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GENERATIVE DESIGN

THE FUTURE OF BIM IS OPTIMIZATION

BILL ALLEN - PRESIDENT, **EVOLVELAB**

“The world’s most valuable resource is no longer oil, but data”
-The Economist

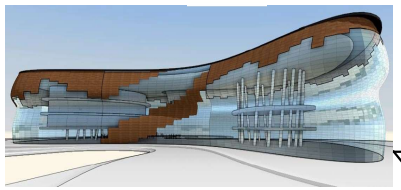
If your data is more valuable than oil how are you using it?

2002

2007

2011

2021



Dynamo

Building Information Modeling

Data Driven Chasm

Building Information Optimization

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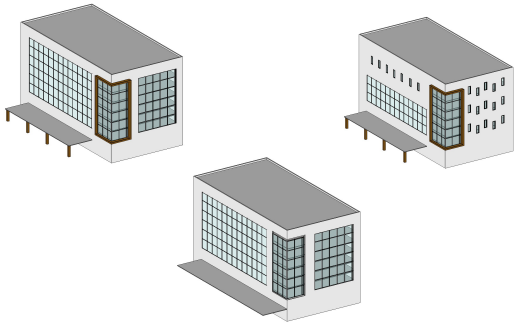
Passive Design

Bald Human

One Computer

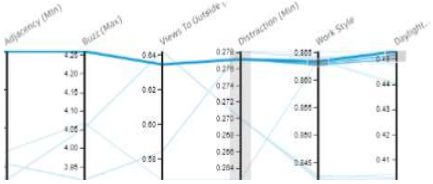
Limited Options (Not Optimized)



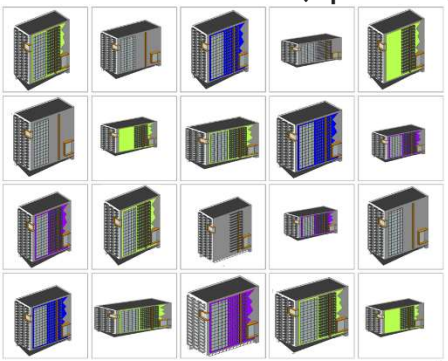
Generative Design

(Still) Bald Human

Logic and Parameters



Thousands of Solutions (Optimized)



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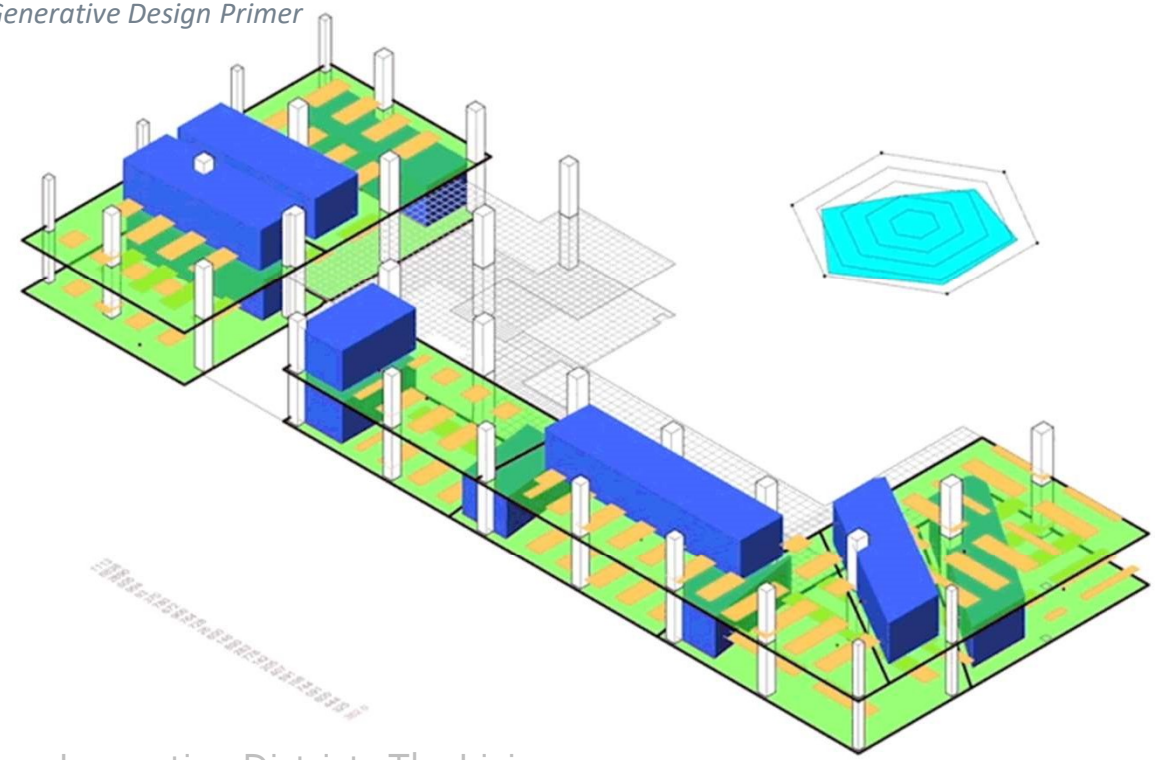
gen·er·a·tive de·sign / noun)

A collaborative design process between humans and computers. During this process, the designer defines the design parameters and the computer produces design studies (alternatives), evaluates them against quantifiable goals set by the designer, improves the studies by using results from previous ones and feedback from the designer, and ranks the results based on how well they achieve the designer's original goals.

Credit Autodesk Generative Design Primer



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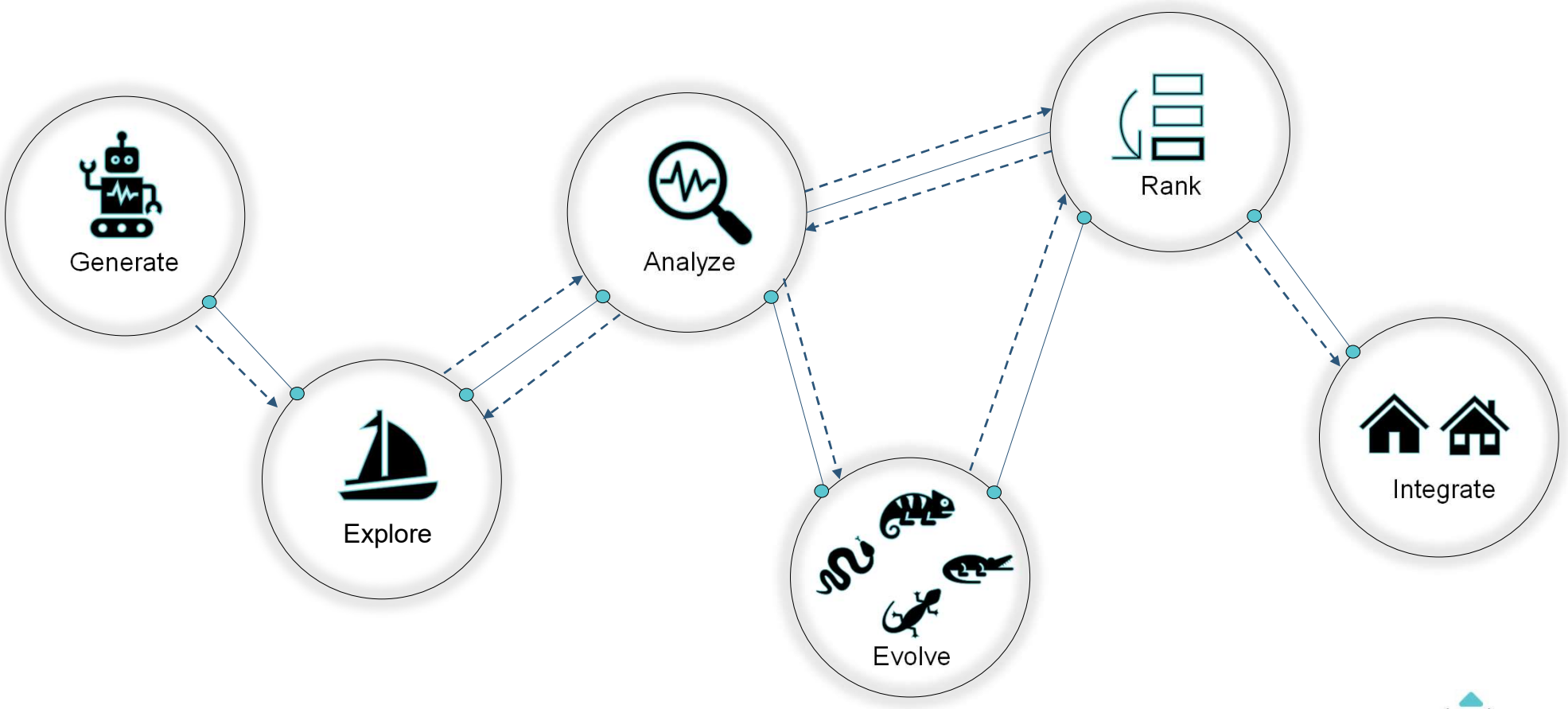
Generative Design Process



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How Do You Design a Pizza?

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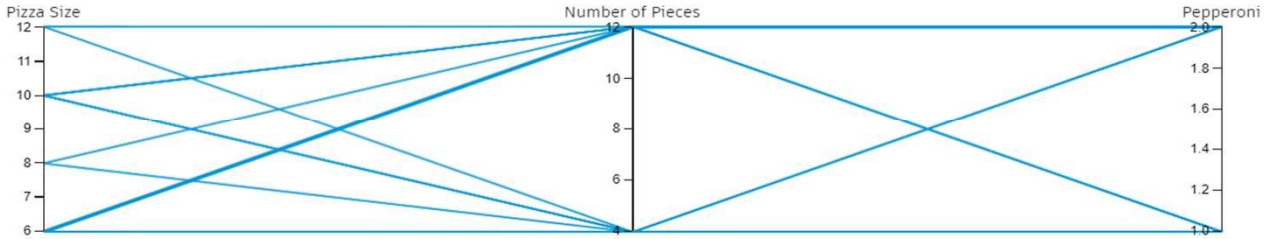
Refinery

Studies

New Study

Studies to show All

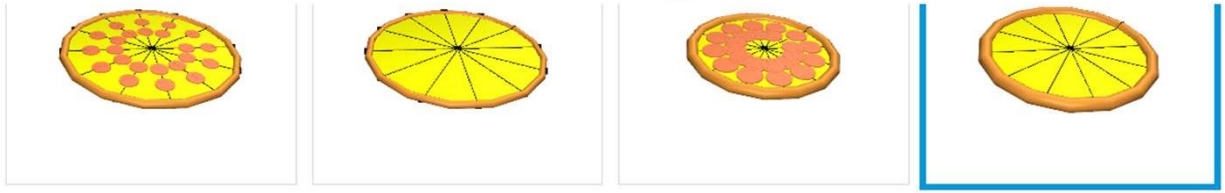
44450ea2-671b-4287-9eac-b87cb	28/28	✓
51c45eca-71cc-4d5f-8f04-5f2af68	200/200	✓
019d72f9-b556-4df3-af11-673f97	40/40	✓
cba32cf3-04e3-406e-bfd0-a488c	10/10	✓

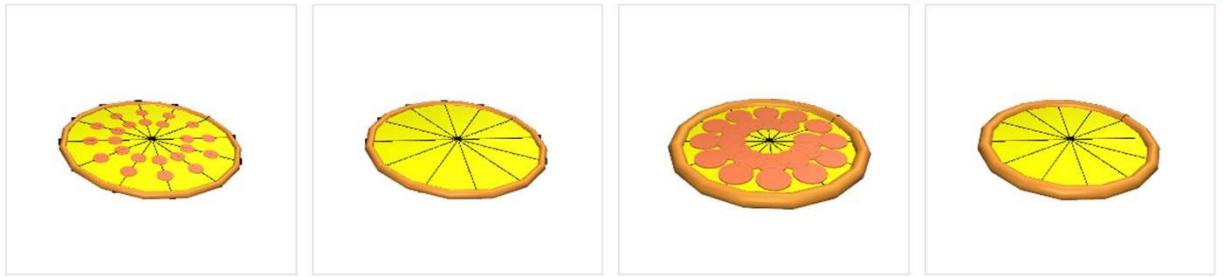


Filter ☑ Click and drag over axes to add filters

Sort by Pizza Size ↑

1 | 2 | 3 | 4



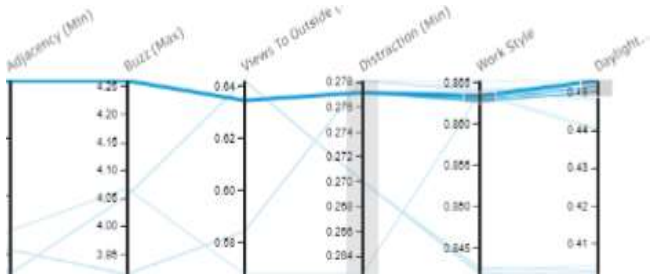


Open in Dynamo

VS.

Single Objective Optimization

Multi-Objective Optimization



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Case Studies

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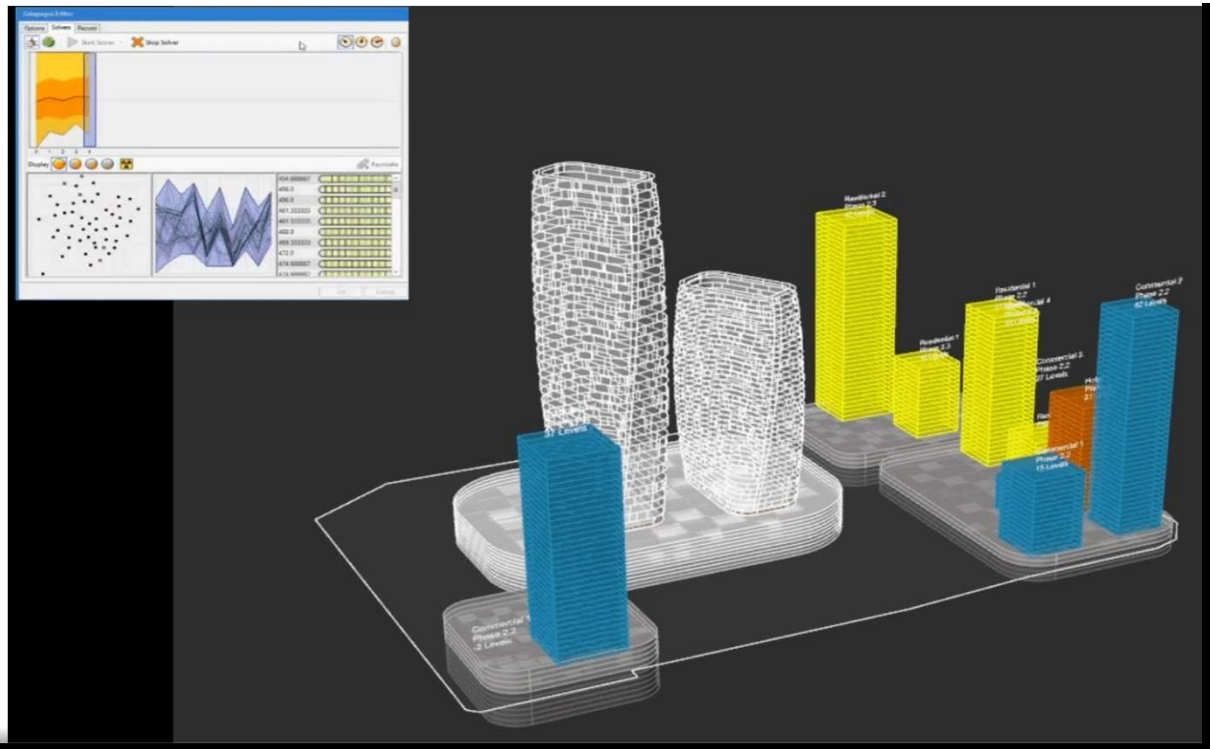
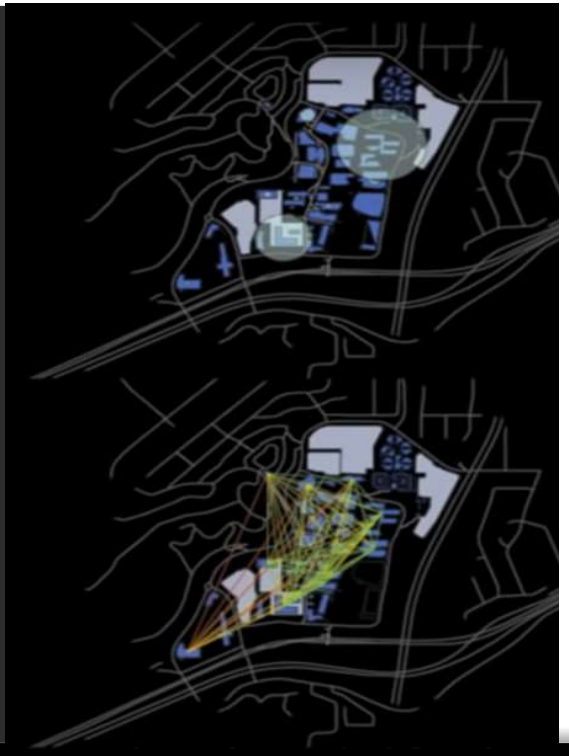
Optimization for Master Planning

We were recently brought on to help with a master planning optimization project in Dubai. We utilized Generative Design and Evolutionary Problem Solving to optimize the project. The fixed parameters were the site perimeter, and the existing buildings. We had a series of podiums that the proposed buildings would sit on, and a fixed space program including office, retail, and residential units. We fed the computer the maximum building heights, and let the computer solve the master plan's optimal building proportions.





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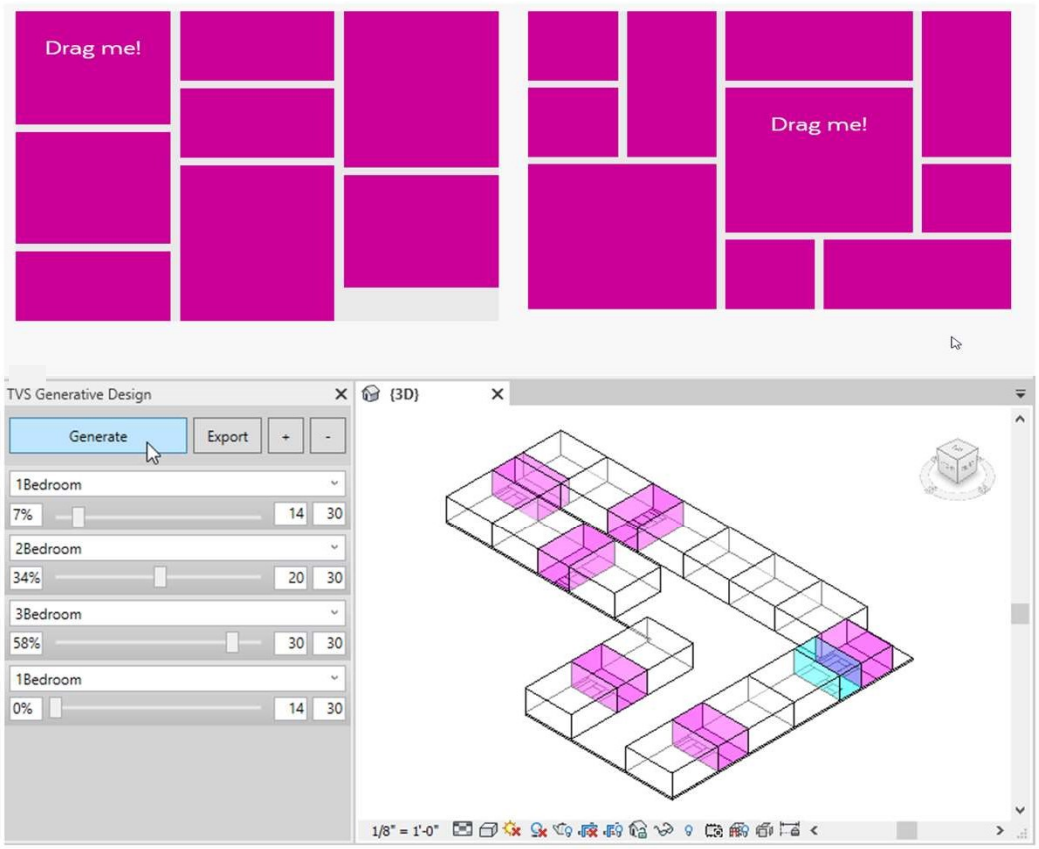
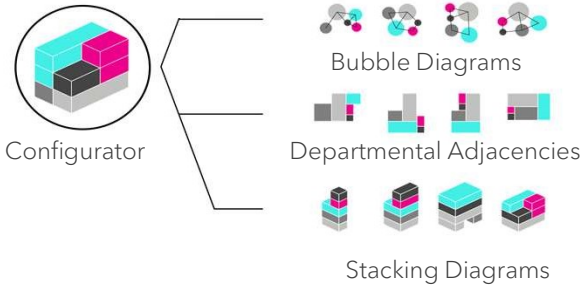
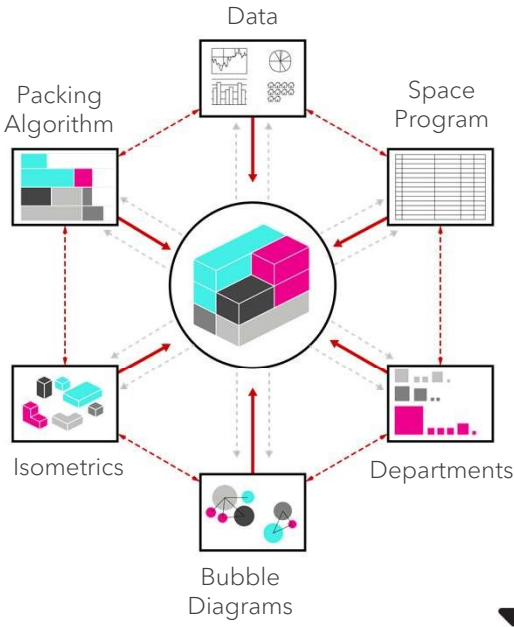
Optimization for Testfitting

The process test fitting directly within Revit using a packing algorithm, and a co-design process paired with generative design. Utilizing packing algorithms, and programmatic design we can create multiple options of 1 bedroom, 2 bedroom, and 3 bedroom apartments.







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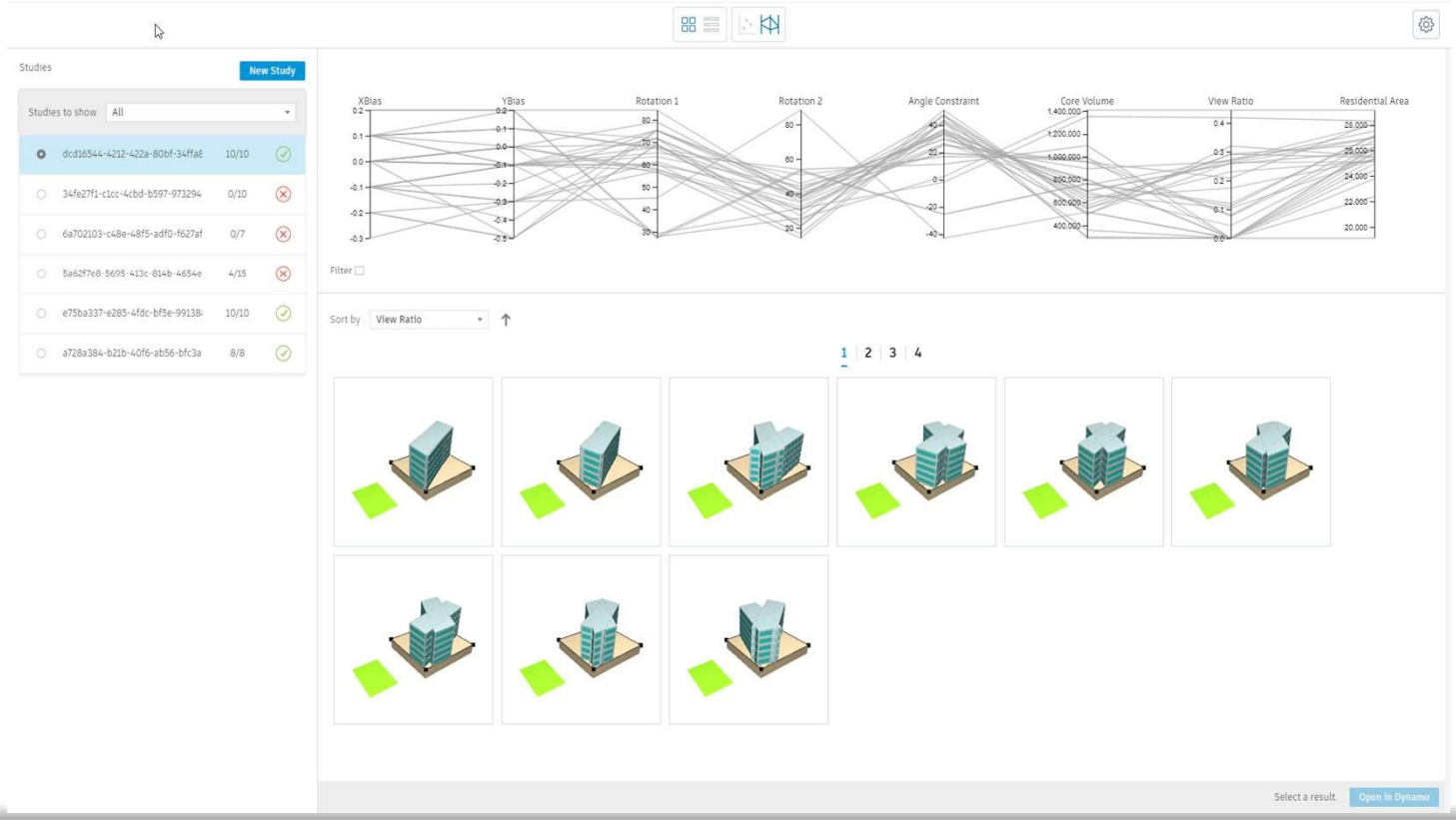
Optimization For View Orientation

We recently started the early stage development of an algorithm that takes a given lot and given target and optimizes building orientation on that lot for available views to the target. Working at this stage in the development, the simplified logic is giving us a good sense of what constraints and optimization goals are useful for creating real building shapes. Once this is understood, layers of complexity will be added to create a more robust algorithm.



Fixed Constraints:

- Lot Size
- Lot Location
- View Target Size
- View Target Location

Variables

- Floor Plate Location
- Floor Plate Rotation

Optimized

- View Ratio

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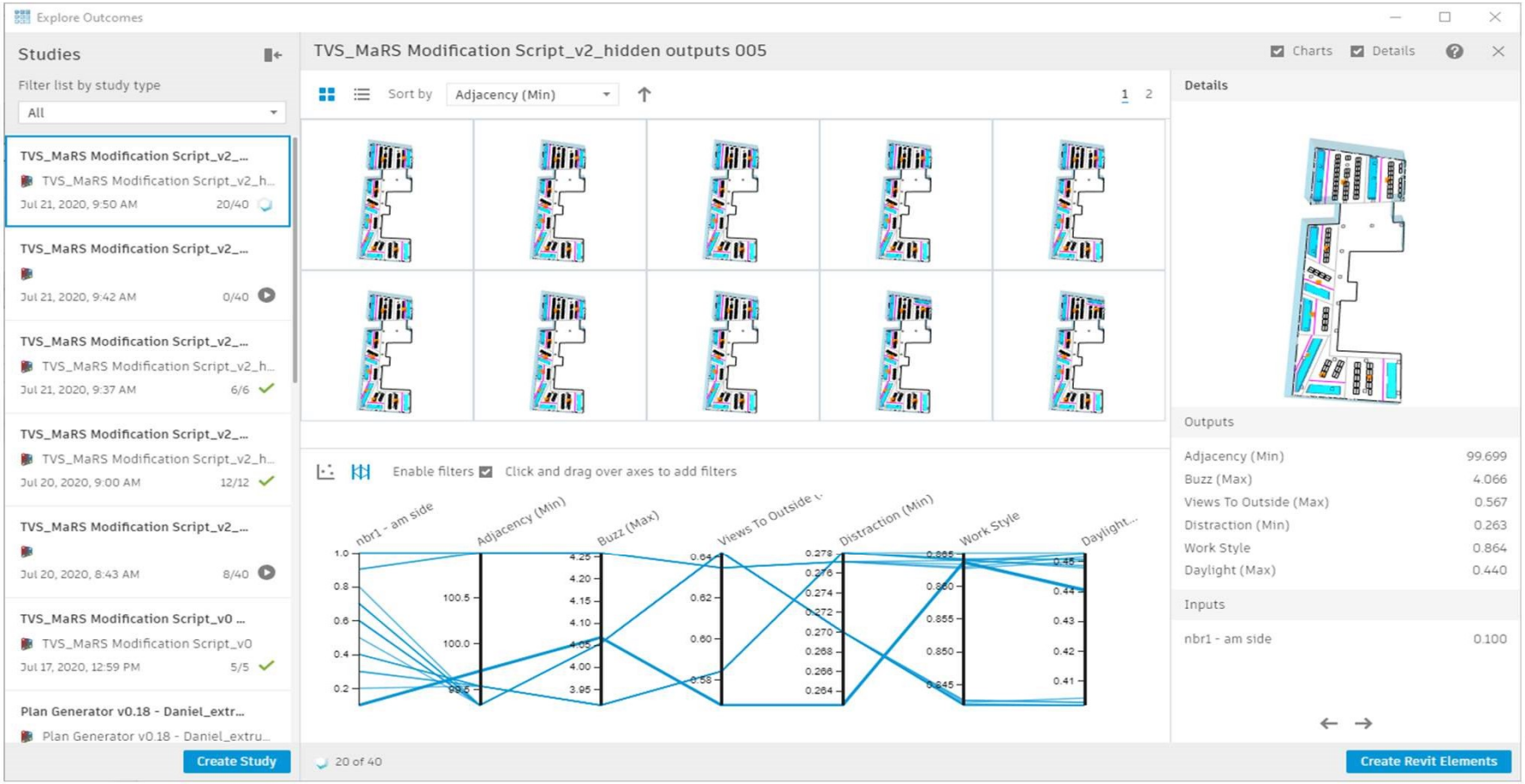
Autodesk Mars Office

Utilizing the dynamo script that was used for the Autodesk Mars office, we brought this design into the Revit 2021 Generative Design program to look at daylighting, views to the outside, workstyle etc.



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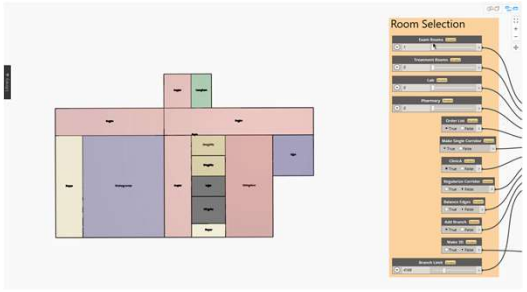
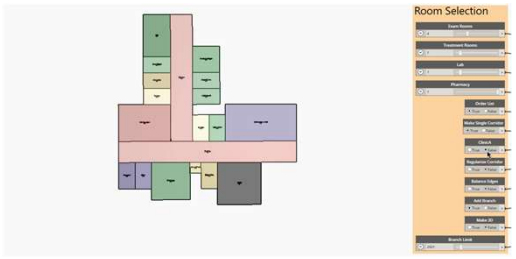
Optimization For Healthcare

Created Generative floor plans for hospital programmatic requirements. Executed a one-to-one relationship for procurement from Revit with Oracle Unifier. Created a Forge BIM viewer





ORACLE for Startups

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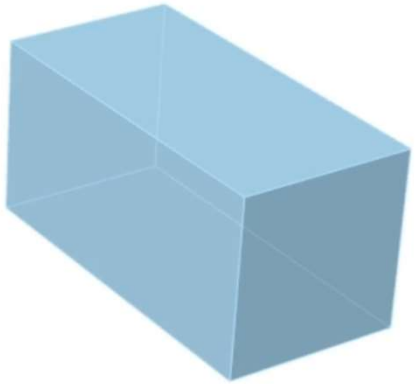
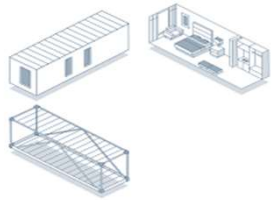
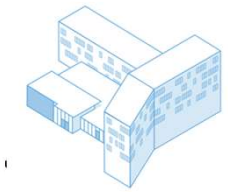
Generative Design For Modular Construction

Assigns modular components including bracing, angles, HSS tubes, brackets, etc. for rapid building prototyping. Takes into client's unique systems, structures, and details.

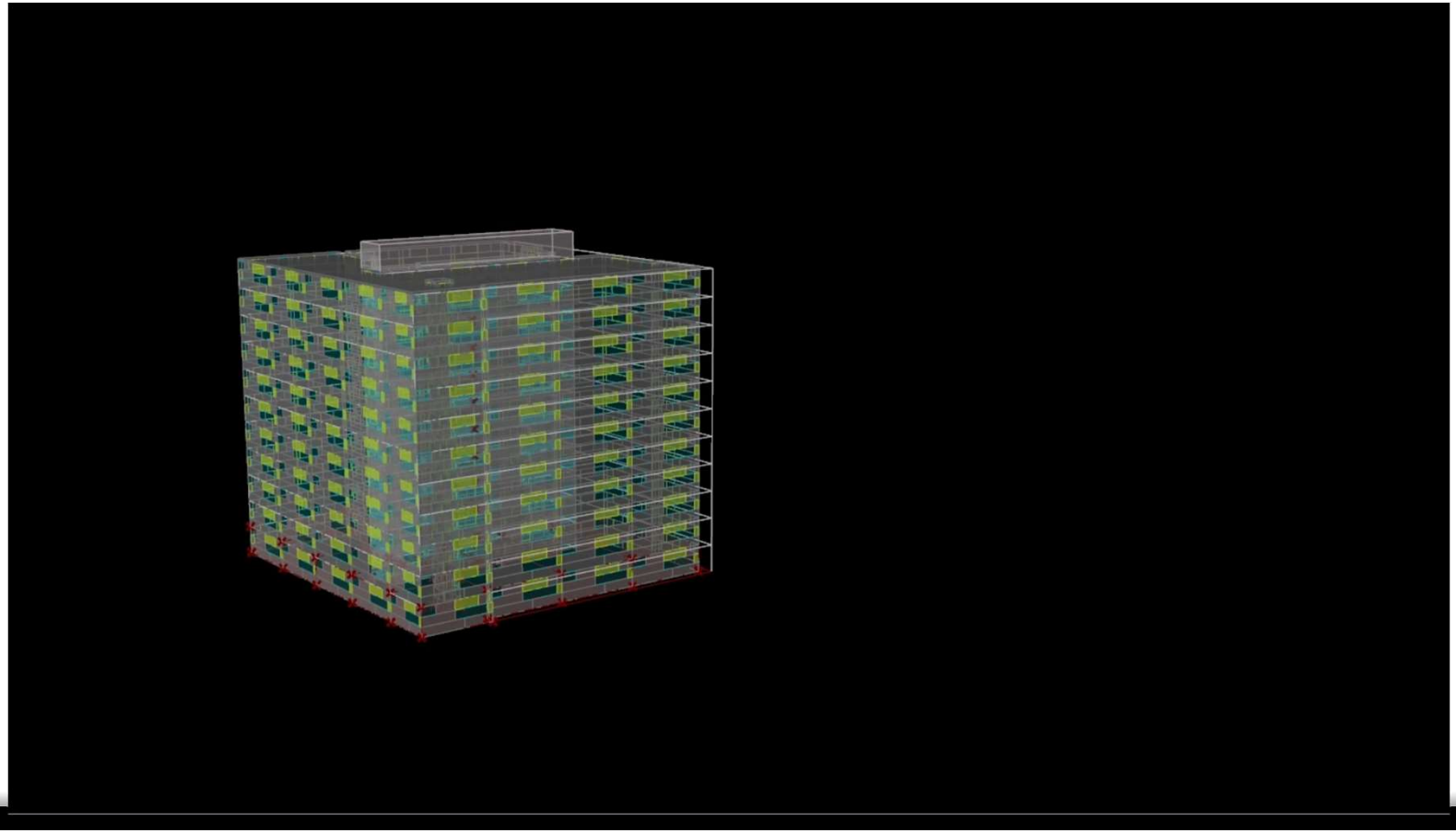


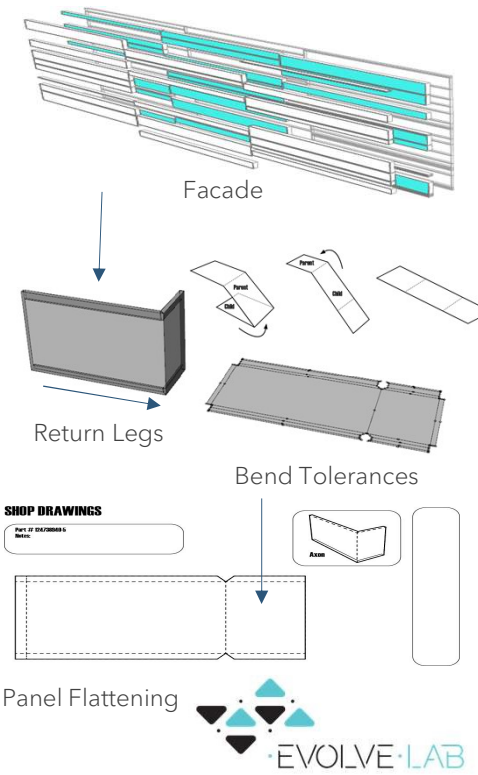




Optimization for Manufacturers

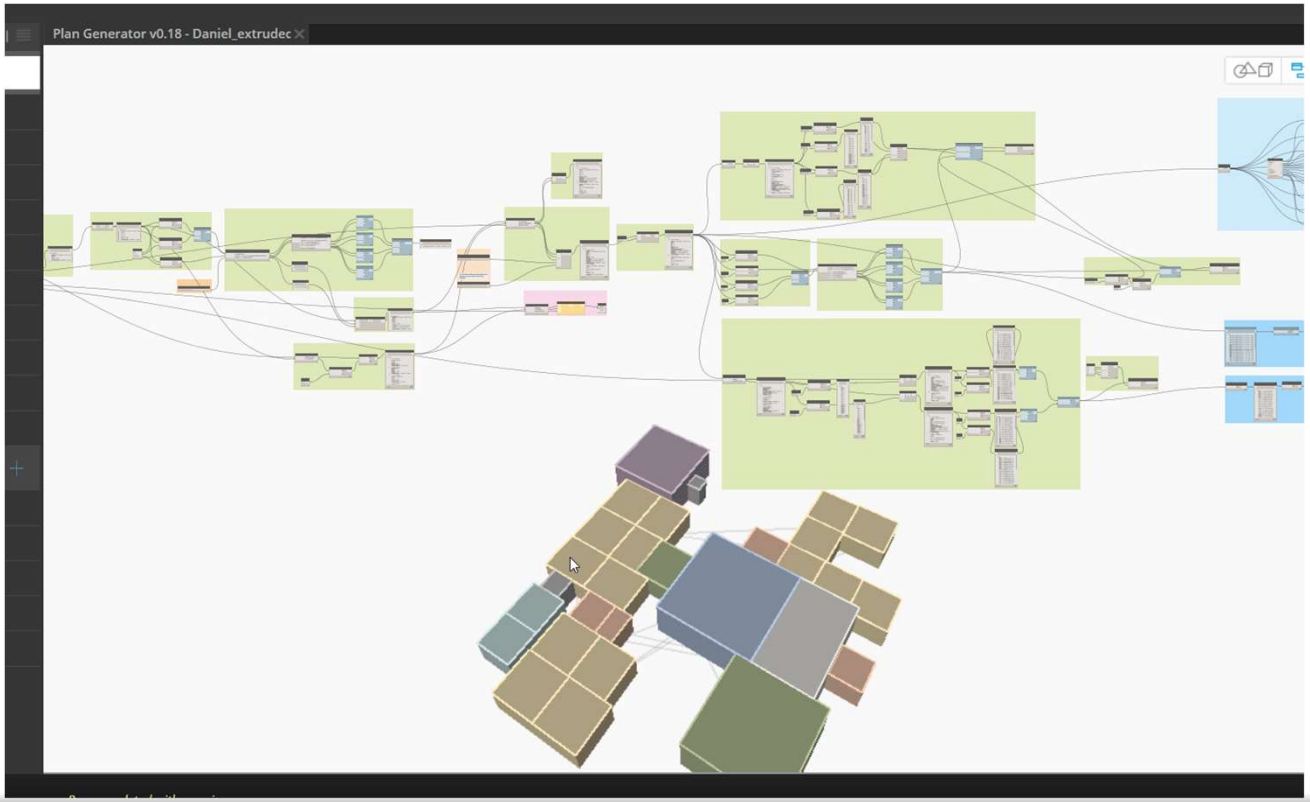
Co-Design process of assigning ACM metal panel, joints, return legs, material, colors, and grain direction. Flattens ACM panel considering bend tolerances and system materials. Upon finishing, creates a bill of materials for the designer.





Optimal Departmental Adjacencies

We developed this Dynamo & Project Refinery example to showcase the power of Generative Design in order to quickly produce multiple design options. The dynamo script chooses a color for each tile for the wall based on the distance between the tile and a tractor point, the percentage of tiles for each color, and how much randomization is inputted. There is no optimal solution, instead the Generative Process outputs a range of options to be then evaluated by the Designers and chosen based on the desired aesthetics.



Fixed Inputs

- Wall Face
- Face Tile Subdivision

Variable Inputs

- Attractor point location (U & V placement at face, 0 to 1)
- Percentage of tiles to be color (20% to 80%)
- Randomness modifier (0 to 1)

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Tile Optioneering

We developed this Dynamo & Project Refinery example to showcase the power of Generative Design in order to quickly produce multiple design options. The dynamo script chooses a color for each tile for the wall based on the distance between the tile and a tractor point, the percentage of tiles for each color, and how much randomization is inputted. There is no optimal solution, instead the Generative Process outputs a range of options to be then evaluated by the Designers and chosen based on the desired aesthetics.

Fixed Inputs

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Variable Inputs

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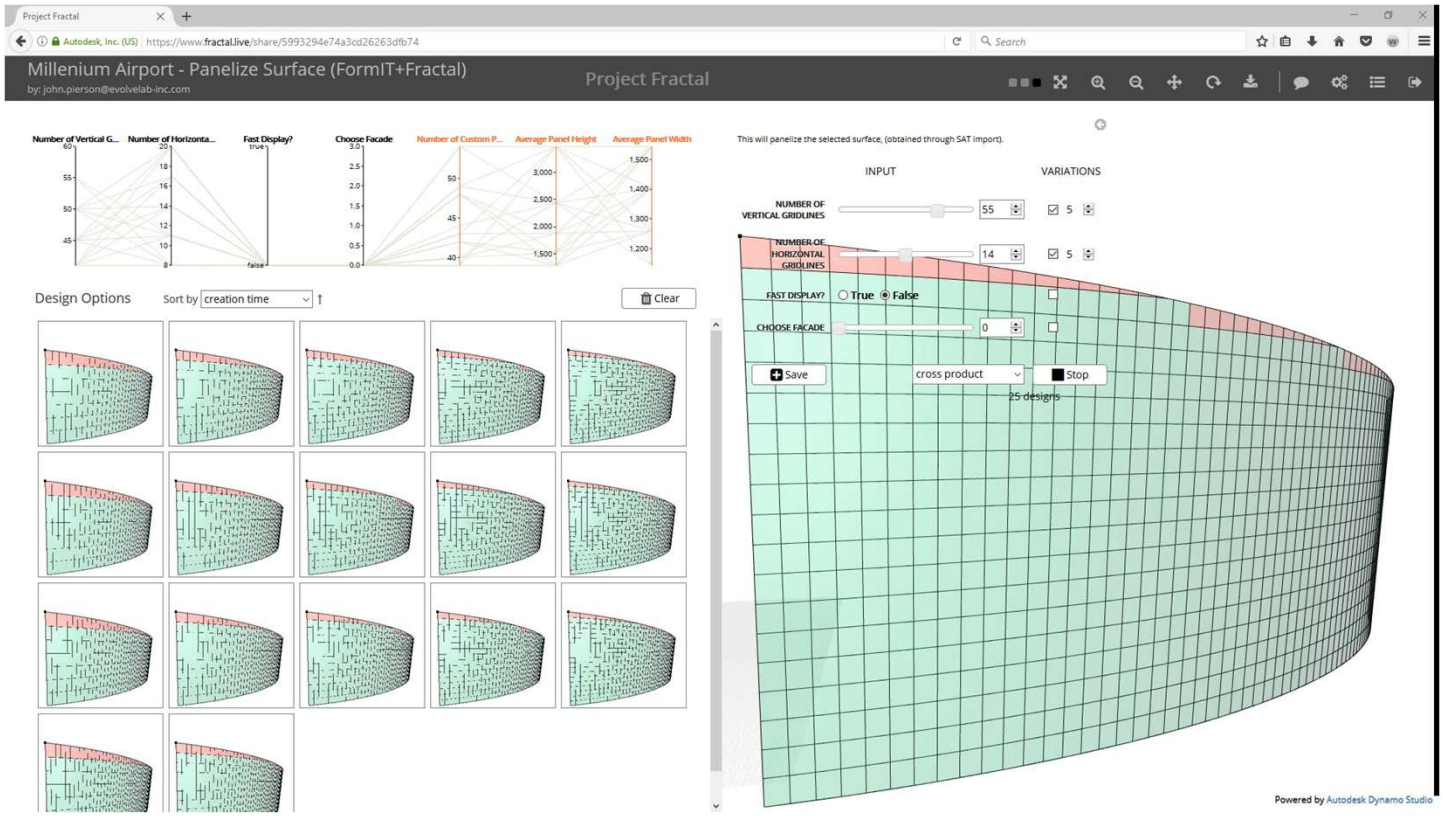
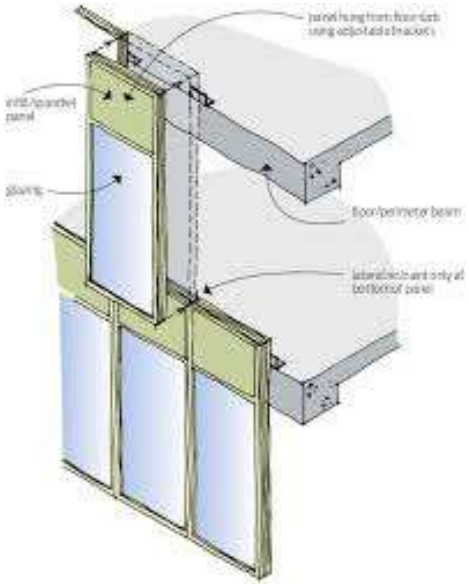
Optimization For Millennium Airport

In this confidential airport project, we were hired to assist with the designing of the exterior façade based on the specified optimization criteria. The application allows flexing of curtain grid spacing, average panel height controls, and most importantly, optimizing the number of custom panels.





Unitized Curtainwall

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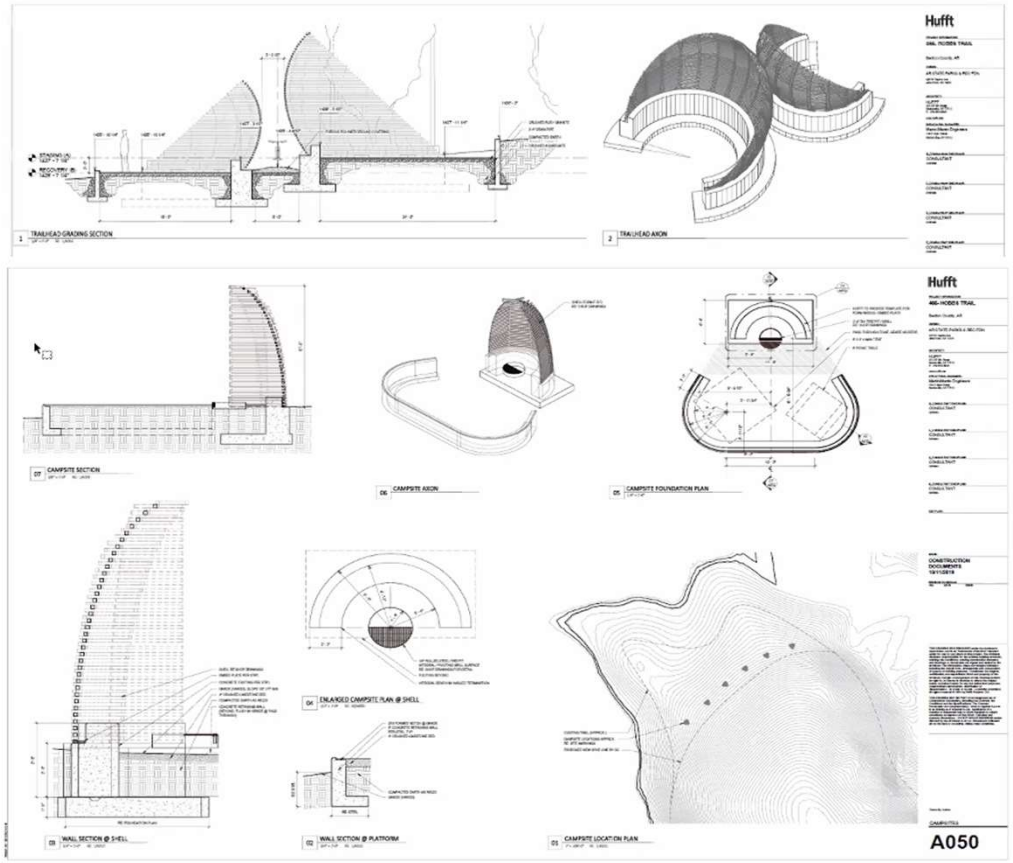
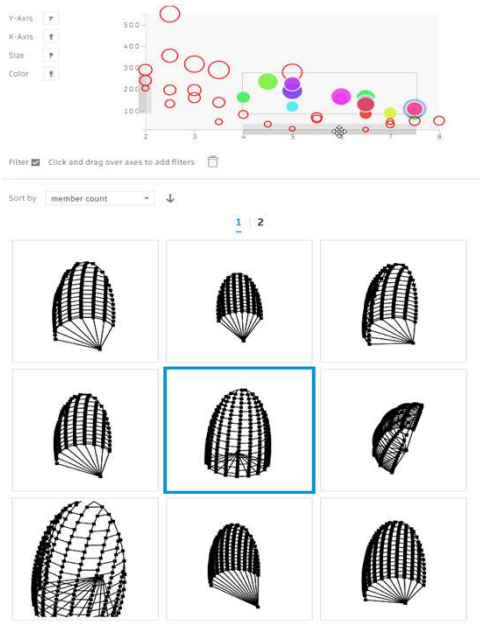
Optimization For Structural Design

Another EvolveLAB also recently completed the Hobbs trail project for Hufft Design in Kansas City. We went through and set up the scrips to optimize standard tube lengths, bracket connections, and intersecting terminations. The whole process was executed and optimized using Refinery.





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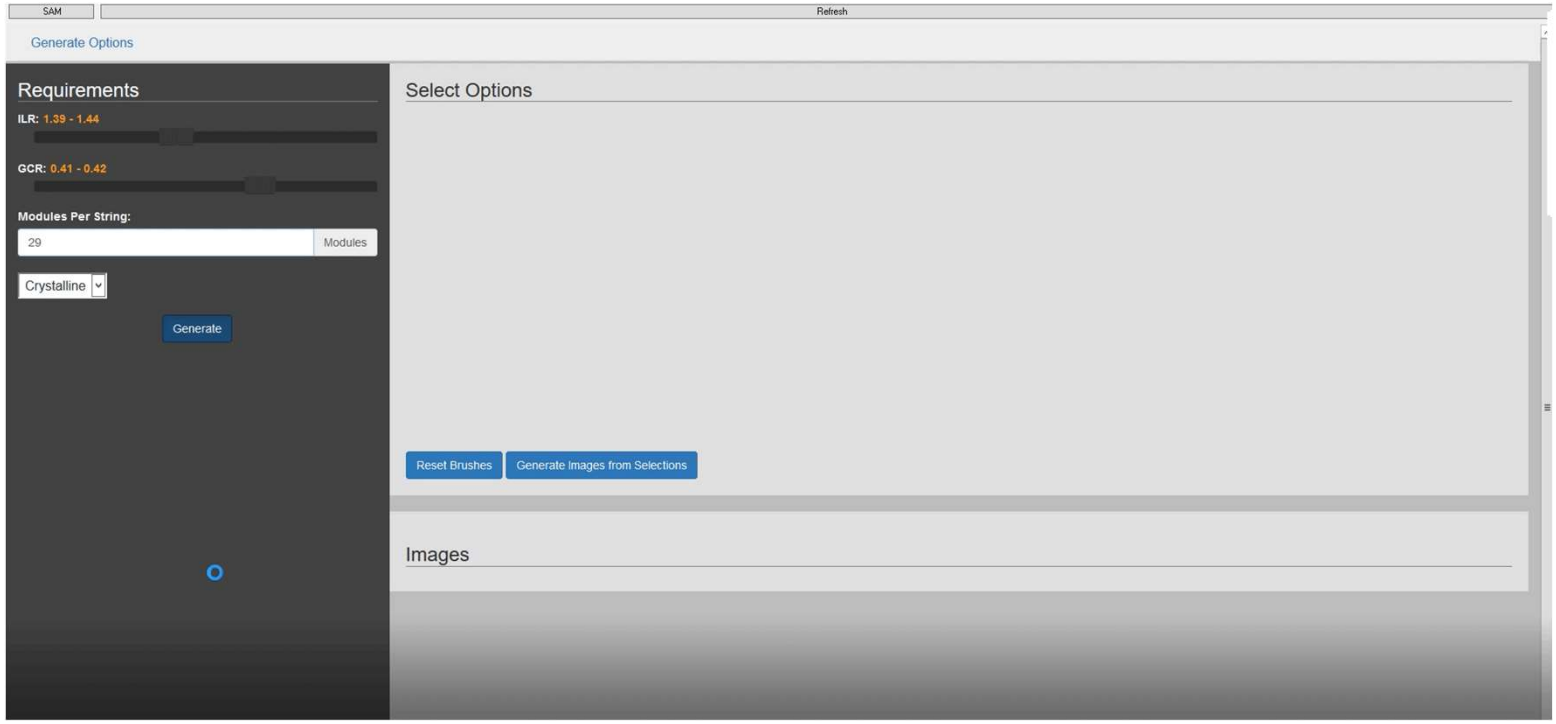
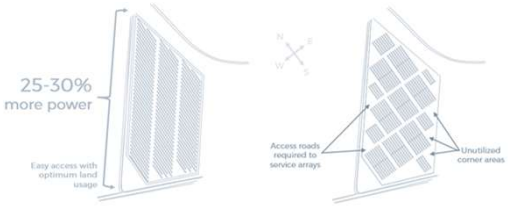
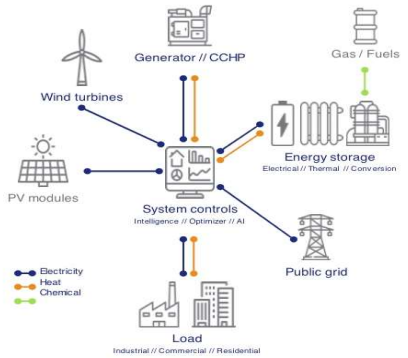
Optimization For Solar Design

Another example of optioneering was a project for Mortenson Construction and their solar design group. We built a custom parallel coordination graph that displays data specific to solar design. This gave their engineers the ability to optimize their site based on the power requirements and density of solar panels.







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Take-Away

If you are an employer

- Invest in people. Find the best talent in the industry, and hire them. Hire people smarter than you.
- Invest in Research and Development.

If you are an employee

- Invest in yourself. There are plenty of resources on website blogs, LinkedIn Learning, Lynda.com, etc.
- Learn to Code, even if it's only visual programming.
    - Digital Fabrication and Robotics
    - Data Driven Design
- Become the expert, and bring the information back to your firm
- Don't wait for someone to ask you

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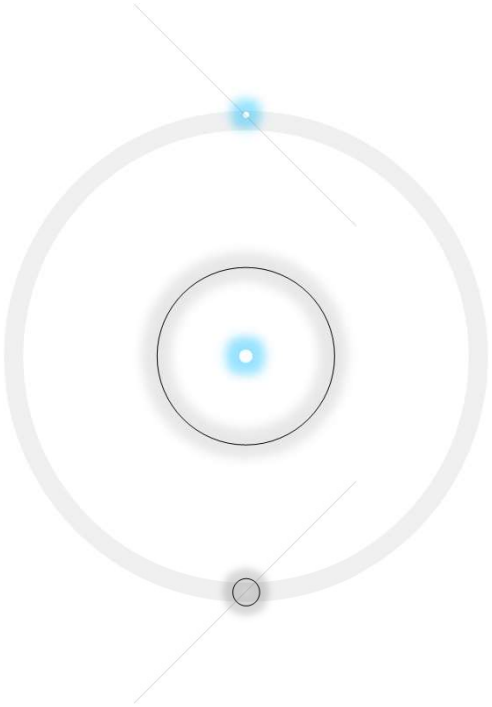

Thank You

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