

# Autodesk AI

Keith Warren

*Sr. Transportation Solutions Executive*

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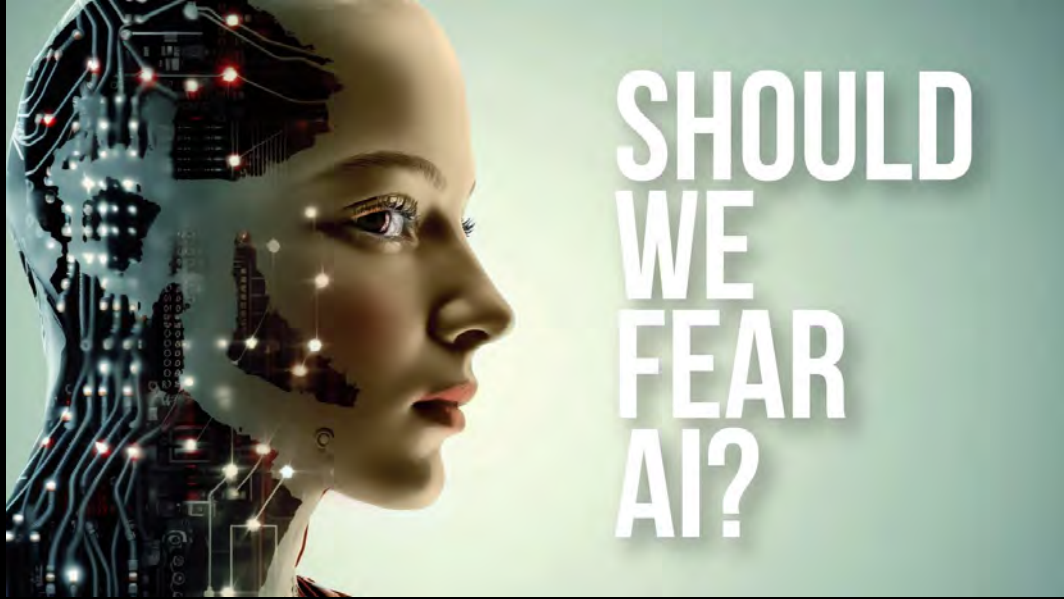
## ***Artificial intelligence (n):***

The theory and development of computer systems able to perform tasks that normally require human intelligence and, in some cases, will surpass it.



**Yes, AI is having a  
moment**





## ***The Fear of Artificial Intelligence: Is It Justified?***

Alongside its remarkable advancements, a palpable fear of AI has also emerged. This apprehension, stems from concerns about job displacement, existential risks, ethics, and the unintended consequences of humankind's insatiable desire to keep pushing for more..

THE SHIFT

## A Coming-Out Party for Generative A.I., Silicon Valley's New Craze

A celebration for Stability AI, the start-up behind the open-source DALL-E 2 image generator, represents the

RUMMAN CHOWHURY

IDEAS APR 6, 2023 9:00 AM

## AI Desperately Needs Global Oversight

As ChatGPT and its ilk continue to spread, countries need an independent board to hold AI companies accountable and limit harms.

Leaders | Technology and society

## How to worry wisely about artificial intelligence

Rapid progress in AI is arousing fear as well as excitement. How worried should you be?



TECH | KEYWORDS: CHRISTOPHER MIMS

## Can You Tell Whether This Headline Was Written by a Robot?

Not this time, but AI is churning out articles, illustrations, fake product reviews and even videos

By [Christopher Mims](#) [Follow](#)

Nov. 12, 2022 12:00 am ET

[Share](#) [Resize](#) [81](#)

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MAGAZINE · EDITOR'S DESK

## ChatGPT shows that the A.I. revolution has arrived. We're not ready

By [ALYSON SHONTELL](#)

January 25, 2023 at 3:00 AM PST



IAN C. BATES—THE NEW YORK TIMES/REDUX

# Generative Design Takes on the Golden Gate



# Gen AI: Accuracy and precision

## Inaccuracy



### Question:

Who is taller, Yao Ming or Shaquille O'Neal?

### ChatGPT 3.5:

Shaquille O'Neal is taller than Yao Ming. Shaquille O'Neal is 7'1" (216cm) while Yao Ming is 7'6" (229cm).

## Imprecision





# BASKETBALL



## Positions

- 1 Point Guard**  
Also known as the "1", they are usually the team's best dribbler. They bring the ball up the court, call the plays and direct the offense. Also excellent passers, they are responsible for setting up plays to create scoring opportunities.
- 2 Shooting Guard**  
Also known as the "2", they must have excellent shooting skills, including a strong jump shot, and good passing skills. A good Shooting Guard must have an excellent "free throw" percentage, and be dependable in close games. They work closely with the Point Guard.
- 3 Small Forward**  
The Small Forward, or the "3", must be a skilled player that balances strong offensive and defensive skills. Usually, they are taller than the Point Guard and the Shooting Guard.
- 4 Power Forward**  
Also known as the "4", the Power Forward is a larger player with strong rebounding and rebounding skills, who provides a strong presence in the middle of the court.
- 5 Center**  
The Center, or the "5", is usually the tallest player on the team and tends to defend and score close to the basket. They are considered the "anchor" of the defense, blocking and rebounding shots whenever possible. They must have good footwork and good ball control.

## Start of Play

**TIP-OFF:** The game begins with a "tip-off", where an official tosses the ball at center court and one player from each team (generally the tallest) tries to tap it to their teammates. The team that takes possession is on offense.

**THROW IN:** When either team causes the ball to cross the sideline, the opposing team gains possession and throws it in to a teammate.

## QUICK FACT BOX

- OBJECT OF GAME:** To get the ball through the opponent's hoop.
- DURATION:** 48 high school to 48 (NBA includes overtime) to 60 minutes, depending on level of game. Most professional basketball games last 48 minutes per quarter. High school has four quarters, eight minutes per quarter.
- OFFICIALS:** A referee, and one or two Linesmen (also called Referees in some games).
- PLAYERS:** Each team has five players on the court at any one time.
- HOOPS:** The ball hoop. The diameter of the rim is 18 inches.

**OFFENSE:** The attackers move the ball up the court using a combination of passing and dribbling (bouncing the ball while running). Taking more than two steps without bouncing the ball ("traveling") is not allowed, as is stopping and starting dribbling ("double dribble"), or holding the ball's handle ("carry"). The offense has limited time to take a shot, ranging from 24 to 30 seconds, depending on the level of game. If they fail to make a shot that touches the rim in that time, the ball is turned over to the opposing team.

Passing is the key to offensive strategy. Moving the ball around quickly, the attackers force the defense to adjust, creating possible openings to score. Commonly, players score by jumping and shooting the ball with both hands ("jump shot"), or stepping at the hoop and tossing the ball in

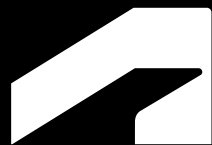
with one hand ("lay-up"), or jumping up near the basket and forcing the ball through the hoop while airborne ("slam dunk").

**DEFENSE:** There are two basic defensive strategies: "man-to-man", where each defender guards one member of the opposition (often the player in the same position), and "zone", where defenders guard specific areas of the court. In both, the defense tries to take possession in three main ways: stealing the ball, preventing a shot from being taken before the shot clock runs out, or forcing a off-court shot and then recovering the rebound (gaining possession of the ball after a failed throw on backboard). The defense takes possession if the offense puts the ball out of bounds, or when an attacker commits a foul or violation.

**Artificial Intelligence:  
Using all points of views.**

Basketball point of view:  
All five players, coaches,  
Ref, and fans.





# **A history of research and publication**

# GENERATIVE DESIGN

First paper published in 2009

## PHYSICS-BASED GENERATIVE DESIGN

RAMTIN ATTAR, ROBERT AISH, JOS STAM,  
DUNCAN BRINSMEAD, ALEX TESSIER,  
MICHAEL GLUECK, AZAM KHAN  
*Autodesk Research, Canada*

**ABSTRACT:** We present a physics-based generative design approach to interactive form-finding. While form as a product of dynamic simulation has been explored previously, individual projects have been developed as singleton solutions. By identifying categories of computational characteristics, we present a novel unified model that generalizes existing simulations through a constraint-based approach. The potential of interactive form finding simulation is explored through exemplary studies: a conceptual approach to a fixed form that acts as a visualization of interacting forces, and a constraint-based model of the fabrication logic for a panelization system are examined. Implications of constraint-based simulation on future directions are discussed.

**KEYWORDS:** Form finding, dynamic simulation, physics-based design, panelization

**RÉSUMÉ:** Dans cet article on présente une approche générative basée sur la physique pour la conception des formes d'une manière interactive. Cette approche a été explorée précédemment mais seulement pour résoudre des problèmes isolés. En identifiant les catégories de caractéristiques numériques, nous proposons un nouveau modèle unifié qui généralise les simulations courantes par une méthode à base de contraintes. Nous explorons la puissance de la conception interactive des formes par deux études concrètes : une approche conceptuelle qui visualise les forces interagissant sur une forme fixe, et une méthode à base de contraintes pour la construction logique d'un système de panneaux. Nous examinons les implications de la simulation à base de contraintes et les directions futures de recherche.

**MOTS-CLÉS :** *Forme recherchée, simulation dynamique, conception basée sur la physique, assemblage de panneaux*

# GENERATIVE AI

First paper published in 2017

## Exploring Generative 3D Shapes Using Autoencoder Networks

Nabeel Ahmed  
Naveen Reddy, Timothy Durrant

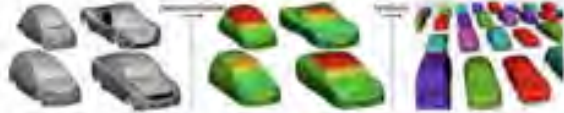


Figure 1: From unstructured images (left) our approach can efficiently and robustly extract a good model with a learned topology (middle) that is implicitly parameterized as a latent map (shown in color gradient). The autoencoder extracts a low-dimensional representation of the set of shapes in cartesian space (right). The generator allows the user to interactively guide the synthesis by directly manipulating on the shape.

### ABSTRACT

We propose a new algorithm for converting unstructured images into cars with a consistent topology for machine learning applications. We describe the self-supervised depth map reconstruction and the depth mapping network by efficiently and robustly yet, sensitive for feature, geometry, appearance, and appearance. We use an autoencoder network to extract the essential of shapes in the same category to capture and evaluate in terms of shape. Furthermore, we introduce a direct manipulation interface to navigate the synthesis. Our dimension reduction approach will serve as a learned set shapes represented as unstructured images.

### KEY CONCEPTS

Learning and optimization → Shape analysis, Shape modeling → Applied computing → Computer-aided design.

### KEYWORDS

Machine learning, 3D shape, generative shape synthesis

### ACM Reference Format

Nabeel Ahmed, Naveen Reddy, Timothy Durrant. 2017. Exploring Generative 3D Shapes Using Autoencoder Networks. In Proceedings of ACM SIGGRAPH Asia 2017, November 04–08, 2017, Seoul, Korea. ACM, 11 pages. <https://doi.org/10.1145/3137441>

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### 1. INTRODUCTION

Recent advances in machine learning have seen the introduction of various applications such as image classification, style transferring, and generation which target tasks such as image and video. However, 3D shape has not gained full traction from machine learning despite the vast number of 3D shapes that exist in the world. This is mainly because the machine learning algorithms require the consistent representation of input and output data such as an orthographically aligned grid (i.e. points in the image). Unfortunately, though, neither the most popular surface representation in the computer graphics, nor their topological structures are usually aligned from one another. This brings the need of machine learning.

In this paper, we present a new generative model for the efficient conversion of a given unstructured image into a well-augmented mesh with consistent connectivity using depth information. Our parameterization is robust to deformation such as feature, geometry, and appearance changes. We achieve compact and explicit parameterizations of 3D shapes by representing the shape as a latent field, which is obtained from the combination of a single positive probability. We demonstrate the robustness of our approach by the generalization of our new dimension reduction.

The main results of our parameterization are the generation of input and output data that is ready for machine learning (Figure 1). Middle from same shapes in the same category are more similar and consistent in a manifold of these shapes using the low-dimensional representations from the autoencoder to the generated and visible, a variation of the 3D shapes of the interesting features (Figure 2) again. We present an interface to interactively manipulate the 3D shape manifold, allowing the user to directly guide the synthesis of a set of a generated shape from the features of unstructured images.

- A compact and efficient parameterization of 3D shapes.
- A full generative framework to generate 3D shapes.
- A direct manipulation interface to generate generated shapes.



# 50+

## AI Research Papers

World's leading publisher for AI research for 3D geometry and design

### Exploring Generative 3D Shapes Using Autoencoder Networks

Figure 1: Three normalized height maps (HMs) are sampled one vertically and adjacently centered a grid block with a measured spacing, similar to the commonly sampled 4x4 grid. Two filters in this context, their relative sizes, and their relative gain are used to determine the final output.

**ABSTRACT**  
We propose a novel algorithm for generating novel 3D shapes. We start with a set of 3D shapes and use an autoencoder network to learn a latent space representation. We then use a generative model to sample from this latent space and produce new 3D shapes. Finally, we use a style transfer network to transfer the style of a target 3D shape to the generated shapes.

**1. INTRODUCTION**  
In recent years, there has been significant progress in the field of generative models. These models are able to learn a latent space representation of a dataset and use this space to generate new samples. In this paper, we explore the use of autoencoder networks for generating 3D shapes. We start with a set of 3D shapes and use an autoencoder network to learn a latent space representation. We then use a generative model to sample from this latent space and produce new 3D shapes. Finally, we use a style transfer network to transfer the style of a target 3D shape to the generated shapes.

**CONCLUSIONS**  
We have presented a novel algorithm for generating novel 3D shapes. Our method is able to learn a latent space representation of a dataset and use this space to generate new samples. We have also presented a style transfer network that is able to transfer the style of a target 3D shape to the generated shapes. Our method is able to generate 3D shapes that are similar to the target shape but with a different style.

### Neural Implicit Style-net: synthesizing shapes in a preferred style exploiting self supervision

Marco Pumarò  
Homas Shapiro  
Aditya Sengul  
Emanuele Rodola

ETH Zürich, University of Toronto, IBM Research, University of Toronto

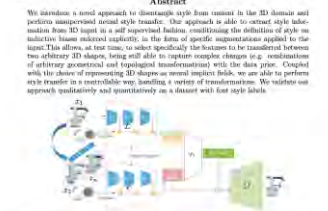


Figure 1: Model overview: an input shape  $x_1$  is augmented by a set of transformation noise  $z$  using specific style features, but generates control information, producing the augmentation  $x_2 = G(x_1, z)$ . Style is encoded in a latent vector space as a function  $F$  of the latent features corresponding to the input shape  $x_1$  and its augmentation, respectively. The latent features are computed by a neural module network  $E$  in a multi-scale fashion. At test time the style codes condition the generation of shapes in a preferred style, using a neural implicit decoder  $D$ .

1. Introduction  
Being able to automatically synthesize shapes with a predefined style is a core task in computer graphics. Classical 3D style transfer techniques tend to rely on a given correspondence

### CAPRI-Net: Learning Compact CAD Shapes with Adaptive Primitive Assembly

Fengze Yu, Zhaohu Chen, Muryi Li, Aditya Sengul, Homas Shapiro, Mingshan Yang  
Shanghai University, Autodesk AI Lab, Tsinghua University

**ABSTRACT**  
We introduce CAPRI-Net, a self-supervised neural network for learning compact and parsimonious implicit representations of 3D computer-aided design (CAD) models, as the form of adaptive primitive assemblies. Given an input 3D shape, our network reconstructs it by an assembly of smaller, simpler primitives (we restrict to axis-aligned rectangular prisms). Without any ground truth shape annotations, our self-supervised network is trained with reconstruction loss, leading to flexible 3D reconstructions with sharp edges and plausible CAD style. When the primitive number of CAD models that only share some small-scale features, or the shape class, they fit more precisely and compactly together, this process is applied upon an adaptive hierarchy of shape of various levels, as 3D shapes. Our network addresses the challenge to capture topology and geometry for 3D shape with such a structure that reconstructs the target geometry as a whole, rather than the surface, and learning (represented by hierarchical ABC, for large and small) from CAD datasets or data, in terms of reconstruction quality, shape, compactness, and adaptability to downstream applications over current alternatives for general CAD reconstruction.

**1. Introduction**  
Computer Aided Design (CAD) models are ubiquitous in engineering and manufacturing, as they assist in making the most product-efficient related to 3D shape and geometry. With the rapid advances in 3D-printed additive manufacturing, reverse CAD models [1, 2] that are used to support research in generative design [3, 4]. A common characteristic of CAD models is that they are composed of well-defined geometric surfaces meeting along sharp edges. While the geometric nature of CAD shapes do make them more predictable, usually not in the general level, as the shape level, there is a great deal of new local and topological variations, which present a significant generalizability challenge to current state-of-the-art for 3D shape [5, 6, 7, 8, 9, 10, 11, 12]. The big

### WorldSmith: Iterative and Expressive Prompting for World Building with a Generative AI

Hui Tang, Frederik Reedy  
University of Bayreuth & Autodesk Research, Bayreuth, Germany, Autodesk Research, Toronto, Ontario, Canada  
George Ffrench-Parsons, George Ffrench-Parsons, Toronto, Ontario, Canada

Figure 1: The workflow and high-level interface of WorldSmith. The user selects one of the four shape files in the Global File Manager, and iteratively refines the file with text prompts, sketches, and image prompts available through the WorldSmith Editor UI. All generated images are collected in the World View UI which allows the user to save previous image states. Furthermore, the few-view automatically generated images can be used to generate new images after clicking on the save button in the Global File View to build the scene into a single image.

**ABSTRACT**  
Creating rich and diverse prompts for generative AI models is a challenging task, and it is often difficult to achieve more interesting and useful results without more time and specialized skill. We investigate the

# AI Across Autodesk AEC

## Autodesk Design Solutions

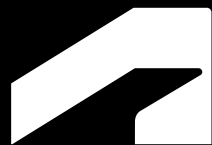
- Generative Design
- Automated Analysis
- Design Tool Assistance

## Autodesk Construction Solutions

- Assistive Workflows
- Predictive Insights
- Intelligent Search

## Autodesk Research

- AI & Machine Learning
- Robotics
- Optimization
- Simulation
- Human and Computer Interaction
- Fundamental Mathematics & Geometry



# Autodesk approach

# Autodesk AI mission

As the trusted technology partner for design and make worldwide, Autodesk has **a mandate to harness the power of AI** on behalf of our customers, and **a duty to do so responsibly.**



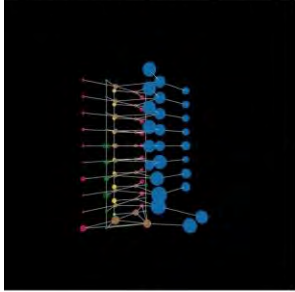
# Autodesk approach



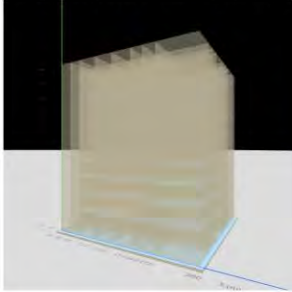
- Suitable workflows
- Align with customer needs
- Combine Generative AI

# Benefits the Three A's

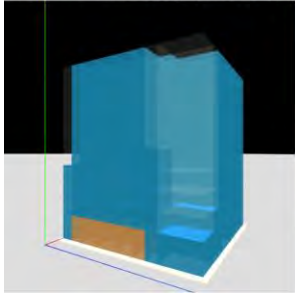
Input 1: Bubble Diagram (Program Graph)



Input 2: Space Partition (Voxel Graph)



Output: Volumetric Design (Voxel Graph)



Finalized Building Design by Architect

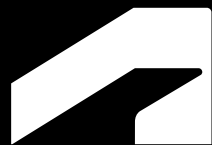


- **Augmentation** : Enhancing exploration and experimentation
- **Automation** : reducing tedious tasks for more creativity
- **Analysis** : Immediate insights, earlier



# AI & Data Ethics





# Example Capabilities



# Forma Rapid Analysis



## Rapid Analysis Suite

microclimate

solar

sun

daylight

wind

views

noise

energy

Machine learning based rapid analysis for wind, microclimate, noise, and operational energy.

**Approach** Machine Learning – Surrogate Models

**Why it matters?** Allows customers to analyze a design's performance without having to stop the design process to run a simulation. If thousands of options are generated, each can be analyzed quickly.

# Recap Scan-to-Design

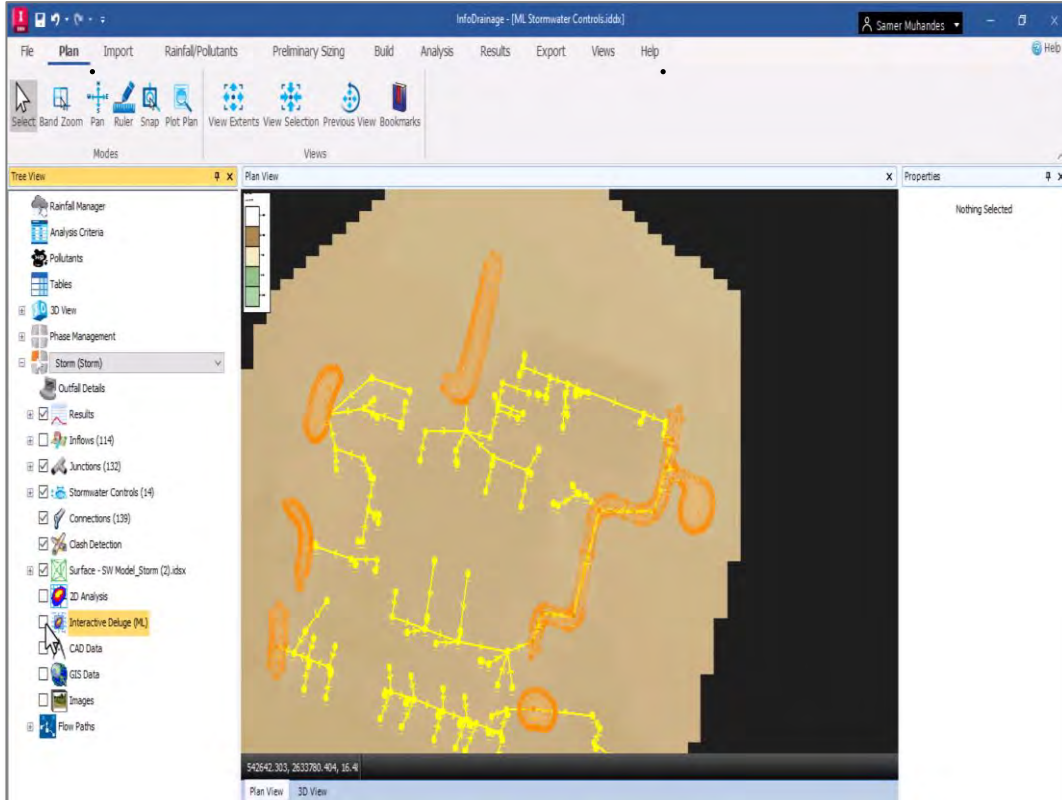


Quickly and easily extract features like curbs from point clouds that are uploaded to ACC in the online viewer reducing manual work

**Approach** Heuristics and ML (Neural Networks)

**Why it matters?** Customers have often used third party tools to do feature extraction in point clouds. Point clouds are large and difficult to work with in a desktop environment. These capabilities allow customers to work with point clouds and create design content in our platform quickly.

# InfoDrainage: Deluge Modeling



Rapidly generate deluge flood maps to inform storage, infrastructure, buildings, and evacuation routes without needing to run lengthy simulations.

**Approach** Machine Learning –  
Surrogate Models

**Why it matters?** Allows customers to understand flood implications quickly without lengthy simulations. Interactive flood maps are coming in FY25.

# Photo Autotags

Autodesk Build



## Details

## References

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Paulo A

Taken on

Data not available


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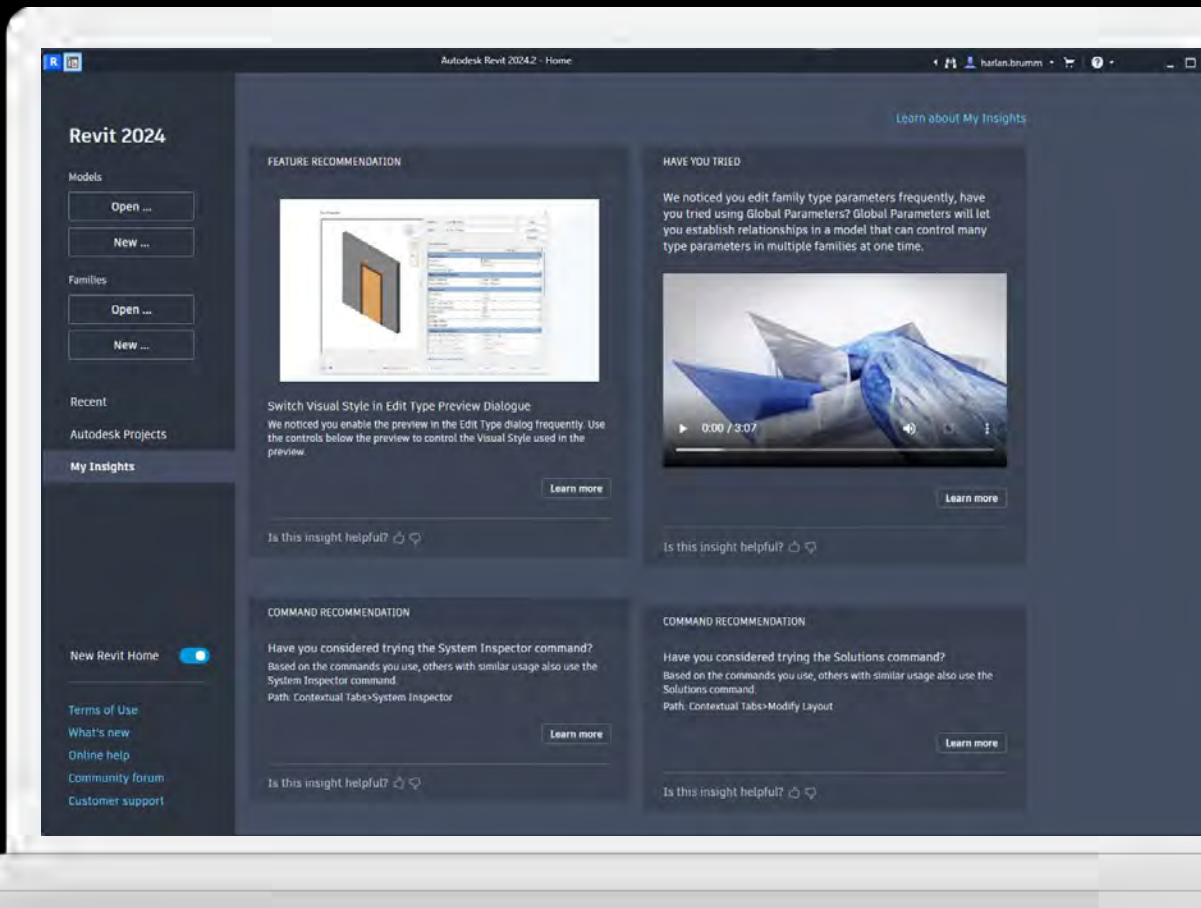
insulation 

metal framing 

people 

# My Insights Dashboard

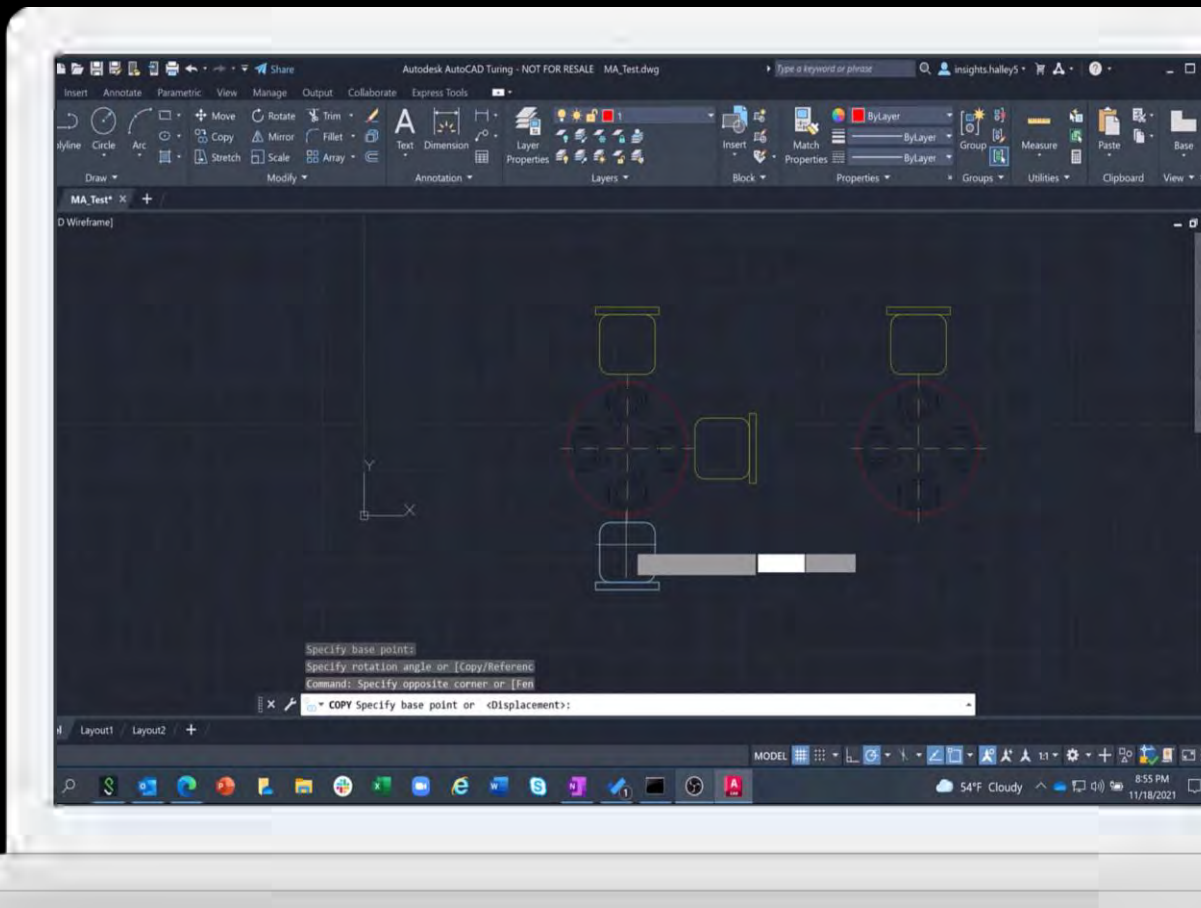
AutoCAD and Revit





# Macro Advisor

AutoCAD





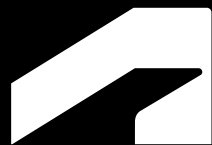
# Dynamo Node Autocomplete



Customers are provided predictions on what node to place next to help them quickly and easily complete their script.

**Approach** Machine Learning – Neural Networks

**Why it matters?** Compared to traditional methods of search and place, this allows customers to build graphs 4x or more faster.



# Autodesk AI in AEC

# Forma Quick geometric design explorations



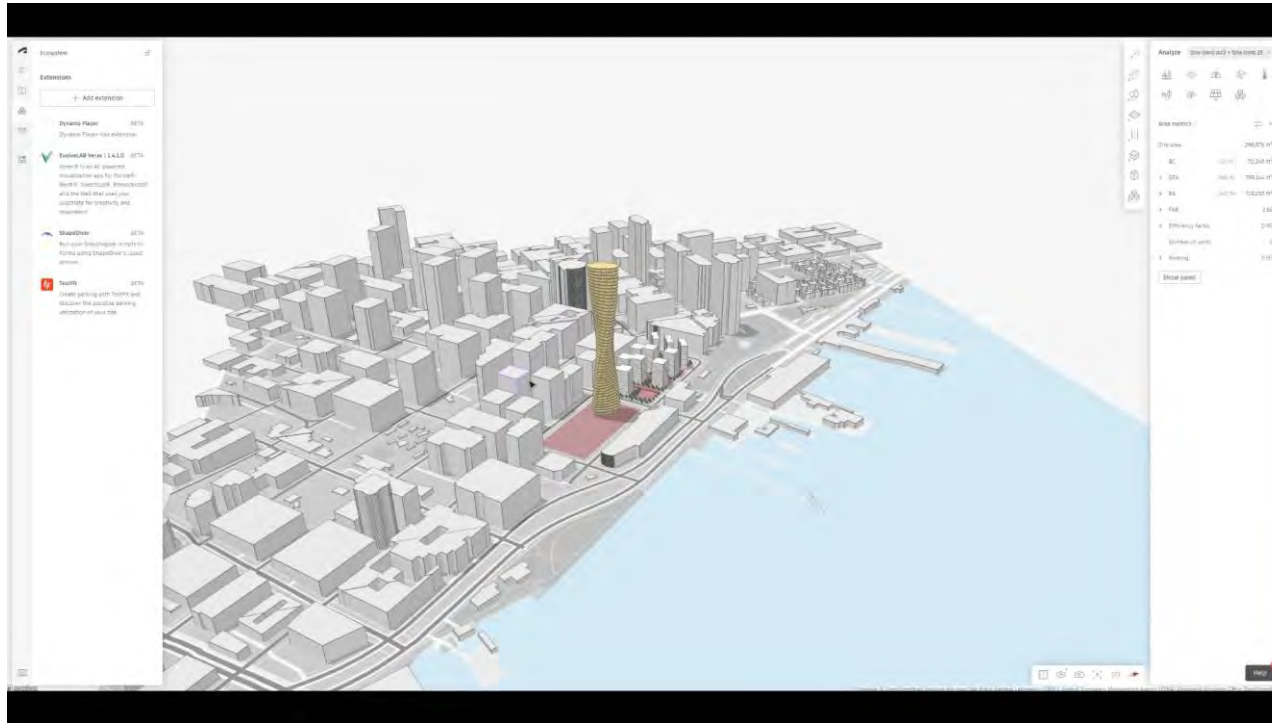
Customers can leverage interactive procedural modeling tools for site layouts, parametrize building features, plant vegetation, and more

**Approach** Generative Design

**Why it matters?** Provides more interactive, in-canvas generative design capabilities. Additionally, Forma Generator APIs allow third parties to easily build generative logic. There will be examples from TestFit and ShapeDiver.

**Third party integration (Testfit)**

# Forma and Revit Quick visual design exploration



Customers can leverage the power of natural language prompts and LLMs to create visual rendering options for their site studies.

**Approach** Generative AI

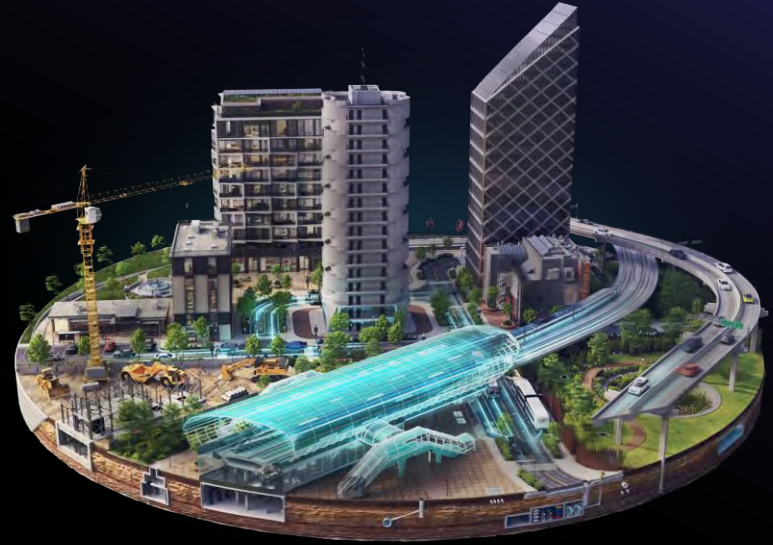
**Why it matters?**

Leverages third party generative models to help customers visualize their designs using their own words.

**Third-party integration (Veras)**

# **Autodesk AI for Construction: FUTURE**

**Data is the backbone, but  
intelligence is the fuel for  
Transformation**





# The Benefits of Autodesk AI for Construction



**Radical  
Efficiency  
Gains**

**Early  
Prevention of  
Construction  
Risk**

**Improve  
Everyday  
Decision  
Making**

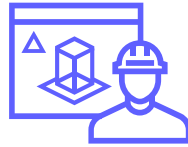
# Why Autodesk AI



## Construction Specific

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AI model built specifically for construction by learning from your project data to provide the most accurate insights



## Strong AEC Foundation

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Combining the technology of LLM's with our decades of global AEC industry experience to deliver more focused AI



## Contextualized Assistance

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AI-generated assistance in the context of construction workflows while maintaining full review and control



## Privacy & Security

Trust us to bring AI solutions to market in a responsible manner that meets our pillars of transparency, caring, reliability, and capability

Visit our [Trust Center](#)



## Autodesk AI:

- Autodesk AI technology enables capabilities in Autodesk's Design and Make Platform and other Autodesk products, with more coming every day.

# Thank you.

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**AUTODESK AI**