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AEC Generative Design and Dynamo Product Briefing

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Learning Objectives

- Discover the value of Dynamo, Dynamo Player, and Generative Design in Revit.
- Discover three examples of how customers are using these tools.
- Learn about the driving principles for future prioritization.
- Discover the future direction of the product and road map.

Description

This product briefing will showcase the latest advances in Dynamo, Dynamo Player, and Generative Design in Revit software. Learn from Autodesk AEC Computational Design and Automation product managers about where they've been focusing their efforts and what's on the road map for future releases. We'll show how we've improved the authoring experience in Dynamo and the running experience in both Dynamo Player and Generative Design in Revit, using real-world examples to showcase these tools. We'll demonstrate the value that Dynamo and Generative Design in Revit bring to the design process. We'll show how customers are using the tools to automate their workflows and design explorations in their projects. We'll cover the product principles that we use to prioritize new work and future directions. Finally, we'll address the future of the product, where we'll be investing, and our road map for achieving the future vision.

Speaker(s)

Lilli Smith, AIA, Sr. Product Manager at Autodesk, is an architect with a passion for re-envisioning the way that buildings are designed. After working for several years as an architect, she joined Revit Technology as a fledgling start up and helped grow it to where it is today in almost every architect's tool box. She has gone on to work on many Autodesk tools including Vasari, FormIt, Dynamo, Project Fractal and Project Refinery which recently graduated to a suite of tools for generative design studies first introduced in Revit 2021.

Sol Amour has a diverse range of experience across the fields of Software Development, Architecture, Construction, Landscaping, Industrial Design, Architecture and more. He has focused his career on Education and a technical understanding of complex problems, tempered by carefully considered holistic design. Most of his career has been set within multidisciplinary firms, working on large scale commercial projects, where his focus has been upon communication, clarity and effectiveness between all parties involved – all while delivering outstanding bespoke design solutions. He now works at Autodesk as the Product Manager of Dynamo, responsible for the strategy, vision, direction and growth of Dynamo moving forward.

Karam Baki is an Architect who started his BIM journey when he was 16 years old, and since then his passion for knowledge has never slowed down. He usually solves extremely complex problems related to Façade engineering in some high profile projects. Karam started AECedx for education and consultation, utilizing his skills to educate, manage and run teams across multiple companies around the world. He's also the author of Dynamo's "Synthesize Toolkit" package, and the Most Voted Author at dynamopackages.com

Dana DeFilippi leads the computation department at SmithGroup, a national multi-disciplinary firm, focusing on integrating efficiencies into standard practice. With over a decade of experience in Architecture and Engineering, she works closely with discipline leaders and staff for development and integration. An active participant in BIM-related user groups, Dana provides resources and education to the community through her YouTube channel DanamoBIM.

Edgar Pestana is a Mechanical Engineer with experience in several MEP projects. He believes that automation has a tremendous potential to increase quality of AEC projects. During his master degree in Business and Production, he conducted several research projects in how Innovation and Digitalization can increase productivity in the AEC industry. Since 2020, he has been working as a BIM Engineer at Basler & Hofmann AG (B&H), Switzerland. B&H is a planning, engineering and consulting company pioneering digitization in the construction sector.

Safe Harbor

During the course of this presentation, we may make statements regarding future events and/or statements regarding planned or future development efforts for our existing or new products and services. We wish to caution you that such statements reflect our current expectations, estimates and assumptions based on factors currently known to us and that actual events or results could differ materially. Also, these statements are not intended to be a promise or guarantee of future delivery of products, services or features but merely reflect our current plans, which may change. Purchasing decisions should not be made based upon reliance on these statements. The statements made in this presentation are being made as of the time and date of its live presentation. We do not assume any obligation to update any statements we make to reflect events that occur or circumstances that exist after the date of this presentation.

Why Computational and Generative Design?

A stunning 40% of global energy is used by our built environment. Buildings alone consume 25% of our water, and building construction produces 30% of all global waste. Architects and engineers as designers of the built environment have a responsibility to take on these issues. Workflows like using visual scripting to automate Revit workflows and generative design have the potential to revolutionize the way we design by speeding up our work, making it less error prone, and using goals and measurable outcomes to guide our designs.

Architectural and engineering services have evolved from drawing by hand on paper and delivering it to others to build buildings. Autodesk digitized this process over 40 years ago with the advent of AutoCAD. We've evolved to Building Information Modeling and more efficient ways to deliver building instructions to the field. What we really want to do next is to pair human

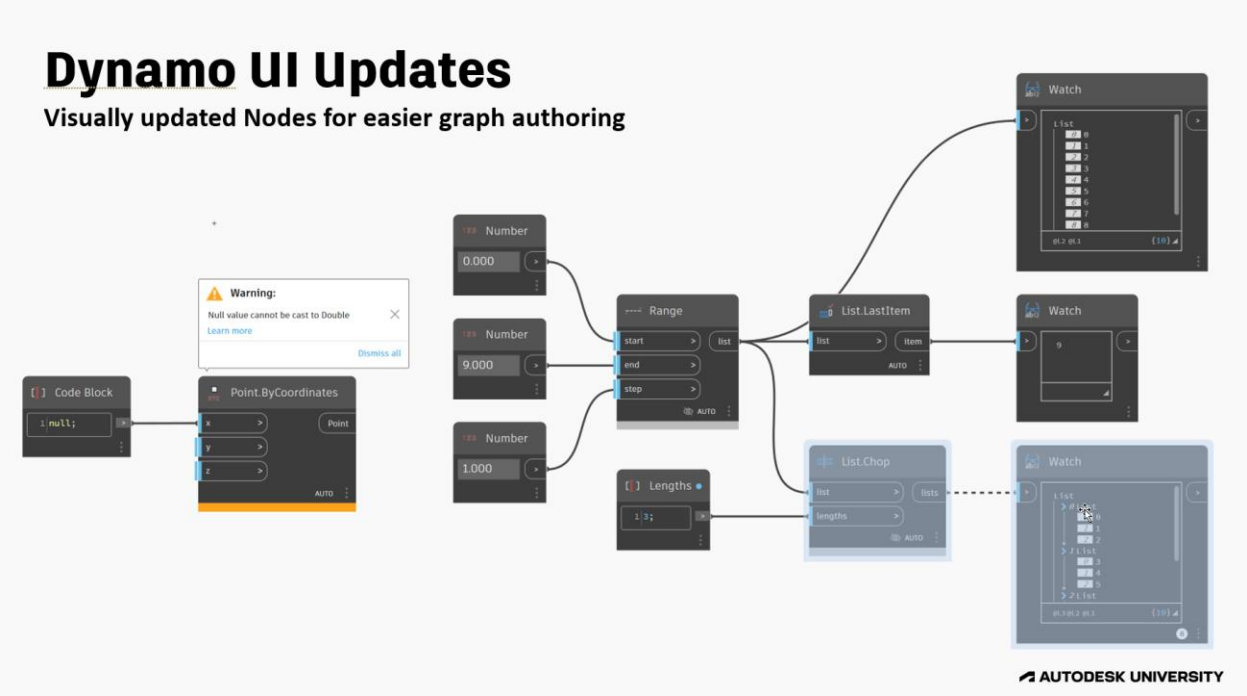
intelligence with machine intelligence so that we can use data-backed design decisions to create a better built environment.

This talk will be split into 3 sections:

1. What's new?
2. How are people using Dynamo and Generative Design?
3. What's next?

1. What's new?

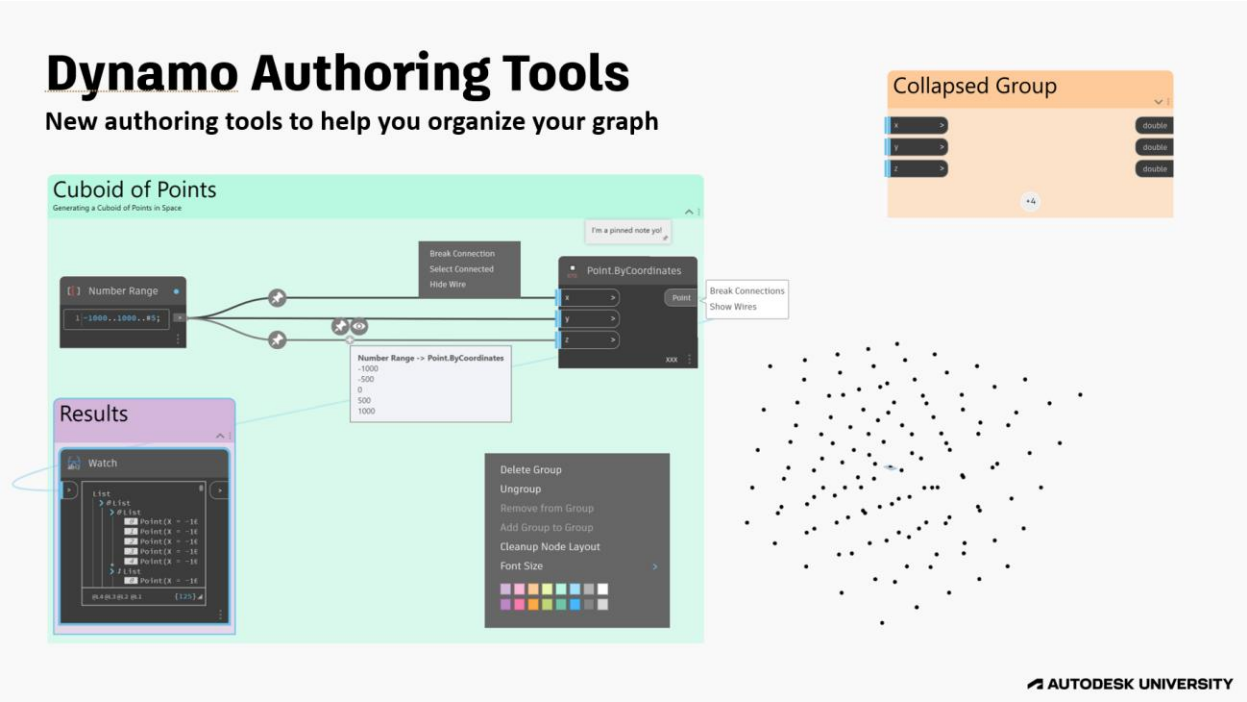
Dynamo UI Updates - Dynamo has undergone a visual refresh that reimagines the paradigms of what Dynamo is while still honoring it's past. With a focus on clarity, consistency and the removal of hidden behaviors, Dynamo's UI has been updated to give you information at your fingertips, ensuring you are well equipped on your Dynamo graph creation journey. A new look, a new feel, many quality-of-life improvements, but still the Dynamo you all know and love under the hood.



Dynamo Authoring Tools Part of this refresh was the introduction of a whole swathe of new graph authoring tools, designed to make your lives easier when building, curating and documenting Dynamo graphs.
We have a new set of Wire Actions, that allow you to:

- Hover over wire to see…
- The Data flowing through wire,
- Where you can also Choose to pin the wire
- Or insert a Watch node if the data is complex.
- You can also Right click on wire for the…

    - Ability to break connections and remove wire,
    - Select all nodes connected to this wire
    - Or hide the wire itself!
- We have also reimagined how Groups work in Dynamo, allowing you to…
    - Describe your Groups with both a Title and Description field,
    - Nest as many child groups inside a single parent group as you like,
    - Collapse groups that do not need to be interacted with often to remove visual clutter and gently lead another through your graph logic.
    - Take note that collapsed groups behave as large nodes, automatically generating inputs and outputs from the nodes contained inside! Epic stuff.



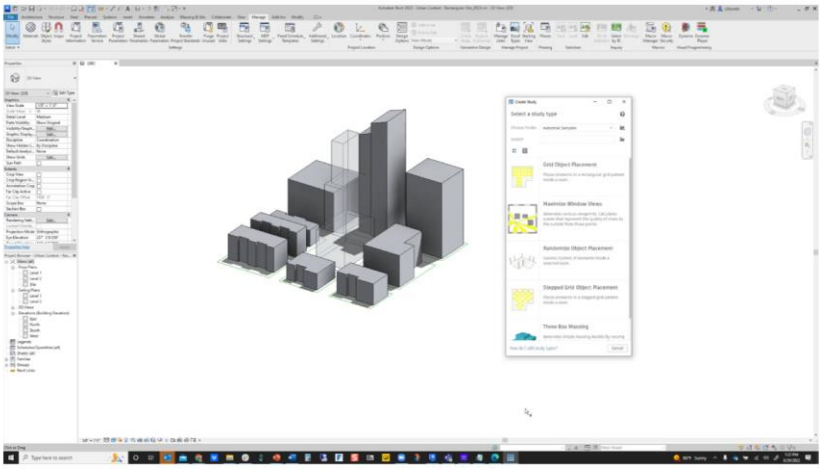
Dynamo Node Auto-Complete for more effective and efficient graph authoring. We've heard a lot of people complain that they often get stuck trying to figure out which nodes can feed into others. Node Autocomplete addresses these concerns by providing an applicable list of choices based on object type. You can think of this as a curated library of nodes that will work with the node you are triggering from. It still requires design intent, but discoverability is much less daunting. We also have some in-depth documentation that you can read inside Dynamo around what Node Autocomplete is and how to use it.

Generative Design Updates

GenDesign – Create Study Improvements

Revit 2023

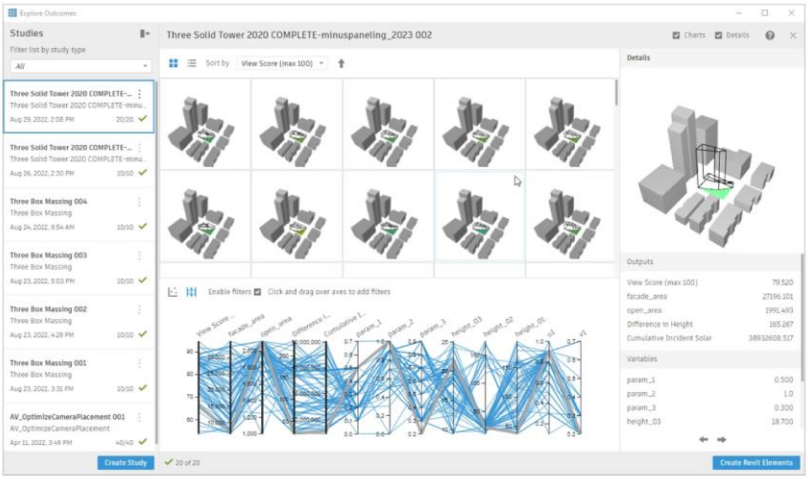
- Keyboard navigation
- New input types
- Detailed information links
- Renamed and better explained option generation methods



Gen Design - Explore Improvements

Revit 2023

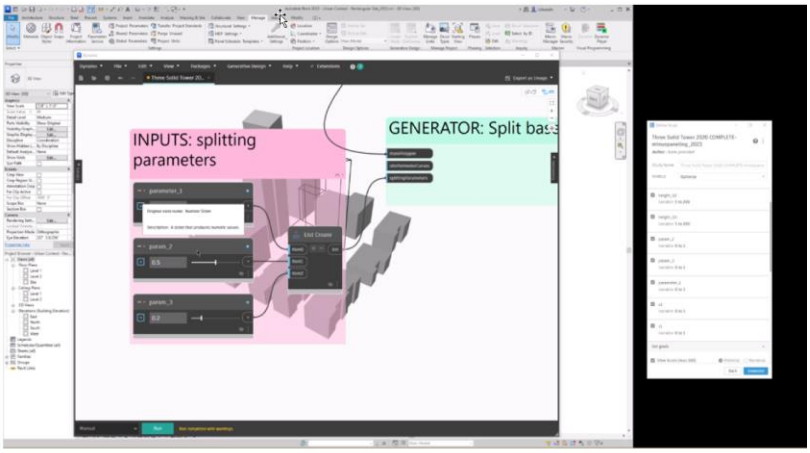
- See more than 10 outcomes at once
- Export outcomes (including thumbnails and rejected options)



Gen Design/Dynamo Improvements

Revit 2023

- Work in Dynamo without having to close Dynamo Player.
- Set graph type to generative design
- Show/edit graph properties

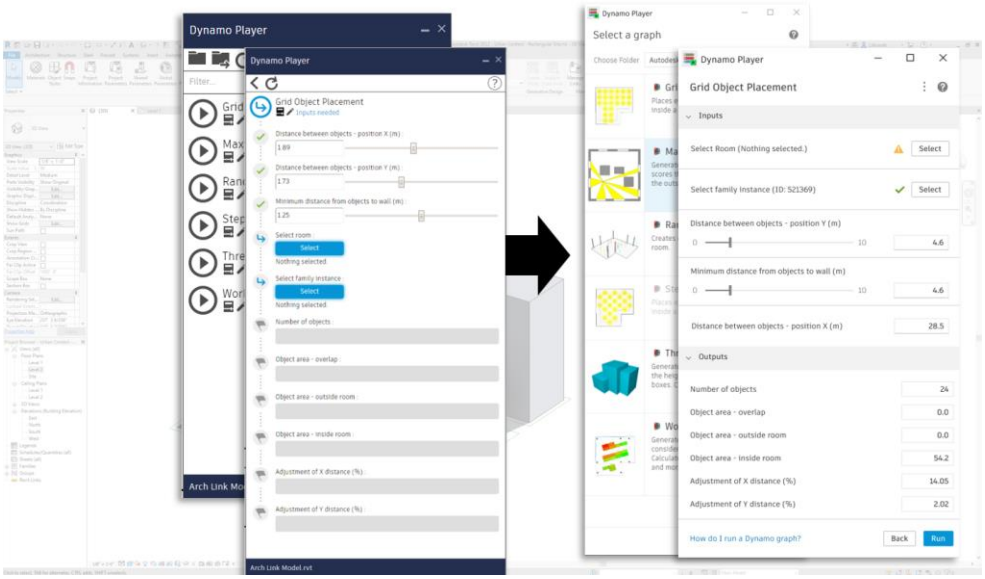


See more information here: [Generative Design Improvements in Revit 2023]

Dynamo Player Updates

Dynamo Player UI Updates

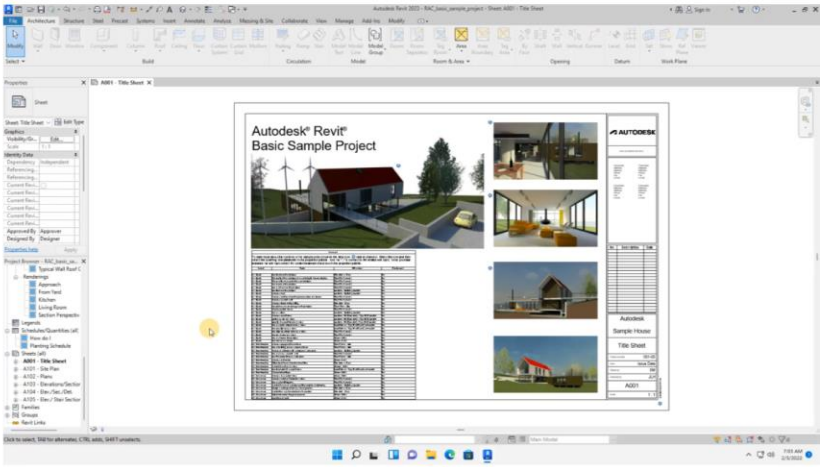
Revit 2023



Dynamo Player Improvements

Revit 2023

- UI consistent with Generative Design
- Manage and save folder locations
- Add descriptions and thumbnails to graphs
- Add links to more detailed information
- Add a description and author information to the graph



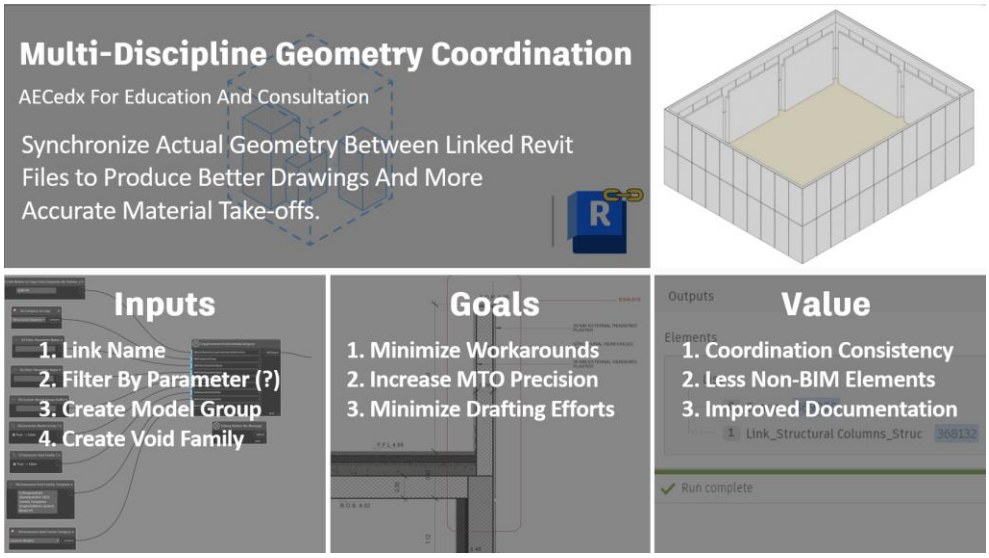
See more information here: [Dynamo Player Improvements in Revit 2023]

2. How are people using Dynamo and Generative Design?

This section covers three customer use cases. Check out the presentations for more details.

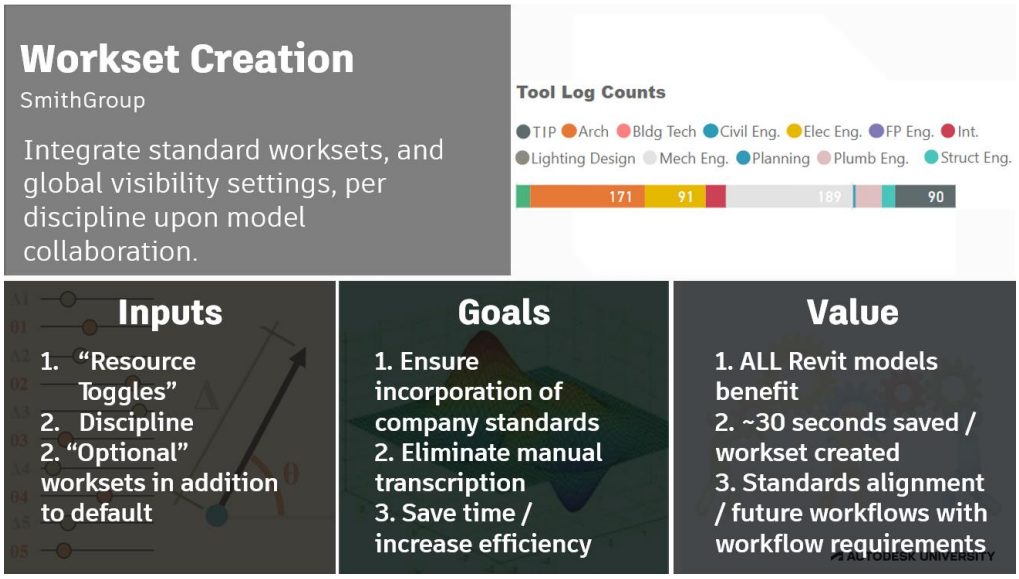
- **Multi-Discpline Geometry Coordination**

  Karam Baki, started AECedx for education and consultation, utilizing his skills to educate, manage and run teams across multiple companies around the world. He will show us a Dynamo workflow to Synchronize Actual Geometry Between Linked Revit Files to Produce Better Drawings And More Accurate Material Take-offs.



- **Workset Creation with Dynamo Player**

  Dana De Filippi, Computational Lead at the Smith Group Architects in Washington DC, will show us a workflow she developed to ensure incorporation of company standards, eliminate manual transcription, and save time.



- **SpacIng - MEP Design Optimization with Generative Design in Revit**

In this story, Edgar Pestana will show you how Basler & Hofmann AG uses Generative Design in Revit to optimize the early project phase of MEP design for Residential Buildings in Switzerland. Choosing the right design concept at an early project phase has extreme impact on its success. However, this phase often has tight deadlines and a shortage of resources. This makes the evaluation of all variants impractical and compromises the project quality. As the residential real estate is evolving, issues such as space optimization and sustainability are key challenges. Basler & Hofmann AG created a GD tool called spacing. spacing uses the architectural layout (IFC) as input, and customizable MEP solutions as variables. The tool iteratively generates intelligent variants based on the input objectives, such as minimizing technical space while ensuring feasibility of the installation. The variants are presented in the Revit model and their respective KPIs in a report.
spacing improves decision-making, reduces rework with time savings up to 60% and ensures space reservation for the detail design.

More on spaceIng

spacing, a generative design product digitalizes the norm-based planning services for MEP design optimization in early phase. It enables architects, investors and other stakeholders to make self-sufficient analysis of technical space requirements for diverse variant proposals with a ‘single-click’. Most significant/sought after use case of *spacing* is to minimize the technical space while ensuring good feasibility of the MEP design.

The tool requires the proposed architectural layout in .ifc format as an input, uses the Swiss National MEP standards for demand analysis and dimensioning and also weighs in the proposed MEP System types and space positioning from the architects.

The primary goal is to find a strong balance between minimizing technical space usage and maximizing feasibility of technical installations, thereby consequently satisfying both the architects and MEP planers with their individual requirements.

spacing adds enormous value by saving 60% process time in comparison to the conventional planning process. It enriches the design options by providing multiple solutions. *spacing* improves design communication between stakeholders with reduced back and forth efforts. In addition, *spacing* simplifies the decision making process with concrete and information-rich visual representations.

Vision

Many specialized planning services like MEP, Fire, Structural etc are based on norms and standards. *spacing* is conceived as a parametric generative design tool which can automate the repetitive norm based planning services and enhance the flexibility of architectural design in the early phase.

Basler & Hofmann started prototyping with MEP as the pilot discipline and are in the process of considering others. For now, *spacing* is developed the tool for Multi-family houses with simple geometrical forms.

spacing process

Inputs

Fundamentally, *spacing* needs the architectural layout in .ifc format with the apartment areas grouped as a IfcZone and the MEP shafts to be predefined as IfcSpace. It also requires the proposed technical rooms and spaces with hot water demand differentiated with another space name.

The detail of technical rooms should be simplified in the model. Elements such as columns and compound walls should be removed from these spaces.

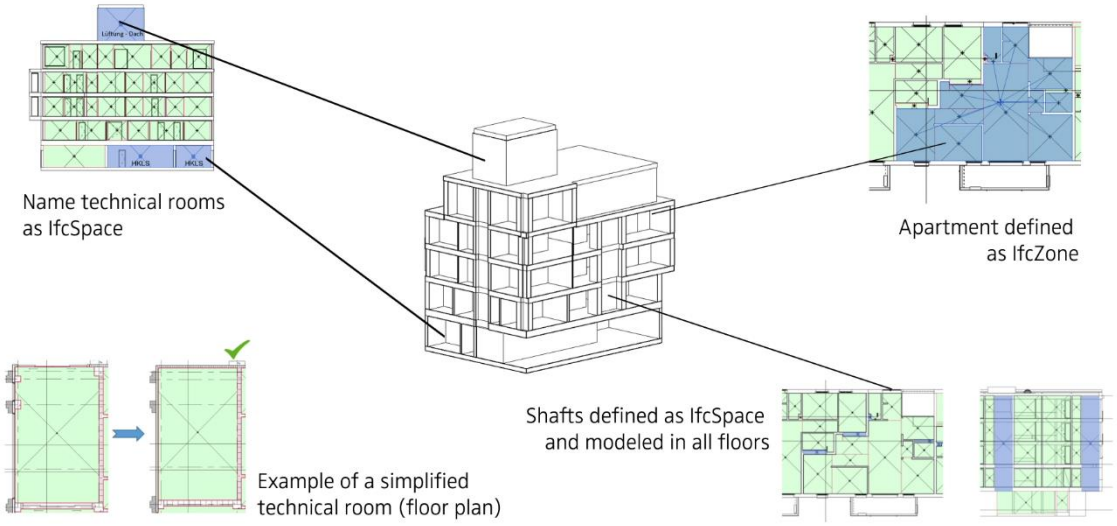


Figure A: *spacing* inputs

Generative Design Algorithm

The algorithm is built with Swiss norms as the basis, but highly adaptable and scalable for other norms. The software tools used are Revit, Dynamo and Generative Design – all from Autodesk.

spacing uses five generative design goals:

1. Usable floor space in basement with recommended free height of 2.25 m – is achieved through minimizing the installations under this height.

2. Collision and clash detection between the different MEP components and elements such as ducts and pipe networks – this function is minimized in the algorithm.

3. Feasibility of technical rooms with enough space for predicted technical equipment – this is a critical parameter and is maximized.

4. Usable apartment spaces – this parameter indicates the direct rentable floor area for an architect and is maximized.

5. Usable common spaces – this parameter represents the usable area for rooms like parking, laundry, bicycle parking et

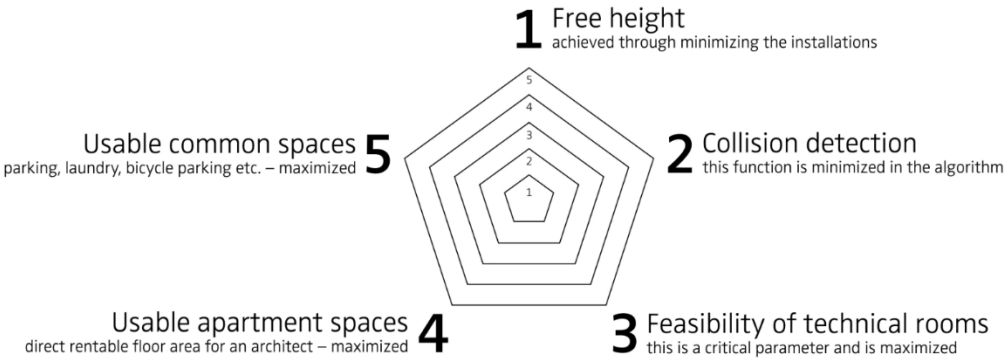


Figure B: *spacing* Generative Design Goals

Results

Normally, a study takes about 10 to 12 hours to achieve satisfactory results. The user then interface with the multi-variable graph or the Pareto front to narrow in on a feasible solution based on our variable choices and push it further for element creation in Revit.

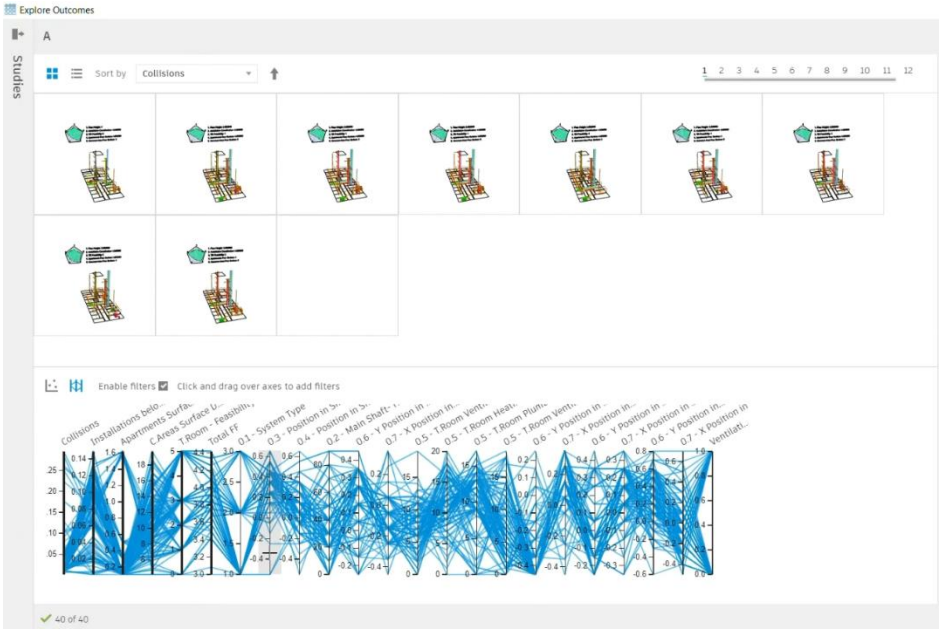


Figure C: Selection of a solution in the Pareto front

The respective elements are then generated in Revit according to our defined template in the algorithm. The elements are created using Revit mass elements.

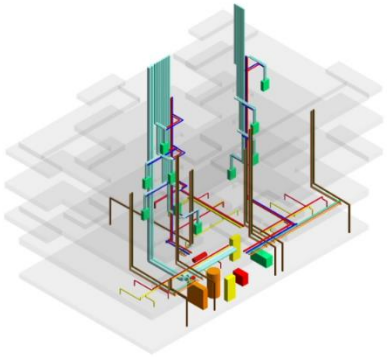


Figure D: *spacing* solution created in Revit

Simultaneously with the creation of the elements in Revit, a report is exported with the values containing information about areas and volumes of the technical and useful spaces of the generated solution.

Figure E: *spacing* Report

The output .ifc model differentiate the technical volumes and the other usable volumes to compare with the initial proposal. In addition, concrete suggestions for large equipment and horizontal/vertical networks are exported so the architects can use it as the basis for further planning.

Figure F: *.ifc exported with spaces differentiated by usage*

Contact us

If you want to know more about spacing, please contact us.

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spacing

by

Basler & Hofmann

3. What's Next?

Here is a brief summary of our computational design and automation roadmap grouped in 3 themes:

1. **Accessibility** - Make Dynamo easier for new users to learn. Make it easier for more people to use Dynamo automation routines.

a. **Dynamo Extended Node Help and Documentation Browser update** - We are improving the Extended Node Help (Which you may have previously known as the Dynamo Dictionary) by making it interactive…You will now be able to more easily read salient information on the node, Explore where this node lives inside of the Library, Review a sample graph by zooming in and panning around, Or even dragging it into your Graph where the nodes will be created as a Group for you to use. You will also be able to interrogate the Inputs and Outputs of the node to better understand how it's built and what it does.

b. **Empower Node-Autocomplete with Machine Learning** The first version of Node Autcomplete is based around Object Types – matching lines to lines, strings to strings and so on. This is a great step in the right direction, but we can do even more. So we are working on empowering Node Autocomplete with Machine Learning, which will not only return a set of results, but will rank them based on the "most likely node that you will want to place" and save your latest used node as a form of favourite too. This means much more efficiency, especially around the more generic nodes that can entertain hundreds of possibilities.

c. **Swiftly understand Graph Node States** We also have heard that large graphs are hard to navigate and especially difficult to find problems, or potential problems in them. So, we've spent calories on allowing you to Swiftly understand graph node states through Zoom States, which show you at a glance what states nodes are in, a Run Bar Footer that collects quick counters of nodal states and the Graph Node Manager, a more in-depth, one stop shop that empowers you to search your nodes in canvas, Understand all their Types, States, Issues and Outputs, Even if they contain null values, or empty lists, as well as the more pressing Errors and Warnings And allow you to read warning data at a macro level or export out all of this information.

2. **Better Sharing** - Make it easier to share and collaborate on Dynamo files inside and outside of your firm.

a. Trusted Locations We are bringing Trusted Locations to Dynamo, ensuring that you control where your graphs are loaded form and whether or not you trust those locations. This gives Dynamo more security, and you more control over how it interacts with graphs.

b. **Dynamo Settings Deployment and Splash Screen**. To enhance sharing even further, we are introducing a Dynamo Splash Screen that not only shows you that something is happening when Dynamo loads up, but also

enables… Authentication to grant access to the Package Manager in all Dynamo instances, and the ability to Import Settings before loading Dynamo, that empowers you and your firm to have a common base line to work from and can be part of your Revit Custom Installer (with other hosts coming afterwards). Inside Dynamo from the Preferences Panel you will again be able to import and also export your Dynamo Settings.

c. **Dynamo File Info on Autodesk Docs** store your files on Autodesk Docs and see more information about versioning, dependencies and authors online. Collaborate on graphs with others more easily.

3. **Better Performance** - Make Dynamo faster and less prone to missing dependency problems.
    a. **Performance Enhancements**: Creation of 1M spheres is expected to complete in 5.4 seconds in Dynamo 2.16. In Dynamo 2.1 it ran out of memory before completing the graph. Rendering a pattern of dense perforations took 7.1 seconds for the first run in Dynamo 2.1 and it took 4.54 seconds to update a slider. In Dynamo 2.16 the same tasks are expected to take 2.55 seconds for first run (3x faster) and 1.19 seconds to update a slider (4x faster)
    b. **Dynamo Player/ GD Dependency Manager** – get warnings and resolve package dependencies in the Dynamo Player as well as in Dynamo.
    c. **Dynamo Engine Refactor** We are diving deep into Dynamo's Engine, looking to refactor away some custom engine layers in favour a foundational Microsoft one. This means that we can remove some intermediate translations and get directly to the execution of graphs, resulting in faster performance, less places for things to go wrong, more streamlined code.
    d. **Dynamo Native Polycurves** Native C++ PolyCurve support that is robust, performant and plays well with the rest of Dynamo's Geometry

Conclusion

In conclusion, I want to leave you with one more thought. Think about how robotics and automation have changed automotive production, and the resulting improvements in the cars we drive today. Think about the automotive manufacturers that are embracing new technology and are reaping success. Now imagine how leveraging more automated and digitized ways of designing and constructing might impact your business and help you address the challenges and opportunities you are facing … How much more might you be able to do with the workforce you have? It doesn't have to be super complicated – this automation does one thing - it simply sorts red and green tomatoes. I bet it is a lot faster than I could do by hand. How might you transform your business to help create the sustainable communities of the future? I want to thank our special guests for joining us today. I find great hope in the stories of innovation and automation that they have shared with us. Please stay for the Q&A to discuss in more detail.

Resources

AU2021 Courses on Generative Design

- Optimize Road Design with Dynamo for Civil 3D and Generative Design (CES500103)
- Generative Design Using Dynamo for Multifamily Residential (AS500109)
- HVAC System Selection with Generative Design (AS500212)
- Two Weeks to Four Hours: How Populous Built Efficiency with Generative Design (AS500272)

AU2020 Courses on Generative Design

- Generative Design in Revit for Workspace Layout - Tomasz Fudala
- Non-Geeks Guide to Optimizing Daily Workflows with Generative Design - Raquel Bascones Recio
- Using Generative Design and Machine Learning for Faster Analysis Feedback - Varvara Toulkeridou
- Generative Design at Hogwarts: Using Tech Instead of Magic - Jacob Small
- Generative Design für Revit in der Praxis - Lejla Secerbegovic
- Diseño Generativo en Revit para todos los públicos - Raquel Bascones Recio
- Generative Design—Daylighting and CFD: A Practical Application for a Nonprofit - Luc Wing
- Generative Design of Landforms with Dynamo in Civil 3D - Andreas Luka

Past Years Autodesk University Courses on Generative Design and Project Refinery

1. Geometry Systems for AEC Generative Design: Codify Design Intents into the Machine
2. MEP Explore: Generative Design for MEP Designers
3. Getting Started with Generative Design for AEC
4. Using Generative Design in Construction Applications

Dynamo Resources

- Getting Started with Dynamo:
  https://primer2.dynamobim.org/
  https://dynamobim.org/learn/
- Dynamo Forum for questions, inspiration:
  https://forum.dynamobim.com/
- Design Script:
  http://designscript.io/DesignScript_user_manual_0.1.pdf
  https://dynamobim.org/wp-content/links/DesignScriptGuide.pdf
  https://github.com/Amoursol/dynamoDesignScript
- Dynamo Office Hours:

https://www.youtube.com/watch?v=diQm3RU_21E&list=PLdlF7MirPEC2yNFTGymESd3t7Xosfk9c2

Generative Design Resources

- Generative Design Primer https://www.generativedesign.org/
- Generative Design in Revit Help
- Generative Design general education: https://medium.com/generative-design