

# Beyond Blueprints: Building the Future of Cities

With Python, Blender, and Generative AI

Presenter: Tadeh Hakopian



IT REVOLUTION  
ENGINEERING TECHNOLOGY  
LEADERSHIP SUMMIT  
2024



## ABOUT ME

Tadeh Hakopian / (Todd-A Ha-co-pea-on)

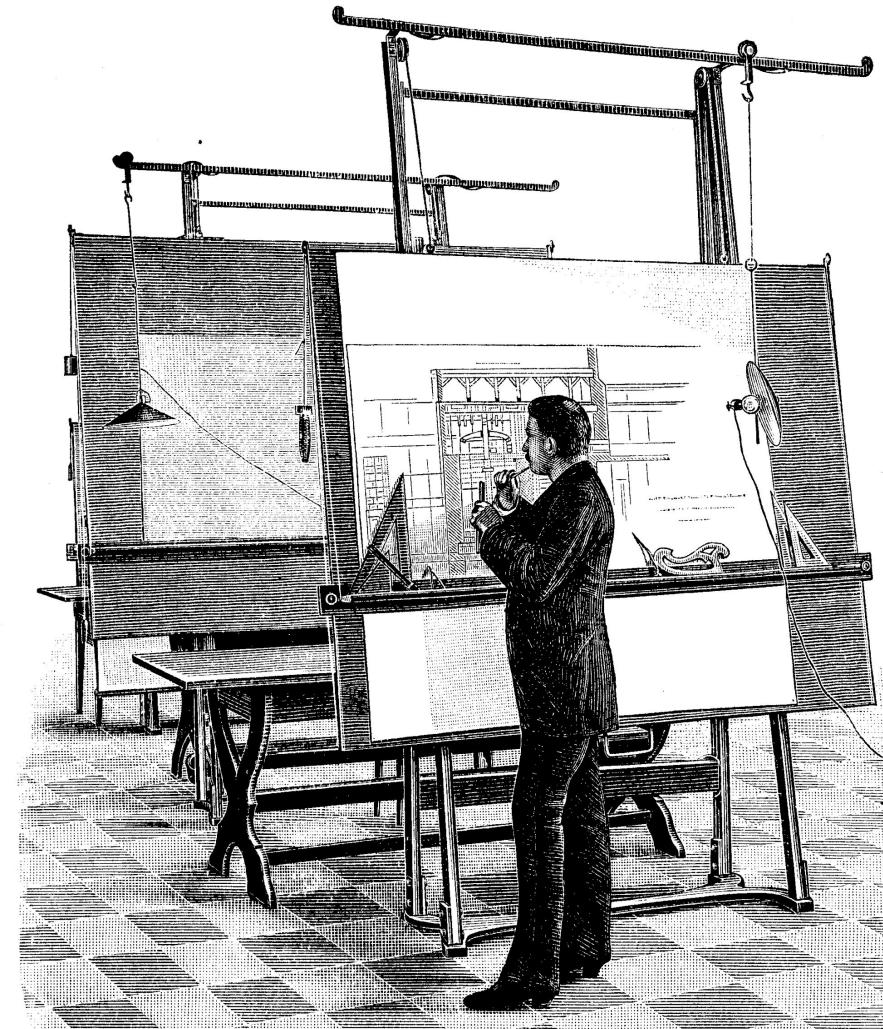
Program Manager @Amazon

Background in Architecture & Construction

Data in Buildings

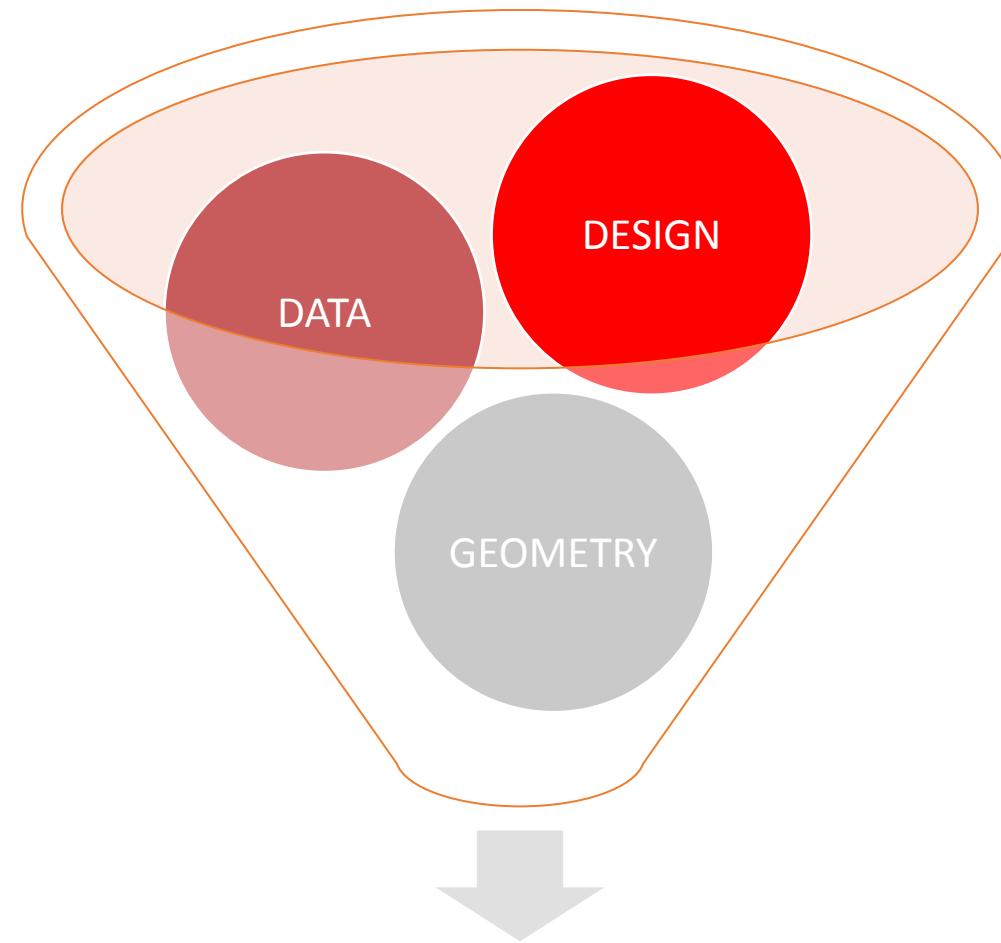
Big Projects





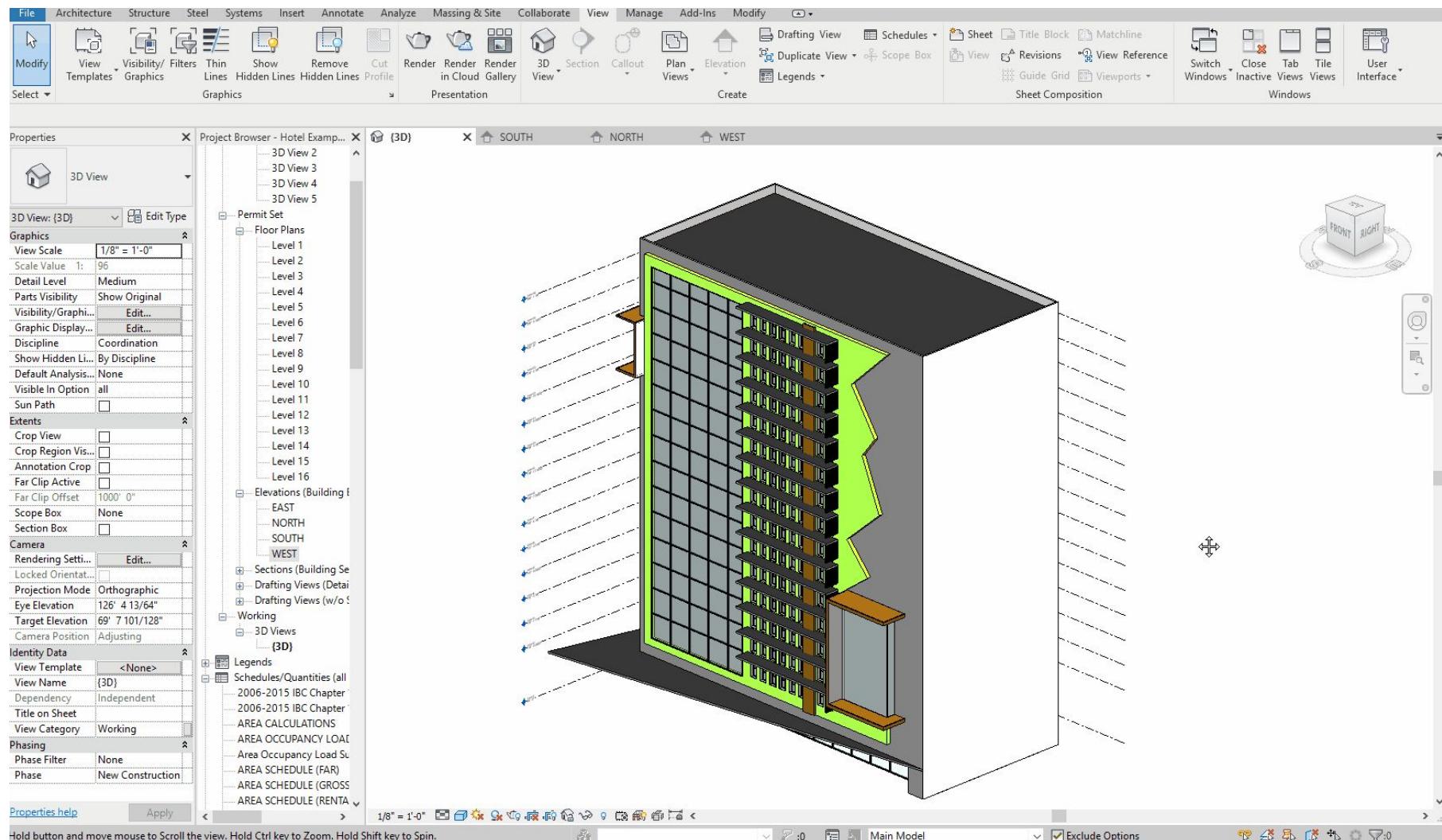
- How does the Architect Explain their Idea with Information?

## BUILDING INFORMATION MODELING



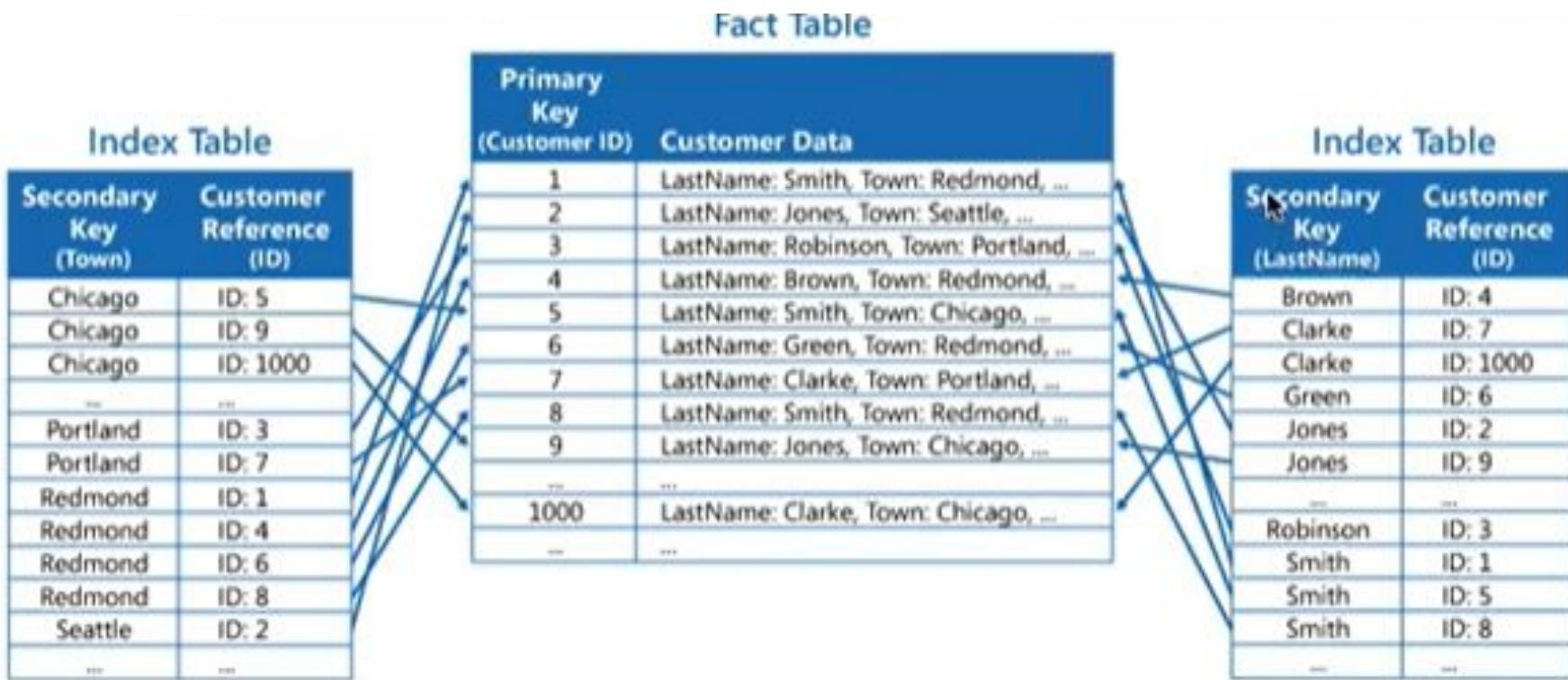
Building Data  
AKA 'BIM'

# 3D MODELING WITH BIM



- Our Source of Building Data, 3D models!

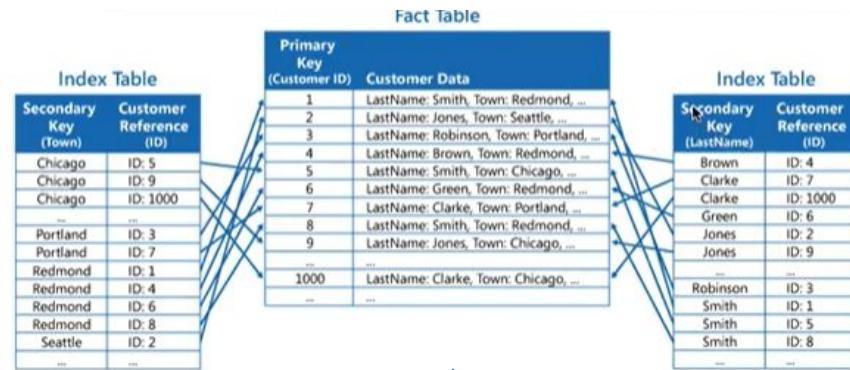
# BUILDING A BUILDING DATABASE



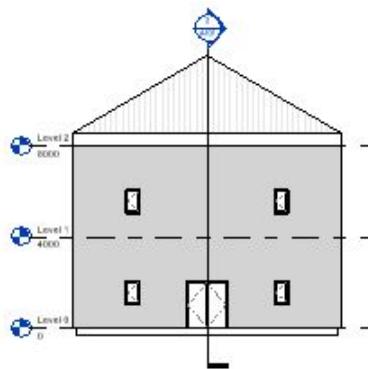
BIM



BIM SOFTWARE

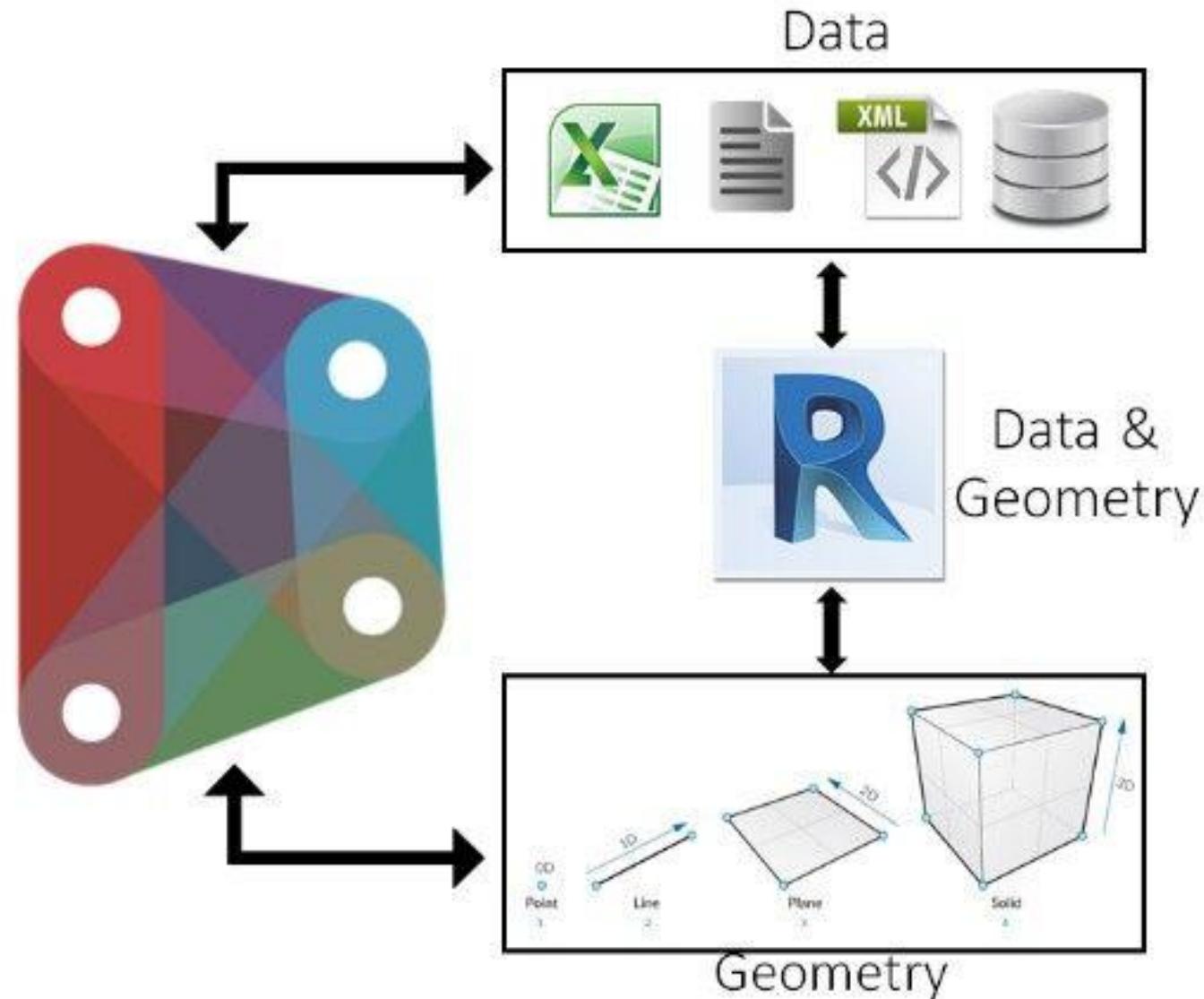


DATABASE

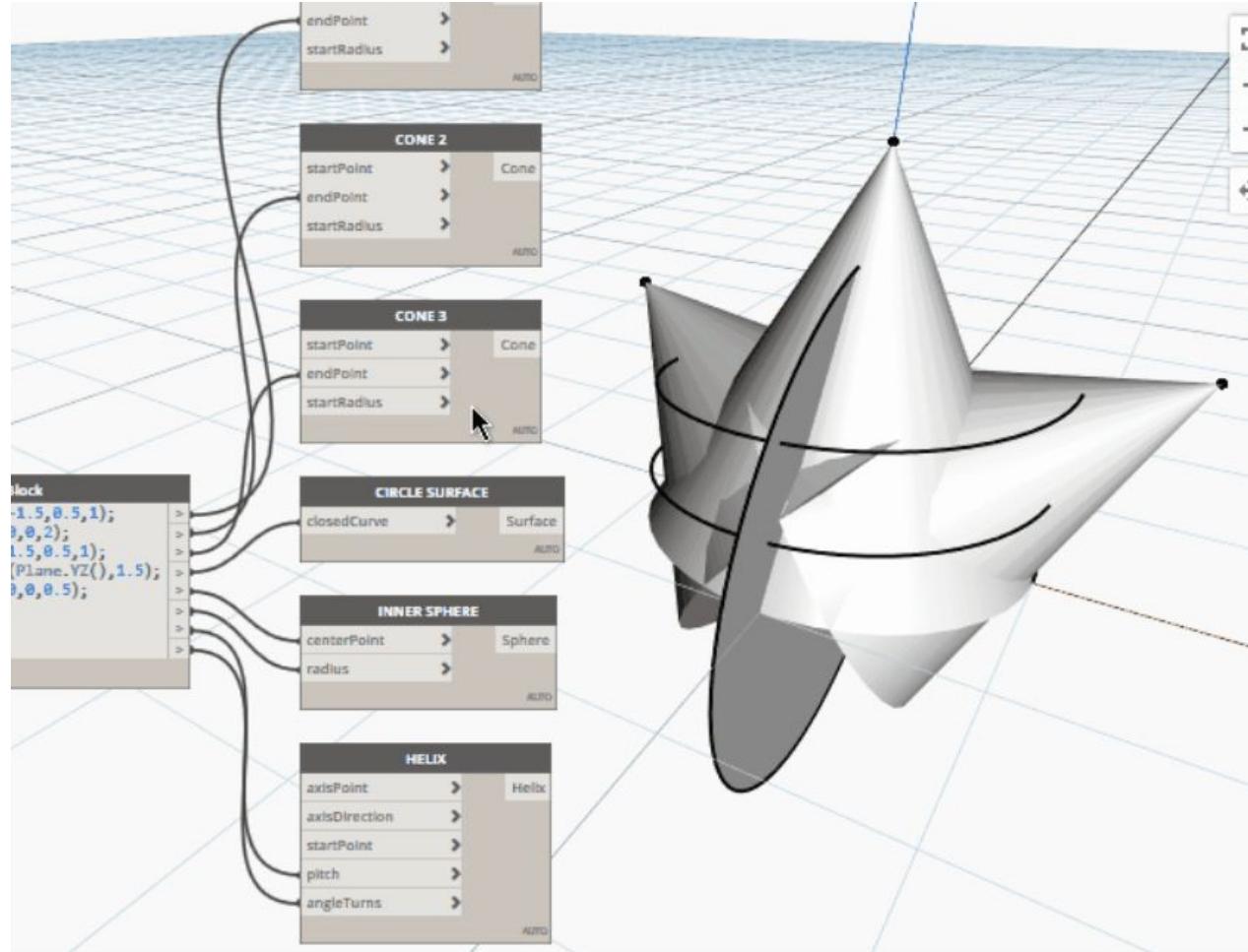


DESIGN PLANS

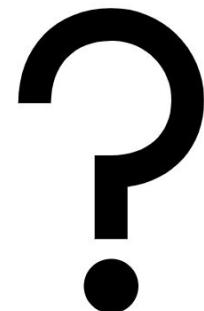
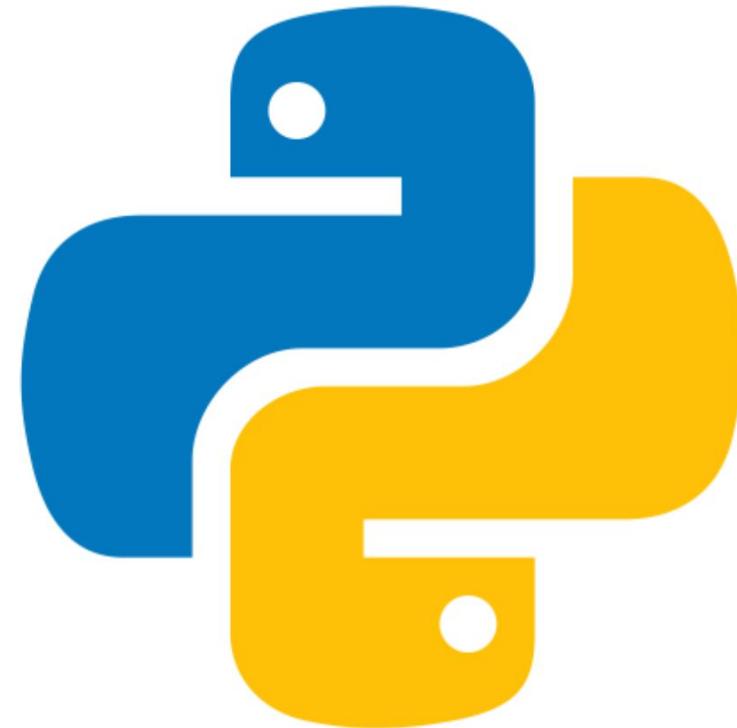
**But we want to go BIGGER**



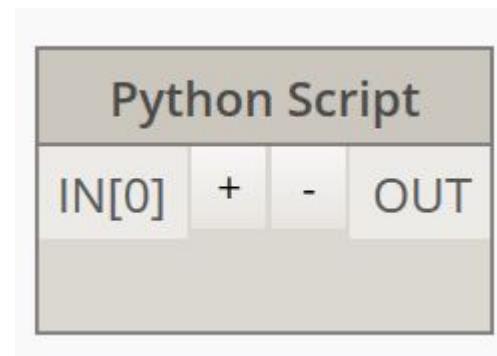
# SCRIPTS



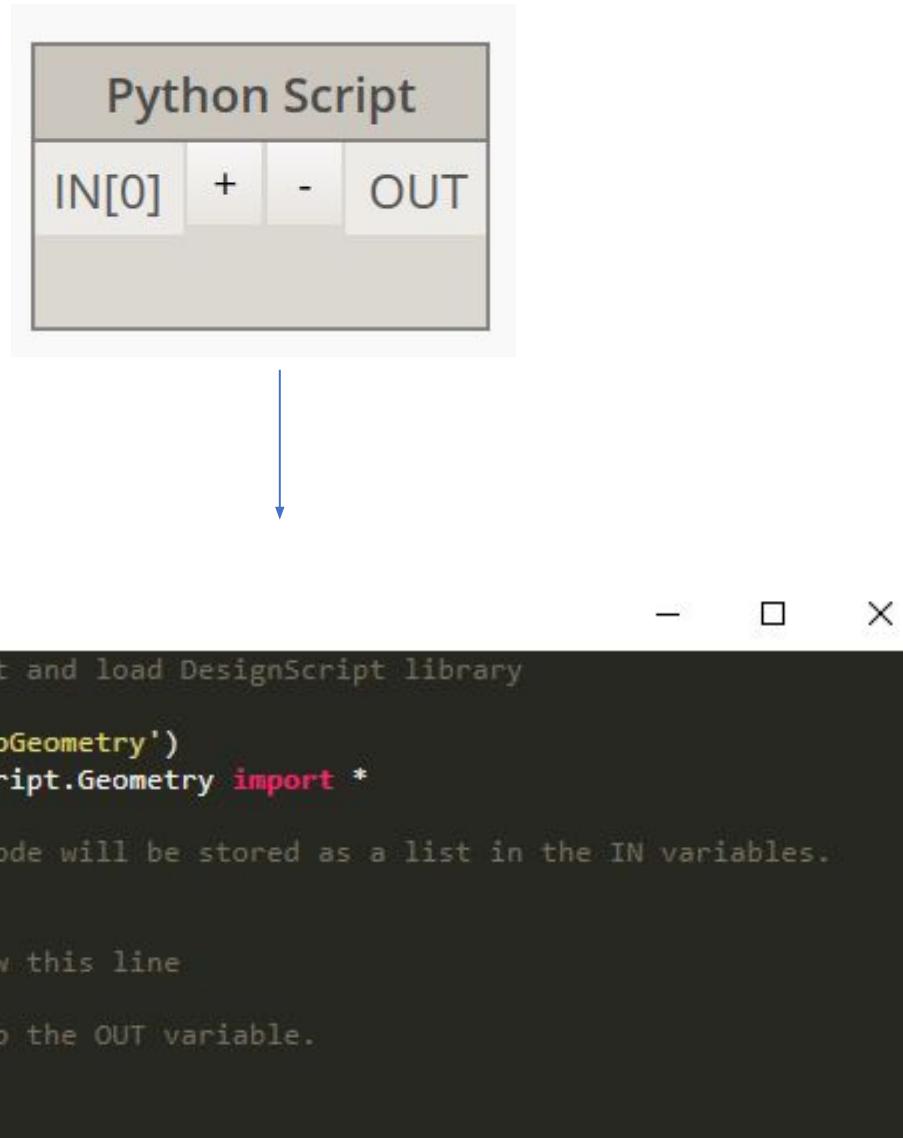
<https://dynamobim.org/dynamo-1-3-release/>



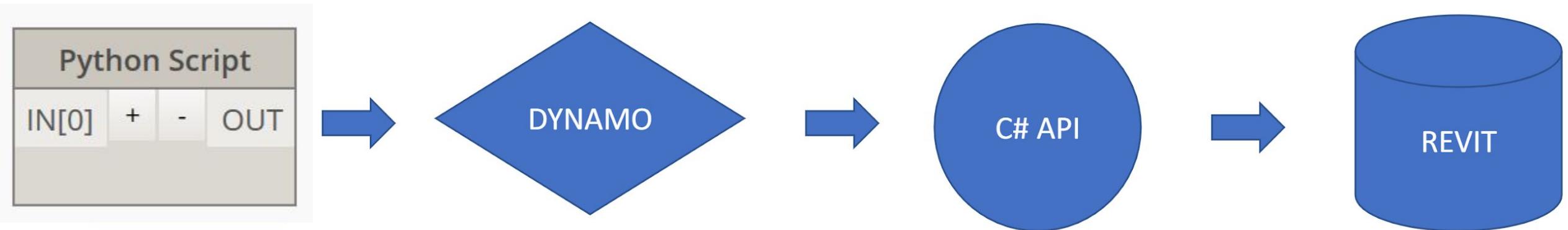
# DYNAMO



# DYNAMO



## DYNAMO

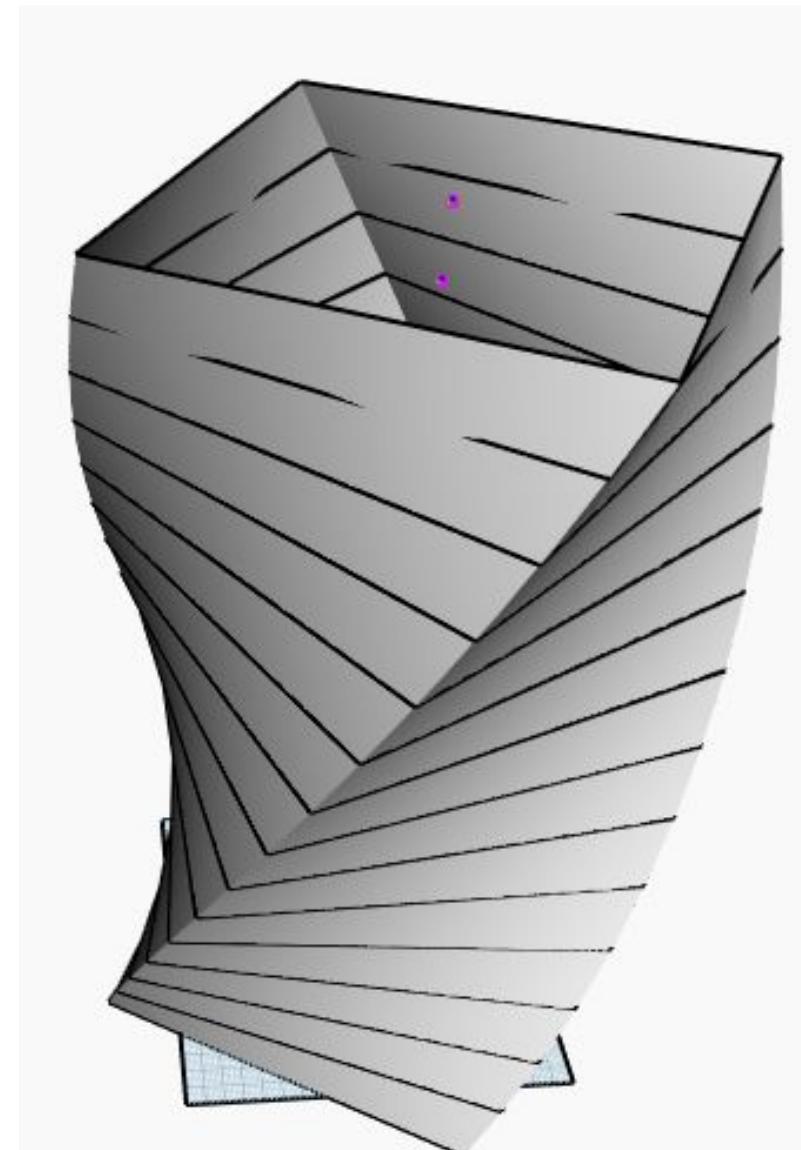


- Nodes in Dynamo allow for **Python** scripting

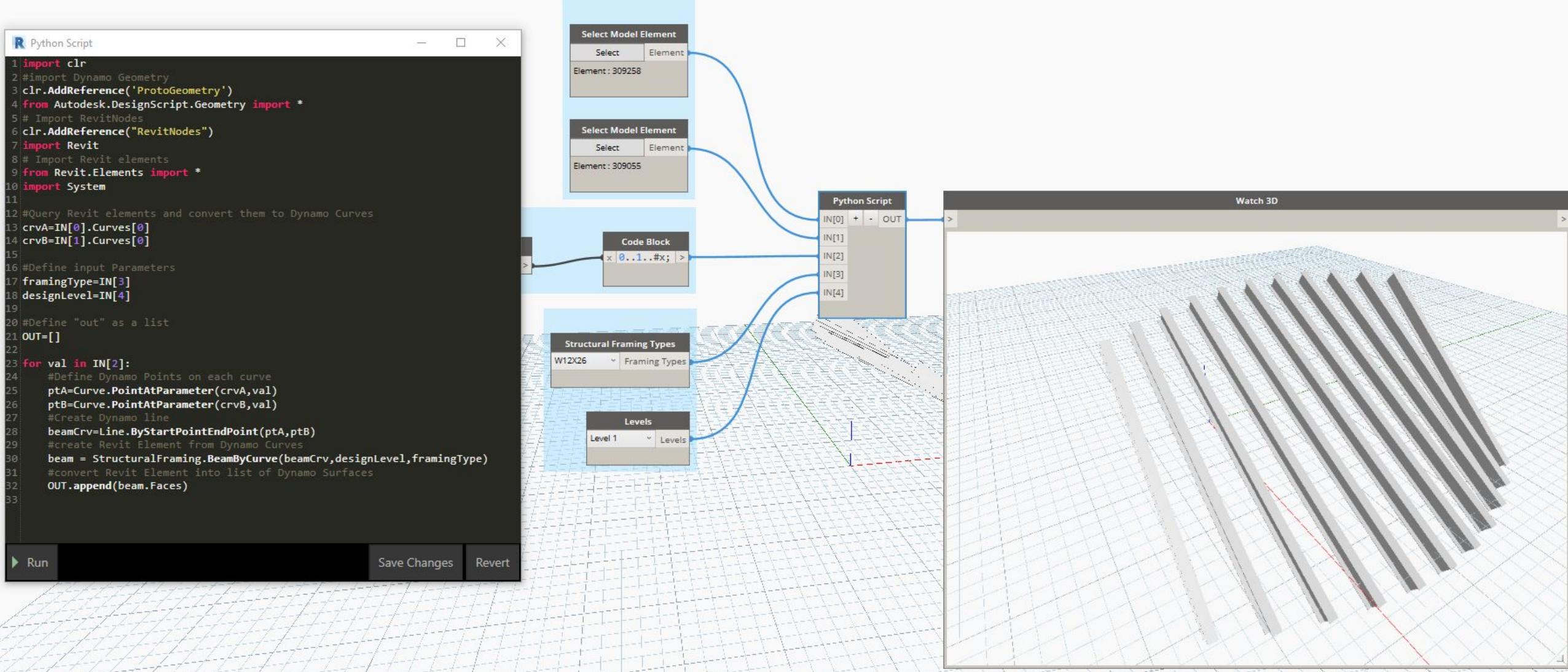
# DYNAMO

## R Python Script

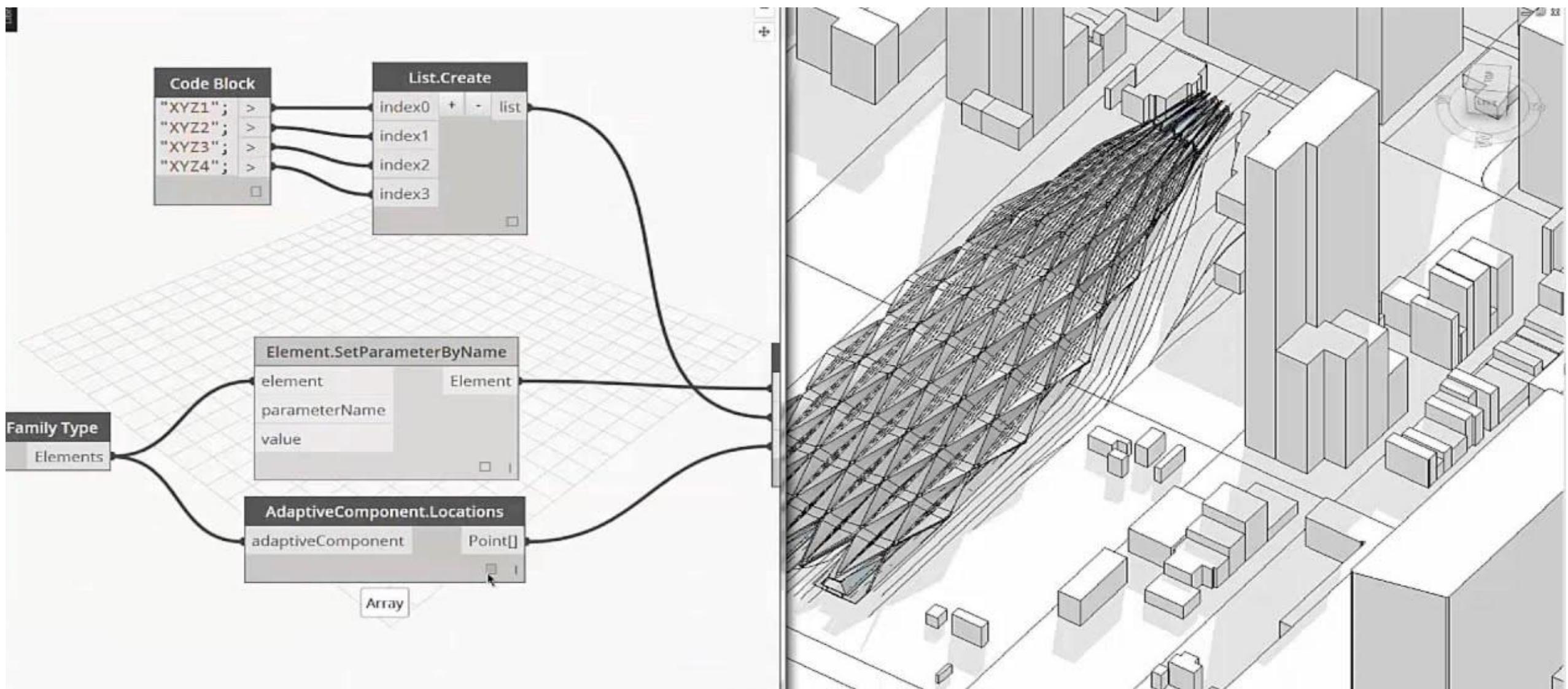
```
1 # Enable Python support and load DesignScript library
2 import clr
3 clr.AddReference('ProtoGeometry')
4 from Autodesk.DesignScript.Geometry import *
5 clr.AddReference('RevitNodes')
6 from Revit.Elements import *
7
8
9 #cs = IN[0]
10 width = 100
11 length = 100
12 rect = Rectangle.ByWidthLength(width,length)
13 origin = Point.Origin()
14 axis = Vector.ZAxis()
15 degree = IN[0]
16
17 #degfloat = [float(i) for i in degree]
18 #degfloat = map(float, degree)
19 degfloat = [float(i) for i in degree]
20
21 GeoRo = Geometry.Rotate(rect,origin,axis,degfloat)
22
23 # output element based on the variable you assigned
24 OUT = GeoRo
```



# DYNAMO



# DYNAMO

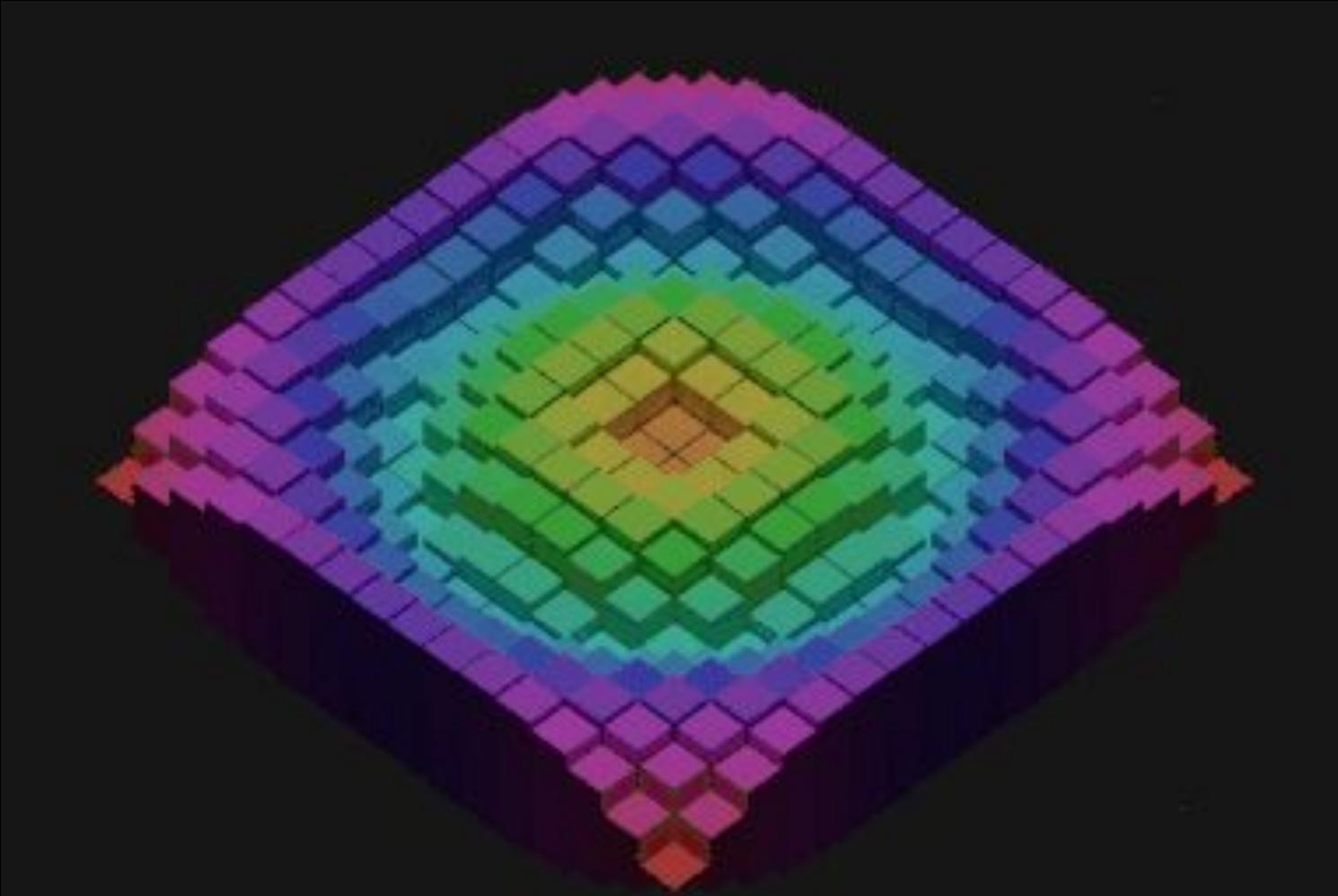


**But we want to go BIGGER**



- General Purpose 3D model software

## BLENDER 3D IN ARCHITECTURE DESIGN



- Blender itself is written in Python, C and C++ code with add-ons written in Python being supported with scripting integrations

## BRIDGING THE GAP WITH IFC



**BLENDERBIM**  
ADD-ON

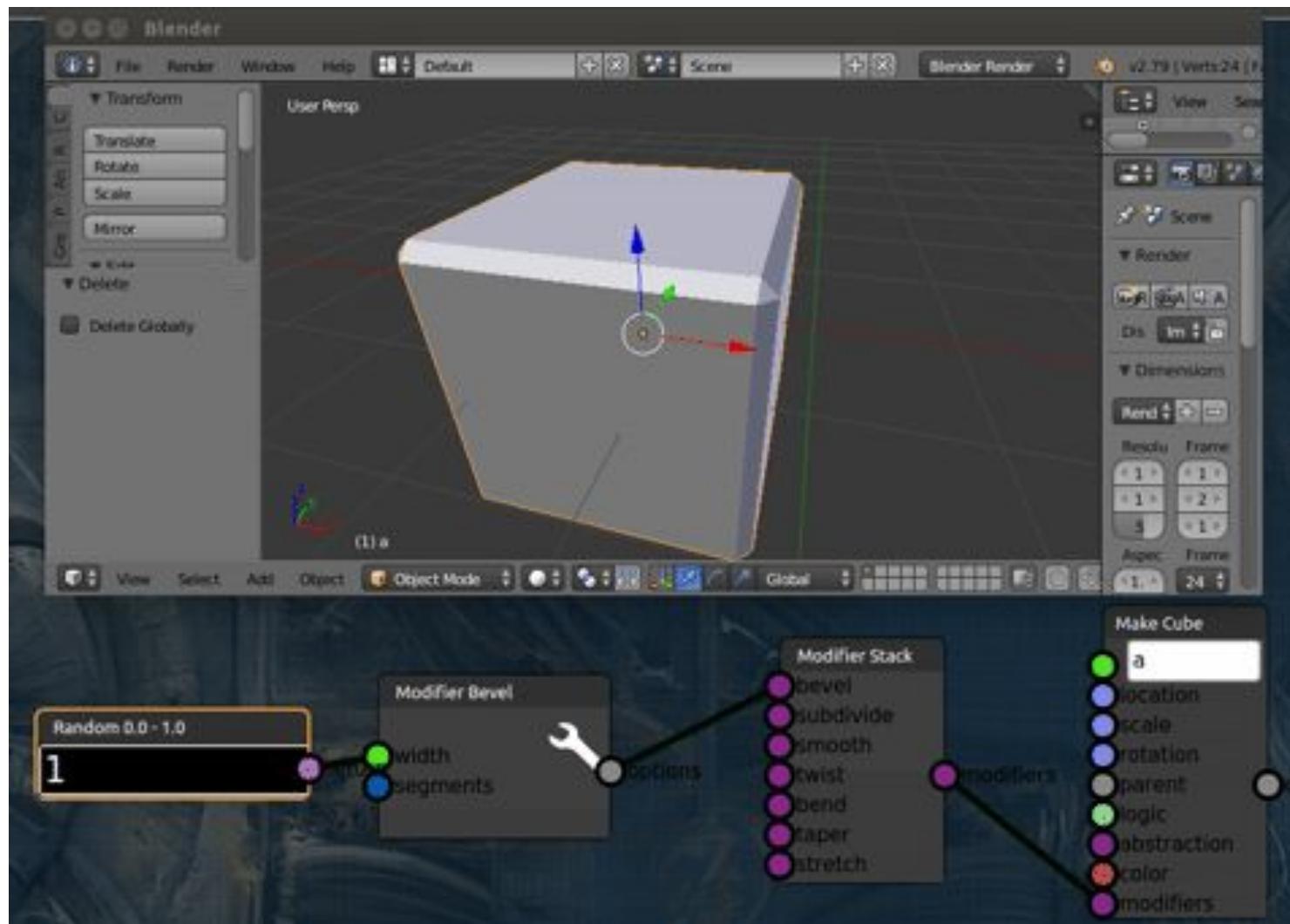


**IfcOpenShell**

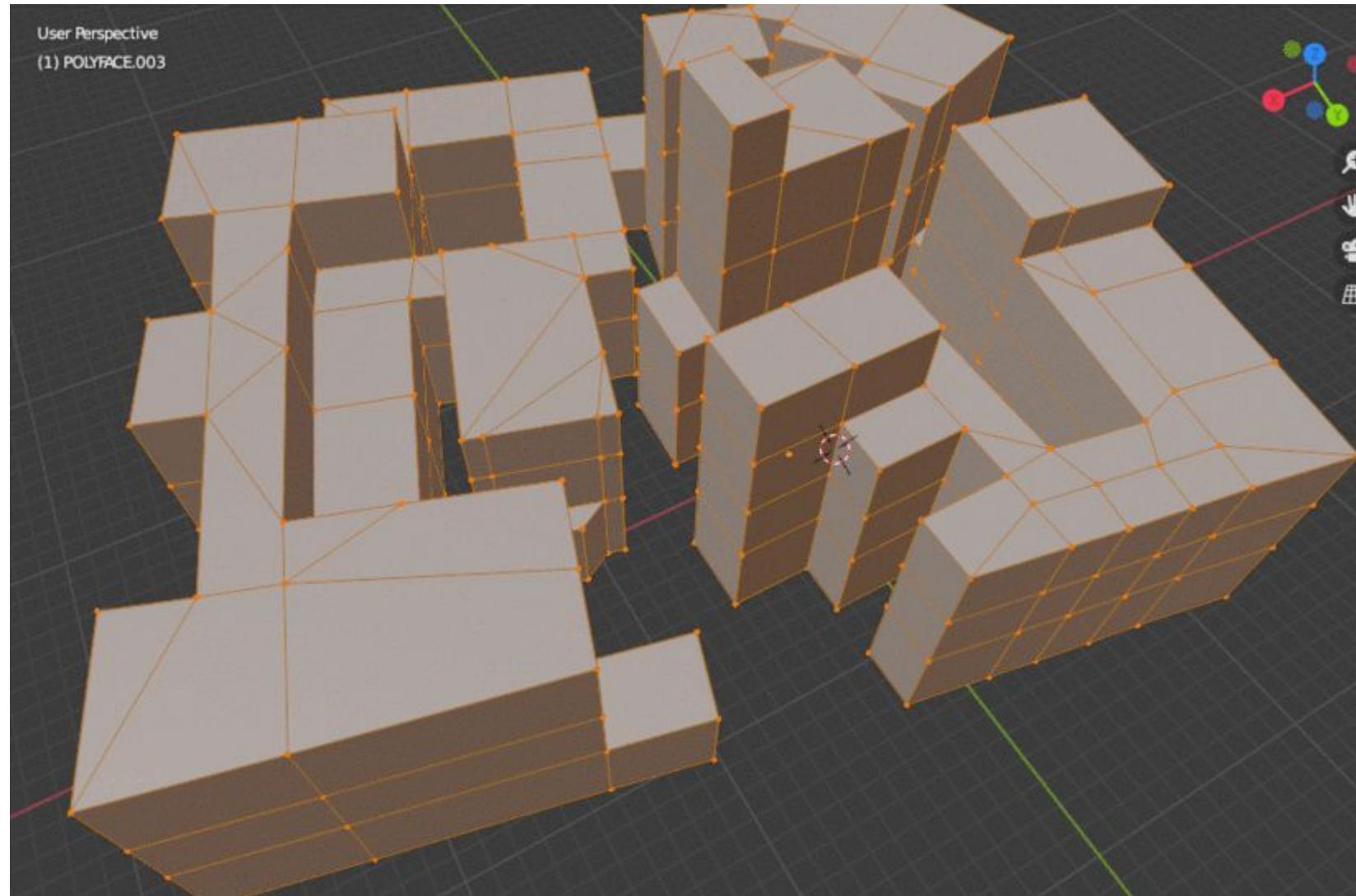
the open source ifc toolkit and geometry engine



# BLENDER MESH PRIMITIVES



# PROCEDURAL MODELING

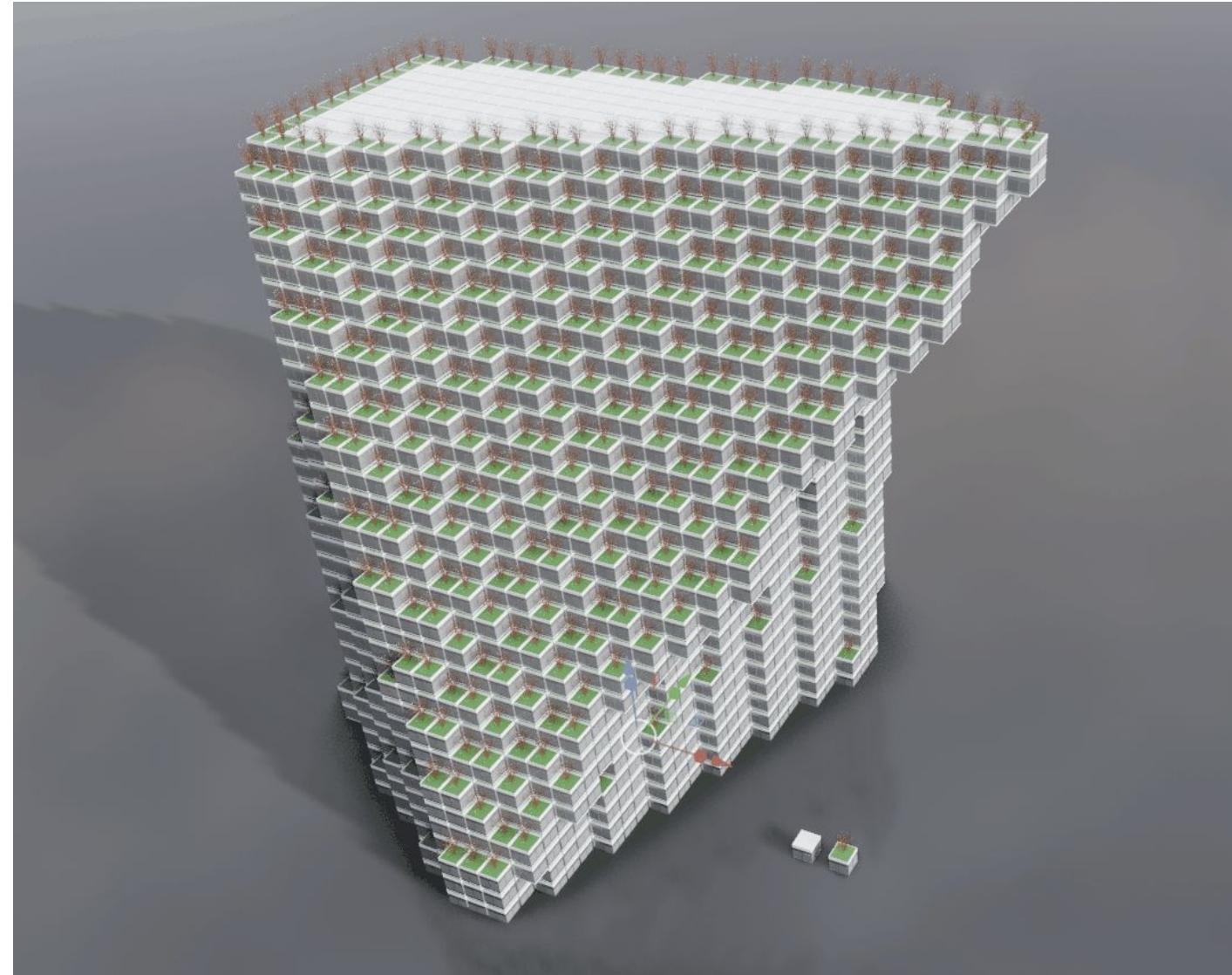


Source: brunopostle

@tadeh\_hakopian/Tadeh Hakopian

[https://community.osarch.org/discussion/comment/2489/#Comment\\_2489](https://community.osarch.org/discussion/comment/2489/#Comment_2489)

# GENERATIVE TOWER DESIGN

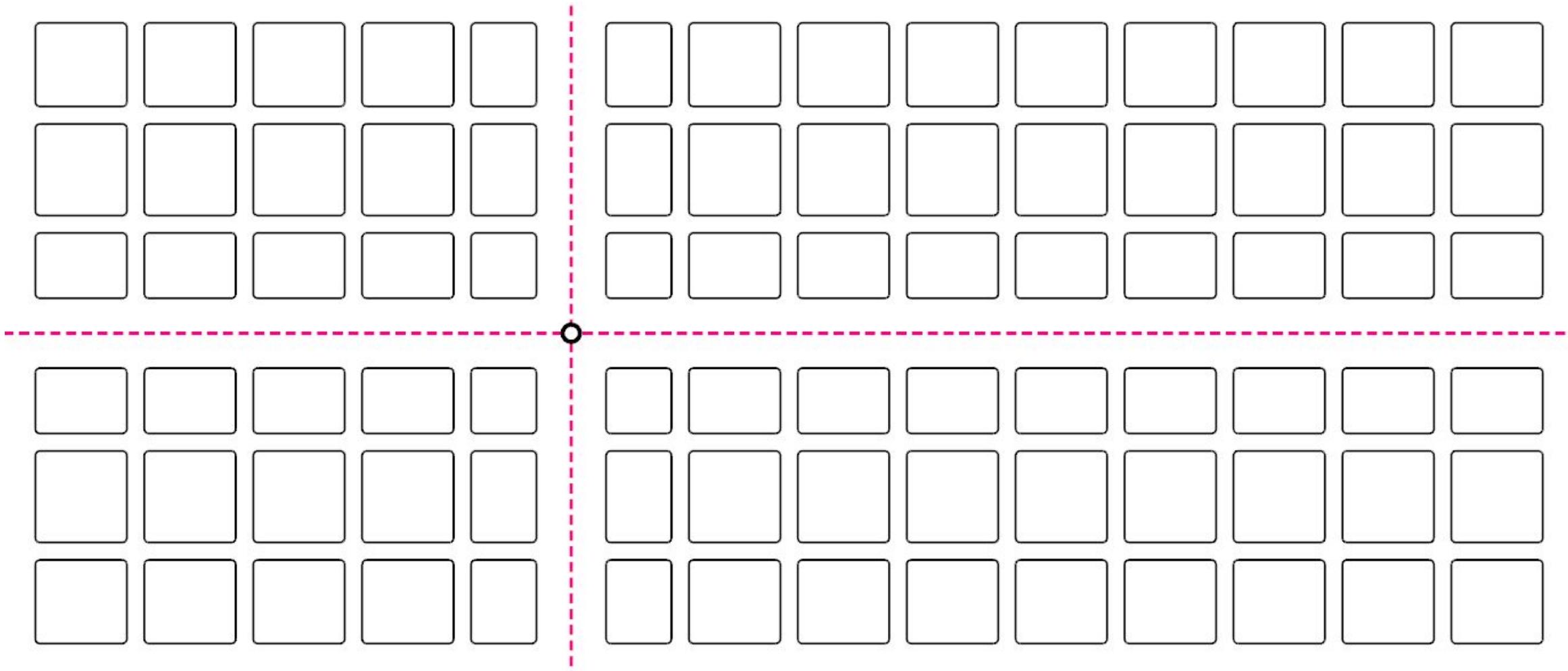


Source: UH Studio

<https://uhstudio.com/posts/blender-geometry-nodes-building>

**But we want to go BIGGER**

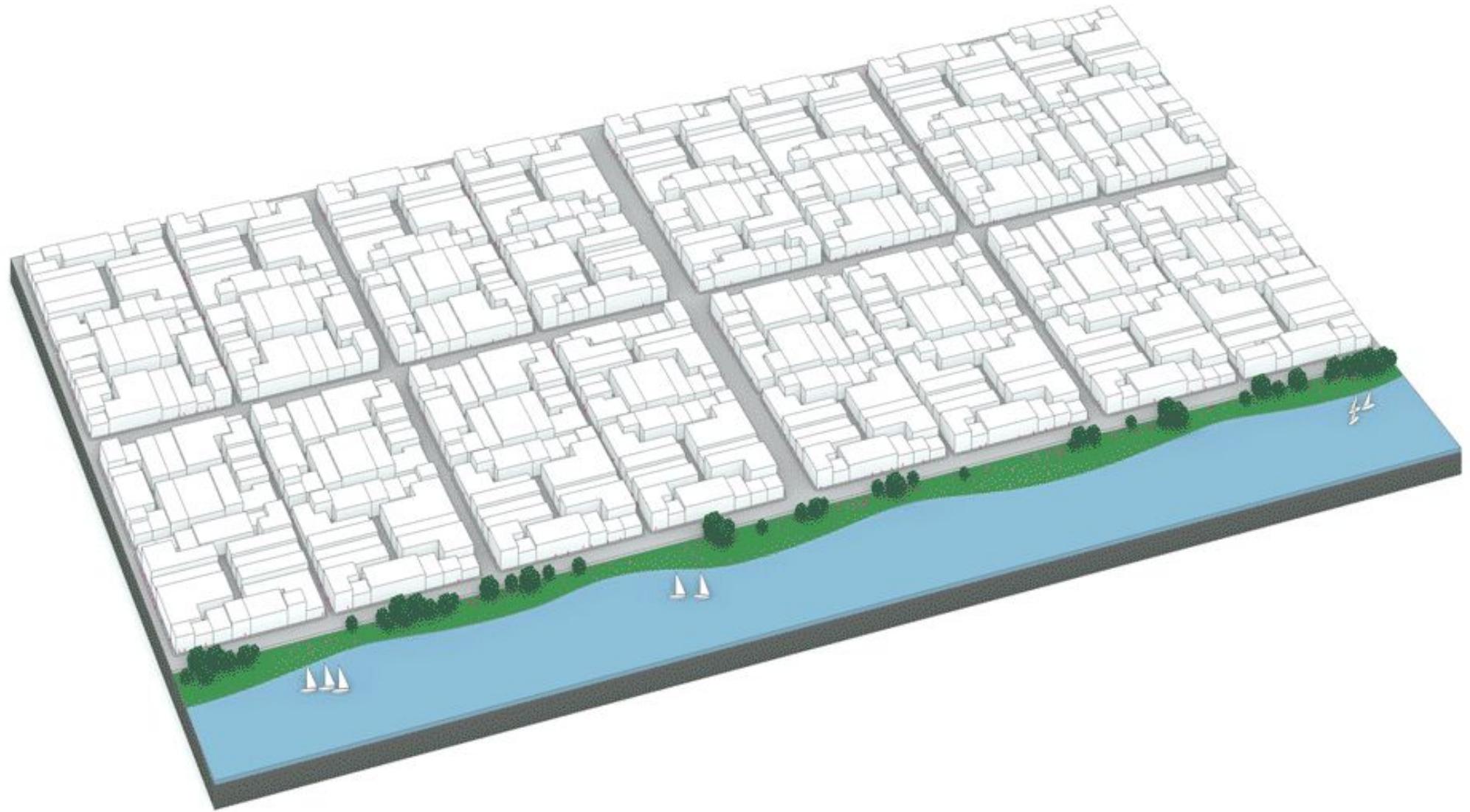
# GENERATIVE CITY DESIGN



Source: KPF Studio

[https://images.squarespace-cdn.com/content/v1/568ee2b4cbced6419694f1fc/1536681750978-Z9W1ERRG621SM  
LL6W4XE/Street\\_Grid.gif?format=2500w](https://images.squarespace-cdn.com/content/v1/568ee2b4cbced6419694f1fc/1536681750978-Z9W1ERRG621SMLL6W4XE/Street_Grid.gif?format=2500w)

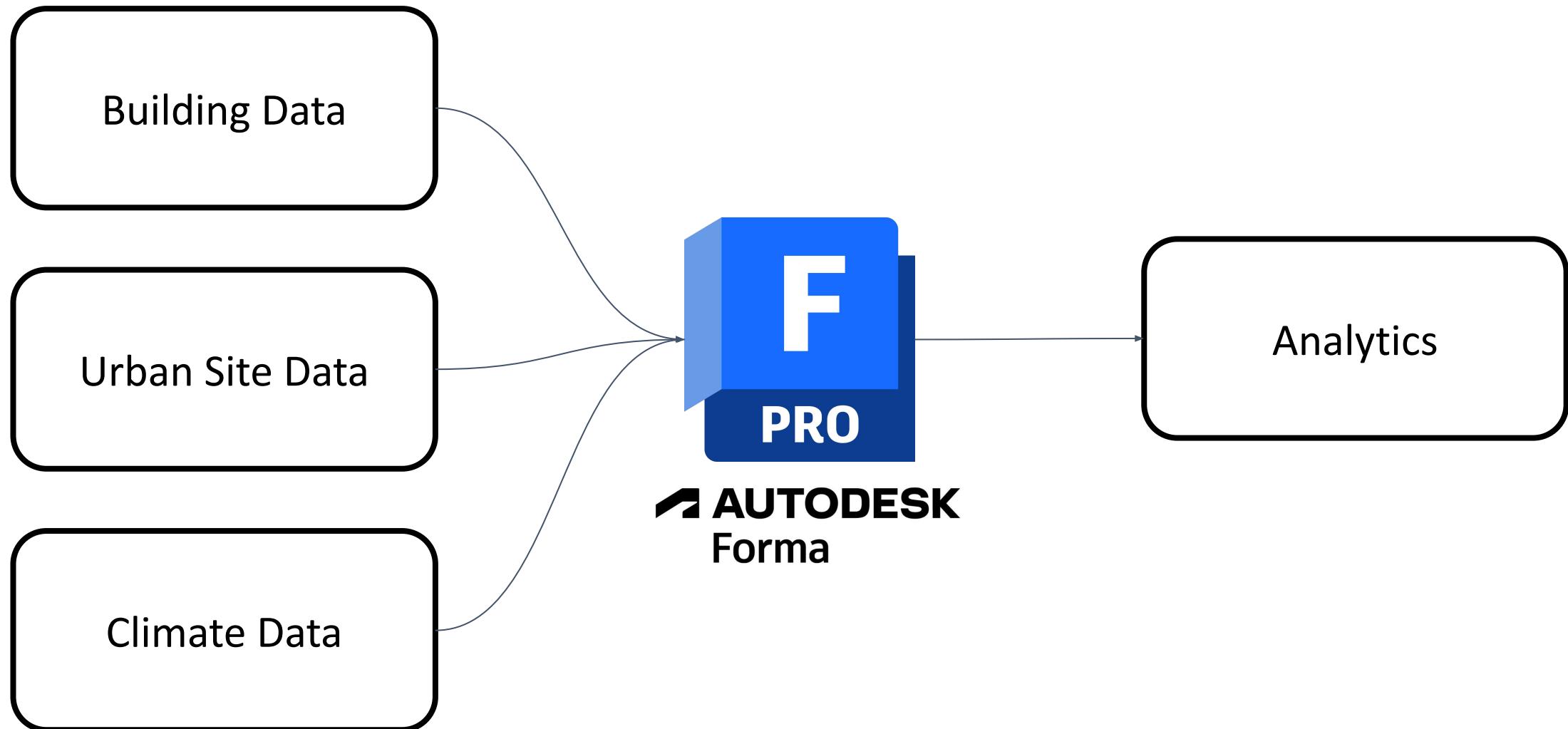
# GENERATIVE CITY DESIGN



Source: KPF Studio

[https://images.squarespace-cdn.com/content/v1/568ee2b4cbced6419694f1fc/1536692488446-L4XTE5M09RP4ZY/DGDYR1/Neighborhood\\_GridRotation\\_White\\_small.gif?format=2500w](https://images.squarespace-cdn.com/content/v1/568ee2b4cbced6419694f1fc/1536692488446-L4XTE5M09RP4ZY/DGDYR1/Neighborhood_GridRotation_White_small.gif?format=2500w)

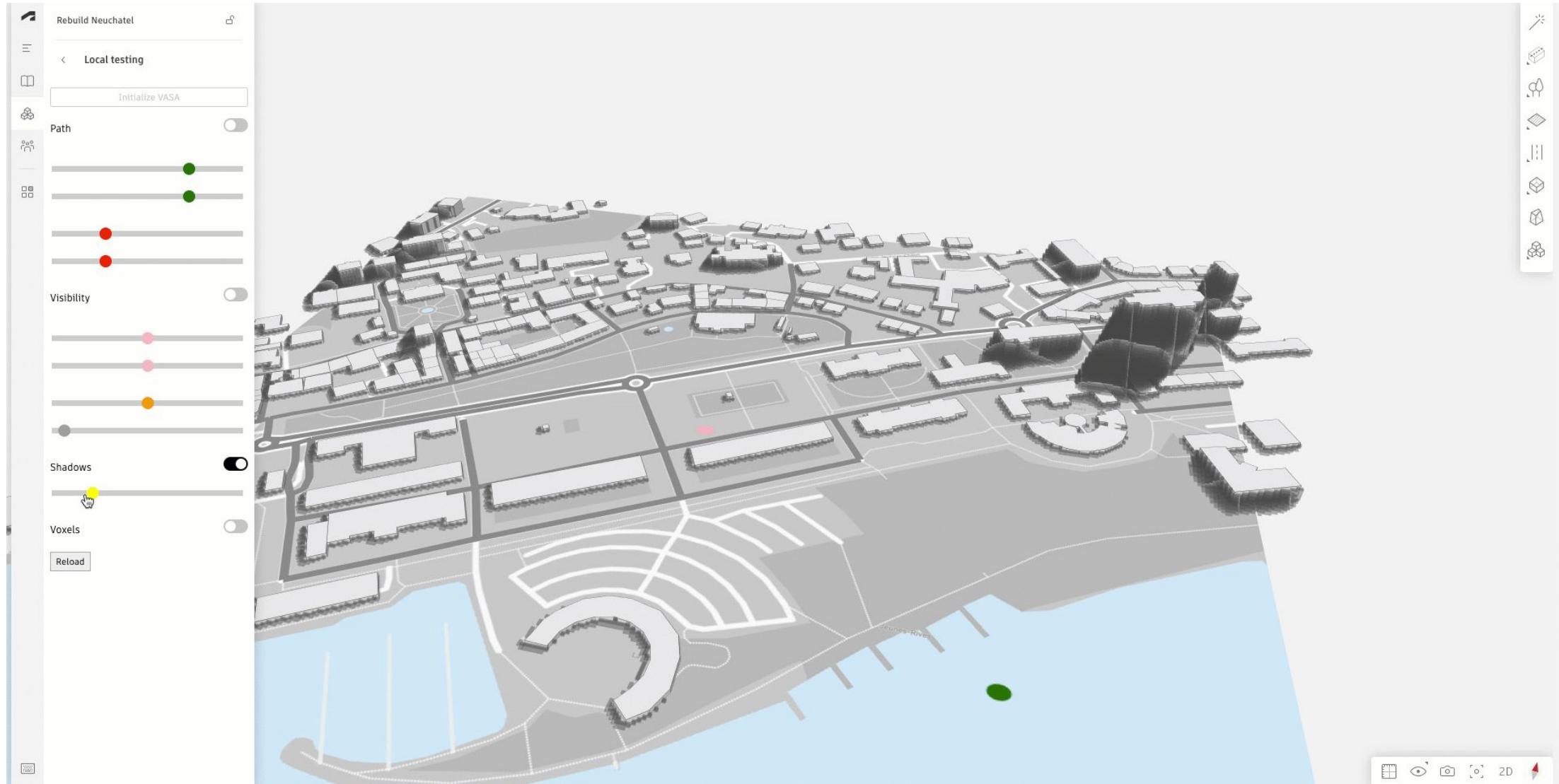
## GENERATIVE CITY DESIGN - ANALYTICS



Autodesk Forma on AWS platform services

Source: Autodesk

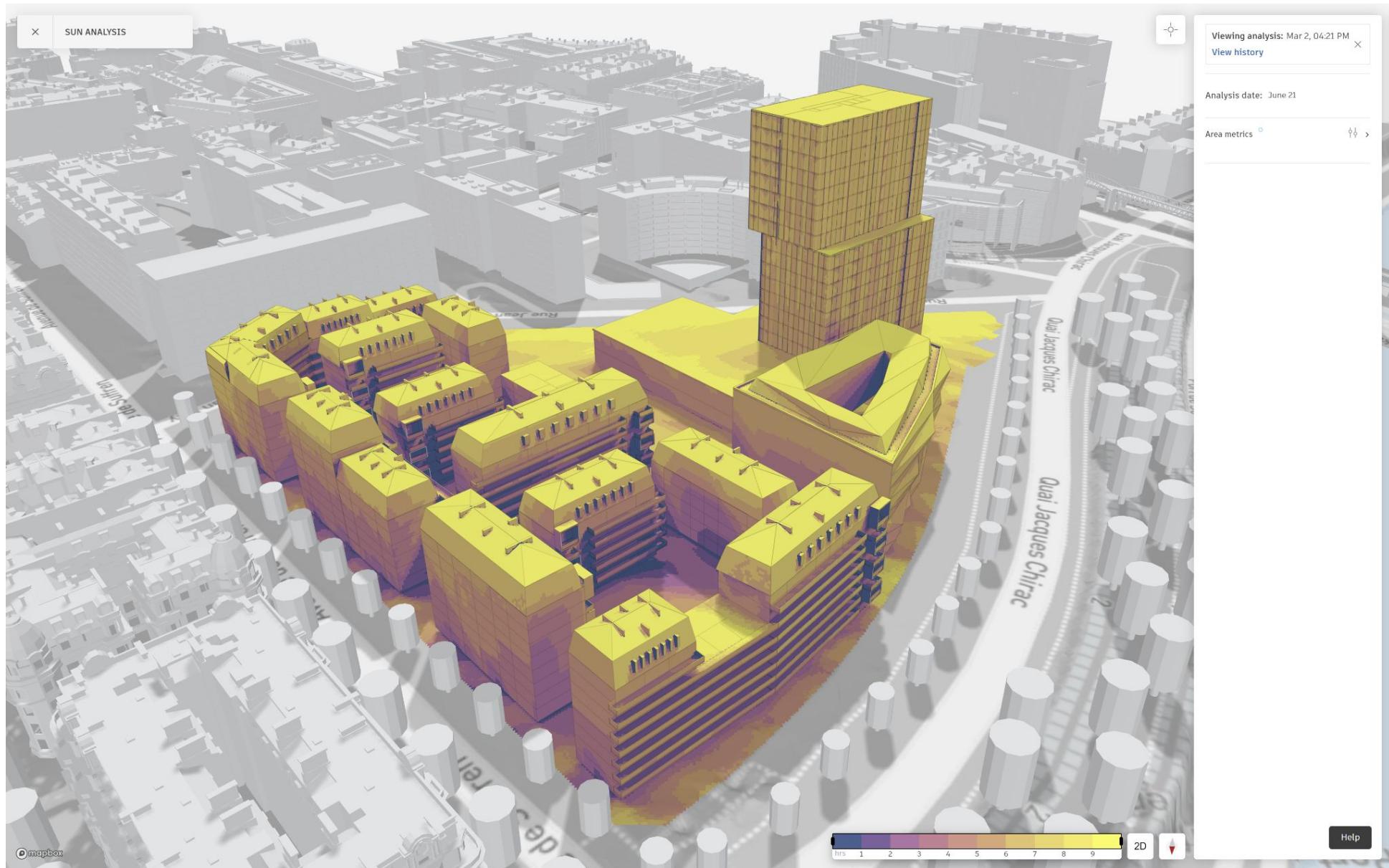
# GENERATIVE CITY DESIGN - FORMA



Source: Autodesk

<https://www.keanw.com/2023/11/using-vasa-with-forma-part-3.html>

# GENERATIVE CITY DESIGN - FORMA



Source: Autodesk

<https://microsolresources.com/tech-resources/article/what-is-autodesk-forma-why-is-it-important-to-the-aec-workflow/>

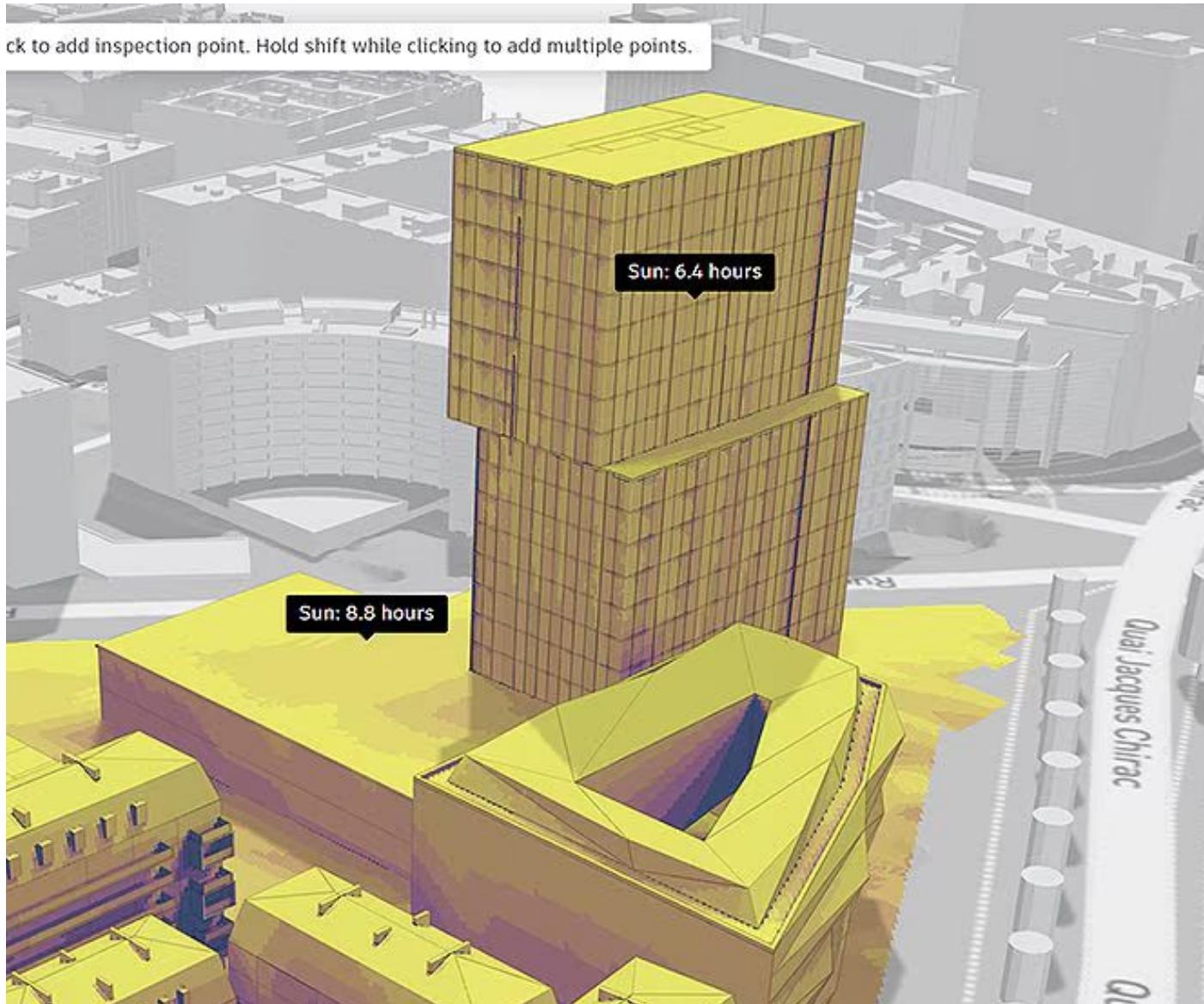
## GENERATIVE CITY DESIGN - FORMA



Source: Autodesk

<https://microsolresources.com/tech-resources/article/what-is-autodesk-forma-why-is-it-important-to-the-aec-workflow/>

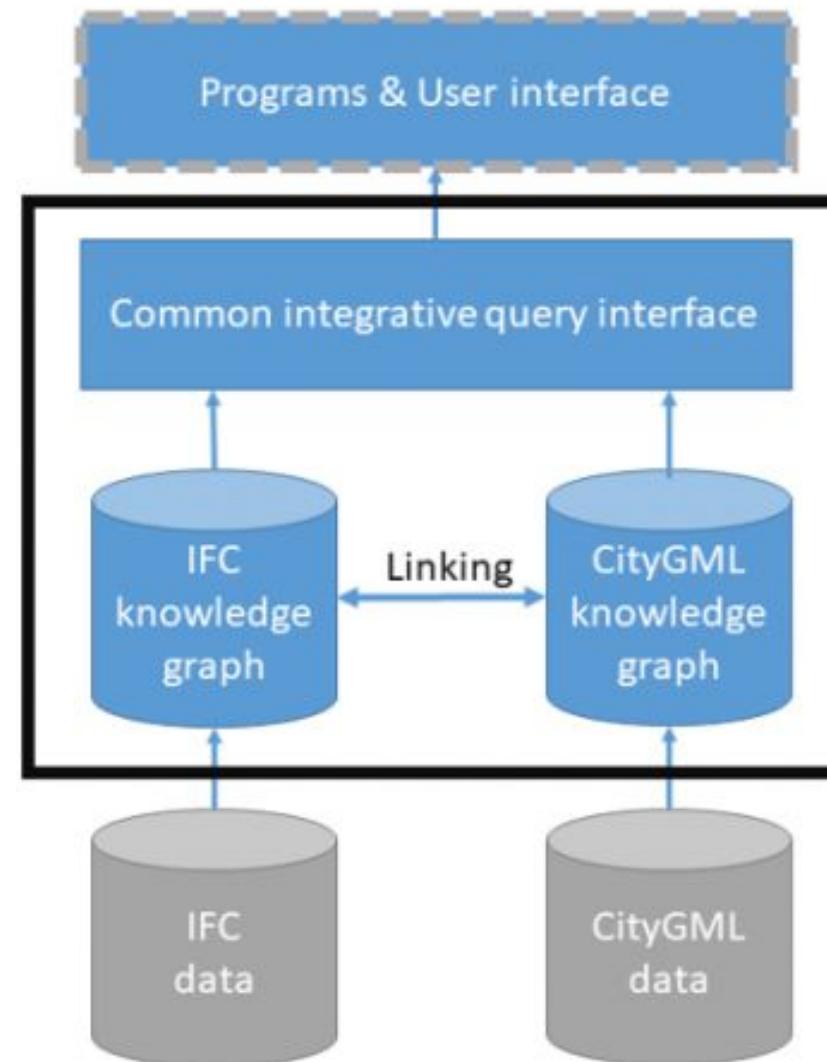
# GENERATIVE CITY DESIGN - FORMA



Source: Autodesk

<https://microsolresources.com/tech-resources/article/what-is-autodesk-forma-why-is-it-important-to-the-aec-workflow/>

**But we want to go BIGGER**



Source: GIM

<https://www.gim-international.com/content/article/using-bim-data-together-with-city-models>

# URBAN SCALE DATA ARCHITECTURE

## 2 SHARING THE TWIN MODELS AS OPEN DATA

Helsinki

### Information System Infrastructure and Architecture of the CityGML Model

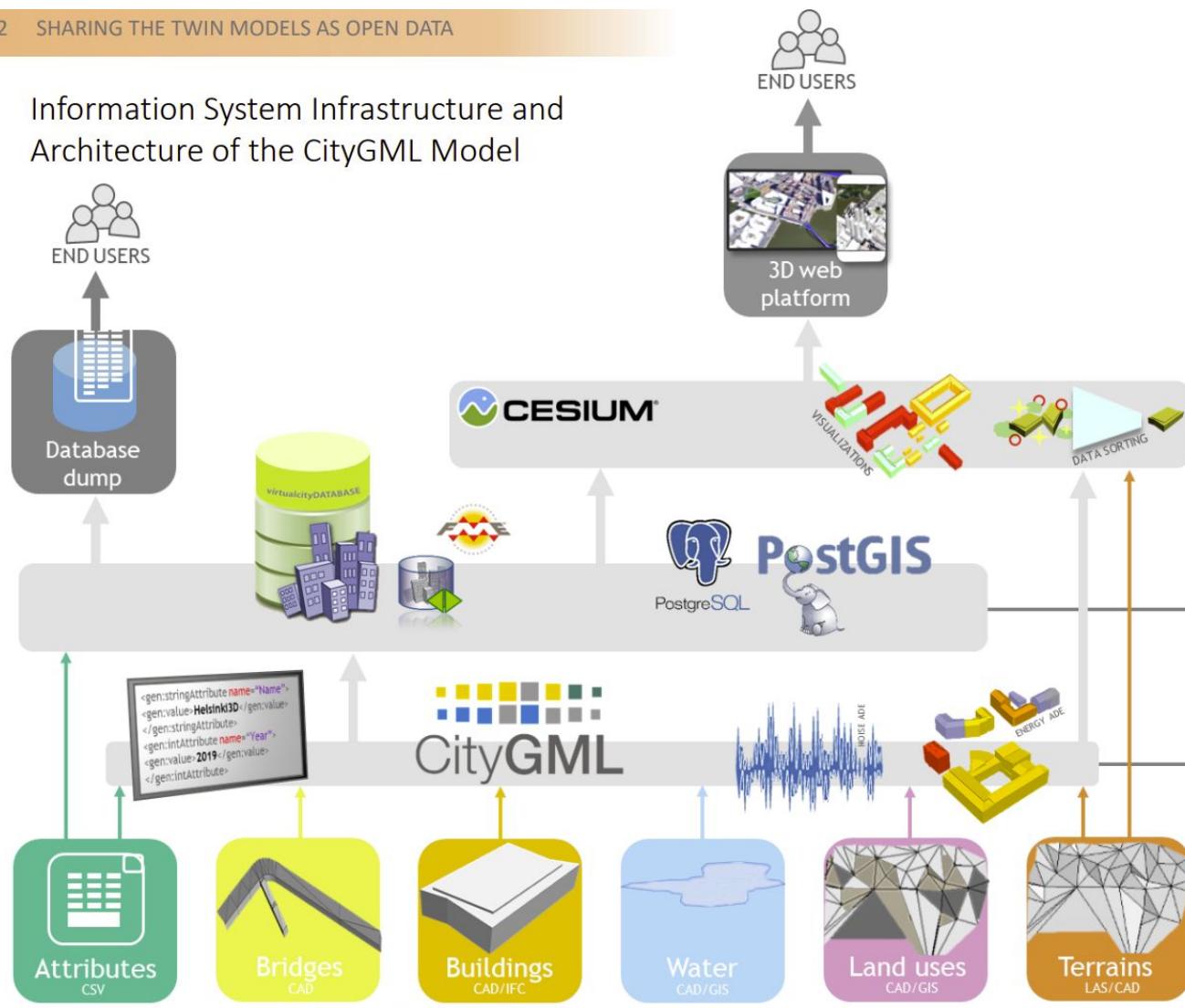


Figure 45. Overall architecture of CityGML model's data infrastructure

The figure illustrates the overall system architecture of the CityGML model's data infrastructure, which can be divided into three modules: the CityGML information model, database and platforms, and services.

- **Platforms and Services:** The content of online service platforms and 3D map sites is defined, and actual user interfaces for city information models are produced.
- **Database:** The city information model is stored in the 3DCityDB database, from which it can be maintained, updated and managed.
- **The CityGML Information Model:** Produces a semantic database-based city model that complies with the CityGML standard.

33

Source: GIM

<https://aec-business.com/helsinki-is-building-a-digital-twin-of-the-city/>

[https://www.hel.fi/static/liitteet-2019/Kaupunginkanslia/Helsinki3D\\_Kalasatama\\_Digital\\_Twins.pdf](https://www.hel.fi/static/liitteet-2019/Kaupunginkanslia/Helsinki3D_Kalasatama_Digital_Twins.pdf)

# URBAN SCALE DEVOPS

## 2 SHARING THE TWIN MODELS AS OPEN DATA

Information System Infrastructure and Architecture of the CityGML Model

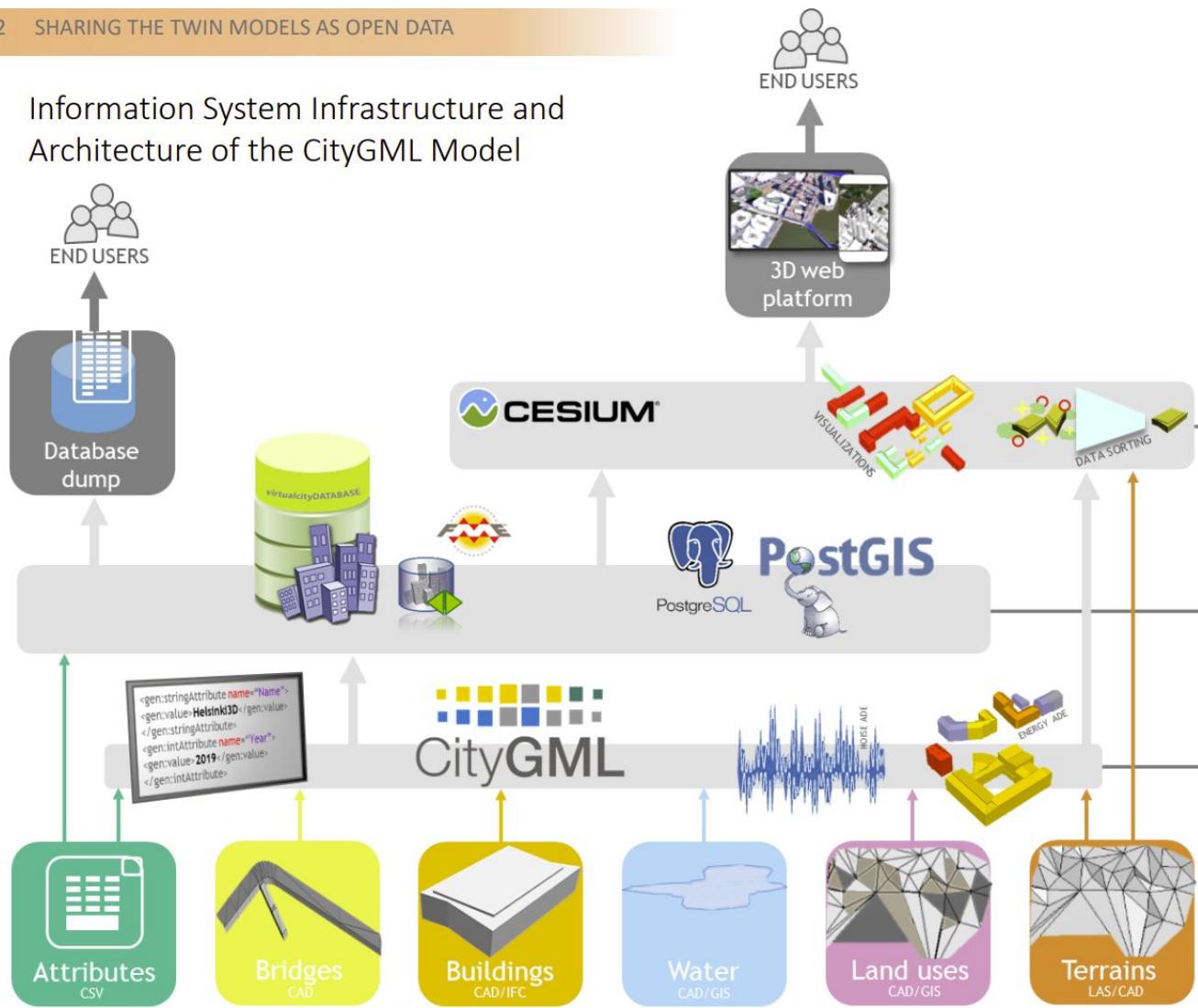


Figure 45. Overall architecture of CityGML model's data infrastructure



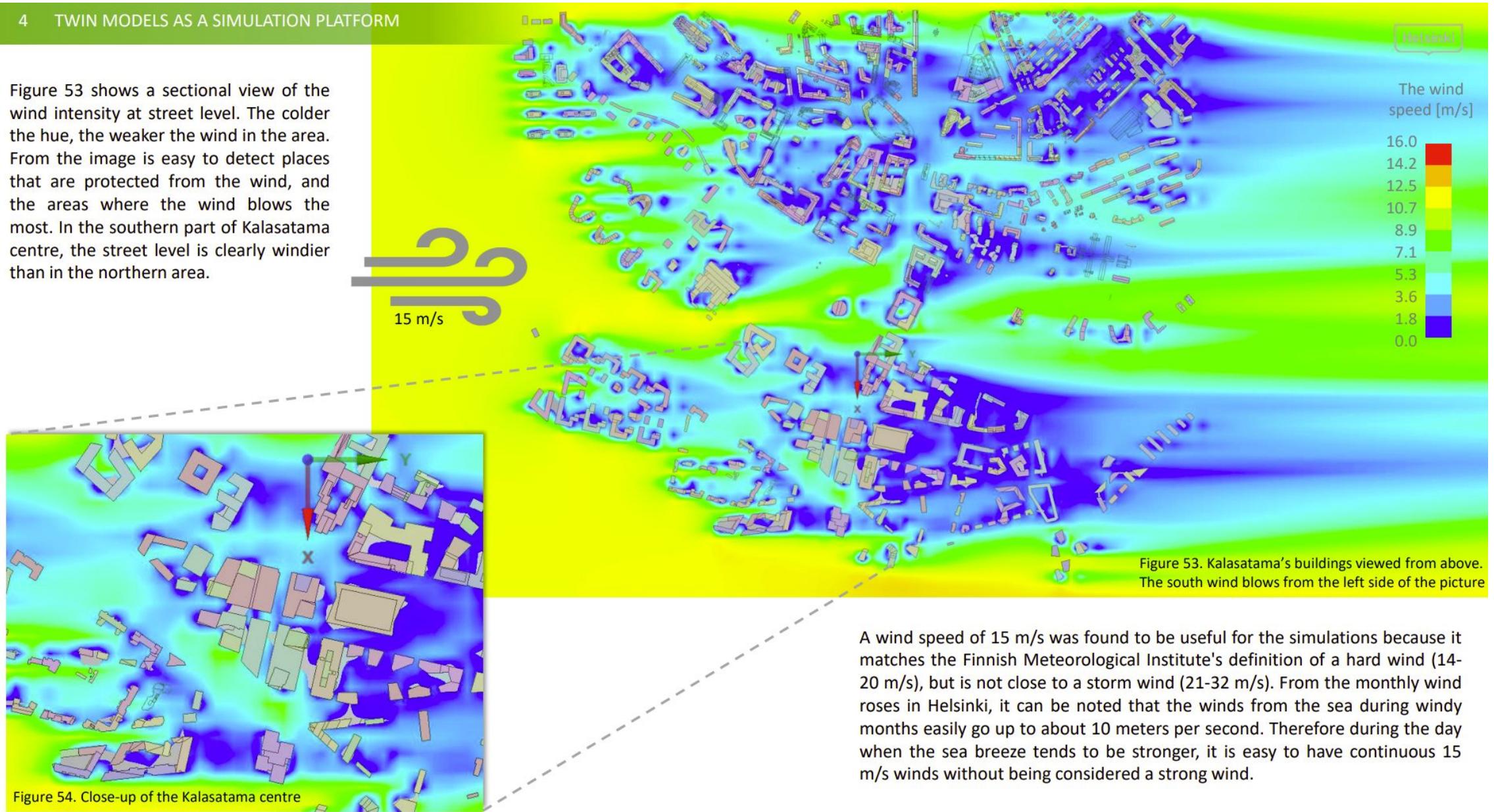
Source: GIVI

[https://www.hel.fi/static/liitteet-2019/Kaupunginkanslia/Helsinki3D\\_Kalasatama\\_Digital\\_Twins.pdf](https://www.hel.fi/static/liitteet-2019/Kaupunginkanslia/Helsinki3D_Kalasatama_Digital_Twins.pdf)

# URBAN SCALE DIGITAL TWIN SIMULATION

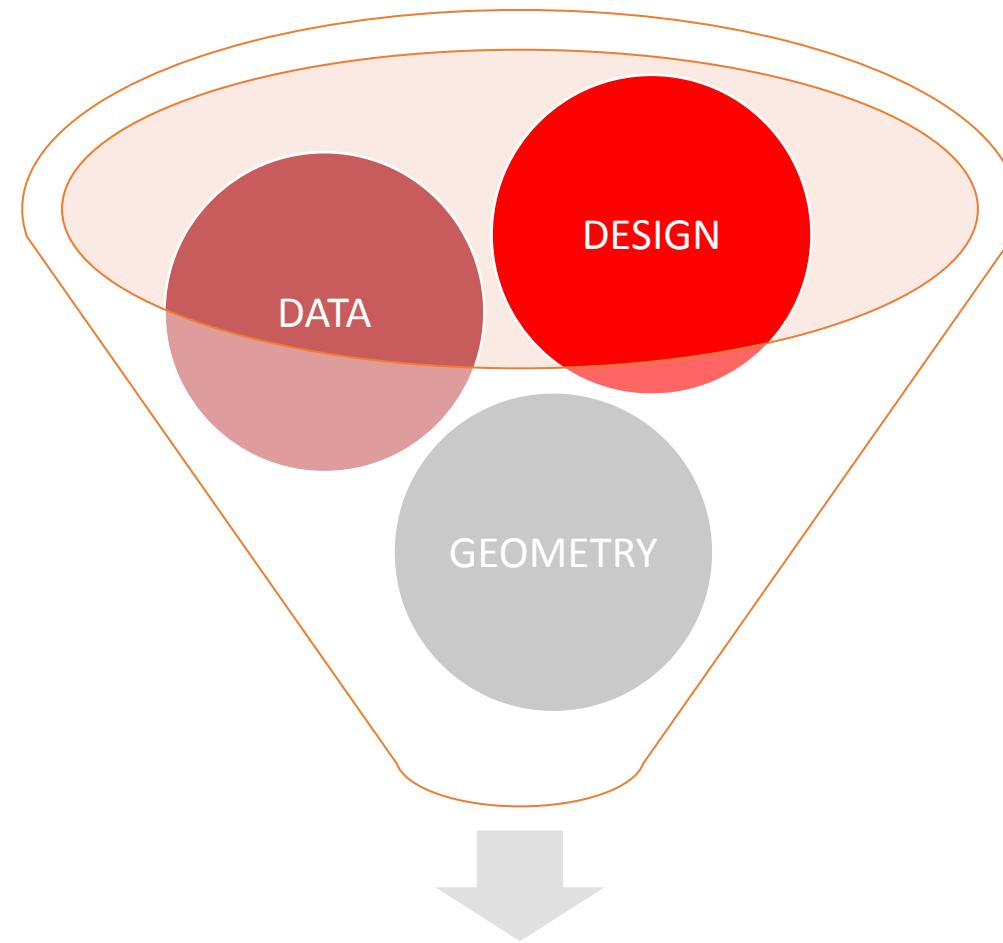
## 4 TWIN MODELS AS A SIMULATION PLATFORM

Figure 53 shows a sectional view of the wind intensity at street level. The colder the hue, the weaker the wind in the area. From the image is easy to detect places that are protected from the wind, and the areas where the wind blows the most. In the southern part of Kalasatama centre, the street level is clearly windier than in the northern area.



**Where to we go Now?**

## BUILDING INFORMATION MODELING



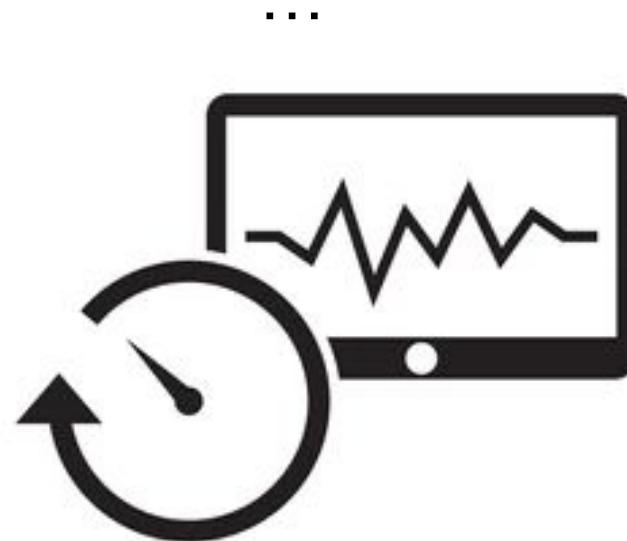
Building Data  
AKA 'Your City'

## URBAN SCALE DATA

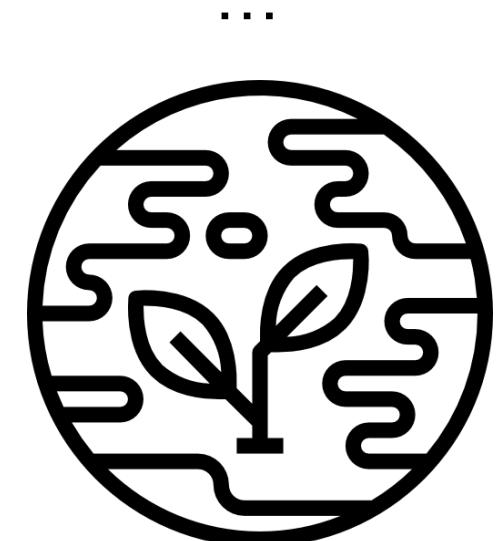
Services



Real Time data



Environmental Data



## SOLUTIONS FOR DEVOPS AT THE URBAN SCALE



- Get involved with user groups and technology for smart cities and digital twins

## KEY TAKEAWAYS

Disconnected data can be gathered and automated with simple tools like Python and Blender

Old processes can be augmented with AI

Scaling can happen as you get bigger but you need to think big

The technology we have can affect our environment including artificial landscapes of cities

New Technology is evolving and emergent, try it out!

## REFERENCES AND CONTINUED LEARNING

- Architecture Pattern Language - <https://www.patternlanguage.com/>
- Dynamo for Revit - [https://primer.dynamobim.org/10\\_Custom-Nodes/10-4\\_Python.html](https://primer.dynamobim.org/10_Custom-Nodes/10-4_Python.html)
- Revit API docs - <https://www.revitapidocs.com/>
- BlenderBIM - <https://blenderbim.org/>
- ifcOpenShell - <http://ifcopenshell.org/>
- Forma - <https://www.autodesk.com/products/forma/overview>
- CityGML - <https://www.opengeospatial.org/standards/citygml>
- Digital Twin Consortium - <https://www.digitaltwinconsortium.org/>
- Smartlab - <https://smartlab.expert/>

# Thanks everyone! Ask Questions!



QR CODE TO DECK



Tadeh Hakopian Contact Information:

Twitter:

[https://twitter.com/tadeh\\_hakopian](https://twitter.com/tadeh_hakopian)

Linkedin:

<https://www.linkedin.com/in/thakopian/>

Github:

<https://github.com/thakopian>