

# The Business Value of Computational and Generative Design for Executives

Emily Bisaga Dunne

Industry Outcomes Lead, Building Design | @DunneDesignTech



# Emily Bisaga Dunne

## About

- Industry Outcomes Lead, Building Design at Autodesk
- Previously Architecture Technical Evangelist
- Specializing in AEC Industry Strategy, Technology and Design
  - 10+ years experience, based in the Boston



[@DunneDesignTech](https://twitter.com/DunneDesignTech)



<https://www.linkedin.com/in/emily-bisaga-dunne-b553a642/>



# Special Thanks

To the following all-stars:

- Kyle Bernhardt – Director, Building Design Strategy
- Michael Gustafson - Senior Industry Strategy Manager, Structural Engineering & Fabrication
- Zach Kron – Senior Product Manager, Generative Design
- Lilli Smith – Senior Product Manager, Generative Design
- Jacob Small – Designated Support Specialist, Computational / Generative Design
- Dieter Vermeulen – Technical Sales Specialist, AEC
- Phil Bernstein – Associate Dean at Yale School of Architecture,  
Architecture Design Data Author

# About This Course

## **The Business Value of Computational and Generative Design for Executives**

In this presentation, we'll examine the business value of computational and generative design for your company by reviewing a comparative analysis of design processes, including covering Dynamo, Refinery, and Revit software.

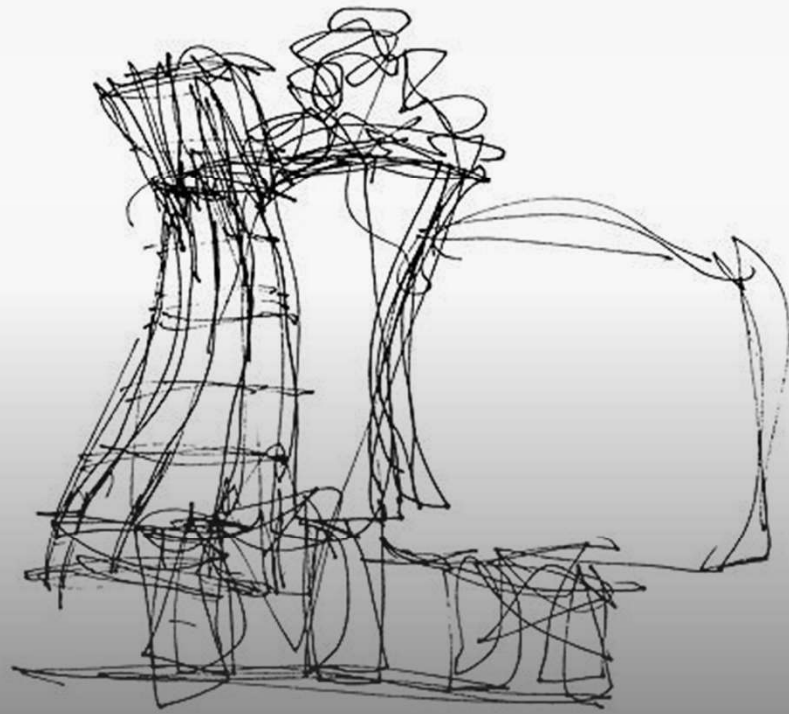
### **Learning Objectives:**

- Gain complete understanding of computational and generative design
- Review a comparative value analysis of business processes
- Learn how to compellingly sell clients on BIM + solution for value add in future projects
- Learn about the implementation process in a project



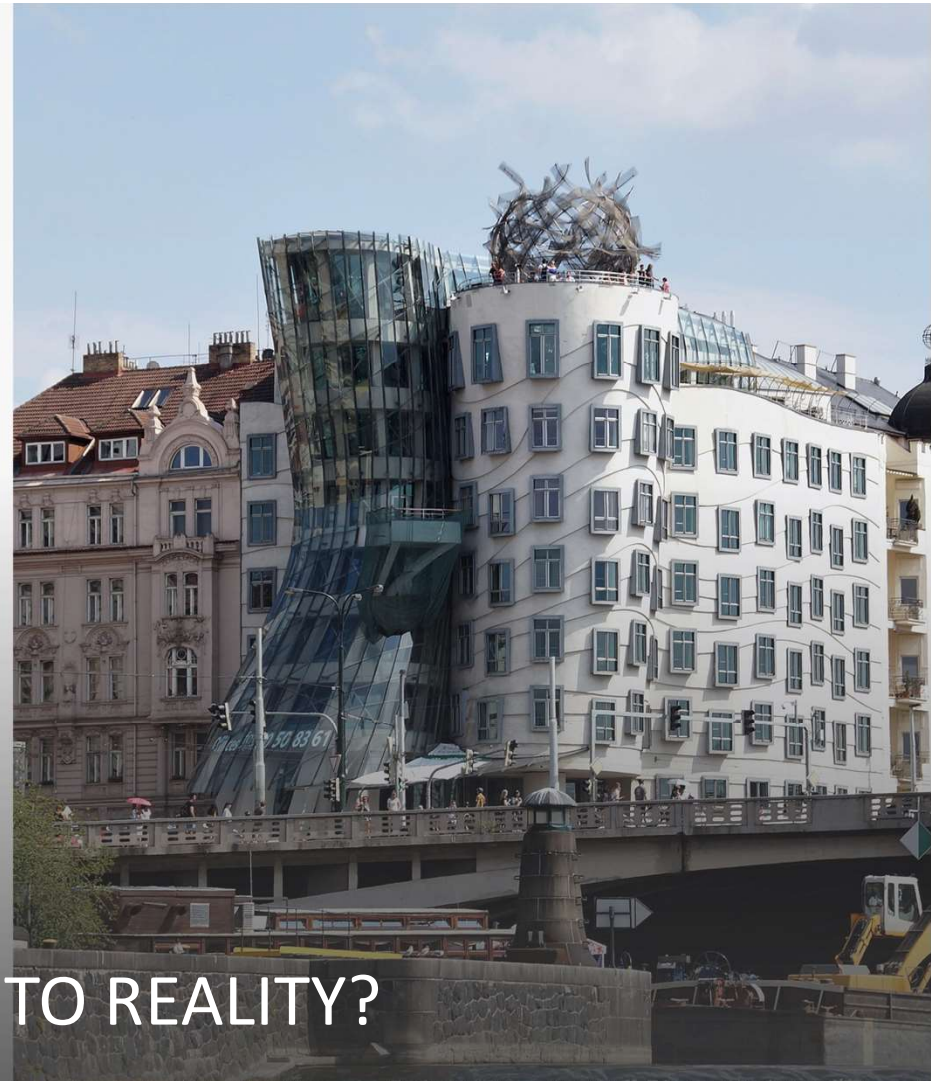


The Autodesk vision is to help people imagine,  
design, and create a better world.



# HOW DO WE GET FROM IDEA TO REALITY?

Image Courtesy of Telegraph.Co.Uk.



# The Evolution of Ideation in Architecture

## Found Materials

- On-site Ideation



## Manual Drawing

## Manual Modeling



(Drawing and modeling do not happen at the same time)



# The Evolution of Ideation in Architecture

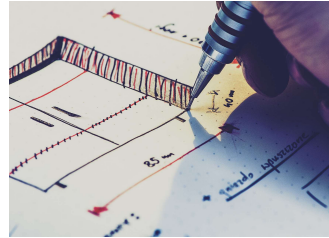
## Found Materials

- On-site Ideation



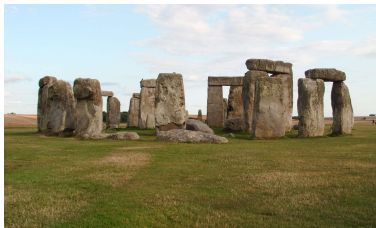
## Paper Innovation

- Previous +
- Mobile Ideation
- Offsite Ideation



Manual Drawing ➡ Manual Drawing

Manual Modeling ➡ Manual Modeling



(Drawing and modeling do not happen at the same time)

# The Evolution of Ideation in Architecture

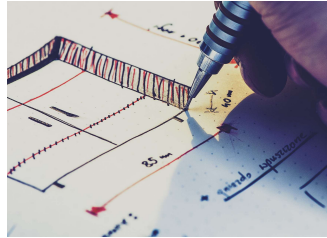
## Found Materials

- On-site Ideation



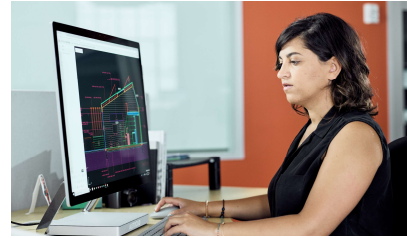
## Paper Innovation

- Previous +
- Mobile Ideation
- Offsite Ideation



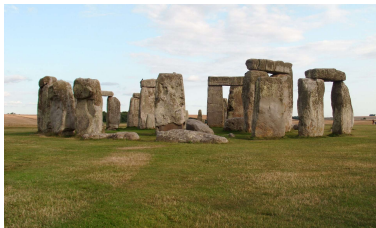
## Computing Innovation

- Previous +
- Extended Drawing & Modeling Capabilities



Manual Drawing → Manual Drawing → Digital Drawing

Manual Modeling → Manual Modeling → Digital Modeling



(Drawing and modeling do not happen at the same time)

# The Evolution of Ideation in Architecture

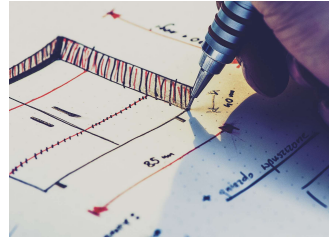
## Found Materials

- On-site Ideation



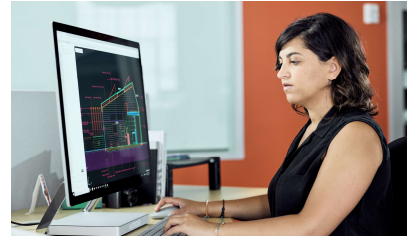
## Paper Innovation

- Previous +
- Mobile Ideation
- Offsite Ideation



## Computing Innovation

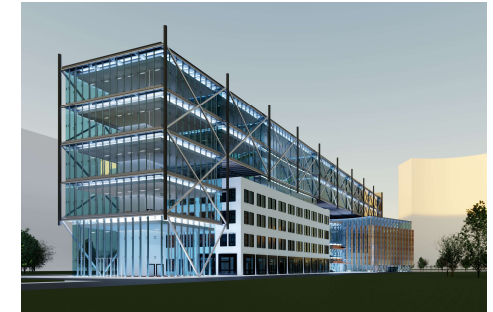
- Previous +
- Extended Drawing & Modeling Capabilities



## Hardware and Software Innovation

- Previous +
- Integrated Modeling, Drawing, Enhanced Visualization & Calculated Insights

## Building Information Modeling With Parametric Design



Manual Drawing



Manual Drawing



Digital Drawing



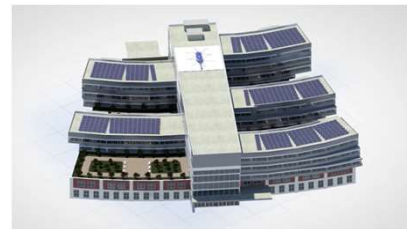
Manual Modeling



Manual Modeling



Digital Modeling



(Drawing and modeling do not happen at the same time)

**BIM**  
Single Source of  
Truth for Ideas

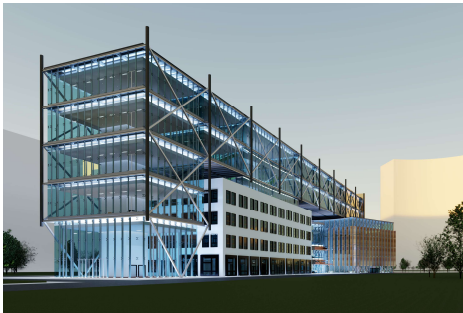
(Drawing and modeling happen at the same time)

# Next Gen Ideation Evolution

## Hardware and Software Innovation

- Previous +
- Integrated Modeling, Drafting, Enhanced Visualization & Calculated Insights

Building Information Modeling  
With Parametric Design



**BIM**

Single Source of  
Truth for Ideas

(Drawing and modeling happen at the same time)

## Cloud Computing Innovation

- Previous +
- Immersive **Visualization**
- Enhanced Collaboration with **Project Delivery**



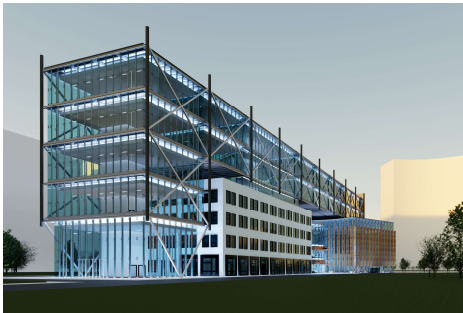


# Next Gen Ideation Evolution

## Hardware and Software Innovation

- Previous +
- Integrated Modeling, Drafting, Enhanced Visualization & Calculated Insights

## Building Information Modeling With Parametric Design



### BIM

Single Source of Truth for Ideas

(Drawing and modeling happen at the same time)

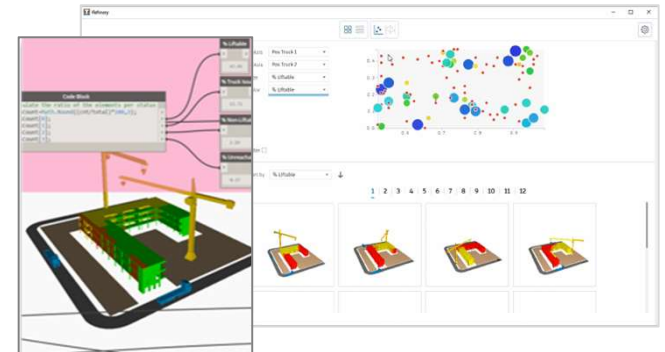
## Cloud Computing Innovation

- Previous +
- Immersive **Visualization**
- Enhanced Collaboration with **Project Delivery**



## Hardware and Software Innovation

- Previous +
- Automating design processes with **Computational Design**
- Optimization of designs through option generation and selection with **Generative Design**



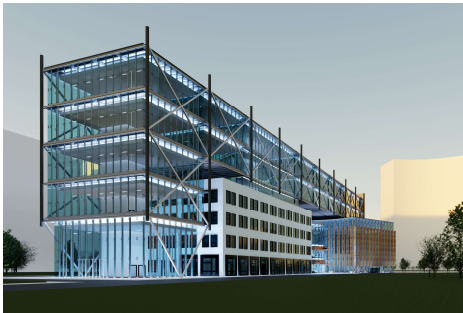


# Next Gen Ideation Evolution

## Hardware and Software Innovation

- Previous +
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## Building Information Modeling With Parametric Design



### BIM

Single Source of Truth for Ideas

(Drawing and modeling happen at the same time)

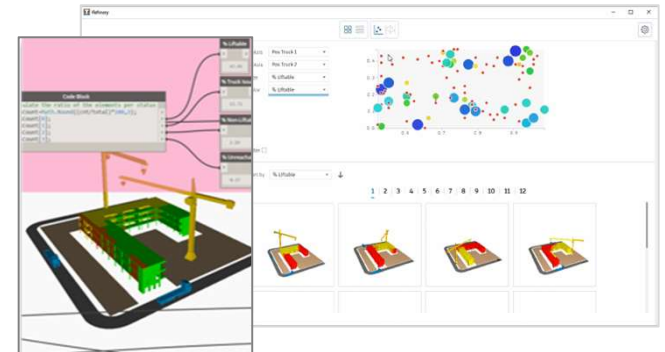
## Cloud Computing Innovation

- Previous +
- Immersive **Visualization**
- Enhanced Collaboration with **Project Delivery**



## Hardware and Software Innovation

- Previous +
- Automating design processes with **Computational Design**
- Optimization of designs through option generation and selection with **Generative Design**



## Artificial Intelligence Innovation

- Previous +
- Predicting design goals, models, drawing and project outcomes with **Predictive Design**

(Processes integrate with BIM)

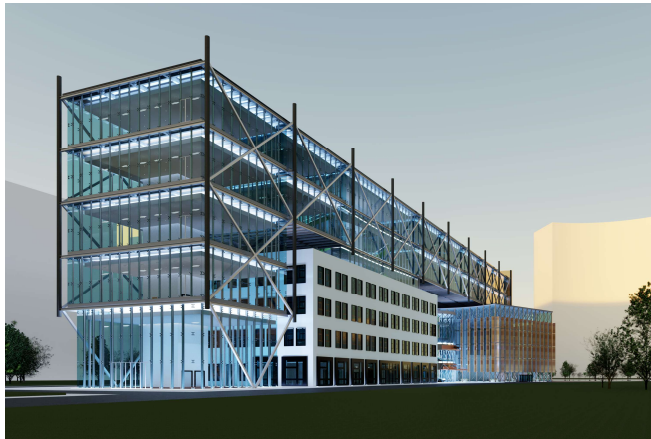


Hi, how can I help?

# Expanding Capabilities, Extending Outcomes

## BUILDING INFORMATION MODELING

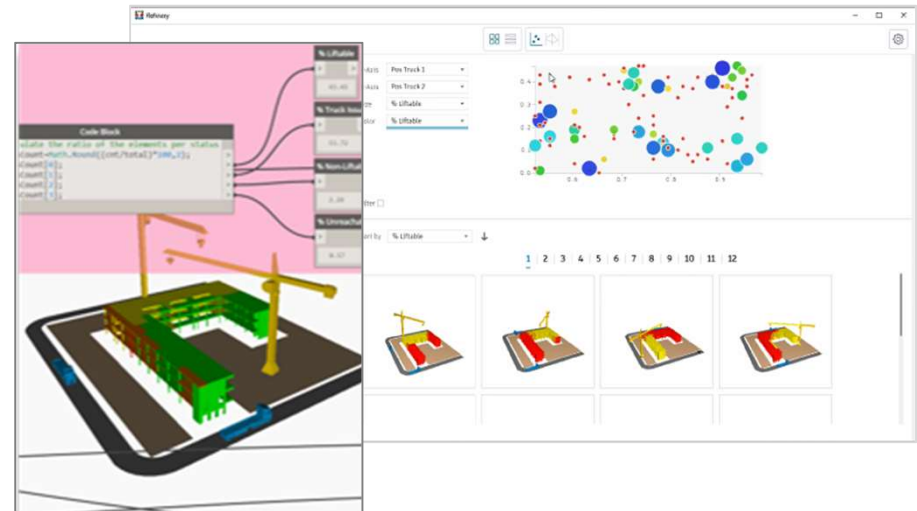
Single Source of Truth for Ideas



- Parametric modeling environment for project data and visualization to create a record of design decisions

## COMPUTATIONAL AND GENERATIVE DESIGN

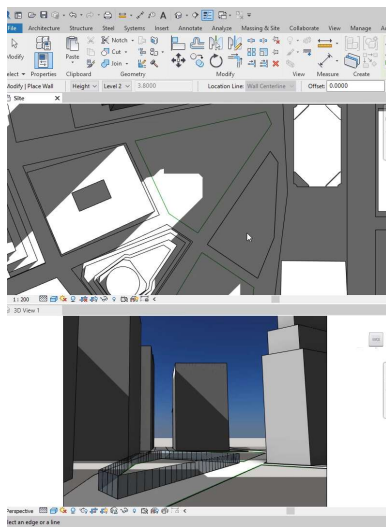
Idea Development, Automation, Generation and Validation



- Visual scripting environment for automating design processes
- Dialogue-driven environment for optimization of designs through option generation and selection

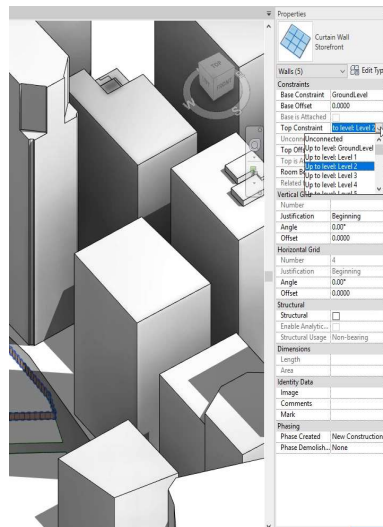
# Conceptual Tower Mass – Building Information Modeling

**AUTODESK®  
REVIT®**



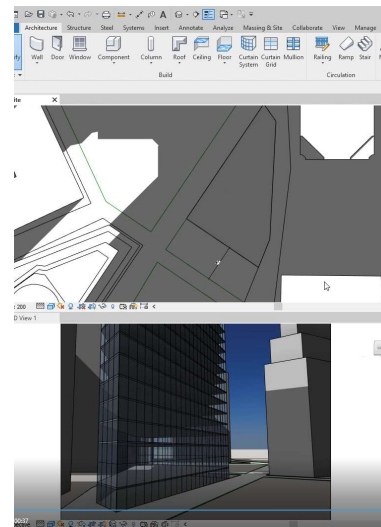
Create Geometry

**AUTODESK®  
REVIT®**



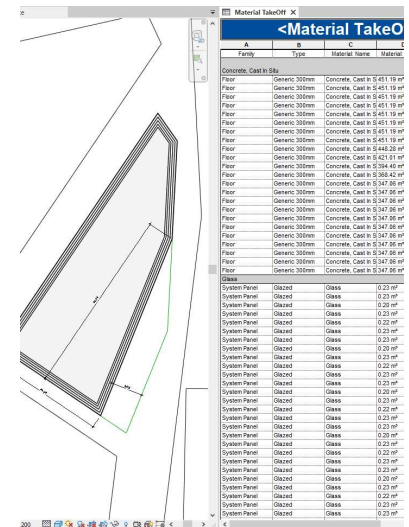
Assign Parametric  
Constraints

**AUTODESK®  
REVIT®**



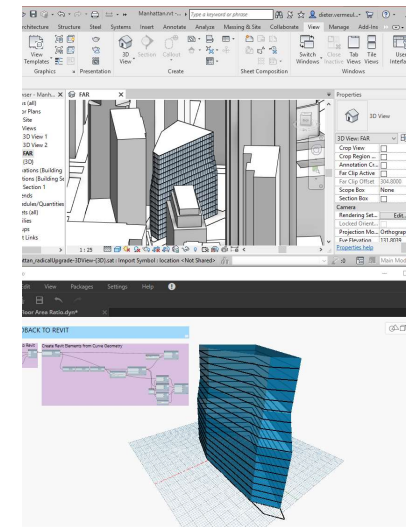
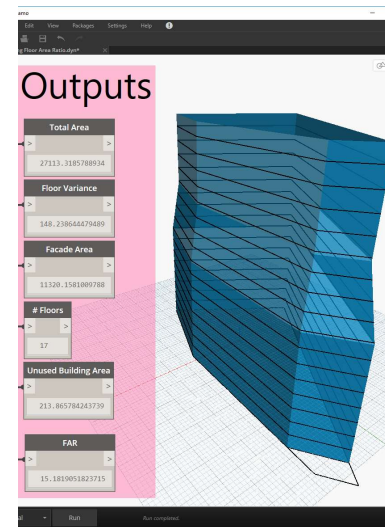
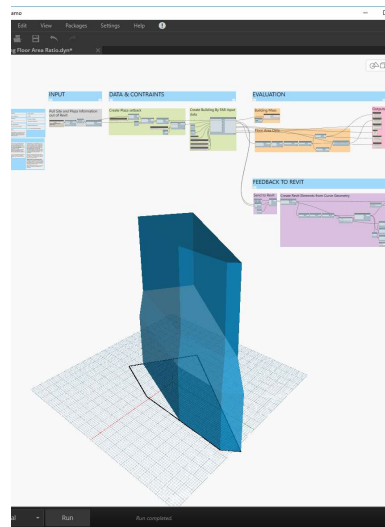
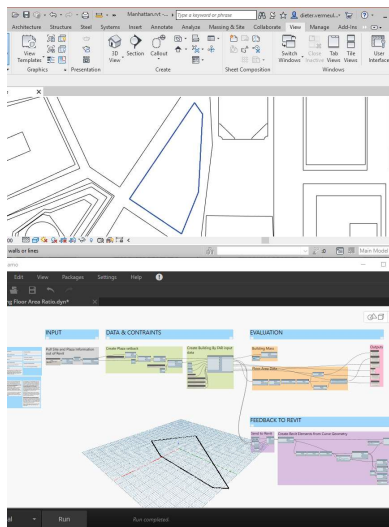
Modify Parameters

**AUTODESK®  
REVIT®**



Document the Idea

# Conceptual Tower Mass - Computational Design



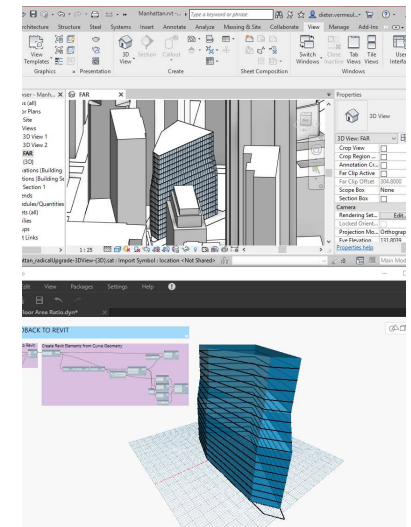
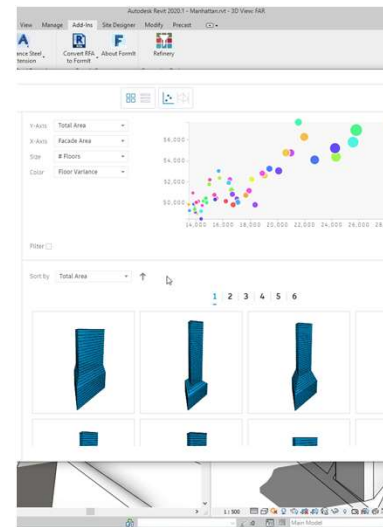
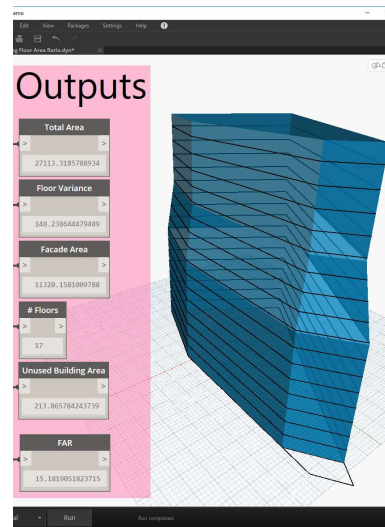
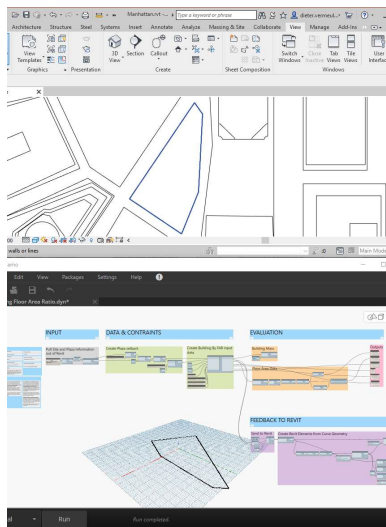
Get Boundaries

Generate  
Geometry

Analyze & Evaluate

Model  
Integration

# Conceptual Tower Mass – Generative Design



Get Boundaries

Computational  
Model

Generate Options

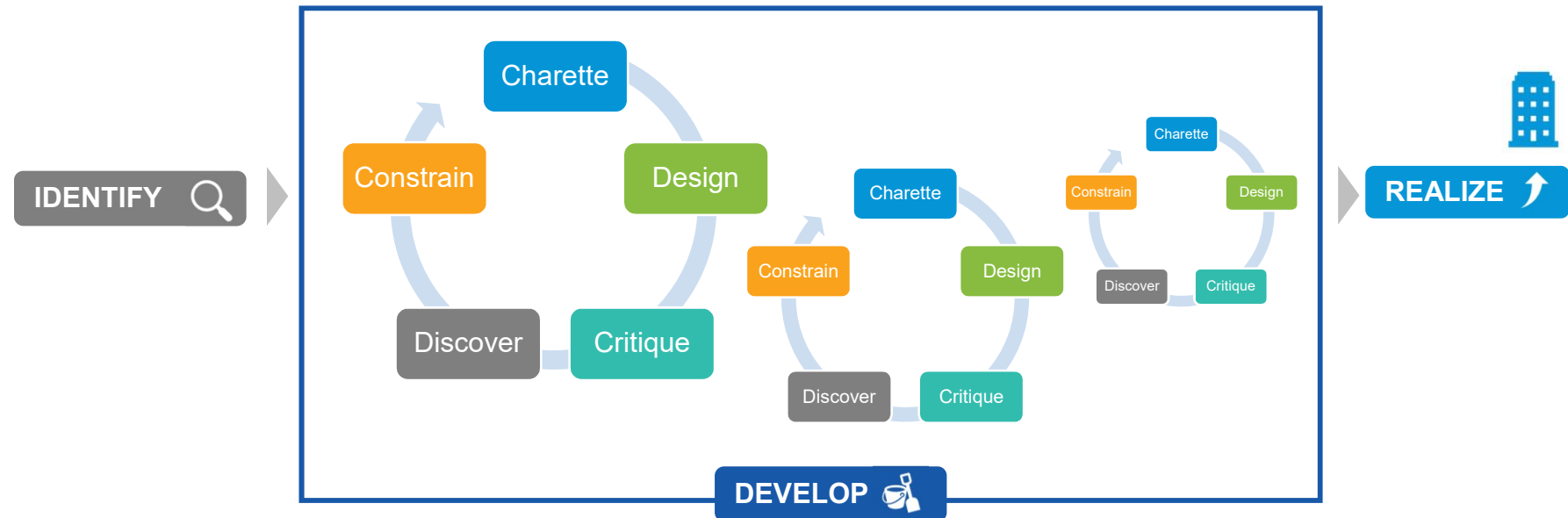
Model  
Integration



# Traditional Project Strategy

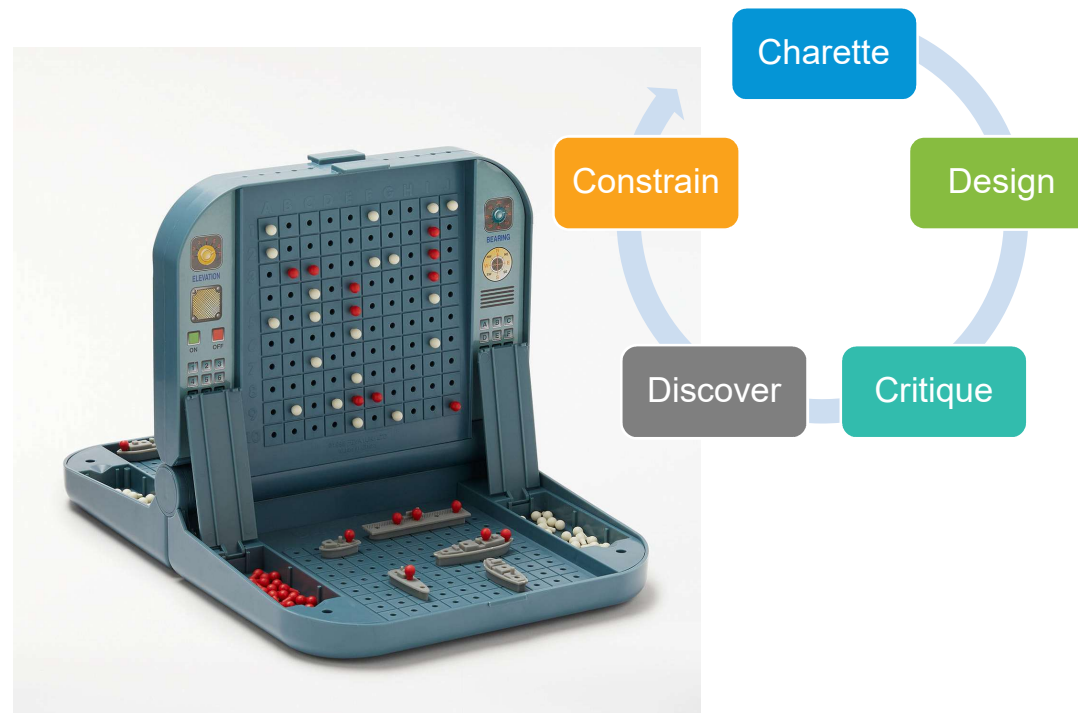
Proactive, reactive – sequences of revelations – focused on one building

## Project Timeline



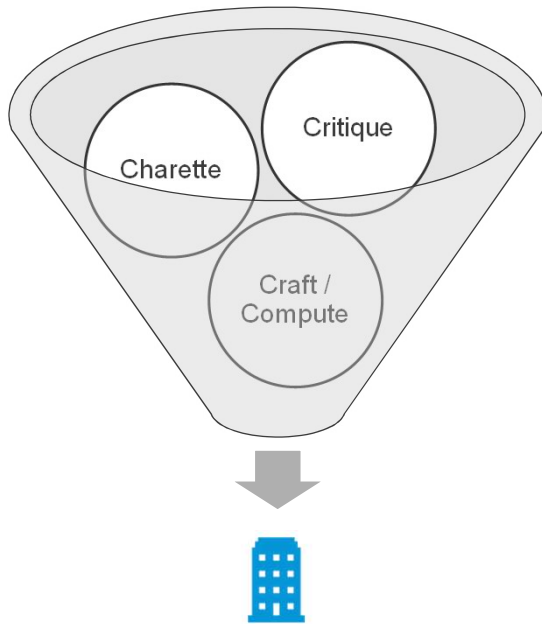
# Traditional Project Strategy

“Combine strategy and luck in this exciting attempt at continuing your project or winning new work with your designs!”

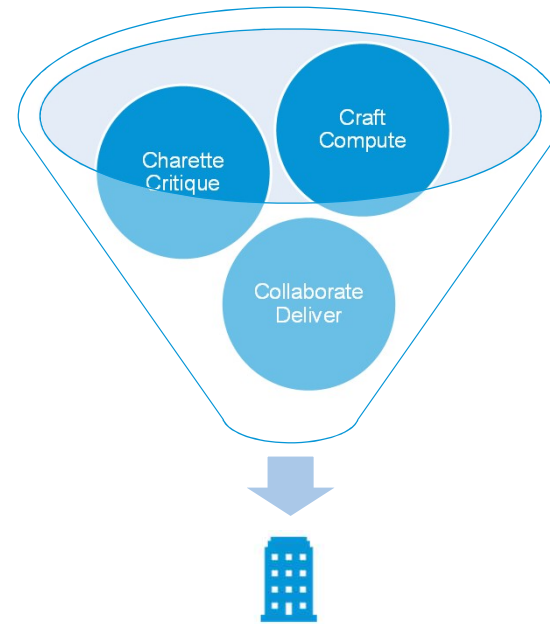


# An Evolving Traditional Project Strategy

## Traditional Design

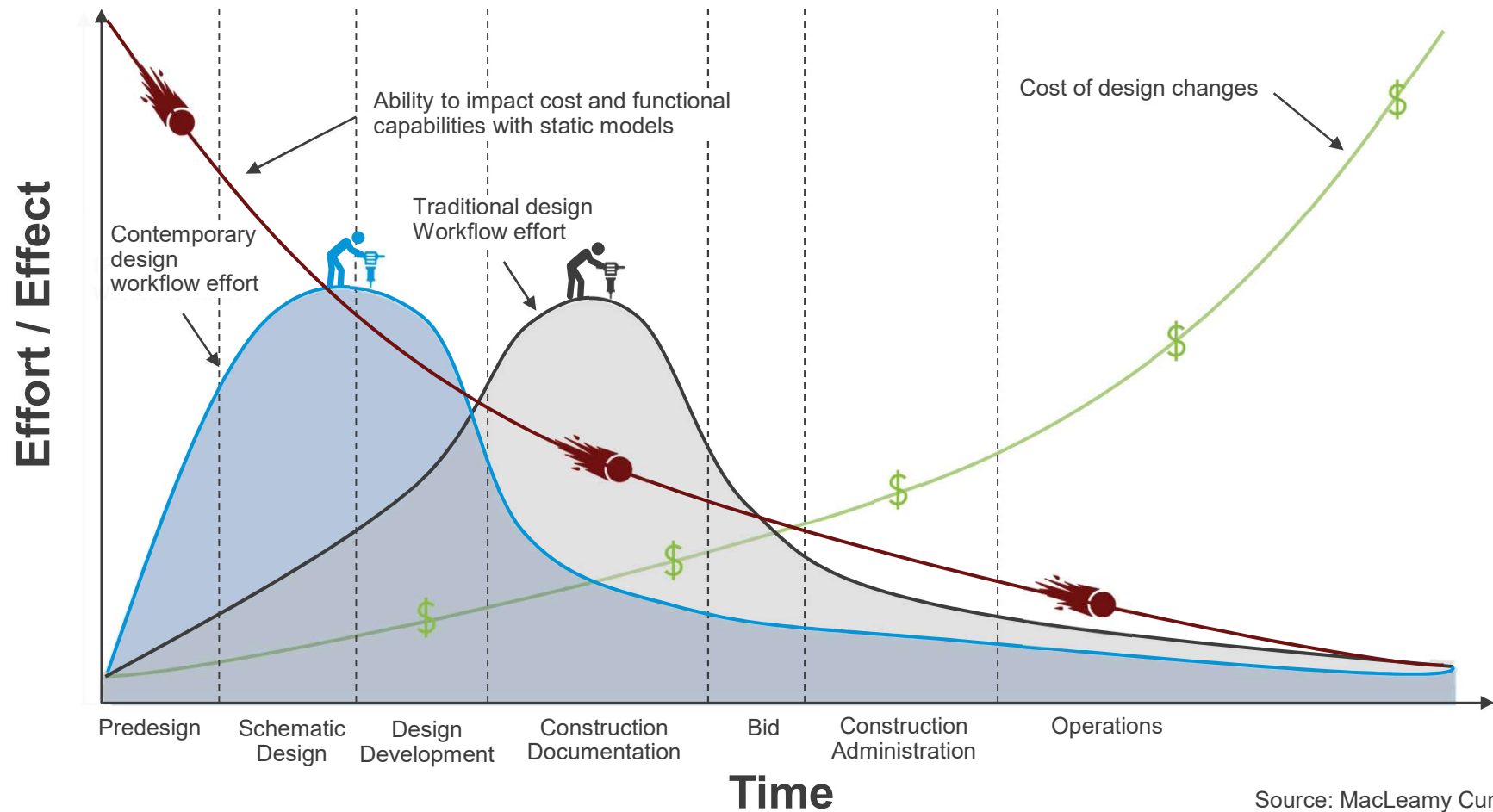


## Contemporary Design





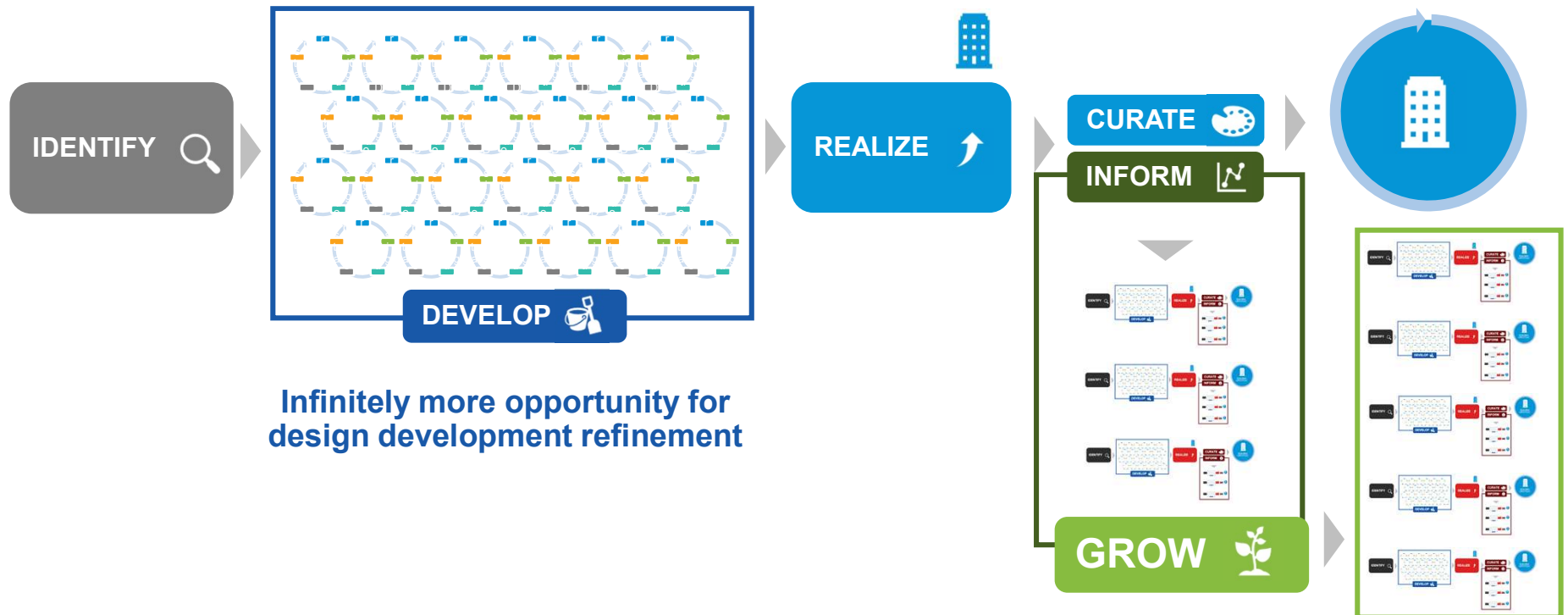
# Comparing Contemporary and Traditional Design Project Strategy



# The Future of Project Strategy

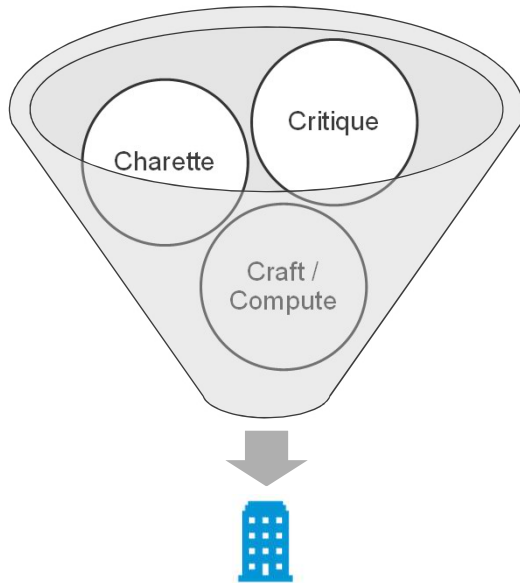
Proactive – informed and flexible – outcome-driven, growth-focused

## Project Timeline

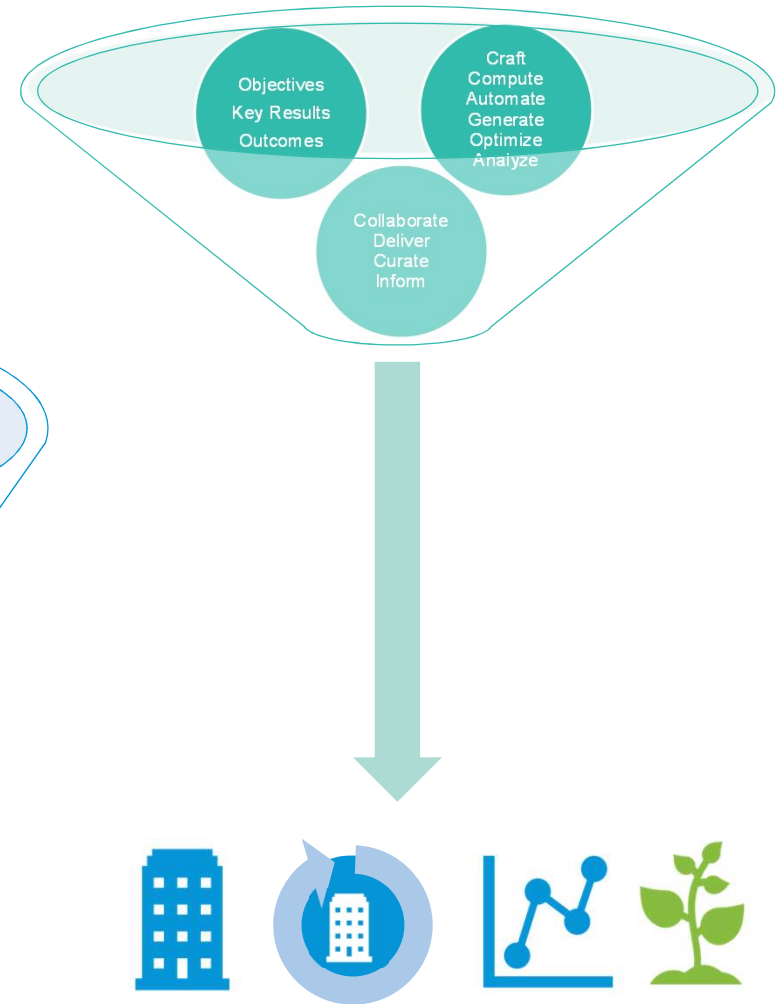
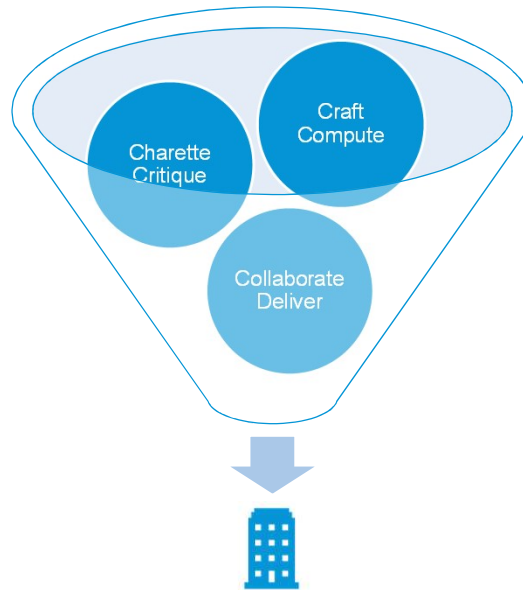


# Outcome-driven Design ▶

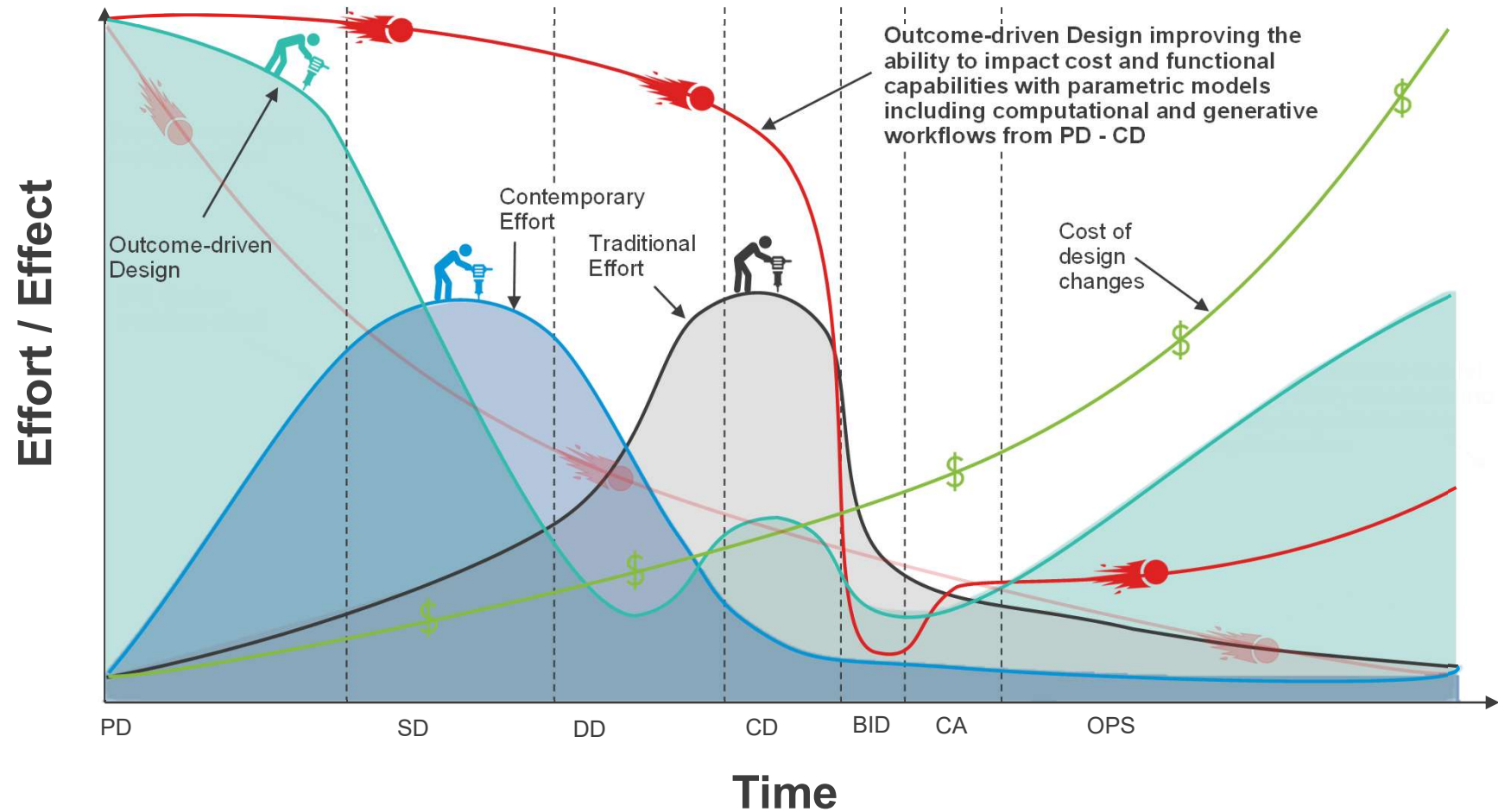
## Traditional



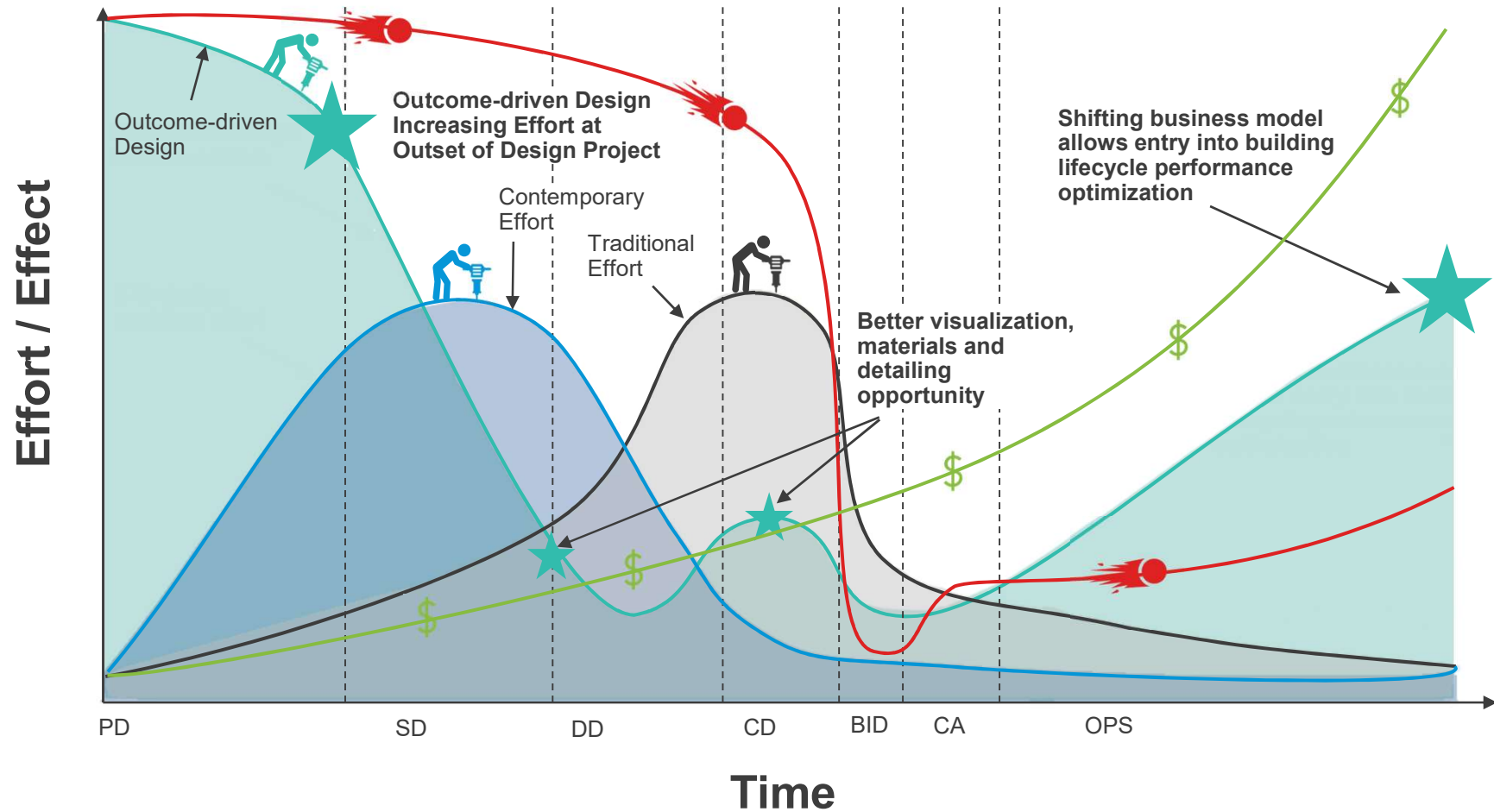
## Contemporary



# Outcome-driven Design: Shifting the Design Paradigm

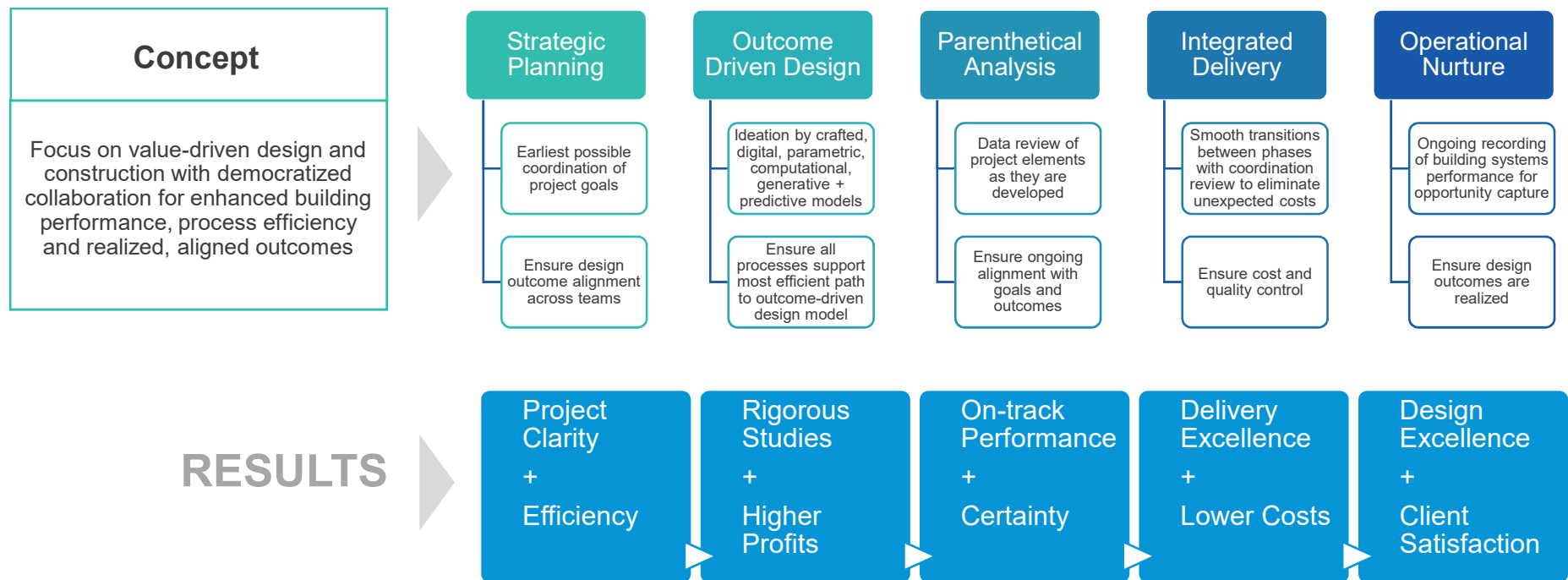


# Outcome-driven Design: Opportunities for Better



# Outcome-driven Design Overview

## KEY COMPONENTS







# In Summary

Computational and Generative Design have influenced project strategy to such a degree that a new project strategy type is unfolding: **Outcome-driven Design**

**Outcome-driven Design** frontloads project effort with the earliest possible stakeholder alignment, eliminates time spent on tedious tasks with inappropriate tools that are not in line with project outcomes and allows for an opportunity to add value at the back end of the design process and inform future projects – all while expanding on traditional and IPD strategies.

**So What? Why is this important?**

**What is the business opportunity?**

# The Pesky Perception of Value Problem



**What my friends think I do.**



**What my society thinks I do.**



**What my parents think I do.**



**What my boss thinks I do.**



**What I think I do.**



**What I actually do.**



# And the Related Salary Problem

## Comparing Value of Architects vs. Lawyers

### Architects

- 110,000 architects / 1:3,000 in US
- Starting salary \$40,000 – \$60,000
- Salary after 5 years \$67,000 - \$85,000

### Lawyers

- 1.3 million attorneys / 1:40 in US
- Starting salary \$54,000 – \$139,000
- Salary after 5 years \$74,000 - \$219,000



## Want a Job? Go to College, and Don't Major in Architecture

Phillip G. Bernstein

# archi tec ture design data

Practice  
Competency  
in the Era  
of Computation

Birkhäuser  
Basel

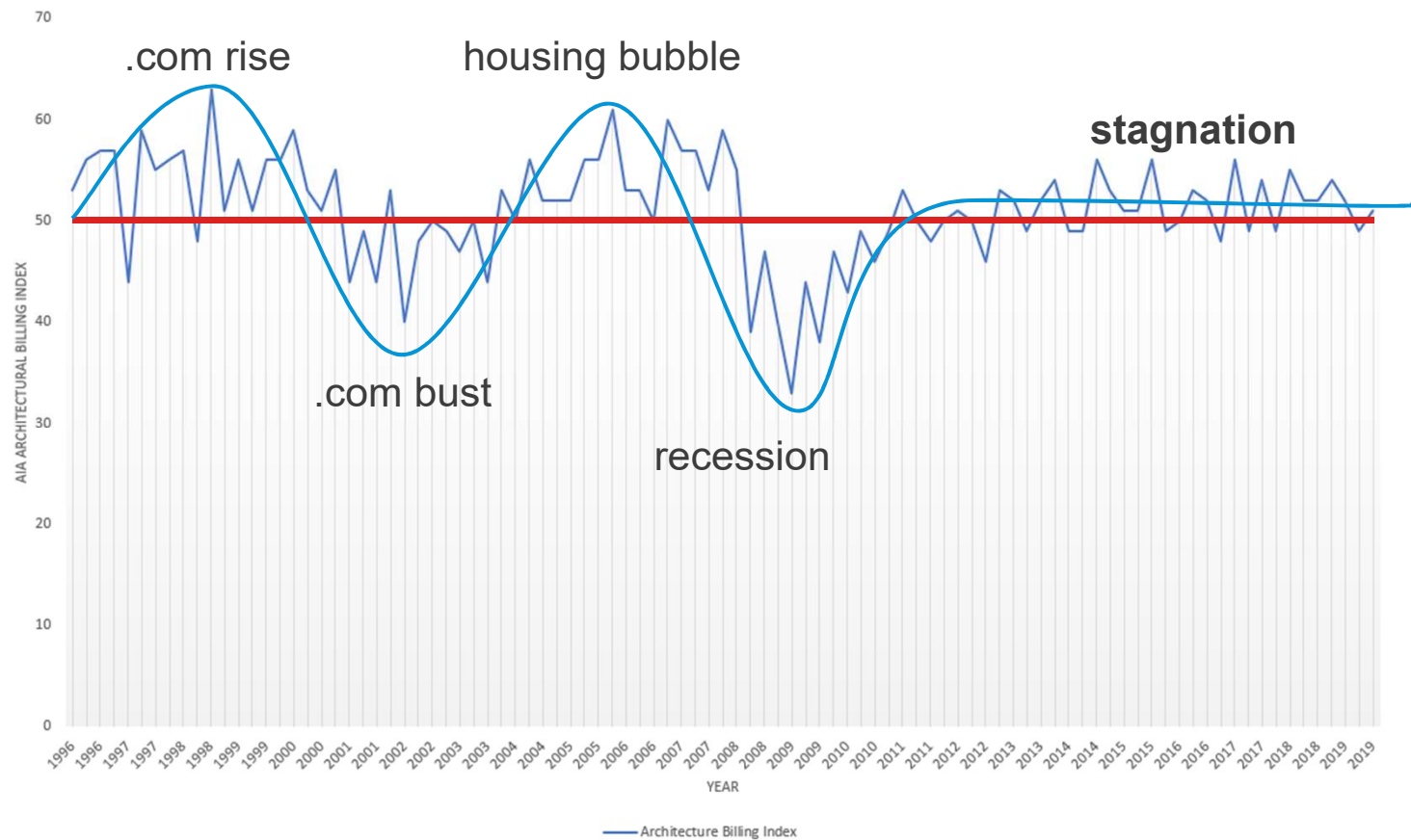
“If architects are a relatively rare commodity (which normally drives up prices) and deliver such important service to society (by creating all of the buildings that it needs to function) **why have we done such a poor job of converting the clear value we deliver into an understanding by clients and the public, and, as a desirable consequence, getting paid accordingly?**”

- Philip G. Bernstein

Source: Architecture Design Data: Practice Competency in the Era of Computation, by Phillip G. Bernstein (Birkhäuser, 2018)



# A Stagnant Architectural Billing Index



# And Recent Architectural Billing Index Woes

Architecture Billings Index dipped: x +

archpaper.com/2019/09/architecture-billings-august-drop/

## The Architect's Newspaper



Search Go

MENU TOPICS ▾ EVENTS COMPETITIONS PRODUCTS JOBS Conferences ▾ Awards Subscribe

NO MONEY, MORE PROBLEMS

### Architecture Billings Index dipped to record lows in August

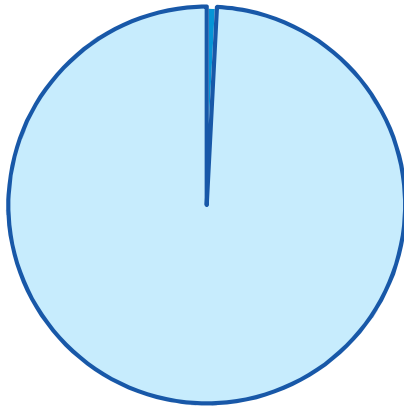
By SYDNEY FRANKLIN • September 23, 2019



Cohesive, cross-category fixture and finish materials that bring beautiful spaces to life, effortlessly.

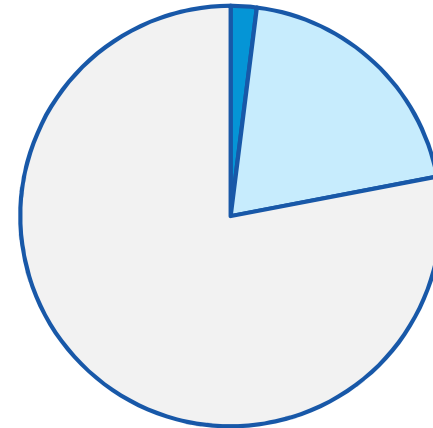
# Fee Structures Reveal Minimal Impact On Project Cost to Increase Compensation for Architects...

Architects' Fees as 10% Percent of Total Design and Construction Costs



■ Architect's Fees ■ Design and Construction Costs

Architects' Fees as .01% Percent of Total Building Lifecycle Costs



■ Design and Construction Costs  
■ Maintenance and Energy Costs  
■ Salaries of Occupants

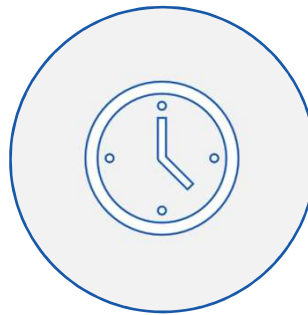
# Amid a Disincentivizing Compensation System...

## Lump Sum / Fixed Fee



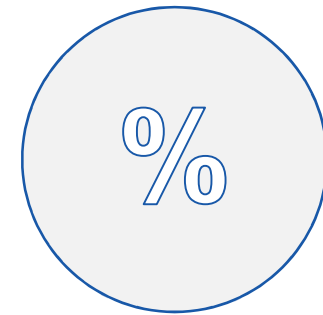
- Scope of services defined comprehensively at outset
- Schedule determined with accuracy
- Fixed price unless project parameters change

## Time Basis / Variable



- Scope of services are difficult to determine or short in duration
- Predesign, partial, additional, conceptual services
- Hourly or per diem

## Percentage-based Fee



- Sliding scale based on construction type
- Not suitable for renovations or highly complex projects



# Producing Inefficient Buildings

Consuming 40% of global energy

Consuming 25% of global water

Consuming 30% of GHG emissions





Excellence in building design  
is practically invaluable.

We in the AEC industry know that the work performed in the design of a building project is extremely valuable.

Our work,  
in it's most traditional execution:

- Reduces project costs
- Improves project timelines
- Leads to the construction of spaces that foster community development and wellness

We are known for going above and beyond and sacrificing our own human needs to ensure that projects are both beautiful and functional to an obsessive and even fanatical degree...



# Architectural Scope of Services

## LEGEND

- Indicates basic services as fee percentage
- Indicates additional services

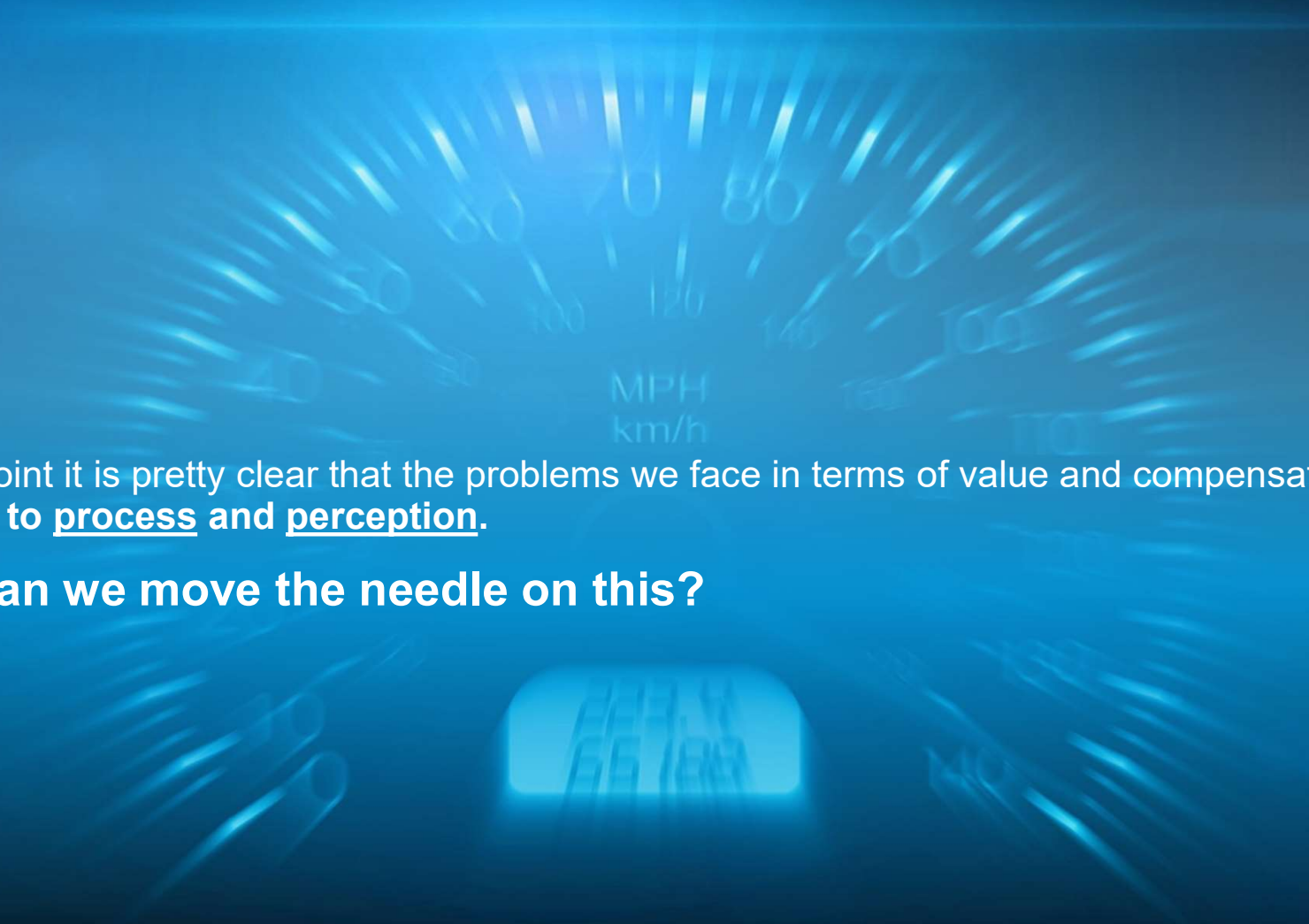
PREDESIGN	SD	DD	CD	BID	CA	OPERATIONS
<b>ARCHITECTURE</b> <ul style="list-style-type: none"> <li>○ Facility Programming</li> <li>○ Space Relationships/</li> <li>○ Flow Diagrams</li> <li>○ Project Development</li> <li>○ Scheduling</li> <li>○ Project Budgeting</li> <li>○ Life Cycle Cost Studies</li> <li>○ Economic Feasibility</li> <li>○ Agency Consulting/</li> <li>○ Review/Approval</li> <li>○ Site Selection/Analysis</li> <li>○ Utilization</li> <li>○ Environmental Studies</li> <li>○ Energy Studies</li> <li>○ Existing Facilities</li> <li>○ Surveys</li> <li>○ Client-Supplied Data Coordination</li> <li>○ Services Related to Project Management</li> <li>○ Presentations</li> <li>○ Marketing Studies</li> <li>○ Special Studies</li> <li>○ Re-Zoning Assistance</li> <li>○ Project Promotion</li> </ul>	<b>ARCHITECTURE</b> <ul style="list-style-type: none"> <li>▪ Client-supplied Data</li> <li>▪ Coordination</li> <li>▪ Program and Budget</li> <li>▪ Evaluation</li> <li>▪ Review of Alternative</li> <li>▪ Design Approaches</li> <li>▪ Architectural Schematic Design</li> <li>▪ Schematic Design Drawings and Documents</li> <li>▪ Statement of Probable Construction Costs</li> <li>▪ Client Consultation</li> <li>○ Interior Design Concepts</li> <li>○ Special Studies (Future Facilities, Environmental Impact, etc.)</li> <li>○ Special Submissions or Promotional Presentations</li> <li>○ Special Models, Perspectives or Computer Presentations</li> <li>○ Project Management</li> <li>○ Agency Consultation</li> </ul>	<b>ARCHITECTURE</b> <ul style="list-style-type: none"> <li>▪ Client-supplied Data</li> <li>▪ Coordination</li> <li>▪ Design Coordination</li> <li>▪ Architectural Design</li> <li>▪ Development</li> <li>▪ Design Development</li> <li>▪ Drawings and Documents</li> <li>▪ Statement of Probable Construction Costs</li> <li>▪ Client Consultation</li> <li>▪ Agency Consultation</li> <li>○ Interior Design</li> <li>○ Development</li> <li>○ Special Studies/Reports (Planning Tenant or Rental Spaces, etc.)</li> <li>○ Promotional Presentations</li> <li>○ Models, Perspectives or Computer Presentations</li> <li>○ Project Management</li> </ul>	<b>ARCHITECTURE</b> <ul style="list-style-type: none"> <li>▪ Client-supplied Data</li> <li>▪ Coordination</li> <li>▪ Project Coordination</li> <li>▪ Architectural Construction Documents (Working Drawings, Form of Construction Contract and Specifications)</li> <li>▪ Document Checking and Coordination</li> <li>▪ Statement of Probable Construction Costs</li> <li>▪ Client Consultation</li> <li>○ Interior Construction Documents</li> <li>○ Alternative Bid Details and Special Bid Documents</li> <li>○ Project Management</li> <li>○ Agency Consultation</li> </ul>	<b>ARCHITECTURE</b> <ul style="list-style-type: none"> <li>▪ Architect's Services</li> <li>▪ Client-supplied Data</li> <li>▪ Coordination</li> <li>▪ Project Coordination</li> <li>▪ Issue Bidding Documents</li> <li>▪ Issue Addenda</li> <li>▪ Bid Evaluation</li> <li>▪ Construction Contract</li> <li>▪ Client Consultation</li> <li>○ Separate Bids or Negotiated Bids</li> <li>○ Services Related to Bidders' Proposals</li> <li>○ Project Management</li> </ul>	<b>ARCHITECTURE</b> <ul style="list-style-type: none"> <li>▪ Field Review</li> <li>▪ Progress Reports/Evaluation</li> <li>▪ Process Certificates for Payment</li> <li>▪ Interpretation of Contract Documents</li> <li>▪ Review of Shop Drawing</li> <li>▪ Product Data/Sample Change Orders</li> <li>▪ Substantial Performance Report and Certification</li> <li>▪ Client Consultation</li> <li>○ Interior Construction review</li> <li>○ Full-time Project Representation</li> <li>○ Administration of Separate Contracts</li> <li>○ Project Management</li> <li>○ Promotional Material</li> <li>○ Record Drawings</li> <li>○ Agency Consultation</li> </ul>	<b>ARCHITECTURE</b> <ul style="list-style-type: none"> <li>▪ Field Review</li> <li>▪ Deficiency Assessment</li> <li>▪ Review of Warranties</li> <li>▪ Total Performance</li> <li>▪ Inspection and Certification</li> <li>▪ Client Consultation</li> <li>▪ Start-up Assistance</li> <li>▪ One-year Warranty</li> <li>▪ Inspections</li> </ul>

# Consulting Scope of Services

## LEGEND

- Indicates basic services as fee percentage
- Indicates additional services

PREDESIGN	SD	DD	CD	BID	CA	OPERATIONS
<p><b>SPECIAL CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Legal Survey</li> <li>○ Geotechnical Analysis</li> <li>○ Project Financing</li> </ul>	<p><b>CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>▪ Structural Design Concepts</li> <li>▪ Mechanical Design Concepts</li> <li>▪ Electrical Design Concepts</li> <li>▪ Statements of Probable Costs</li> </ul> <p><b>SPECIAL CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Civil Design Concepts</li> <li>○ Landscape Concepts</li> <li>○ Statements of Probable Costs</li> <li>○ Costs</li> </ul>	<p><b>CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>▪ Structural Design Development</li> <li>▪ Mechanical Design Development</li> <li>▪ Electrical Design Development</li> <li>▪ Statements of Probable Costs</li> </ul> <p><b>SPECIAL CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Civil Engineering Design Development</li> <li>○ Landscape Development</li> <li>○ Detailed Construction Cost Estimates or Quantity Surveys</li> </ul>	<p><b>CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Structural Construction Documents</li> <li>○ Mechanical Construction Documents</li> <li>○ Electrical Construction Documents</li> <li>○ Statements of Probable Costs</li> </ul> <p><b>SPECIAL CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Civil Engineering Construction Documents</li> <li>○ Landscape Documents</li> <li>○ Detailed Construction Cost Estimates or Quantity Surveys</li> </ul>	<p><b>CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Issue Bidding Documents</li> <li>○ Issue Addenda</li> <li>○ Bid Evaluation</li> </ul> <p><b>SPECIAL CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Issue Bidding Documents</li> <li>○ Issue Addenda</li> <li>○ Bid Evaluation</li> </ul>	<p><b>CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>▪ Structural review/ Reports</li> <li>▪ Mechanical review/ Reports</li> <li>▪ Electrical review/ Reports</li> <li>○ Record Drawings</li> <li>○ Certification of Progress</li> </ul> <p><b>SPECIAL CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Civil Construction review</li> <li>○ Landscape Inspection</li> <li>○ Detailed Cost Accounting</li> </ul>	<p><b>CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Fine Arts/Crafts/ Graphics</li> <li>○ Non-building Equipment Selection</li> <li>○ Building Analysis and Reports</li> <li>○ Services Related to Alterations and Demolition</li> <li>○ Life Cycle Cost Monitoring</li> <li>○ Environmental Monitoring</li> <li>○ One-year Warranty Inspections</li> </ul> <p><b>SPECIAL CONSULTANTS' SERVICES</b></p> <ul style="list-style-type: none"> <li>○ Start-up Assistance</li> <li>○ Systems Performance Review</li> <li>○ Non-building Equipment Selection</li> <li>○ Life Cycle Cost Monitoring</li> <li>○ Services related to Alterations and Demolition</li> </ul>

A speedometer with a needle pointing to 65 km/h. The speedometer has a scale from 0 to 180 km/h, with markings every 10 units. The needle is positioned at the 65 mark. The text "MPH" and "km/h" are visible on the speedometer face. The background of the slide is a blurred image of the speedometer.

At this point it is pretty clear that the problems we face in terms of value and compensation  
Are due to process and perception.

**How can we move the needle on this?**

# Tactics to Increase Fees and Profitability for Architects

For fixed-fee projects

## Negotiation



- Negotiate the highest possible fee at the outset of work
- Limited flexibility to stretch up in this approach
- Minimally able to impact gross fee

## Efficiency

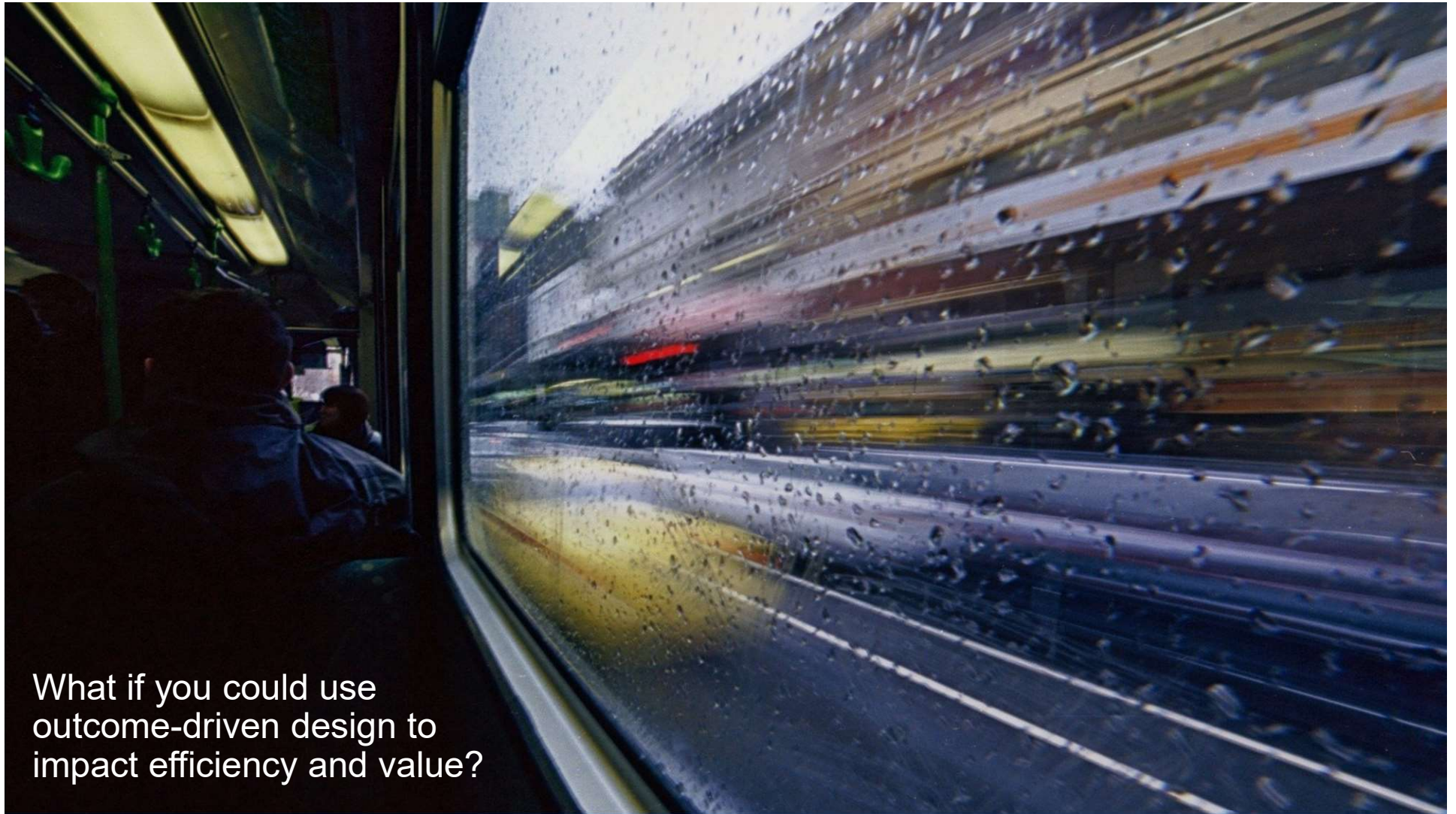


- Only complete work specific to deliverable completion
- Utilize automation and optimization on a per task basis and also in project process
- Not able to impact gross fee

## Value Add



- Reconsider design processes and increase scope of services
- Creates returning client and improves future work via data
- Able to impact gross fee and extend value

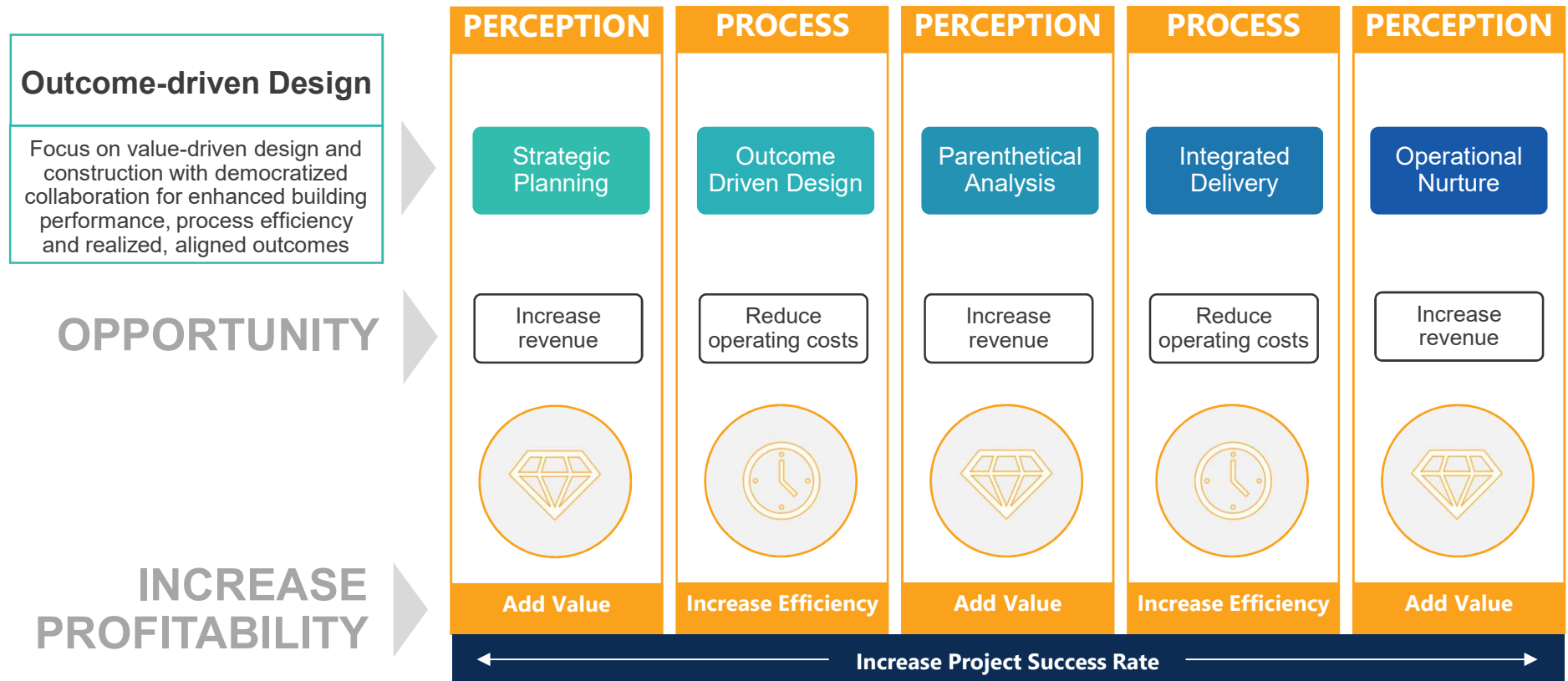


What if you could use  
outcome-driven design to  
impact efficiency and value?



# Tactics to Increase Fees and Profitability for Architects

## IMPACT OF KEY COMPONENTS



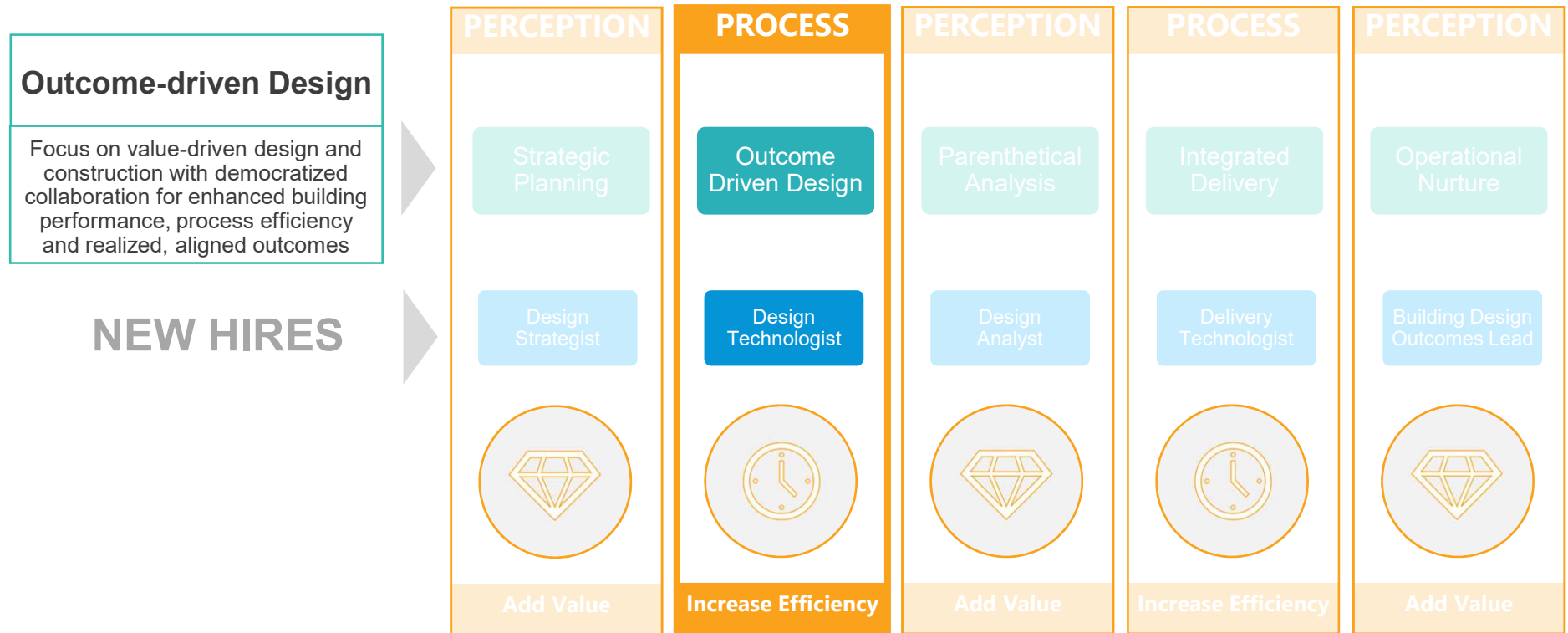
# Tactics to Increase Fees and Profitability for Architects

## IMPACT OF KEY COMPONENTS



# Tactics to Increase Fees and Profitability for Architects

## IMPACT OF KEY COMPONENTS



# Design Technology Team for Outcome-Driven Design

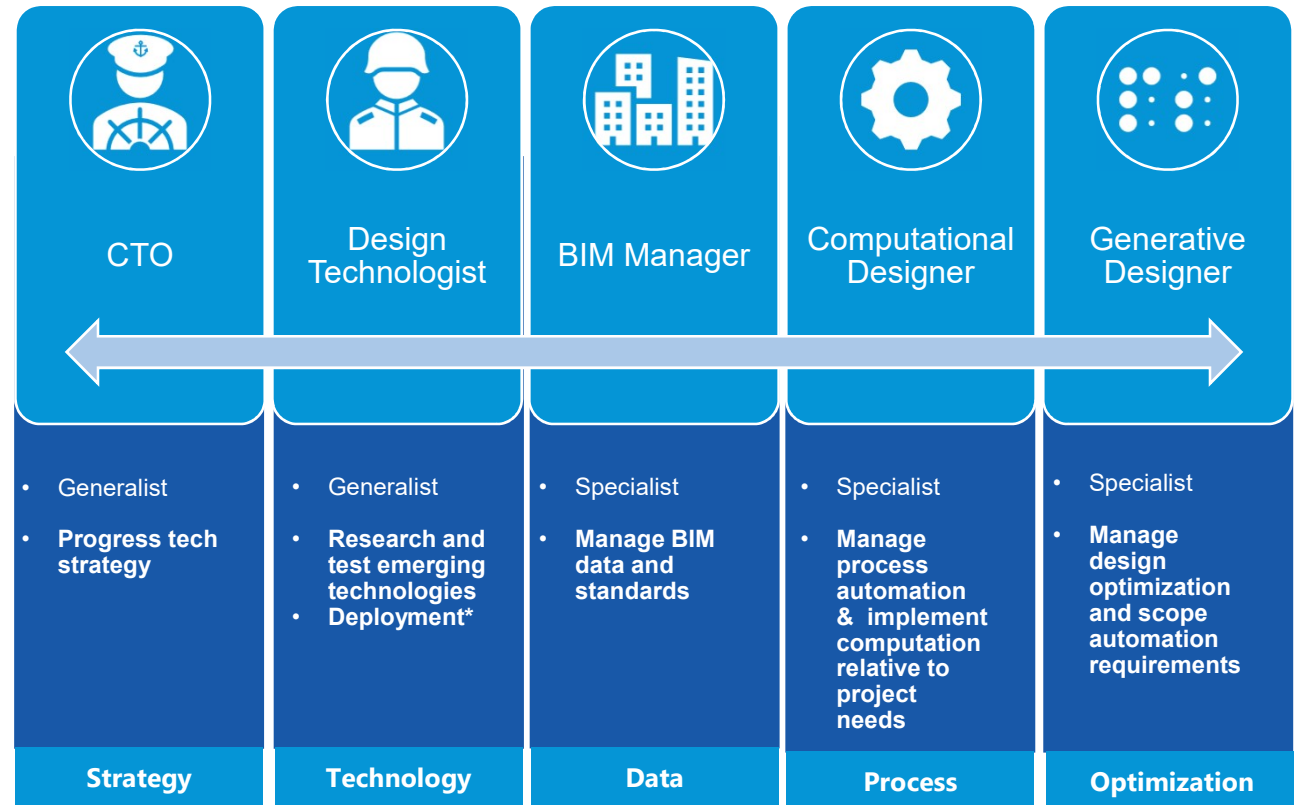
## Outcome-driven Design

Focus on value-driven design and construction with democratized collaboration for enhanced building performance, process efficiency and realized, aligned outcomes

## PROCESS

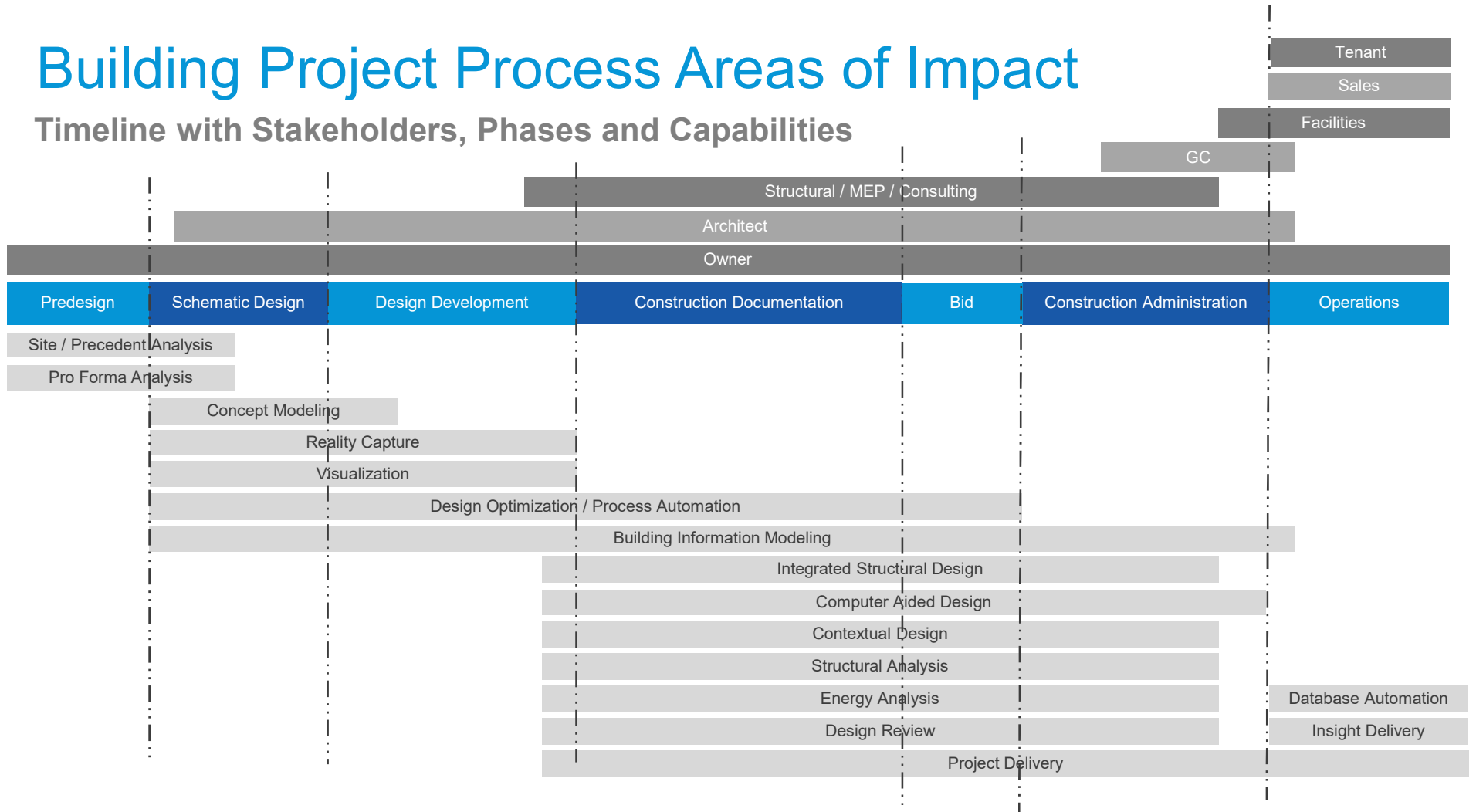


Increase Efficiency



# Building Project Process Areas of Impact

## Timeline with Stakeholders, Phases and Capabilities



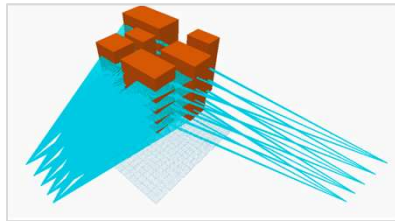


# Emerging Design Processes in AEC

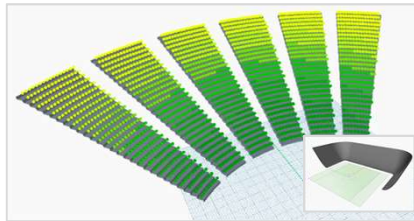
Computational and generative design in action



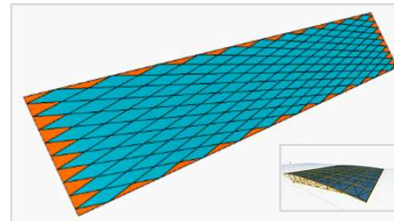
Glazing Optimization



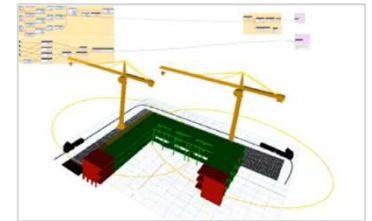
View Optimization



Stadium and Seating Optimization



Panel Optimization



Crane Location Optimization

PD

SD

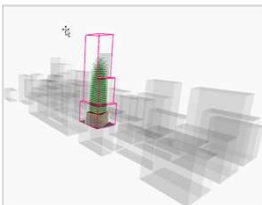
DD

CD

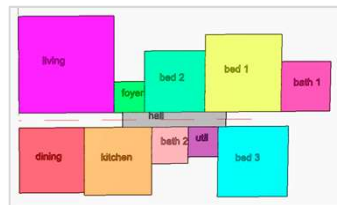
BID

CA

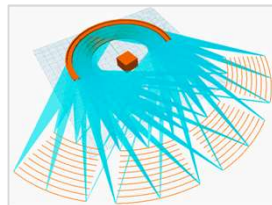
OPS



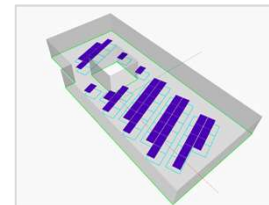
Building Mass Optimization



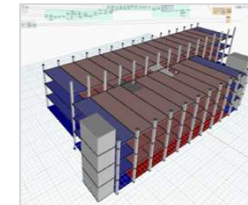
Room Layout Optimization



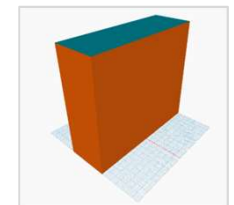
View Optimization



Open Office Desk Layout Optimization



Parking Garage Optimization



Building Cost Optimization



AUTODESK®  
DYNAMO FOR REVIT

# Computational Design

## Process Automation

- Automate repetitive tasks for precision and speed
- Solve for complex geometric problems
- Rationalize designs with logic approach
- Rapidly test and study multiple ideas manually

Image courtesy of Flanagan Lawrence

# Project Objective: Automate Building Mass + Cost

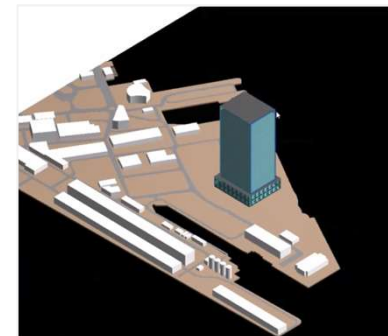
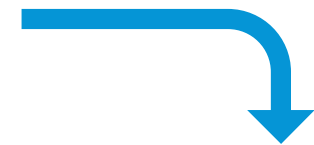
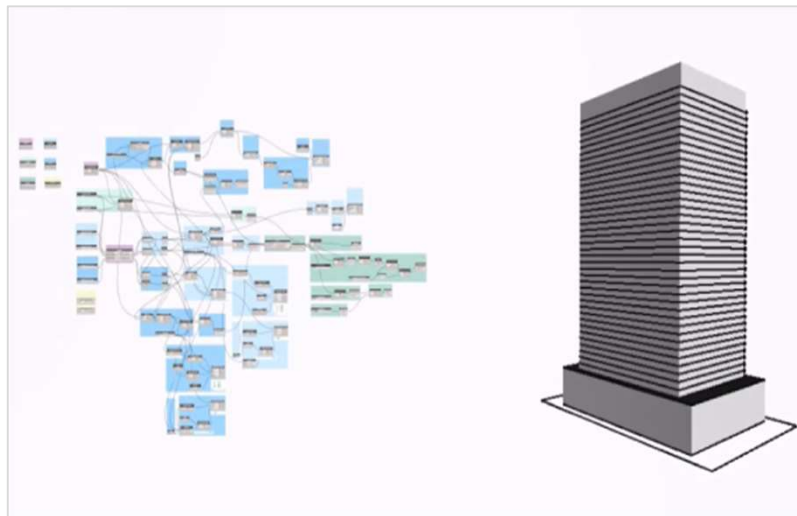
Developer: Emily Bisaga Dunne, Autodesk

## Design Objectives:

- Automate mass from
- Calculate Far
- Show cost and ROI calculations as different geometries are tested manually
- Automate Revit elements from early stage mass study

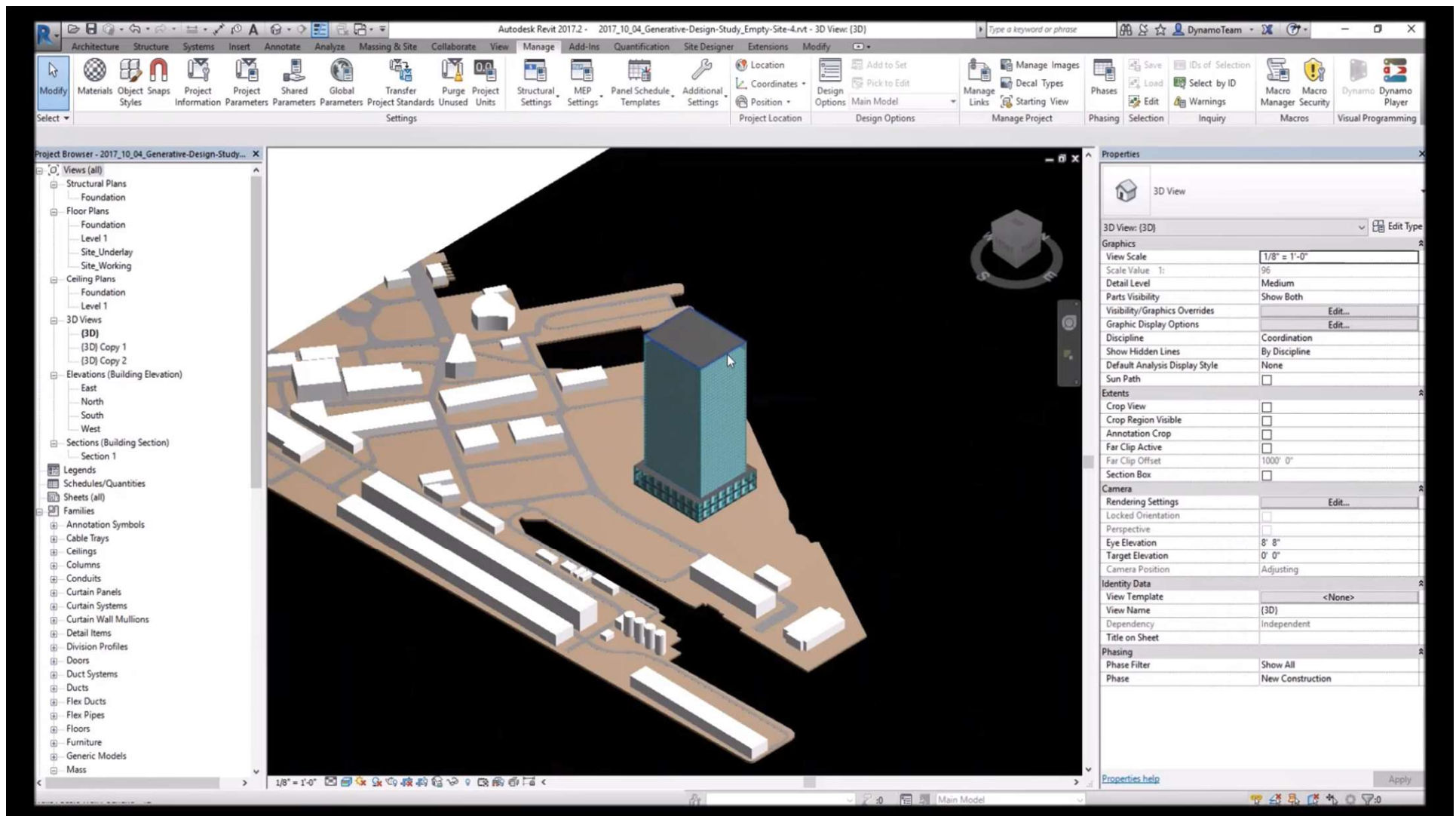


Increase Efficiency



## KEY OUTCOMES:

Reduced time to design development  
Increased early-stage design profit  
Improved cashflow management





# Project Objective: Automate Sheet Development

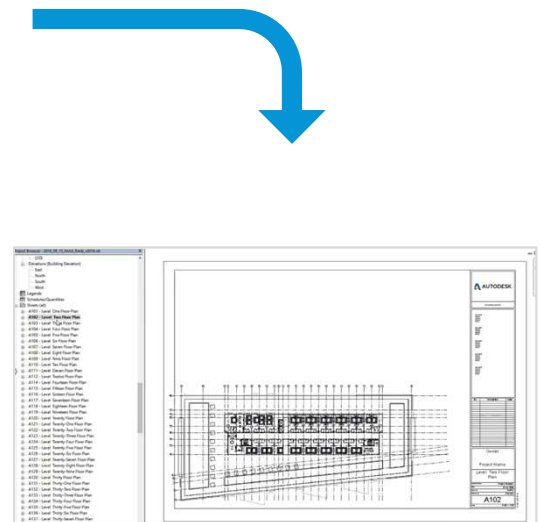
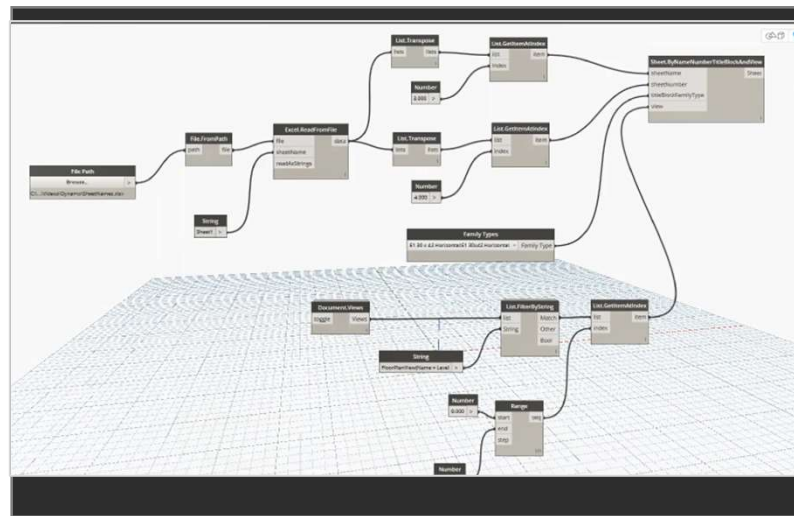
Developer: Emily Bisaga Dunne, Autodesk

## Design Objectives:

- Automate the creation of sheets and the placement of view on sheets for building design set



Increase Efficiency



**KEY OUTCOME:**  
Reduced time to design development  
Increased early-stage design profit  
Improved design change management



Autodesk Revit 2016 - 2018\_09\_15\_Hotel\_Emily\_v2016.rvt - Sheet: A102 - Level Two Floor Plan

Type a keyword or phrase

Architecture Structure Systems Insert Annotate Analyze Massing & Site Collaborate View Manage Add-Ins Extensions Modify

Modify Go Live Glue Clash Pinpoint Equipment Properties Dynamo 0.9 Convert RFA to Formit About Formit Launch Screencast Interactive Python Shell

Select Revit Live BIM 360 Visual Programming Formit 360 Converter Screencast RevitPythonShell

Project Browser - 2018\_09\_15\_Hotel\_Emily\_v2016.rvt

- (3D)
- Elevations (Building Elevation)
  - East
  - North
  - South
  - West
- Legends
- Schedules/Quantities
- Sheets (all)
  - A101 - Level One Floor Plan
  - A102 - Level Two Floor Plan**
  - A103 - Level Three Floor Plan
  - A104 - Level Four Floor Plan
  - A105 - Level Five Floor Plan
  - A106 - Level Six Floor Plan
  - A107 - Level Seven Floor Plan
  - A108 - Level Eight Floor Plan
  - A109 - Level Nine Floor Plan
  - A110 - Level Ten Floor Plan
  - A111 - Level Eleven Floor Plan
  - A112 - Level Twelve Floor Plan
  - A114 - Level Fourteen Floor Plan
  - A115 - Level Fifteen Floor Plan
  - A116 - Level Sixteen Floor Plan
  - A117 - Level Seventeen Floor Plan
  - A118 - Level Eighteen Floor Plan
  - A119 - Level Nineteen Floor Plan
  - A120 - Level Twenty Floor Plan
  - A121 - Level Twenty-One Floor Plan
  - A122 - Level Twenty-Two Floor Plan
  - A123 - Level Twenty-Three Floor Plan
  - A124 - Level Twenty-Four Floor Plan
  - A125 - Level Twenty-Five Floor Plan
  - A126 - Level Twenty-Six Floor Plan
  - A127 - Level Twenty-Seven Floor Plan
  - A128 - Level Twenty-Eight Floor Plan
  - A129 - Level Twenty-Nine Floor Plan
  - A130 - Level Thirty Floor Plan
  - A131 - Level Thirty-One Floor Plan
  - A132 - Level Thirty-Two Floor Plan
  - A133 - Level Thirty-Three Floor Plan
  - A134 - Level Thirty-Four Floor Plan
  - A135 - Level Thirty-Five Floor Plan
  - A136 - Level Thirty-Six Floor Plan
  - A137 - Level Thirty-Seven Floor Plan
  - A138 - Level Thirty-Eight Floor Plan
  - A139 - Level Thirty-Nine Floor Plan
  - A140 - Level Forty Floor Plan

Properties

Sheet

Sheet: Level Two Floor Plan Edit Type

Graphics

Visibility/Graphics O... Edit...

Scale 1/16" = 1'-0"

Identify Data

Dependency Independent

Referencing Sheet

Referencing Detail

Workset View "Sheet: A102 - Le..."

Edited by emily.bisaga.dunne

Current Revision Issu...

Current Revision Issu...

Current Revision Date

Current Revision Des...

Current Revision

Approved By Approver

Designed By Designer

Checked By Checker

Drawn By Author

Sheet Number A102

Sheet Name Level Two Floor Plan

Sheet Issue Date 09/15/18

Appears in Sheet List ☒

Revisions on Sheet Edit...

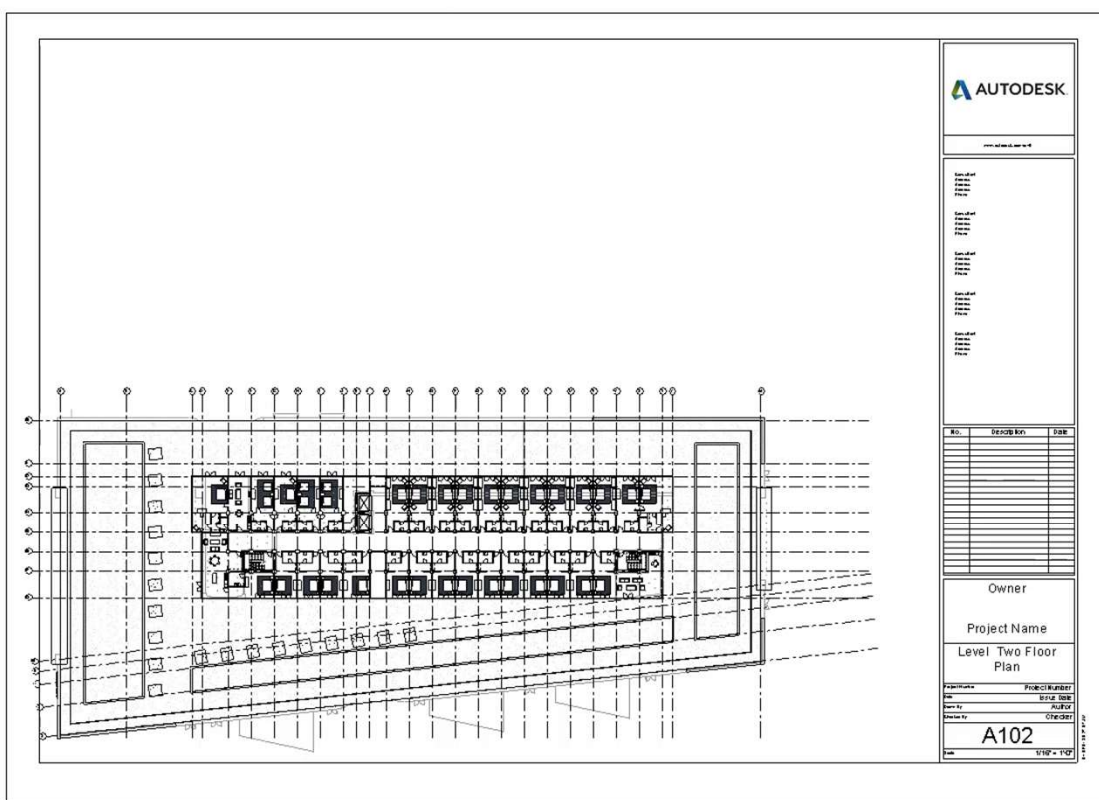
Other

File Path C:\Users\dunnee\Des...

Guide Grid <None>

Properties help Apply

Ready Podium - Roof Garden (Not Editabl) Main Model Editable Only



# Project Objective: Brick Layout

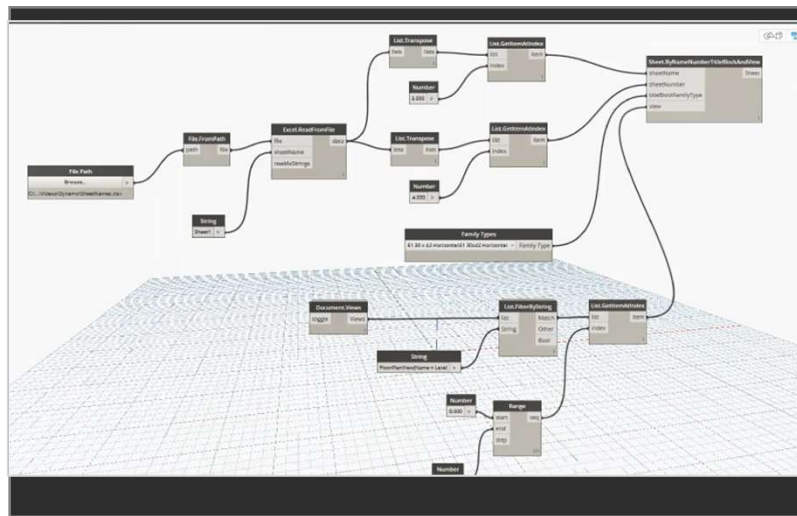
Developer: Jacob Small, Autodesk

## Design Objectives:

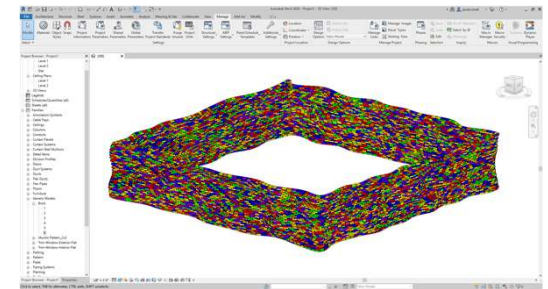
- Place 8,388 bricks accurately along a curvy wall form
- Reduce waste

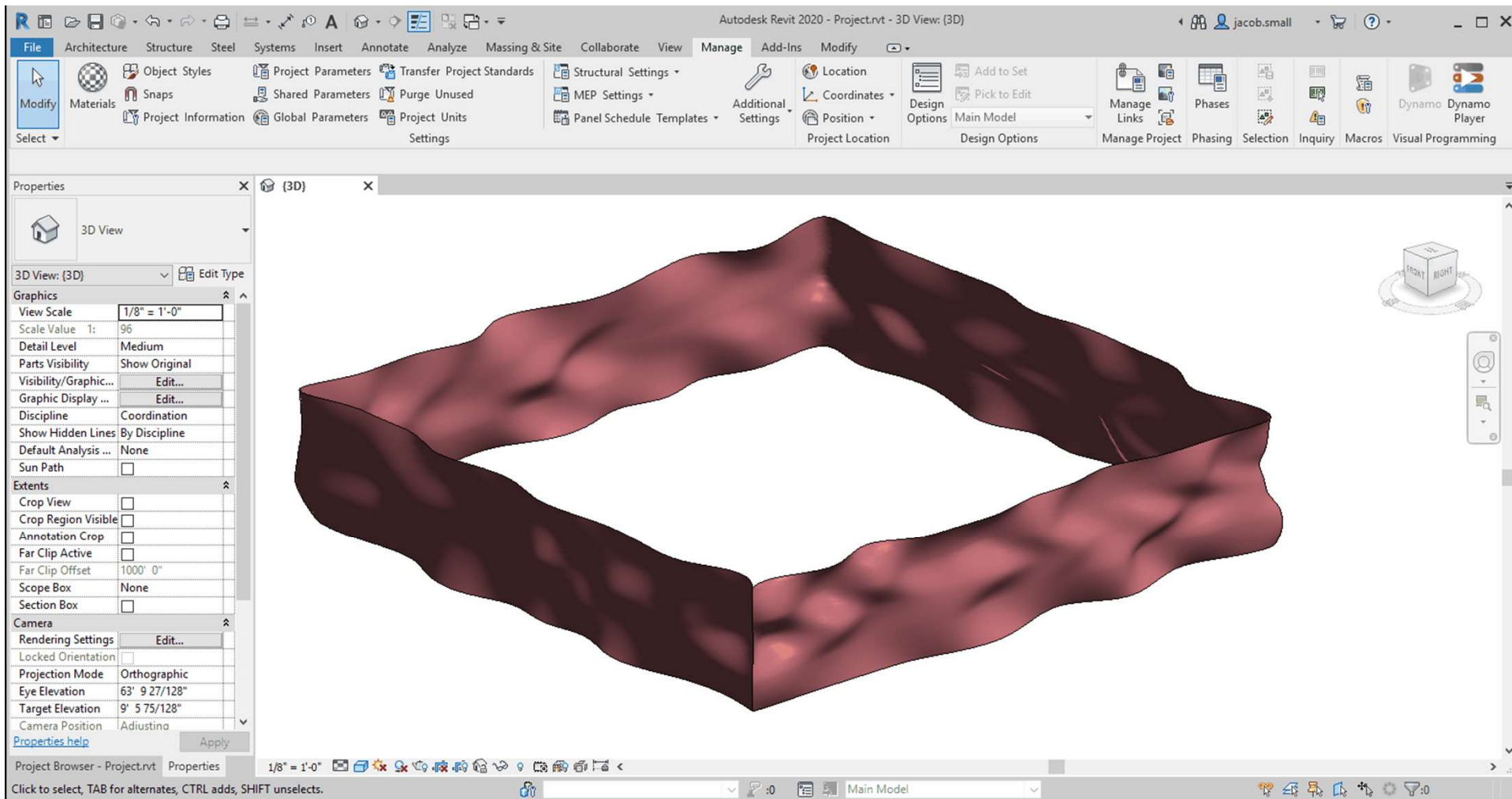


Increase Efficiency



**KEY OUTCOMES:**  
Reduced time to construction  
Improve design quality  
Improve coordination





# Project Objective: Utility Routing

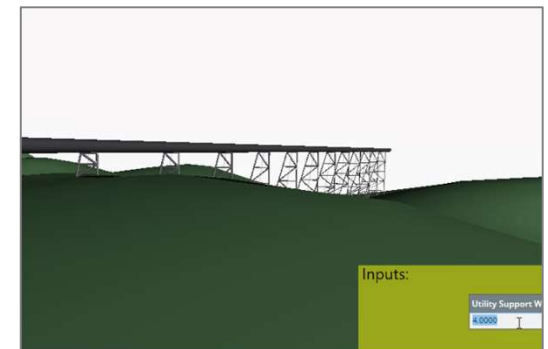
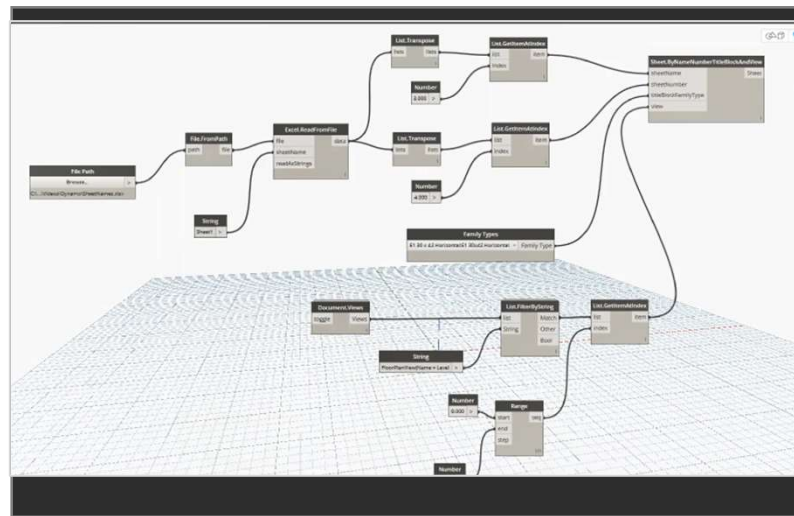
Developer: Jacob Small, Autodesk

## Design Objectives:

- Automates placement of a utility line on a specific terrain
- As the terrain updates, the structure and routing update

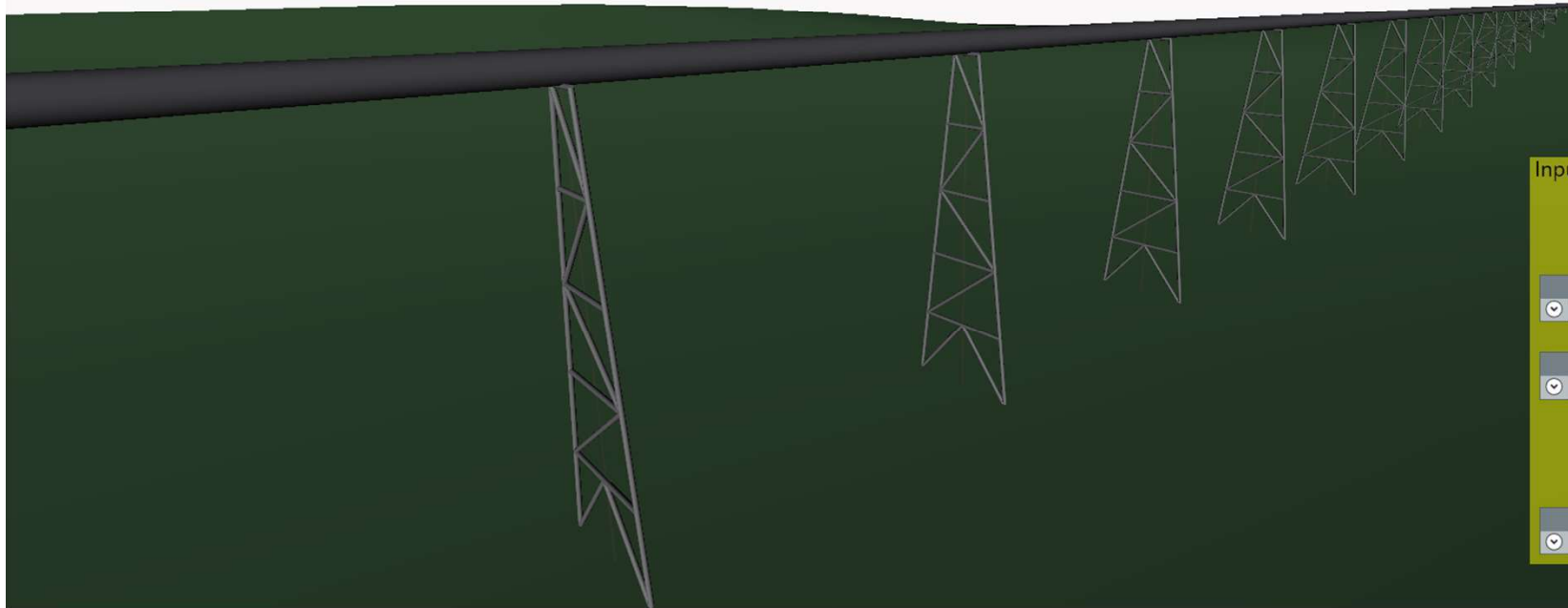


Increase Efficiency



**KEY OUTCOMES:**  
Improved coordination  
Improved design quality  
Reduction in waste

Library



Inputs:

Utility Support Width	4.0000	>
Start Elevation	3	>
End Elevation	0	>
Max Span	50.0000	>
Terran severity	3	>

Automatic

Run completed.



# Project Objective: Furniture Placement

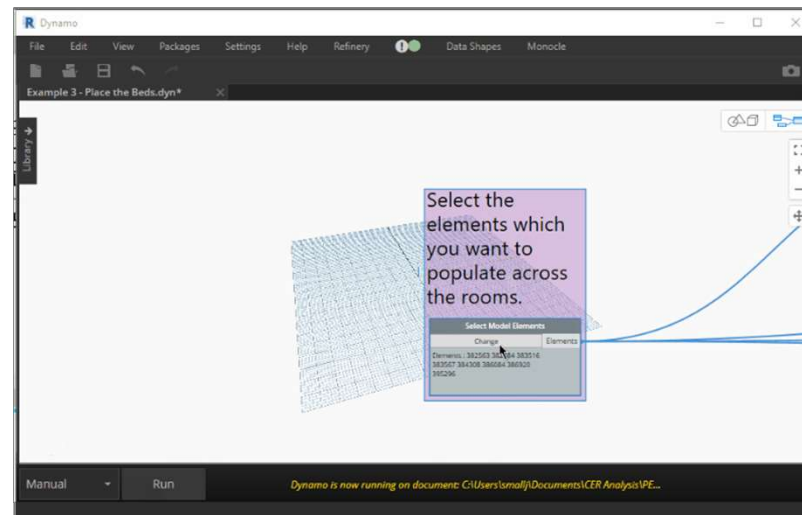
Developer: Jacob Small, Autodesk

## Design Objectives:

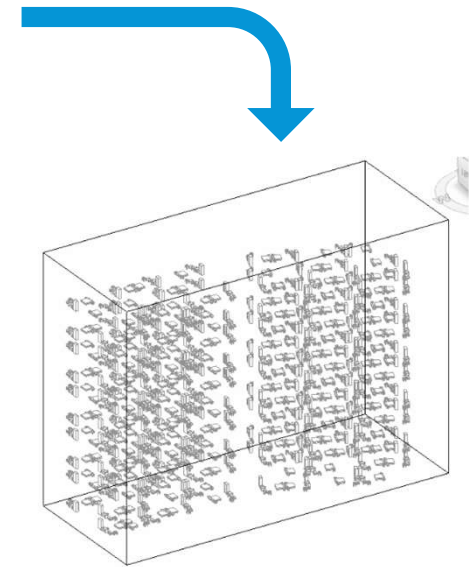
- Automates placement of furniture within rooms by room type

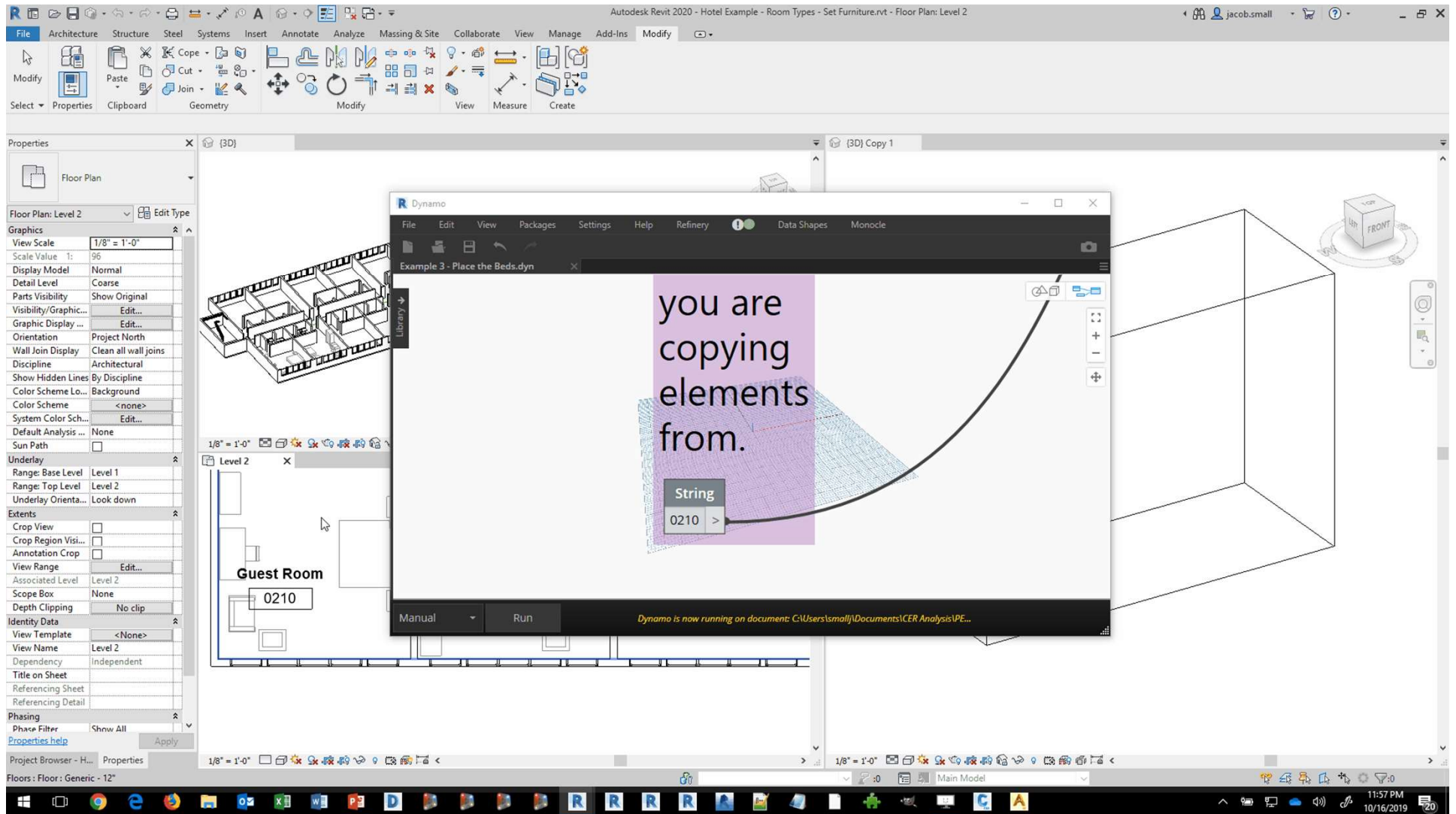


Increase Efficiency



**KEY OUTCOMES:**  
Improved coordination  
Improved change management  
Reduced errors





# Project Objective: Steel Diagrid Waste Evaluation

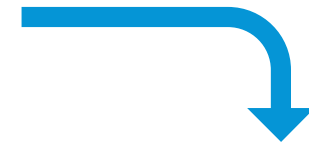
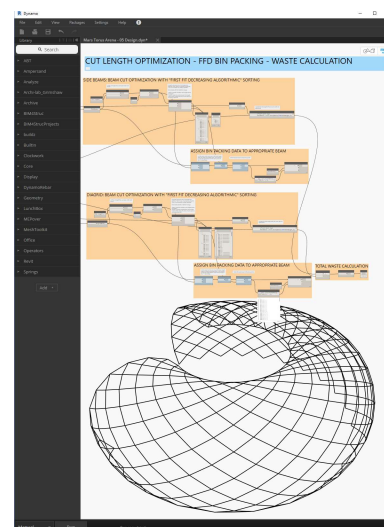
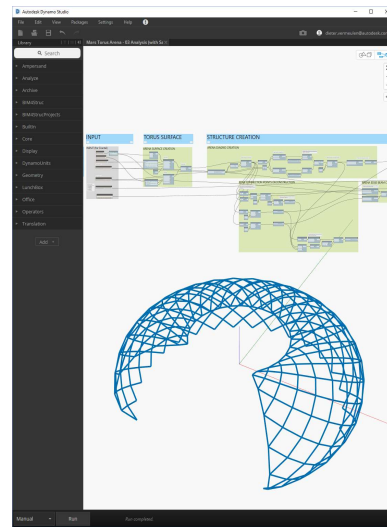
Developer: Dieter Vermuelen, Autodesk

## Design Objectives:

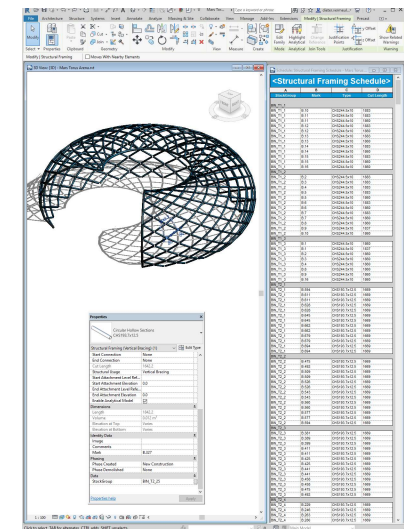
- Automates the form of a steel diagrid structure and allows for the cut length to be optimized.



Increase Efficiency



**KEY OUTCOMES:**  
Improved data for fabrication  
Reduced waste  
Reduced cost



Autodesk Revit 2020.1 - Mars Torus Arena.rvt - Structural Plan: Site

Dynamo

File Edit View Packages Settings Help Refinery

Mars Torus Arena Design Automation.x

# MARS TORUS ARENA

DYNAMO PROJECT

MARS TORUS ARENA DESIGN AUTOMATION

DYNAMO VERSION

2.2

ASSOCIATED FILE(S)

Mars Torus Arena.rvt

AUTHOR(S) / CREATION DATE

Dieter Vermeulen, Autodesk / 2019.11.18

DESCRIPTION

Graph that creates the conceptual design of the Mars Torus Arena, based on swept surfaces and diagrid creation.

The results from previous optioneering and analysis operations are now used to generate the design model in Revit.

At the same time, cut optimization is performed on the bars again, and the results are pushed back to the Revit parameter of each beam, by assigning them to the appropriate packing bin, which represents the stocklength bar which to cut it from.

REQUIRED DYNAMO PACKAGES

PACKAGES:  
BIM4Struc.Productivity

CUSTOM NODES:  
Mars Torus Arena Diagrid Creation.dyf

Manual Run

Click to select, TAB for alternates, CTRL adds, SHIFT unselects.

Precast

Location  
Coordinates  
Position  
Select Location

Add to Set  
Pick to Edit  
Main Model  
Design Options

Manage Images  
Decal Types  
Manage Links  
Starting View  
Manage Project

Save  
Load  
Edit  
Phasing  
Selection

IDs of Selection  
Select by ID  
Warnings  
Inquiry

Macro Manager  
Macro Security  
Macros

Dynamo  
Dynamo Player  
Visual Programming

Site

3D View 1

1 : 100

Structural Framing Schedule

<Structural Framing Schedule>			
A	B	C	D
StockGroup	Mark	Type	Cut Length

Main Model

# Project Objective: Structural Framing Automation

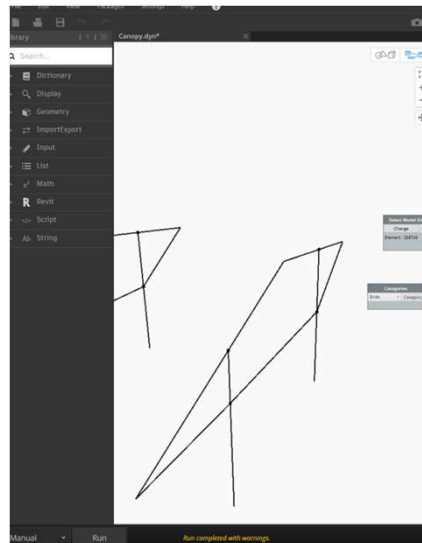
Developer: Jacob Small, Autodesk

## Design Objectives:

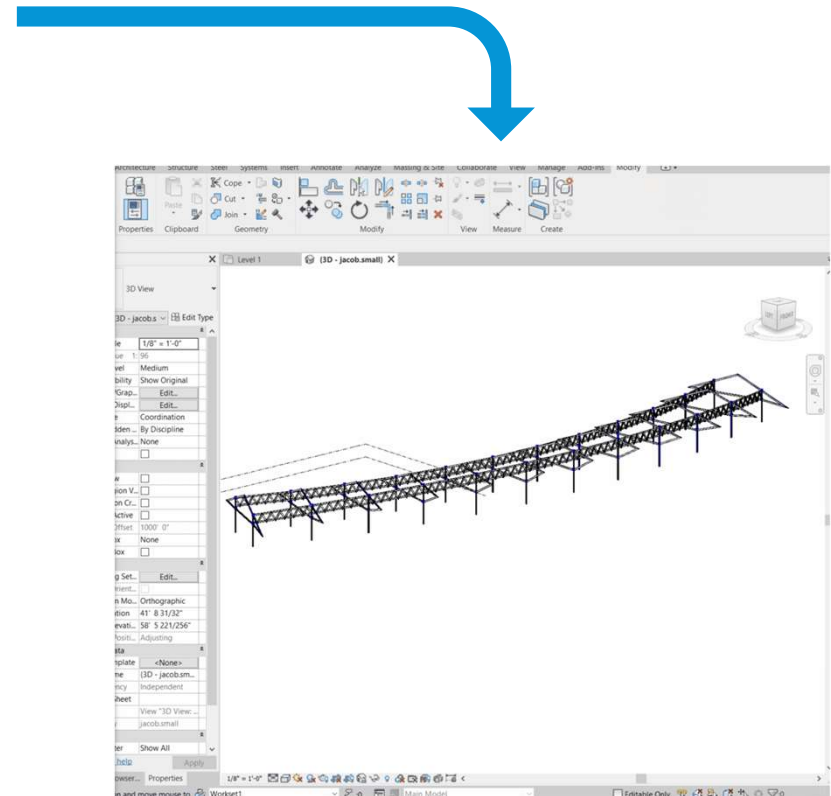
- Automates the form of a structure based on a curved form in the Revit model



Increase Efficiency



**KEY OUTCOMES:**  
Reduced errors  
Reduced time  
Reduced cost





File Edit View Packages Settings Help

Library | Canopy.dyn\*

Search...

- Dictionary
- Display
- Geometry
- ImportExport
- Input
- List
- Math
- Revit
- Script
- String

Select Model Element

Change	Element
Element: 358745	

Categories

Grids	Category

Properties

3D View

3D View: [3D - Jacobs.s] Edit Type

Graphics

View Scale: 1/8" = 1'-0"

Scale Value: 1:96

Detail Level: Medium

Parts Visibility: Show Original

Visibility/Grap... Edit...

Graphic Displ... Edit...

Discipline: Coordination

Show Hidden... By Discipline

Default Analys... None

Sun Path: ☐

Extents

Crop View: ☐

Crop Region V... ☐

Annotation Cr... ☐

Far Clip Active: ☐

Far Clip Offset: 1000' 0"

Scope Box: None

Section Box: ☐

Camera

Rendering Set... Edit...

Locked Orient... ☐

Projection Mo... Orthographic

Eye Elevation: 45' 4 11/256"

Target Elevati... 58' 5 221/256"

Camera Positi... Adjusting

Identity Data

View Template: <None>

View Name: [3D - jacob.sm...

Dependency: Independent

Title on Sheet

Workset: View "3D View: ...

Edited by: jacob.small

Phasing

Phase Filter: Show All

Properties help

Apply

Project Browser... Properties

Click to select, TAB Workset1

1/8" = 1'-0"

Main Model

Editable Only

Manual Run

# Savings Analysis

Artem Boiko



## Runtime

00:01:10

- Placement completed:
- ✓ **Base Plate Column** - Eaves Columns
  - ✓ **Plate Column Base 90° rotated** - Gable Columns
  - ✓ **Anchor Plinth +500** - Eaves Columns (outside)
  - ✓ **Anchor Plinth +500** - Gable Columns (outside)
  - ✓ **Anchor Truss 90° rotated** - Gable Columns (inside)
  - ✓ **Anchor Sandwichpanel** - Eaves Columns (outside)
  - ✓ **Anchor Sandwichpanel** - Gable Columns (outside)

## Runtime

01:02:00

- Placement completed:
- ✓ **Base Plate Column** - Eaves Columns
  - ✓ **Base Plate Column 90° rotated** - Gable Columns
  - ✓ **Anchor Truss 90° rotated** - Gable Columns (inside)
  - ✓ **Anchor Plinth +500** - Eaves Columns (outside)
  - ✓ **Anchor Plinth +500** - Gable Columns (outside)
  - ✓ **Anchor Sandwichpanel** - Eaves Columns (outside)
  - ✓ **Anchor Sandwichpanel** - Gable Columns (outside)



AUTODESK®  
PROJECT REFINERY

## Generative Design

### Design optimization

- Generate design options and select optimal solutions
- Easily connect selected design back to Dynamo and Revit
- Provide optimized solution for conflicting design objectives
- Evolve your design process to an outcome-driven approach

Image Courtesy of Flanagan Lawrence

# Project Objective: Optimize Urban Neighborhood

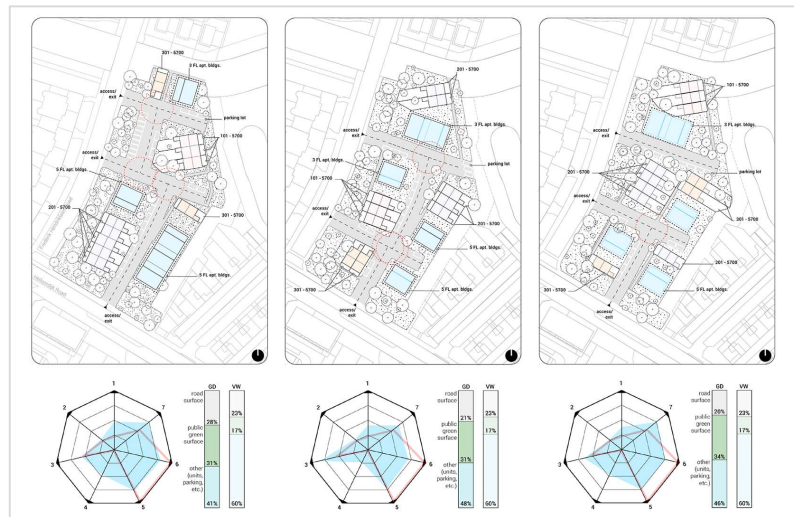
Developer: Van Wijnen

## Design Objectives:

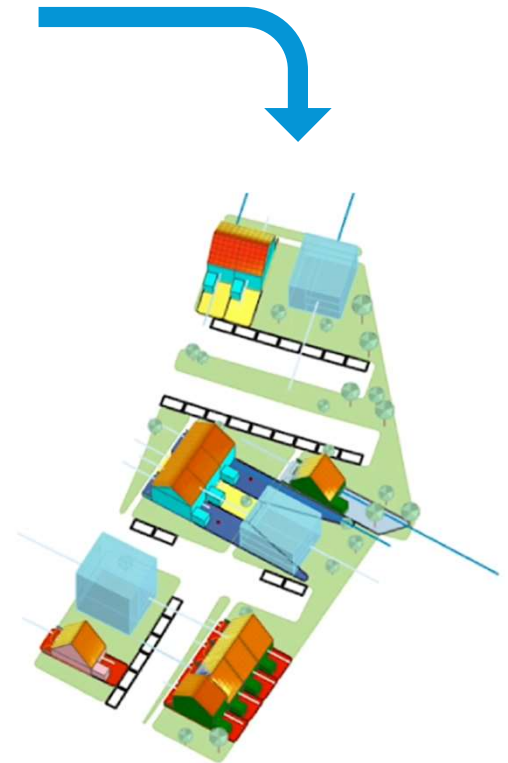
- Minimize cost
- Optimize parking
- Optimize orientation
- Optimize revenue
- Optimize ROI
- Test unit mix
- Test unit type
- Test site design

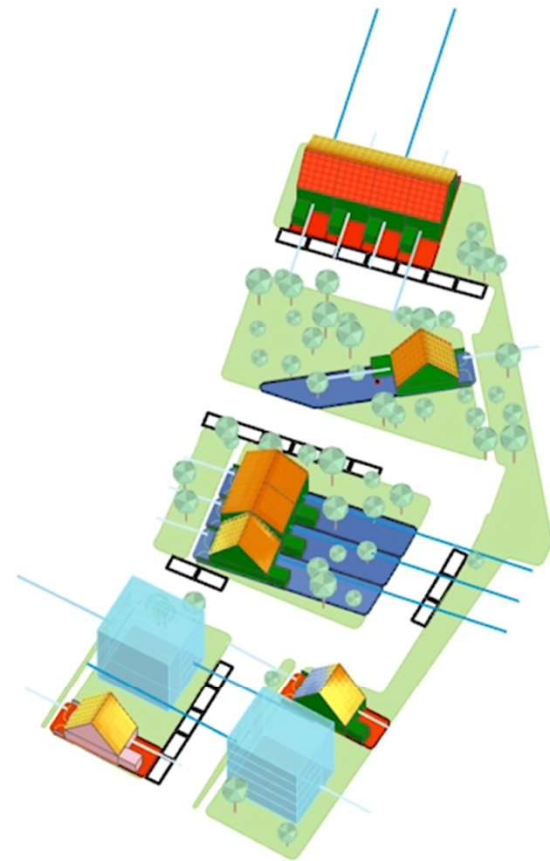
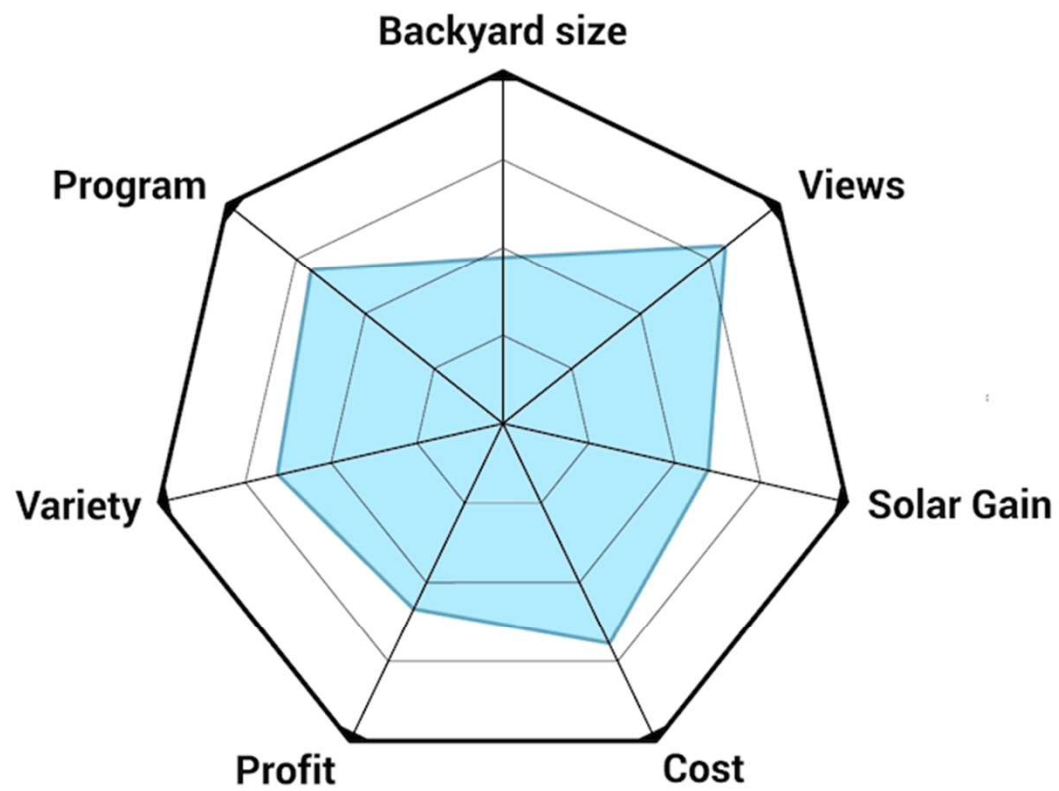


Increase Efficiency



**KEY OUTCOMES:**  
Minimize project cost  
Maximize project revenue  
Maximize return on investment







# Project Objective: Optimize Buildings For Site

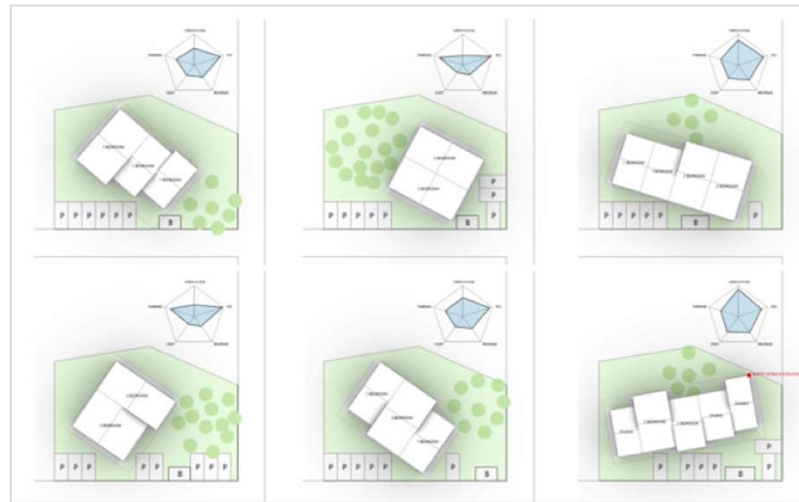
Developer: Daiwa House

## Design Objectives:

- Minimize cost
- Optimize parking
- Optimize orientation
- Optimize revenue
- Optimize ROI
- Test unit mix
- Test unit type
- Test site design



Increase Efficiency

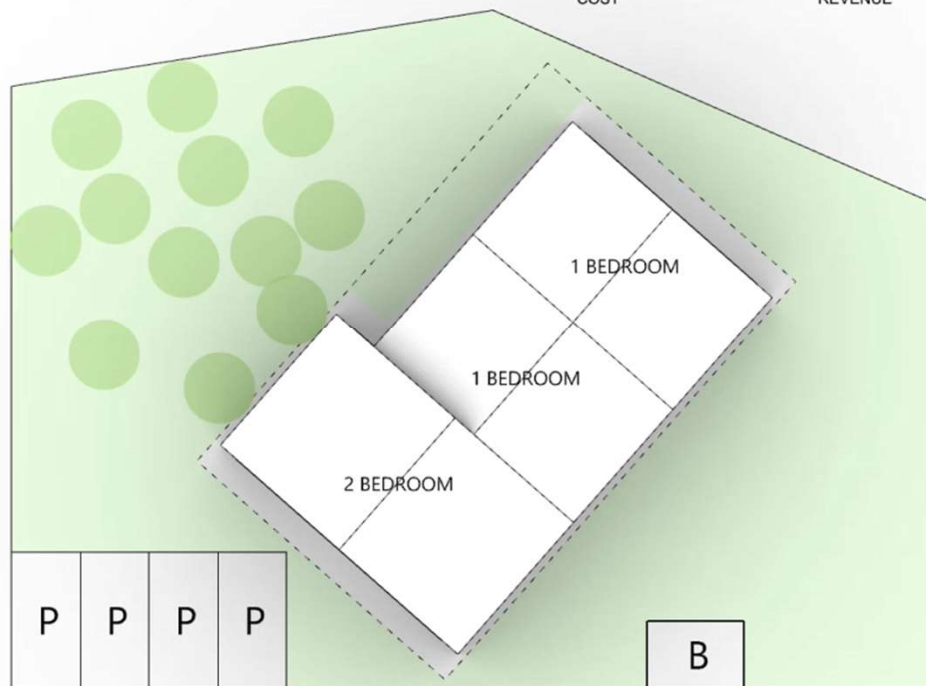
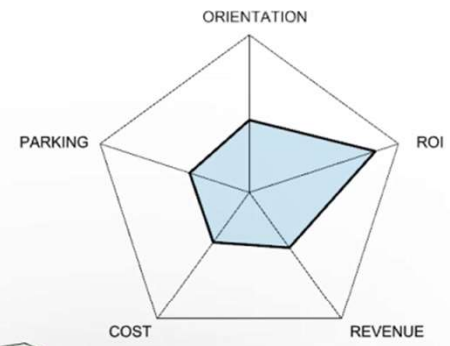


## KEY OUTCOMES:

Minimize project cost

Maximize project revenue

Maximize return on investment



# Project Objective: Optimize Building Position

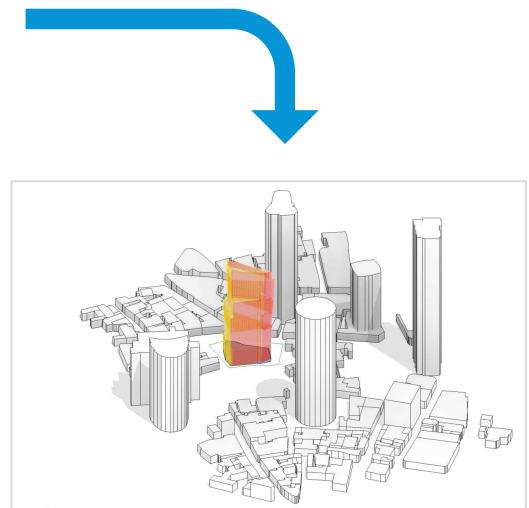
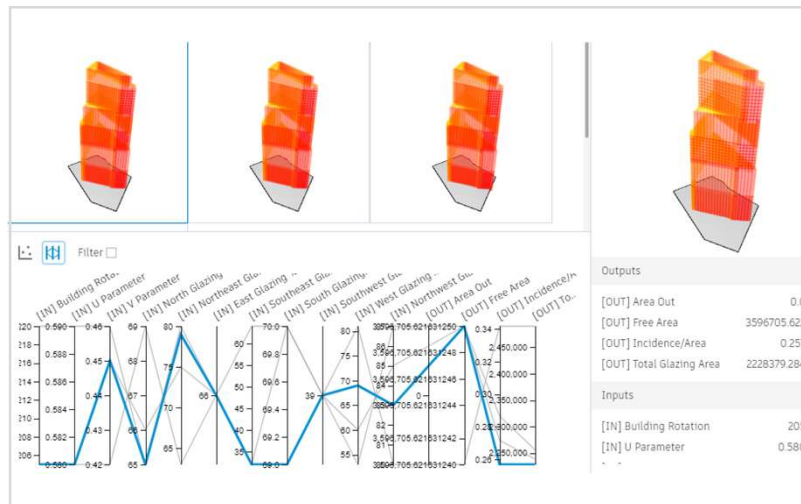
Developer: Design Tech IO\* for Autodesk

## Design Objectives:

- Minimize area
- Maximize free area
- Minimize incidence / area
- Maximize total glazing area



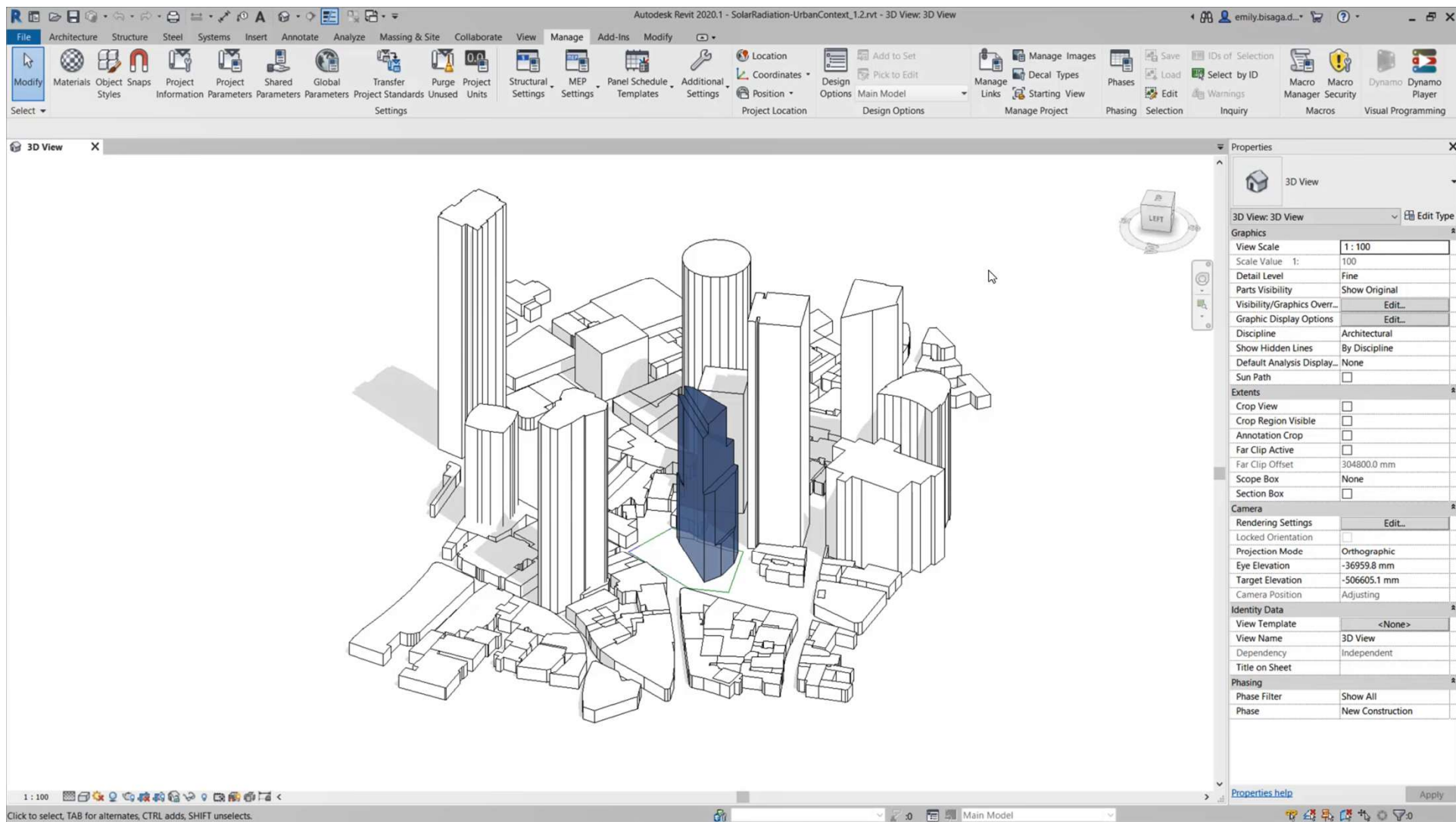
Increase Efficiency



## KEY OUTCOMES:

Reduced time to glazing analysis

Improved sustainability integration in design



# Project Objective: Optimize Building Program

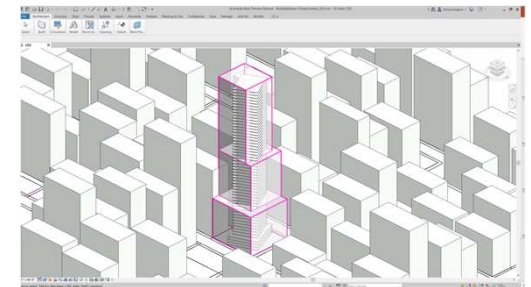
Developer: Refinery Team, Autodesk

## Design Objectives:

- Study massing
- Study program
- Calibrate via cost
- Calibrate via value
- Explore ratio of retail to office
- Explore office dimensions
- Explore rotation on site



Increase Efficiency



## KEY OUTCOMES:

Minimize project cost

Maximize project value per year

Add value via pro forma visualization





# Project Objective: Optimize the Floor Plan Layout

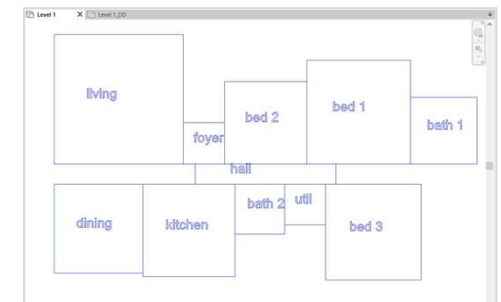
Developer: Jacob Small for Autodesk

## Design Objectives:

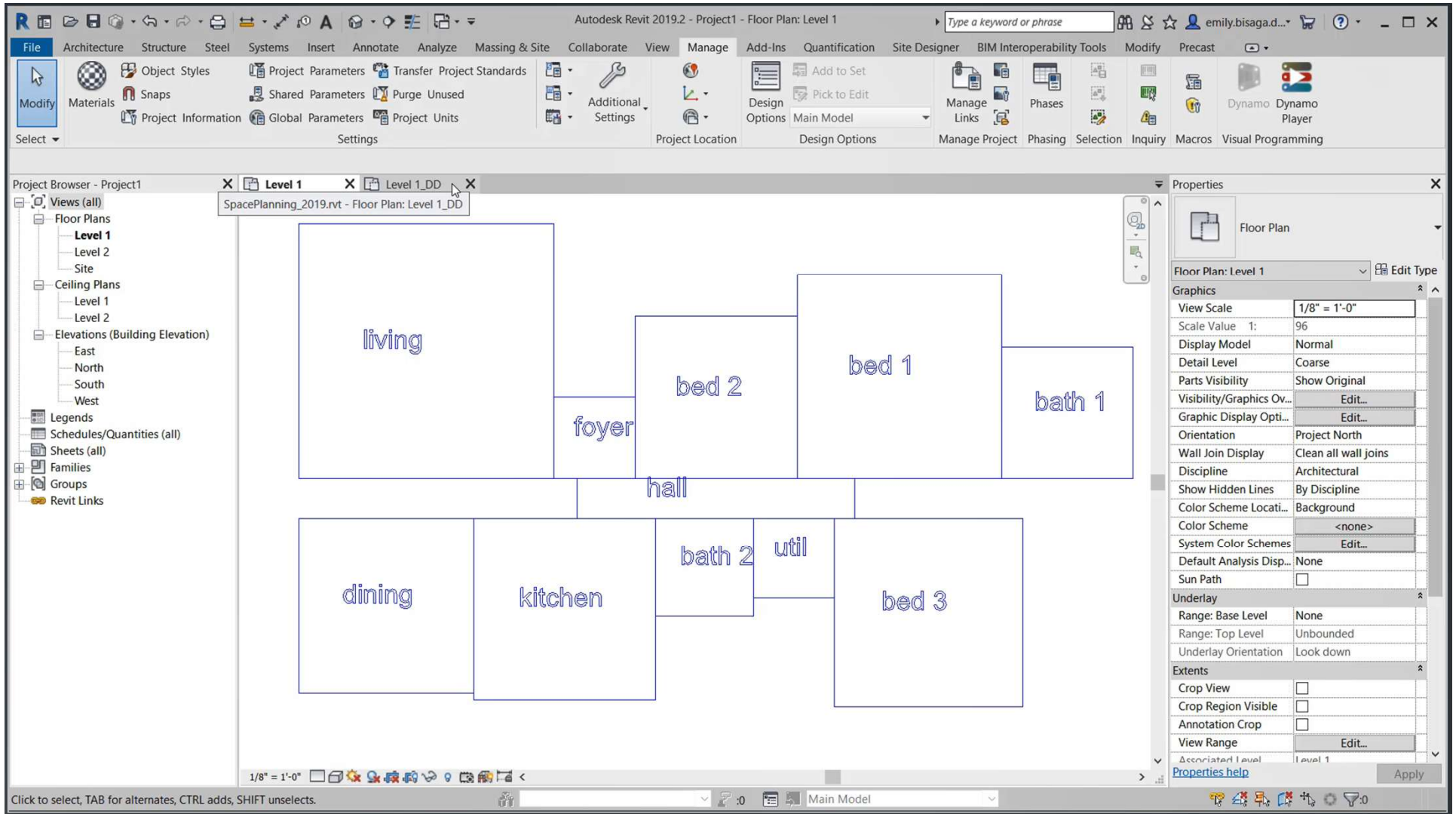
- Generate layout options
- Reduce unwanted noise in room adjacencies
- Minimize proximity score
- Minimize noise score
- 



Increase Efficiency



**KEY OUTCOMES:**  
Improve customer experience  
Improve wellness



# Project Objective: Crane Position Optimization

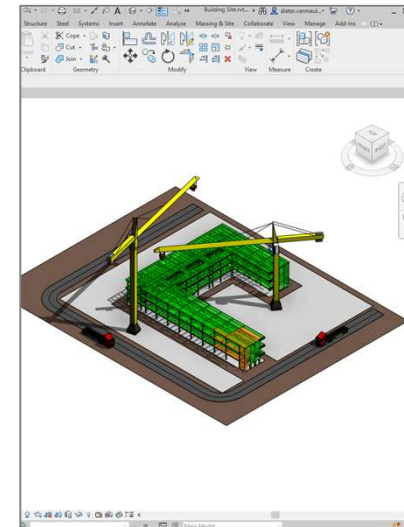
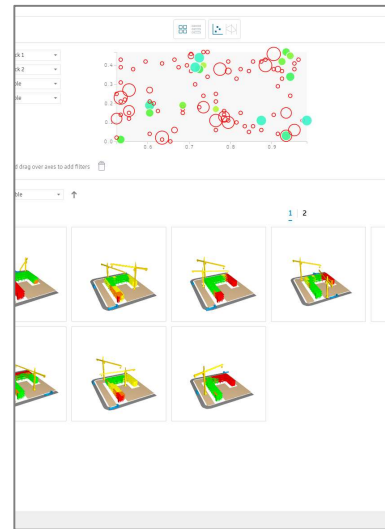
Developer: Dieter Vermeulen for Autodesk

## Design Objectives:

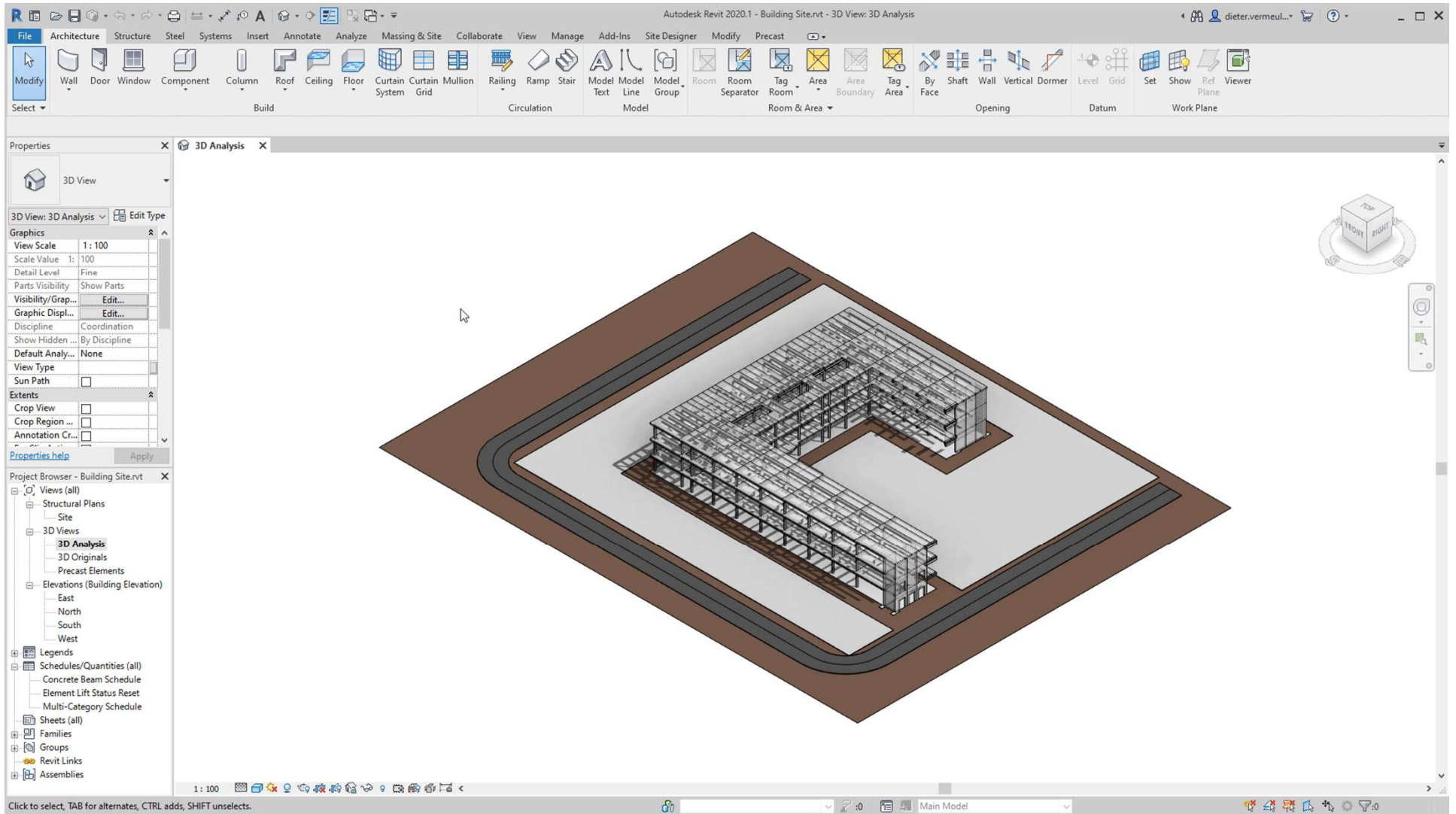
- Ensure crane locations are in best possible positions



Increase Efficiency



**KEY OUTCOMES:**  
Reduce waste  
Improve coordination





# Project Objective: Parking Layout Optimization

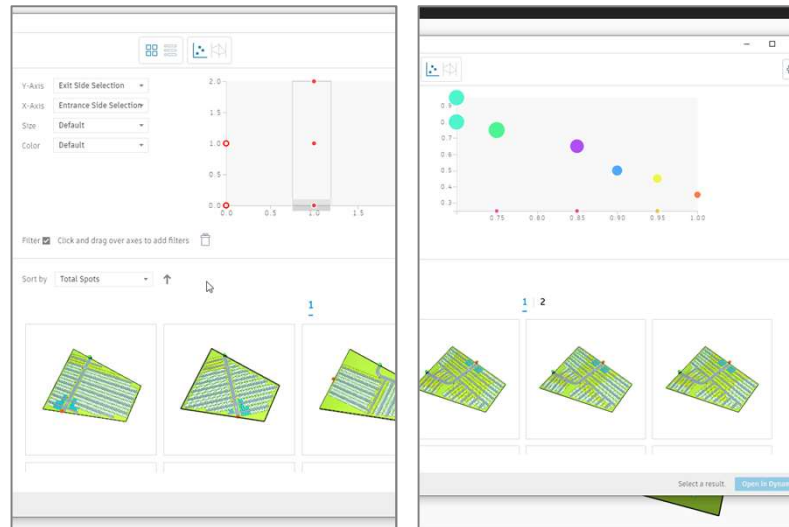
Developer: Dieter Vermeulen for Autodesk

## Design Objectives:

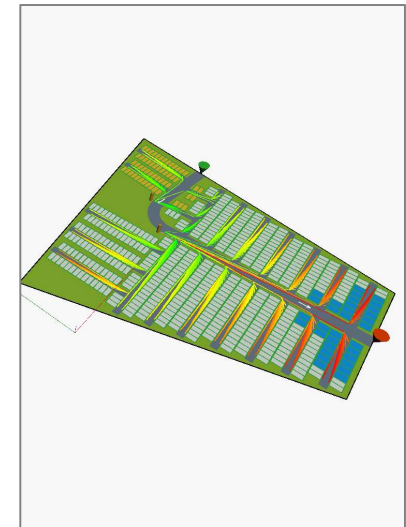
- Ensure most efficient and optimal parking layout

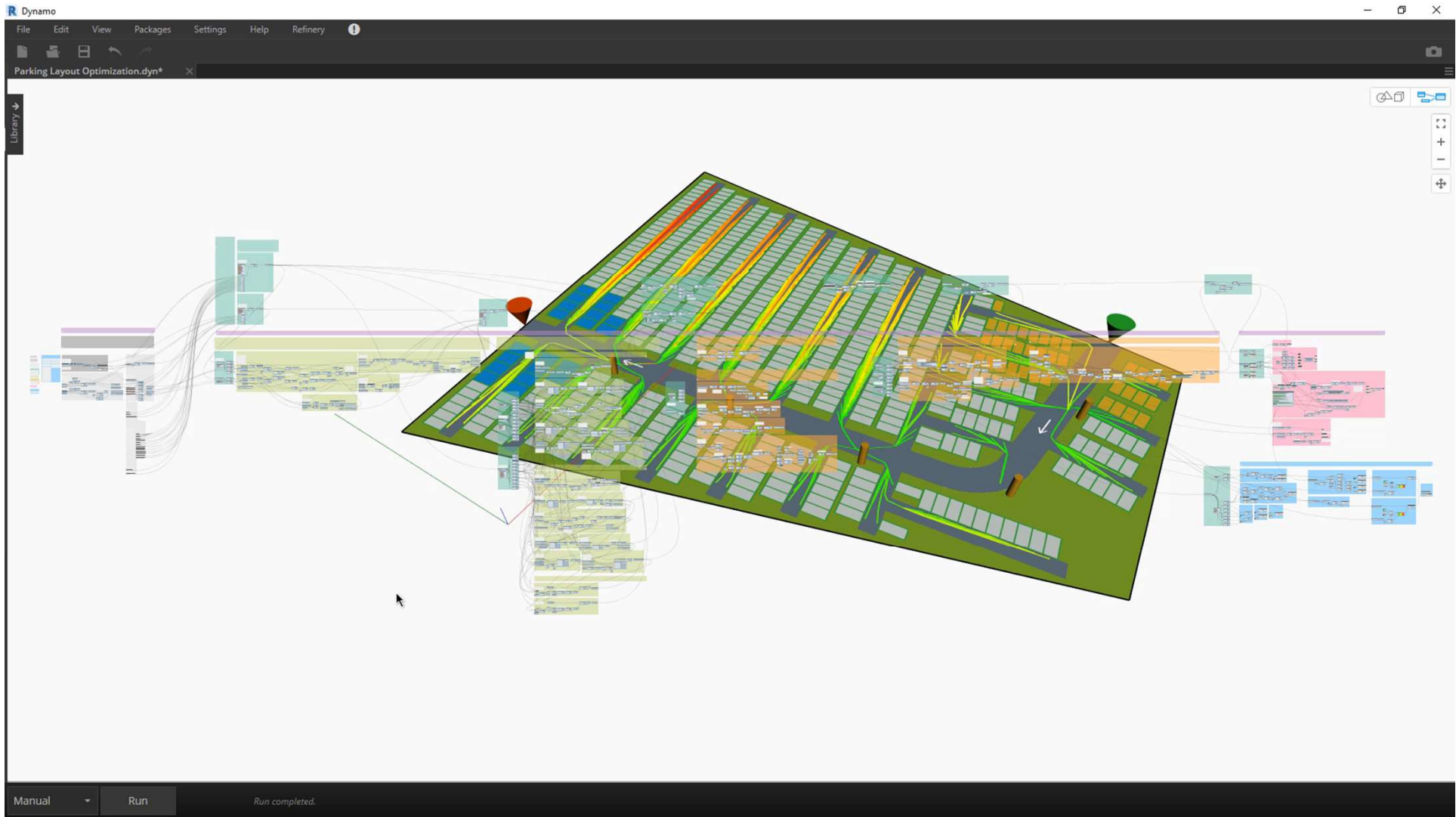


Increase Efficiency



**KEY OUTCOMES:**  
Improve circulation efficiency  
Reduce time to exit, Max ROI  
Integrate sustainable design





# Project Objective: Optimize Office Layout

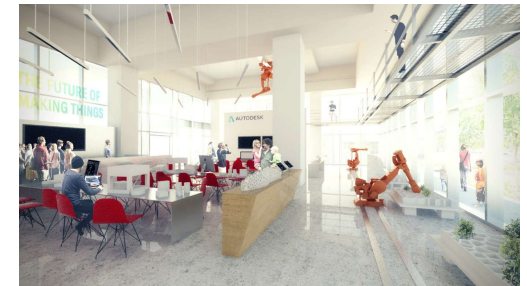
Developer: The Living, Autodesk

## Design Objectives:

- Reduce distraction
- Accommodate varying work styles
- Optimize views to outside
- Optimize daylighting
- Improve interconnectivity
- Honor adjacency preferences

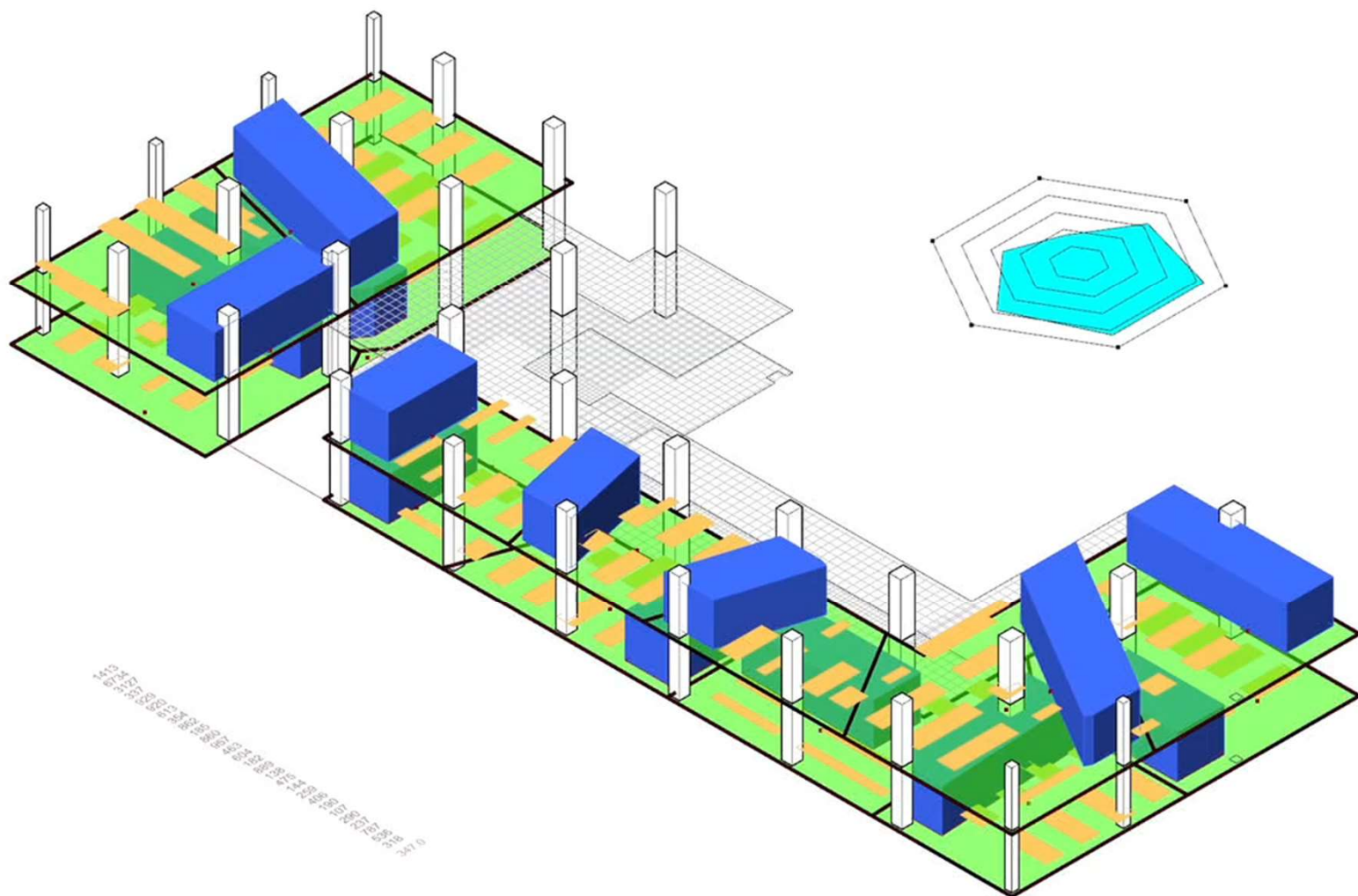


Increase Efficiency



## KEY OUTCOMES:

Reduced time to optimal design discovery  
Increased employee satisfaction and productivity



147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 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2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 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2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743 2744 2745 2746 2747 2748

**“We want to be able to learn from more designs than it is physically possible to generate or evaluate ‘by hand’.”**

– Danil Nagy, The Living



An aerial photograph of a city skyline, likely Chicago, during sunset. The sun is low on the horizon, casting a warm, golden glow over the city. The skyline is dense with skyscrapers, including the Willis Tower. The city extends to the water's edge, with a large body of water visible in the background. The sky is a mix of orange, yellow, and blue.

**VALUES MATTER**

**OUTCOMES MATTER**



Rethinking the importance of values and outcomes.



# Sampling of Values Related to Building Design

Sustainability	Completion	Experience	Exterior	Return on Investment
Cost	Preservation	Function	Interior	Maximizing FAR
Iconography	Innovation	Finish	Systems	Legacy
Maintaining Status Quo	Scale	Details	Program	Expression

# Values in Harmony

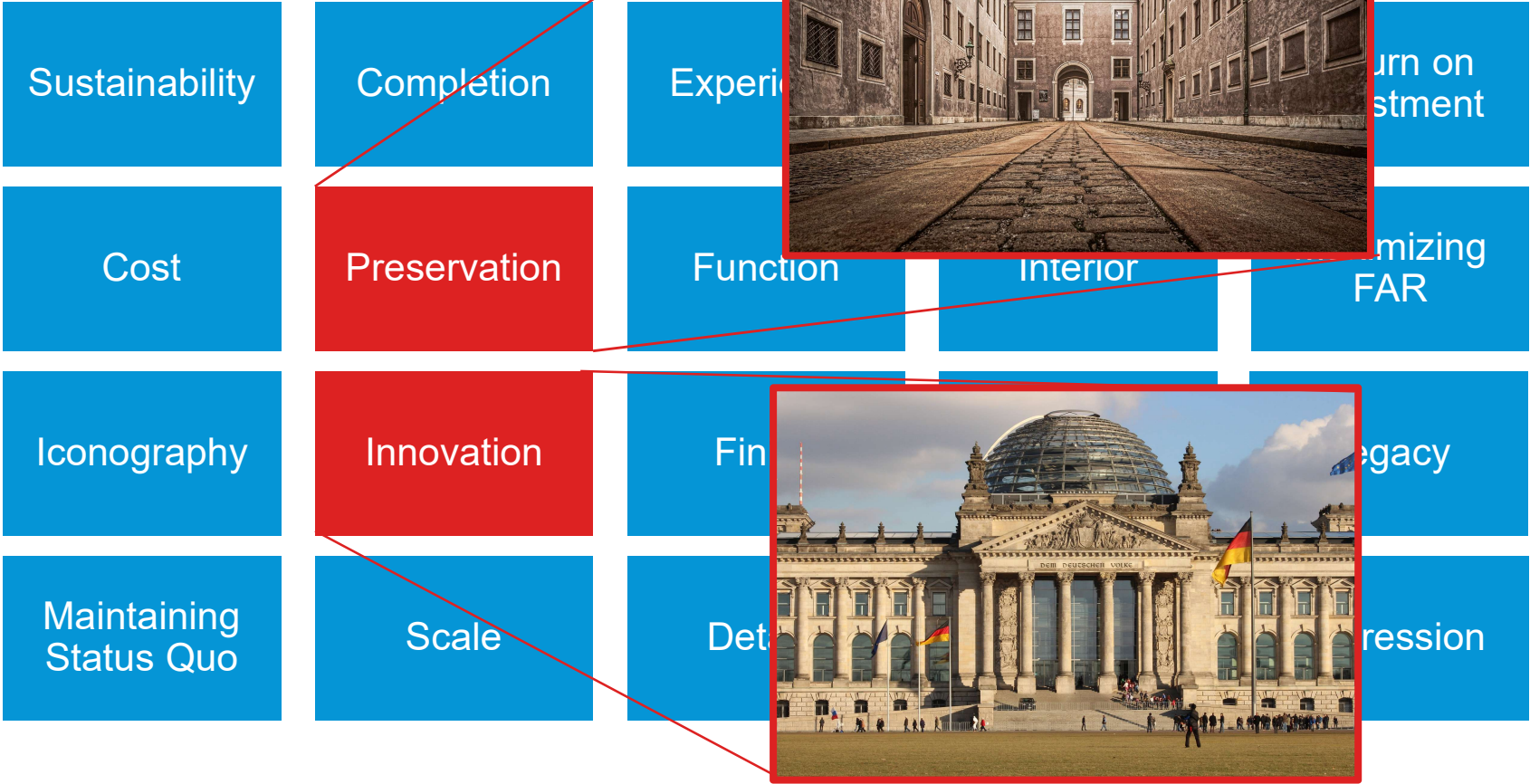


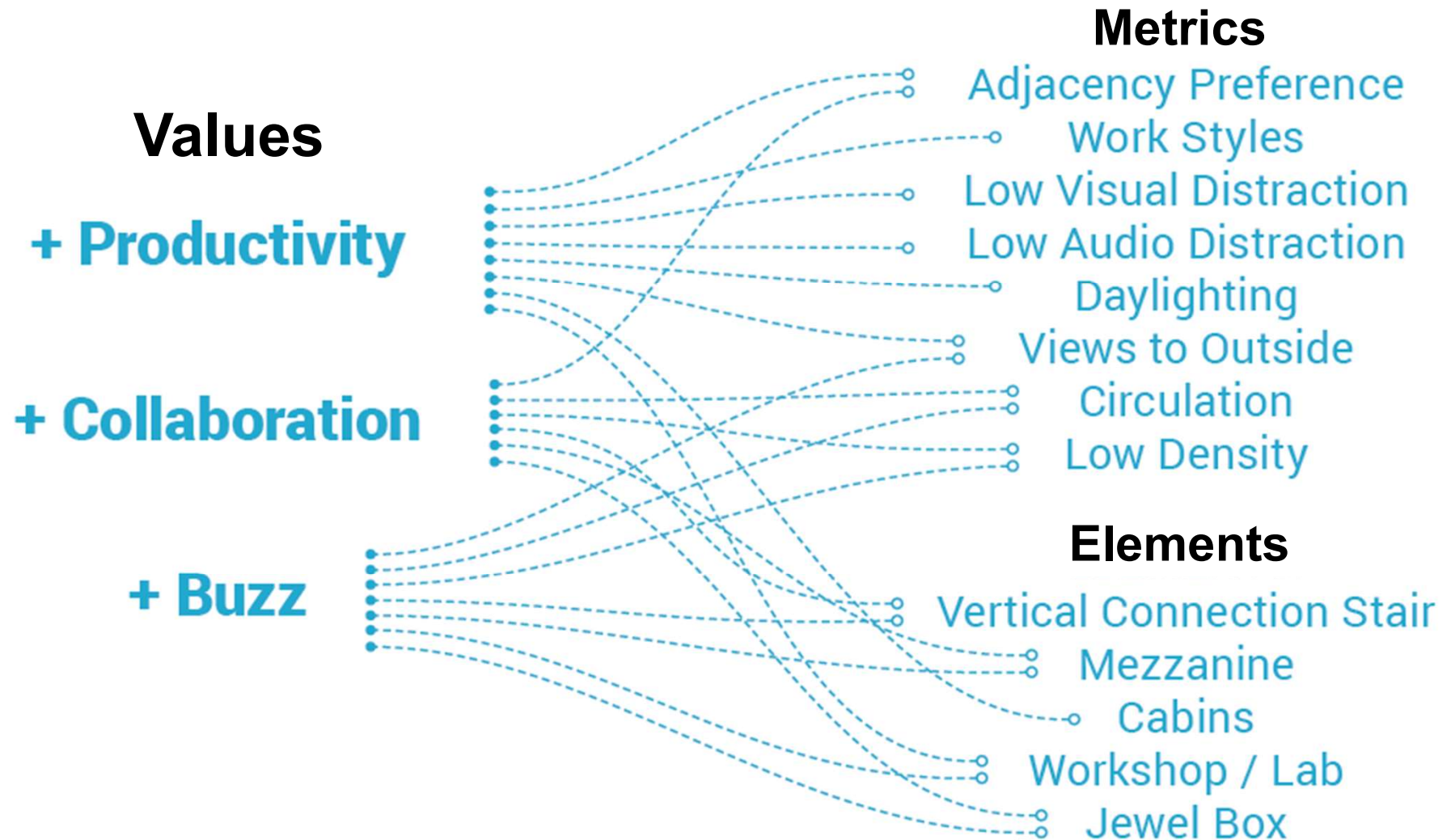
# Values Possibly Coexisting Simultaneously in Project



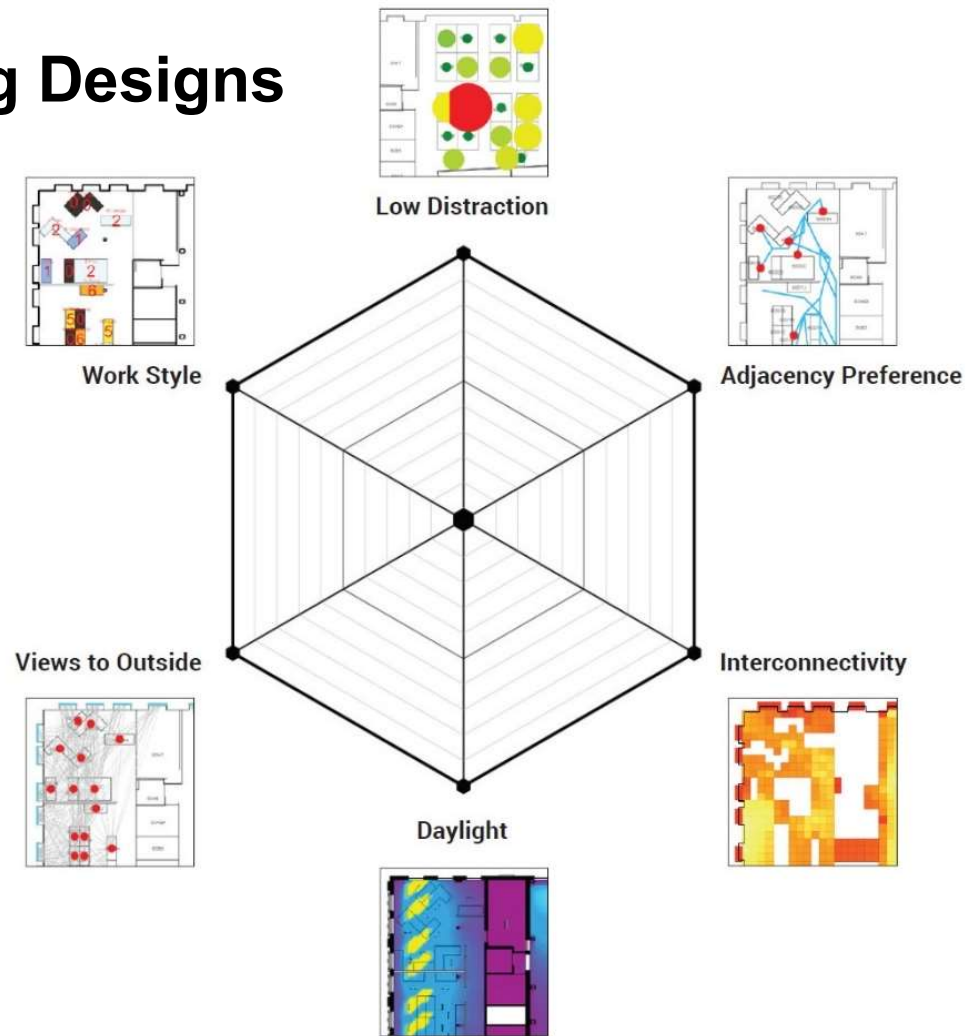


# Values in Opposition





# Values Driving Designs





A hand is shown holding a thick stack of US dollar bills, including \$20 and \$100 denominations. The hand is positioned in the foreground, with the bills fanned out slightly. In the background, a tall, modern glass skyscraper with a curved facade and many windows rises into the sky. The image is taken from a low angle, looking up at the building. The overall color palette is dominated by the blue of the building's glass and the tan of the money.

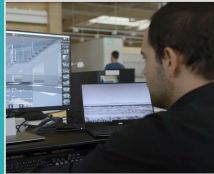
**Outcomes  
Driving  
Investment**

# Power Up With Outcome-driven Design

Strategic Planning



Outcome-driven  
Design



Parenthetical  
Analysis



Integrated Delivery



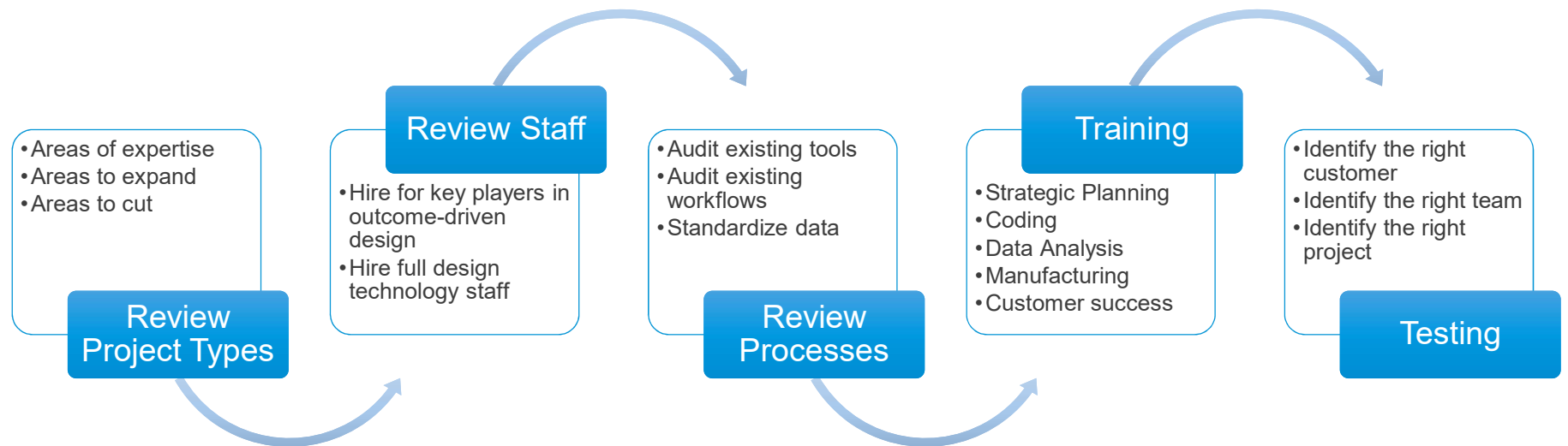
Operational Nurture



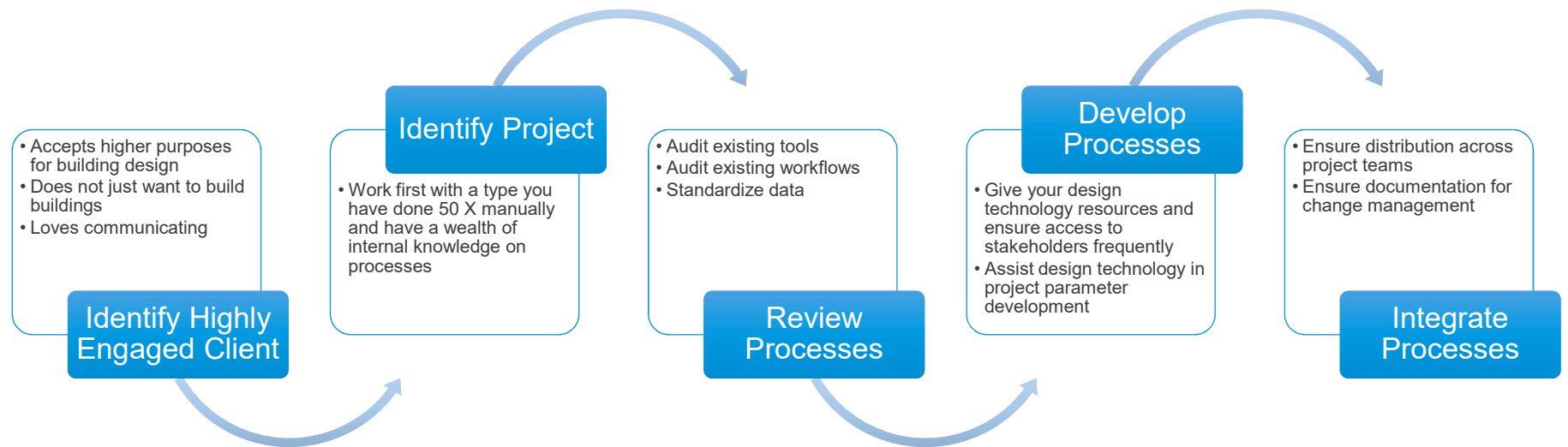
**PROCESS ADOPTION OUTCOME:  
BETTER BUILDINGS, FASTER, WITH LESS**



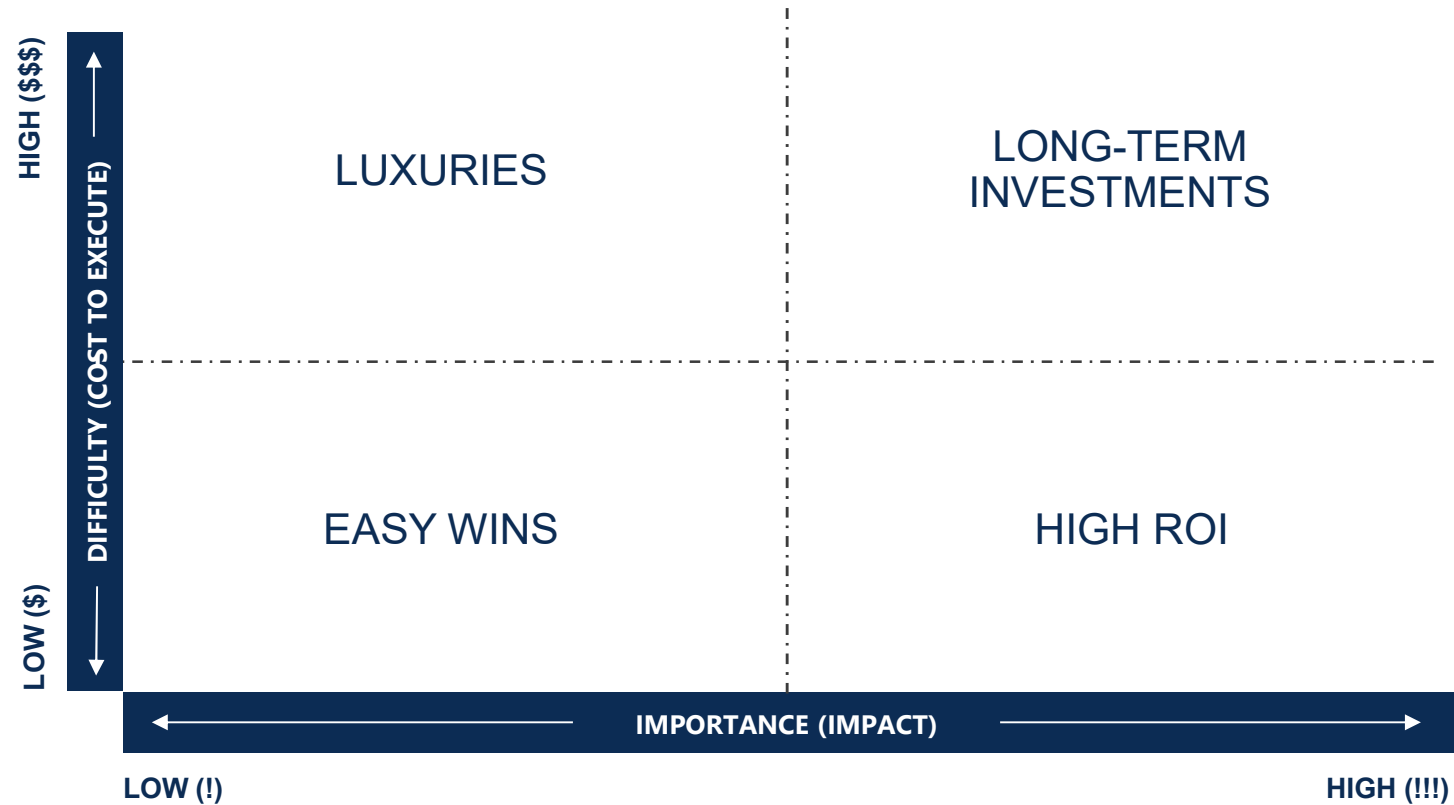
# Where to Start in Redefining Project Strategy



# Where to Start With Implementing Computational and Generative Design in Projects



# Identifying Projects for Execution



# Dynamo

- Revit 2020
- Civil 3D 2020
- Advance Steel 2020
- Alias 2020
- FormIt v.17



Home > News > AECO, Engineering – Apr 15, 2019 1:07 pm

## New Autodesk Civil 3D Gets Powered by new Dynamo Integration

by Anthony Frausto-Robledo AIA, LEED AP

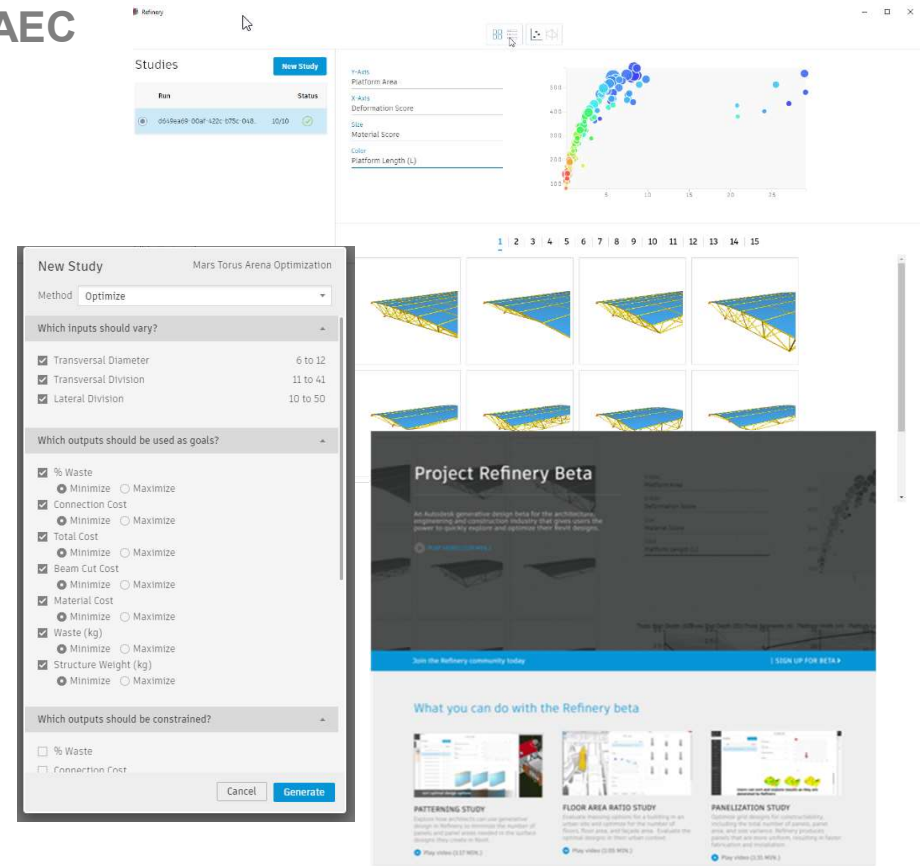
Dynamo for Civil 3D helps Autodesk's key infrastructure package enter the next era of civil design.



# Refinery

## Public Beta Project for Generative Design in AEC

- Explore and optimize designs
- Uses NSGA-II optimization algorithm  
Learn more here:  
[https://www.iitk.ac.in/kangal/Deb\\_NSGA-II.pdf](https://www.iitk.ac.in/kangal/Deb_NSGA-II.pdf)
- Advanced results display
- Syncing selected option back to Dynamo
- More information and beta access:  
[www.autodesk.com/solutions/refinery-beta](http://www.autodesk.com/solutions/refinery-beta)





# Additional Resources

Getting Started with Dynamo:

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

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

Dynamo Forum for questions, inspiration:

<https://forum.dynamobim.com/>

Project Refinery:

<https://www.autodesk.com/solutions/refinery-beta>

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

Generative Design education:

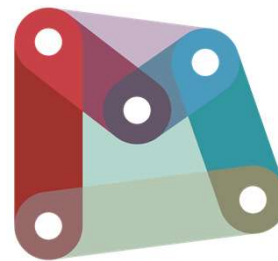
<https://medium.com/generative-design>

Design Script:

[http://designscript.io/DesignScript\\_user\\_manual\\_0.1.pdf](http://designscript.io/DesignScript_user_manual_0.1.pdf)

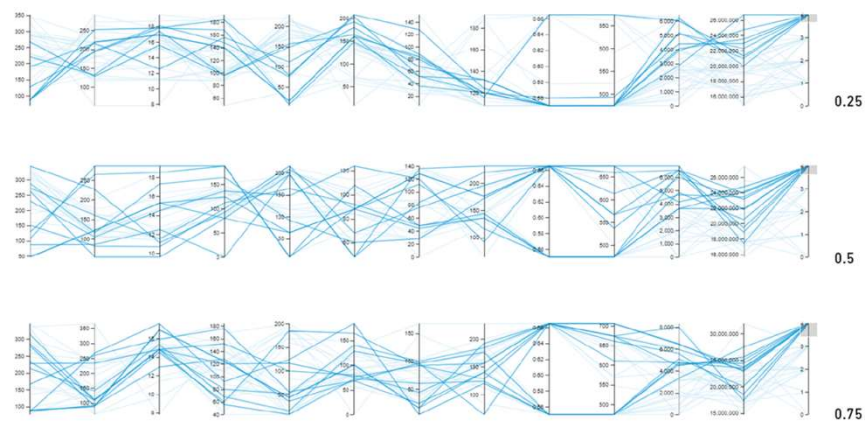
<https://dynamobim.org/wp-content/links/DesignScriptGuide.pdf>

<https://github.com/Amoursol/dynamoDesignScript>



<http://dynamobim.org/a-world-of-user-groups/>

# Toronto Generative Design Residency



## Exploring Generative Design for Coastal Resilience

Published on July 27, 2019



**Isaac Seah**  
Incoming Business Technology Analyst

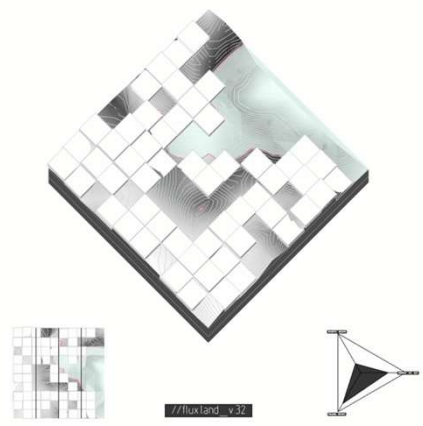
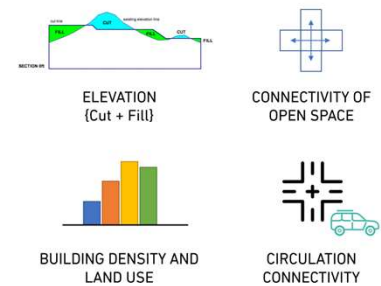
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### THE GD PROCESS

The generative design process will demonstrate the pipeline for an iterative design cycle using parcel level data, measured against quantitative measures that seek to maximize land values whilst reducing flood risk.



### DESIGN SPACE



# Checklist for Outcome-driven Design Project

- ☐ Determine project is an Outcome-driven Design project
- ☐ Mandate integrated project delivery methodology
- ☐ Ensure architects, technologists, engineers, consultants, contractors and all relevant parties to the design, construction and operation of the building are signed into a contract that incentivizes design excellence and starts collaboration at the inception of the work.
- ☐ Hold a week long offsite to determine big picture goals and project strategy with the client, including techniques such as LUMA for value discovery.
- ☐ Ensure clarity around building lifecycle objectives, initiatives, tactics and key results.
- ☐ Ensure commitment to design process strategy and development trajectory up front.
- ☐ Develop flexible parametric BIM model appropriate for the building typology
- ☐ Develop parentetic design analysis dashboard that captures the flexing design metrics
- ☐ Reduce time spent in rework and development through computational design integration
- ☐ Improve performance through holistic generative design approach at key process points
- ☐ Spend more time in tight coordination with architecture, systems and environmental teams for added value through enhanced detailing and design performance
- ☐ See project through to construction/completion with reduced errors and improved quality
- ☐ Monitor the lifecycle of the building and hold reality to proposal
- ☐ Recommend future work for the building based on usage and experience.
- ☐ Inform future typologies with results

# Sampling of Opportunities for Process Automation

## Schematic Design:

- Sun settings slider
- Match elements to reference plane
- Space and room data automation and manipulation
- Calculate FAR and GFA values
- Diagramming
- Expedited initial studies

## Design Development:

- Scope box review
- View range management
- Parameter assignment
- Create sheets and place Views on Sheets
- Excel square footage to family instance
- Area boundary to floor element
- Populates rooms with equipment / furnishings
- Manipulating grids
- Auto-dimensions grid lines
- Automating wall chamfers
- Create levels from excel

## Construction Documentation:

- Equipment to Excel
- Columns splicing
- Write to mechanical equipment
- Auto-set all equipment locations by space name
- Caissons to topography
- Create sheets and place Views on Sheets
- Populates rooms with equipment / furnishings
- Linked elements intersecting spaces data transfer
- Manipulating tags
- Updating text
- Swapping title blocks
- Place a legend on multiple sheets

## Construction Administration:

- Update design quickly
- Pipe height adjustment
- Construction field report automation
- Export instance and type parameters to excel
- Shop drawing review
- Clash detection
- Coordination



# Sampling of Opportunities for Generative Design

**[Residential]** Floor plan layout optimization

**[Residential]** Cabinet layout and location optimization

**[Environmental]** Sound reduction and wellness optimization through form location and material optimization

**[Performance Hall]** Seating automation and layout optimization, acoustic panel optimization

**[Healthcare]** Lift system location optimization

**[Environmental]** Building form optimization based on the impact of a shadow on a common space

**[Academic]** Desk layout automation and optimization

**[Office]** Workstation layout optimization

**[Healthcare]** Robotic sanitation system path of travel route optimization

**[Multi-family]** Unit mix automation and layout optimization

**[Urban Plan]** Optimize plan layout for bicycle transit requirements – think smart cities

**[Engineering]** Structural system optimization based on waste reduction and building envelope

## Conclusions

**Computational and Generative Design** are influencing design strategy

A new project strategy type is unfolding: **Outcome-driven Design**

Building design is facing **process and perception** problems related to compensation

The path to increasing profit and fees starts with **design efficiency and adding value**

### **Computational and Generative Design**

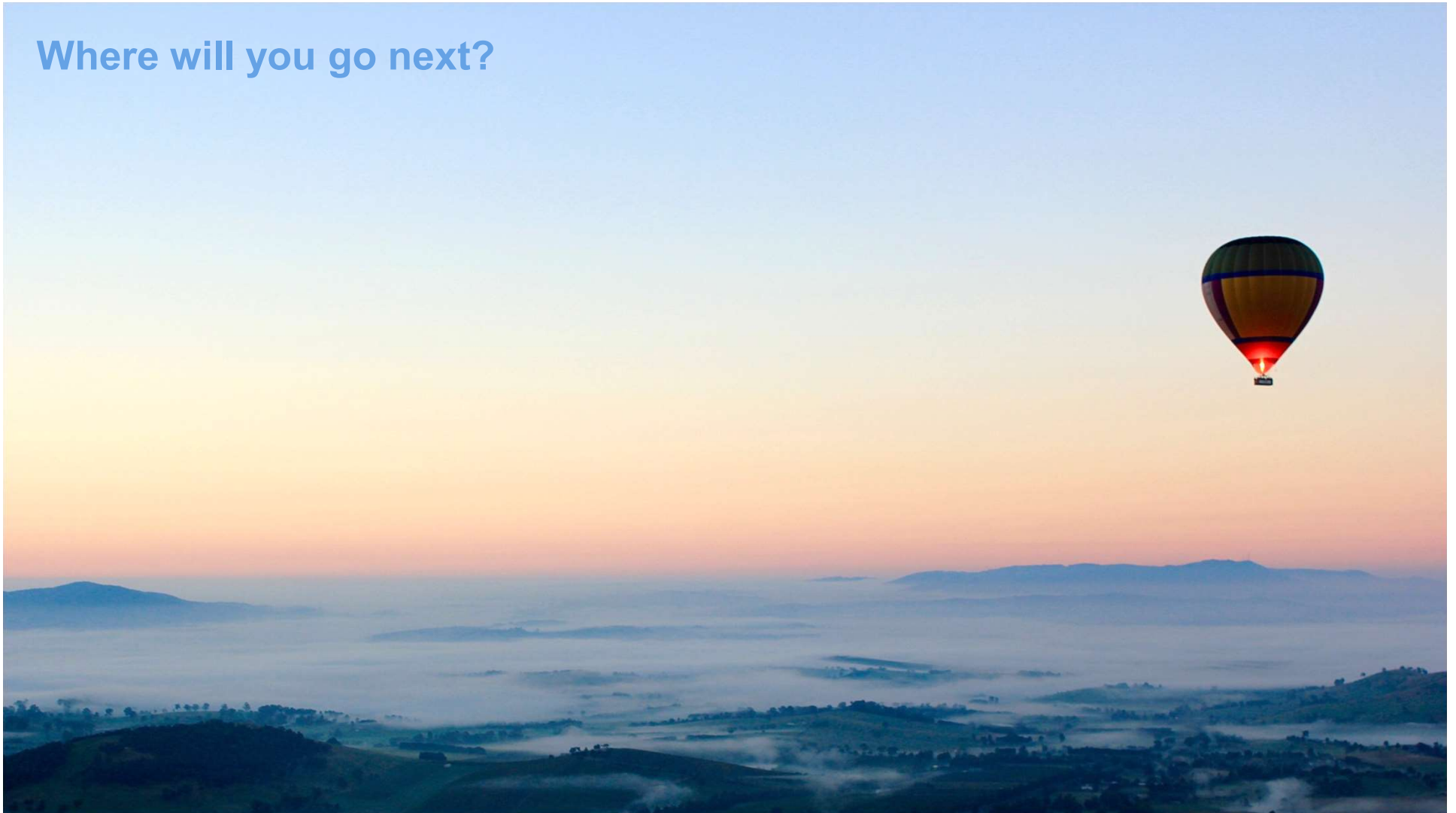
- Move the needle on design efficiency
- Add value
- Integrate into existing processes.

Implementing Generative Design in a project requires

**A shift in mindset on project strategy and early implementation in a project**

**Reach new heights with tangible design outcomes and expanding opportunities**

Where will you go next?





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