BIM CON CFIA 2024

Colegio Federado de Ingenieros y de Arquitectos de Costa Rica

Autodesk AI

Enfoque basado en resultados

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SECTOR AECO: ARQUITECTURA INGENIERÍA CONSTRUCCIÓN OPERACIONES

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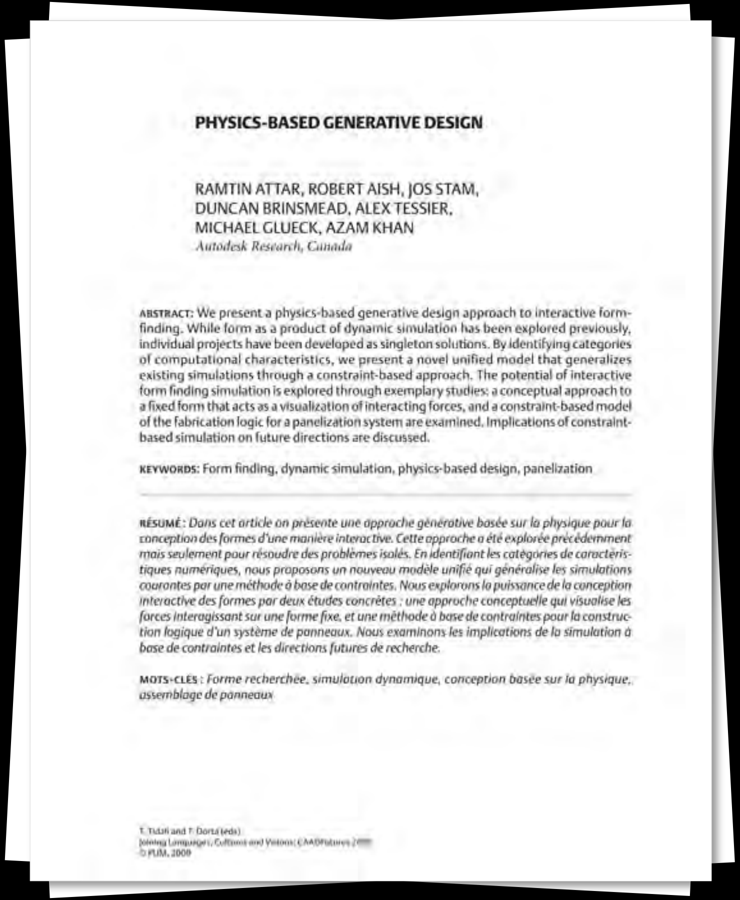
Una historia de investigación y publicación abiertas

GENERATIVE DESIGN

Primer artículo publicado en 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

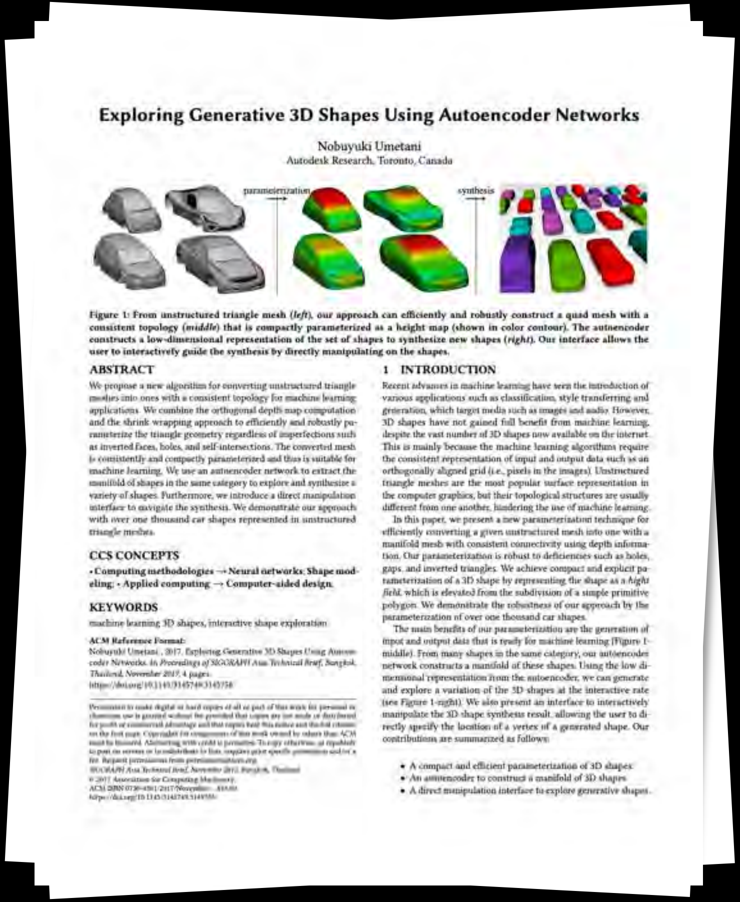
RÉSUMÉ : *Dans cet article on présente une approche générative basée sur la physique pour la conception des formes d'une manière interactive. Cette approche a été explorée précédemment mais seulement pour résoudre des problèmes isolés. En identifiant les catégories de caractéristiques numériques, nous 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*

T. Tidafi and T. Dorta (eds)
Joining Languages, Cultures and Visions: CAADFutures 2009
© PUM, 2009

GENERATIVE AI

Primer artículo publicado en 2017



Exploring Generative 3D Shapes Using Autoencoder Networks

Nobuyuki Umetani
Autodesk Research, Toronto, Canada

Figure 1: From unstructured triangle mesh (*left*), our approach can efficiently and robustly construct a quad mesh with a consistent topology (*middle*) that is compactly parameterized as a height map (shown in color contour). The autoencoder constructs a low-dimensional representation of the set of shapes to synthesize new shapes (*right*). Our interface allows the user to interactively guide the synthesis by directly manipulating on the shapes.

ABSTRACT

We propose a new algorithm for converting unstructured triangle meshes into ones with a consistent topology for machine learning applications. We combine the orthogonal depth map computation and the shrink wrapping approach to efficiently and robustly parameterize the triangle geometry regardless of imperfections such as inverted faces, holes, and self-intersections. The converted mesh is consistently and compactly parameterized and thus is suitable for machine learning. We use an autoencoder network to extract the manifold of shapes in the same category to explore and synthesize a variety of shapes. Furthermore, we introduce a direct manipulation interface to navigate the synthesis. We demonstrate our approach with over one thousand car shapes represented in unstructured triangle meshes.

CCS CONCEPTS

• **Computing methodologies → Neural networks; Shape modeling;** • **Applied computing → Computer-aided design.**

KEYWORDS

machine learning, 3D shapes, interactive shape exploration

ACM Reference Format:
Nobuyuki Umetani . 2017. Exploring Generative 3D Shapes Using Autoencoder Networks. In *Proceedings of SIGGRAPH Asia Technical Brief, Bangkok, Thailand, November 2017,* 4 pages.
https://doi.org/10.1145/3145749.3145758

SIGGRAPH Asia Technical Brief, November 2017, Bangkok, Thailand

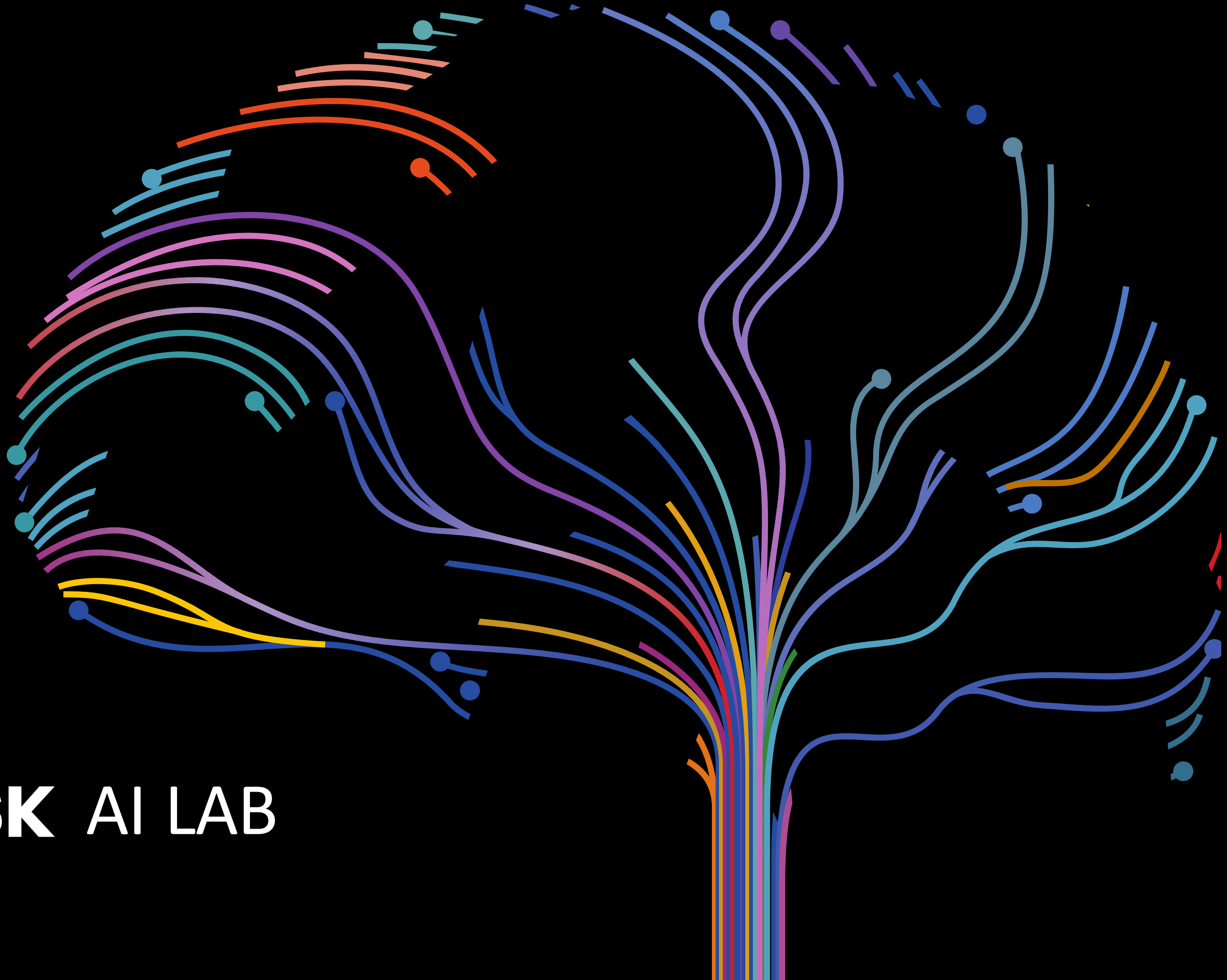
1 INTRODUCTION

Recent advances in machine learning have seen the introduction of various applications such as classification, style transferring and generation, which target media such as images and audio. However, 3D shapes have not gained full benefit from machine learning, despite the vast number of 3D shapes now available on the internet. This is mainly because the machine learning algorithms require the consistent representation of input and output data such as an orthogonally aligned grid (i.e., pixels in the images). Unstructured triangle meshes are the most popular surface representation in the computer graphics, but their topological structures are usually different from one another, hindering the use of machine learning.

In this paper, we present a new parameterization technique for efficiently converting a given unstructured mesh into one with a manifold mesh with consistent connectivity using depth information. Our parameterization is robust to deficiencies such as holes, gaps, and inverted triangles. We achieve compact and explicit parameterization of a 3D shape by representing the shape as a *hight field*, which is elevated from the subdivision of a simple primitive polygon. We demonstrate the robustness of our approach by the parameterization of over one thousand car shapes.

The main benefits of our parameterization are the generation of input and output data that is ready for machine learning (Figure 1-middle). From many shapes in the same category, our autoencoder network constructs a manifold of these shapes. Using the low dimensional representation from the autoencoder, we can generate and explore a variation of the 3D shapes at the interactive rate (see Figure 1-right). We also present an interface to interactively manipulate the 3D shape synthesis result, allowing the user to directly specify the location of a vertex of a generated shape. Our contributions are summarized as follows:

- A compact and efficient parameterization of 3D shapes.
- An autoencoder to construct a manifold of 3D shapes.
- A direct manipulation interface to explore generative shapes.

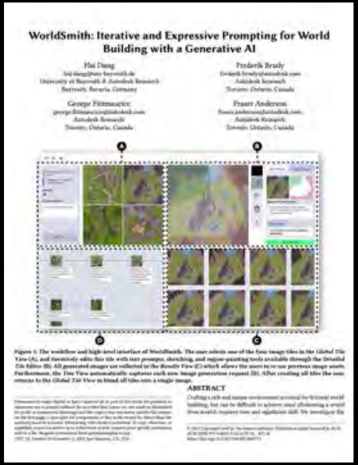


AUTODESK AI LAB

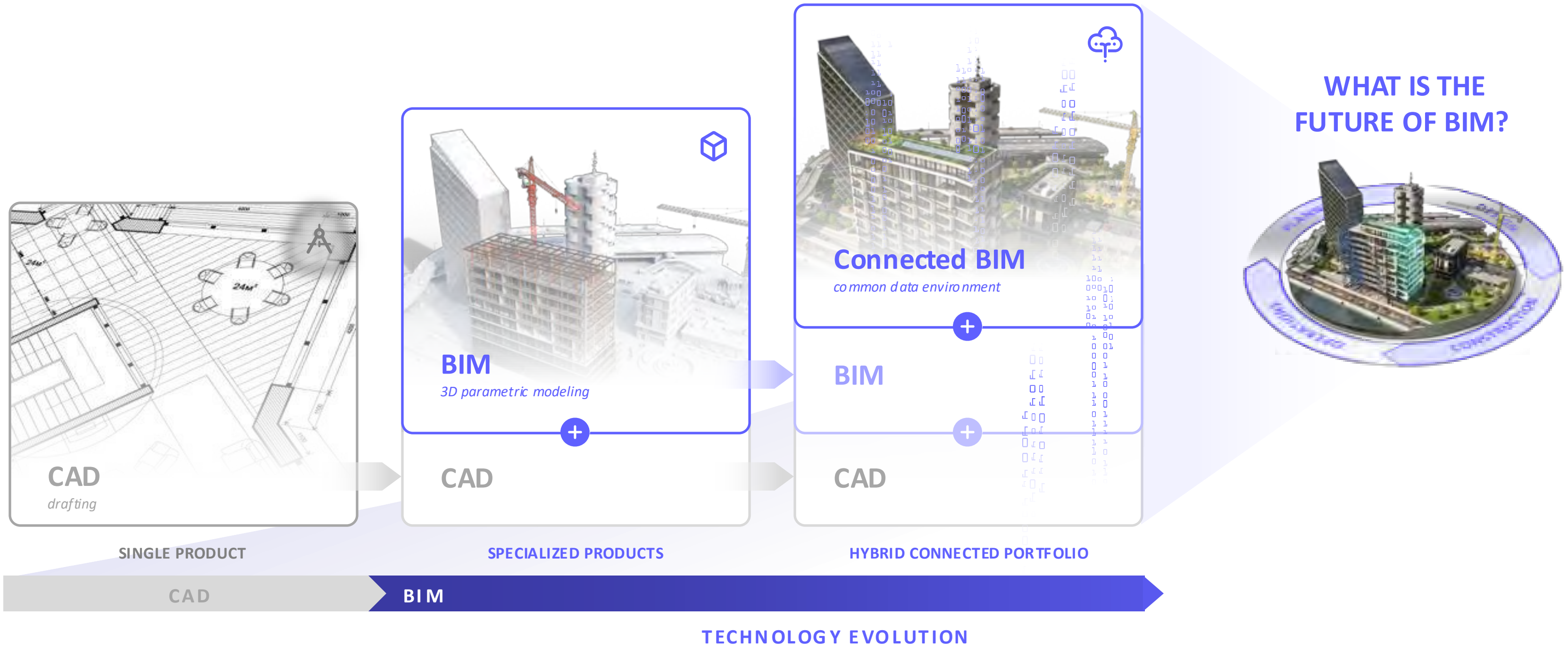
60+

AI Research Papers

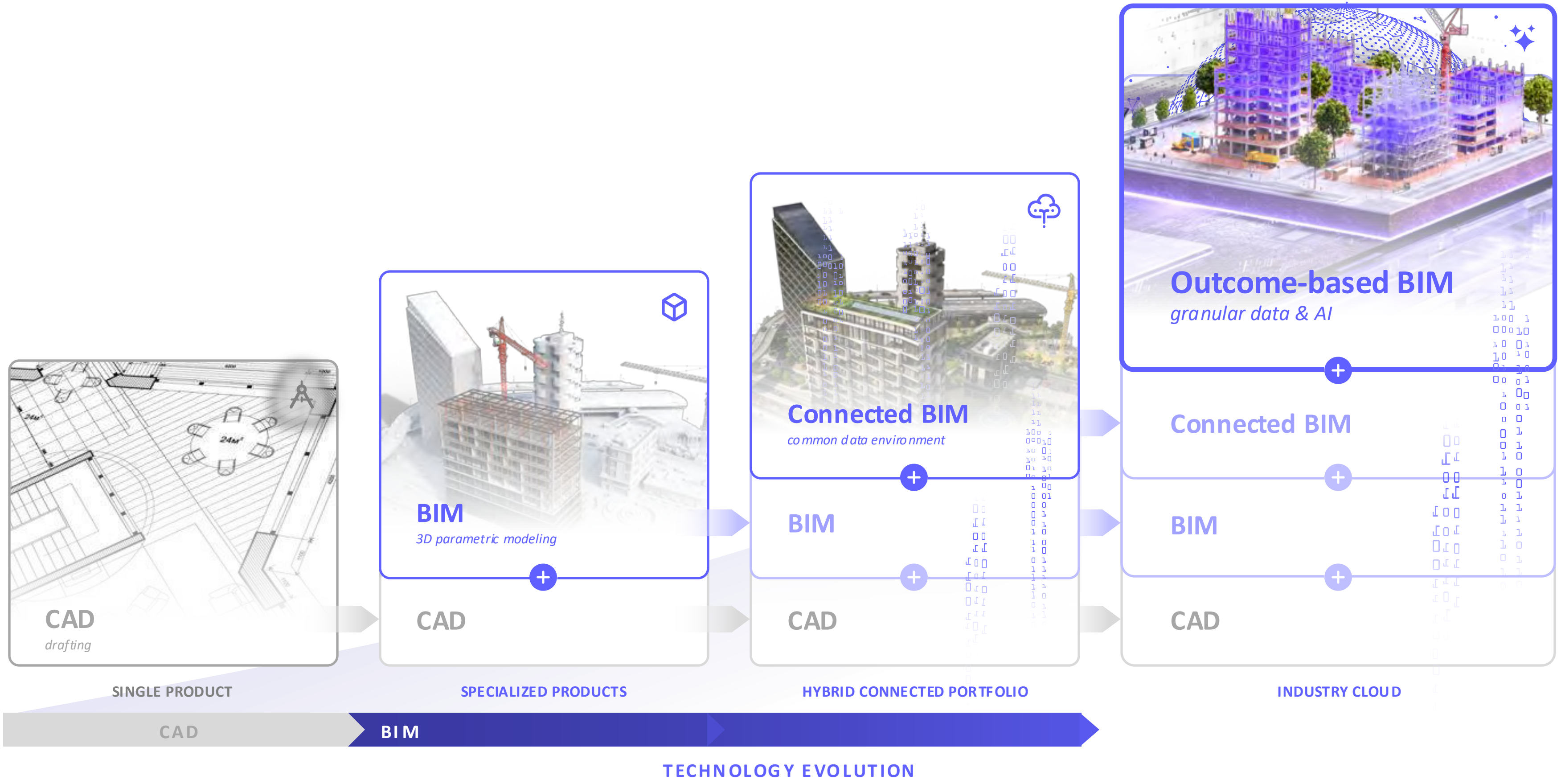
La editorial líder mundial en
Investigación de IA para la geometría
y el diseño 3D



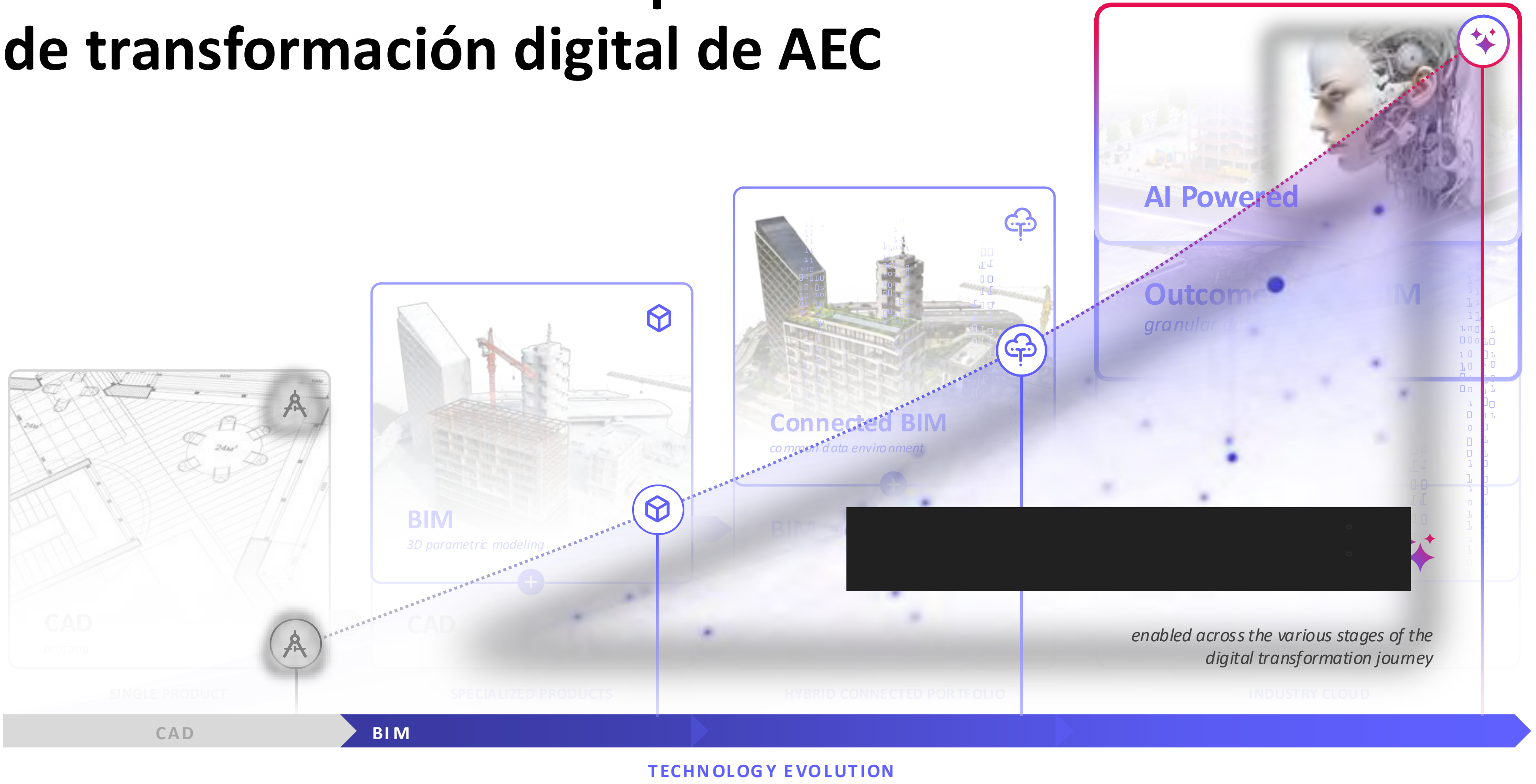
Es el momento de la próxima transformación digital en AECO



Outcome-based BIM



La IA de Autodesk en el proceso de transformación digital de AEC



Mejor flujo de datos, pero sigue siendo un proceso altamente iterativo

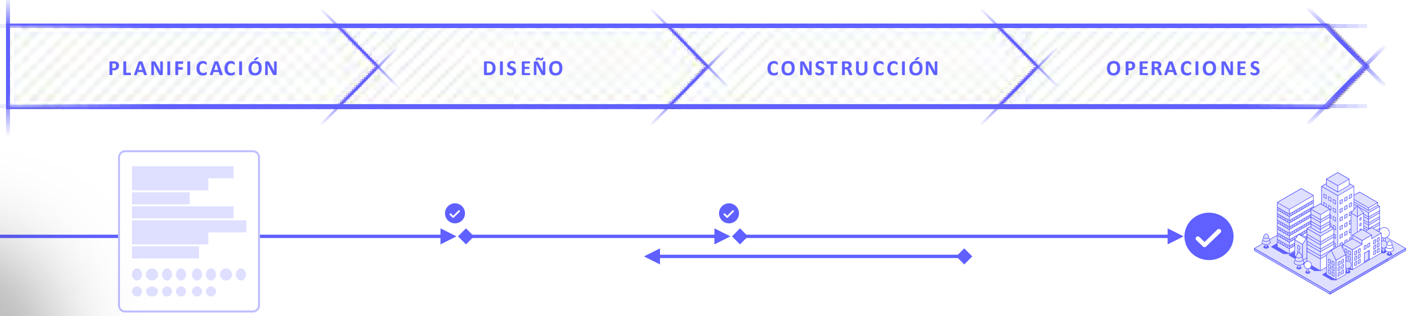
Basado en resultados impulsado por Inteligencia Artificial

CRITERIOS DE RESULTADO

- Sostenibilidad
- Costo
- Tiempo de Entrega

ESTADO FUTURO:

Comience el proceso con el resultado en mente, menos retrabajo e iteraciones de ida y vuelta



Enfoque basado en resultados

Comience el proceso de diseño centrándose en los resultados para los usuarios, la comunidad y el medio ambiente

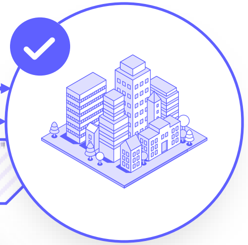
CRITERIOS DE RESULTADO

- Sustainability
- Cost
- Time to Deliver
- Habitability
- Diversity
- Net Operating Income
- Human Experience
- Affordability

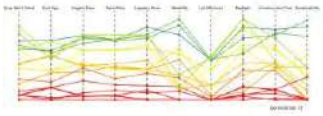
Better, Connected Granular Data

Real World Context and Knowledge

AI CO-CREATION



DESIRED OUTCOMES



ACHIEVE DESIRED, BETTER OUTCOMES

Unit Counts
BL1: 66
CR2: 53
SD0: 13

Pro forma
Studio: 13
1BR: 66
2BR: 53

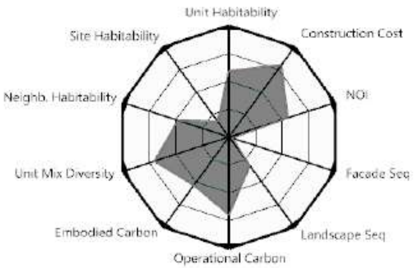
Financial
NOI: $211,278.00
Expense: na
Rent: na

Carbon (Embodied)**
7,642,801.10 kg CO2 eq
Carbon (Landscape)**
102645

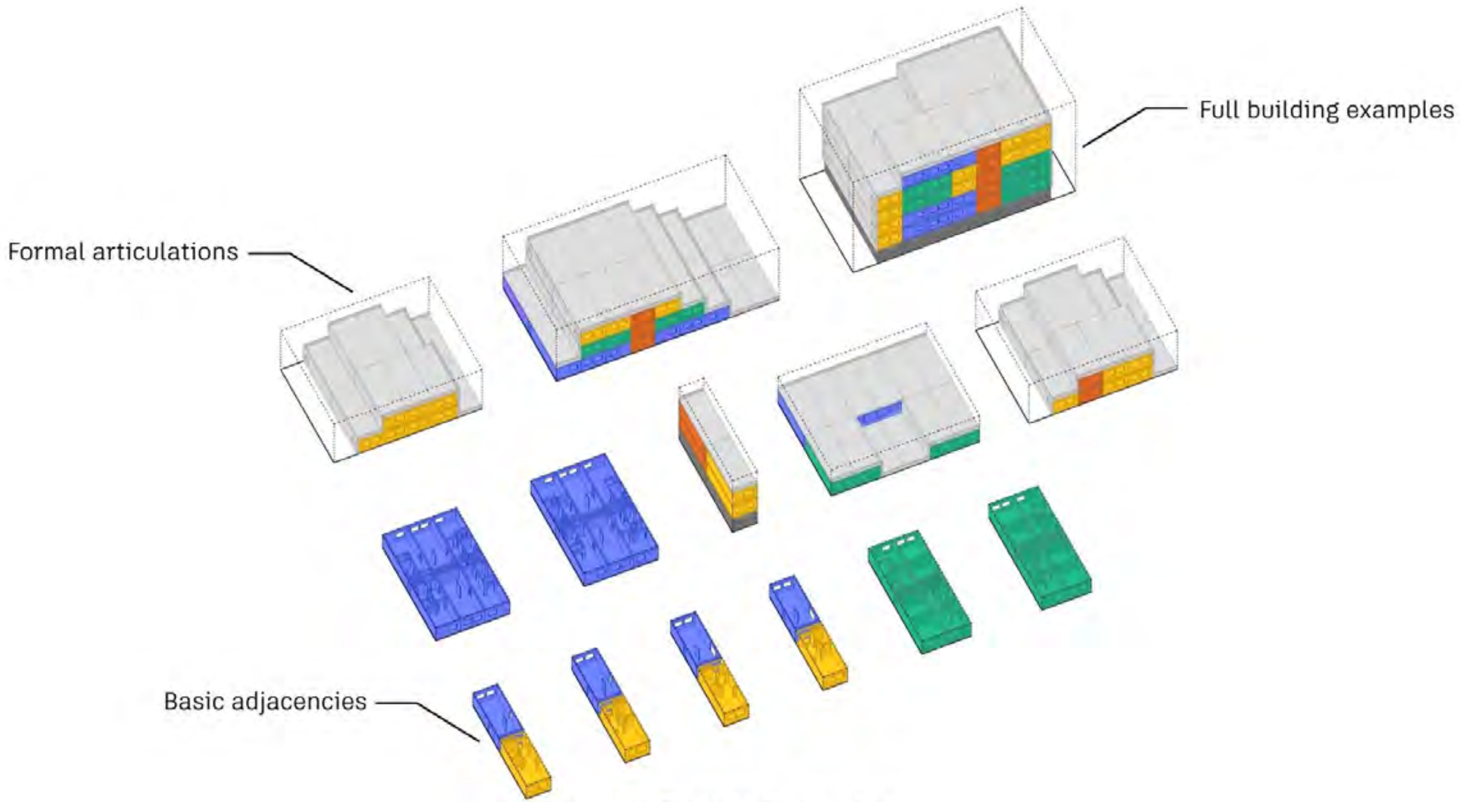
Gen, Sol: 0_22
ID: 60ab3486-c4e3-46b3-84dc-3fb30f63715a
Unit_Delta: 11

Livability
Unit Mix Variation: 787
Terraces: 20
Corners: 18

Valid:



AI-Enabled Example-Based Design



Create Design Examples

Combine ABM and WFC for multi-scalar approach

Capacidades AI Disponibles Actualmente

AUTODESK FORMA

Real-time analysis

Perform predictive analysis for wind, noise, and operational energy in real time, so you can make smart design decisions that improve outcomes.

AUTODESK AUTOCAD

Markup assist

Convert comments, identify handwritten text, add objects, and automate edits through recognized instructional text and strikethroughs from markup files.

AUTODESK INFODRAINAGE

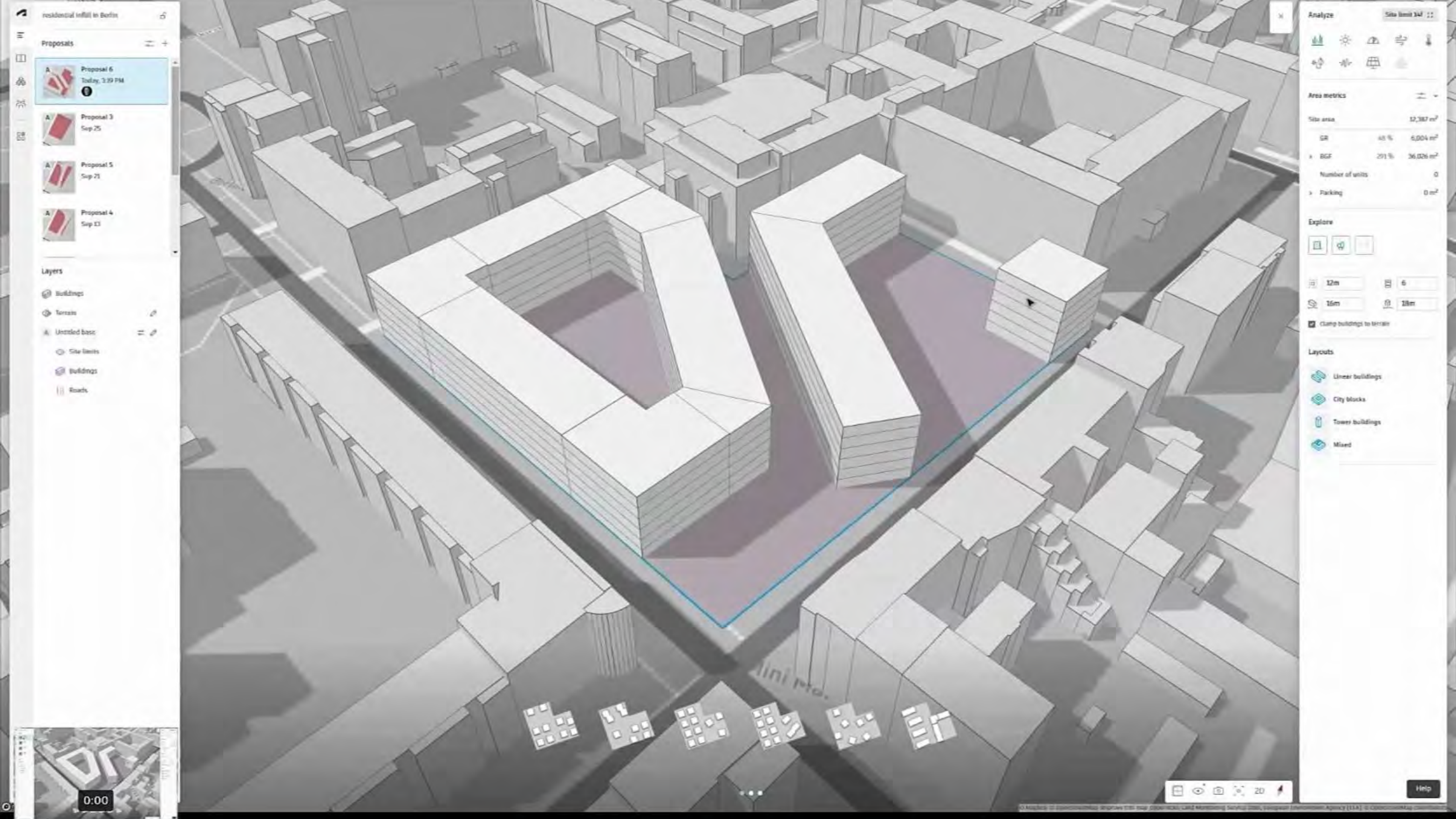
Machine learning deluge tool

Predict flood maps quickly and accurately when applying water on the site surface, all while leveraging new built-in artificial intelligence.

AUTODESK CONSTRUCTION CLOUD

Construction IQ

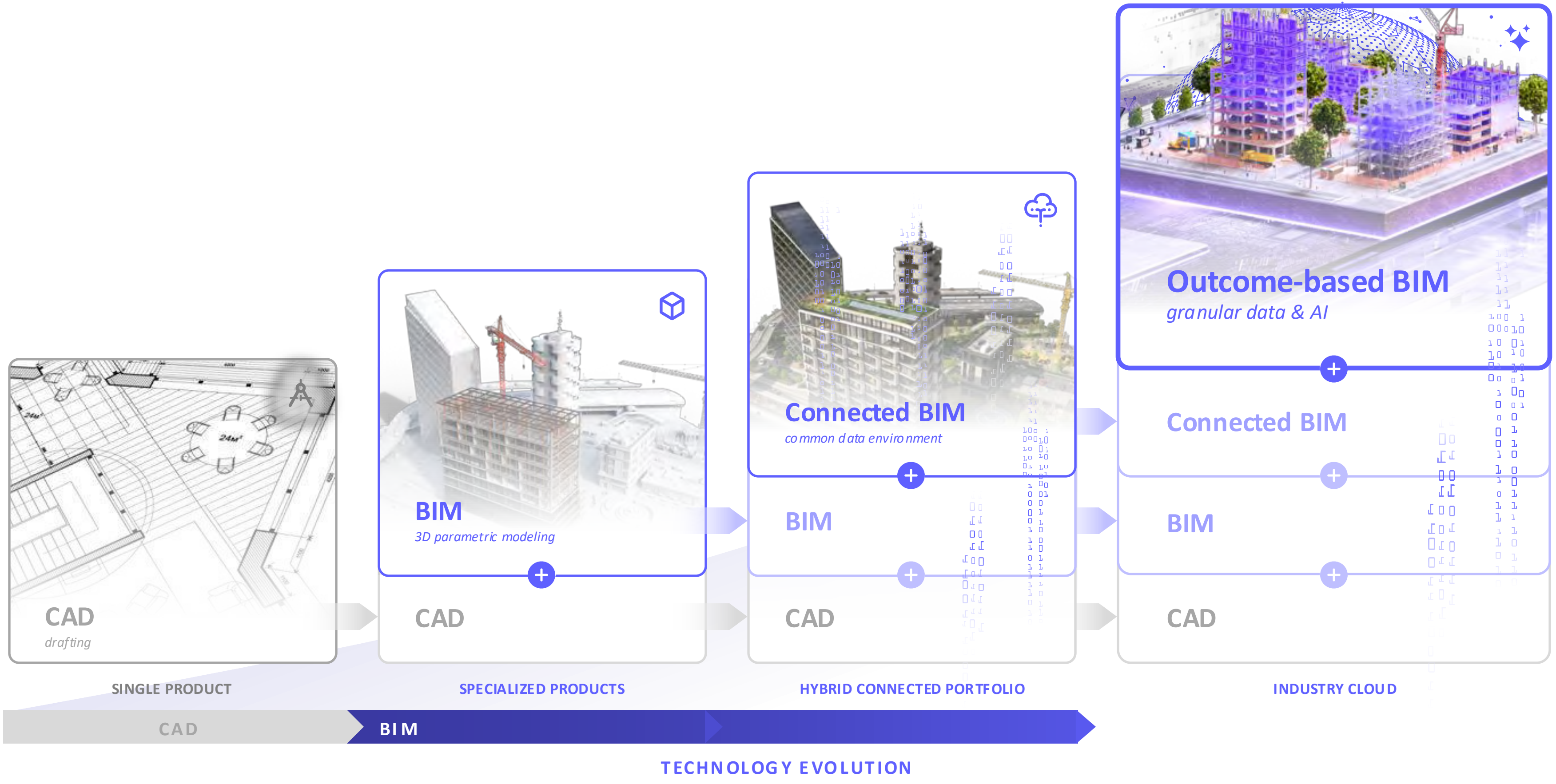
Analyze project data to identify and prioritize design, quality, safety, and project control risks to help resolve issues and make decisions earlier.



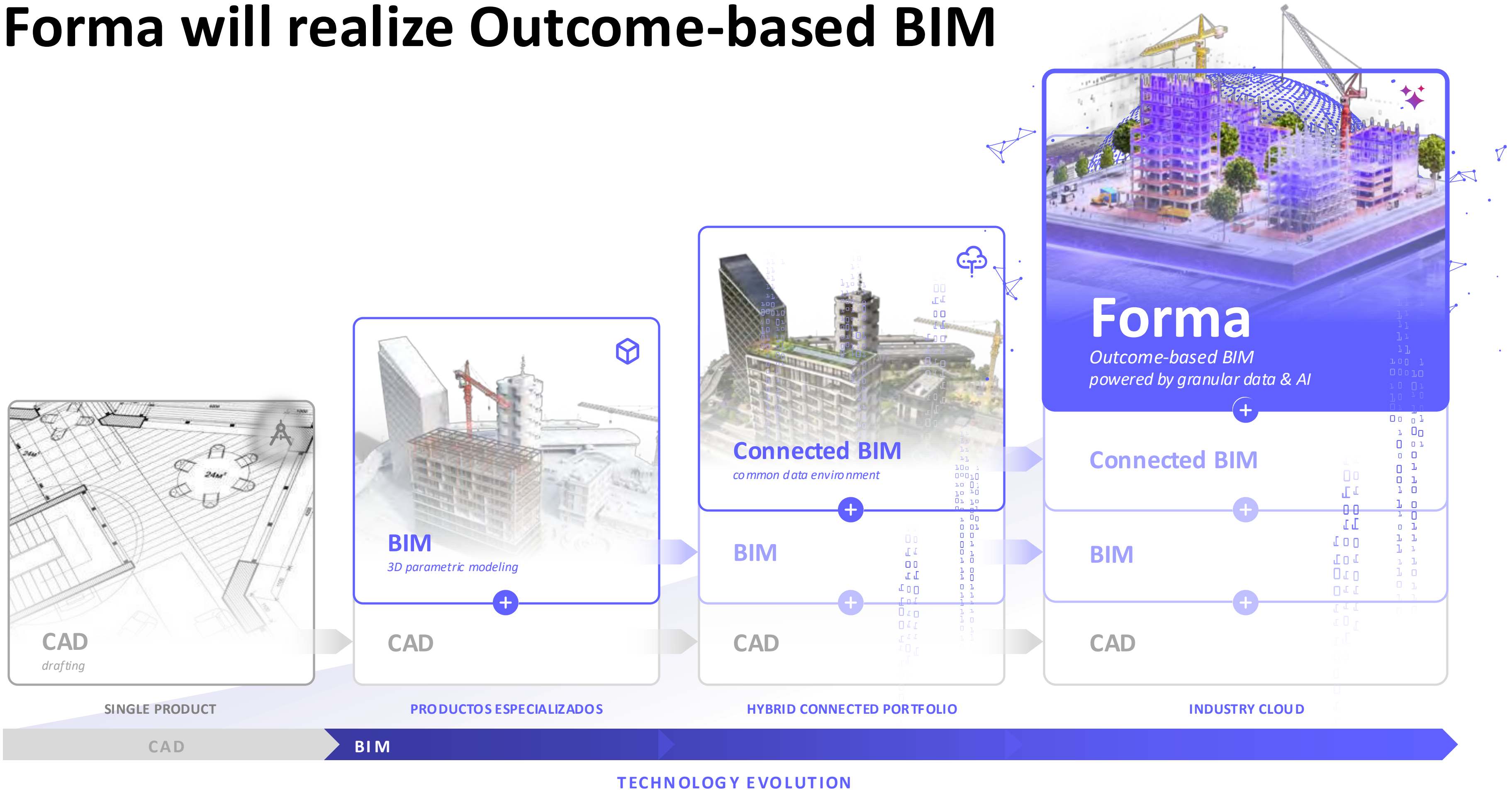
residential infill in Berlin
Proposals
Proposal 6
Today, 3:39 PM
Proposal 3
Sep 25
Proposal 5
Sep 21
Proposal 4
Sep 13
Layers
Buildings
Terrain
Untitled base
Site limits
Buildings
Roads
0:00
Analyze
Area metrics
Site area
12,387 m²
6,004 m²
BGF
36,026 m²
Number of units
0
Parking
0 m²
Explore
12m
6
16m
18m
Clamp buildings to terrain
Layouts
Linear buildings
City blocks
Tower buildings
Mixed
2D
Help


Area metrics
Selection
Area metrics
Site area
ES
0 m²
SHOB
0 m²
Number of units
0
Parking
0 m²
Zone
Name

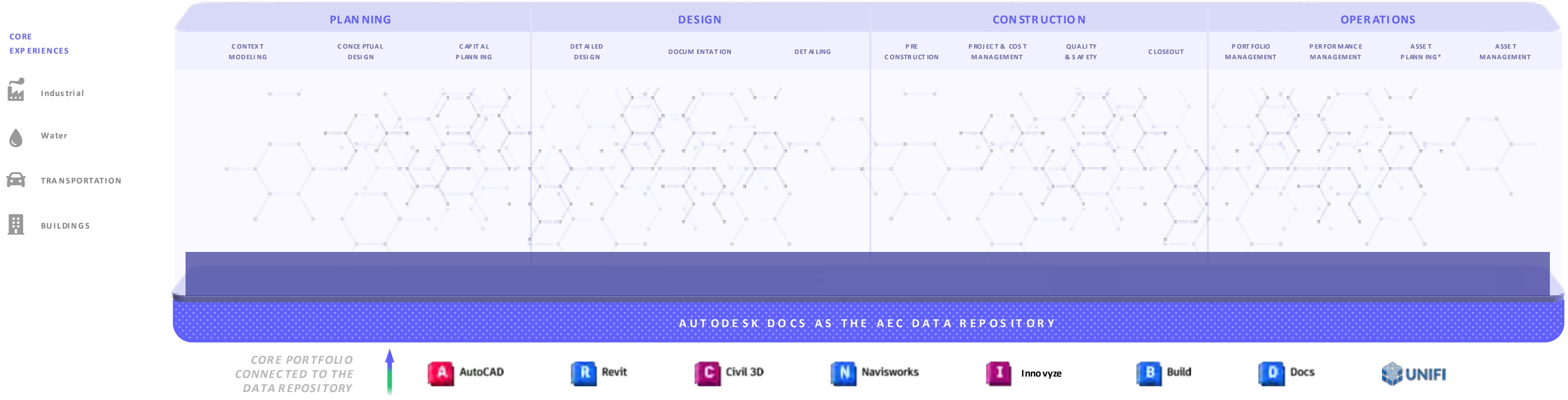
Outcome-based BIM



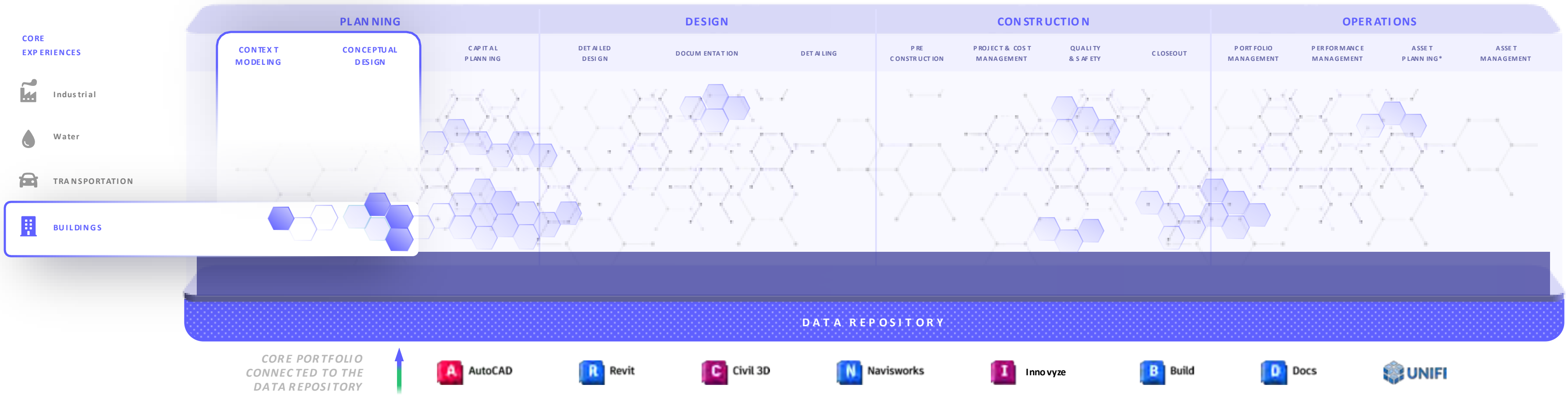
Forma will realize Outcome-based BIM



Mapa de Capacidades en Forma



Primer release



Outcome-based BIM, Powered by Autodesk AI