



The Journey from Design Automation to Generative Design in AEC

Dieter Vermeulen

Technical Sales Specialist AEC
Generative Design & Engineering
@BIM4Struc

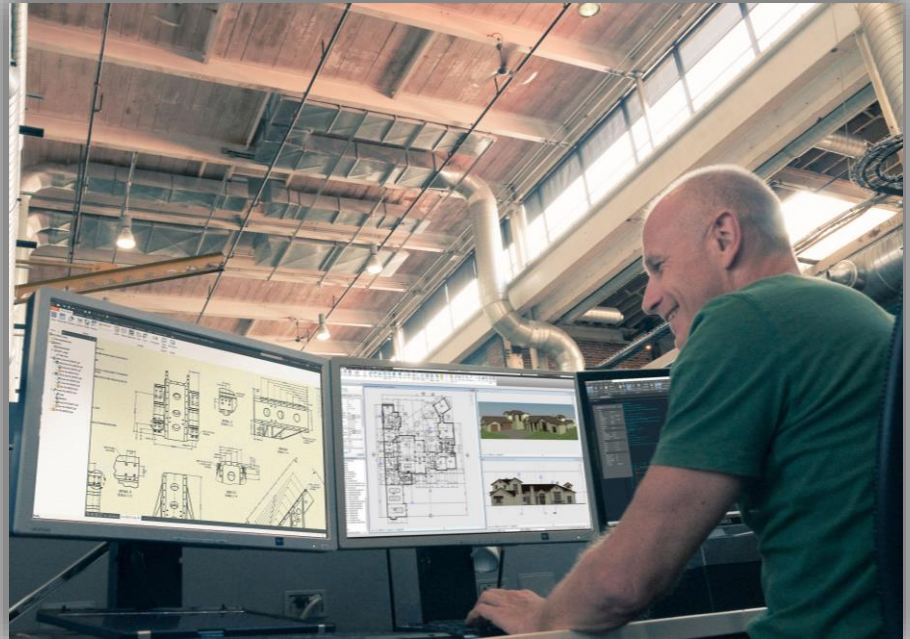


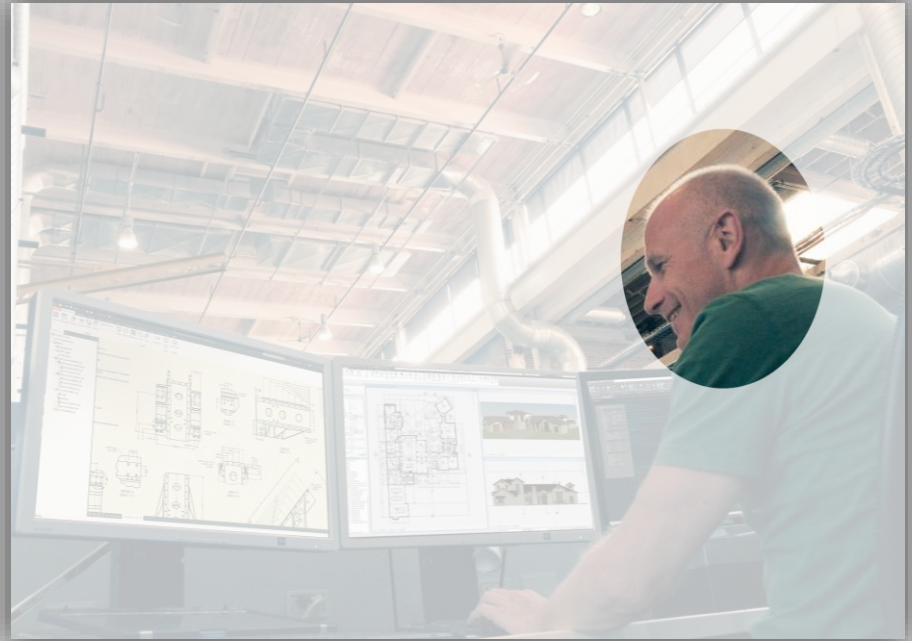


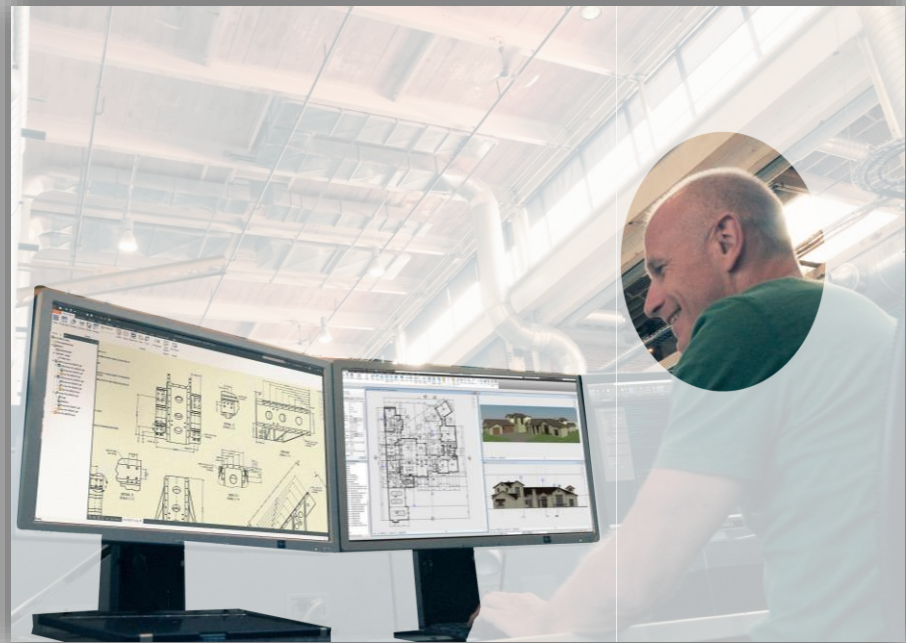
**DESIGNS
TODAY**

TRADITIONAL DESIGN PROCESS









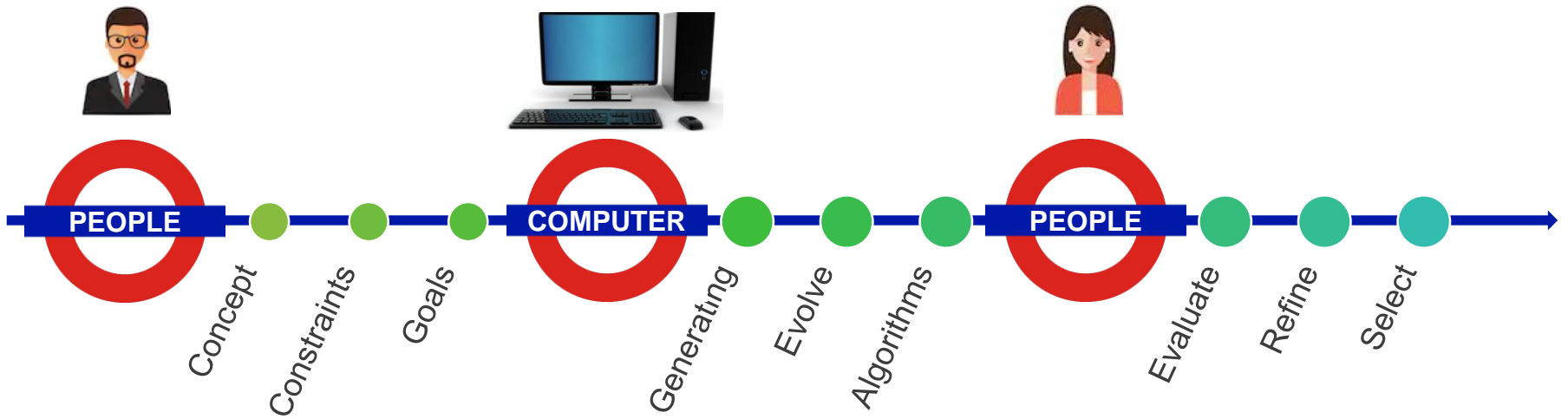


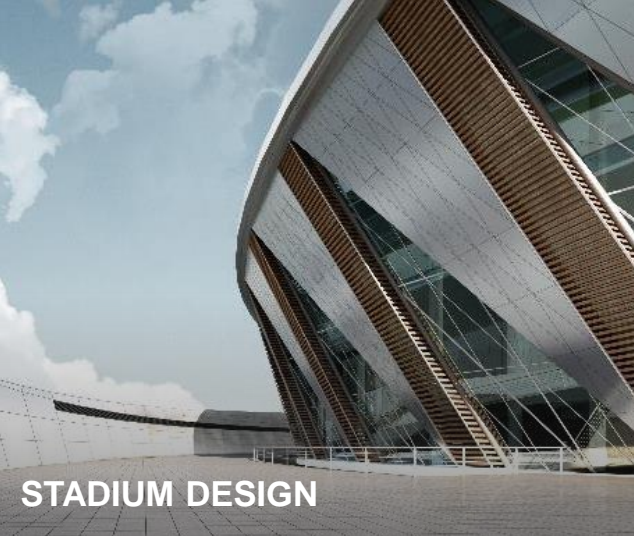
An aerial, top-down view of a modern building with a complex, curved facade. The building is heavily integrated with nature, featuring multiple levels of green roofs and terraces. The greenery includes various types of plants, such as palm trees, ferns, and dense foliage. A prominent feature is a large, curved, wavy structure that runs along the top and sides of the building, covered in lush green plants. The building's glass facade reflects the surrounding environment. In the foreground, a street with several cars is visible, providing a sense of scale. The overall scene is a blend of urban architecture and natural elements, showcasing a sustainable and innovative design approach.

GENERATIVE DESIGN:

A form of artificial intelligence, dedicated to the creation of better outcomes for products, buildings, infrastructure and systems.

GENERATIVE DESIGN PROCESS





STADIUM DESIGN



CONSTRUCTION PLANNING



SITE DRAINAGE



NEIGHBORHOOD PLANNING



SPACE PLANNING



FAÇADE DESIGN

Generative design is a
methodology and a process
more than a singular product
or tool

Benefits of Generative Design



Designers can generate options using the power of computation



Explore the full range of options while focusing on the higher performing solutions



Gain more insight into your designs by studying the relationships between inputs and results at scale



Make more informed decisions in less time by leveraging what is learned in each study

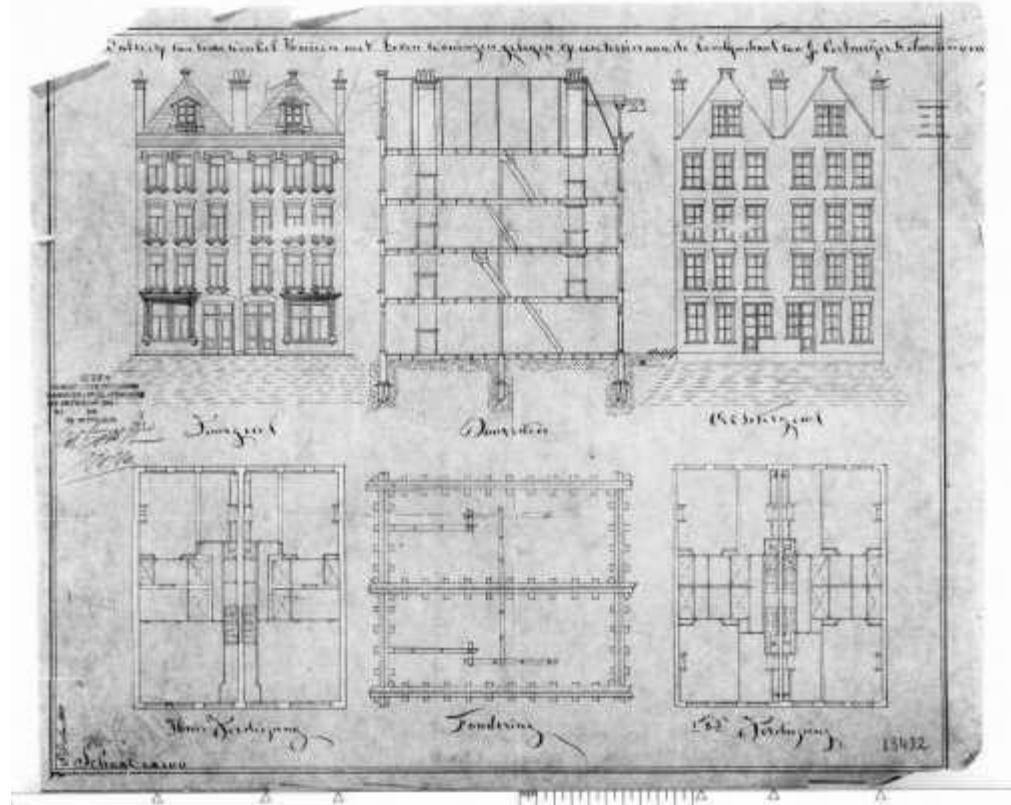
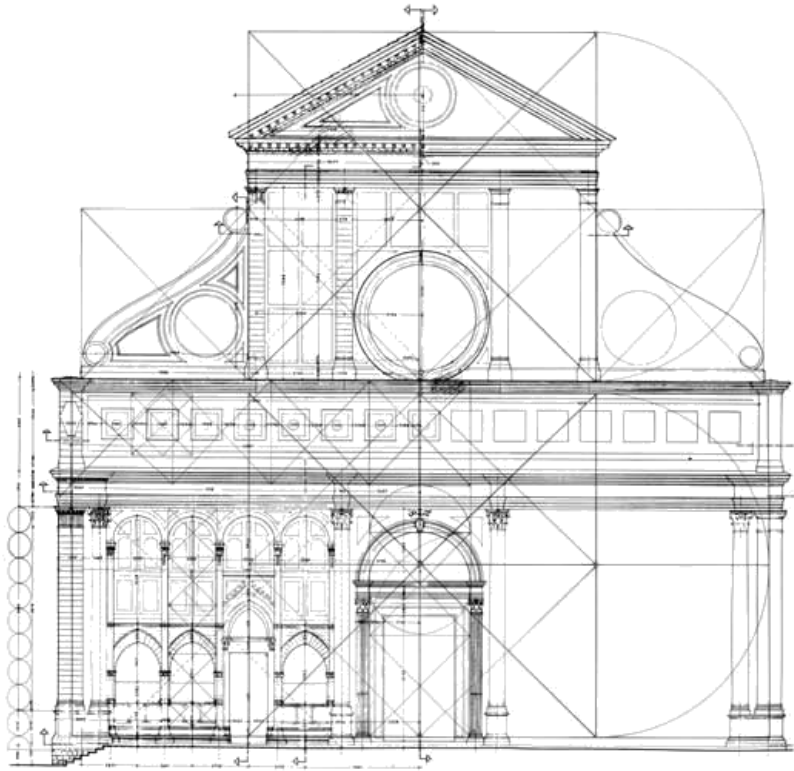
What level of design progression ?



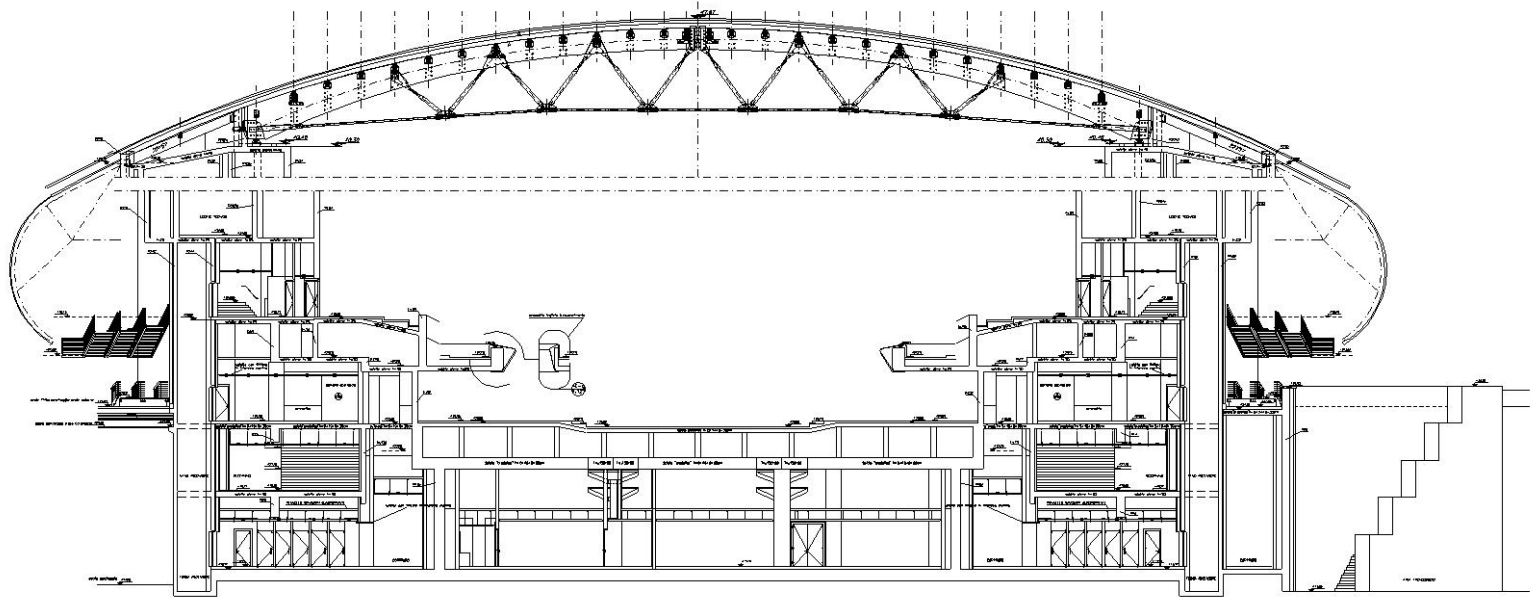
The background of the slide is a grayscale architectural floor plan. It shows various rooms and fixtures, including a kitchen area with a stove labeled 'ST', a sink area labeled 'F', and a bathroom with a toilet. Dimensions like '8'0"' and 'D/W' are visible. A green rectangular box is overlaid on the left side of the image, containing the text 'Traditional Design'.


Traditional Design

Sketching




Computer Aided Drafting





Parametric Design



PARAMETRIC DESIGN

Designer/engineer uses computer as passive machine



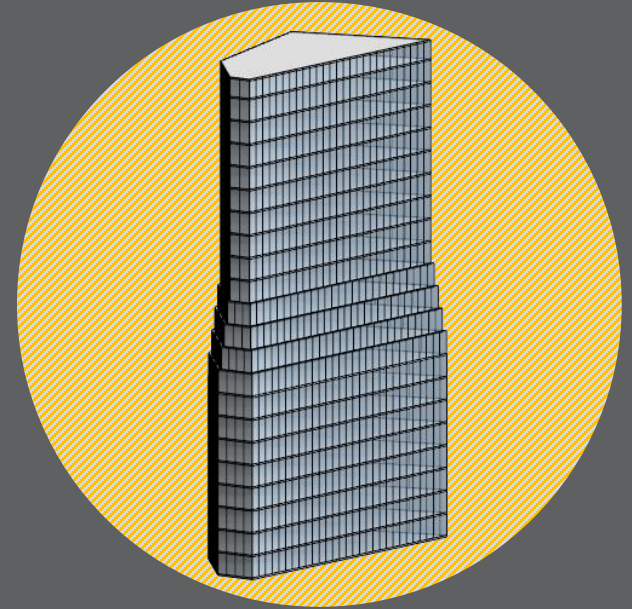
one
human

+



one
computer

=



limited
design





PARAMETRIC MODELING

Parametric Modeling

$$a = 2$$

$$b = 1$$

$$a - b = c$$

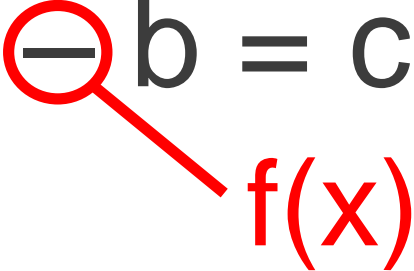
Parametric Modeling

$$a = 2$$

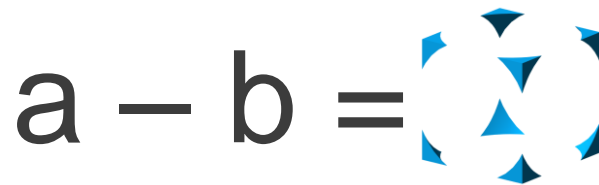
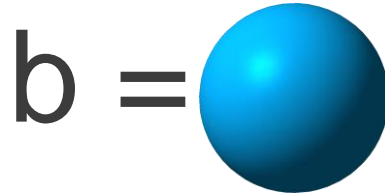
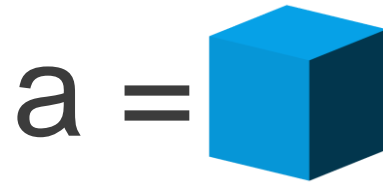
$$b = 1$$

$$a - b = c$$

$f(x)$



Parametric Modeling



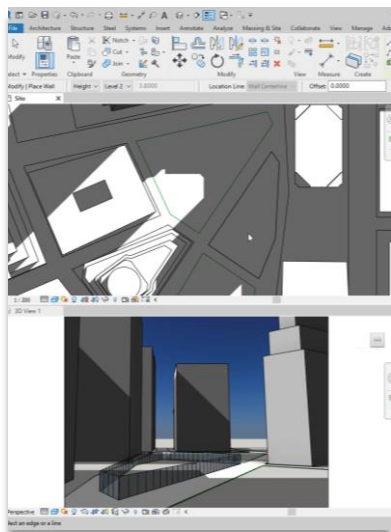
Conceptual Tower Mass – Design Model

 AUTODESK
REVIT®

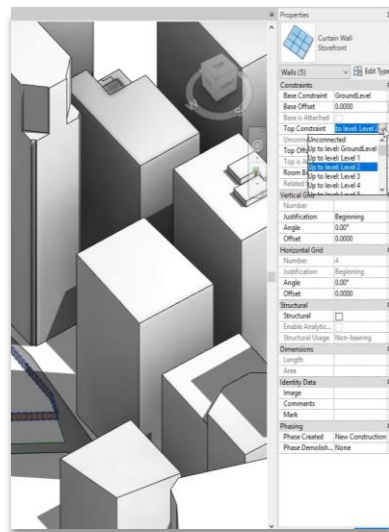
 AUTODESK
REVIT®

 AUTODESK
REVIT®

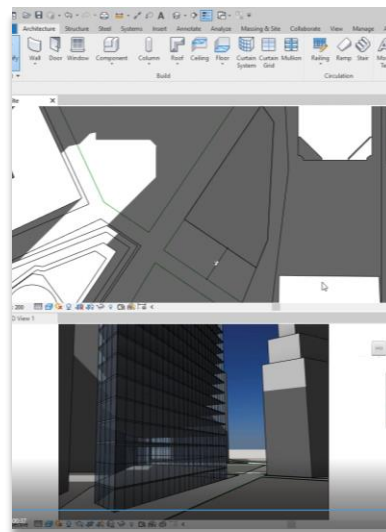
 AUTODESK
REVIT®



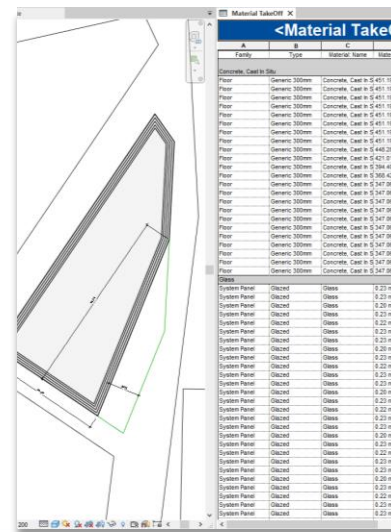
Create Geometry



Assign Parametric
Constraints



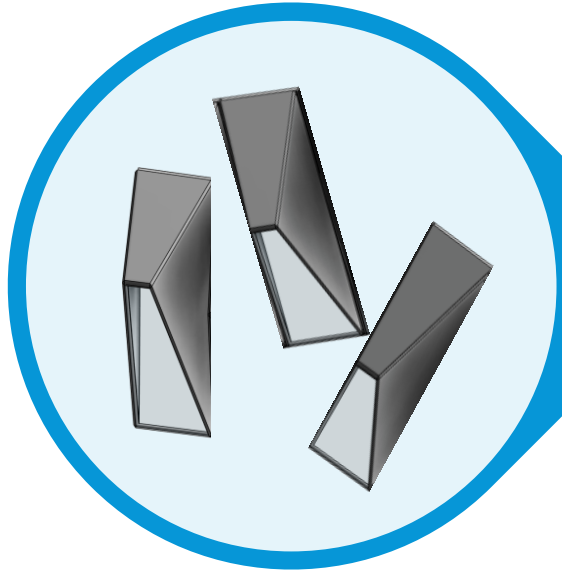
Modify Parameters



Document the Idea

Design Automation





input



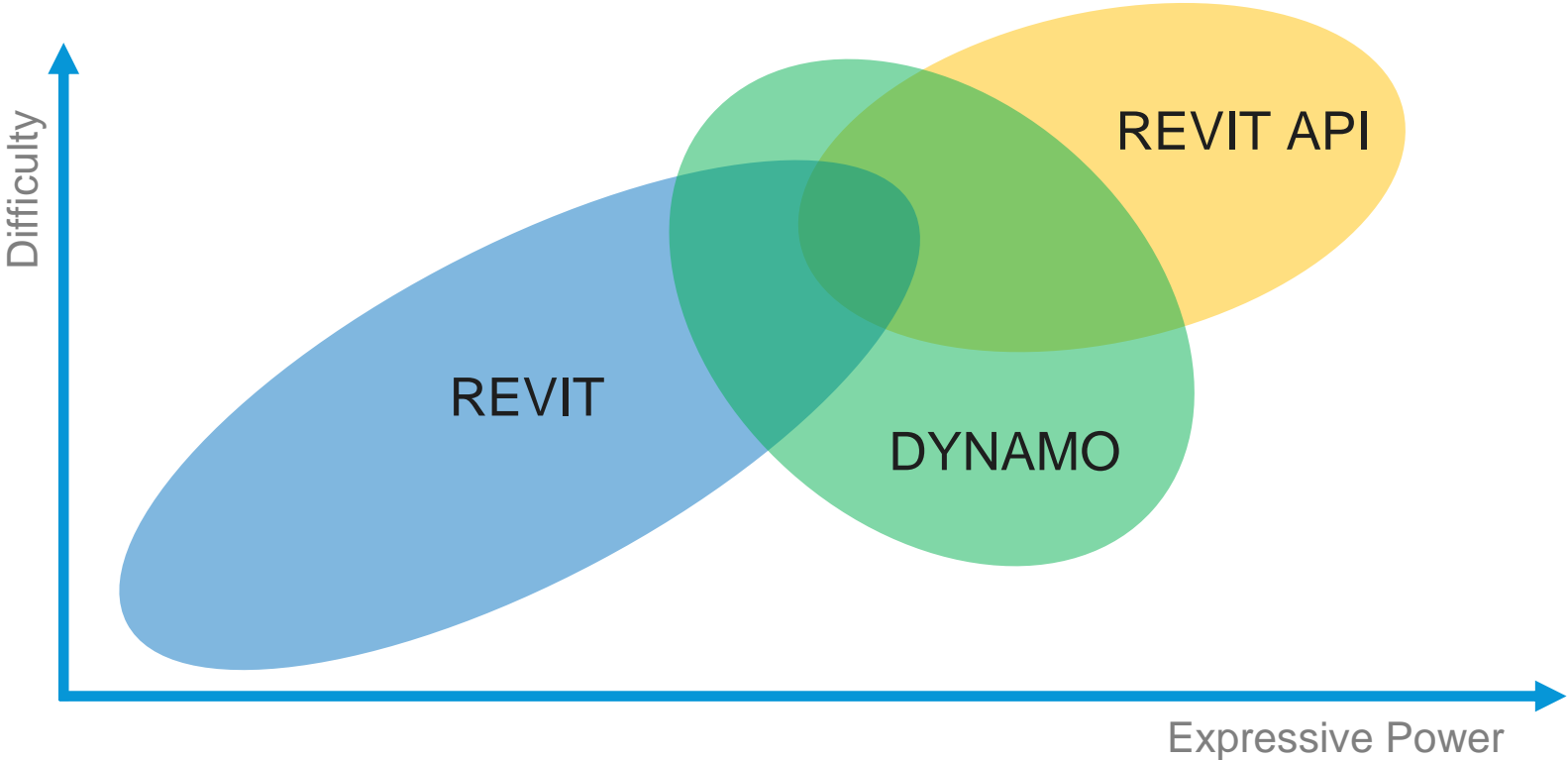
design
automation



output

Dynamo

Ecosystem to increase capabilities



Dynamo to simplify things

PROGRAMMING

```
void GetElementParameterInformation(Document document, Element element)
{
    // Format the prompt information string
    String prompt = "Show parameters in selected Element: \n\r";

    StringBuilder st = new StringBuilder();
    // Iterate element's parameters
    foreach (Parameter para in element.Parameters)
    {
        st.AppendLine(GetParameterInformation(para, document));
    }

    // Give the user some information
    TaskDialog.Show("Revit", prompt + st.ToString());
}

String GetParameterInformation(Parameter para, Document document)
{
    string defName = para.Definition.Name + "\t : ";
    string defValue = string.Empty;
    // Use different method to get parameter data according to the storage type
    switch (para.StorageType)
    {
        case StorageType.Double:
            //convert the number into Metric
            defValue = para.AsValueString();
            break;
        case StorageType.ElementId:
            //Find out the name of the element
            Autodesk.Revit.DB.ElementId id = para.AsElementId();
            if (id.IntegerValue >= 0)
            {
                defValue = document.GetElement(id).Name;
            }
            else
            {
                defValue = id.IntegerValue.ToString();
            }
            break;
        case StorageType.Integer:
            if (ParameterType.YesNo == para.Definition.ParameterType)
            {
                if (para.AsInteger() == 0)
                {
                    defValue = "False";
                }
                else
                {
                    defValue = "True";
                }
            }
            else
            {
                defValue = para.AsInteger().ToString();
            }
            break;
        case StorageType.String:
            defValue = para.AsString();
            break;
        default:
            defValue = "Unexposed parameter.";
            break;
    }

    return defName + defValue;
}
```

Select Model Element	
Select	Element
Element : 296833	

String	
Volume	>

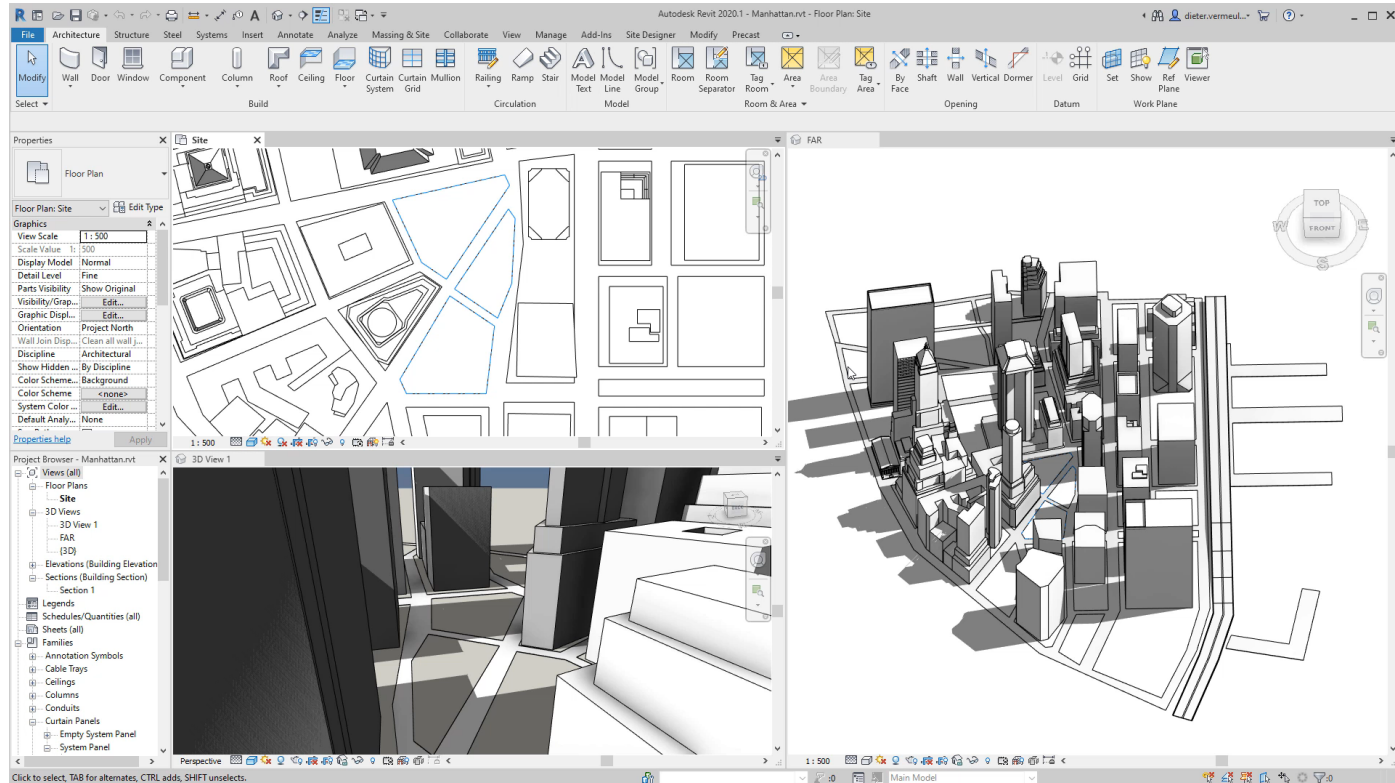
VISUAL SCRIPTING

Element.GetParameterValueByName	
element	> var[]..[]
parameterName	>
AUTO	

Result	
>	>

Conceptual Tower Mass - Automated Placement

Design Automation with Revit and Dynamo Player



Cut Openings in Structural Walls

Design Automation with Revit and Dynamo

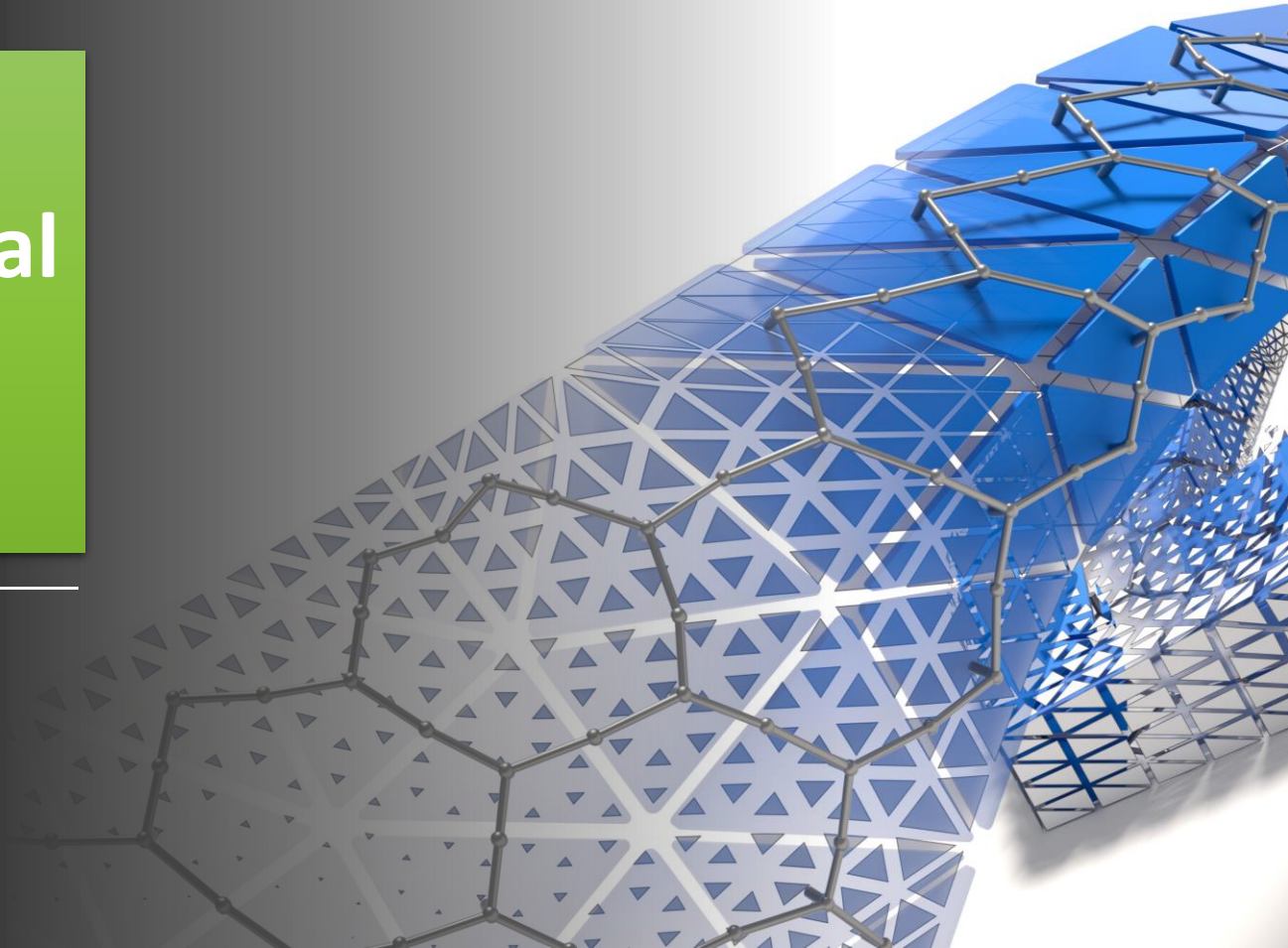


Thanks for contributing:
Jesper Wallaert, AB Clausen, Denmark

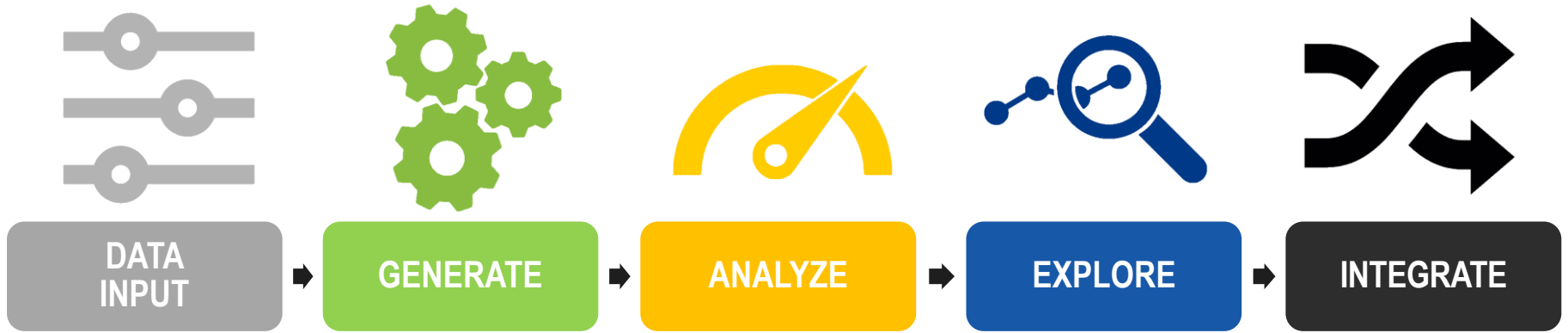




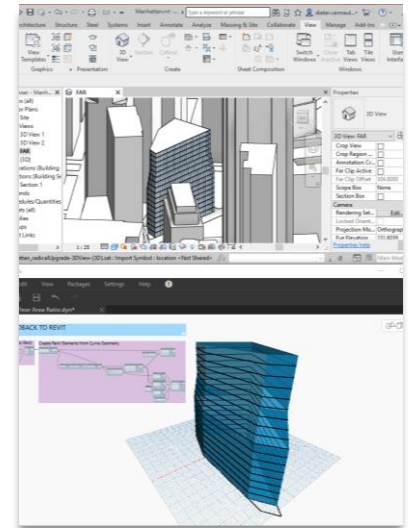
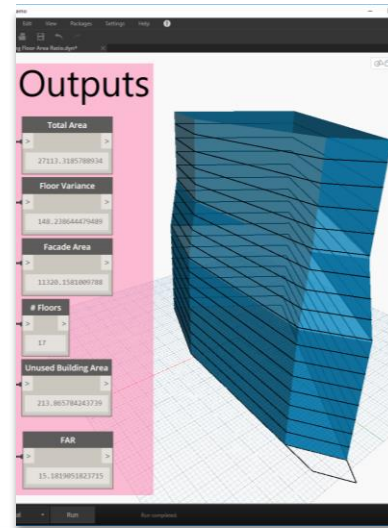
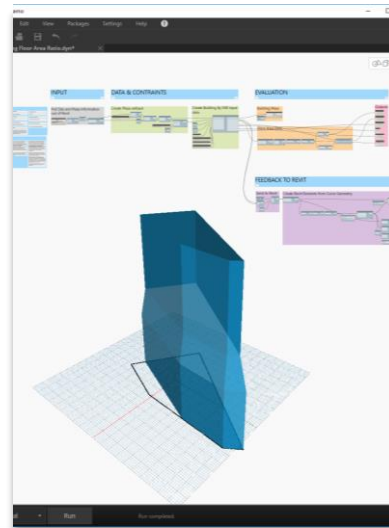
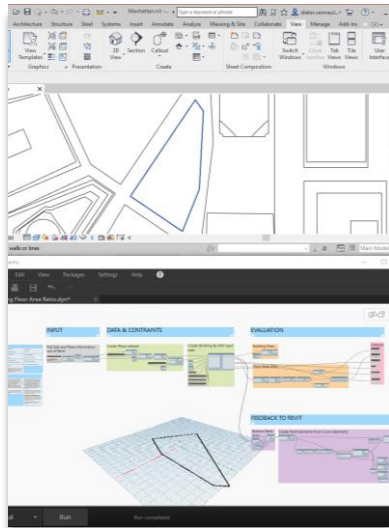
Computational Modeling



Computational Modeling Process



Conceptual Tower Mass with Computational Modeling



Get Boundaries

Generate
Geometry

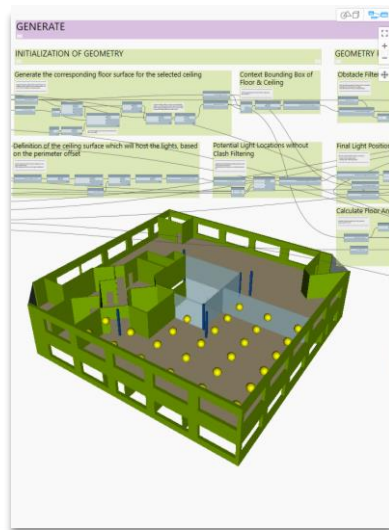
Analyze & Evaluate

Model
Integration

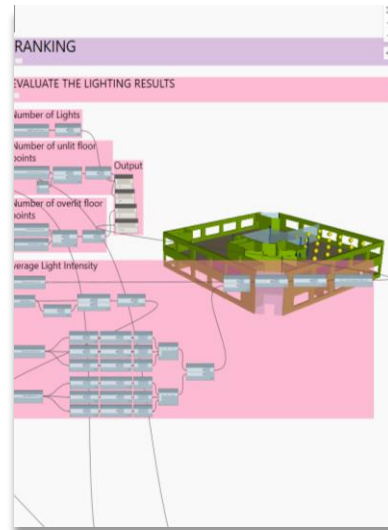
Light Distribution Analysis



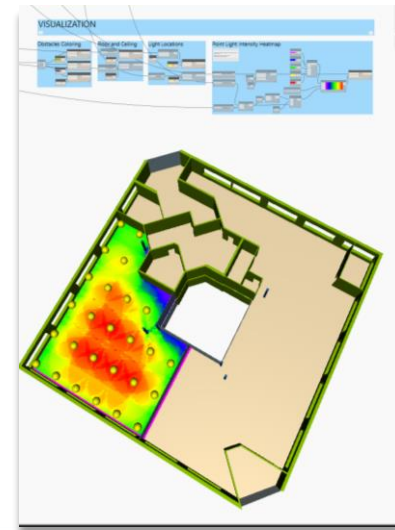
Get Revit Context



Generate Option for
Light Distribution



Conceptual Analysis
Point Intensity



Evaluation

Light Distribution Analysis

Computational Modeling with Revit and Dynamo

Special thanks for contributing:
Jared Linden, Hoare Lea, UK
Radu Gidei, UK

DESCRIPTION

DYNAMO FILE NAME	DYNAMO VERSION
Light Distribution Optimization.dyn	2.2
ASSOCIATED REVIT FILE(S)	WORKING REVIT VERSION(S)
Light Distribution.rvt	2020
AUTHOR(S)	REQUIRED DYNAMO PACKAGES
Dieter Vermeulen (Autodesk)	BIMStruc.LightDistribution Project Refinery (install from https://beta.autodesk.com/key/RefineryLanding)
DESCRIPTION	Special thanks and credits to Jared Linden, Digital Applications Developer at Hoare Lea and Radu Gidei from Matterlab for contributing to this example.

This Light Layout Optimiser prototype is built for use with Refinery and creates and analyzes lighting positions on a floor layout.

Choose the floor and ceiling face from your Revit model.

The script will place "lights" below the ceiling and an array of points on the floor.

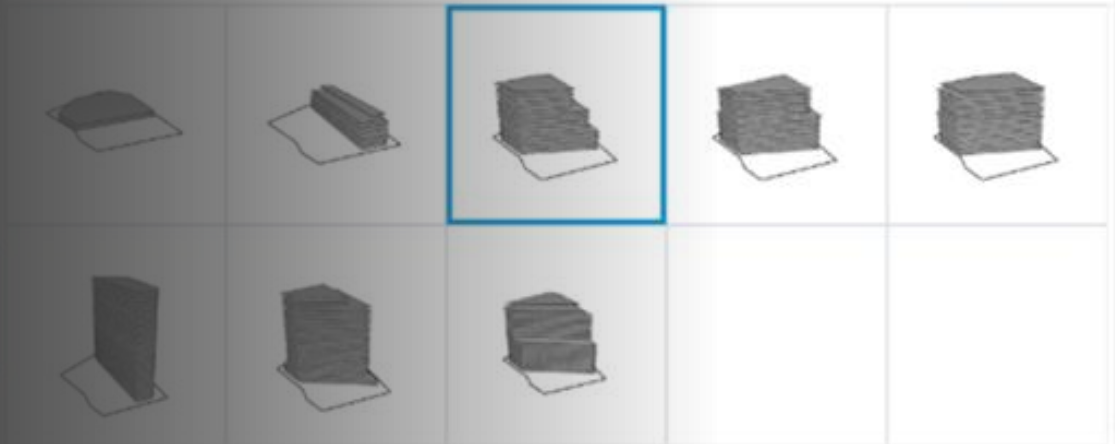
It will then ray cast every light to every floor point (taking into account obstacle geometry) and add up the number of unit floor points.

Generative Design

02-01_Primer_sample_BuildingGenerator 001

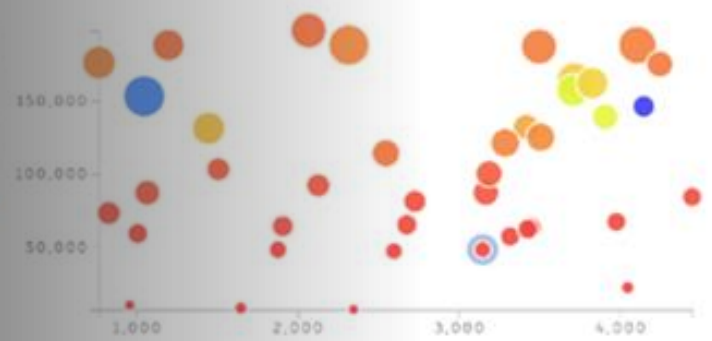
Sort by OUT_Total Building Area ↑

1 2 3 4



enable filters Click and drag over axes to add filters

- Y Axis: IN_Building Height
- X Axis: IN_Site Offset
- Size: OUT_Total Building Area
- Color: OUT_Lift Provision Area

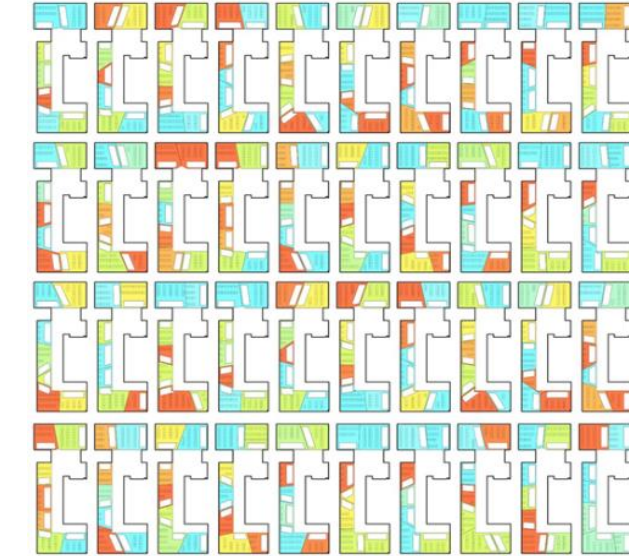


GENERATIVE DESIGN

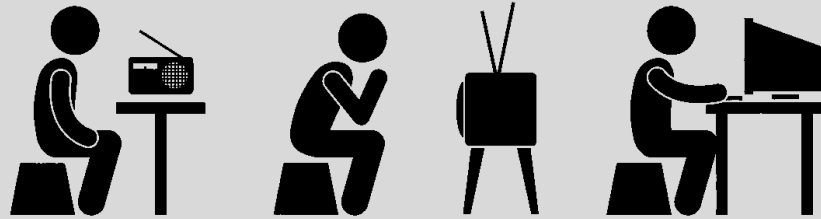
Computer and designer/engineer
unite as cocreators



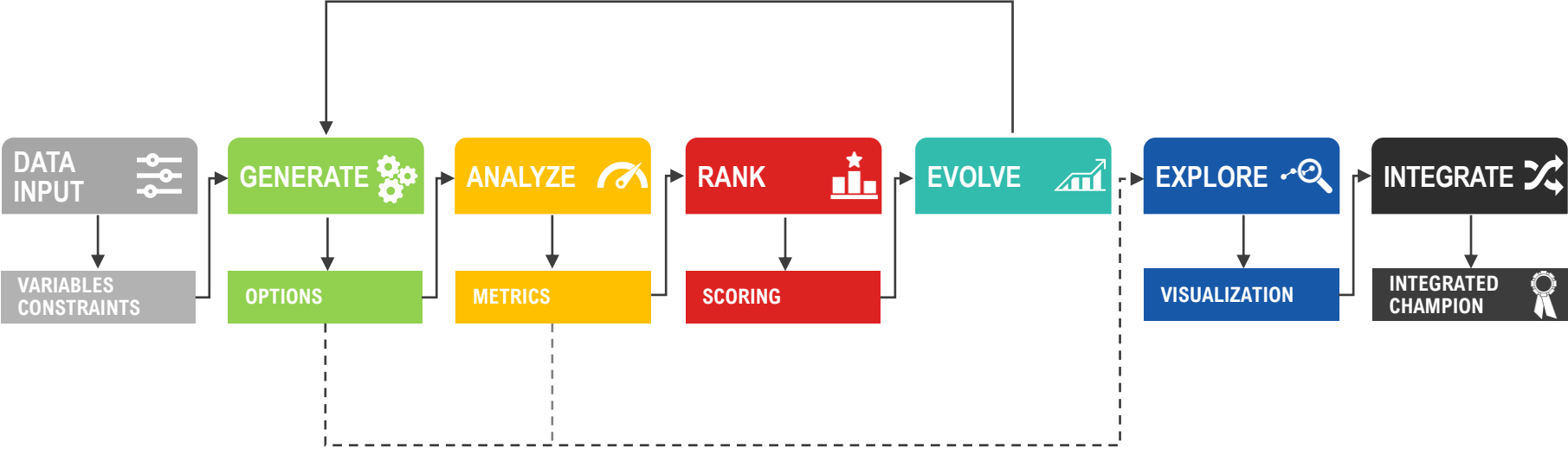
one human + computational algorithms + computing power

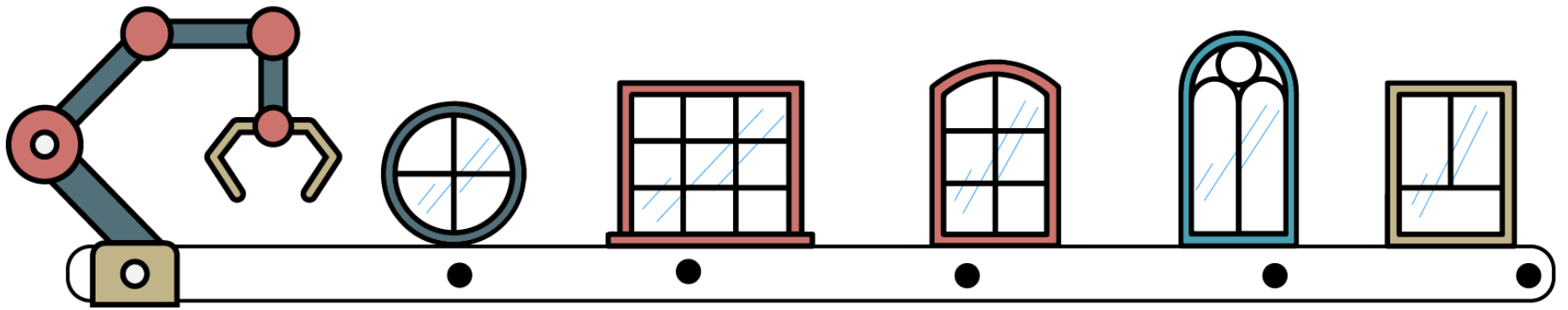


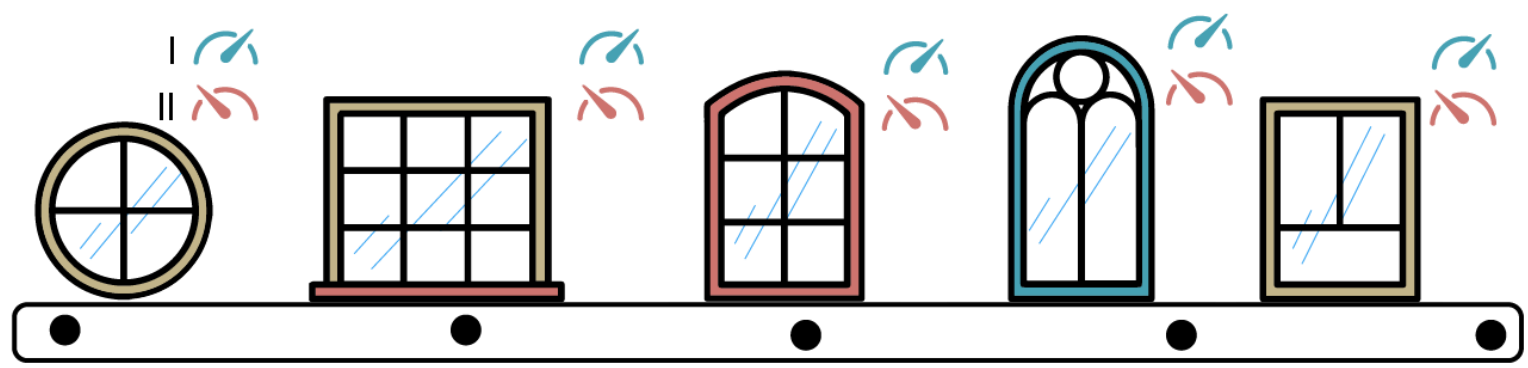
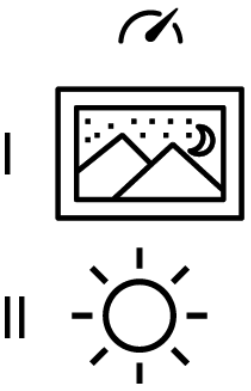
= 100s to 1000s
of
design options

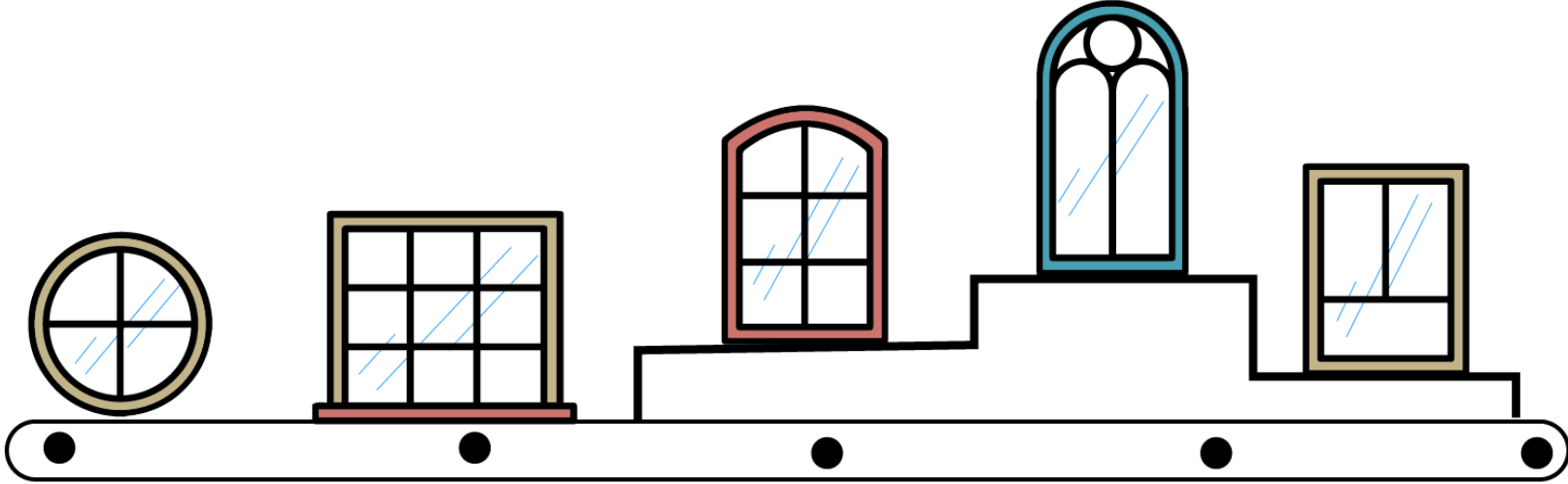


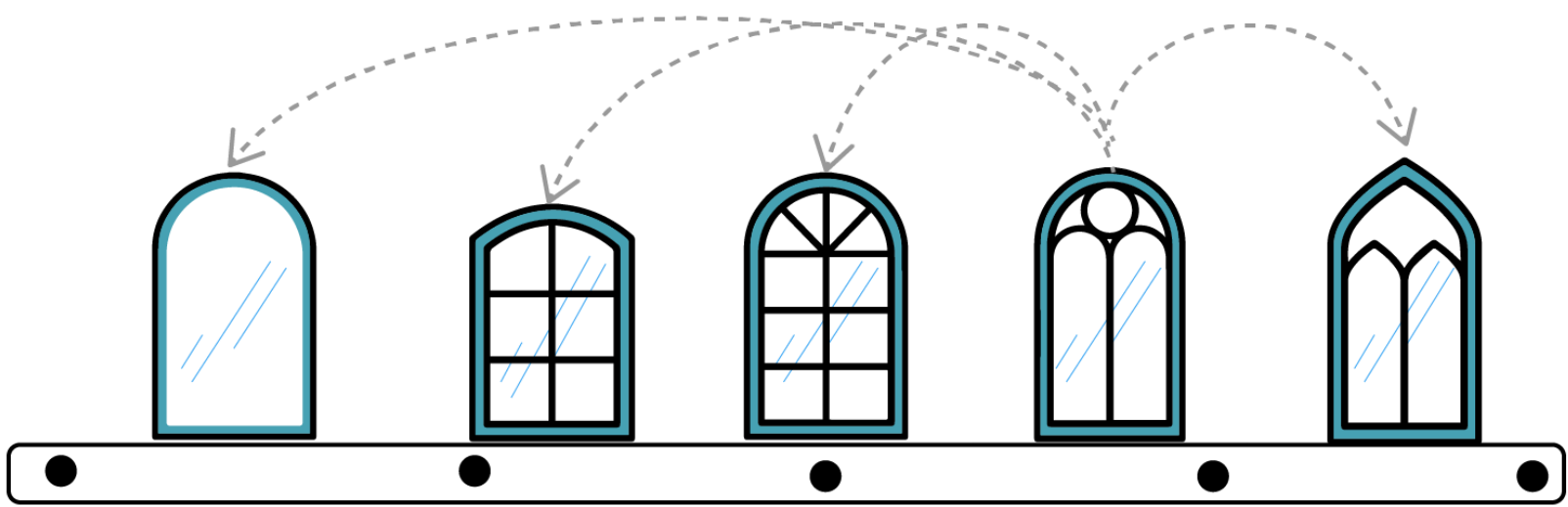
Generative Design Process

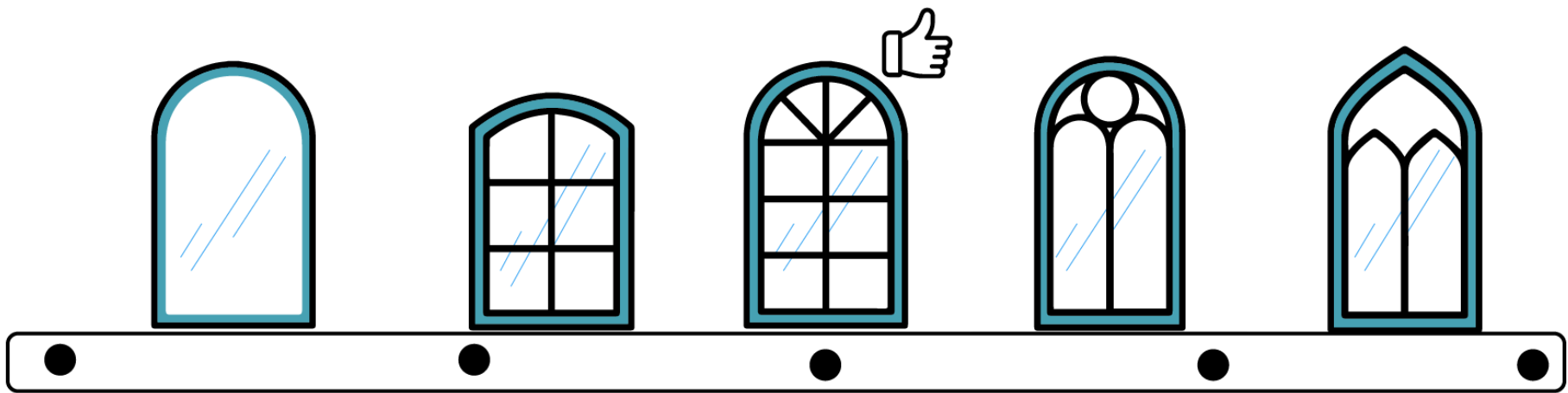












DATA
INPUT



GENERATE



ANALYZE



RANK



EVOLVE



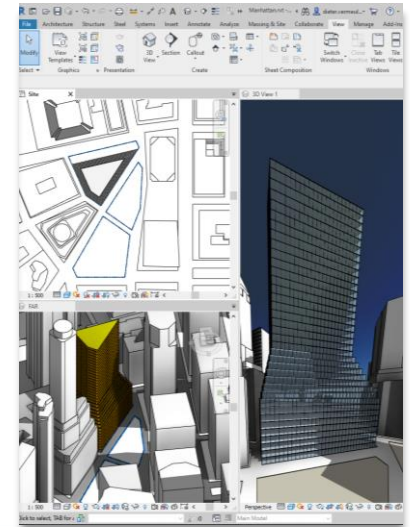
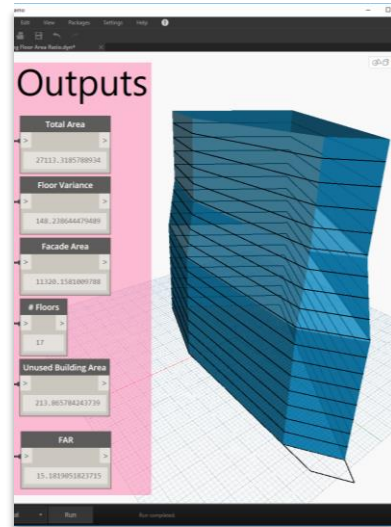
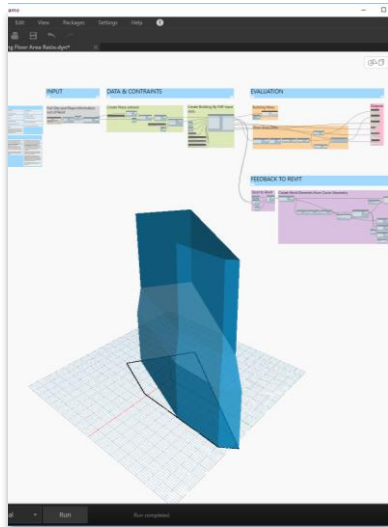
EXPLORE



INTEGRATE



Conceptual Tower Mass Optimization



Data and Constraints

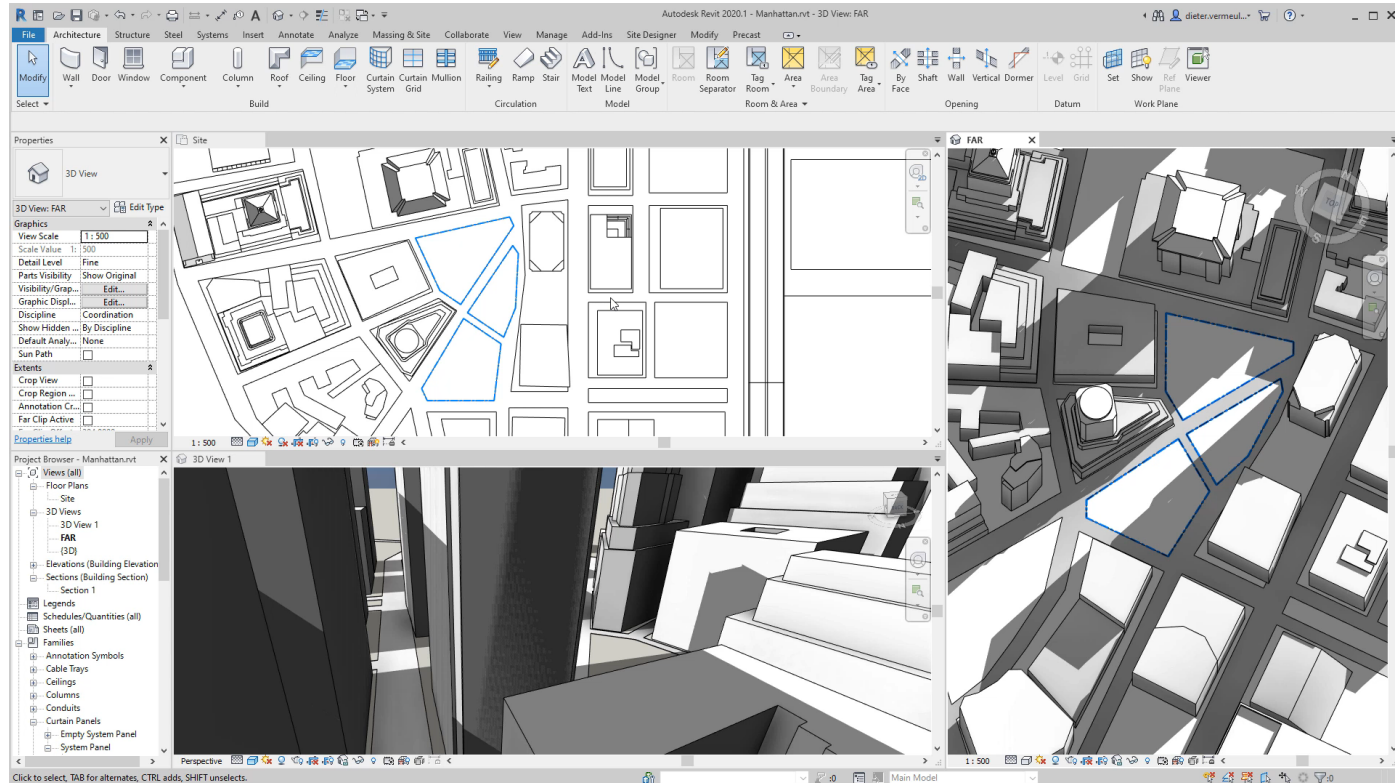
Define
Computational
Model

Optimization
Champion Selection

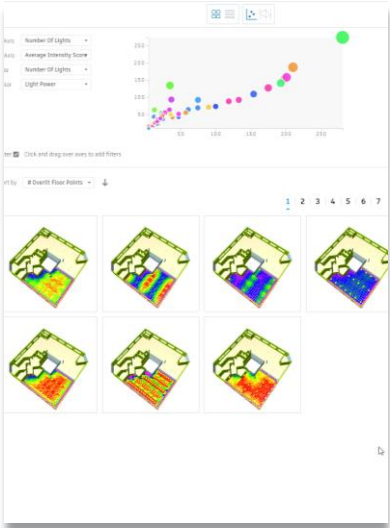
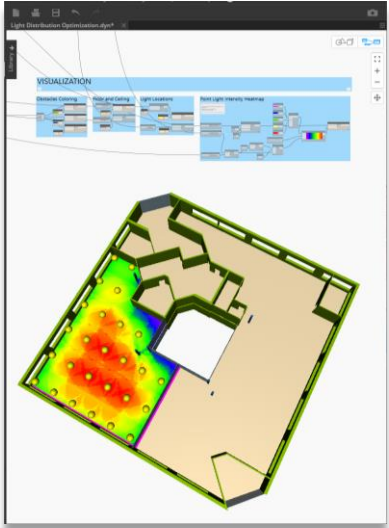
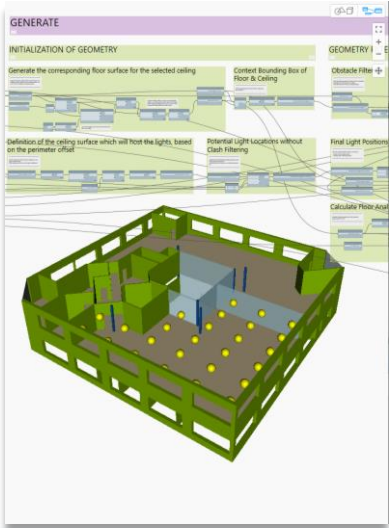
Integrate in design

Conceptual Tower Mass Optimization

Optimization with GD in Revit



Light Distribution Optimization



Data & Constraints

Generate

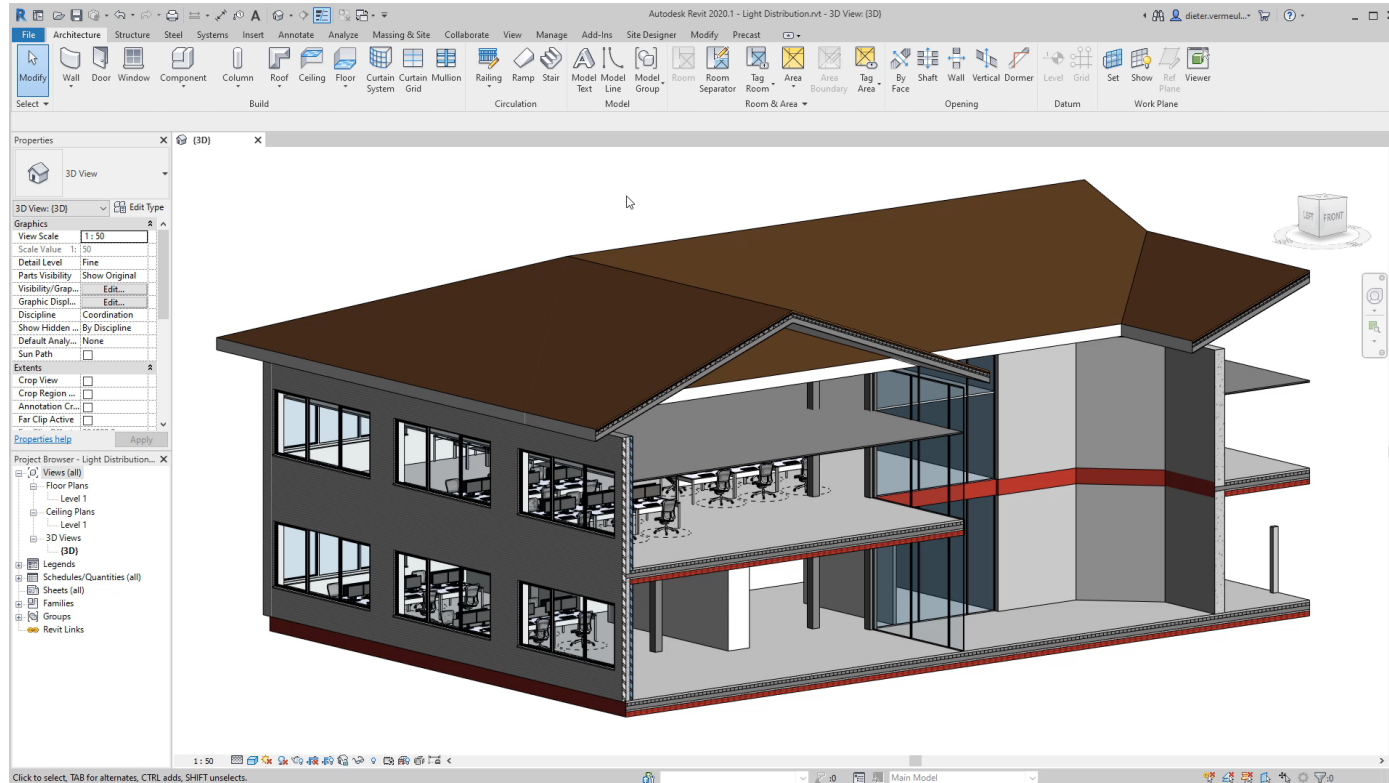
Analyze & Ranking

Evolve Explore Results

Light Distribution Optimization

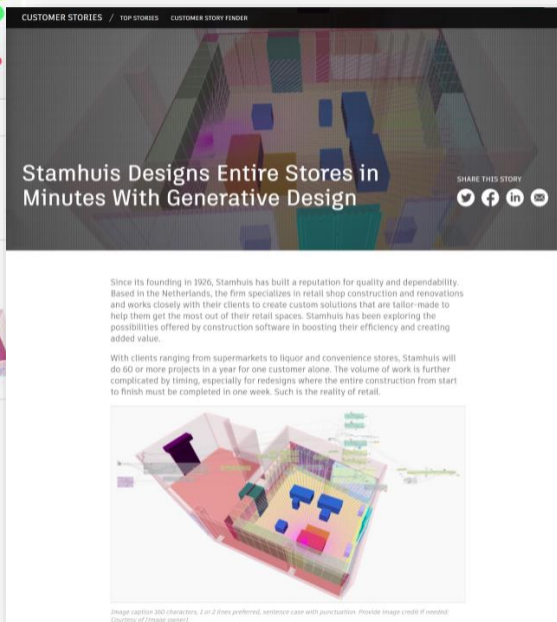
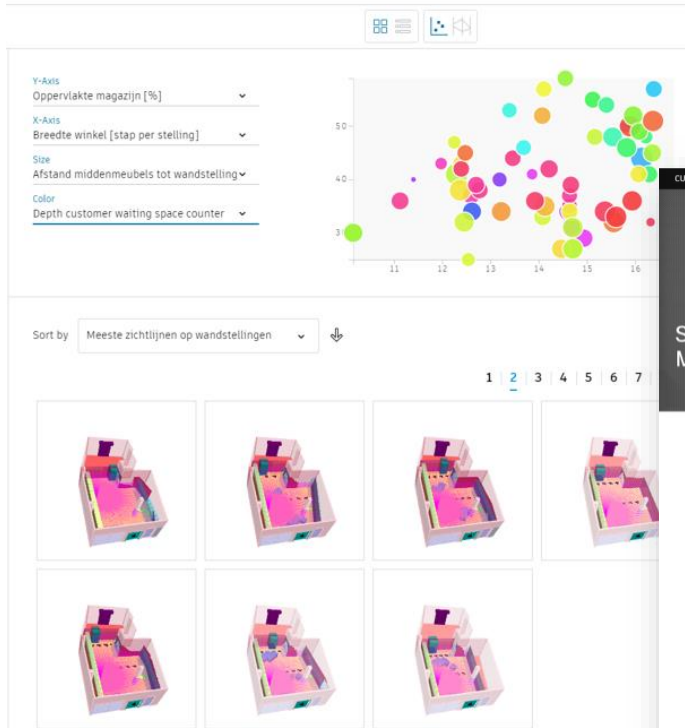
Design Optimization with Revit, Dynamo and GD

Special thanks for contributing:
Jared Linden, Hoare Lea, UK
Radu Gidei, Matterlab, UK



Shop Layout Planning

Optimize the ratio of shop and storage area of a liquor store



CUSTOMER STORIES / TOP STORIES / CUSTOMER STORY FINDER

Stamhuis Designs Entire Stores in Minutes With Generative Design

SHARE THIS STORY

Since its founding in 1926, Stamhuis has built a reputation for quality and dependability. Based in the Netherlands, the firm specializes in retail shop construction and renovations and works closely with their clients to create custom solutions that are tailor-made to help them get the most out of their retail spaces. Stamhuis has been exploring the possibilities offered by construction software in boosting their efficiency and creating added value.

With clients ranging from supermarkets to liquor and convenience stores, Stamhuis will do 60 or more projects in a year for one customer alone. The volume of work is further complicated by timing, especially for redesigns where the entire construction from start to finish must be completed in one week. Such is the reality of retail.

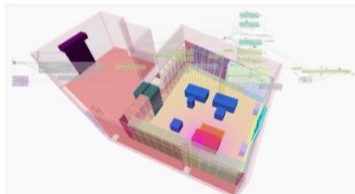
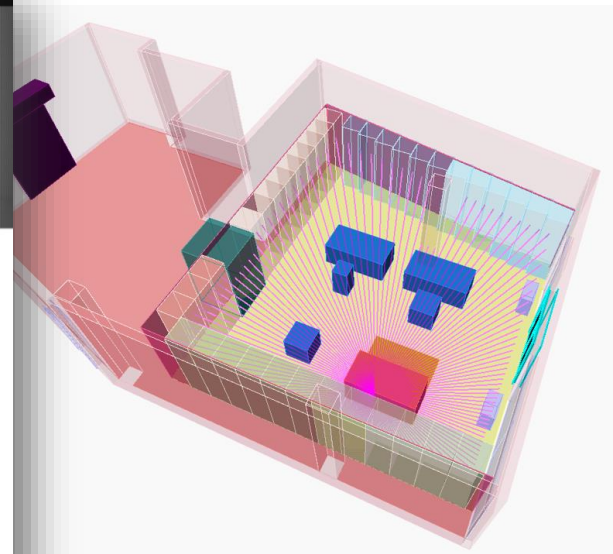
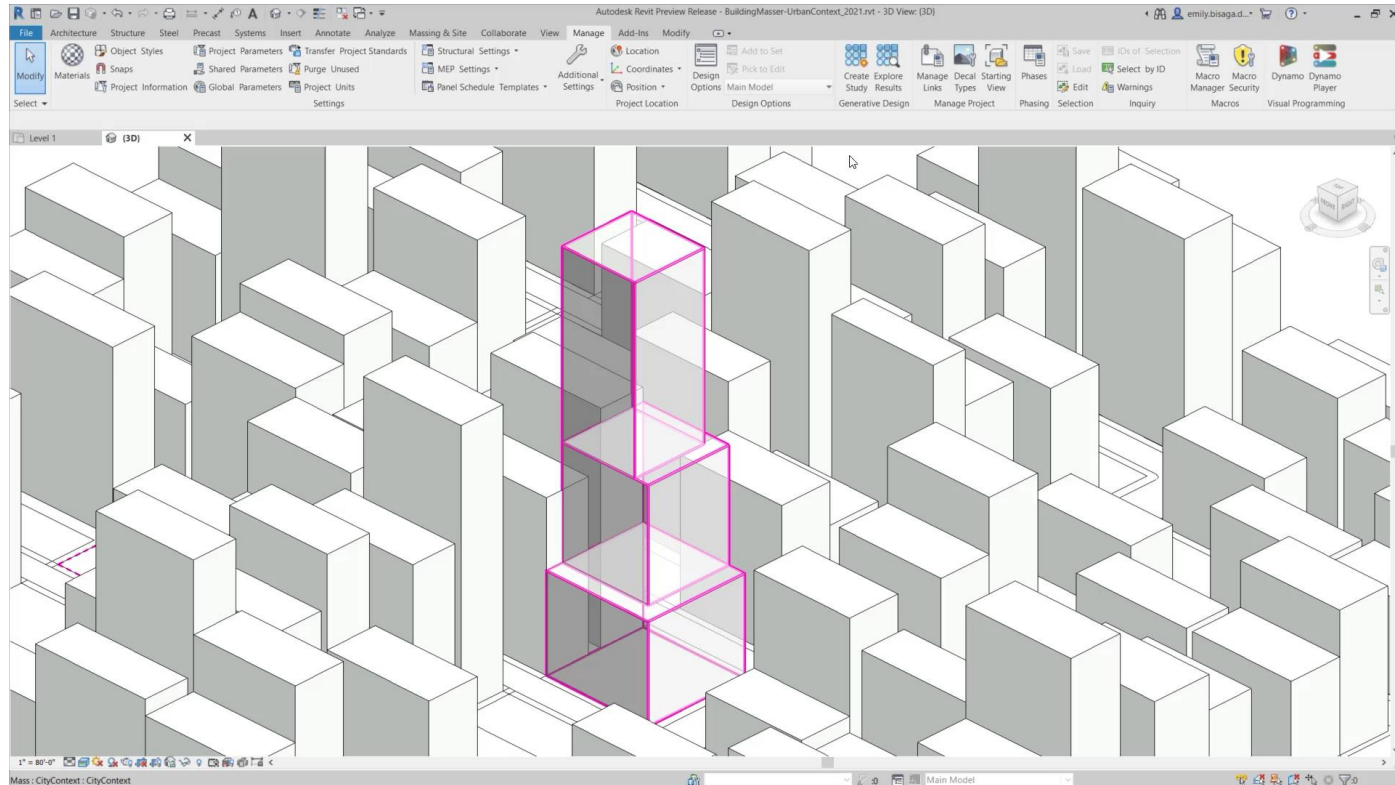


Image caption 260 characters. 2 of 2 lines preferred, sentence case with punctuation. Provide image credit if needed. (Maximum image length)



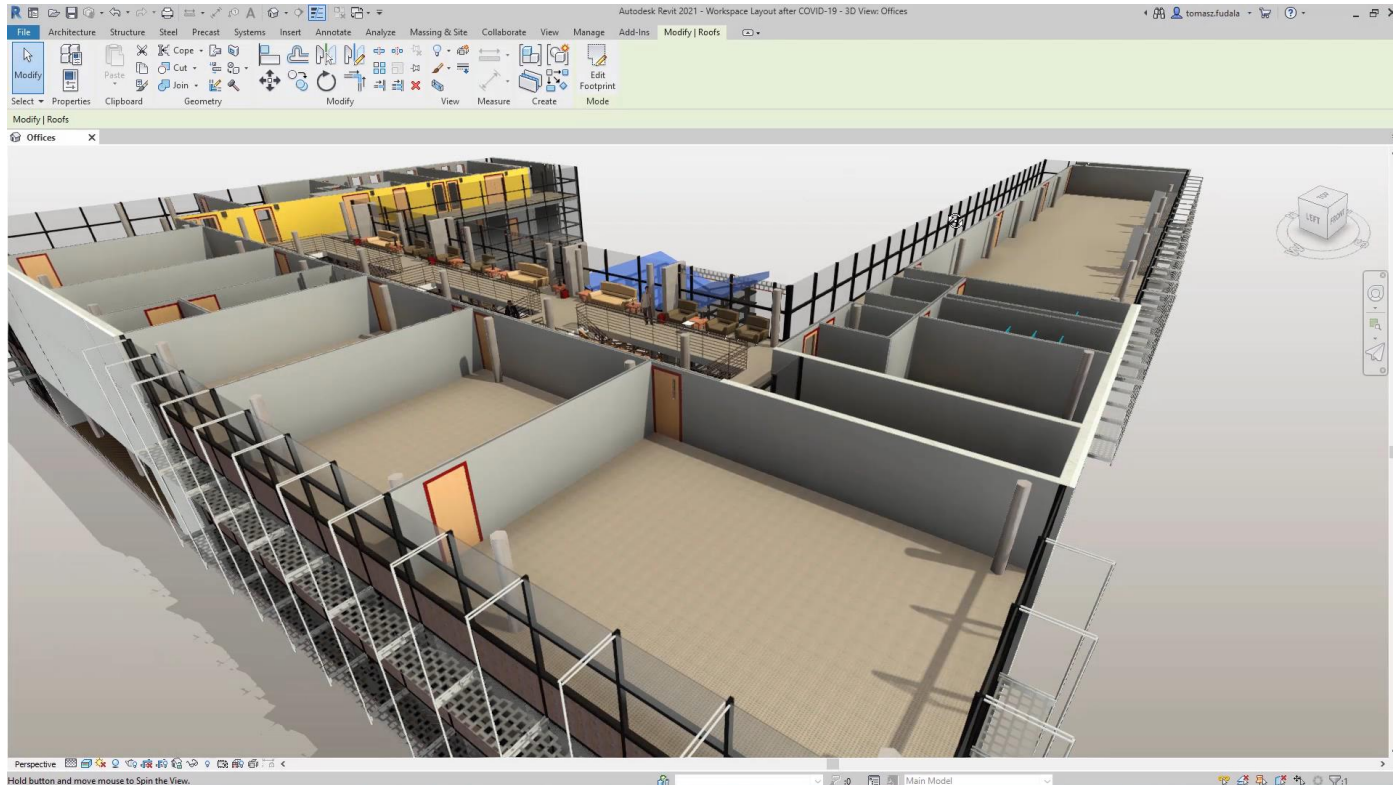
Building Massing Conceptual Analysis

Optimization with Generative Design in Revit

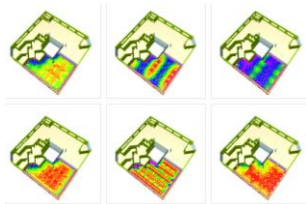
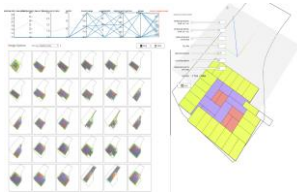
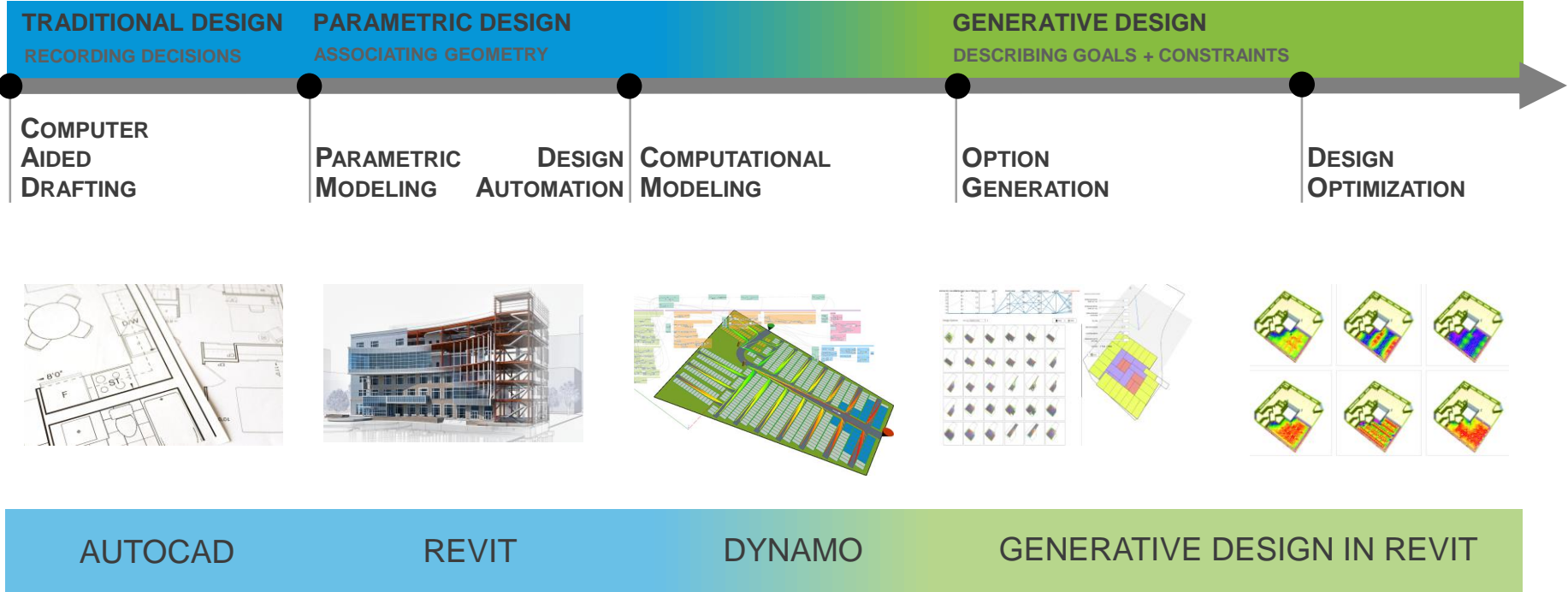


Office Workspace Layout

Optimization with Generative Design in Revit



Design Technology Progression



What level of design progression ?



You know what to do ! 🖐️

Where to get started with Dynamo ?

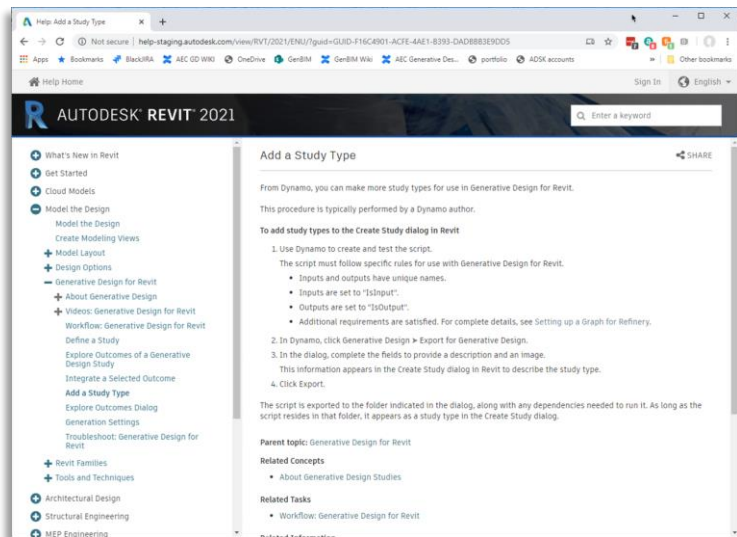
<https://primer.dynamobim.org/>



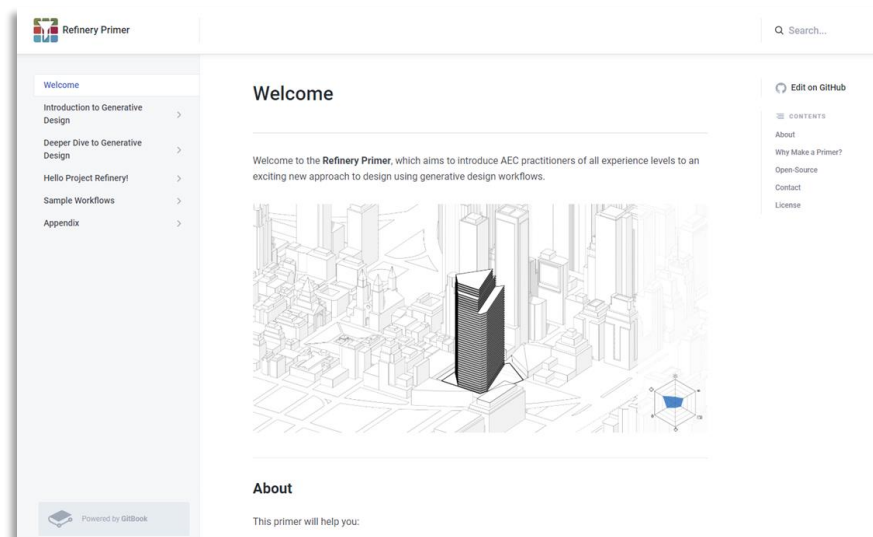
A screenshot of a web browser displaying the "The Revit Connection" page on the primer.dynamobim.org website. The browser's address bar shows the URL "primer.dynamobim.org/08_Dynamo-for-Revit/8-1_The-Revit-Connection.html". The page has a dark header with the "Dynamo" logo and social media icons. The main content area features the title "The Revit Connection" and a large graphic of the Dynamo logo connected to a stylized blue "R" and a green/blue arrow-like shape, all linked by a black chain. Below the graphic, there is introductory text about Dynamo for Revit. A left-hand navigation menu is visible, listing various topics like "Importing Geometry", "Designing with Lists", and "Code Blocks and DesignScript". The browser's taskbar at the bottom shows several open files, including "dynamo-studio-pr...zip", "dynamo-studio-log...tif", "Navisworks_Manag...tif", "AEC_BINIM_04_Hybrid.tif", "DPR_Construction...tif", and "Navisworks_Constru...tif".

Learning Content

Revit Help and more in-depth primer content



Access from within Revit > Help



Generative Design Primer:
<https://www.generativedesign.org/>





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Make anything[™]

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