

THE FUTURE IS A DESIGN CHALLENGE

Solving tomorrow's challenges with
automation and generative design





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Introduction

Throughout the design process, architects constantly evaluate trade-offs and synchronize project priorities to deliver value for clients. With creativity and precision, architects strike a balance between exceeding client expectations and creating a design that's optimized, beautiful, and functional.

Achieving this consistently can be challenging because of increased project costs, growing client expectations, and a highly varied workforce. With these challenges top of mind, architects are transforming their design processes in order to deliver more value to clients.

Emerging technologies, like generative design and automation, are aiding this transformation by helping architects explore a wider range of design options with outcomes in mind. With these tools you can quickly evaluate and optimize your designs and make higher-performing decisions throughout the design process, freeing up your time to focus on tougher, more complex challenges.

In this ebook, we'll review what generative design and automation can do for more successful project outcomes and how you can implement these workflows today to deliver more value to your clients.

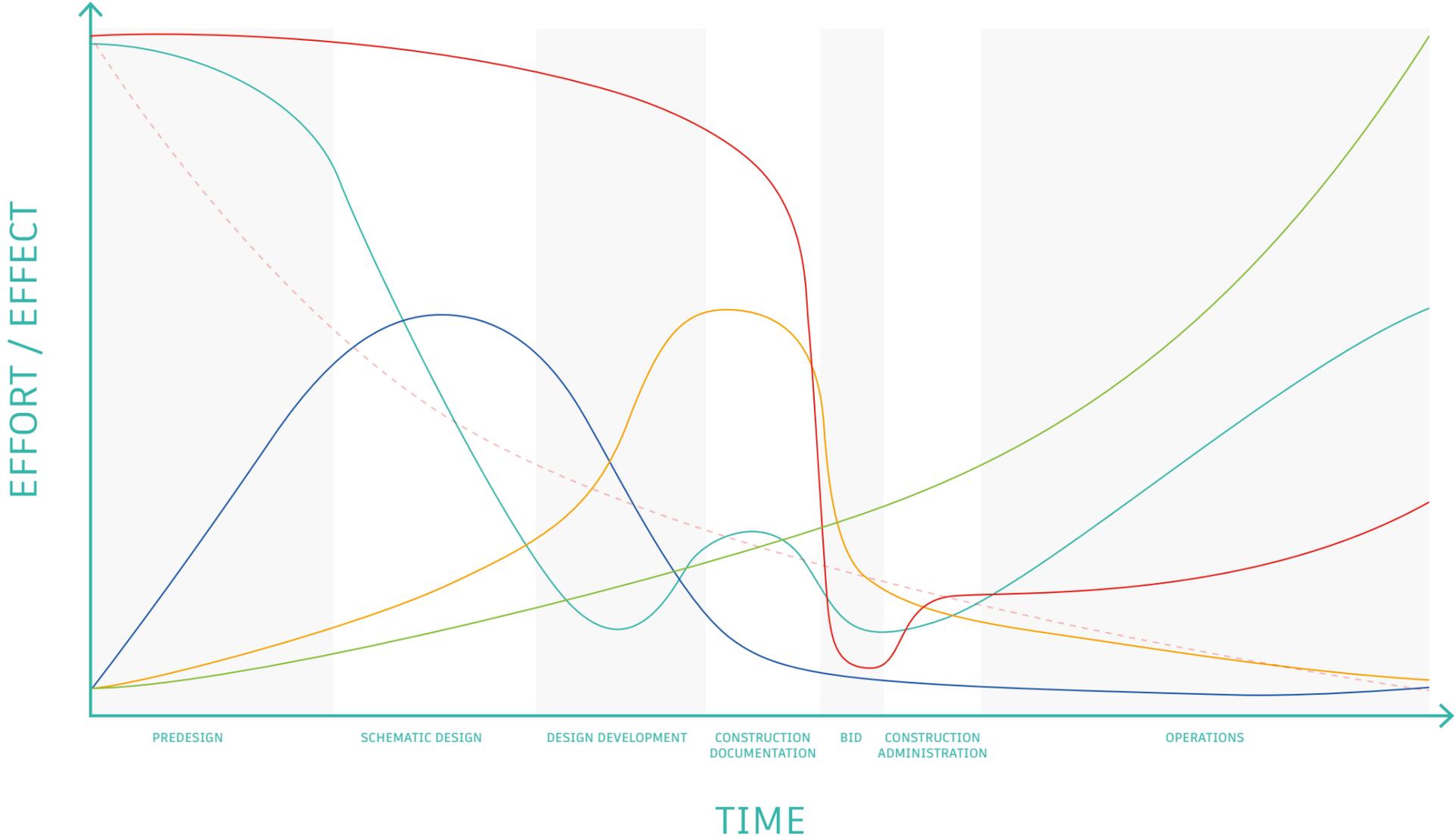


Designing with outcomes in mind

When you design with outcomes in mind, the effort that goes into a building project shifts from the design development phase into the predesign and schematic design phases. Aligning upstream and downstream stakeholders to identify what everyone needs upfront means that projects have a greater chance of success while increasing each individual's impact on the process. Designing with outcomes in mind focuses efforts on operational efficiency, from improved team collaboration to data handover, leading to reduced overall design time and a net increase in your workload capacity.

The ability to design with flexible parametric models, optimized by automation and generative design toolsets, allows you to make major changes to design later in the design phases. This extends the window of opportunity to impact cost and functional capabilities while pivoting and course-correcting the project in real time—see figure 1.

With automation and generative design processes, you can add more value to your projects. For example, you can improve visualizations, research and source local and sustainable materials and systems, or spend more time digging into project detailing.



-  **Future effort**
-  **Traditional effort**
-  **Outcome-based design**
 Parametric models informed by automation and generative design enable better definition of project outcomes, improving ability to impact cost and functional capabilities
-  **Contemporary effort**
-  **Cost of design changes**

Figure 1: Automation and generative design shift the design paradigm

Rewriting the project strategy rulebook

Beyond evolving design processes to prioritize values and outcomes, these emerging technologies are also revealing an entirely new approach to project strategy.

With traditional project strategy, the design process is linear, consisting of proactive and reactive work on a single building. Ideas are tested one-by-one, often without enough information to know in advance what will work. Each time, you must react and adjust the design based on shifting stakeholder priorities. You may only get to test a few ideas before time and budget constraints drive you to make a decision and move forward—see figure 2.

Automation and generative design are rewriting the rulebook. To automate and optimize workflows in the development phase of the design process requires a rigorous and extensive review of project and design goals at the beginning. This has the benefit of establishing clear transparency from the start. You're able to make decisions confidently and with the visibility you need to be successful. The design process is then largely proactive, yet flexible, allowing you to inform upstream development frameworks with downstream ideas and enabling you to have more meaningful conversations around design outcomes at any stage of the process—see figure 3.

Traditional project strategy

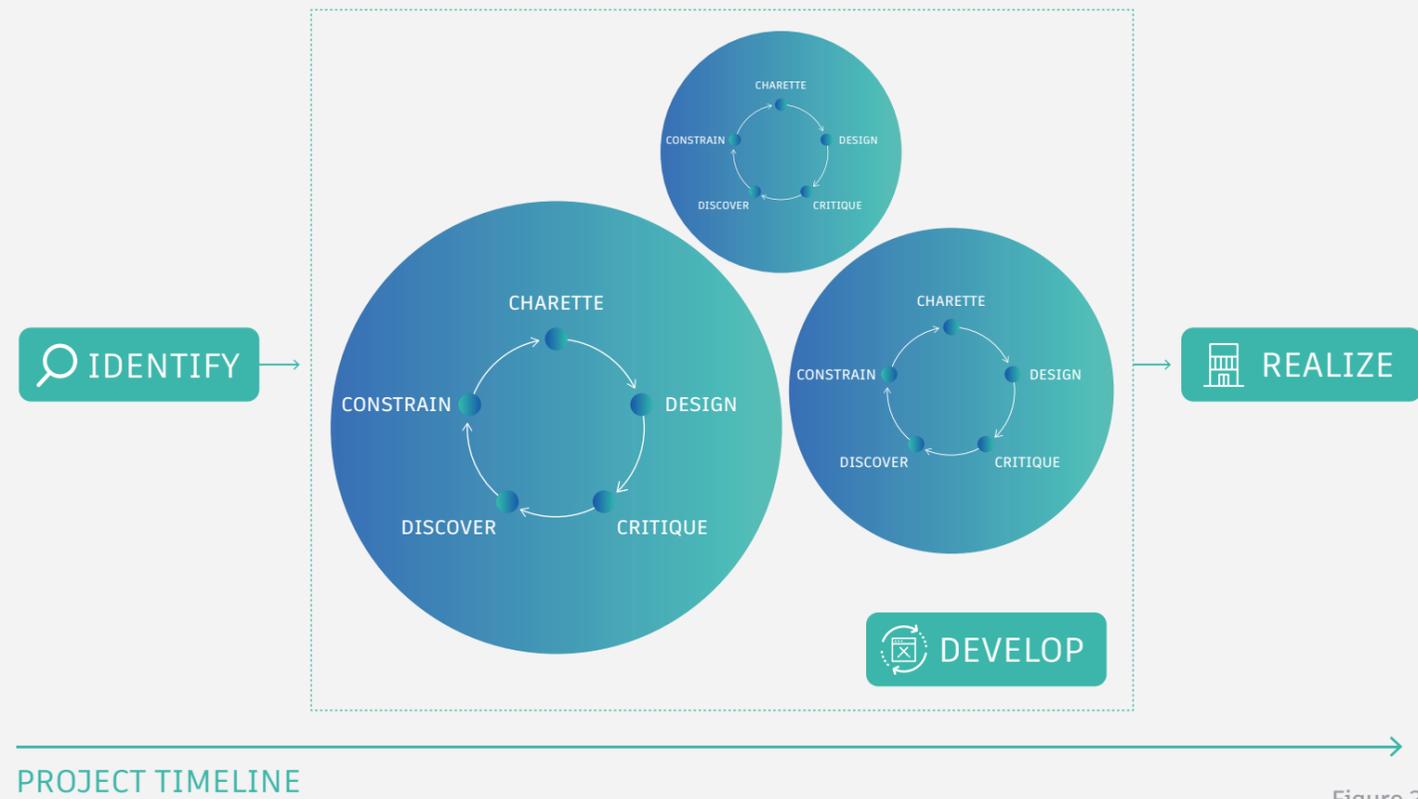


Figure 2

Future project strategy

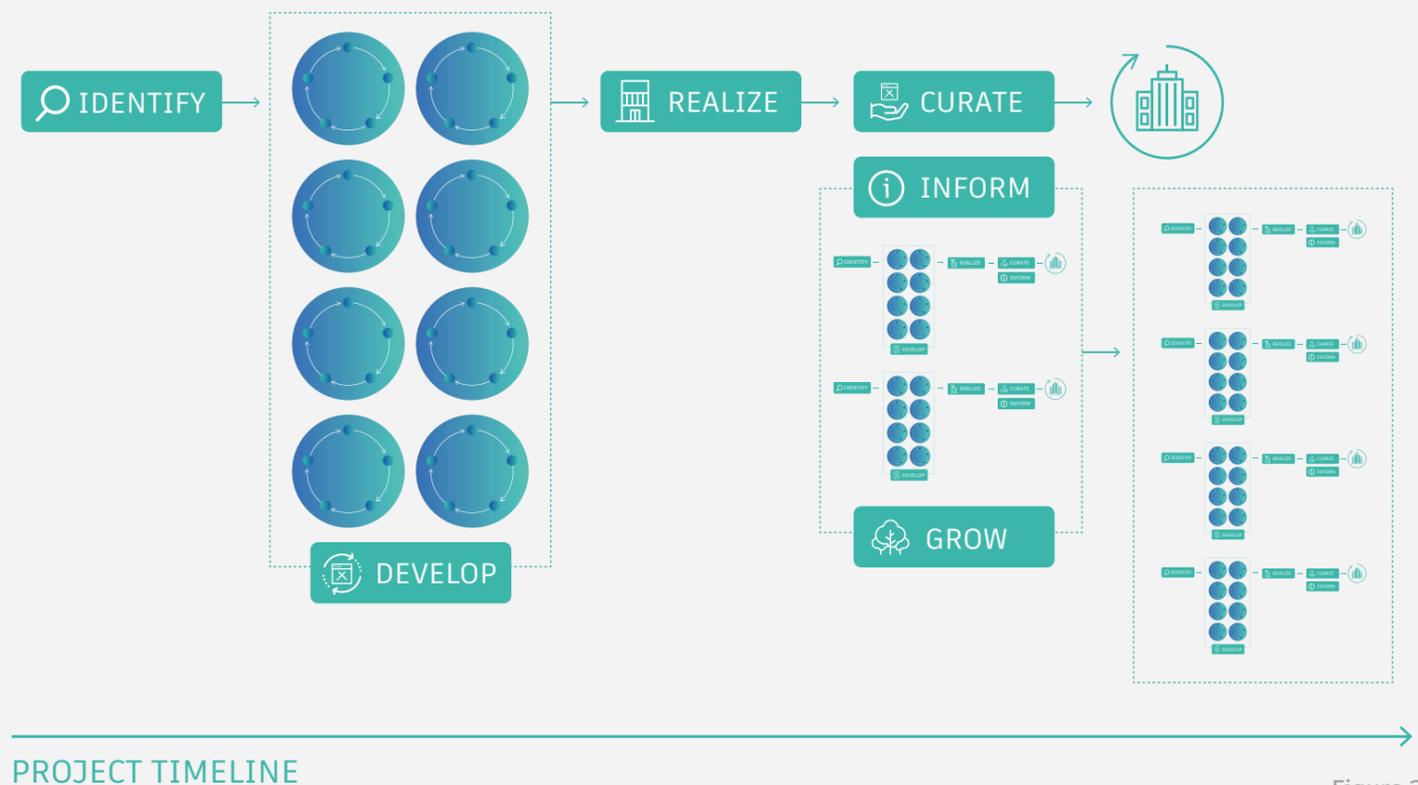


Figure 3

Implementing these workflows today

Ready to see some examples of what generative design and automation processes can do? Whether optimizing building forms based on view opportunities or ensuring that desks are laid out in the best possible way, generative design and automation processes are making optimization possible and integral to the design process.

Getting started with generative design

Generative design is a form of artificial intelligence, dedicated to the creation of better outcomes for buildings and systems. It utilizes algorithms, machine learning, and computational geometry to quickly explore multiple solutions to a given design problem.

With generative design, the designer can choose the highest-performing option based on the most critical criteria to meet their project goals. By using the computer to explore many design options and all possible iterations of a design, designers are able to achieve the outcomes they are targeting for the project and their business.

Emerging technology like Generative Design in Revit—a feature available through the Architecture, Engineering & Construction Collection with Revit 2021—is expanding generative design methodologies to a larger number of architects and designers. Think of Generative Design in Revit as a design optimization assistant, a way to gather data quickly to help make more informed design decisions.

Getting started with generative design

For example, perhaps you're designing a new office and need to optimize the number of desks but minimize the distance to the exits. Generative Design in Revit can help you create options based on your most important metrics, like desk count and distance to exits, so you can quickly find the most desirable solution. Check out the case study on optimizing office space layout in figure 4.

USE CASE: OPTIMIZE WORKSPACE LAYOUT

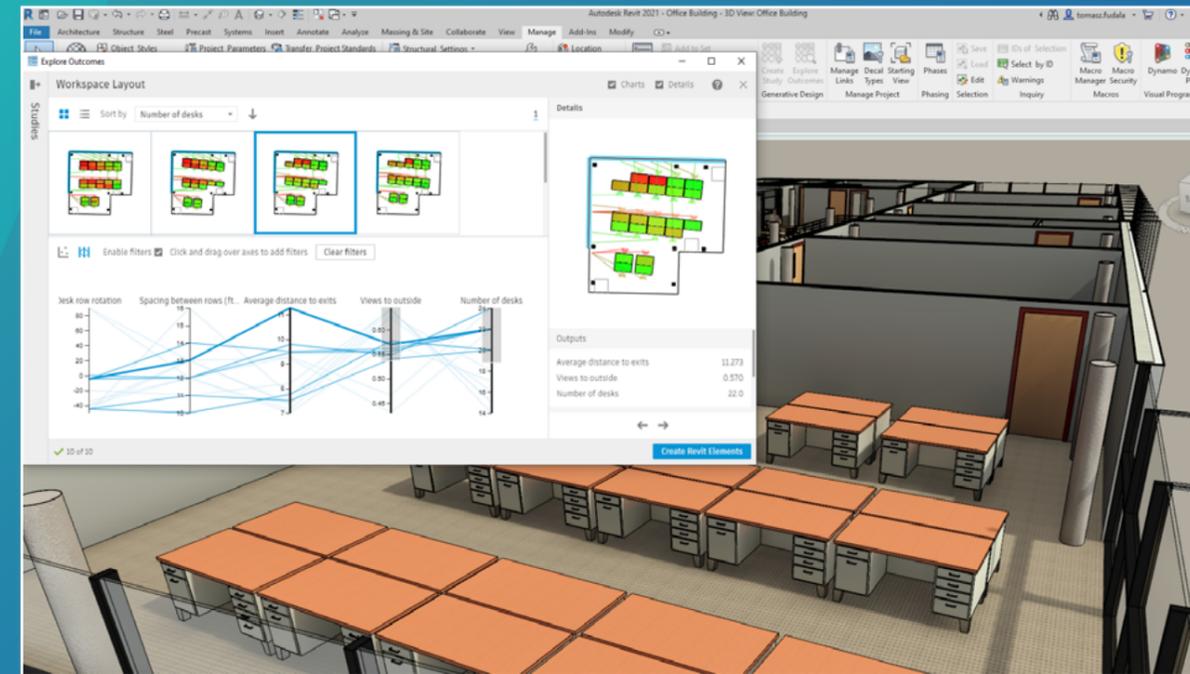


Figure 4: Generative Design in Revit

The task

Design a new office layout

The challenge

Maximize the number of desks while minimizing the distance to the exits

The tool

'Workspace Layout' study in Generative Design in Revit

Using generative design, you can quickly generate alternative floor plan layouts based on desk count, aisle width, and distance to exits.

Directly within Revit, the 'Workspace Layout' study can be used to optimize the floor plan. Start by choosing variables, then set the project goals.

Once the setup is completed, results are generated in minutes, leaving you free to continue to work in Revit or other applications. When the study is ready, you can start to explore the design options to see which works best for your project.

Take a detailed look at how to use this study [here](#).

Getting started with generative design

Or perhaps your client wants to expand their building with a new wing. You need to optimize rentable space while minimizing surface area to reduce construction costs. Generative design capabilities in Revit can help you find the best outcomes. Take a look at the building massing study in figure 5.

USE CASE: MAXIMIZE RENTABLE SPACE

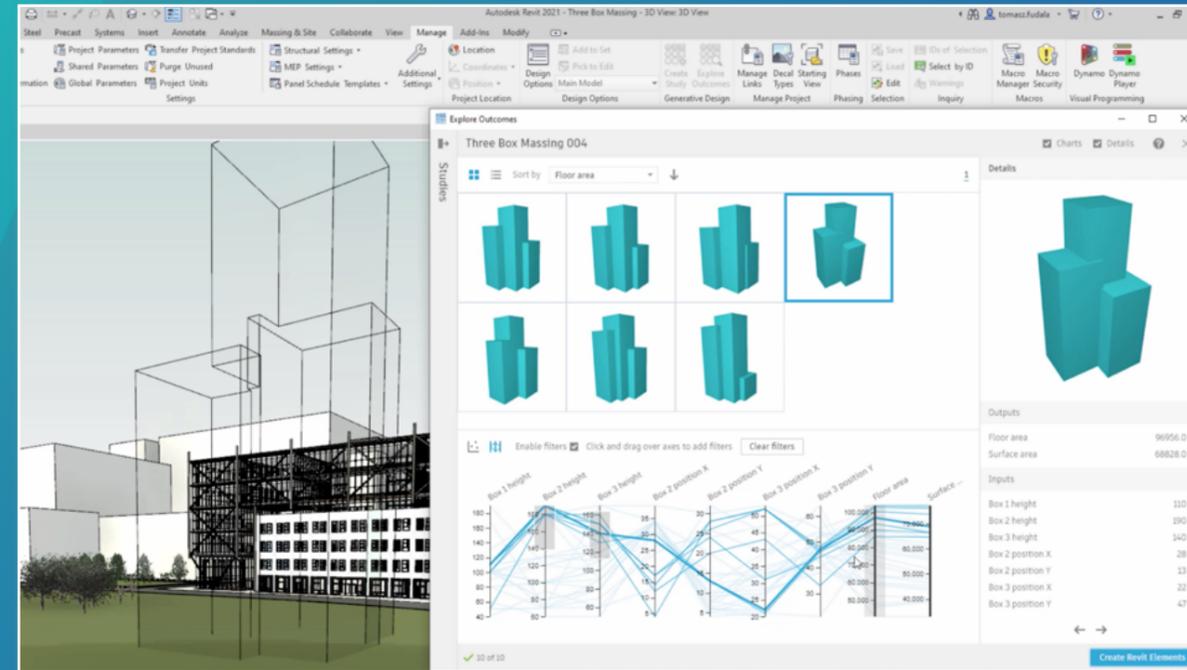


Figure 5: Generative Design in Revit

The task

Design a new office building wing for a client

The challenge

Minimize costs and maximize the rentable space

The tool

'Three Box Massing' study in Generative Design in Revit

Using this study, it's possible to review and analyze design options based on project goals. This example aims to maximize floor area while minimizing surface area to reduce construction costs.

Once you've generated options by inputting the variables and goals, each option is generated as a 3D view that you can manipulate to test its suitability. It's easy to review options by adjusting the scatterplot and changing criteria used for the X and Y axes.

After reviewing these potential outcomes, you can either iterate the study to alter the settings and generate further alternatives, or select a particular outcome to integrate into your model.

Find out more about how to use this study [here](#).

Getting started with generative design

And, if your client wants tenants to have great views from inside the office, Generative Design in Revit can help you identify where to place furniture for the best window views. You'll be able to generate various viewpoints, then use graphs to rank your designs based on what matters most. See how to maximize window views in figure 6.

As well as the pre-set studies available in Generative Design in Revit, you can customize or create your own studies through Dynamo in Revit. These studies can be shared with your whole firm to help serve the needs of your own studio-specific standards and challenges.

USE CASE: AMPLIFY WINDOW VIEWS

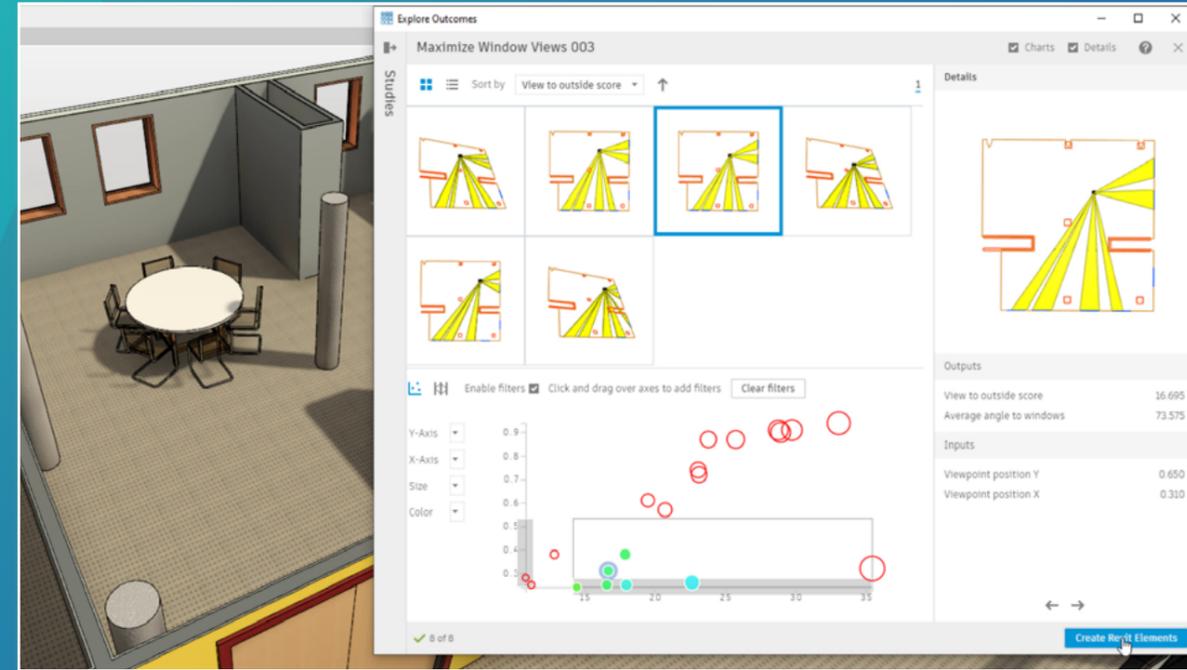


Figure 6: Generative Design in Revit

The task

A client wants their tenants to have great views from within their office

The challenge

Determine the best position in a room for optimal views to the outside

The tool

'Maximize Window Views' study in Generative Design in Revit

This study enables you to generate and analyze alternatives to find the best position in a room relative to window views. First, select a movable element within the room from which to calculate the views. Then, select the multiple window or curtain elements as well as elements that will obstruct views. Finally, set the goals.

Once the design outcomes are ready to explore, the tool will display the average angle to windows and a score that rates the view to outside. This is illustrated by a geometry visualization to help see results at a glance.

Learn more about this study [here](#).

Getting started with automation

While generative design allows you to explore what's possible, workflow automation is the tool to use when you know what you're trying to achieve. When you have a design solution in mind, automation can help get you there faster.

Automation can help architects and designers solve complex geometric problems with precision and speed, freeing up designers' time to focus on extending architectural services and adding more value to projects.

Once an architect or designer has decided on an outcome and formulated the problem they need to solve, automation comes into play. By inputting the relevant data, they can use tools such as Dynamo for Revit to iterate a solution automatically.

Dynamo extends the power of design tools with visual programming. It allows users to model more sophisticated design geometry using simple data, logic, and analysis. For example, you can automate the creation of sheets for multiple views using Dynamo by creating a reusable script that runs this task in a matter of minutes. See how to automate sheet creation in figures 7 and 8.

USE CASE: AUTOMATING SHEET CREATION

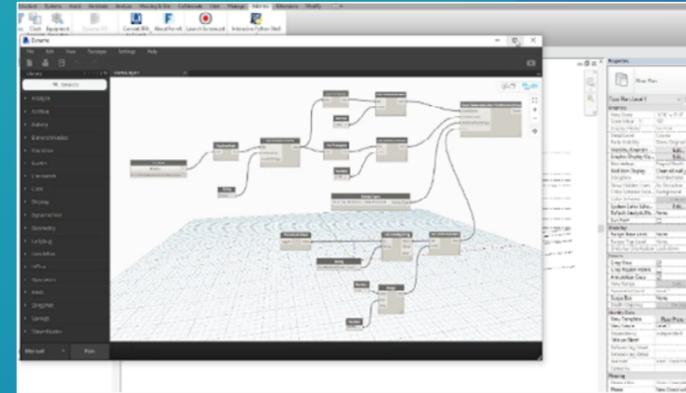


Figure 7: Automation in Dynamo

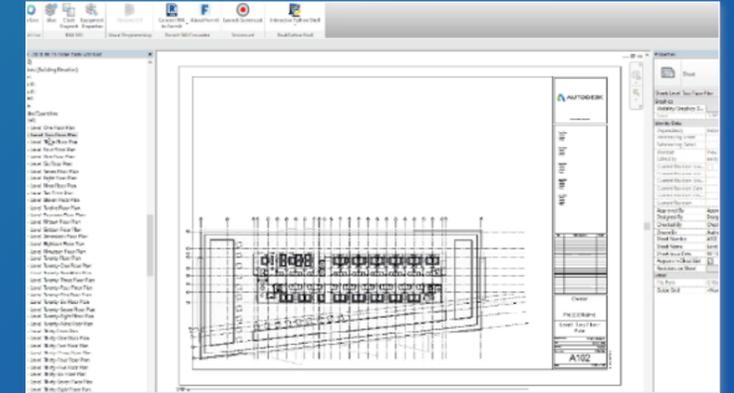


Figure 8: Sheet creation using Dynamo

The task

Create 39 views in your project browser for levels one through 40 of your

The challenge

Minimizing the time spent on sheet creation

The tool

A reusable Dynamo script for sheet creation

This task, which typically may take thirty minutes to an hour, can now be accomplished in just five minutes, with the click of a button using automation.

From the Revit add-ins toolbar, launch Dynamo and have a script ready to go for the task in hand. Drive the sheet names and numbers with data from Excel, using filtering in a list to specify the views to place on the sheets.

As you run the script using the manual run process, the Excel sheet opens up while referenced and Revit and Dynamo work together in the background to complete the task. Once the run is completed, the sheets have automatically been added to the project in Revit and the views are placed on the sheets.



The future of design starts here

This paradigm shift towards designing with outcomes in mind is the next step in the future of design. Automation and generative design allow architects to work faster and smarter, and spend more time solving complex design problems. They also add value by growing and extending your architectural services, while rising to the ever-expanding challenges of today and tomorrow. To find out more about how Autodesk is helping to shape the future of design, explore the links below.

New to generative design? [Learn more here](#)

Read a step by step guide on getting started with [Generative Design in Revit](#)

[Get Generative Design in Revit](#), available in the AEC Collection beginning with Revit 2021



About the author

Emily Bisaga Dunne is the Industry Outcomes Lead for Building Design at Autodesk.

In this global, strategic and operational position, she uses her expertise gleaned from several years' experience in the AEC industry to help Autodesk understand key business outcomes for architectural and engineering technology customers. Emily is passionate about BIM, Generative Design and Cloud Solutions, and is driven to ensure innovative technology adoption and usher the AEC industry into the next generation of design technology. The content of this ebook was derived from Emily's popular AU class, "The Business Value of Computational and Generative Design for Executives". Watch Emily's class [here](#).

