KTP Spring 2025 - Tech Dev Workshops
Graham Ballantyne

Building Information Modeling and Data Analytics

My Background

Intern with Turner Construction Company

2022 - Operations & Closeout Project Management @ Beth Israel Deaconess Hospital, Boston MA

2023 - Virtual Design Construction @ Oakland Office and San Francisco International Airport, Oakland CA

Motivation

As of 2024, the U.S. construction industry is valued at anywhere between 1.57 & 2.1 trillion USD and an CAGR estimate of 5.0% between 2024 and 2028.

Buildings and construction account for 37% of all global carbon emissions & is outpacing decarbonization efforts - technological innovations increase efficiency reducing carbon footprint.

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01

Building Technology Systems

Building Blocks: What Makes a Structure a Building?

Structure

Concrete, steel, timber, etc.

HVAC

Heating, Ventilation, and Air Conditioning

MEPFP

Mechanical, Electrical, Plumbing, & Fire Protection

Structural Elements

Materials like concrete, steel, and timber dominate the structural component of most large buildings

Concrete production accounts for 7% of global emissions, steel 8%

Massive incentives for optimizing steel & concrete usage even with green alternatives available.

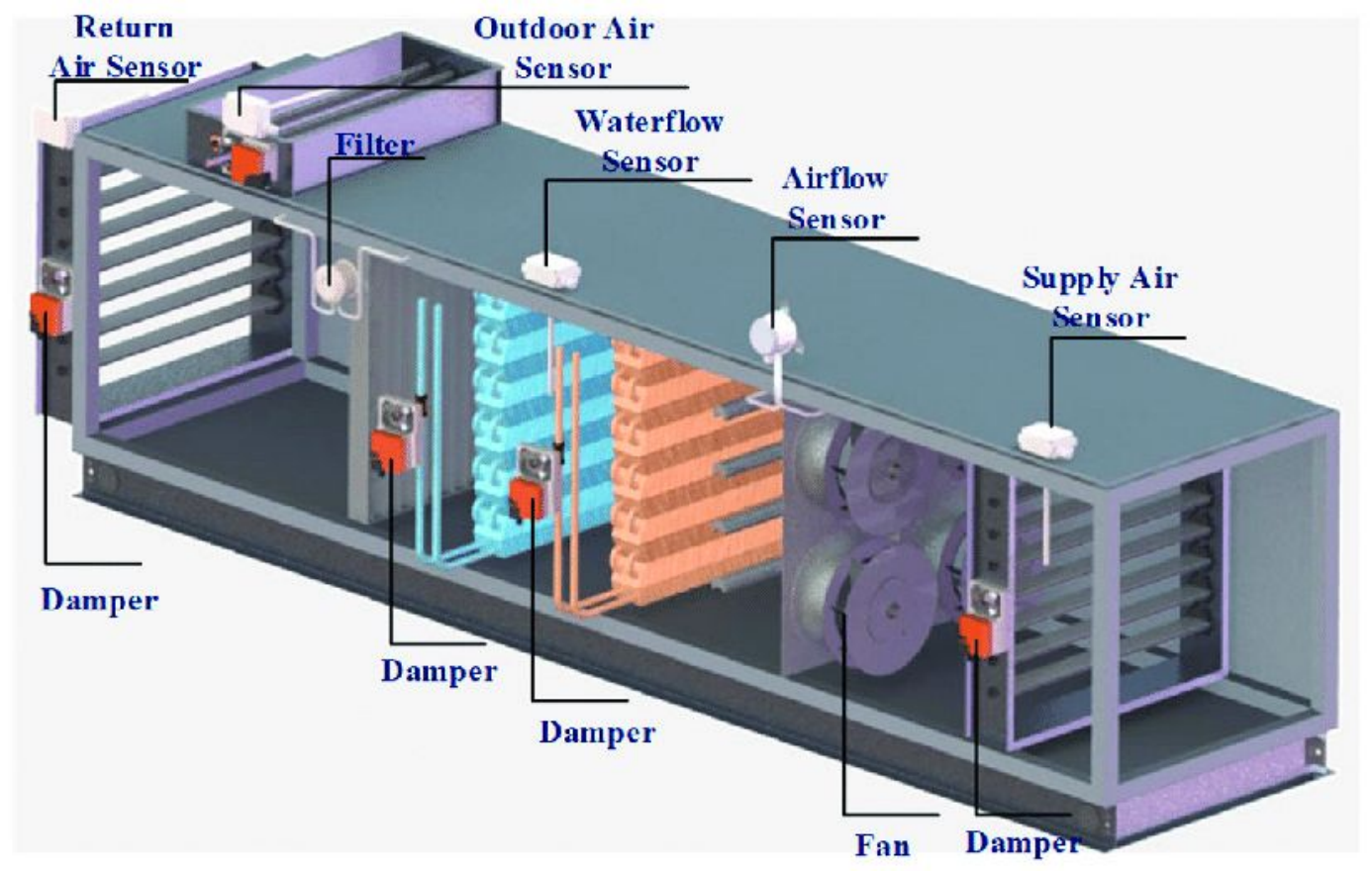
HVAC Elements

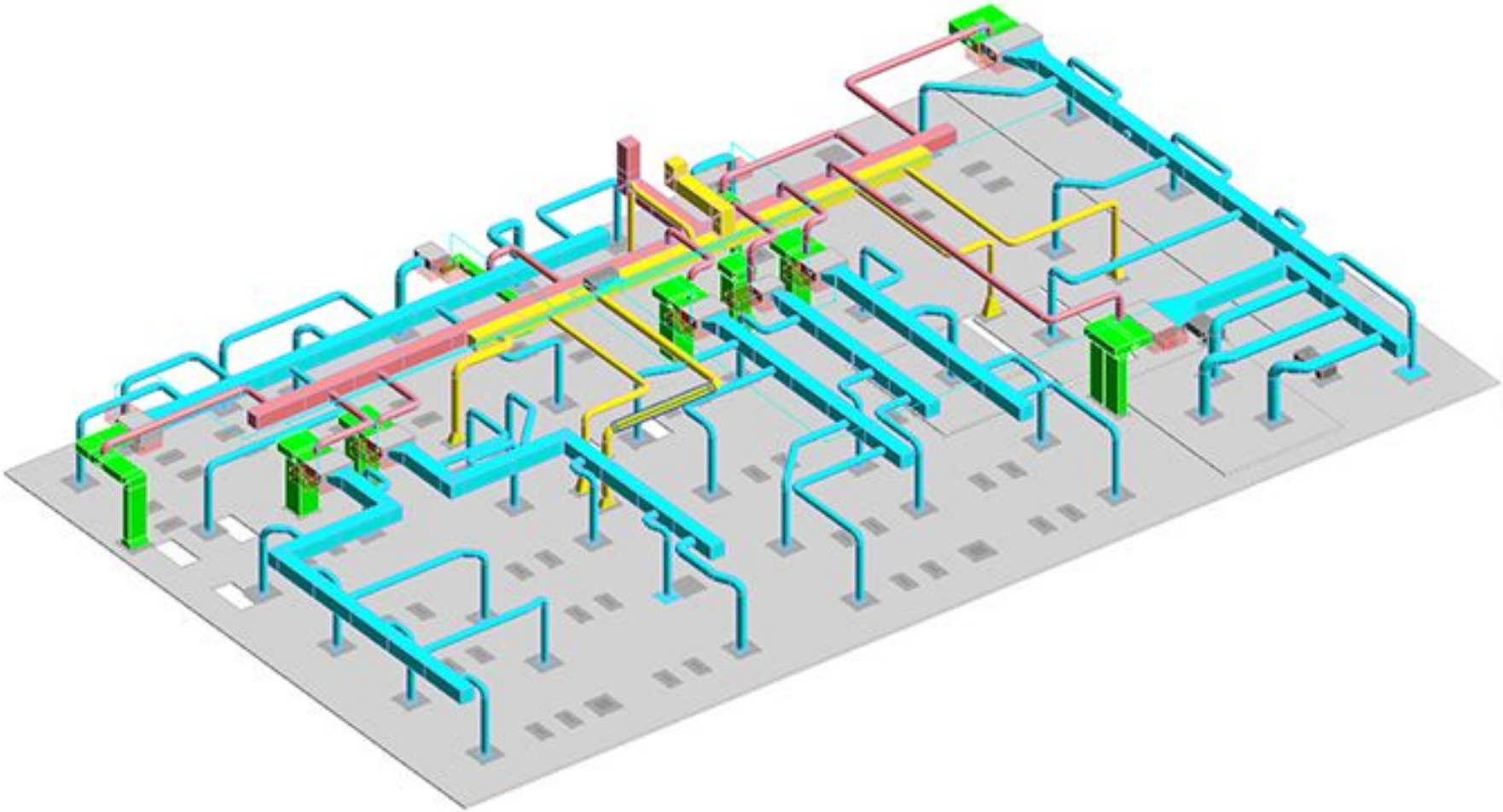
HVAC systems work to control the temperature, humidity, air quality, and air circulation in a building.

Air Handling Unit

Variable Air Volume Terminal

Shout Out - Air Handling Unit





MEPFP Elements

Process Piping

Fire Protection

Mechanical

Electrical

Plumbing

02

Building Information Modeling (BIM)

What is BIM?

High Level Overview

- Dynamic, data-intensive model of project compiled from general contractor & subcontractors
- Integration of geometric, scheduling, and budgeting data (4D/5D)
- Complete life cycle management of building

Geometric Data & 3D Modeling

Areas of Interest

Structure

- Steel & Timber Members, Concrete
- Load & Finite Element Analysis

MEPFP

- Mechanical (HVAC), Electrical, Plumbing, & Fire Protection
- Clash Detection for Project Management

Modeling Techniques

- CAD (Autodesk Revit, ArchiCAD, AutoCAD)
- 3D Point Cloud Scanning (Autodesk ReCap)

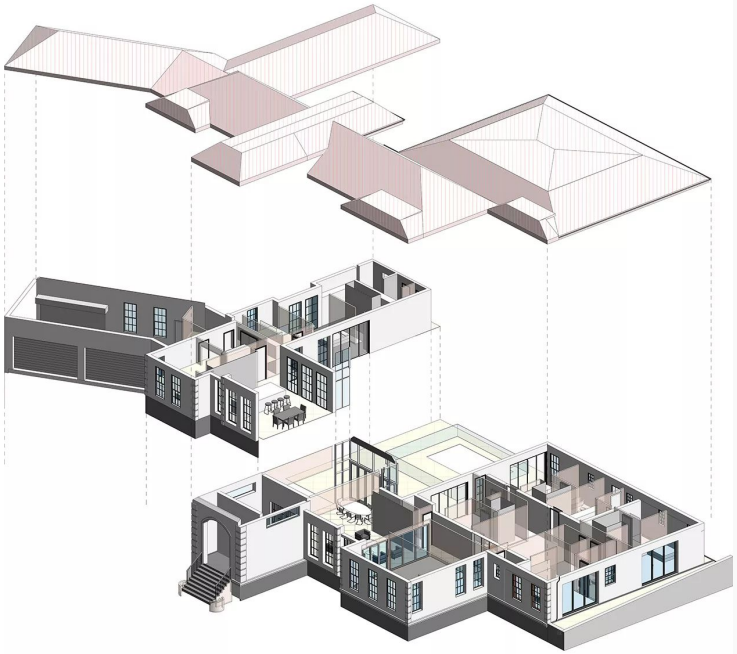
Computer Aided Design

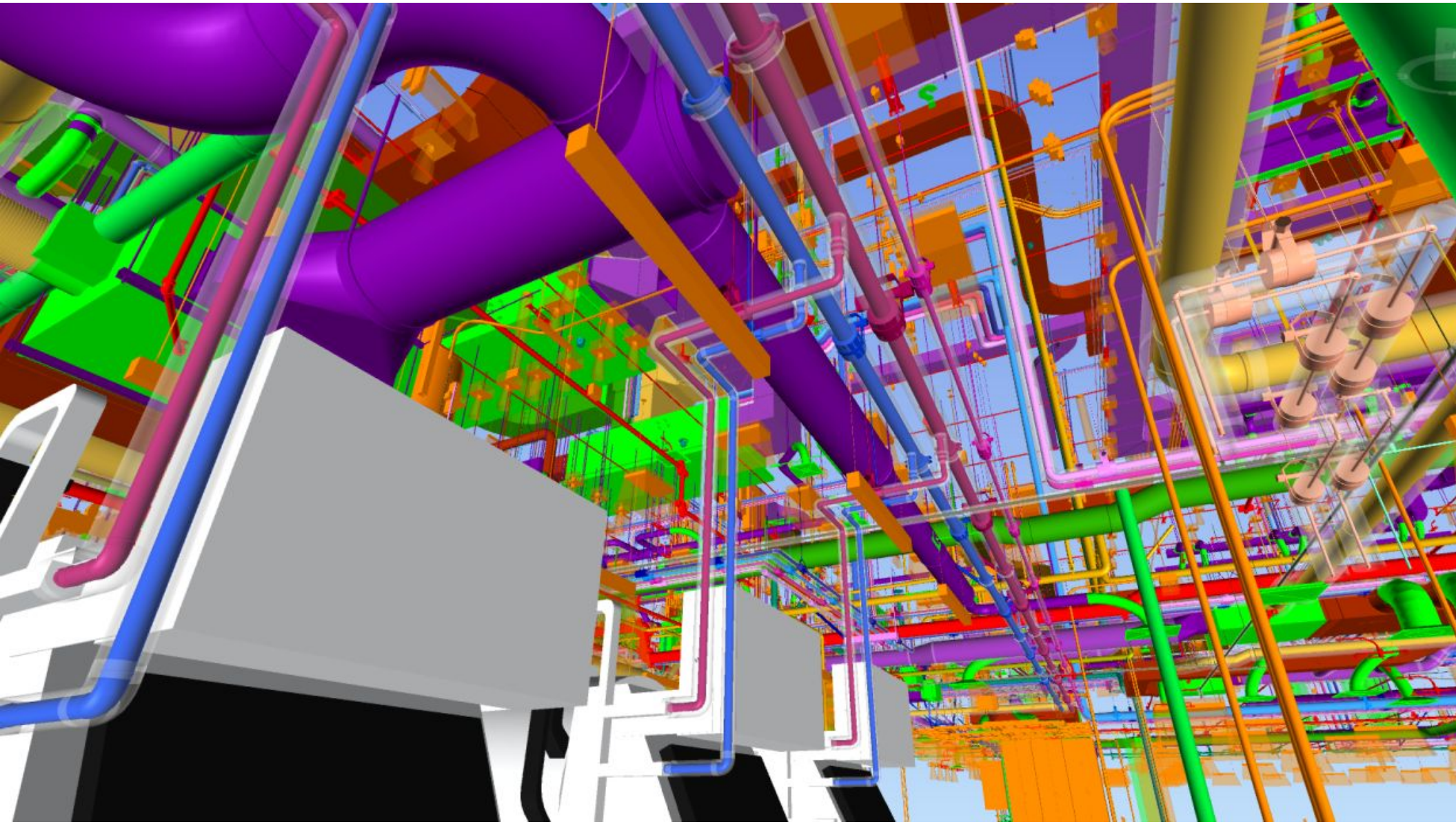
Digitally Modeled Elements

- Come to Workshop on 04/09 to learn basic CAD!

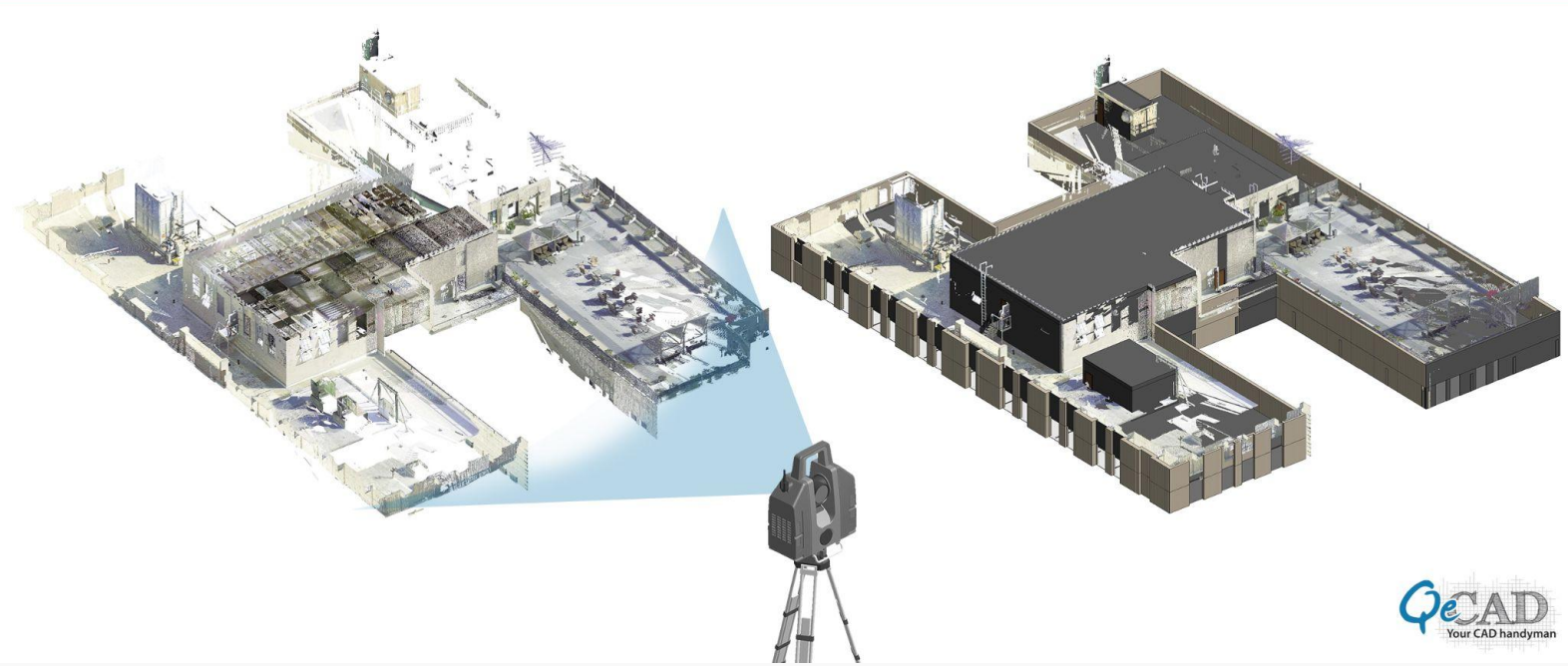
Software presents parametric CAD templates for common elements

- HVAC elements like Duct, AHU, and VAV's
- Piping Elements & Hangers





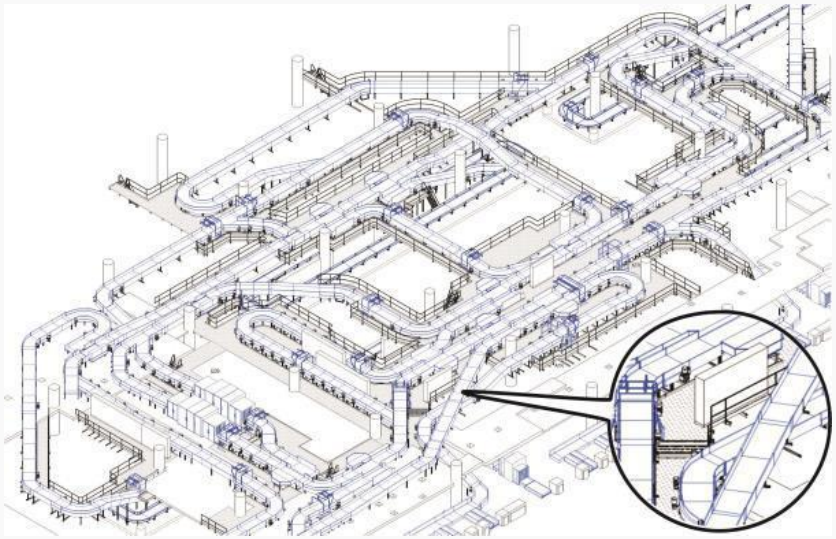
Point Cloud Scanning

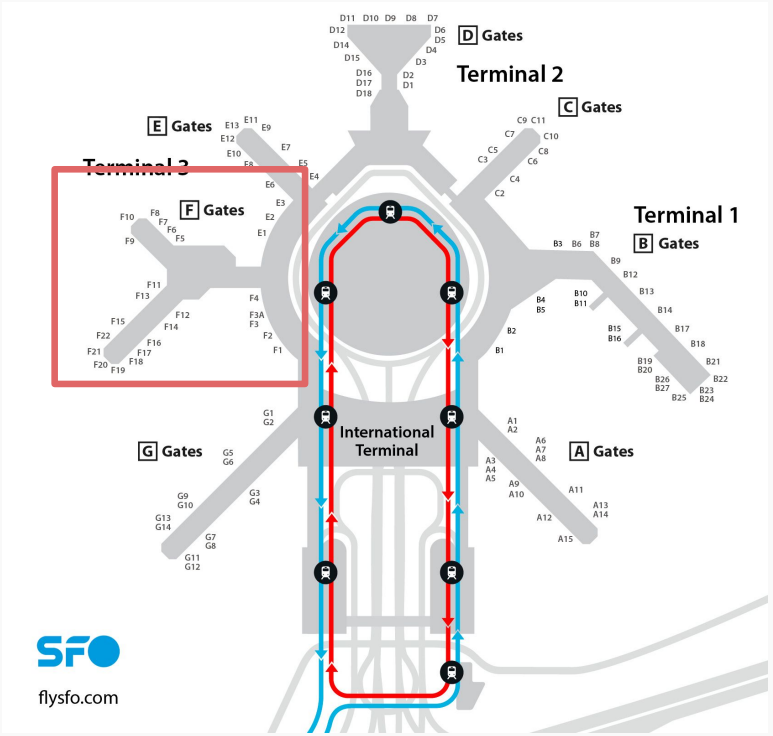


Compile point system defined by φ, θ, & r, where r = cΔt. Point cloud can be used for comparison to built structure or compiled to CAD with ML processing.

Integrating CAD & Point Cloud for Project Management

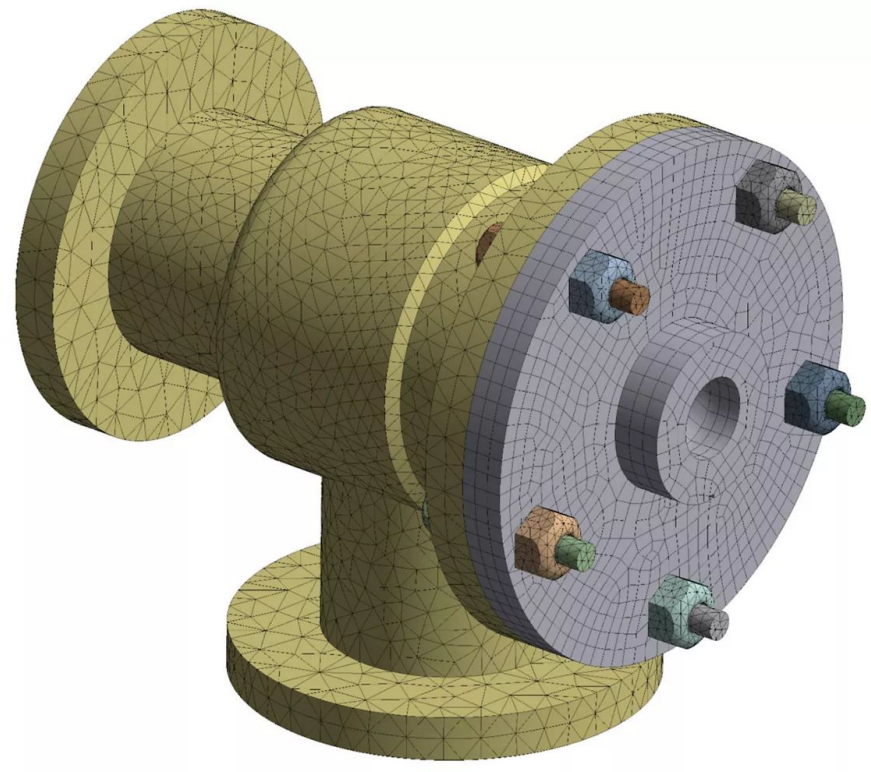
My Experience...

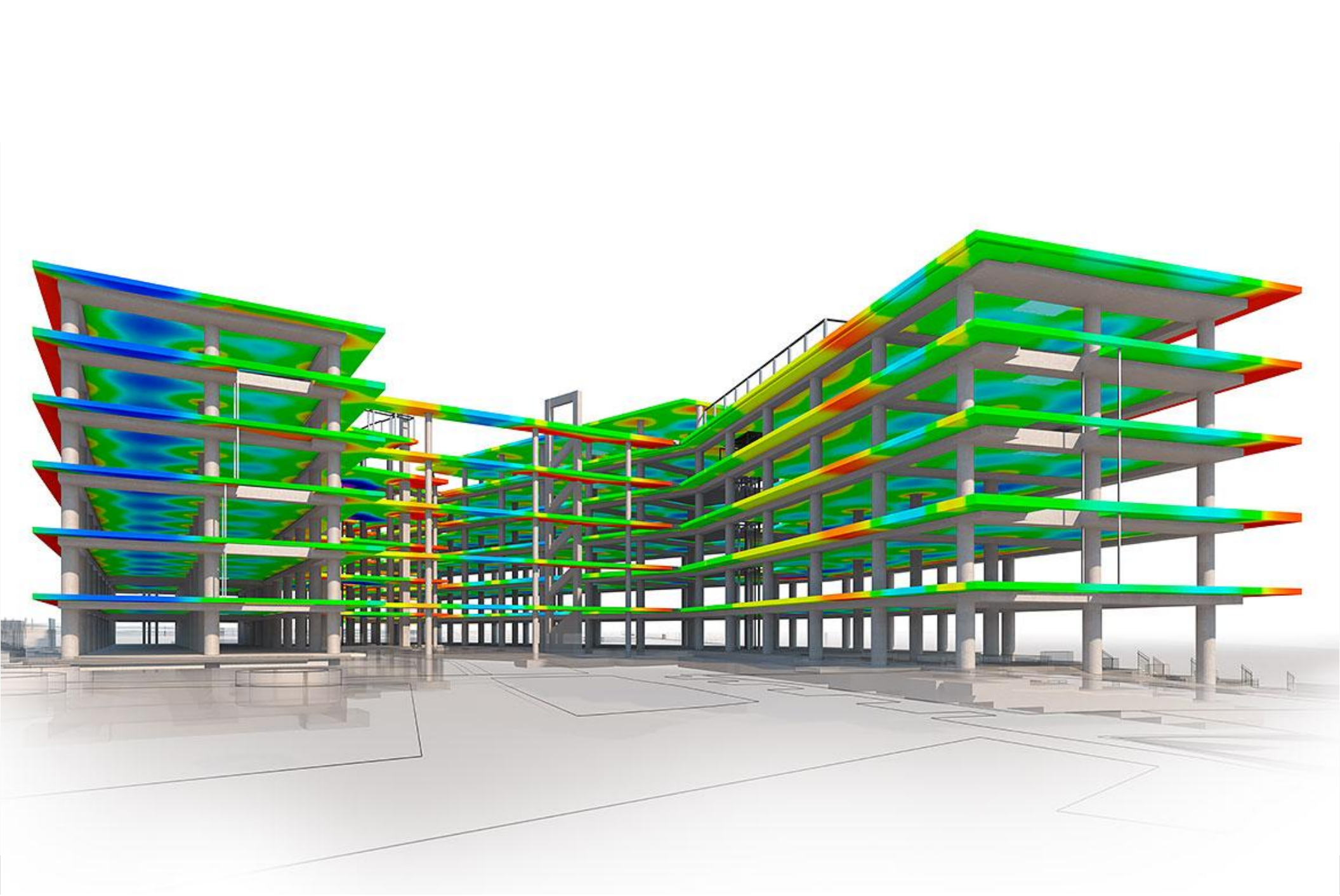




Finite Element Analysis (FEM & FEA)

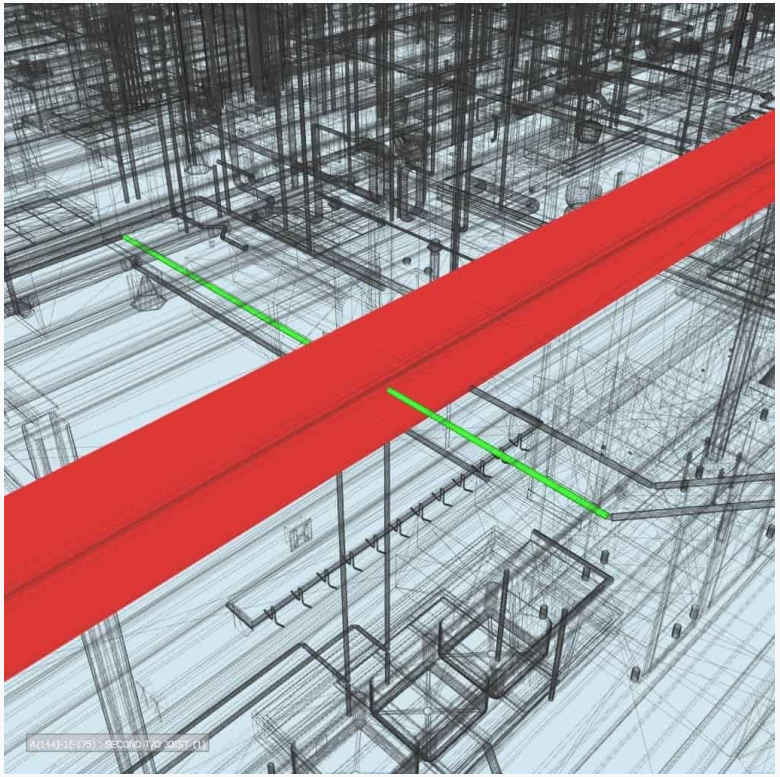
- Deconstructs complex parts & assemblies into geometrically favorable subcomponents
  - - Tetrahedral, Hexahedral, & Hybrid
- PDE's dictating the mesh & nodal behavior are approximated with linear or ODE systems
  - - Displacement, Stress/Strain





Clash Detection

- Scans project model for intersection components, clearances, and supports
- Assigns responsible contractor for fix to prevent in-field inefficiencies



Data Layering (4D/5D)

Scheduling Data (4D)

- Assign scheduling date to model elements
- Aesthetic and technical applications to streamline construction process.

Cost Data (5D)

- Assign cost to model elements
- Greater cost estimate and resource allocation capabilities

Additional Data

- Management data & sustainability data may be added to further enhance the value of BIM model

GATE 6
GATE 2
CRANE 4

03

Construction Data Analytics

Timeline of Data Analytics in Construction

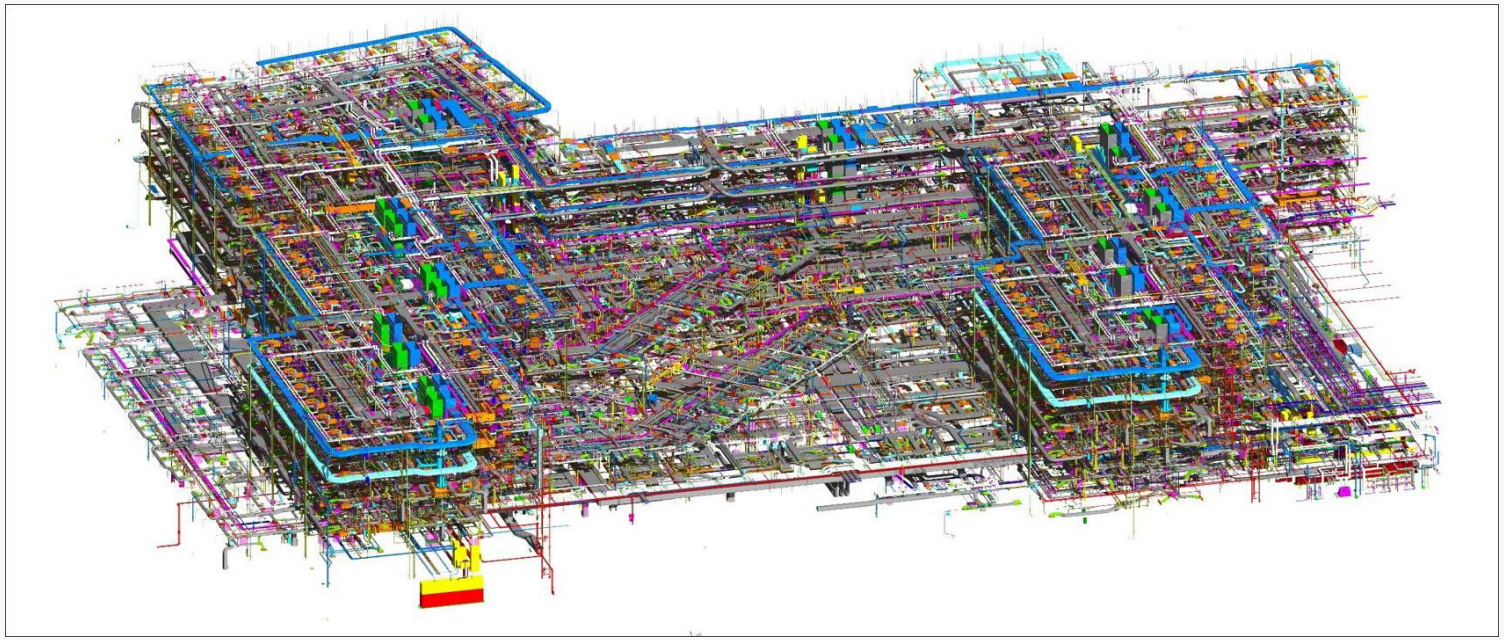
BIM Analytics

Extracting date from a BIM model to gain project insight.

Optimization Analytics

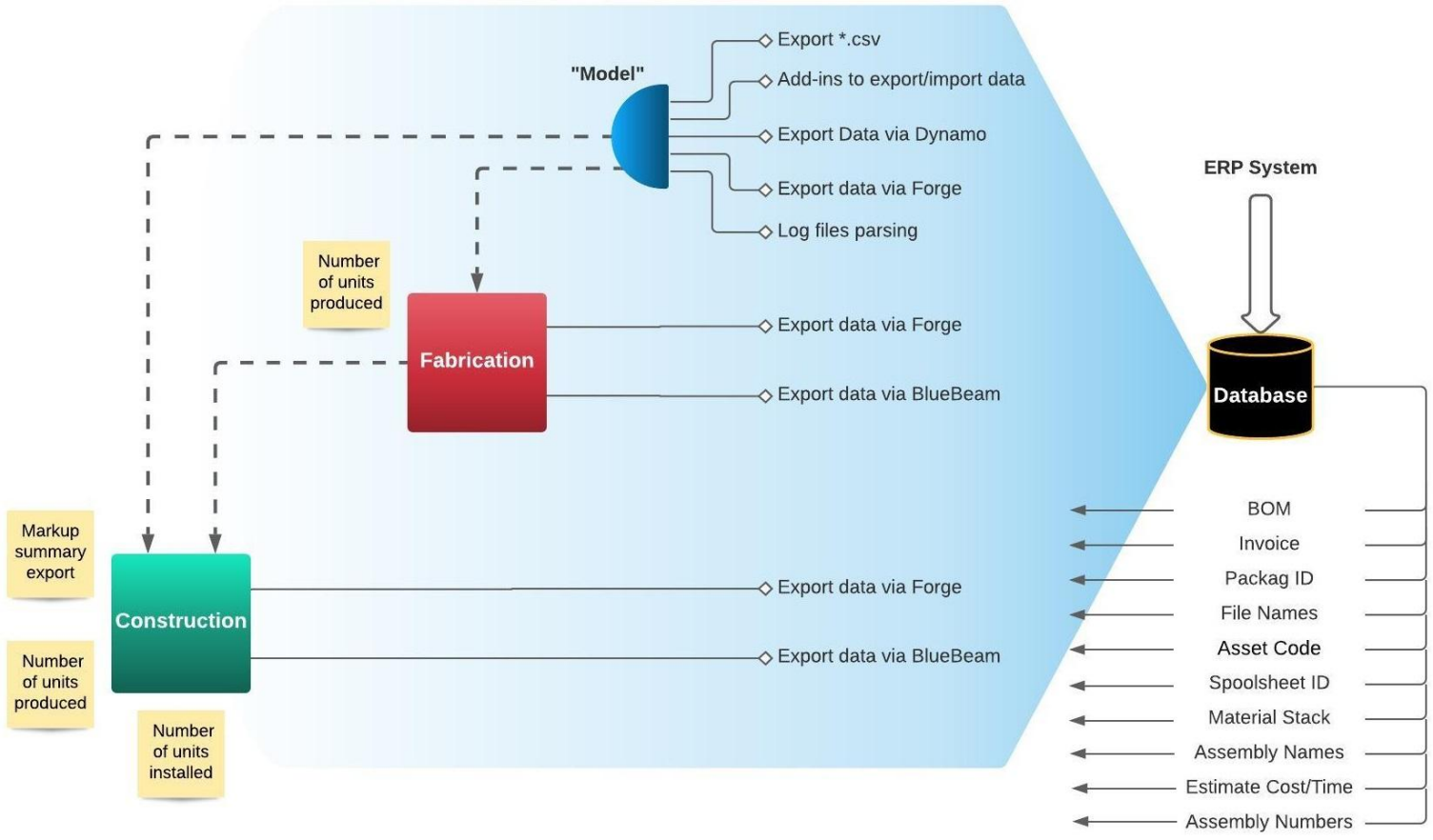
Utilizing machine learning to create sustainable solutions in energy efficiency.

BIM Analytics



Wow, that's a lot of data... how can data be extracted for useful insights in predictive modeling and optimization?

Where Does the Data Come From



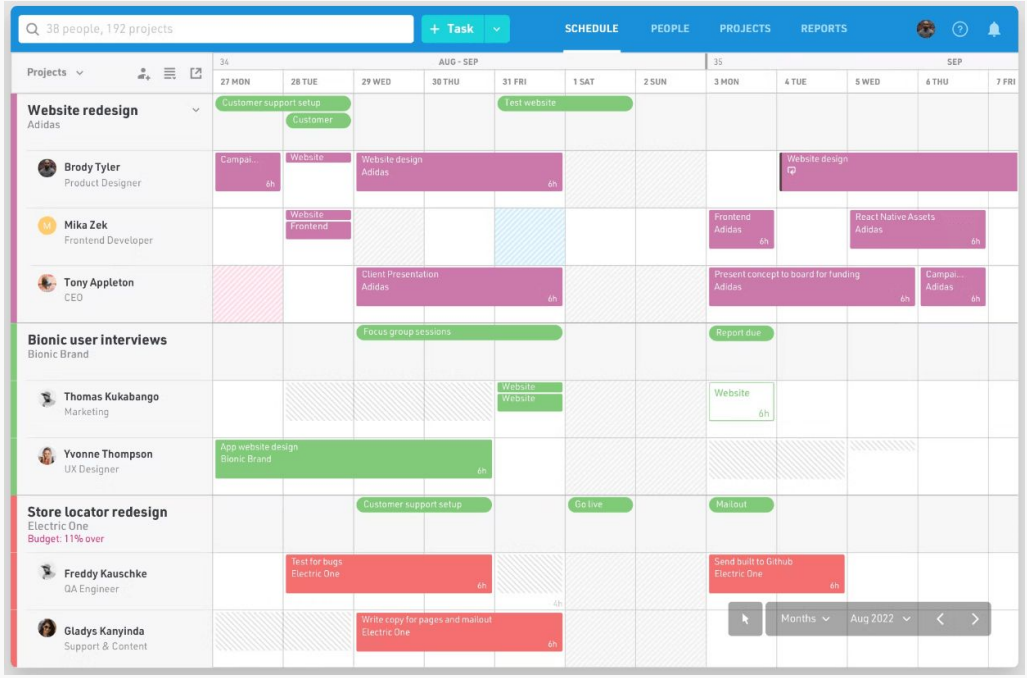
Optimization Analytics

Scheduling Optimization

- 3D/ 4D Clash Detection
- RL or ML model simulations for scheduling options

Cost Optimization

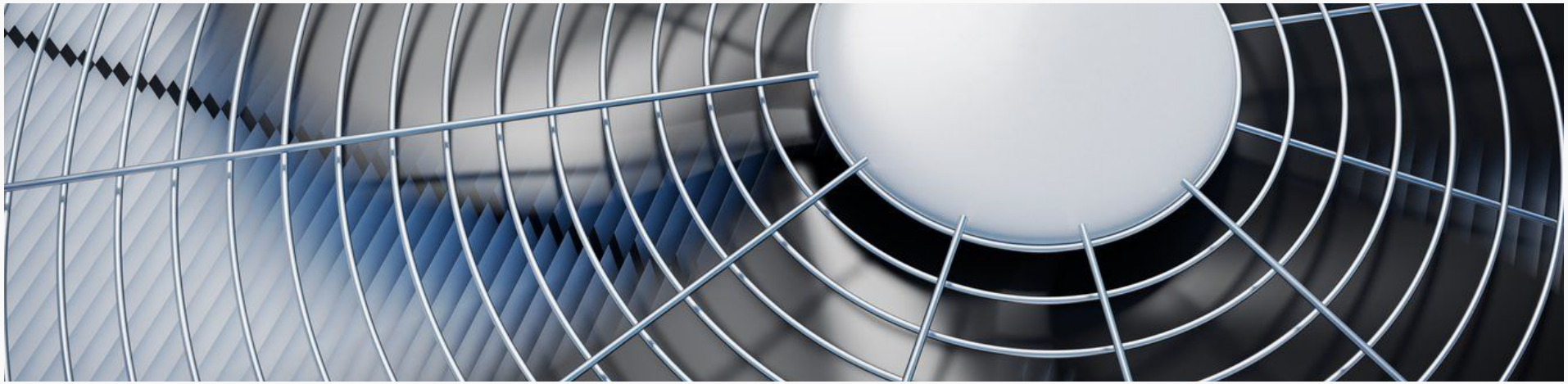
- 4d scheduling, RL & ML model simulations



Energy Optimization

Most energy consumption of a building is in its HVAC system. This load can be optimized with following strategies...

- Demand Based Heating & Cooling
- Zoning Efficiency
- Load Balancing



Thanks!

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