Connecting Autodesk to the Internet of Things

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Autodesk Research
@keanw

Class summary

The Research Team at Autodesk, Inc., has been developing technology for the Internet of Things (IoT) since before people called it that. Project Dasher is a building performance management tool that displays historical and real-time sensor data inside a building model. The Research Team has taken the learning acquired while developing Project Dasher and used it to create technology that addresses the needs of the broader IoT market. This session will look at how IoT APIs (application programming interfaces) from Autodesk Research can be used to display information in websites integrating the viewer from the Forge Platform to inform the design process and even power generative design. This session features Forge and Dynamo Studio.

Key learning objectives

At the end of this class, you will be able to:

- Learn what Autodesk Research is doing with IoT
- Learn how to use IoT APIs to access historical and real-time sensor data
- Learn how to integrate visualization components from Autodesk Research into Autodesk viewer applications
- Learn how to call IoT APIs from Dynamo Studio to power generative design

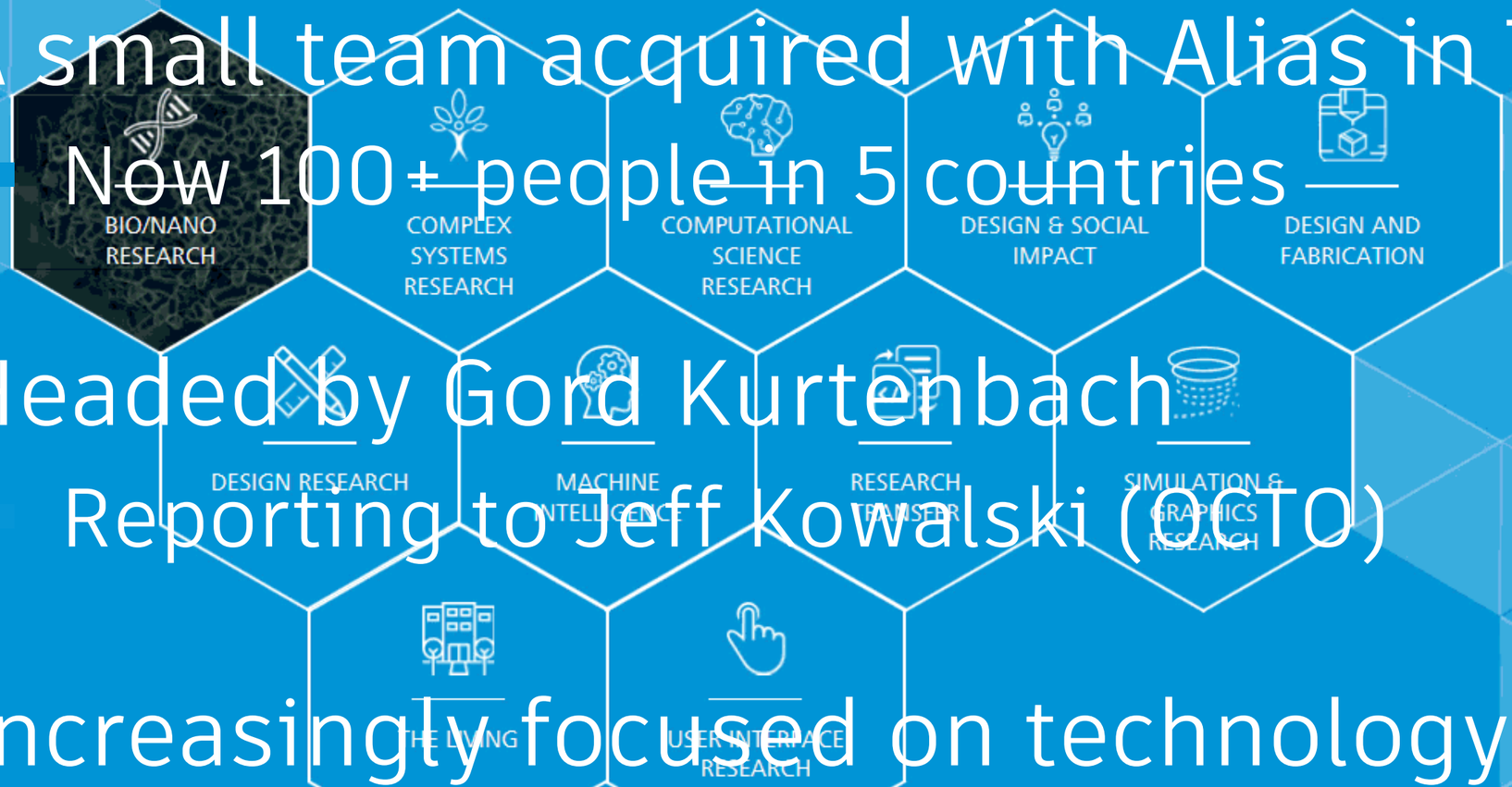
About me

- 21 years at Autodesk
  - UK ➔ Switzerland ➔ USA ➔ India ➔ Switzerland
  - 16.5 years in the Developer Network
  - 4 years in AutoCAD Engineering
  - 8 months in Autodesk Research
- 10 years blogging at Through the Interface
  - AutoCAD development, now Forge, IoT & AR/VR

Autodesk Research and Project Dasher

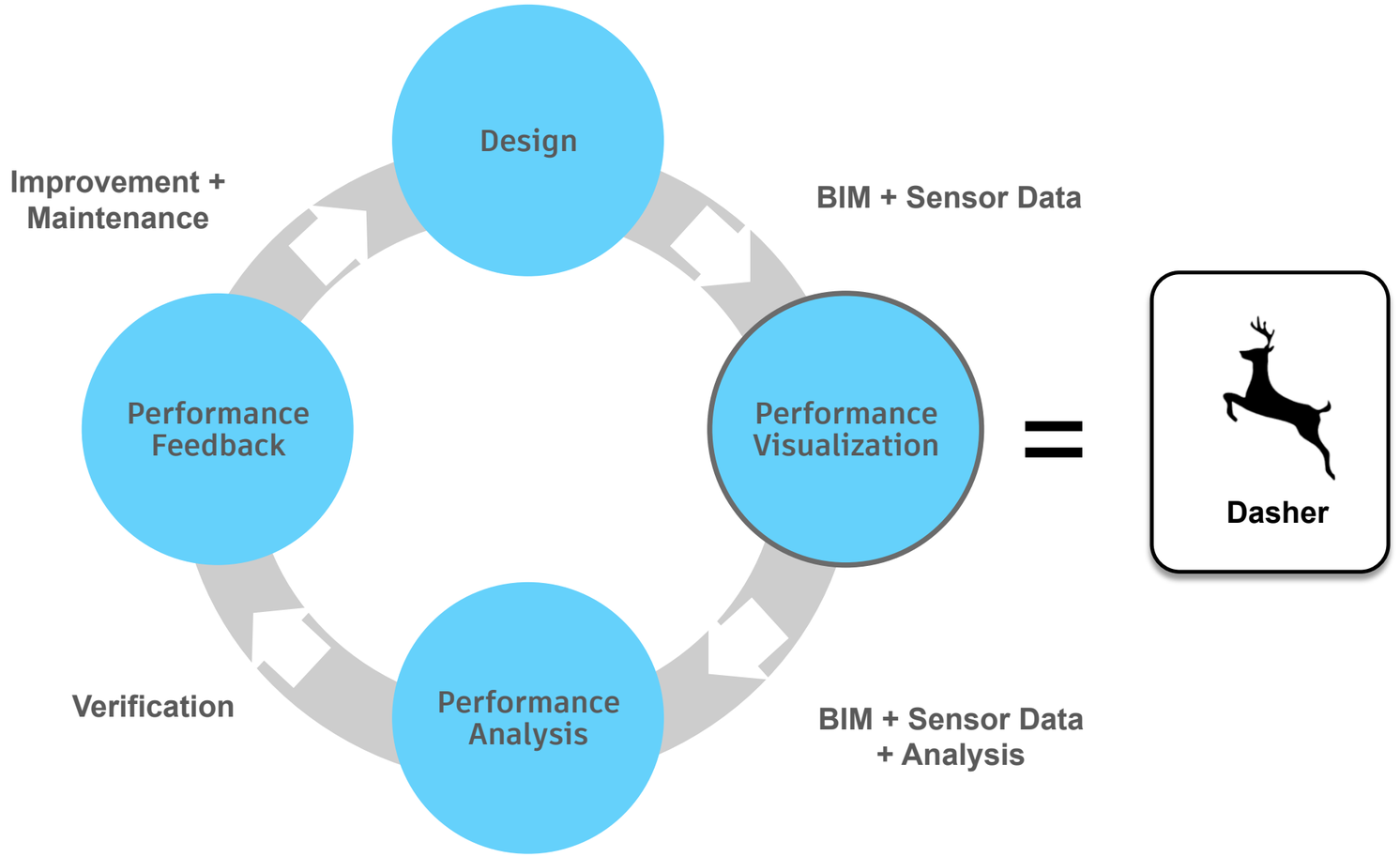
Autodesk Research

- A small team acquired with Alias in Toronto
- Now 100+ people in 5 countries
- Headed by Gord Kurtenbach
  - Reporting to Jeff Kowalski (OCTO)
- Increasingly focused on technology transfer
  - Meshmixer, Draco, Dreamcatcher



Project Dasher

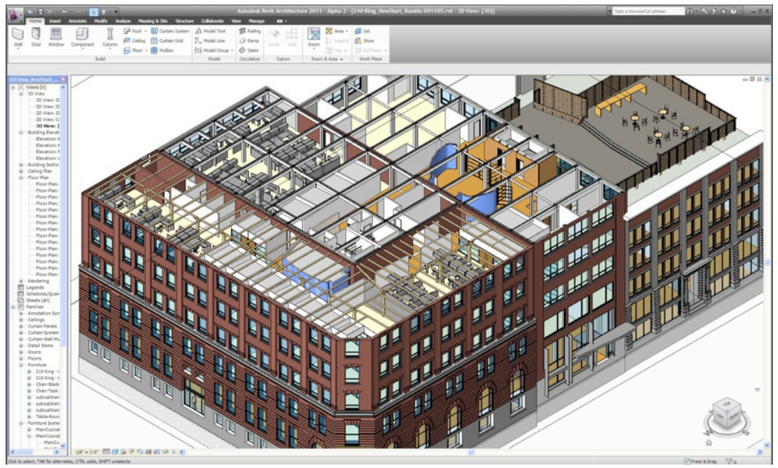
A visualization tool for improving building performance



BUILDING LIFECYCLE

Project Dasher

Project Dasher is BIM plus sensors + meters



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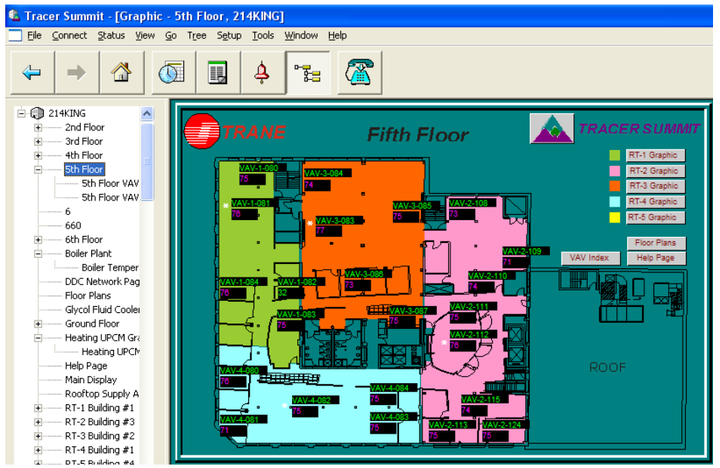

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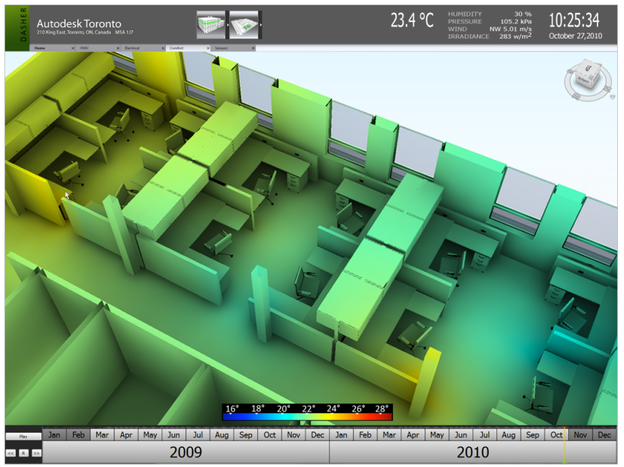


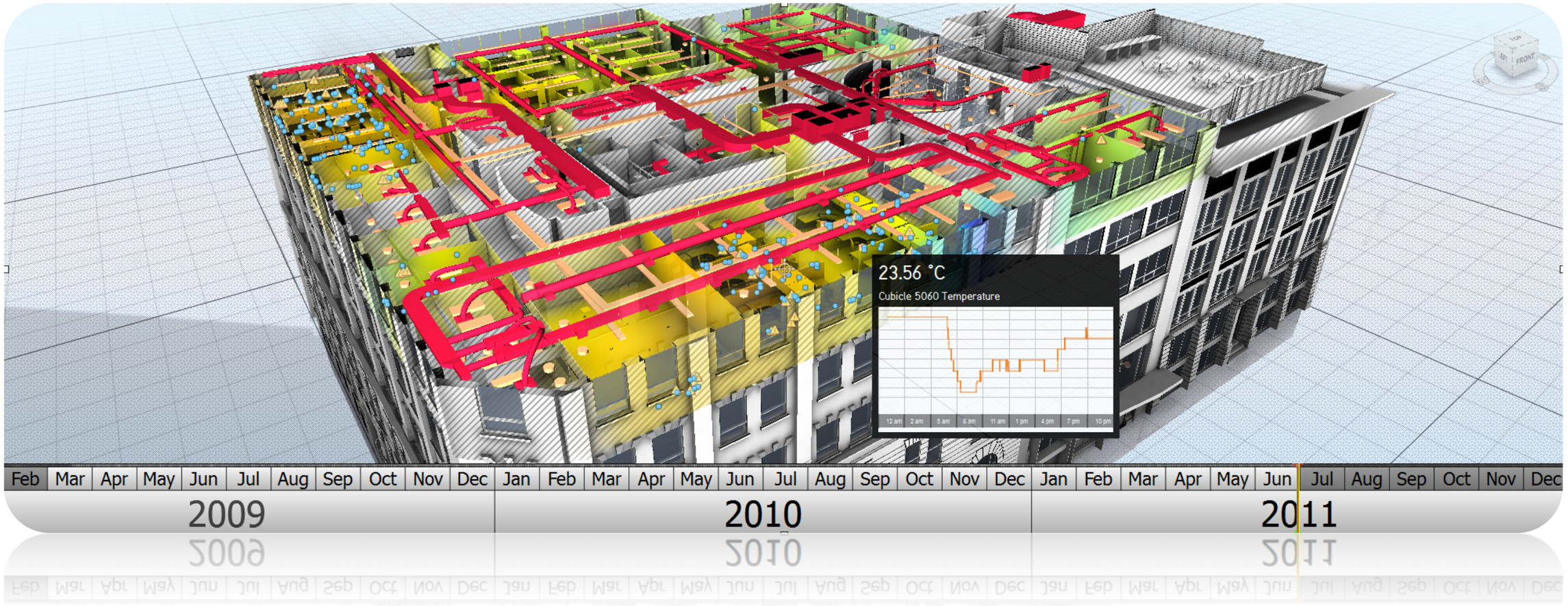
Building Information Modeling (BIM)
Detailed architectural, structural, mechanical, and electrical models

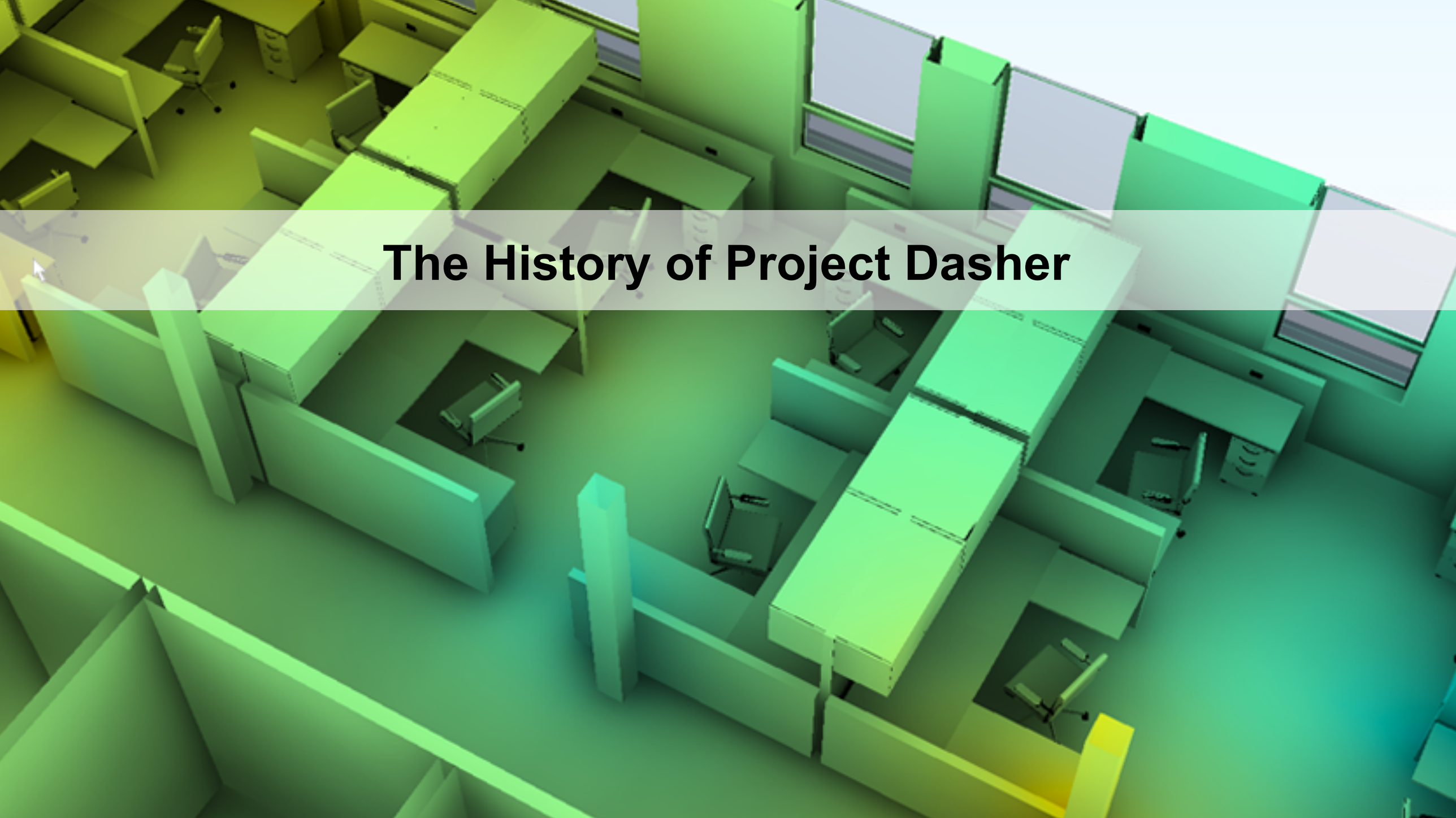
Building Management Systems (BMS)
User interface for data visualization, control, and automation of systems

Project Dasher
Historic and real-time data visualization in 3D space

Project Dasher

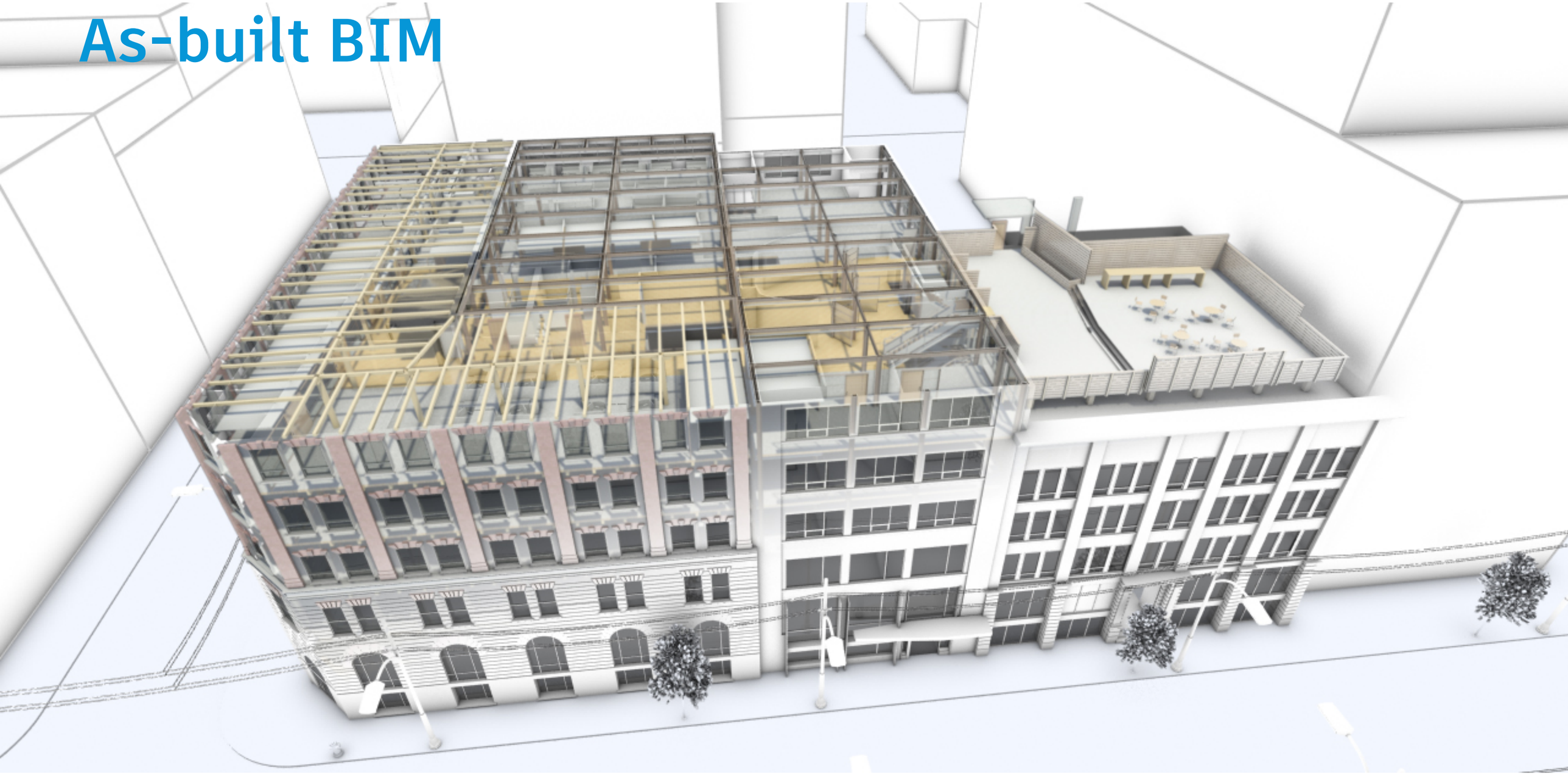
Extends BIM as a life-cycle tool





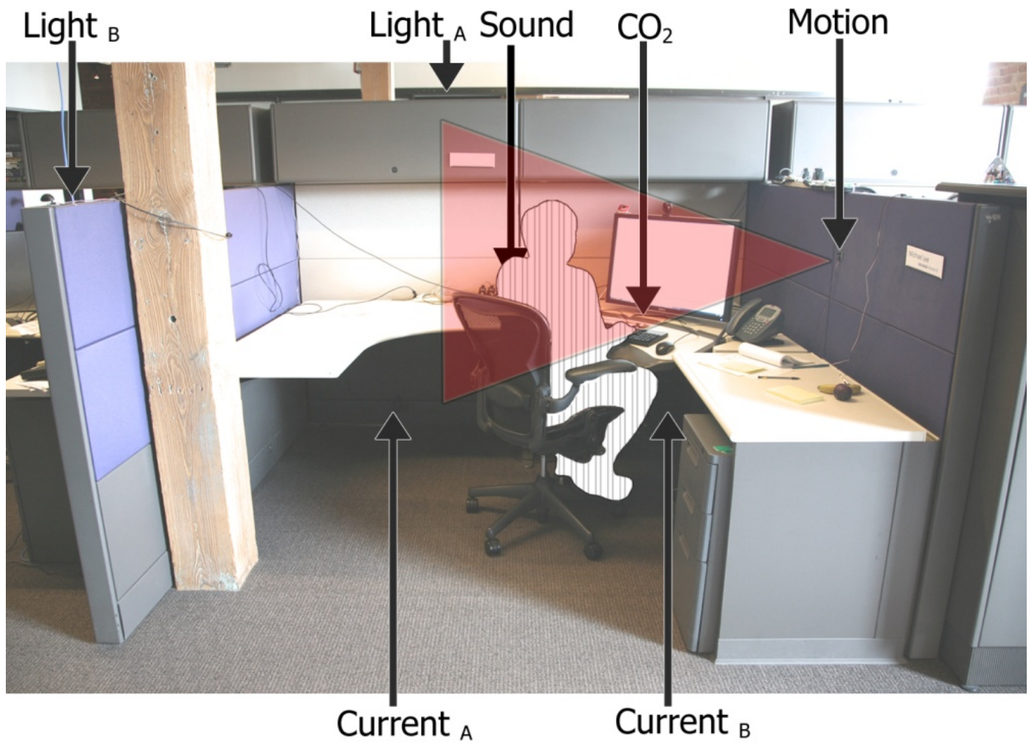
The History of Project Dasher

As-built BIM



Highly detailed model of Autodesk’s Toronto office

Sensors

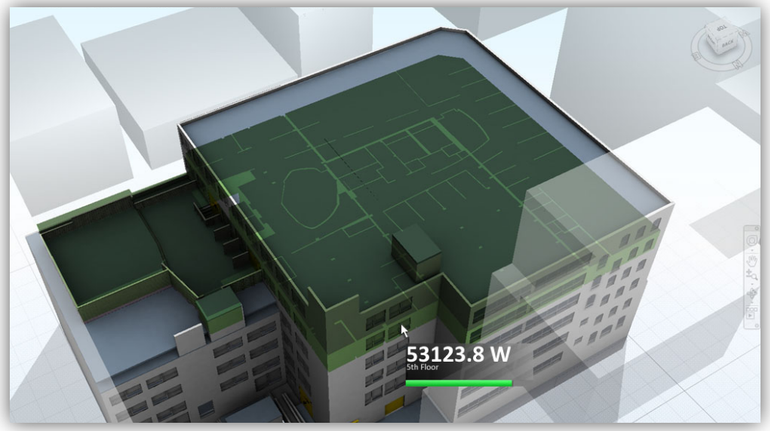


Networked Sensor Installation
Sensors installed in the physical environment track light, sound, occupancy, CO_2, temperature and energy use

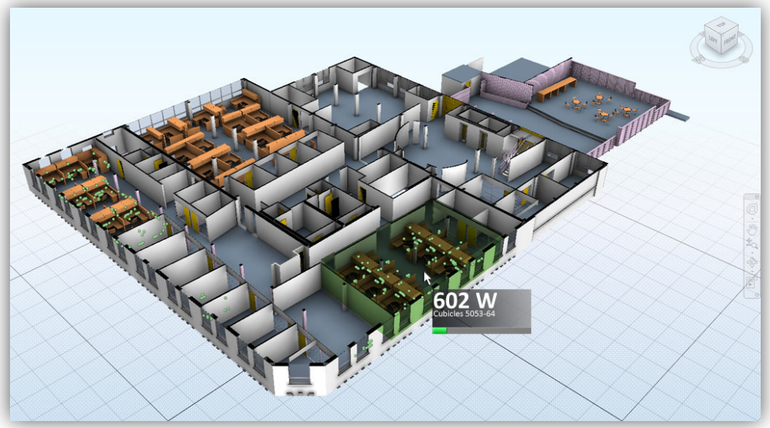
Revit Model w/ Networked Sensors
Sensors are placed and uniquely named within the as-built Revit model

Data resolution

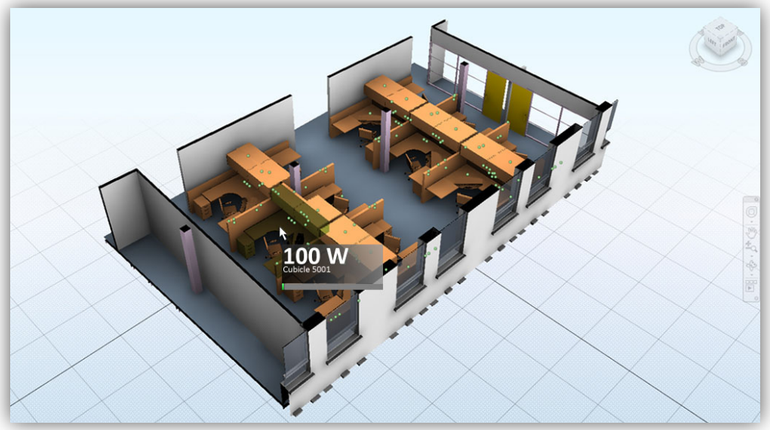
Floor / Area
multiple sensors



Workgroup / Zone
multiple sensors



Workstation / Individual
individual sensors



Increasing levels of detail

Autodesk Toronto
210 King St East, Toronto, ON, Canada, M5A 1J7
Building
Floor 4
Main
Electrical
Occupancy
Comfort
Sensors
IFC
HVAC
28° 26° 24° 22° 20° 18° 16°
-0.33 °C
VAV-3-2-80 Thermostat

Autodesk Toronto
210 King St East, Toronto, ON, Canada, M5A 1J7
Building
Floor 3
Main
Electrical
Occupancy
Comfort
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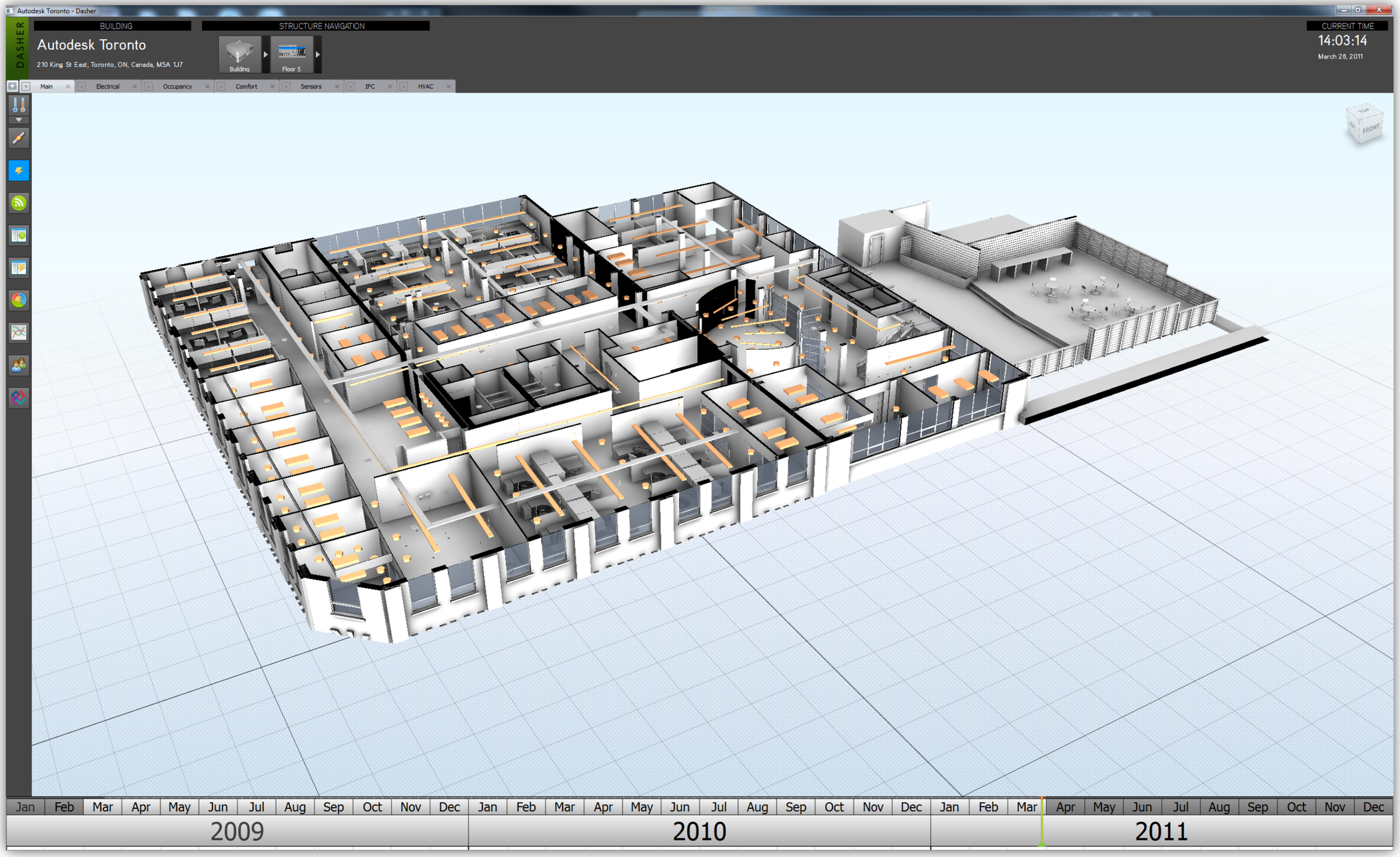
IFC
HVAC
28° 26° 24° 22° 20° 18° 16°


Autodesk Toronto - Dasher
DASHER
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Autodesk Toronto
210 King St East, Toronto, ON, Canada, M5A 1J7
STRUCTURE NAVIGATION
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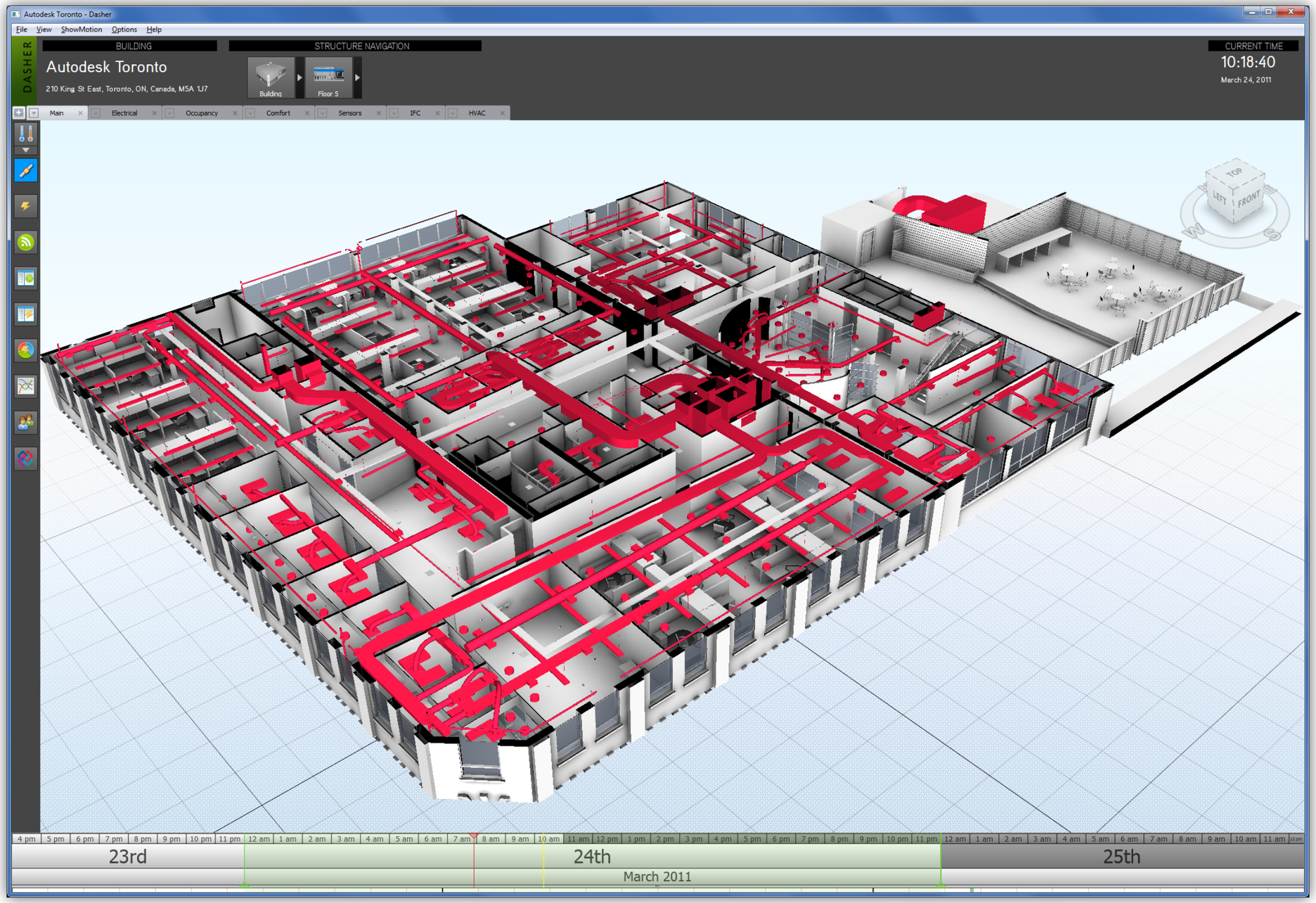
Autodesk Toronto - Dasher
File View ShowMotion Options Help
DASHER
BUILDING
Autodesk Toronto
210 King St East, Toronto, ON, Canada, M5A 1J7
STRUCTURE NAVIGATION
Building
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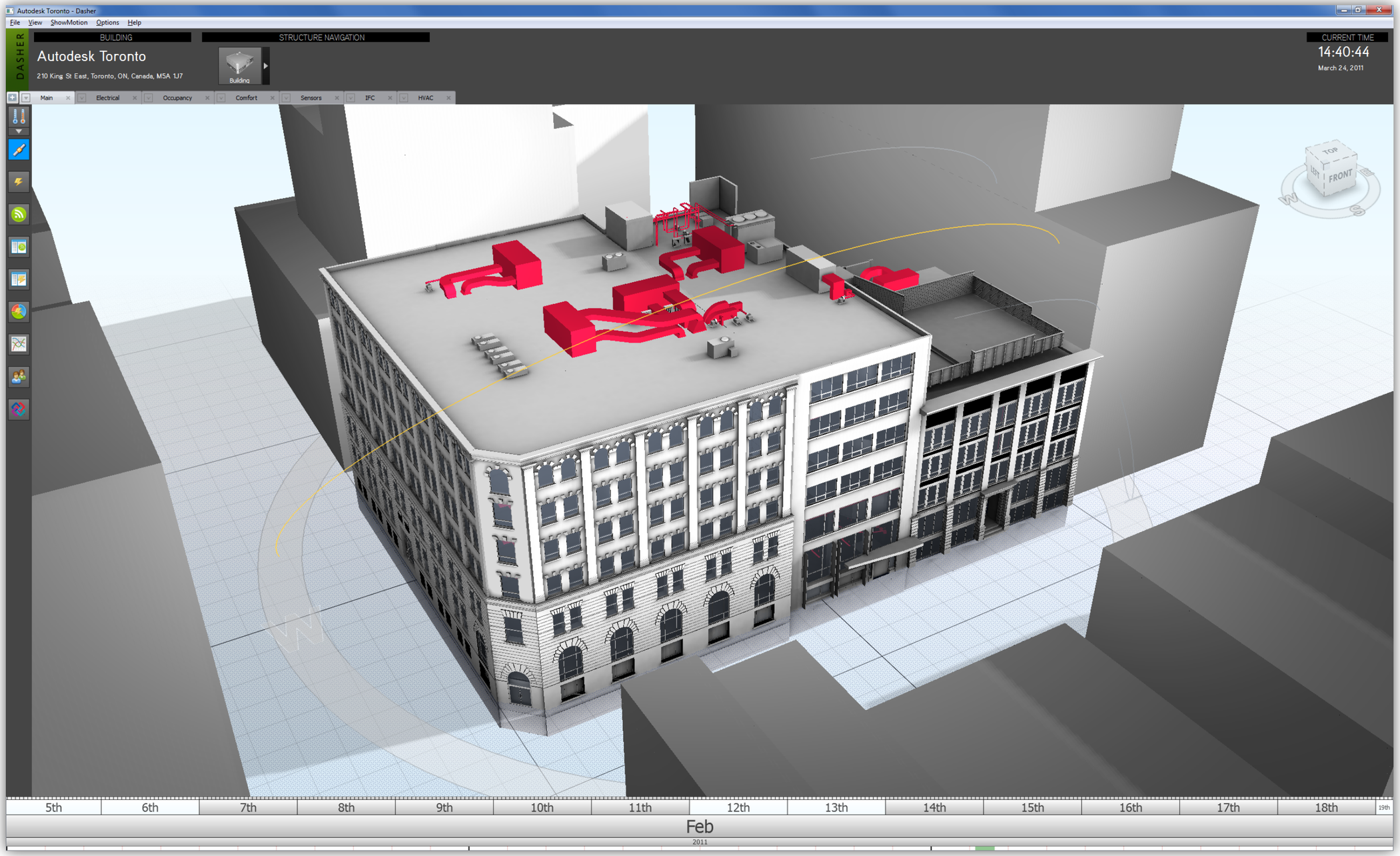
Autodesk Toronto - Dasher
File View ShowMotion Options Help
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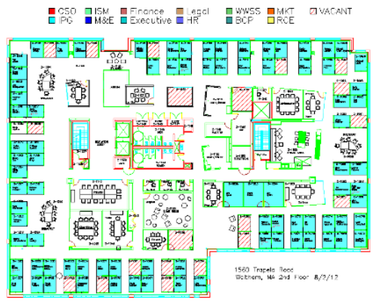
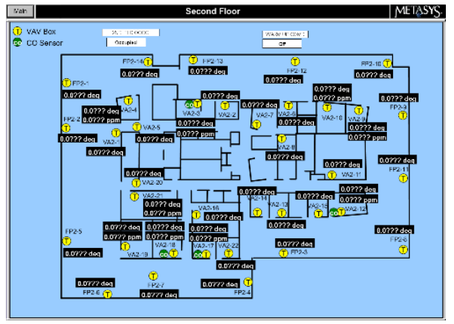
Project Dasher

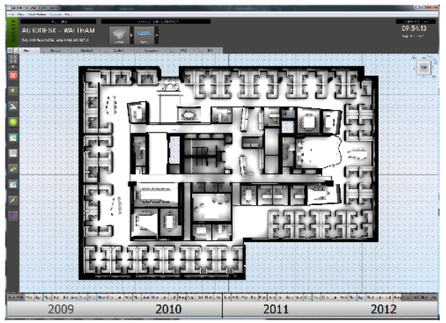
Operations & Management Interfaces
BMS and facility management interfaces leave something to be desired

Project Dasher
Merges spatial information with live and historic data

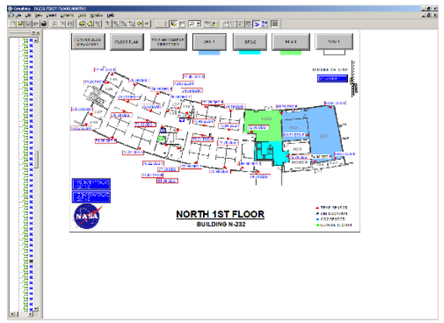
Autodesk Waltham Office

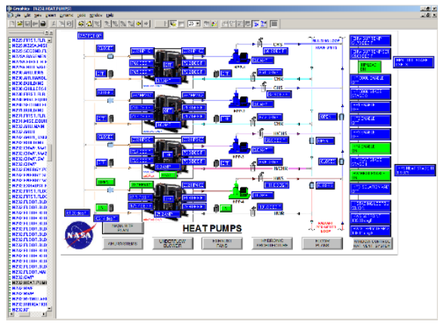


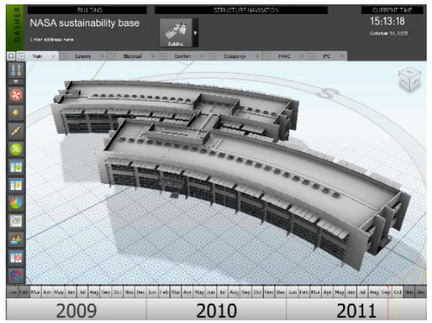




NASA Ames Sustainability Base







Presenting information in a single 3D context

Where is all that sensor data?

- For Dasher to work, we needed data storage
  - Lots & lots of data storage ☺
- In 2010, time-series databases were immature
  - We rolled our own extensions to HBase
- We now call it Data 360
  - Codenamed Blitzen – the engine powering Dasher

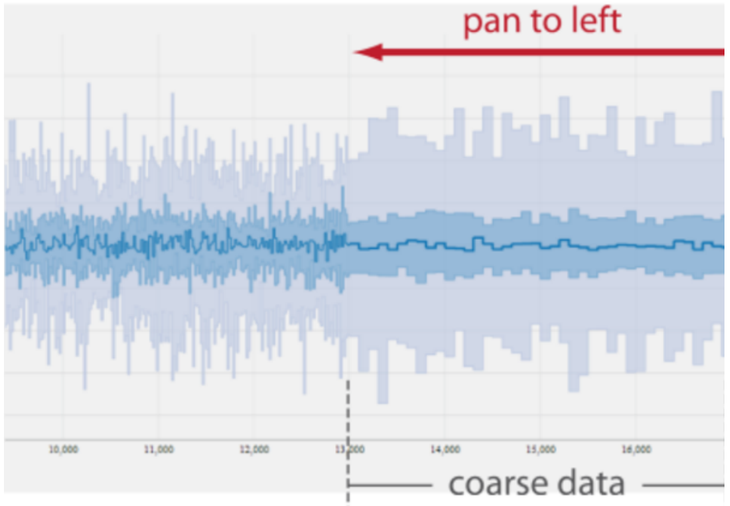
Data 360

- Highly scalable time-series database
  - Tuned for large volumes of sensor data
  - Multiple levels of detail to avoid slow queries
- Exposes a REST API for data access/import
  - We also create conduits to federate data
- Looking to make this part of Forge, in due course

Splash

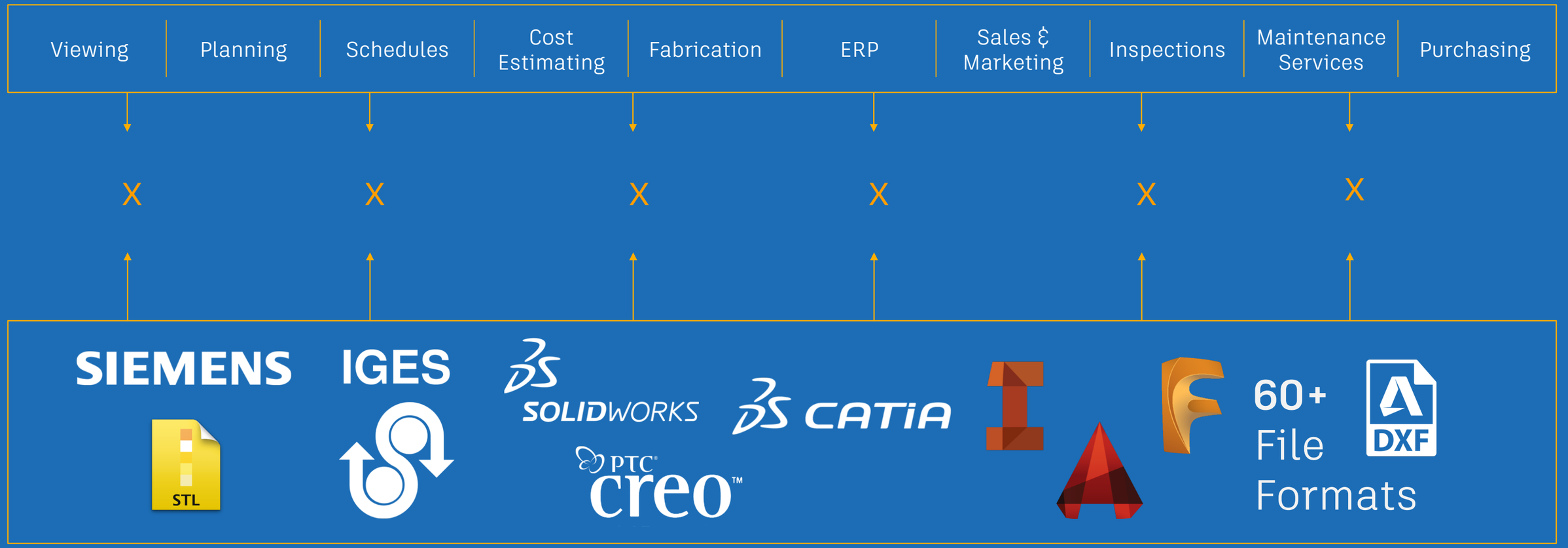
- Data 360 stores different levels of detail
  - We need a viewing component that supports
    - https://autodeskresearch.com/publications/splash
  - Like Google Maps for sensor data

Demo

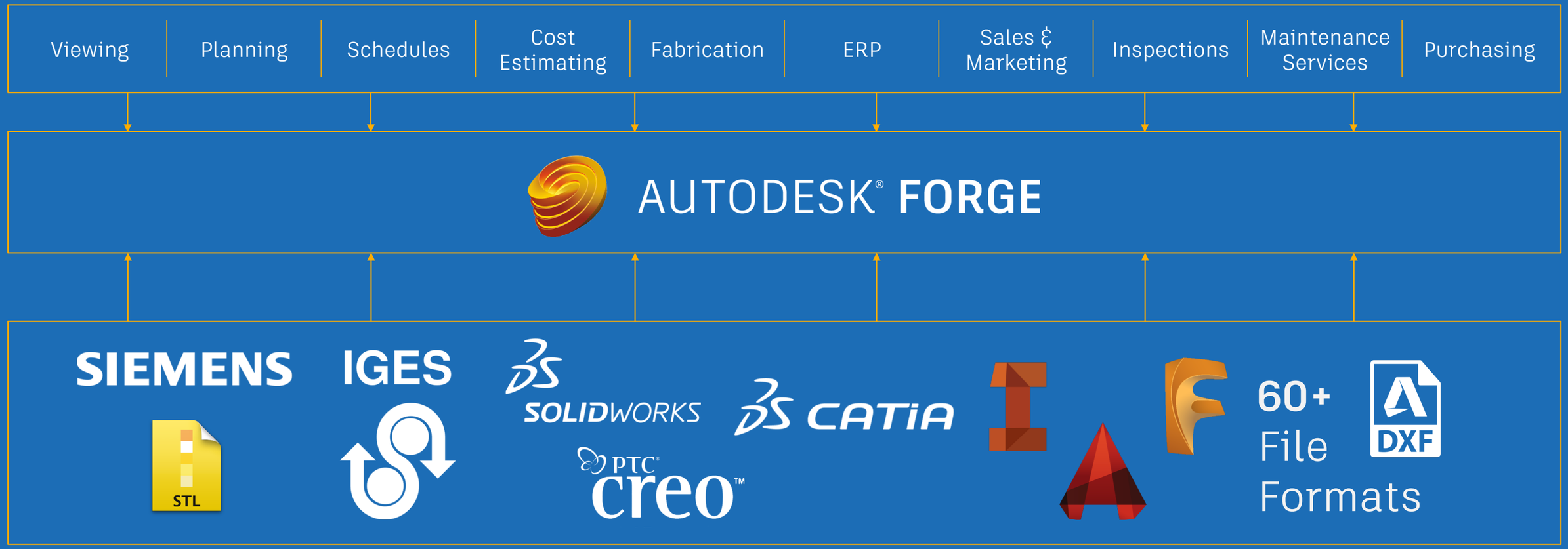


Forge and Dasher 360

The Forge Platform



The Forge Platform



The Forge Platform, today

Data Management API NEW

Manage your data across A360, Fusion 360, and our native Object Storage Service.

Model Derivative API NEW

Translate your design files from one format to another, prepare them for online viewing, and extract geometry data.

Viewer RENAMED

Show off your design files in a web-based viewer.

Design Automation API RENAMED

Run scripts on your design files at cloud scale.

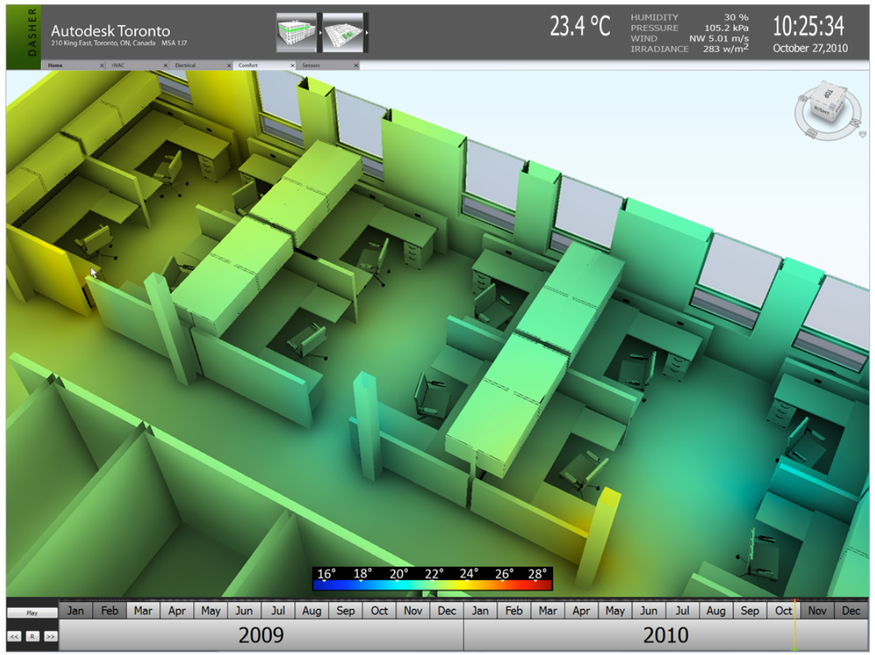
OAuth NEW FEATURES

Open standard used across the Forge Platform for token-based authentication and authorization.

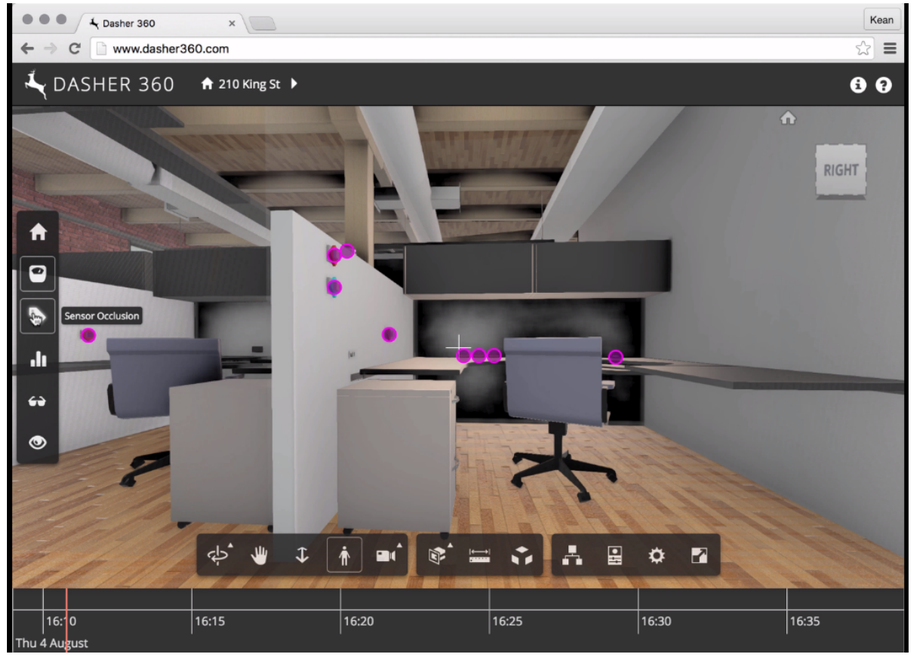
3D Print API BETA

Prepare design files for 3D printing, manage printers, and more.

Moving to Forge



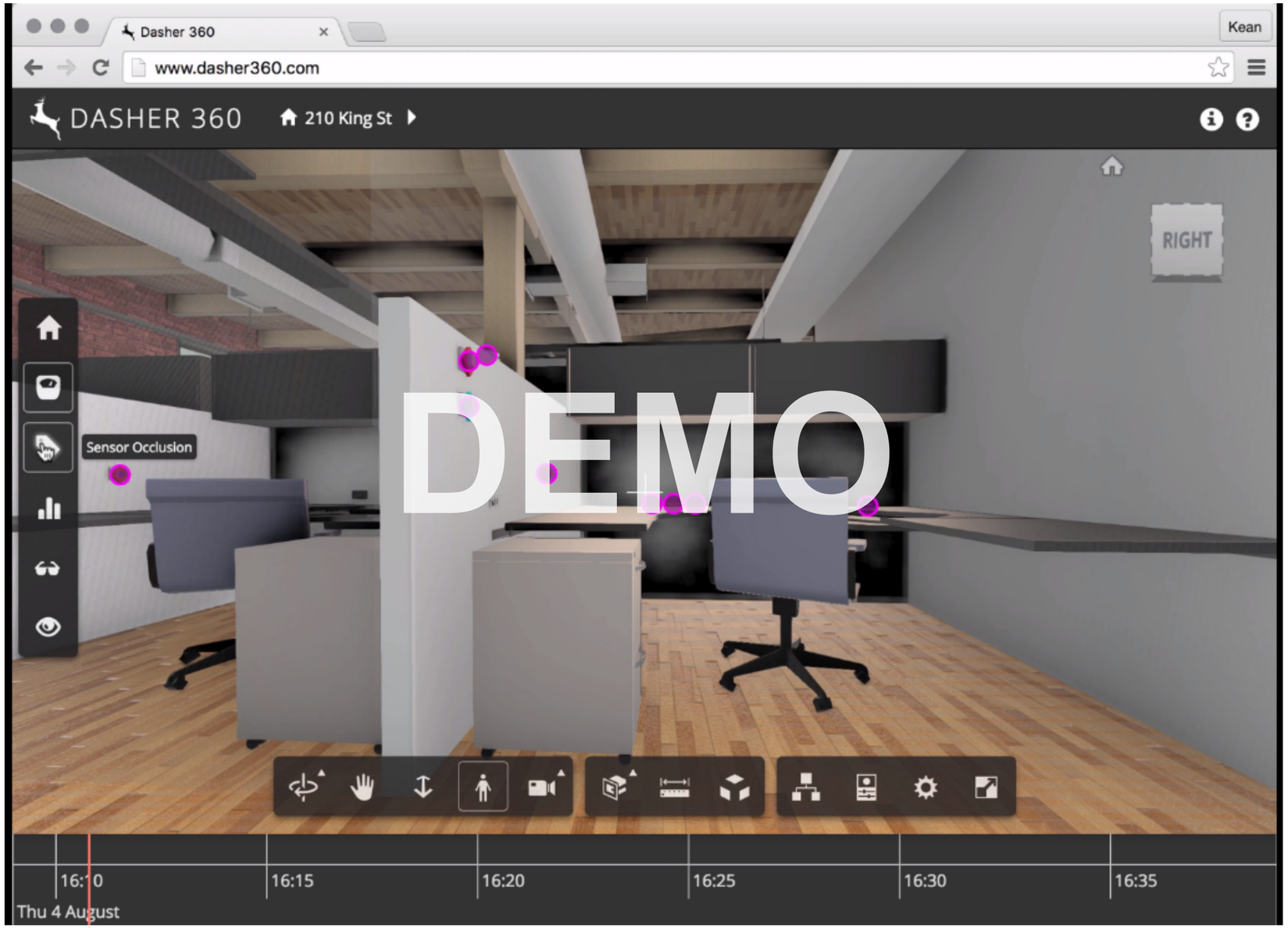
Dasher Desktop
desktop software prototype



Dasher 360
Dasher functionality in the web browser

Re-thinking Dasher for the web

- *Phase 1*
  - Use the Viewer to integrate sensors with BIM
    - Prototype surface shading and advanced visualization
- *Phase 2*
  - Integrate more Forge APIs & add sensor management
- *Phase 3*
  - Beyond BIM & replicate Dasher feature-set
- *Phase 4*
  - Historical ➔ predictive



dasher360.com

Using Forge in your own IoT applications

How we've used Forge for Dasher 360 (Phase 2)

- Forge Viewer
  - Advanced 3D viewing, lots of great samples
- Data Management API
  - Access models on Collab for Revit & Fusion 360
- Model Derivative API
  - Translate models and allow public sharing
- OAuth
  - 3-legged for DM API, 2-legged for sharing

Forge Viewer

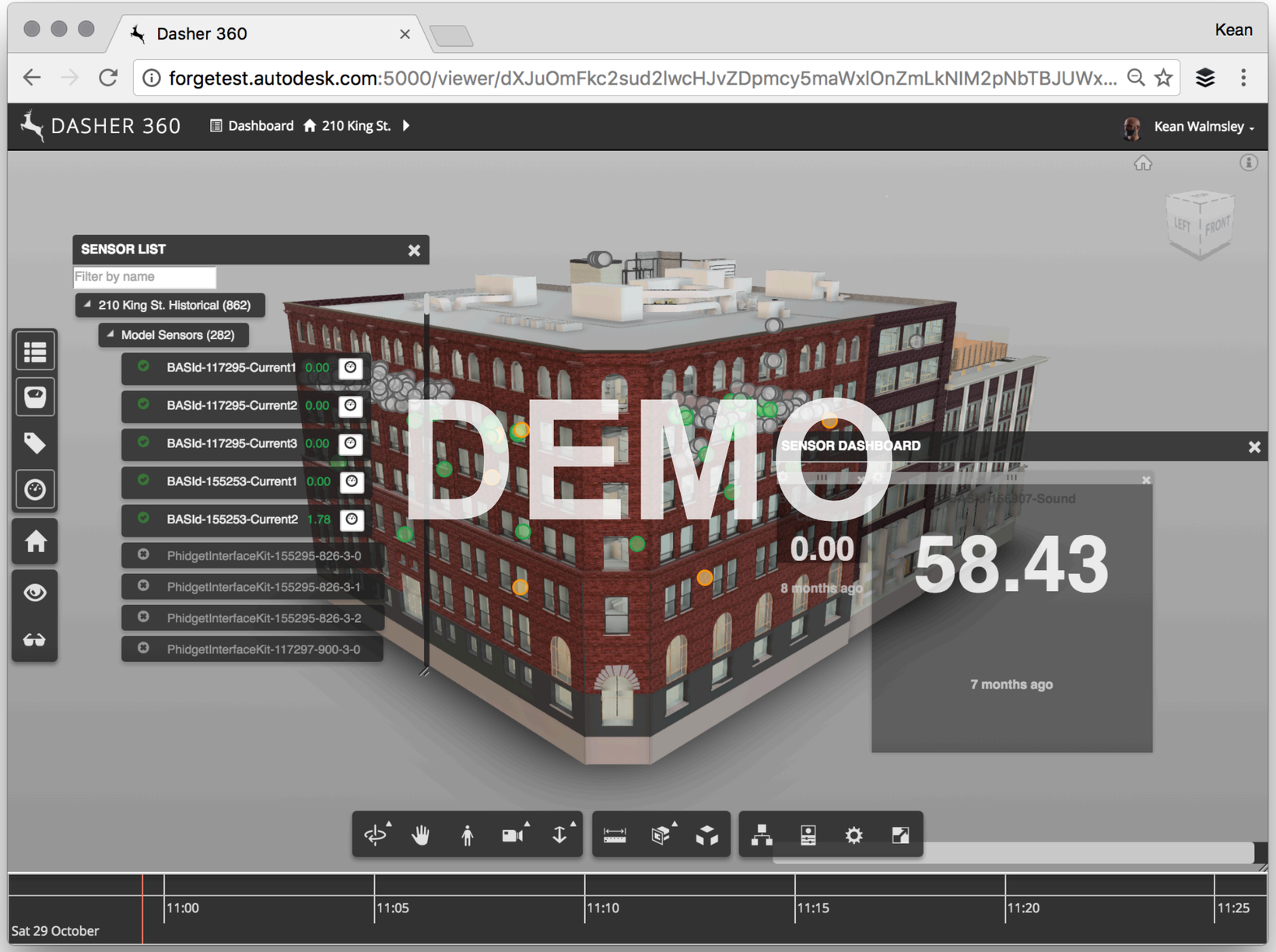
- Feature-rich, WebGL/THREE.js-based viewer
  - Geometry isolation, sectioning, first-person, VR
- Helpful samples
  - Sensor dots & extension framework
    - https://github.com/Developer-Autodesk/library-javascript-viewer-extensions
  - Surface shading
    - https://github.com/timoxley/threejs/blob/master/examples/webgl_shader2.html

Data Management API

- REST API allowing you to access models
  - On Collaboration for Revit & Fusion 360
    - Technology formerly known as A360
- The user logs in with their own credentials
  - Uses 3-legged authentication
  - The application can browse a user's hubs/projects
    - Close link to the Model Derivative API

Model Derivative API

- REST API allowing you to translate models
  - For viewing via the Forge Viewer
  - Into downstream, derivative formats such as OBJ
- Also provides access to metadata
  - Formerly only available in the Viewer
  - Can be used to create non-graphical tools



dasher360.com

Accessing Data 360

Populating Data 360

- Databases need data…
- Use the REST API to send data across
  - Conduits can federate data from existing systems
- The Programmable Data Router
  - Raspberry Pi-based system
  - Simplifies sensor connection and API usage

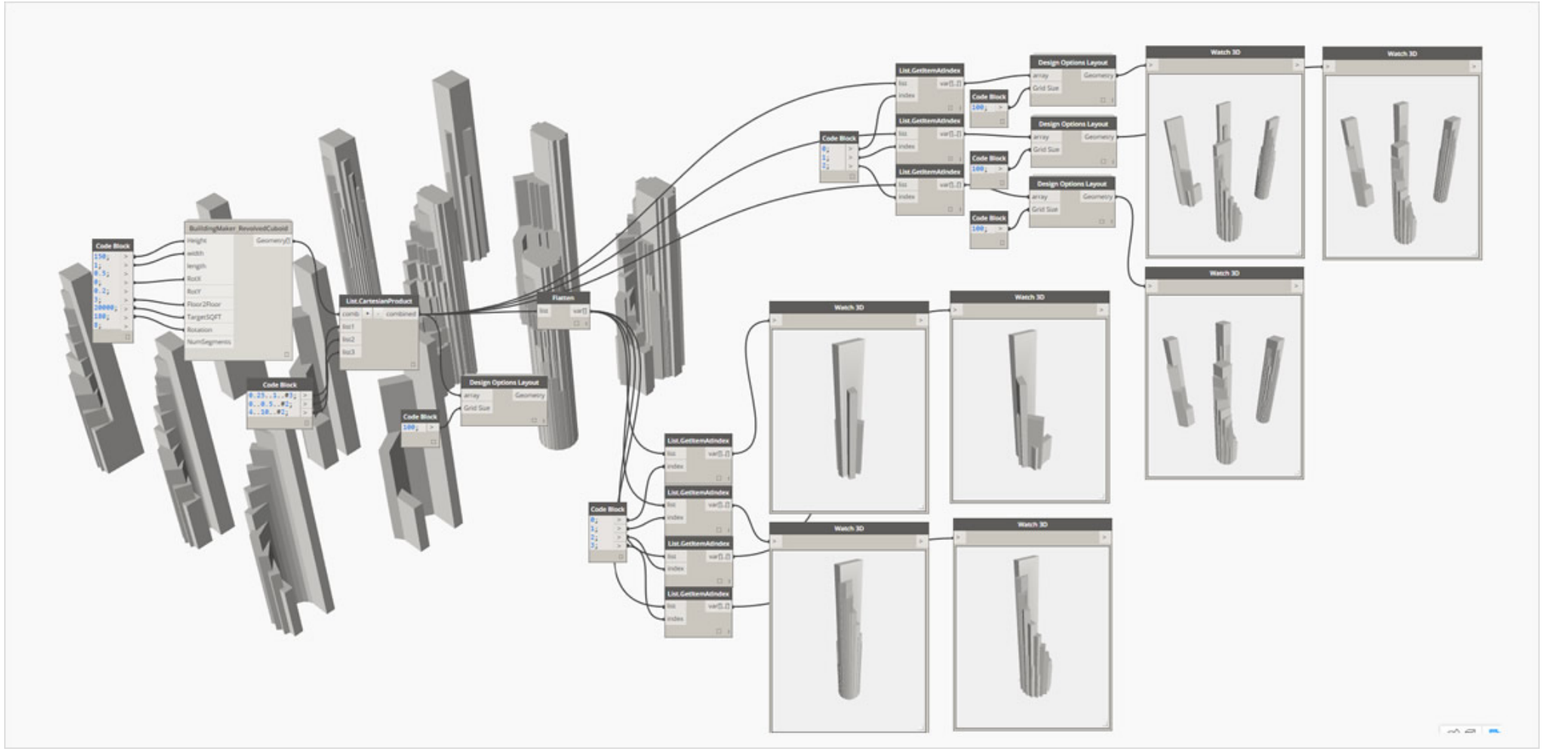
Reading from Data 360

- Our simplified API is easiest for data access
  - https://projectdasher-staging.api.autodesk.com/api/v1/projects/my-project-id/readings?sensorList=sensor-id&latestReading=true
- Returns JSON containing latest sensor reading

Using Data 360 from Dynamo

Dynamo

- Node-based programming environment
  - Tuned for computational design for BIM

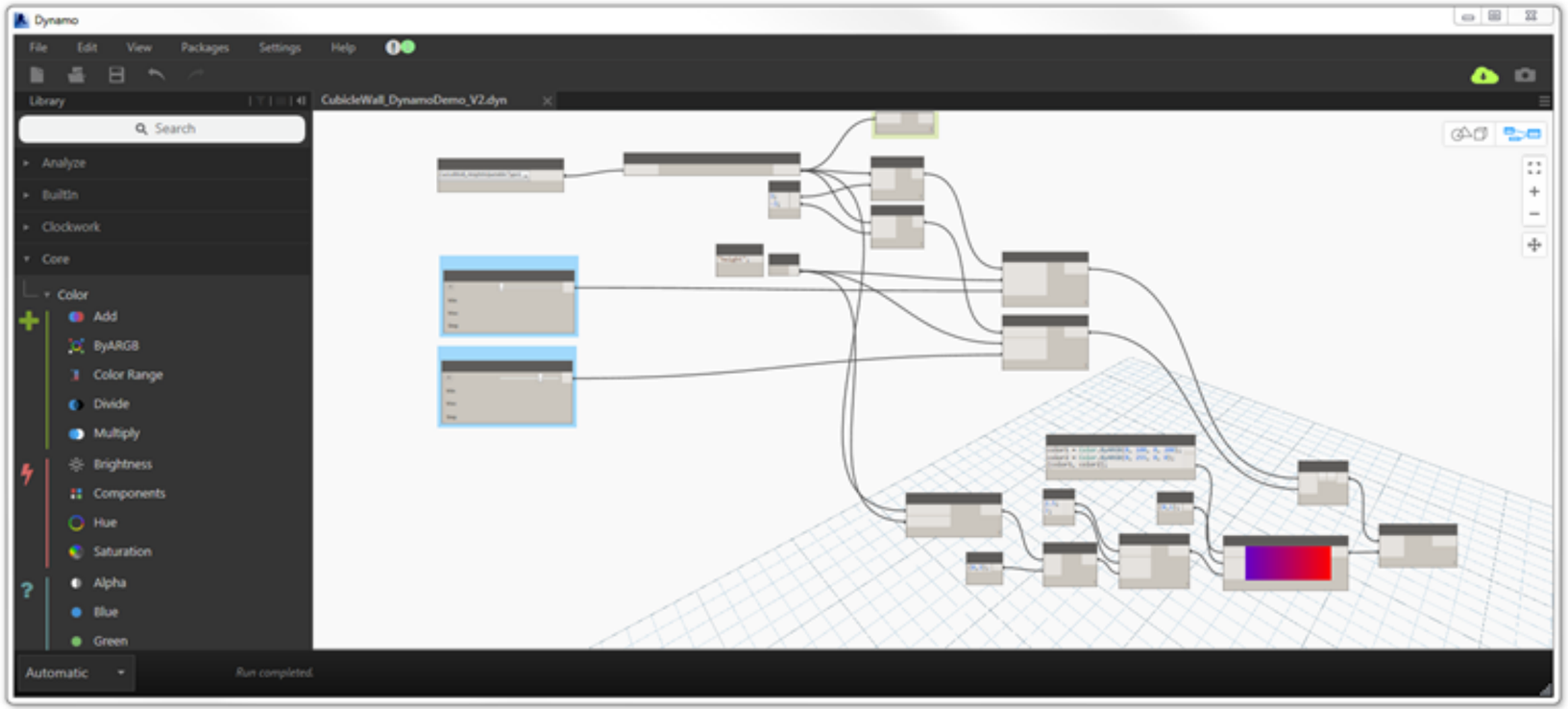


Dynamo is a highly flexible tool

- Integrated with Revit
  - Also has a standalone version, Dynamo Studio
- You can build custom nodes in C# or Python
  - Accessing REST APIs is trivial
- Use Data 360 to drive designs based on data
  - Might be historical or real-time

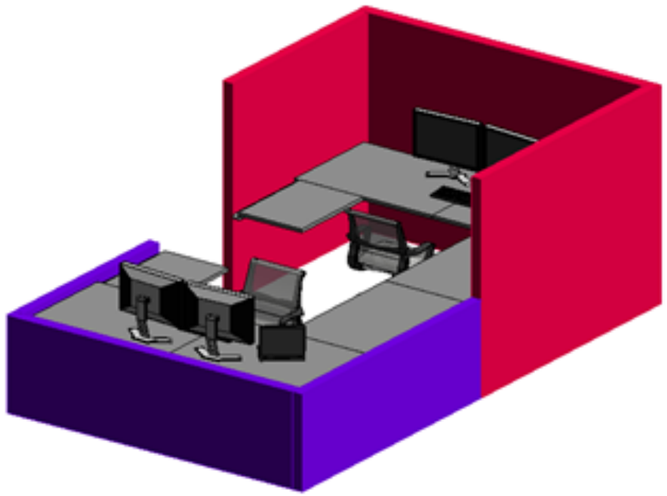
Historical data in Dynamo

- Show how past data might influence a design
  - Change the height of partitions based on sound



Real-time data in Dynamo

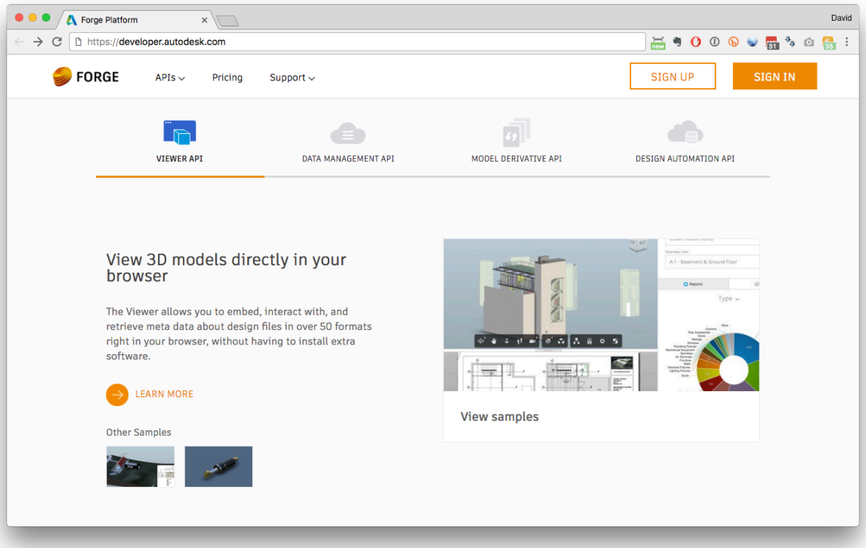
- Custom Dynamo nodes can be “Periodic”
  - Which means they can be polled regularly for data
- Now for some fun…
  - Let’s see how high we can raise those partitions!



Moving forward

What's next?

- Private beta for Data 360
  - If interested, leave me your card or email us at project.dasher@autodesk.com
- More projects with Dasher 360
- Convergence of my current areas of interest
  - 3D display of IoT data + AR/VR
  - In-context IoT data and analysis



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Questions?

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