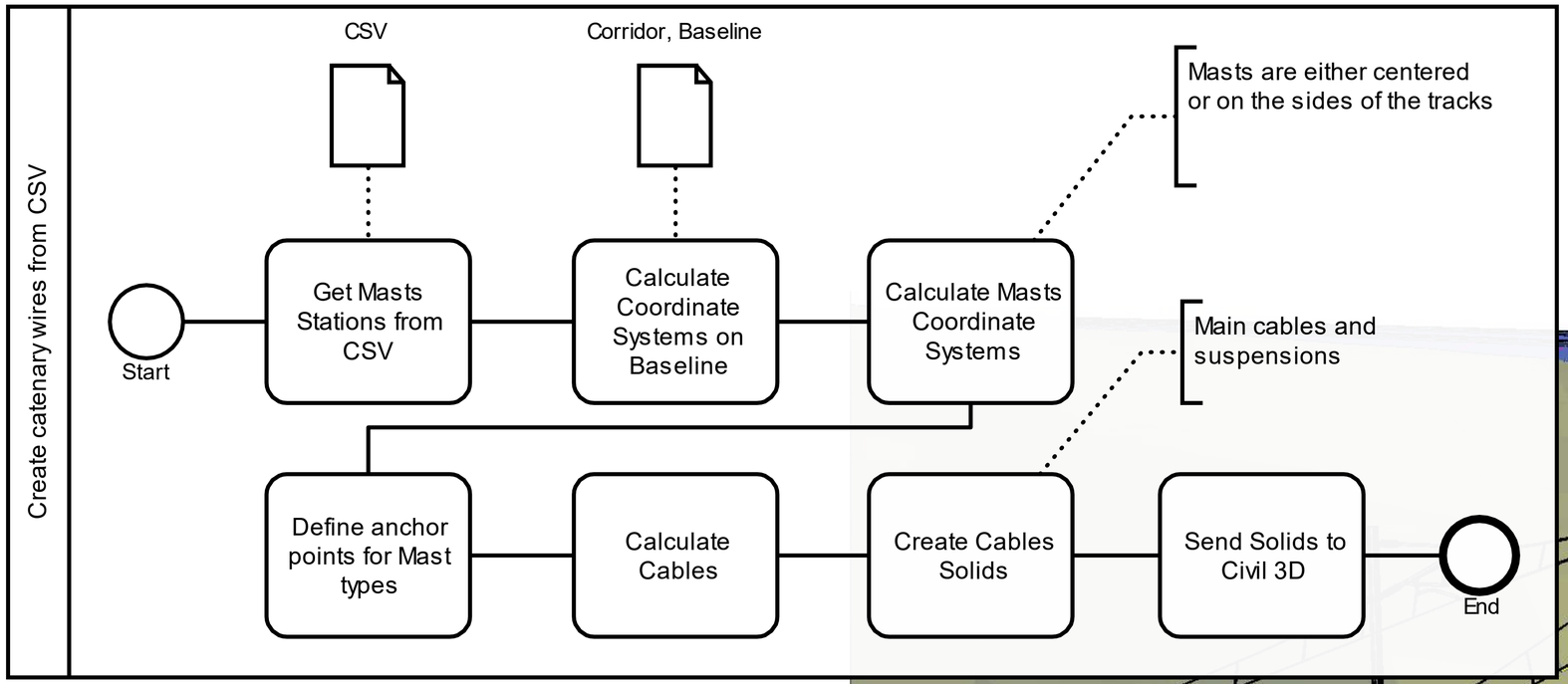
A1 OCS POLE LOCATIONS

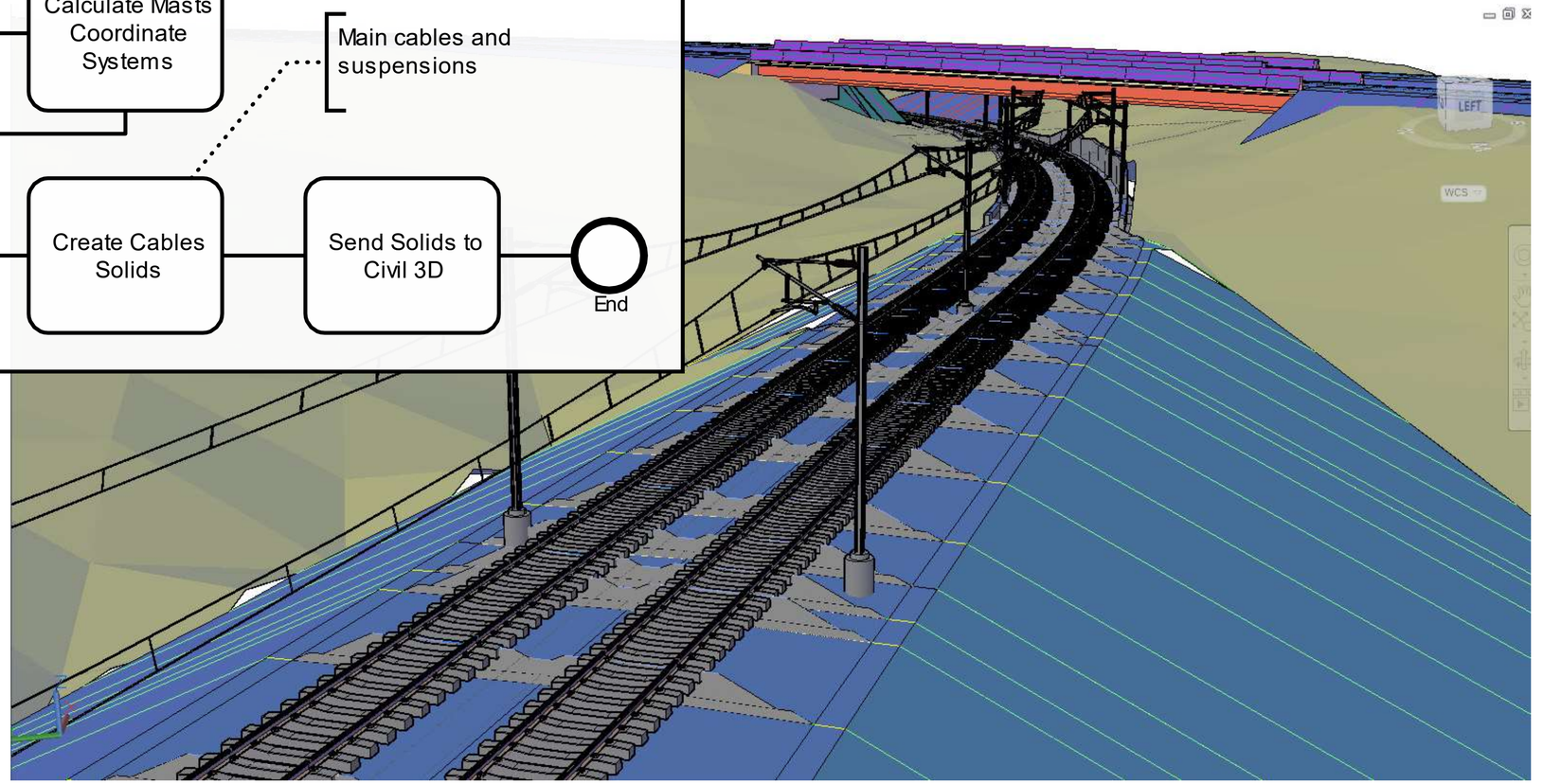
	A	B	C	D	E	F
1	OCS POLE LOCATIONS					
2	STATION	OFFSET	TYPE			
3	551+00.00	0.0	OCS_CNTR			
4	552+50.00	0.0	OCS_CNTR			



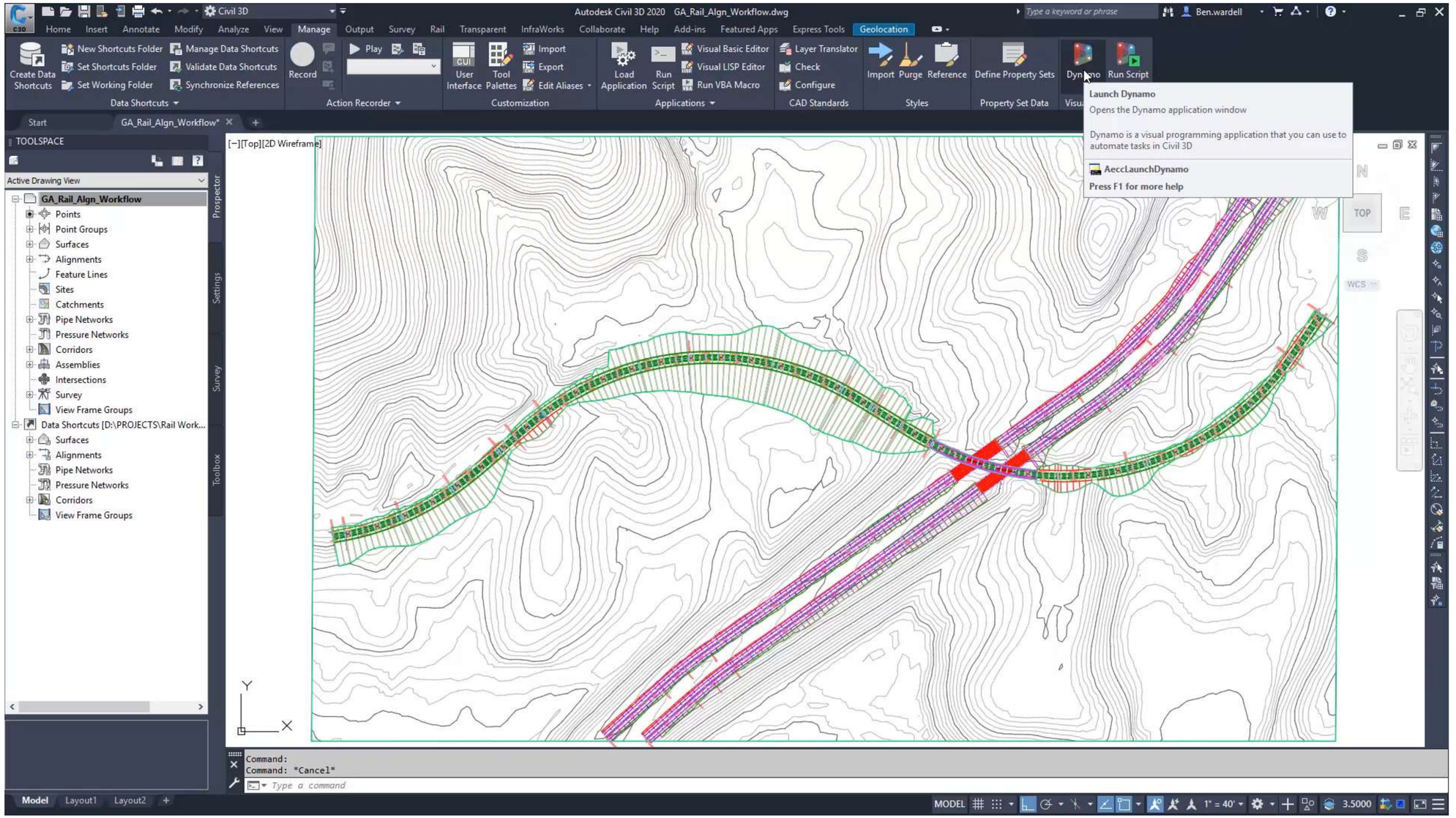
Rail Workflows

OCS Cables





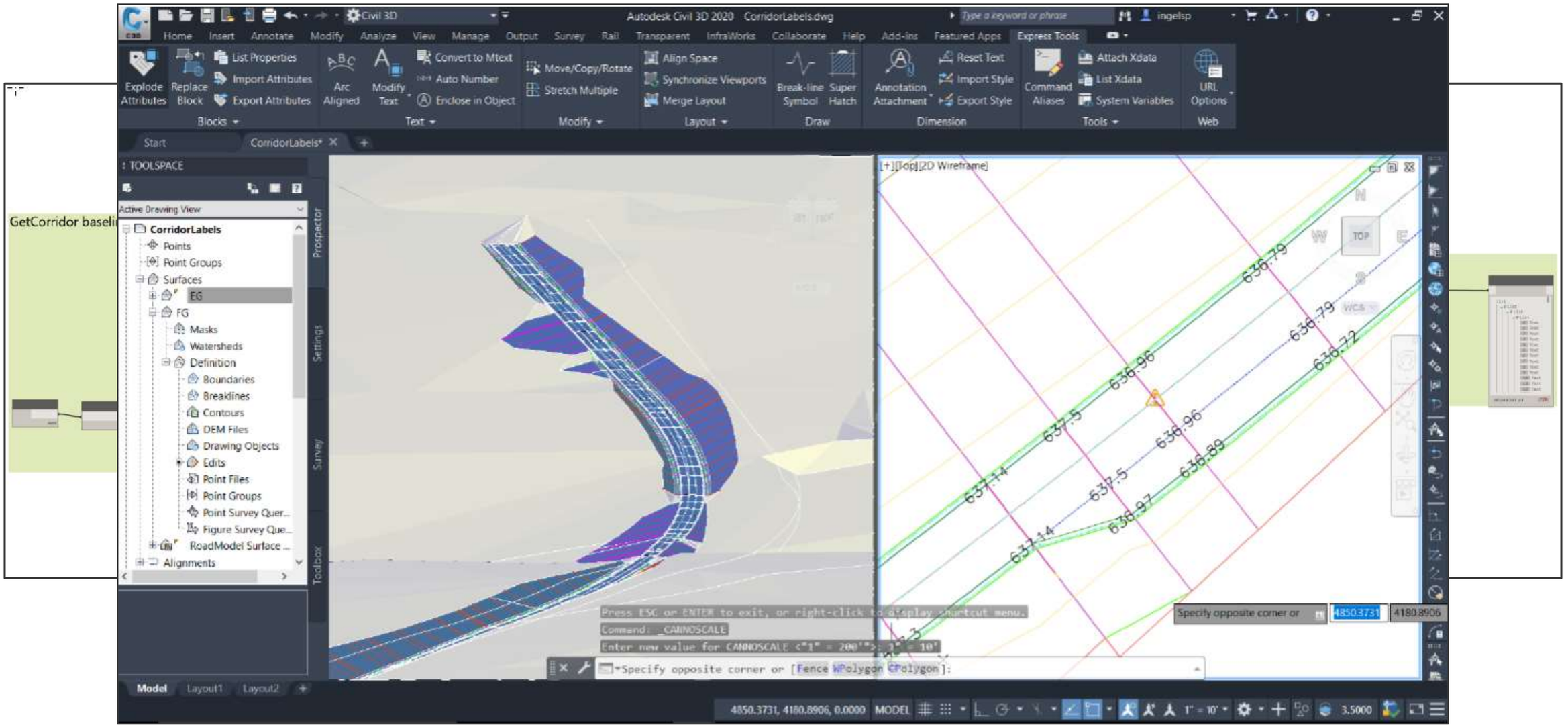
Rail



Concrete ties, masts and overhead catenary systems wires…

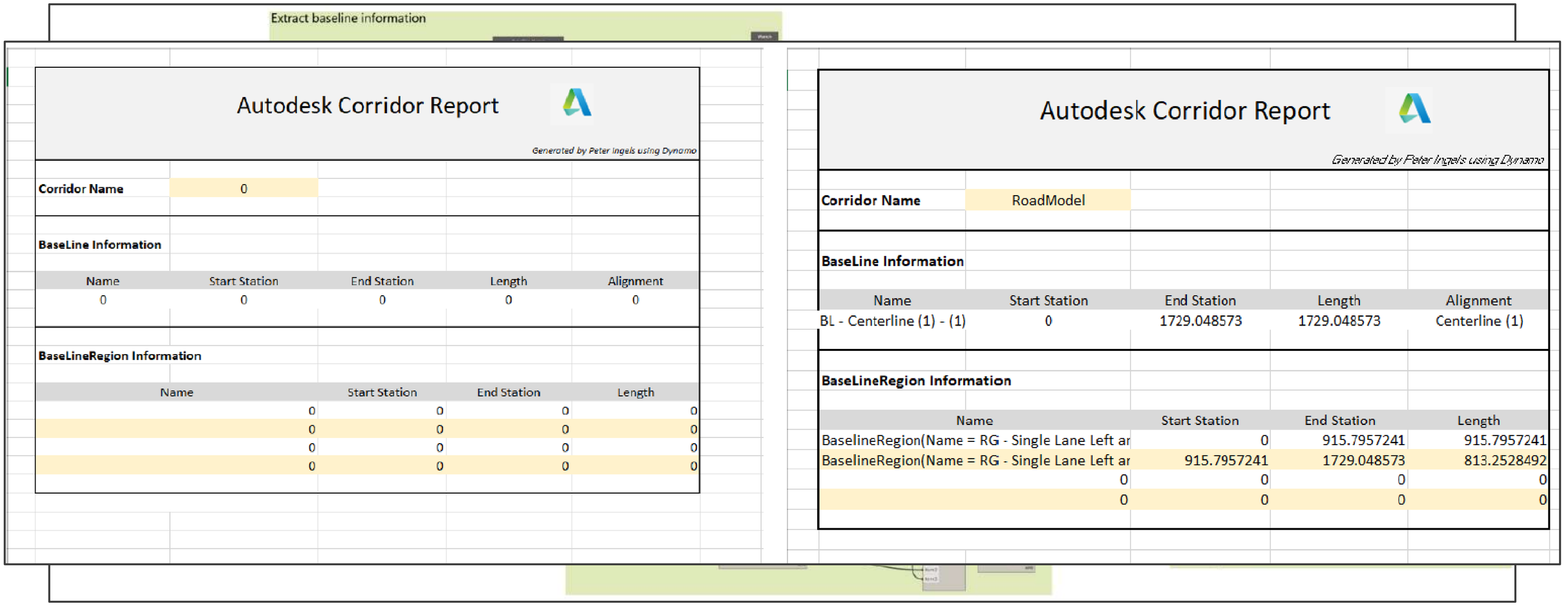
Dynamo Use Cases

Documentation



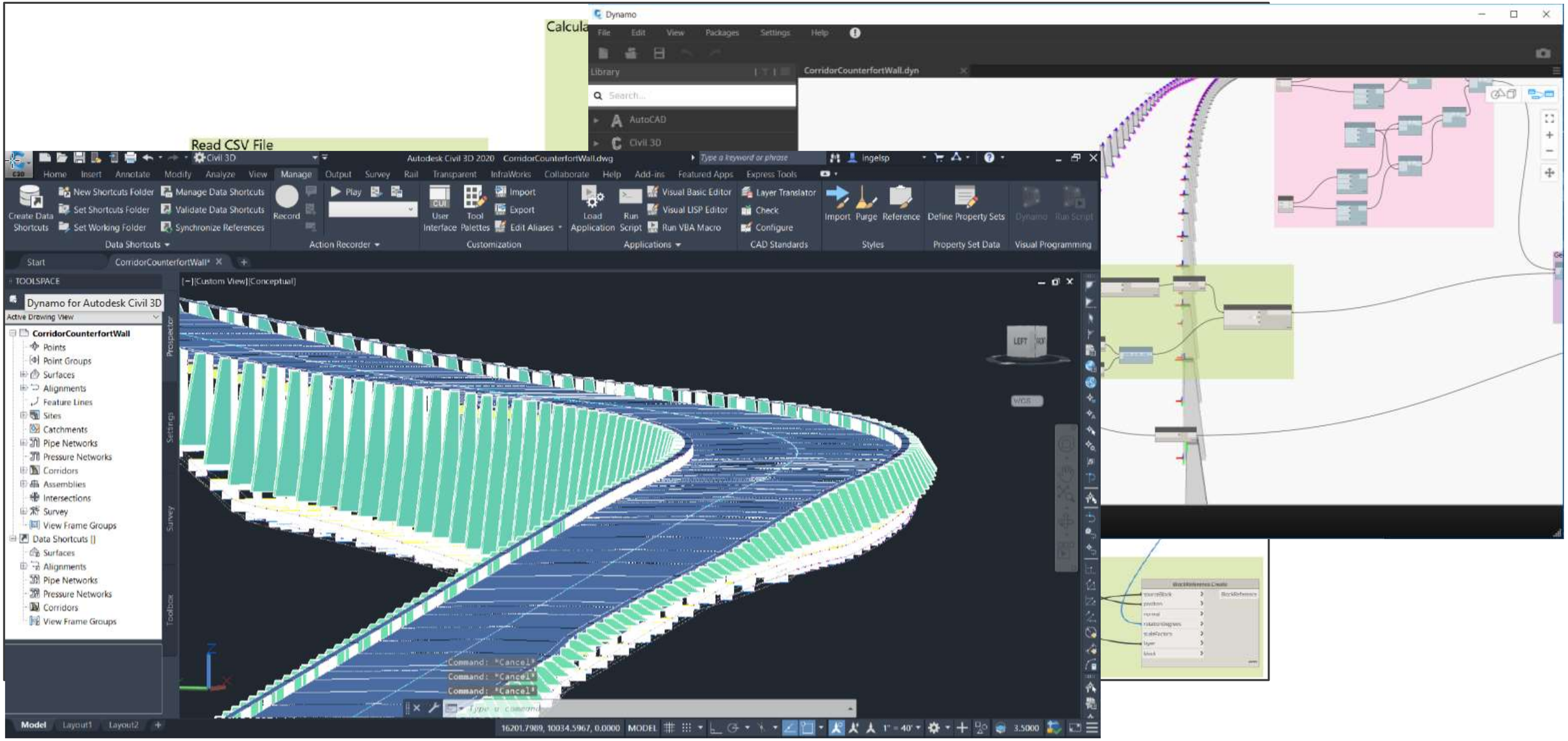
Dynamo Use Cases

Custom Reporting

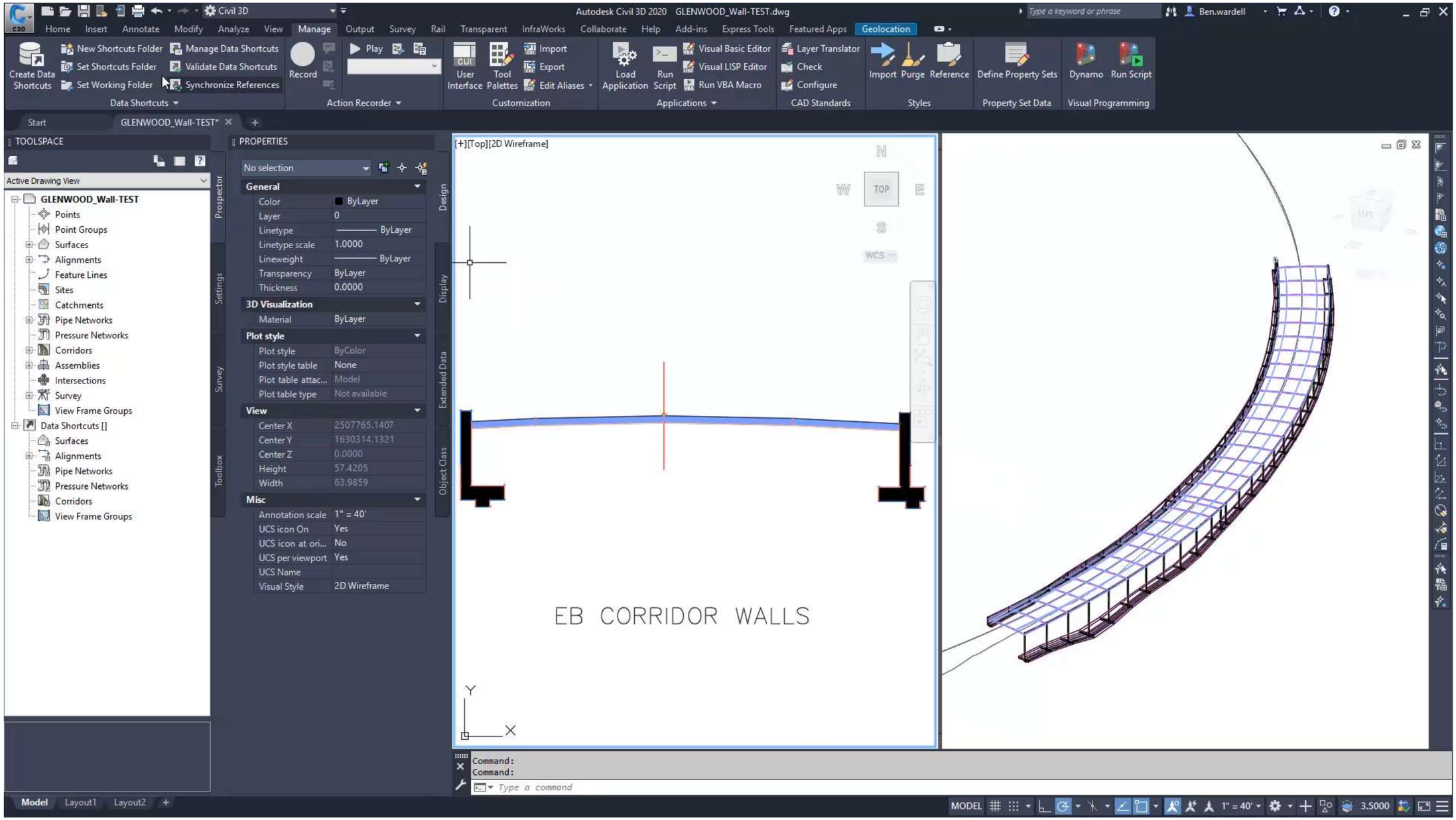


Dynamo Use Cases

Modeling–Object Placement (Ex: Retaining Walls, Power Poles, Rail objects, Guard Rails…)



Custom Wall


Autodesk Civil 3D 2020 GLENWOOD_Wall-TEST.dwg
Ben.wardell
Home Insert Annotate Modify Analyze View Manage Output Survey Rail Transparent InfraWorks Collaborate Help Add-ins Express Tools Featured Apps Geolocation
Create Data Shortcuts
New Shortcuts Folder
Set Shortcuts Folder
Set Working Folder
Manage Data Shortcuts
Validate Data Shortcuts
Synchronize References
Data Shortcuts
Record
Play
Action Recorder
User Interface
Tool Palettes
Import
Export
Edit Aliases
Customization
Load Application
Run Script
Visual Basic Editor
Visual LISP Editor
Run VBA Macro
Applications
Layer Translator
Check
Configure
CAD Standards
Import
Purge
Reference
Styles
Define Property Sets
Property Set Data
Dynamo
Run Script
Visual Programming
Start
GLENWOOD_Wall-TEST*
TOOLSPACE
Active Drawing View
GLENWOOD_Wall-TEST
Points
Point Groups
Surfaces
Alignments
Feature Lines
Sites
Catchments
Pipe Networks
Pressure Networks
Corridors
Assemblies
Intersections
Survey
View Frame Groups
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Surfaces
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Pipe Networks
Pressure Networks
Corridors
View Frame Groups
PROPERTIES
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General
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Linetype scale 1.0000
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Transparency ByLayer
Thickness 0.0000
3D Visualization
Material ByLayer
Plot style
Plot style ByColor
Plot style table None
Plot table attac... Model
Plot table type Not available
View
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Center Y 1630314.1321
Center Z 0.0000
Height 57.4205
Width 63.9859
Misc
Annotation scale 1" = 40'
UCS icon On Yes
UCS icon at ori... No
UCS per viewport Yes
UCS Name
Visual Style 2D Wireframe
[+][Top][2D Wireframe]
N
W
TOP
E
S
WCS
EB CORRIDOR WALLS
Y
X
Command:
Command:
Type a command
Model
Layout1
Layout2
MODEL
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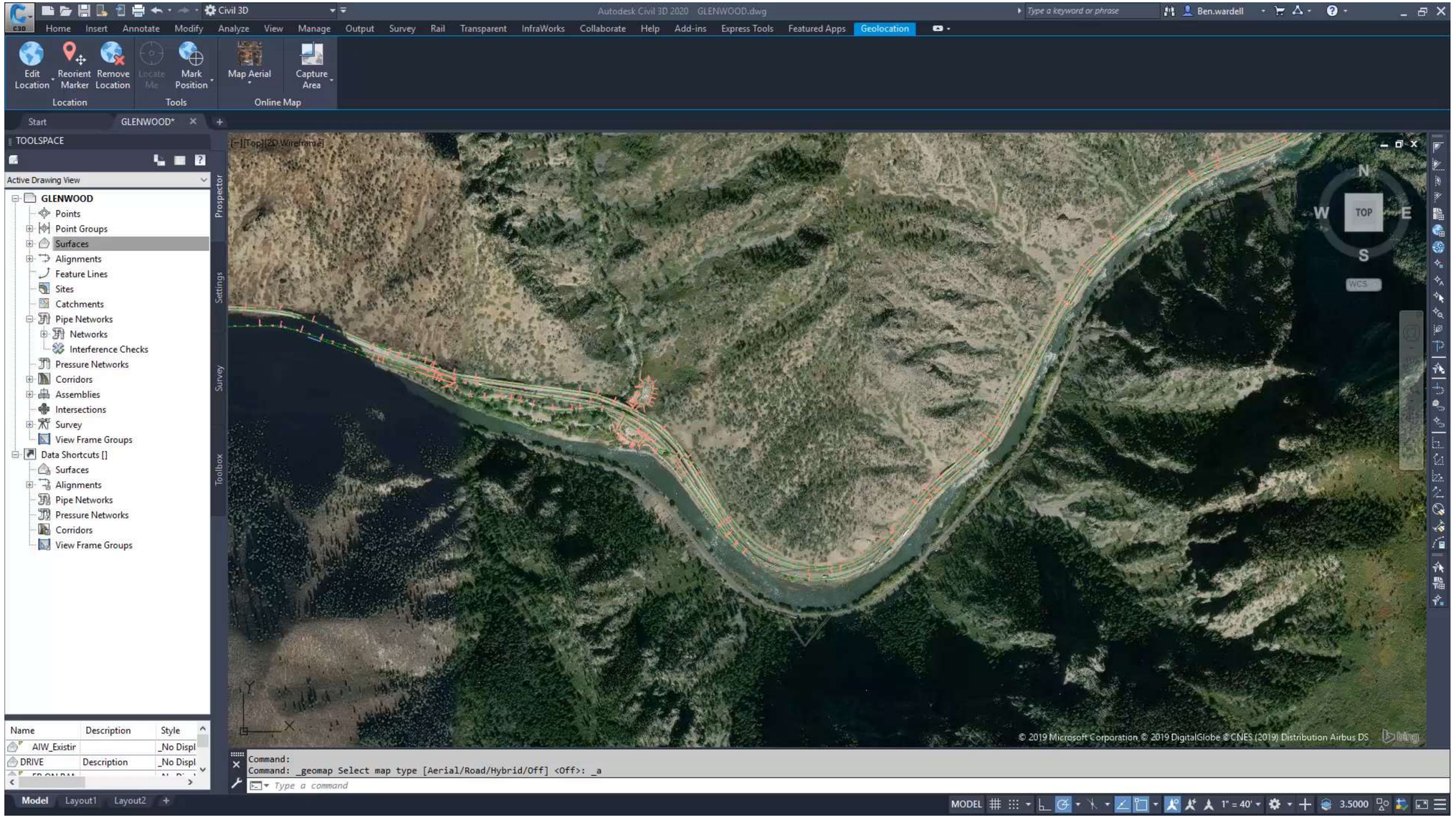
3.5000

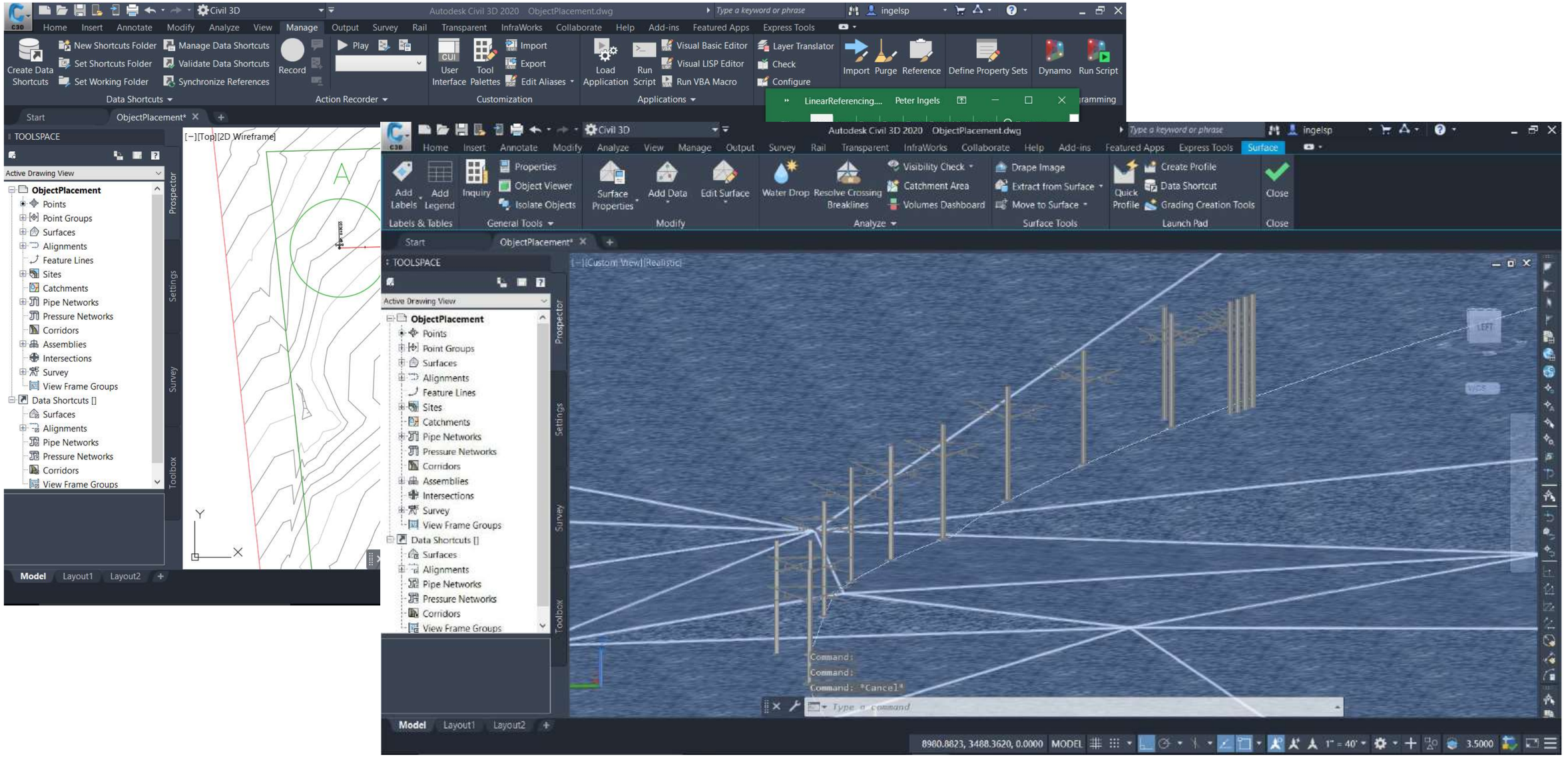
Highway Corridors



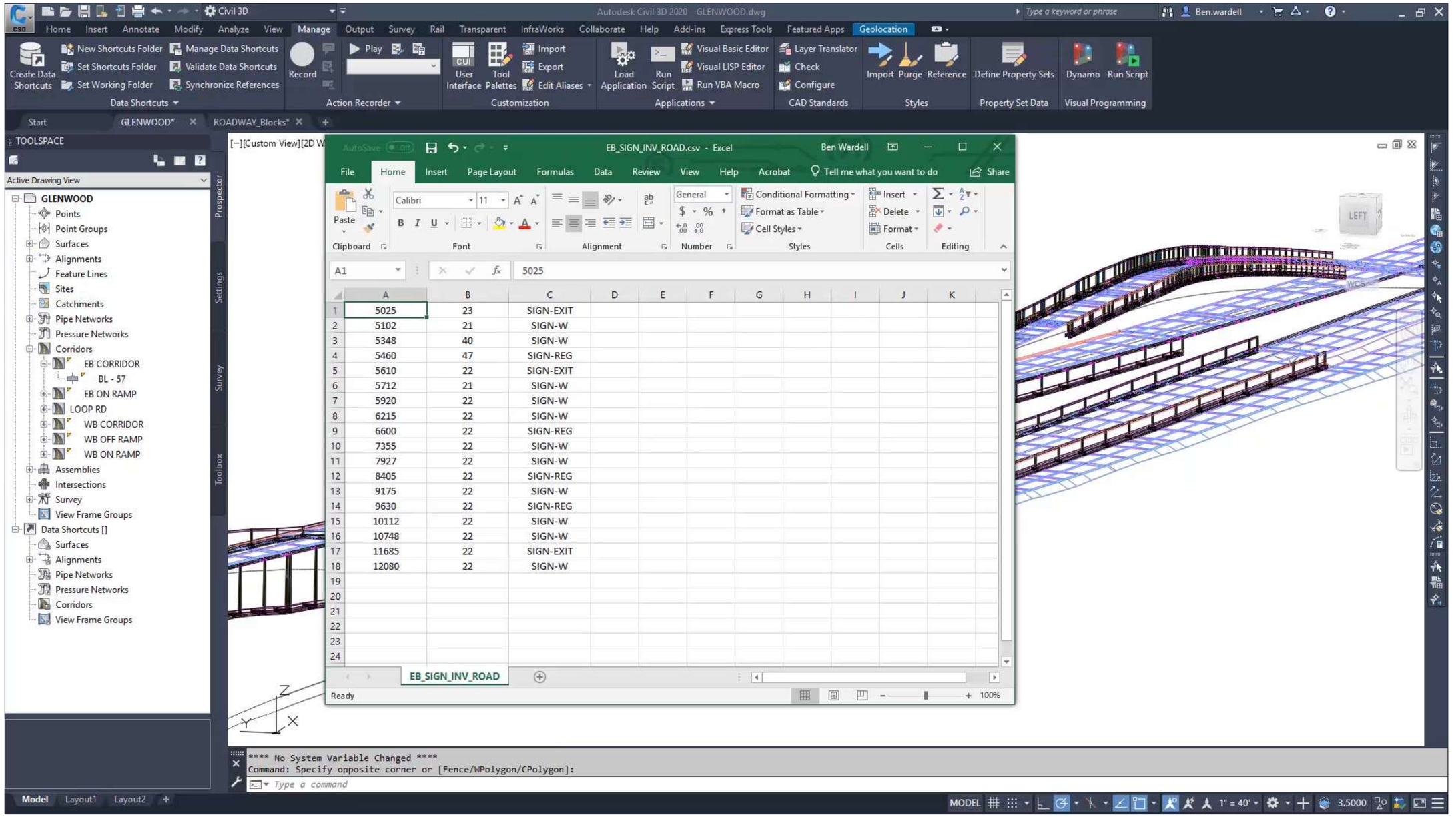
Barriers, signals and lighting posts, counterfort walls…

Dynamo Use Cases

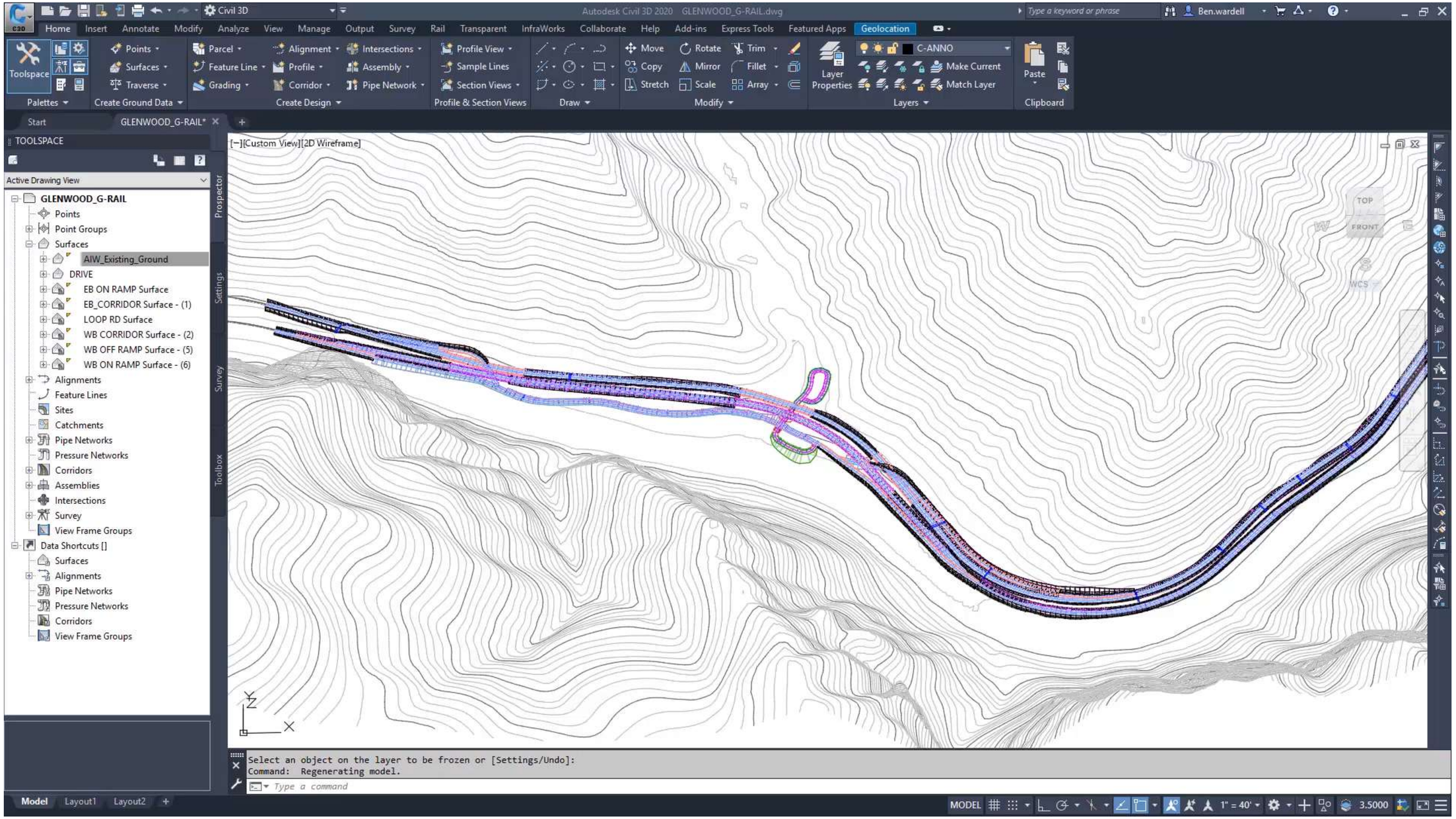
Modeling–Object Placement (Ex: Retaining Walls, Power Poles, Rail objects…)



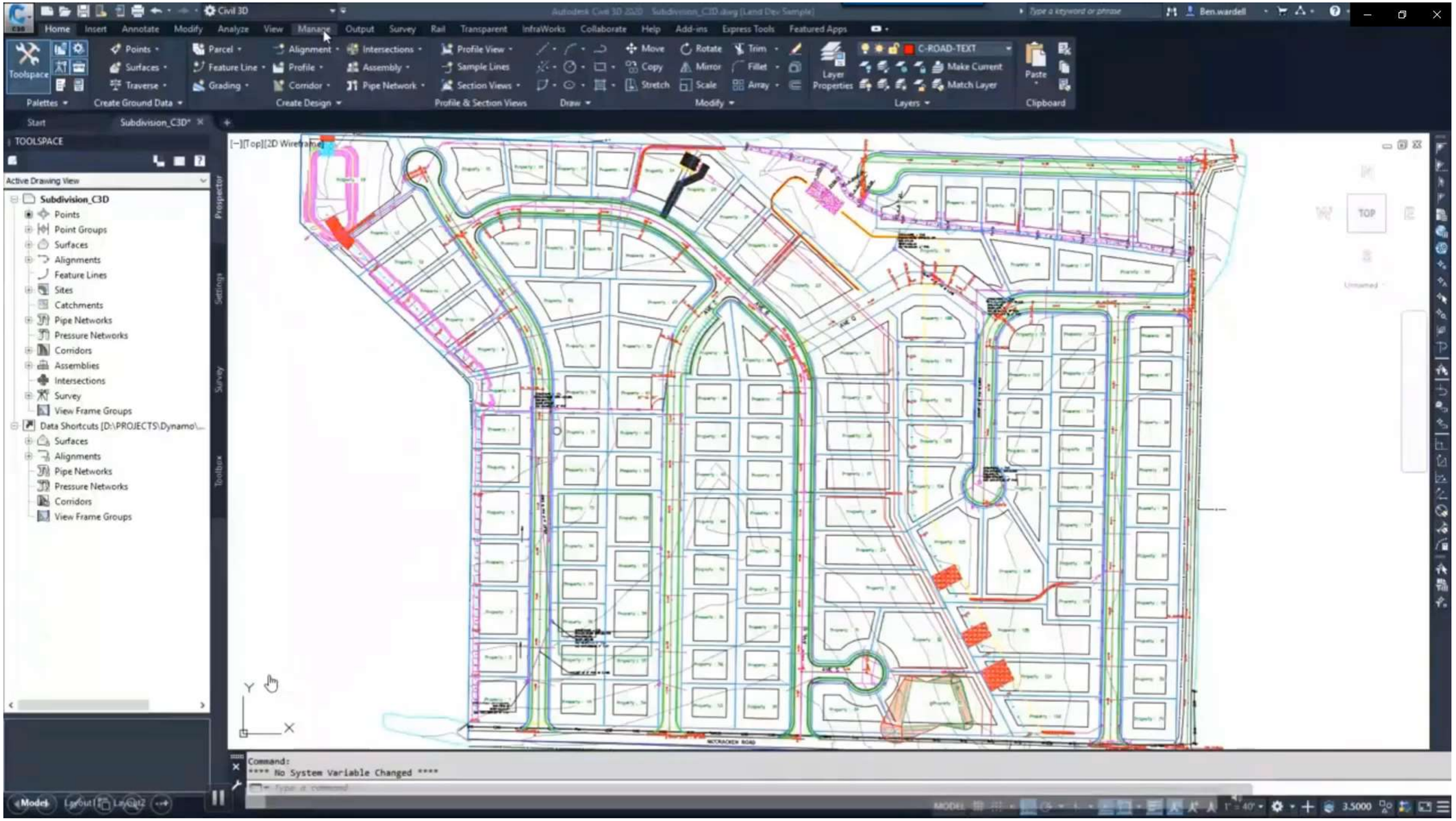
Using External Data Files



Objects by Region



Land Development

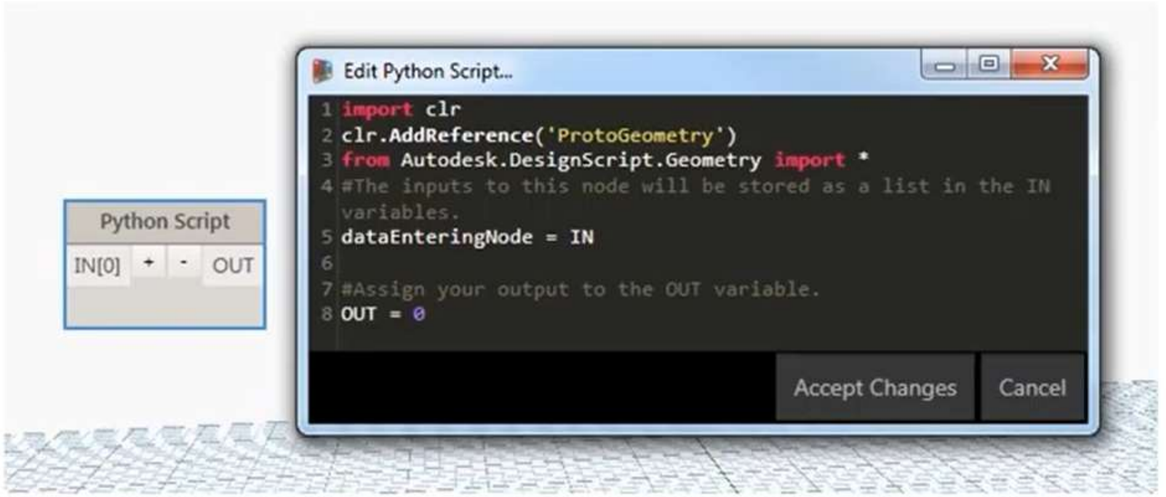


Ramps, COGO points, curbs report ….

Python and Dynamo

Iron Python | .NET Compatible

- Interpreted Programming Language (no need to compile)
- IronPython 2.7 installed with Dynamo
- .NET capabilities (e.g. Revit, Civil 3D, Navisworks, etc.)



- Advance Steel
- Alias
- Civil 3D
- FormIt
- Revit
- Sandbox

Expand Automation Workflows

- For the workflows that are still missing in the nodes shipped in Dynamo use Python
- Create Python modules for AutoCAD and Civil 3D to be reused in Dynamo
- Leverage the full .NET API in a prototyping environment
- Look out on the Dynamo Package Manager for Civil 3D dedicated packages
- Create and share custom nodes for Civil 3D using C#

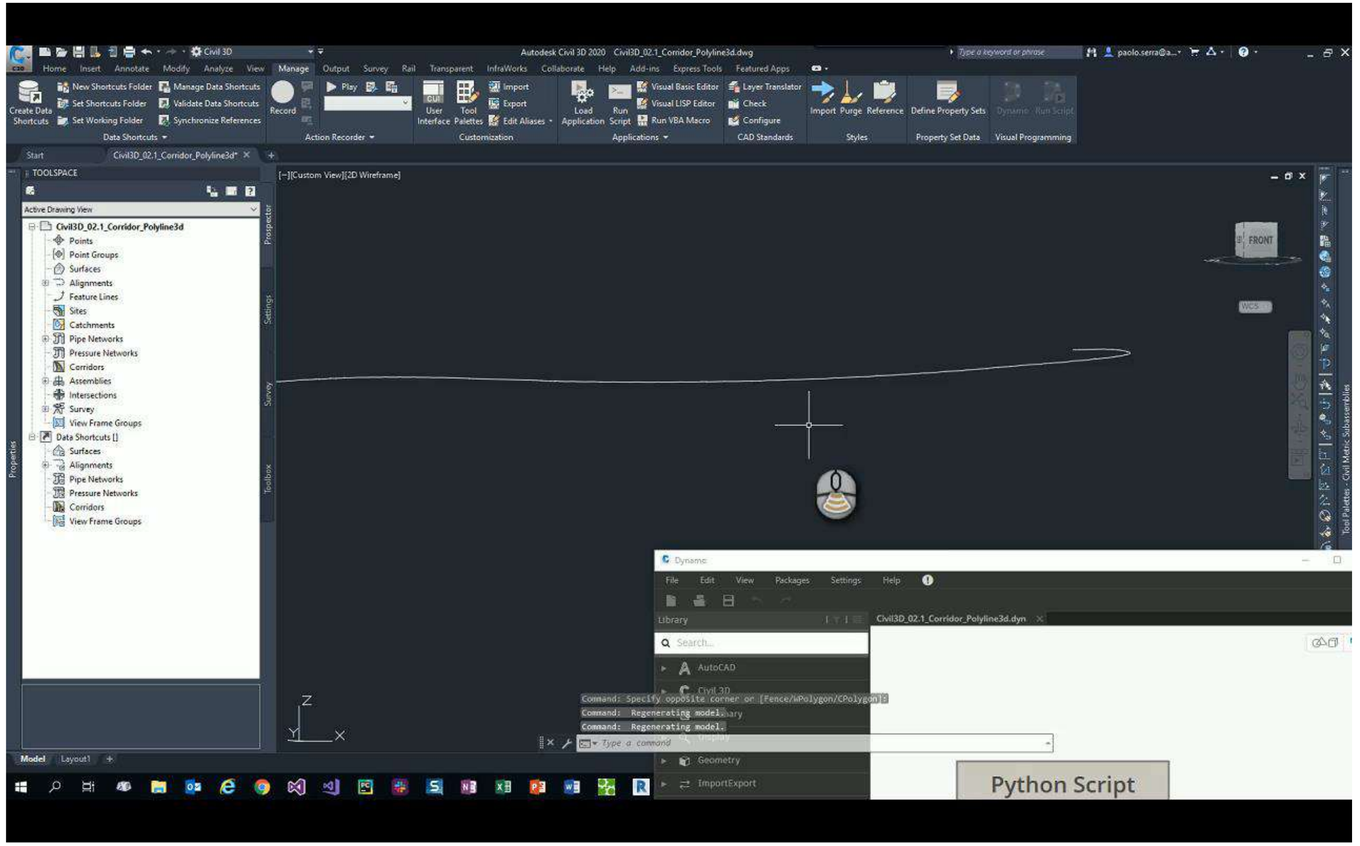
Dynamo Package Manager

Microsoft® .NET™

Python | Corridor from 3D Polyline

- 3D polyline to alignment
- 3D polyline to profile
- Stock / Custom subassemblies

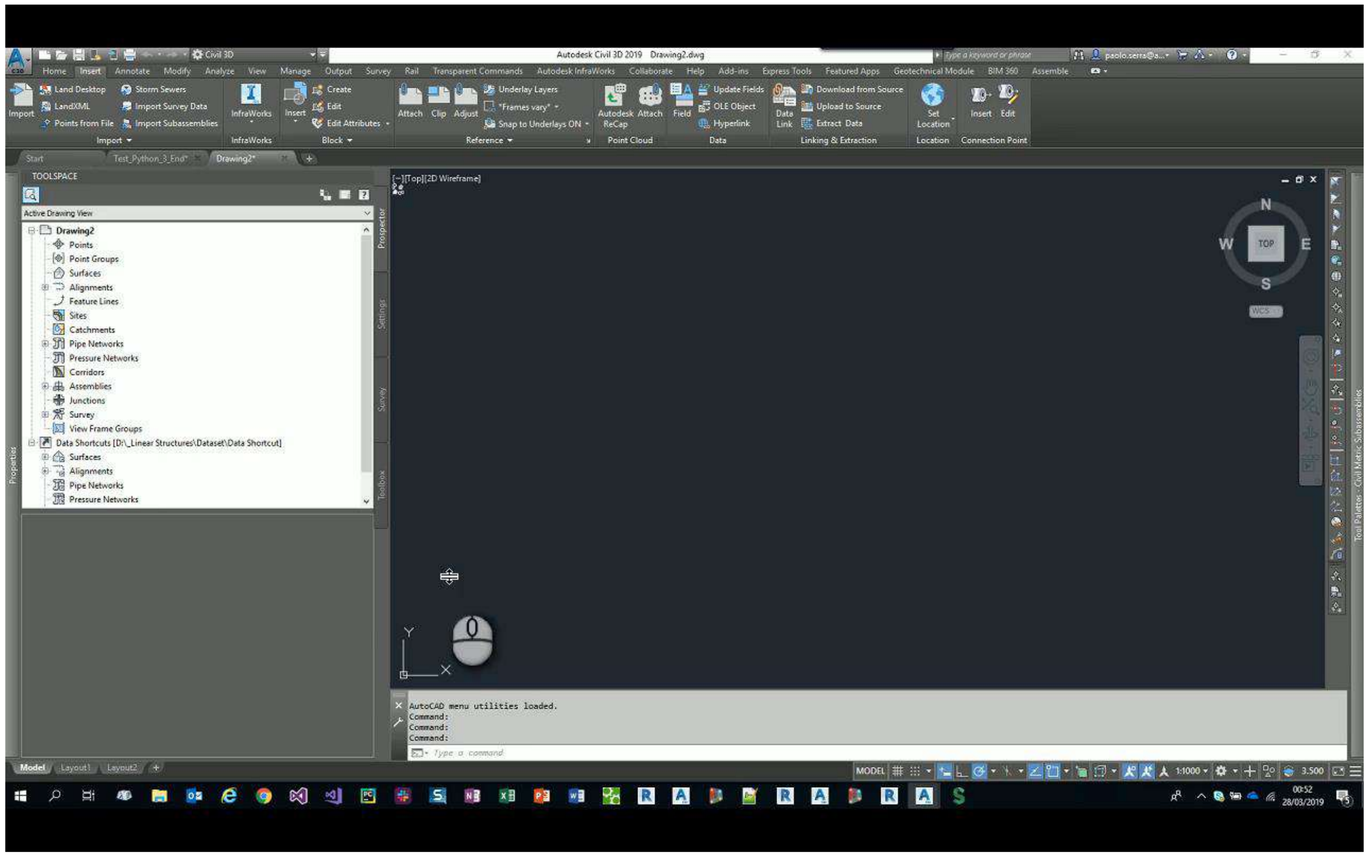
```
import clr

# Add Assemblies for AutoCAD and Civil 3D APIs
clr.AddReference('acmgd')
clr.AddReference('acdbmgd')
clr.AddReference('accoremgd')
clr.AddReference('AecBaseMgd')
clr.AddReference('AecPropDataMgd')
clr.AddReference('AeccDbMgd')
clr.AddReference('AeccPressurePipesMgd')
clr.AddReference('acdbmgdbrep')
clr.AddReference('System.Windows.Forms')
```



Link to Video

Python | Corridors from LandXML

- Alignments from LandXML
- Break lines with codes assigned
- Simple assembly with target parameters




```
import clr

# Add Assemblies for AutoCAD and Civil 3D APIs
clr.AddReference('acmgd')
clr.AddReference('acdbmgd')
clr.AddReference('accoremgd')
clr.AddReference('AecBaseMgd')
clr.AddReference('AecPropDataMgd')
clr.AddReference('AeccDbMgd')
clr.AddReference('AeccPressurePipesMgd')
clr.AddReference('acdbmgdbrep')
clr.AddReference('System.Windows.Forms')
```

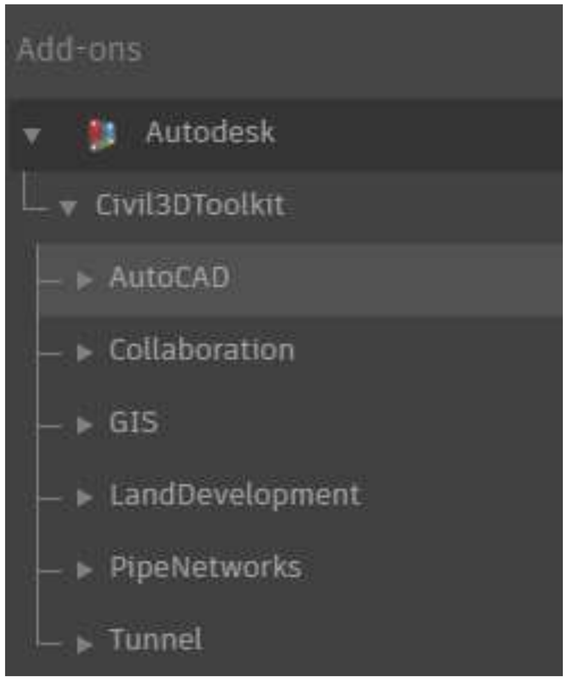
Link to Video

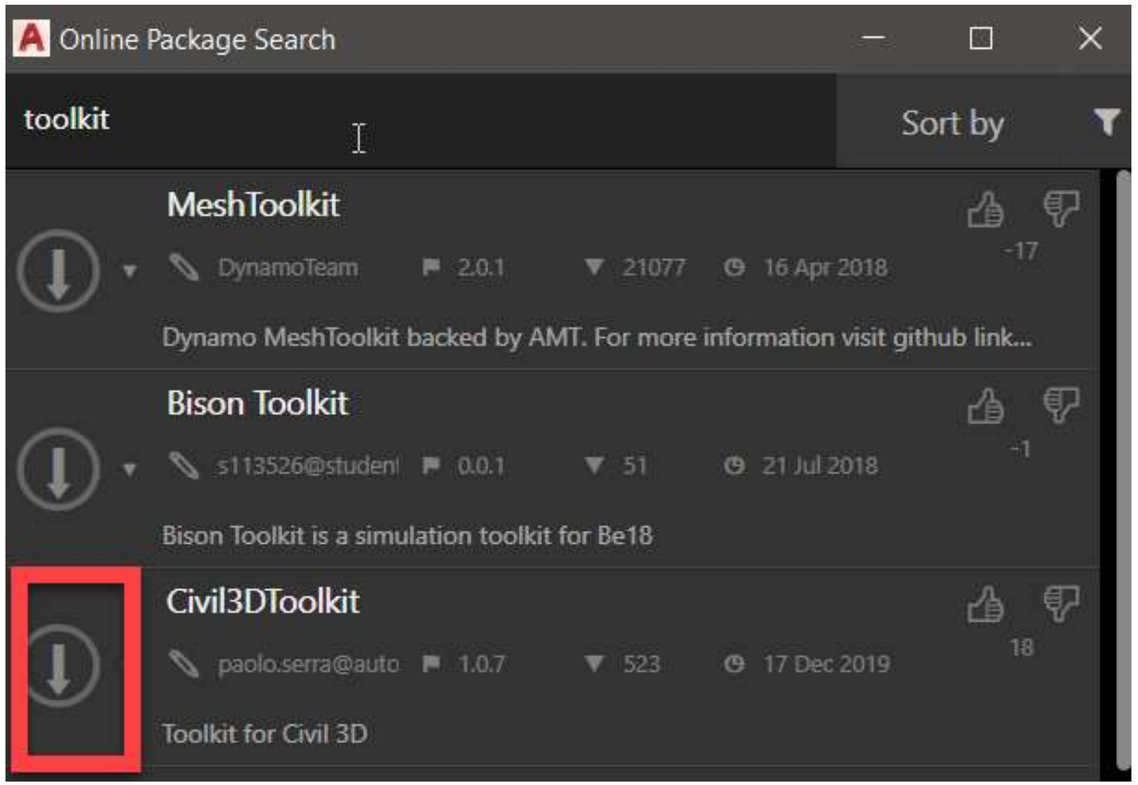
This video demonstrates how to leverage the CivilConnection workflows starting from a LandXML import into Civil 3D. The Python Script generates a Civil 3D Corridor complete with assemblies, baselines, regions and targets based on the LandXML input. The corridor can then be used as a regular input for CivilConnection.

Civil 3D Dynamo Toolkit Package

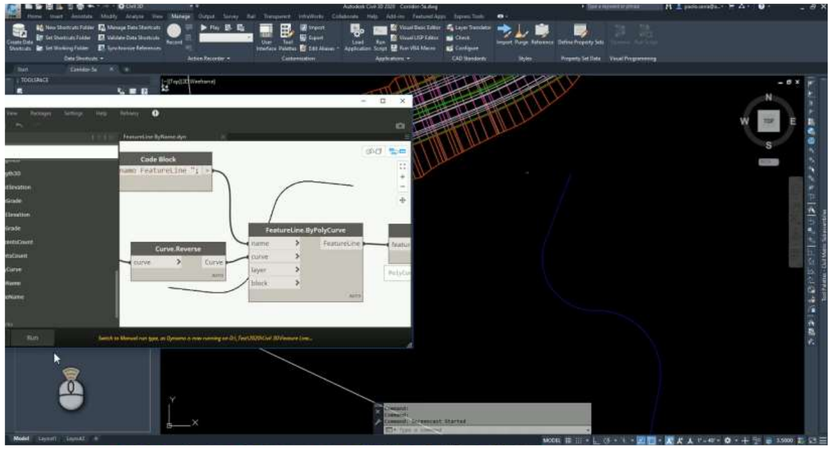
Civil 3D Toolkit …Highly Recommended!

- Extend OOTB functionalities
- Enable workflows beyond transportation
- Support Collaboration
  - 50 shelves
  - 500+ nodes



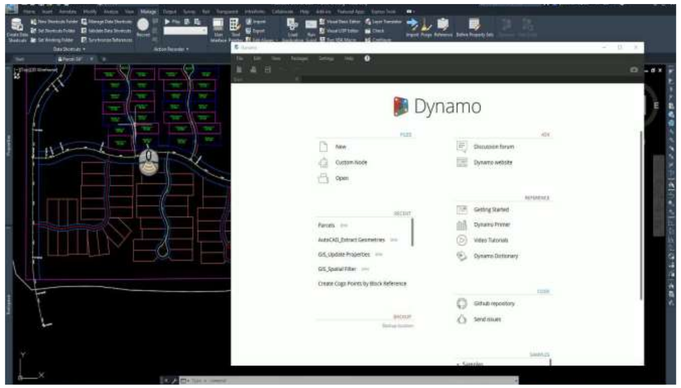


Civil 3D Toolkit Use Cases



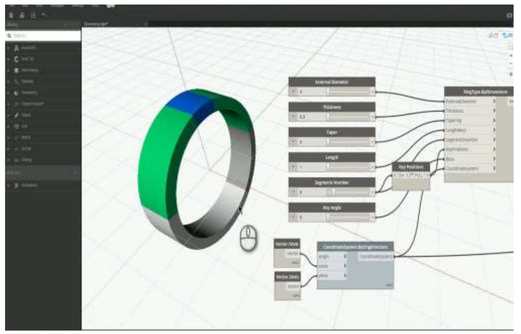
1- Feature Lines – Read & Write Feature Lines
- Access Geometry data
- Access Style and Name

2- Parcels – Read Parcels
- Access geometry data
- Access Style and Number



3- Filter map properties – access map features

4- Pipe networks - Read & Write Pipe Networks (Pipes & Structures)
- Extract Properties & Geometry
- Get / Set Part Data



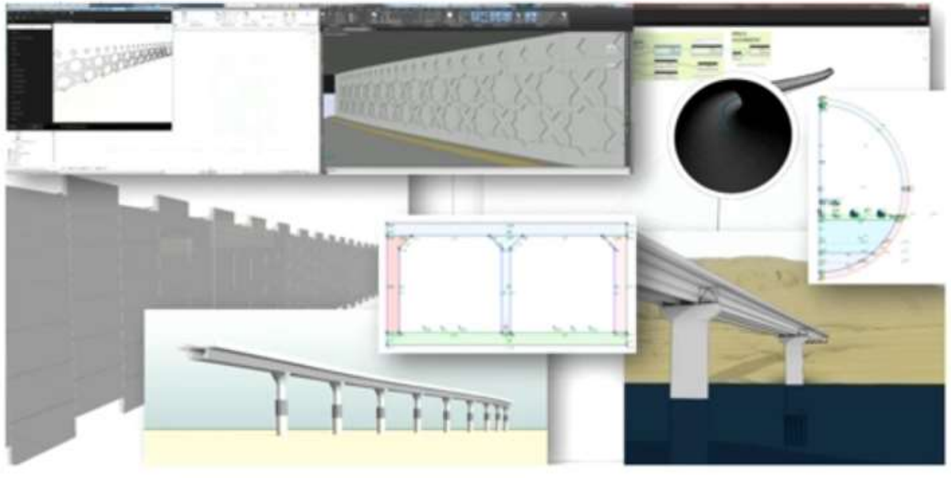
5- Tunnels … etc

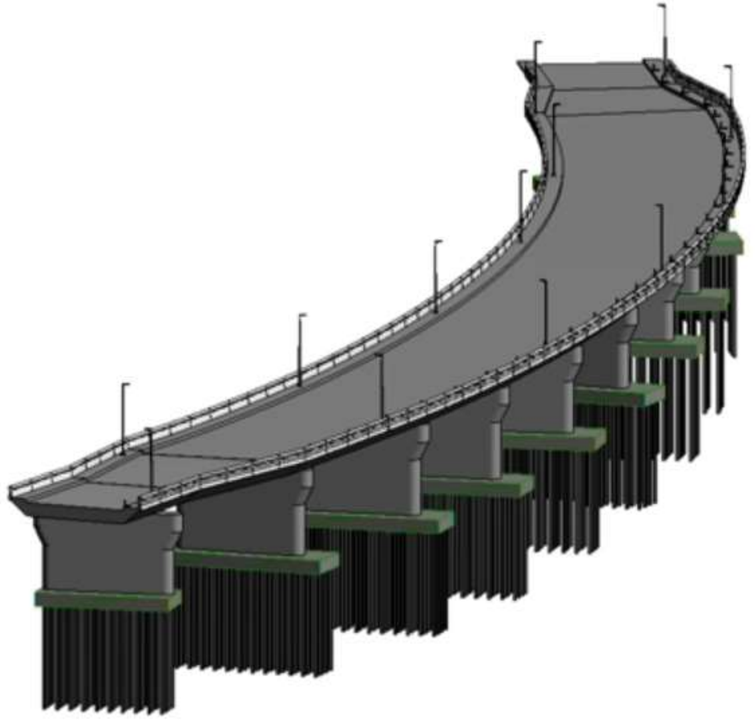
[Link to the AU Session by Paolo Serra]

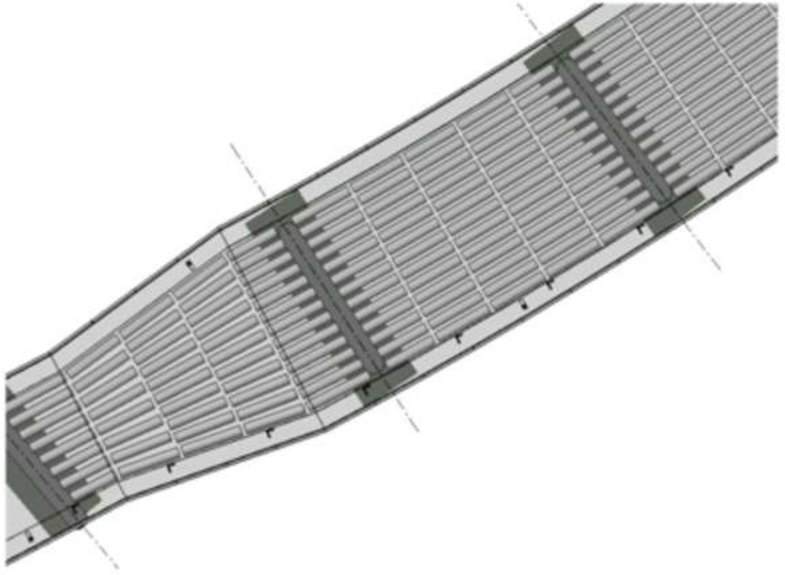
Dynamo for Civil 3D
CivilConnection Package

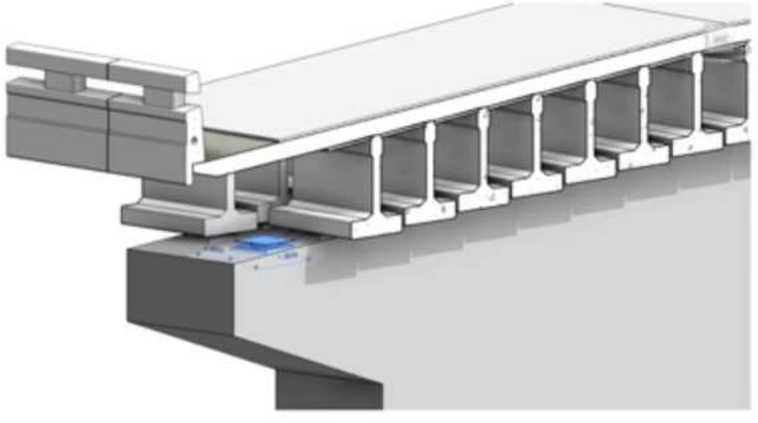
CivilConnection & CivilPython

- Connects Civil 3D and Revit
- Computational design toolkit for infrastructures
- On Dynamo Package manager
  - Open Source & customizable
  - Link to Customer Success Stories





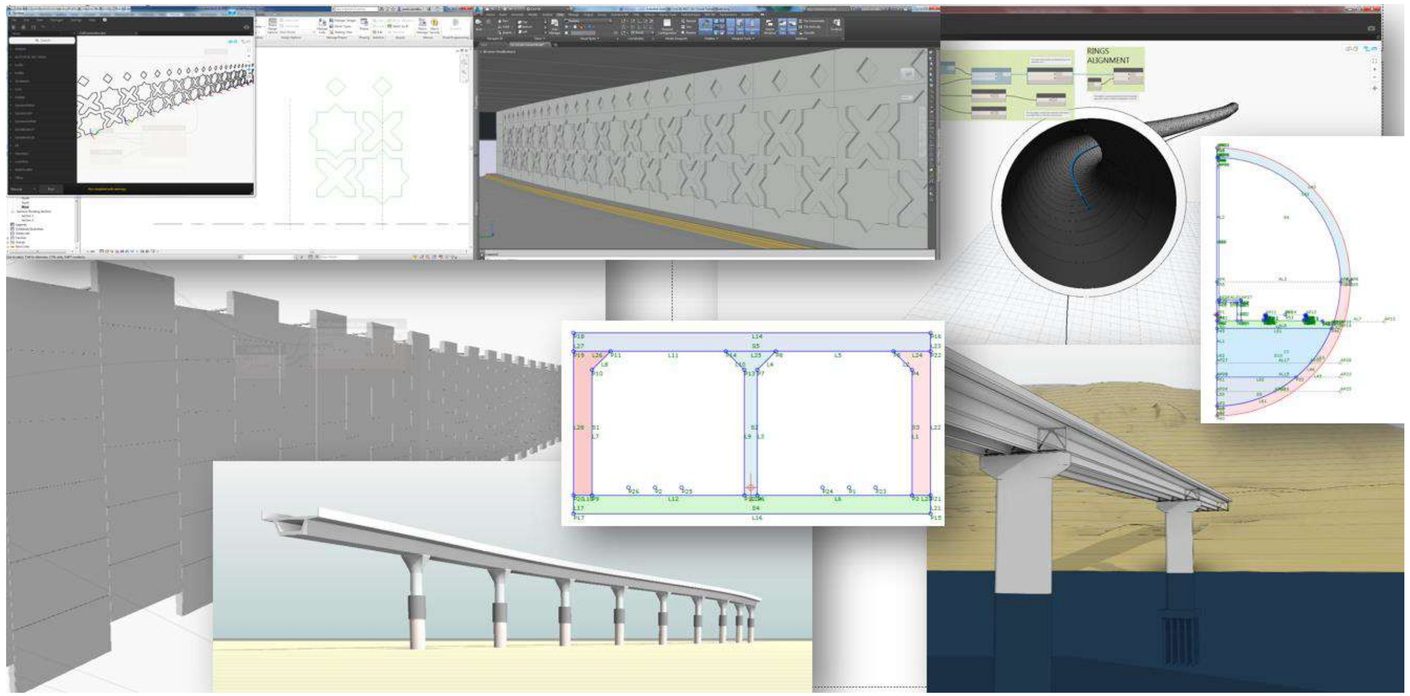


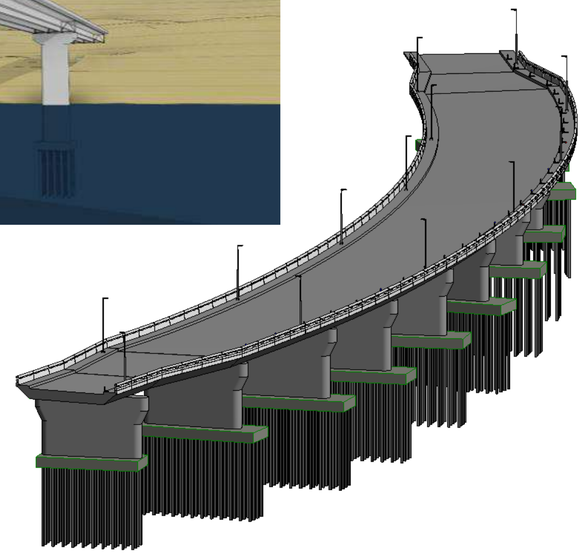


CivilConnection

Dynamo Package (Autodesk Consulting)

- Complementary to InfraWorks Civil Structures workflows and for detailed design
- Bidirectional flow of information between Civil 3D and Revit
- Toolkit to leverage computational design for infra structures
- Open Source & customizable



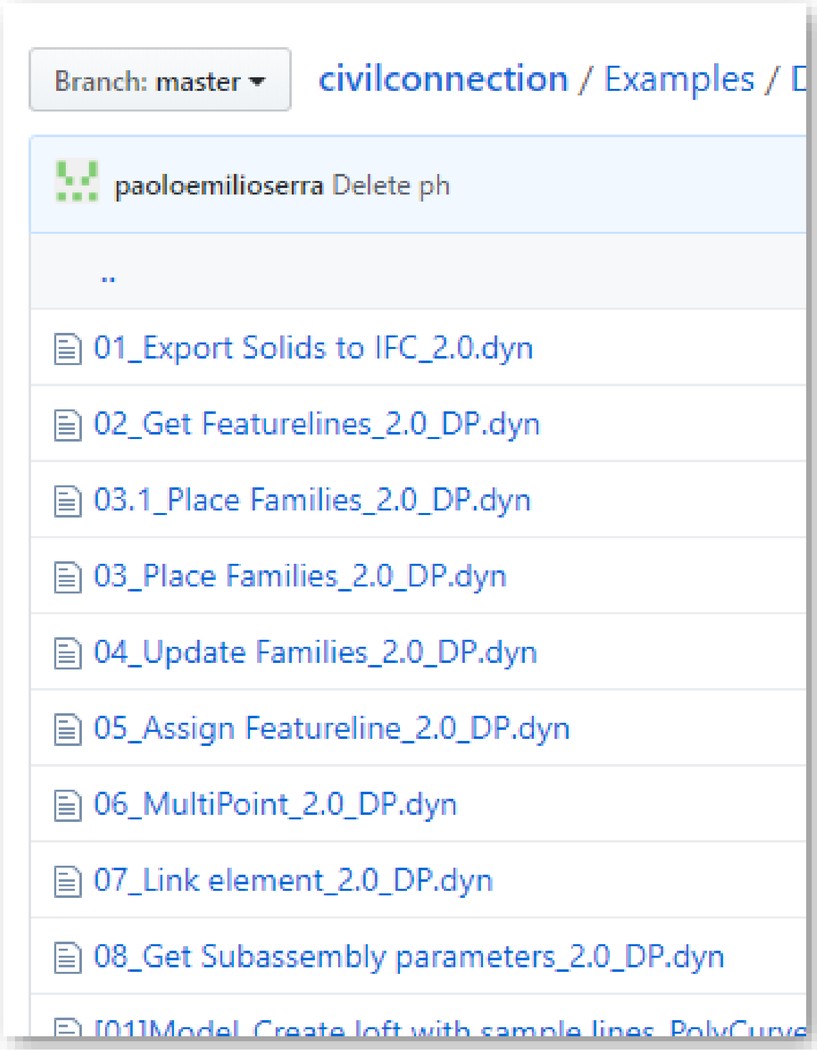


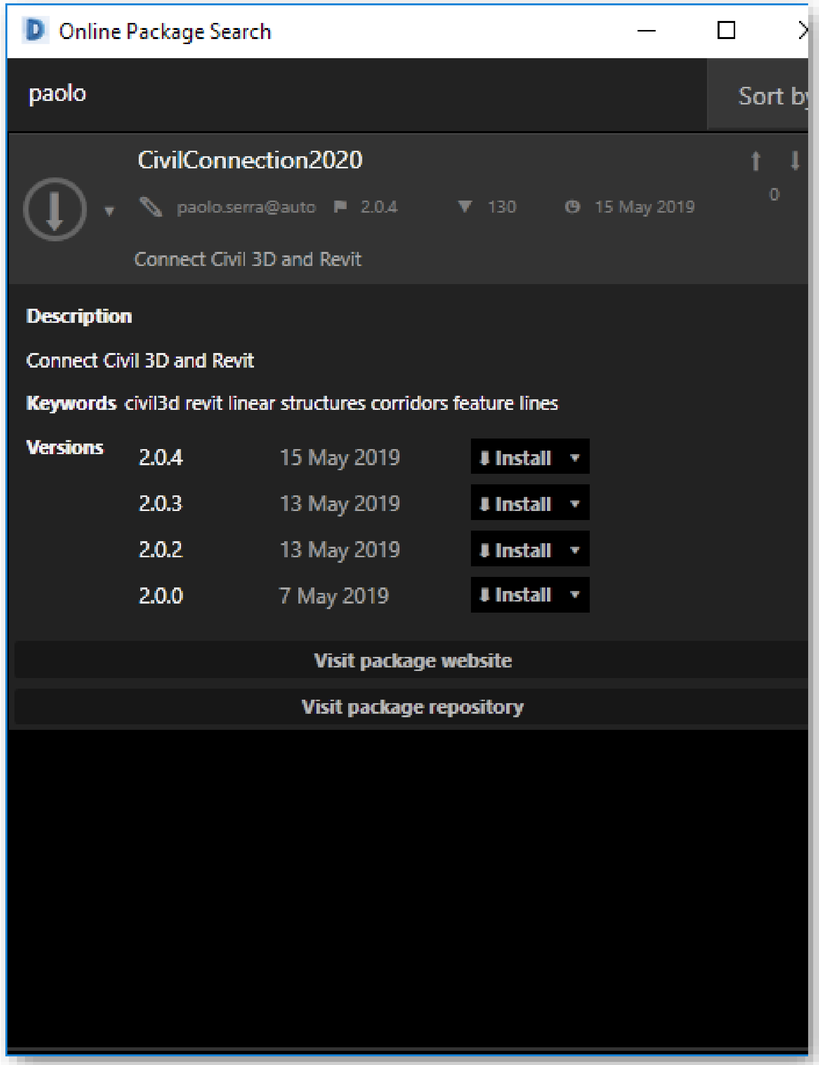
[Link to Webinar](#) - **Computational Design for Civil Engineers using DYNAMO for Civil 3D**

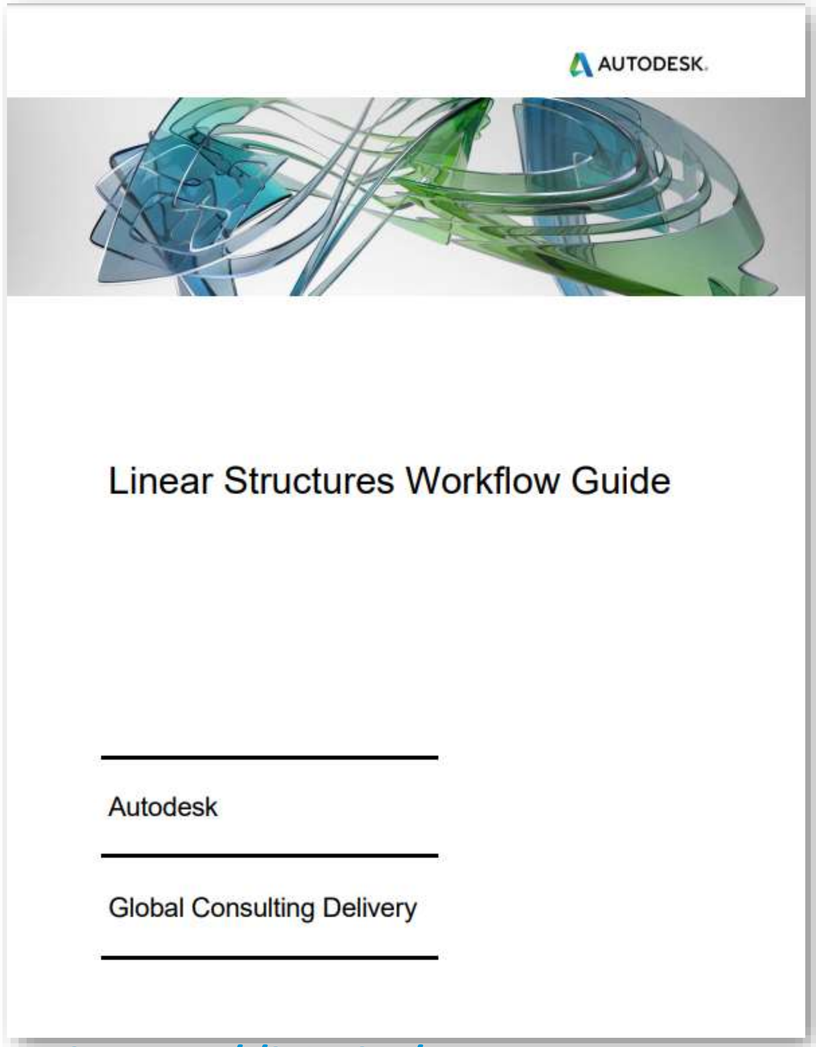
[Dynamo Packages Link](#)

CivilConnection

@Github [CivilConnection docs]







https://bit.ly/2YBu4Ve

CivilConnection Major Features

- ✓ **Enables the exchange of information between Civil 3D, Dynamo and Revit.**
- ✓ **Reads the information embedded in rich linear objects such as Civil 3D alignments, corridors or feature lines and creates proxy elements in Dynamo. In turn the proxy elements can be used to establish dynamic relationships to drive the creation of discrete Revit elements (i.e. single point family instances, line based objects such as structural framing or MEP segments, complex objects such as adaptive components, floors, walls, Revit link instances).**
- ✓ **Provides features to update the location, orientation and metadata of Revit elements against a Civil 3D input.**
- ✓ **Reads the shapes and links of the Civil 3D Corridors and create and update modifiable Revit families without any tessellation. This enables to further the detailing in Revit, use parts and rebar, assign custom materials to the objects and preparing it for the construction phase.**
- ✓ Creates basic AutoCAD entities such as layers, points, line, arcs, polylines 2d and 3d, region, solids.
- ✓ Creates basic Civil 3D entities such as point groups or alignments to enable the creation of TIN surfaces or providing targets for corridors.
- ✓ Performs Boolean operations between AutoCAD solids; this functionalities are used to add details to the Civil 3D models with discrete elements or performing subtraction that preserve the individual solids involved.
- ✓ Imports geometry elements generated in Dynamo into Civil 3D via SAT Export / Import.
- ✓ Imports and updates the solids in the geometry of Revit elements into Civil 3D via the link Element functionality.
- ✓ Gets or sets the parameters of the subassemblies in a corridor and force the corridor to rebuild.
- ✓ Sends commands to the Civil 3D command line (this feature can be used to launch CivilPython).

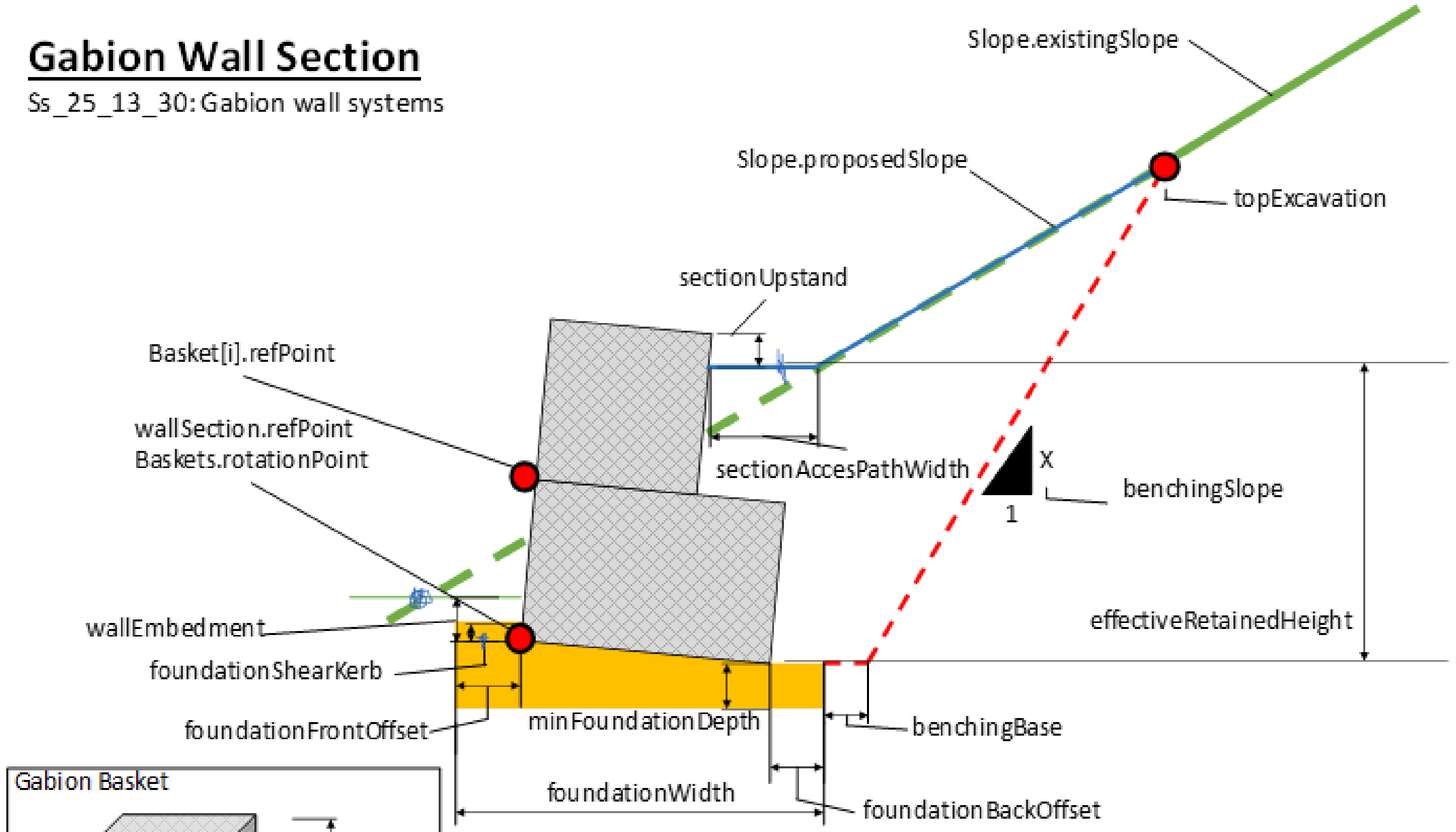
Optimised Gabion Wall Design

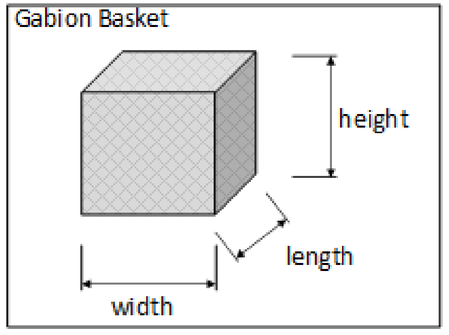
AUTODESK UNIVERSITY

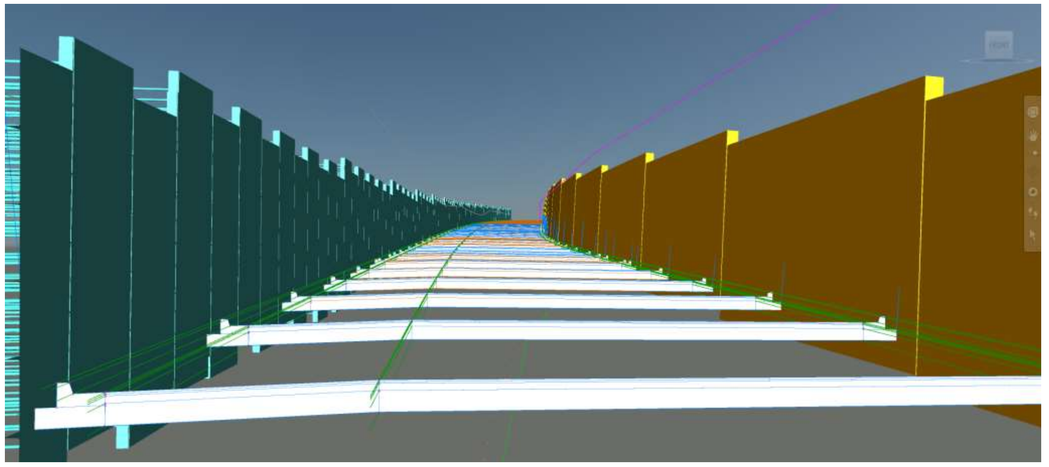
ATKINS
Member of the SNC-Lavalin Group

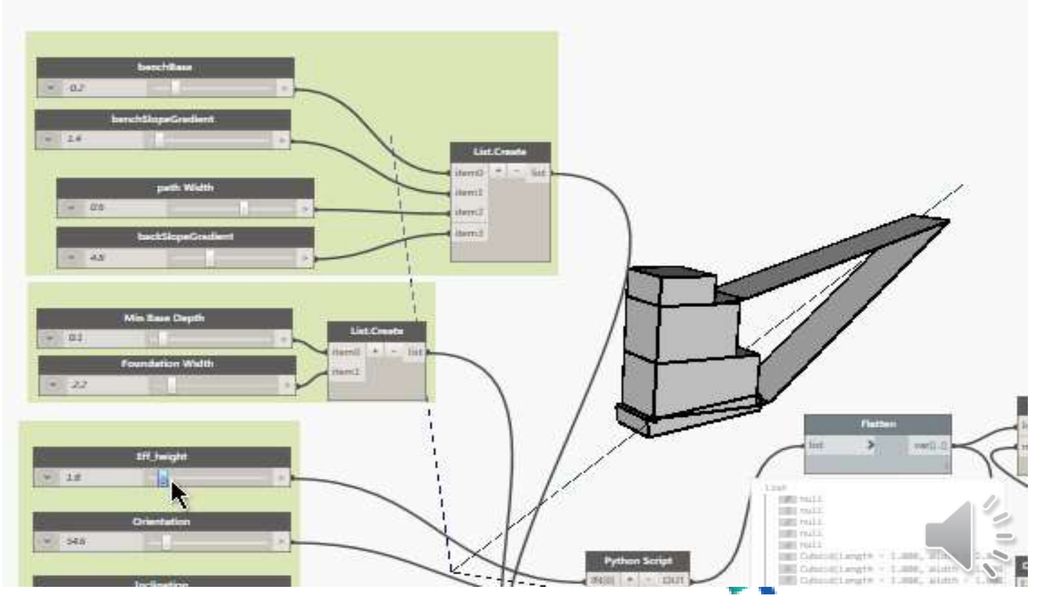
Gabion Wall Section

Ss_25_13_30: Gabion wall systems

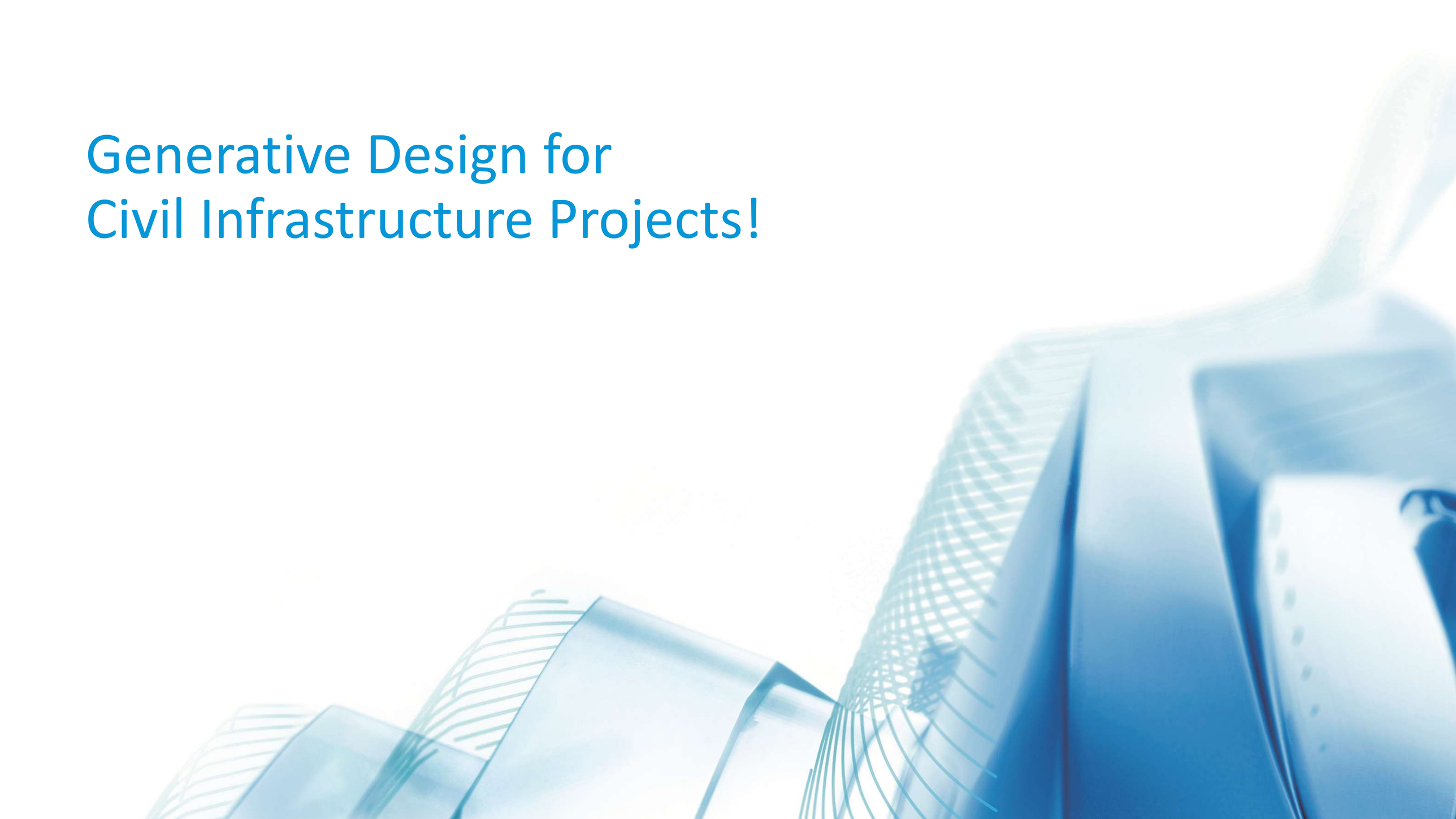


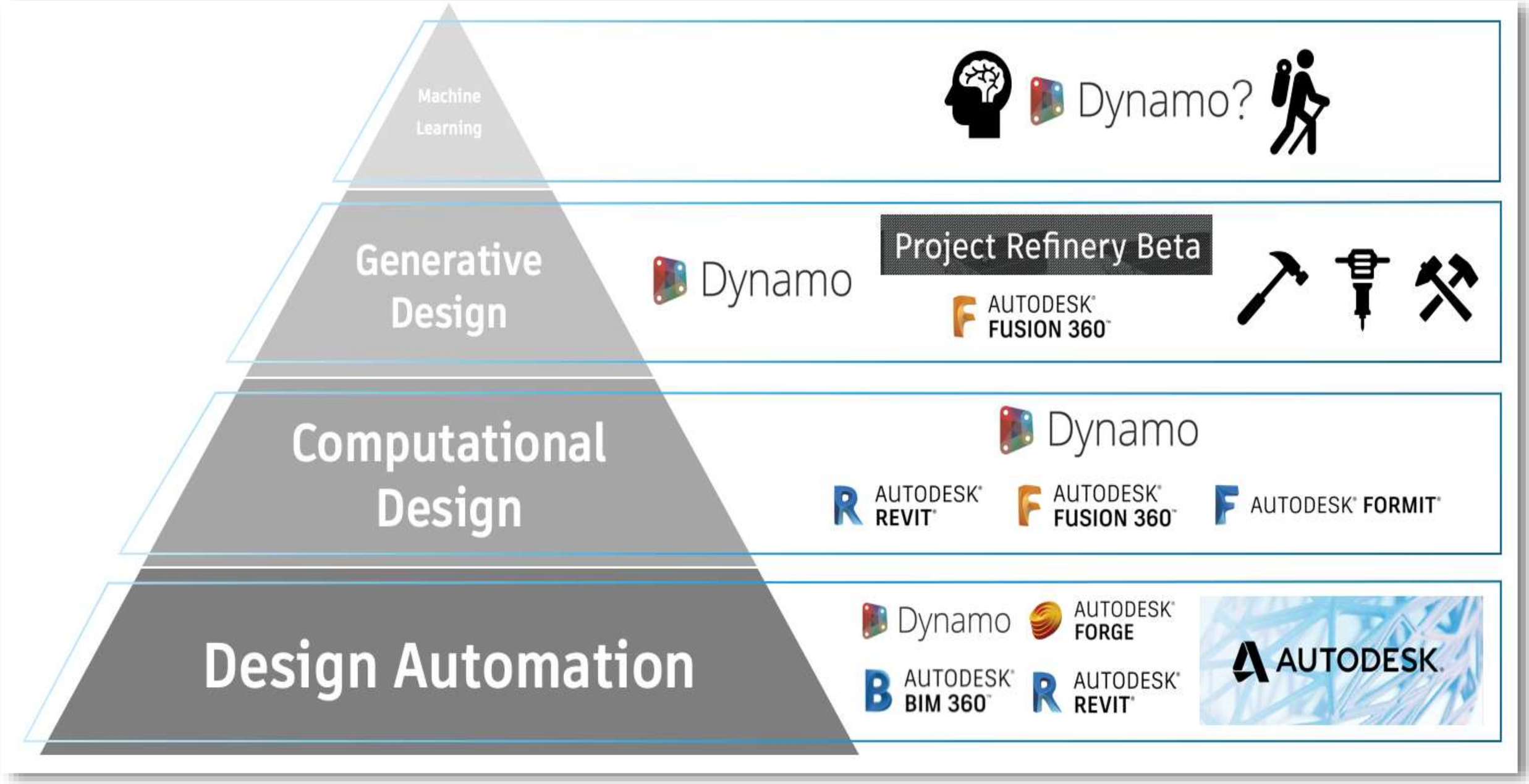




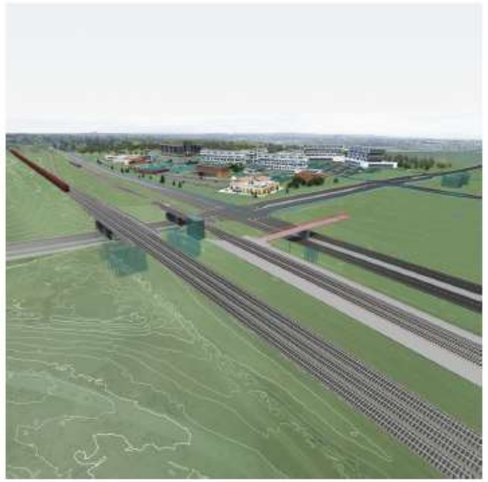


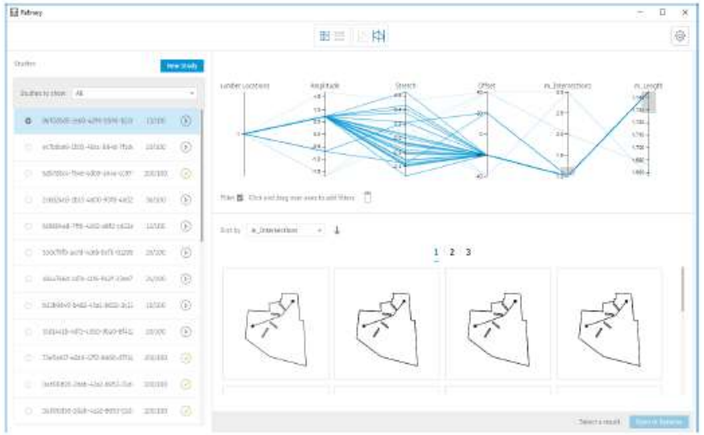
Generative Design for Civil Infrastructure Projects!




Machine Learning
Dynamo?
Generative Design
Dynamo
Project Refinery Beta
AUTODESK FUSION 360
Computational Design
Dynamo
AUTODESK REVIT
AUTODESK FUSION 360
AUTODESK FORMIT
Design Automation
Dynamo
AUTODESK FORGE
AUTODESK BIM 360
AUTODESK REVIT
AUTODESK

Generative Design Approach | Project Refinery





Evolve

Project Refinery

Gather Data → Generate → Evaluate → Select

Defining Model

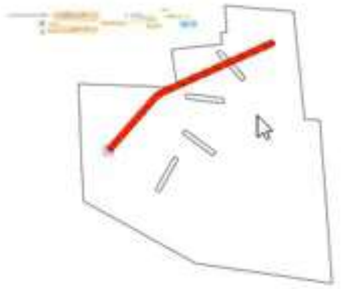
Computational Strategy

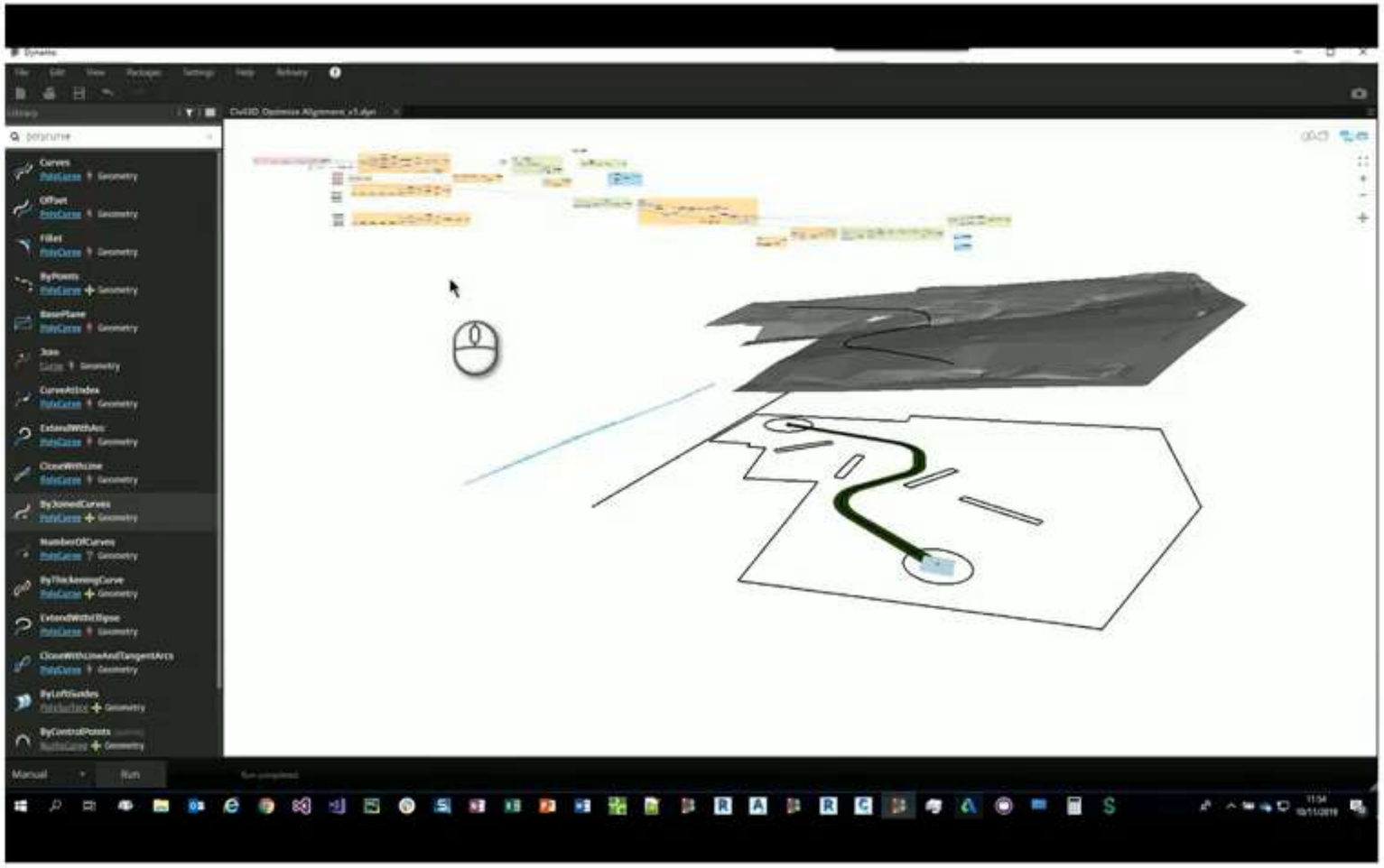
Metrics Scores

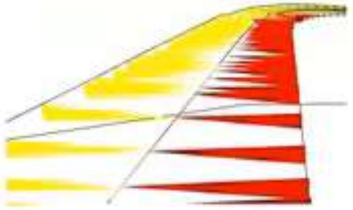
Data / Feedback Driven

[Sign up for Project Refinery here]

Optimize Alignment

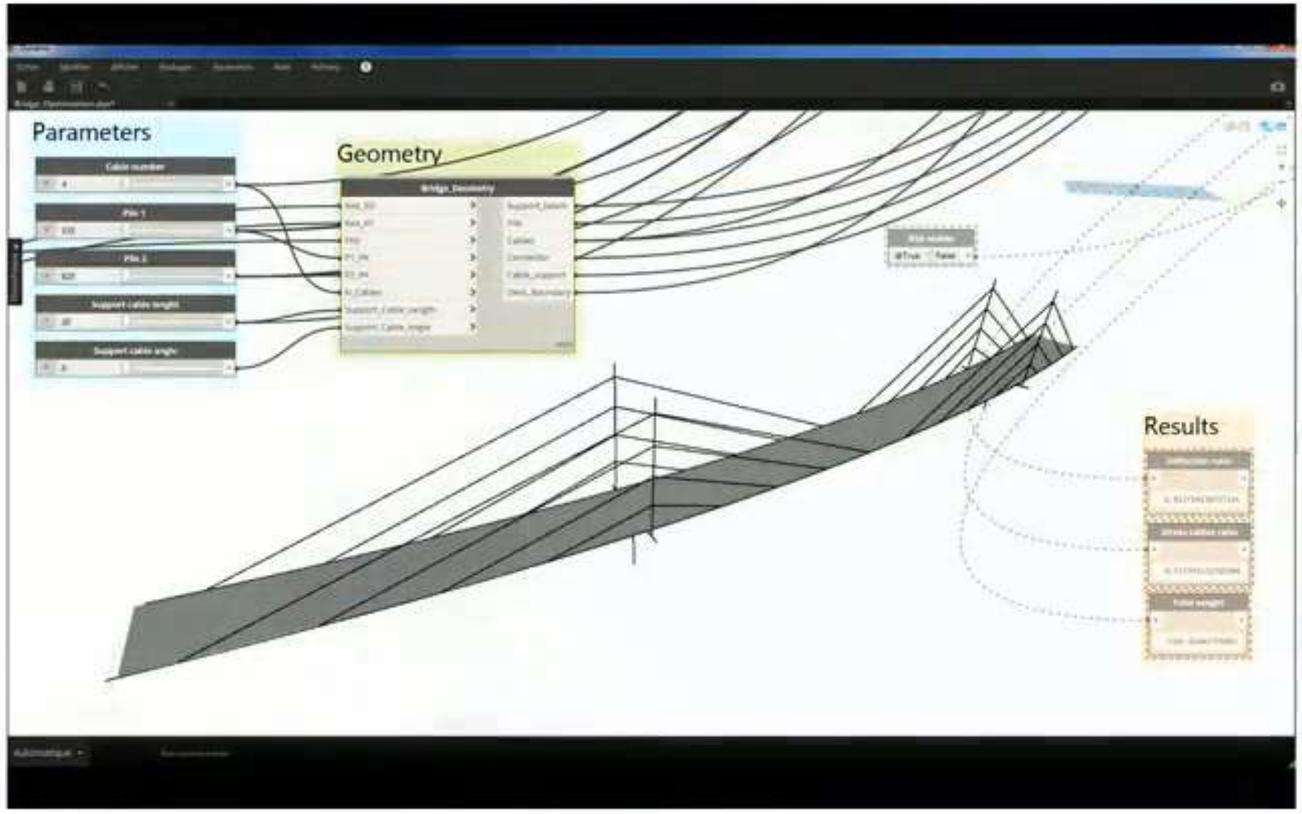






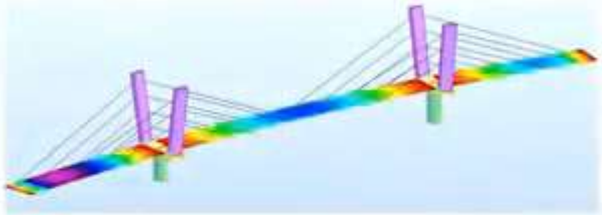
[Link To Video]

Optimize Cable-Stayed Bridge



Cable stress ratio

Deflection ratio

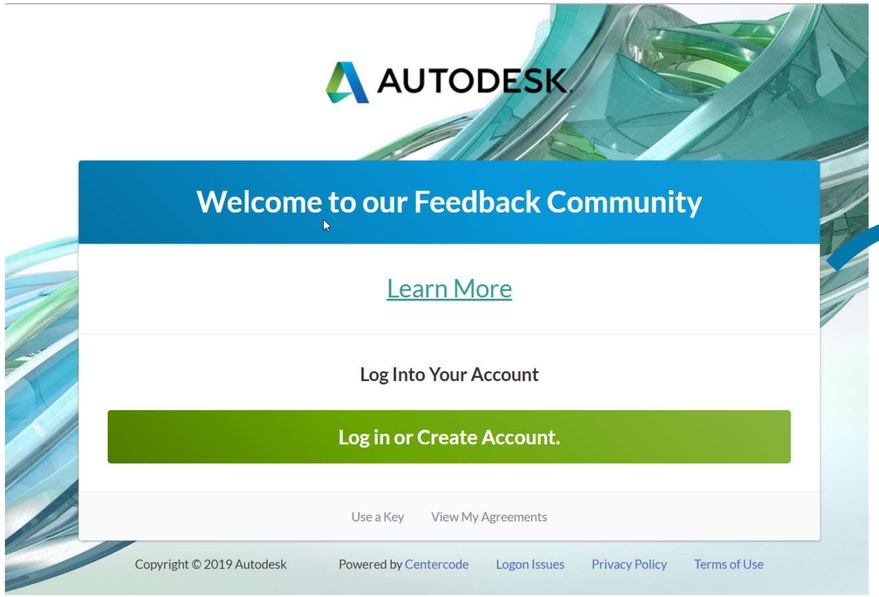


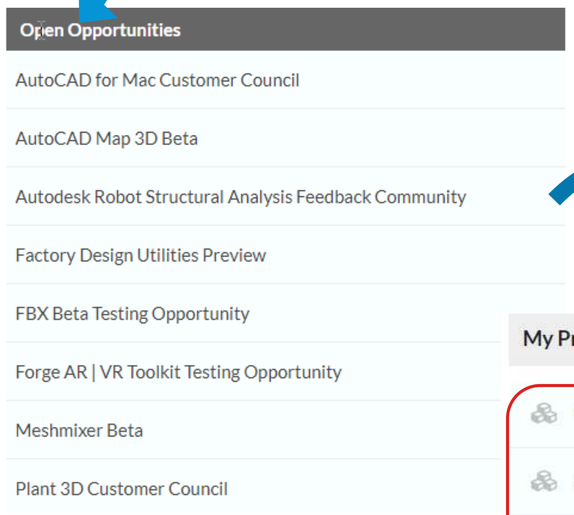
Total weight

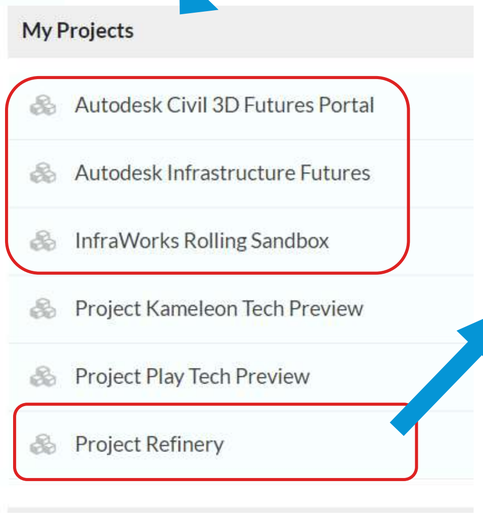
[Link To Video]

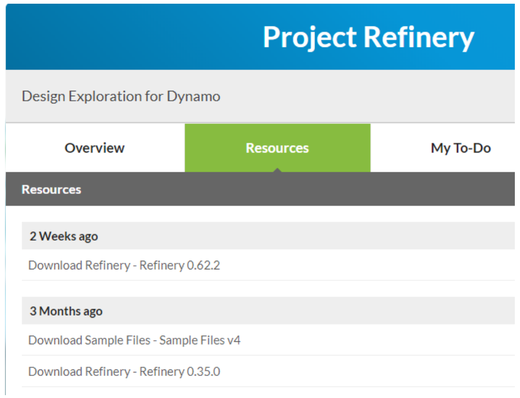
Link to create an account for Autodesk Feedback Community for testing the Generative Design algorithm “Project Refinery”:

https://feedback.autodesk.com/welcome/









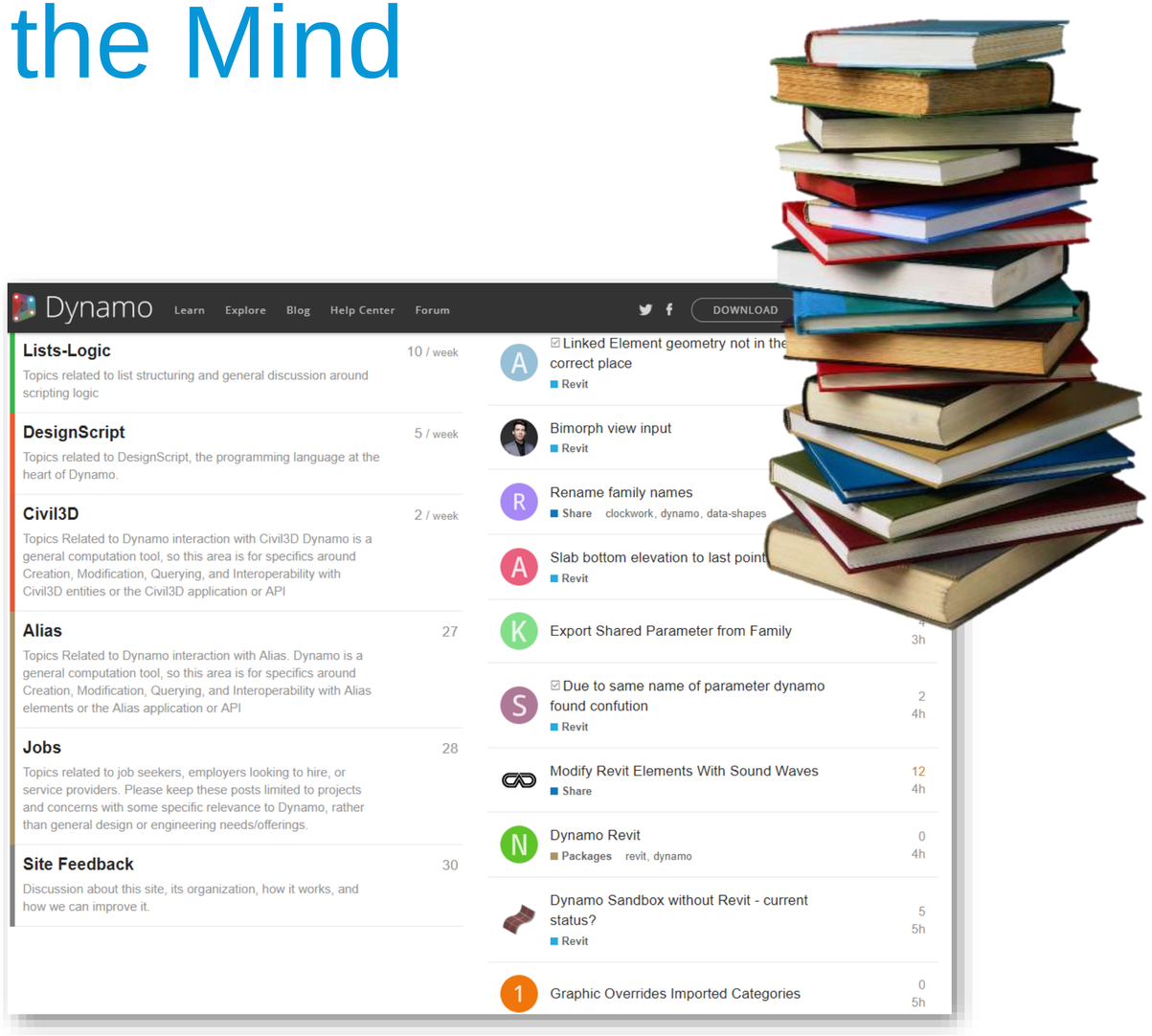
Create an account and log in then look for available projects under the “Open Opportunities” section then click on the projects you are interested to accept the agreement details then you will see you projects available for downloading and testing under your “My Projects” list

I also recommend that you also check the other projects highlighted in Red to stay up to date with what is being developed on tools like Civil 3D and InfraWorks:

Learning Never Exhausts the Mind

Learning Resources

- DynamoBIM.org forum | Civil 3D category
- DynamoPrimer.com
- Autodesk University RS
- DynamoNodes.com
- GitHub/DynamoDS
- Blogs, YouTube videos
- AU lessons and handouts
- Lynda.com / CadLearning.com



Thank You!

Download Material:

https://myshare.autodesk.com/:f:/g/personal/mohammad_abouassali_autodesk_com/Etux4GNxYQZPk14c1HbwevoBpT9R6p7in84J5XtqyGtXyg?e=Jyppog

*Starting Thursday, Dec 19

** Link is valid for 20 years only

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