

# Using Forge to Connect BIM to the Internet of Things

Kean Walmsley

Autodesk

Join the conversation #AUCity #AU2018



# Class Summary

Autodesk Research's Project Dasher 360 is a building performance management tool that displays historical and real-time sensor data inside a building model. In this session, we'll take a close look at how the Forge platform has been used to implement the Dasher 360 project, leading to a multi-year desktop development project being largely re-created for the web in a matter of months. We'll pay particular attention to the techniques used to contextualize sensor data within intelligent models displayed via the web, explaining the implementation details of reusable Forge Viewer extensions created using JavaScript.



## About the speaker

Kean Walmsley | @keanw | [keanw.com](http://keanw.com)

Kean works for Autodesk Research as a Platform Architect and Evangelist, focusing on the intersection of BIM with IoT and a little VR/MR. He has worked for Autodesk in a number of roles and in a number of different countries – he’s currently based in Switzerland – and spends a significant amount of time engaging with Autodesk’s developer community via his popular programming-oriented blog, “[Through the Interface](#)”.

# 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

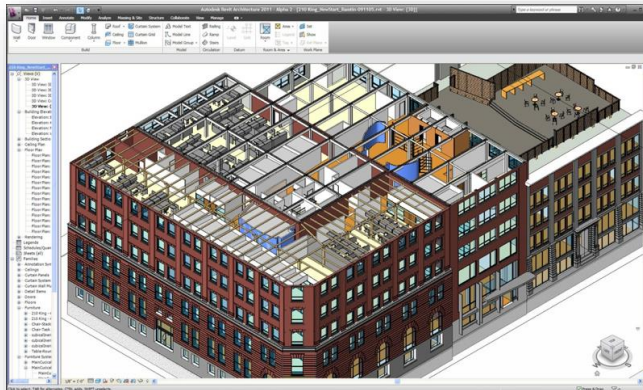
# History of Project Dasher





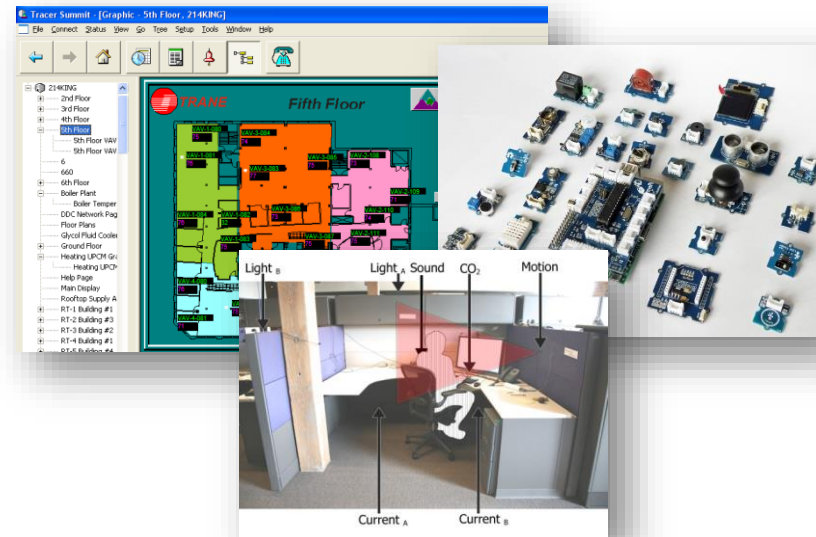
# Project Dasher Desktop

Project Dasher began in 2009 as a research project to develop visualization and analytics tools for building operations data in the context of Building Information Models



## As-Built BIM

Highly detailed AEC models



## Building Data

Building management systems (BMS) and IoT enabled sensors for operations and management data collection



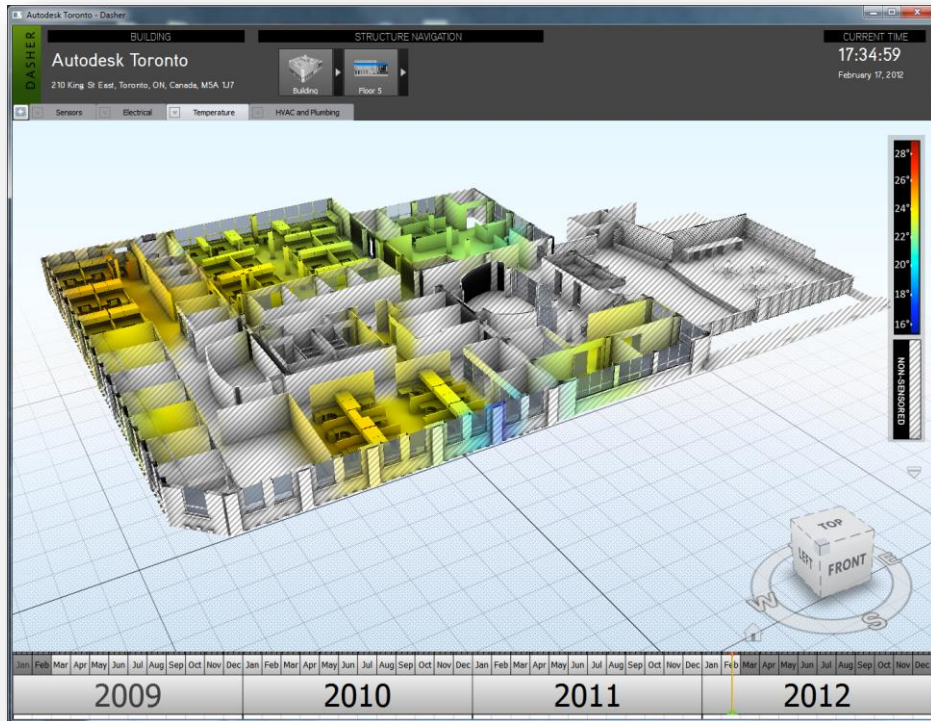
## Project Dasher

A visualization to help customers understand their data in context of the 3D model and debug operational issues



# Migrating to Dasher 360

C++, GLSL Shaders



JavaScript, TypeScript, CSS, HTML, GLSL Shaders



Viewer



Authentication



Data  
Management



Model  
Derivative



AUTODESK®  
FORGE



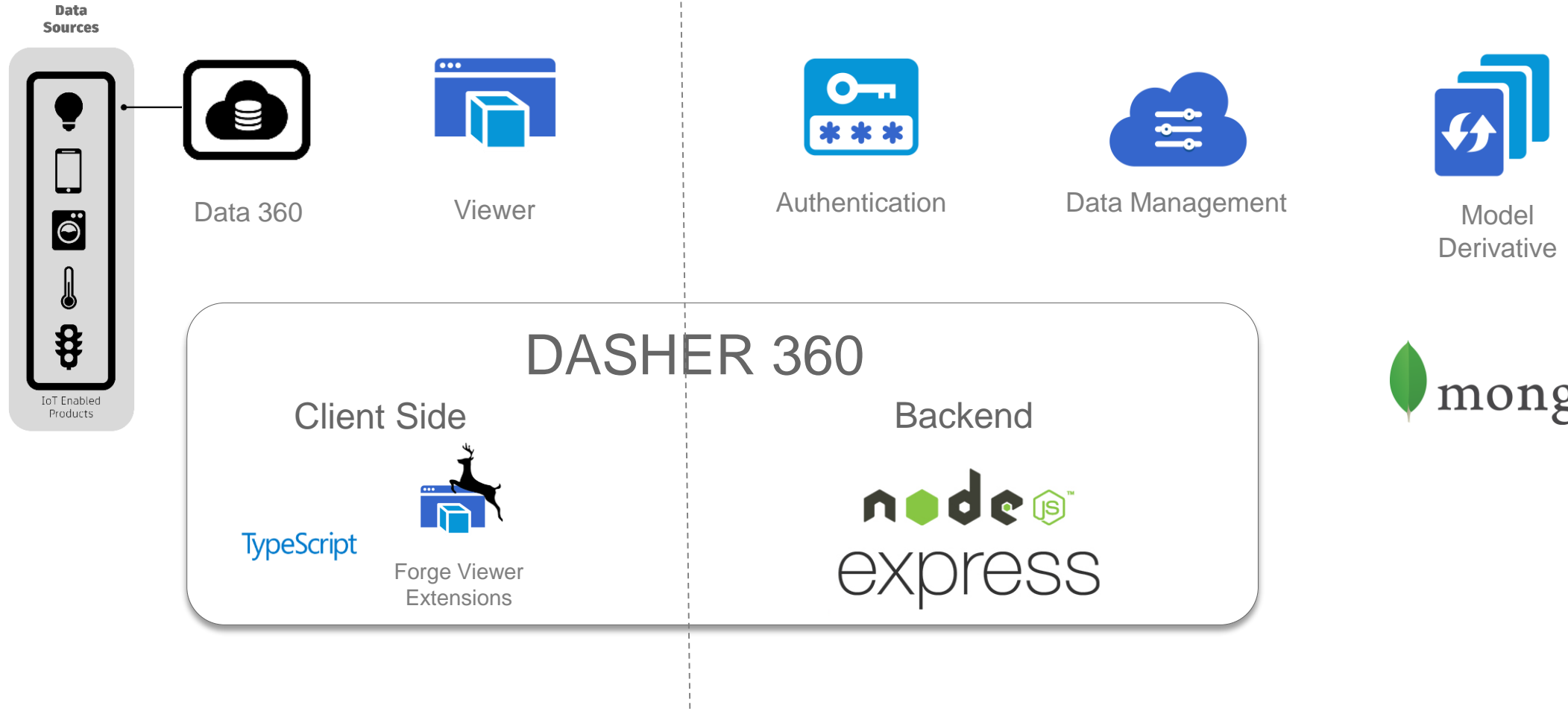
# Dasher 360's use of Forge



# Dasher Forge Usage



AUTODESK<sup>®</sup>  
**FORGE**

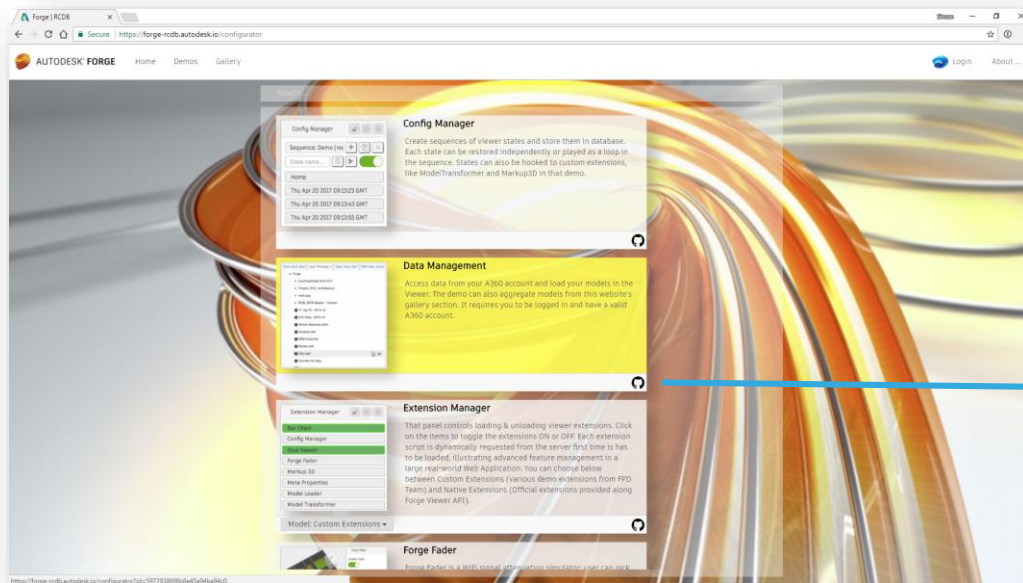


# Forge Examples

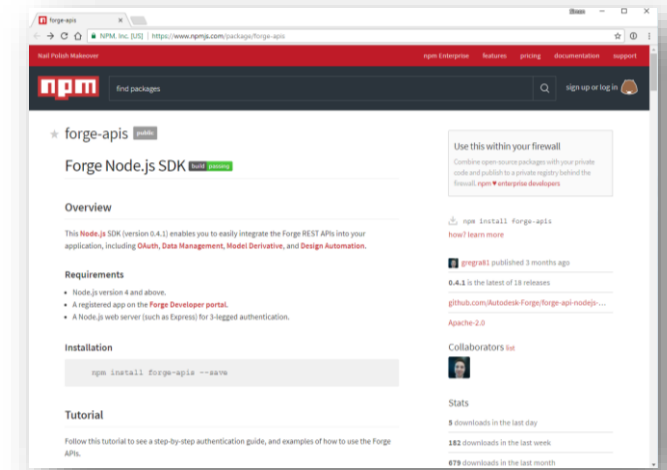


<https://github.com/Autodesk-Forge>

- model.derivative-nodejs-sample
  - Demo: <https://derivatives.autodesk.io>
- forge-rcdb.nodejs
  - Demo: <https://forge-rcdb.autodesk.io>



Source Code!



<https://www.npmjs.com/package/forge-apis>



Authentication

# Authentication

Sign in

Email

[NEXT](#)

NEW TO AUTODESK? [CREATE ACCOUNT](#)

Your account for everything Autodesk  
[LEARN MORE](#)



Welcome  
simon.breslav@autodesk.com

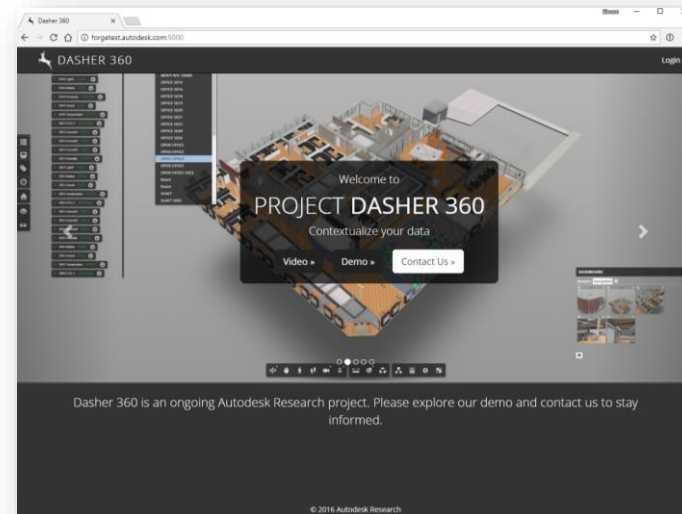
Password [FORGOT?](#)

[SIGN IN](#)

☐ Stay signed in

Your account for everything Autodesk  
[LEARN MORE](#)

Demo



# Data Management



Data Management



A360

Screenshot of the Dasher 360 web interface. The browser address bar shows [forgetest.autodesk.com:5000/projects](http://forgetest.autodesk.com:5000/projects). The page title is "DASHER 360" and the user is "Simon Breslav".

**Recent Files**

Name	Version	Open
Autodesk Pier 9 ADSK_Pier 9_Staging.nwc	v1	Open
210_King_R2016_MERGED_AU201...	v1	Open
TestRevit robotArmH.fbx	v1	Open
Factory Demo VRFactory_AllParts.FBX	v1	Open

**Shared Files**

Name	Version	Link	Public	Requires Password	Edit	Delete
210_King_R2016_MERGED_AU2016.nwc	1	<a href="http://forgetest.autodesk.com:5000/share/r1fktWLbe">http://forgetest.autodesk.com:5000/share/r1fktWLbe</a>	✓	X	Edit	Delete
210_King_R2017_Public_DEMO.nwc	1	<a href="http://forgetest.autodesk.com:5000/share/hyNTTrmIMg">http://forgetest.autodesk.com:5000/share/hyNTTrmIMg</a>	✓	X	Edit	Delete
210_King_MERGED_GEdemo_2016-08-25_good.nwc	2	<a href="http://forgetest.autodesk.com:5000/share/B17K-nVW-">http://forgetest.autodesk.com:5000/share/B17K-nVW-</a>	✓	X	Edit	Delete
Cube	1	<a href="http://forgetest.autodesk.com:5000/share/Bkdc-nNbW">http://forgetest.autodesk.com:5000/share/Bkdc-nNbW</a>	✓	X	Edit	Delete
robotArmH.fbx	1	<a href="http://forgetest.autodesk.com:5000/share/B1IMSH6cW">http://forgetest.autodesk.com:5000/share/B1IMSH6cW</a>	✓	X	Edit	Delete
VRFactory_AllParts.nwc	1	<a href="http://forgetest.autodesk.com:5000/share/SjV8tStcW">http://forgetest.autodesk.com:5000/share/SjV8tStcW</a>	✓	X	Edit	Delete

**Simon Breslav Hub**

- TestRevit
  - VRFactory\_AllParts.FBX
  - msh\_conveyor\_belt.fbx
  - msh\_robot\_arm.fbx
  - msh\_robot\_arm\_extension.fbx
  - msh\_wheel\_railing.fbx
  - rac\_advanced\_sample\_project.rvt
  - rac\_basic\_sample\_project.rvt
  - revit file with test survey type converted\_v3.nwc
  - robotArmGameExport.fbx
  - robotArmH.fbx
- Customers
  - 210 King St. E.
  - Grenoble 38TEC Building
  - FusionTest
  - Moebius
  - PHP

Screenshot of the TestRevit - A360 web interface. The browser address bar shows <https://myhub.autodesk360.com/ue29c9c75/g/projects/2017010457220656/data/dXJuOmFkc2sud2lwcHJvZDpmcy5mb2xkZkx0I6Y28uUTFBZ...>. The page title is "TestRevit" and the user is "Simon Breslav".

**Home > TestRevit**

**Upload** **+ New**

Name	Owner	Last Updated
msh_conveyor_belt.fbx	Simon Breslav	Aug 23, 2017
msh_robot_arm.fbx	Simon Breslav	Sep 5, 2017
msh_robot_arm_extension.fbx	Simon Breslav	Sep 5, 2017
msh_wheel_railing.fbx	Simon Breslav	Aug 23, 2017
rac_advanced_sample_proje...	Simon Breslav	Jan 4, 2017
rac_basic_sample_project.rvt	Simon Breslav	May 8, 2017
revit file with test survey typ...	Simon Breslav	Sep 27, 2017
robotArmGameExport.fbx	Simon Breslav	Sep 5, 2017
robotArmH.fbx	Simon Breslav	Sep 5, 2017
VRFactory_AllParts.FBX	Simon Breslav	Aug 23, 2017

**Details** **Activity**

**TestRevit**  
10 Files

**PROJECT MEMBERS (3)** **Invite**

- Simon Breslav  
simon.breslav@autodesk.com  
Project Admin
- Hali Larsen  
hali.larsen@autodesk.com
- Alexander Tessier  
alex.tessier@autodesk.com

**View and Manage Members**

© Copyright 2017 Autodesk Inc. All rights reserved. [Privacy Policy](#) [Terms and Conditions](#) [About](#)





# Data Management: Examples

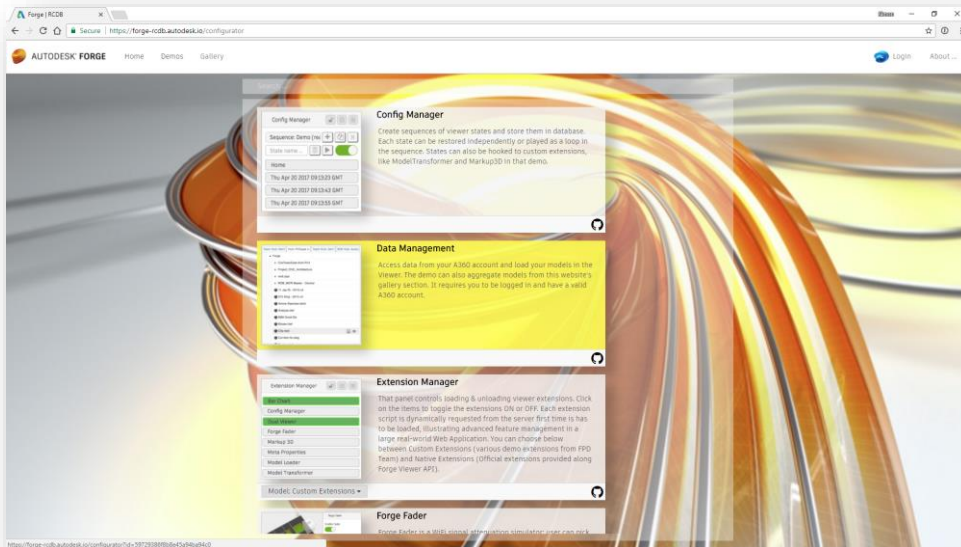
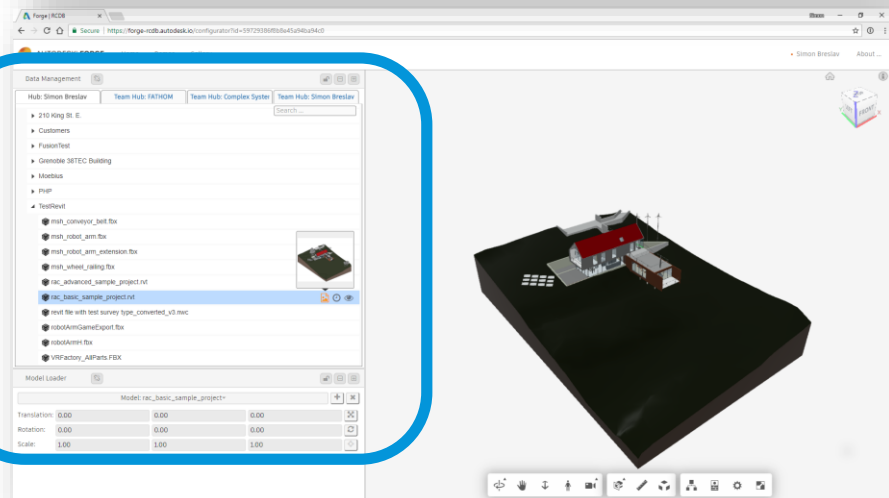
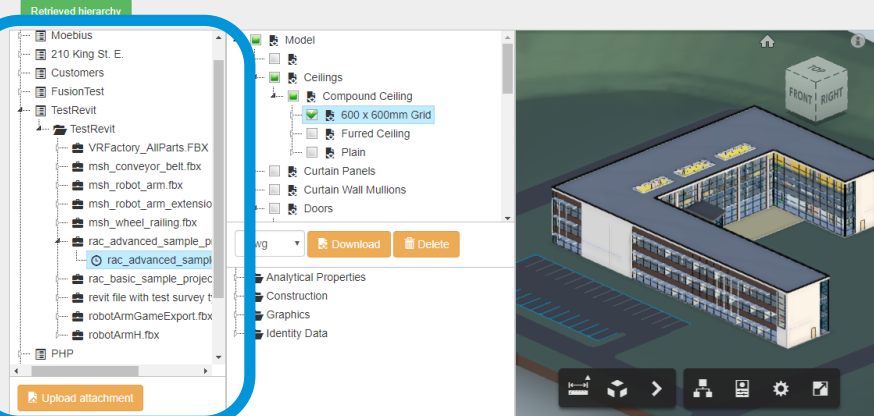
<https://github.com/Autodesk-Forge>

- model.derivative-nodejs-sample
  - Demo: <https://derivatives.autodesk.io>
- forge-rcdb.nodejs
  - Demo: <https://forge-rcdb.autodesk.io>

## Model Derivative API - Basic Node.js Sample

Show the entire list of Hubs, Projects, Folders, Items and Versions under your account.  
Select an item version to show a file using Autodesk Viewer

You're logged in



# Model Derivative: Example



Model  
Derivative

<https://github.com/Autodesk-Forge>

- [models.autodesk.io](https://models.autodesk.io)
  - Demo: <https://models.autodesk.io>

Developer Autodesk

Large Model Viewer - View & Data API

Just choose a model to upload on your account, or upload your own model.

View sources on GitHub

Load Models on your account

Choose one of the model examples below,

Samples:

Chair

Translate this one for me.

or upload your own model.

Drag 'n Drop a file inside...

Or click here to Browse...

Please note that your uploaded models are not visible for others. The list is saved into a cookie and will be removed from the list once you leave this session.

Available Models on your account

List of translated models on your account loaded through that web site, during this session

Currently translating...

Ready:

Chair.dwg

dXJuOmFkc2sub2JqZWNoZcpvcy5vYmplY3Q6bW9kZWwyMDE1TA2LTEyLTE0LTl

Remember to save these urn by copying them before closing your session, otherwise you will lose the reference to your translated files.

This is the token returned by the Autodesk View & Data API serve

The Access Token is currently saved into a cookie for the duration of your session and will expire in about 30 minutes.

Access Token:

SFMZJTeFmT6NWQX7D1s19UDT7sa

Release the Access Token

Minutes

28:25

Seconds

Model as a Service, Accelerating Hackathons!

@Autodesk Developer Network

# Viewer



Viewer



Viewer

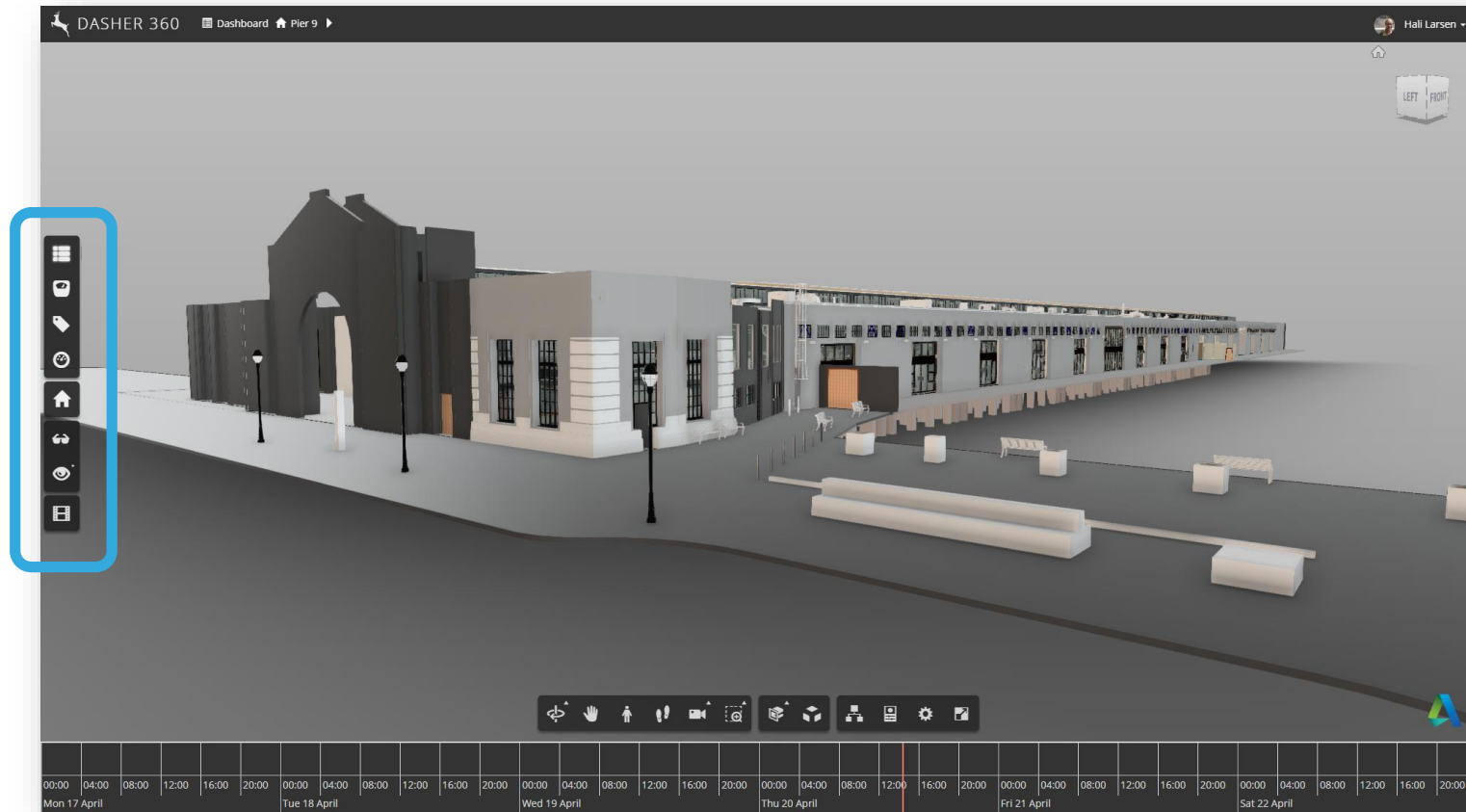


Viewer  
Extensions

# Navigation extensions (demo)



# Toolbar



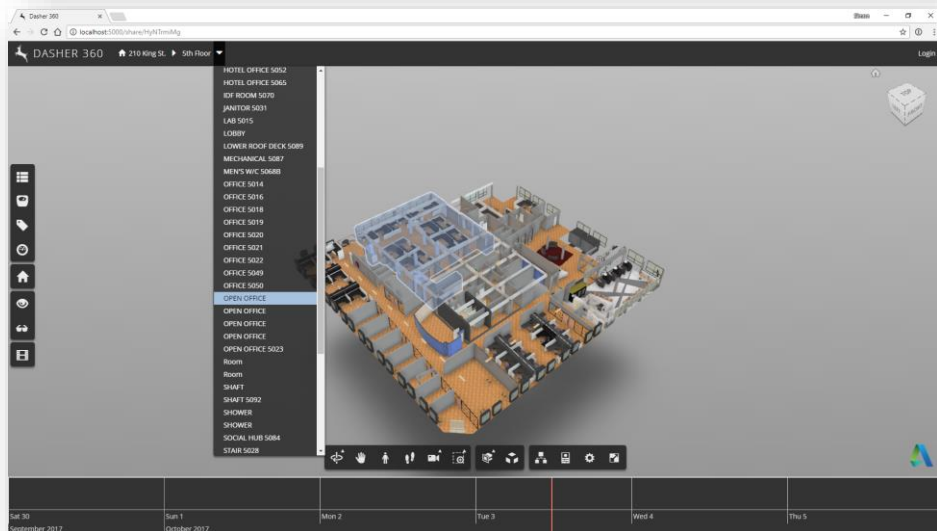
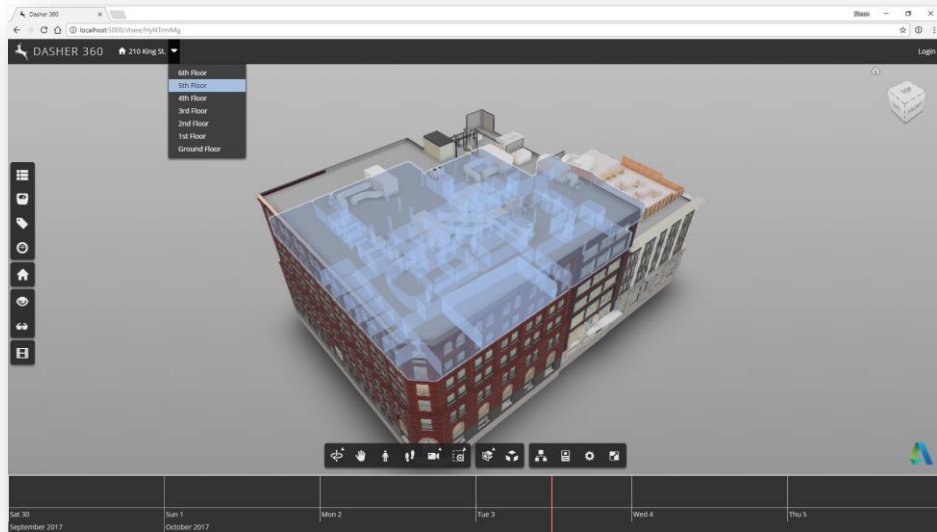
[Creating a vertical toolbar extension for the Autodesk viewer](http://keanw.com/2016/05/creating-a-vertical-toolbar-extension-for-the-autodesk-viewer.html)

<http://keanw.com/2016/05/creating-a-vertical-toolbar-extension-for-the-autodesk-viewer.html>



# Breadcrumbs: Floor & Room Navigation

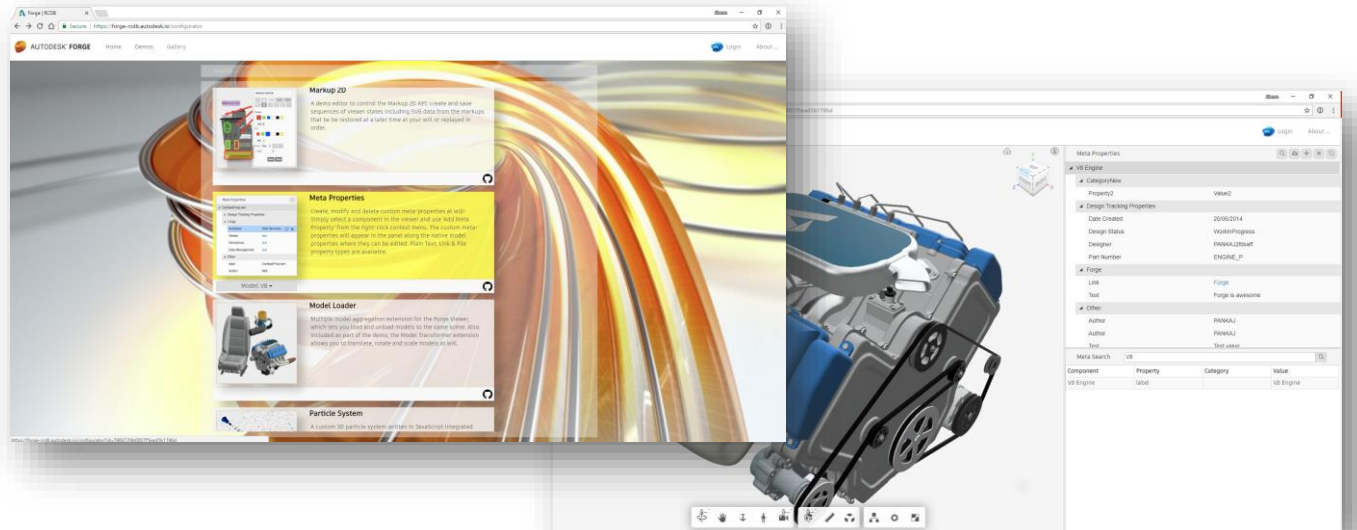
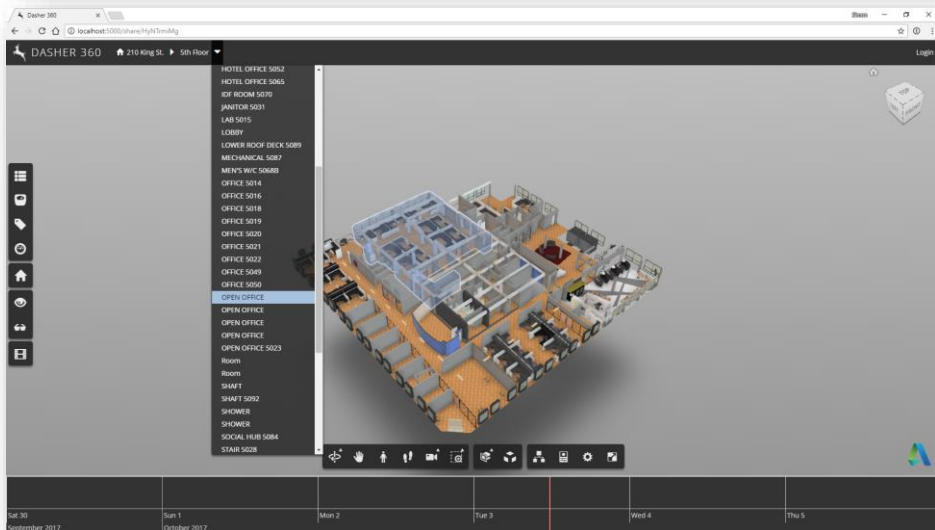
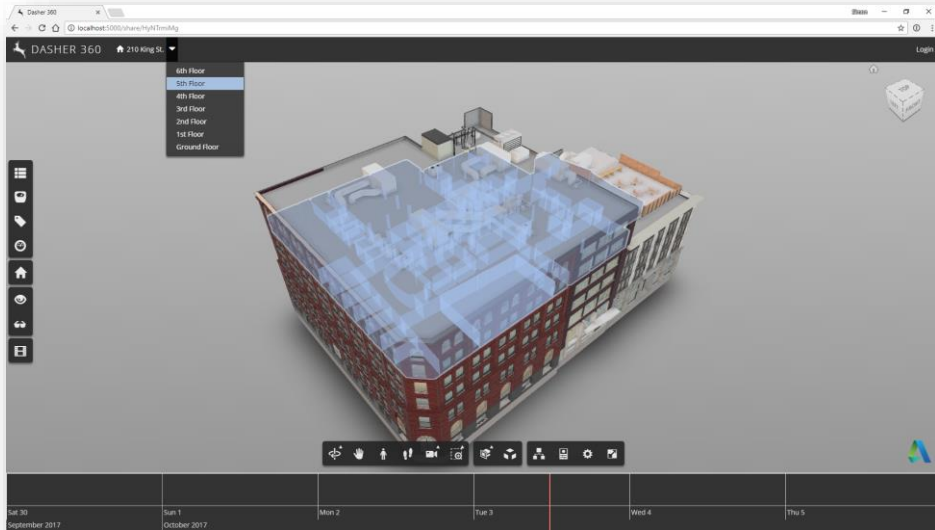
- Breadcrumb navigation widget
- Floor and room hierarchy
  - Combination of settings and property parsing



```
"levels": [  
  { "match": "SIXTH FLOOR", "value": 6, "name": "6th Floor" },  
  { "match": "FIFTH FLOOR", "value": 5, "name": "5th Floor" },  
  { "match": ["LEVEL 4 FLR. FIN.", "FOURTH FLOOR"], "value": 4, "name": "4th Floor" },  
  { "match": ["LEVEL 3 FLR. FIN.", "THIRD FLOOR"], "value": 3, "name": "3rd Floor" },  
  { "match": "LEVEL 2 FLR. FIN.", "value": 2, "name": "2nd Floor" },  
  { "match": "LEVEL 1 FLR. FIN.", "value": 1, "name": "1st Floor" },  
  { "match": "Ground Level", "value": 0, "name": "Ground Floor" }  
]
```

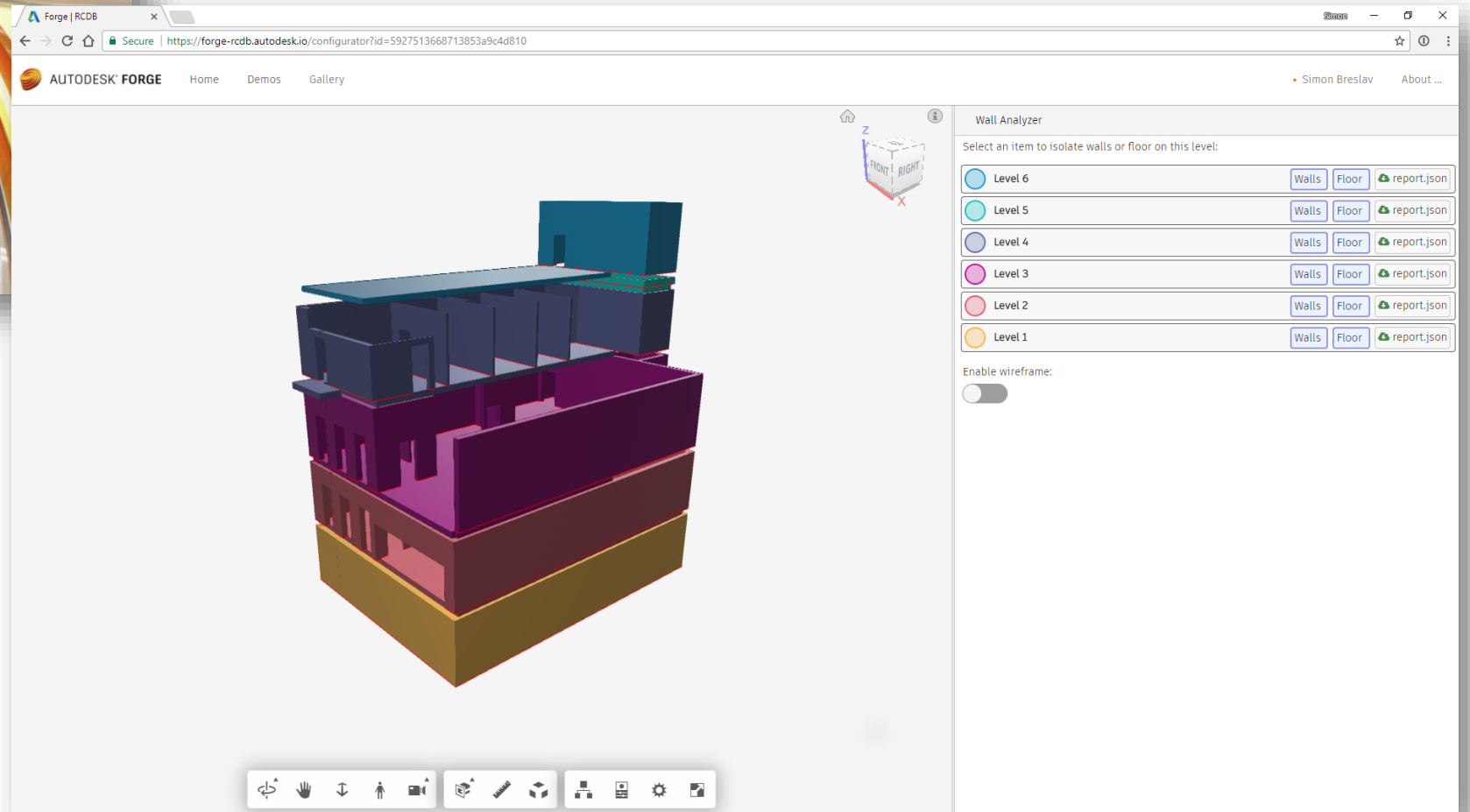
# Breadcrumbs: Floor & Room Navigation

- Breadcrumb navigation widget
- Floor and room hierarchy
  - Combination of settings and property parsing
  - See Meta Properties demo on <https://forgercdb.autodesk.io>



# Breadcrumbs: Future Work: Geometric Analysis

## Wall Analyzer Demo!

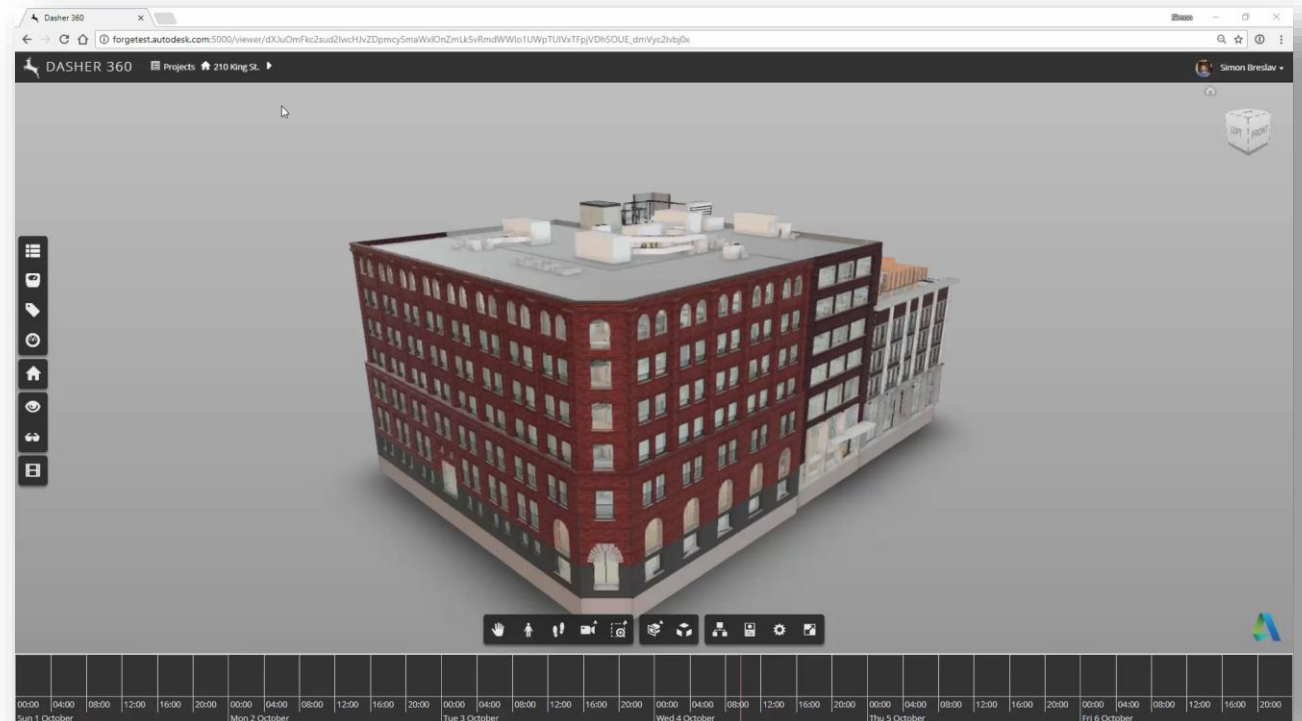
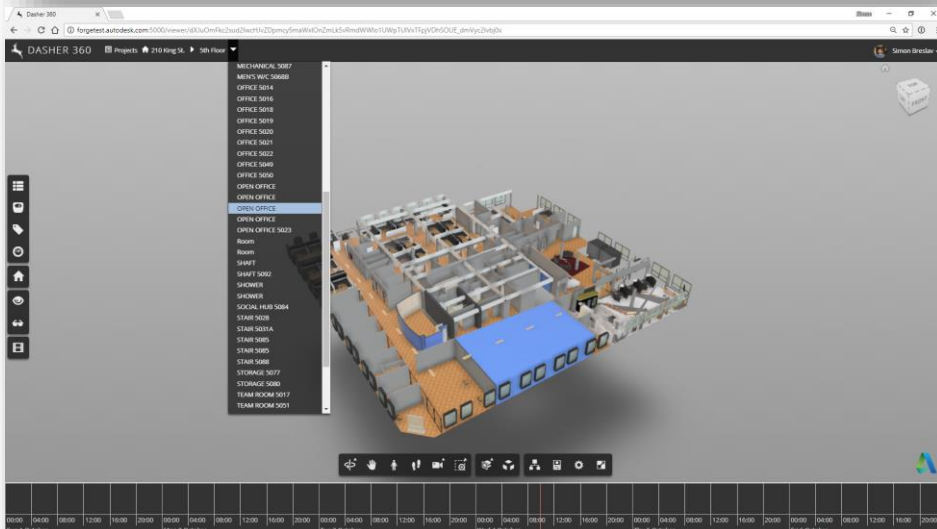
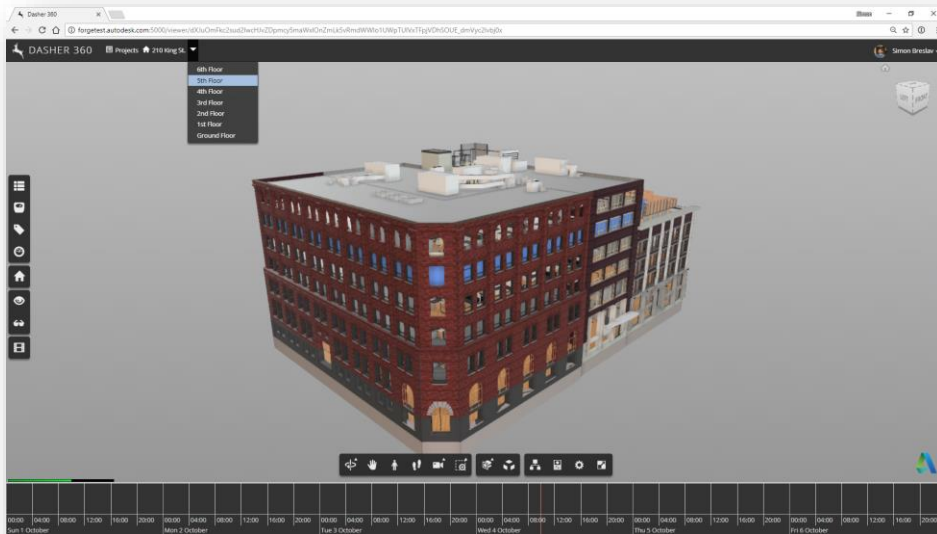


<https://forge-rcdb.autodesk.io>

# Breadcrumbs: Floor & Room Navigation

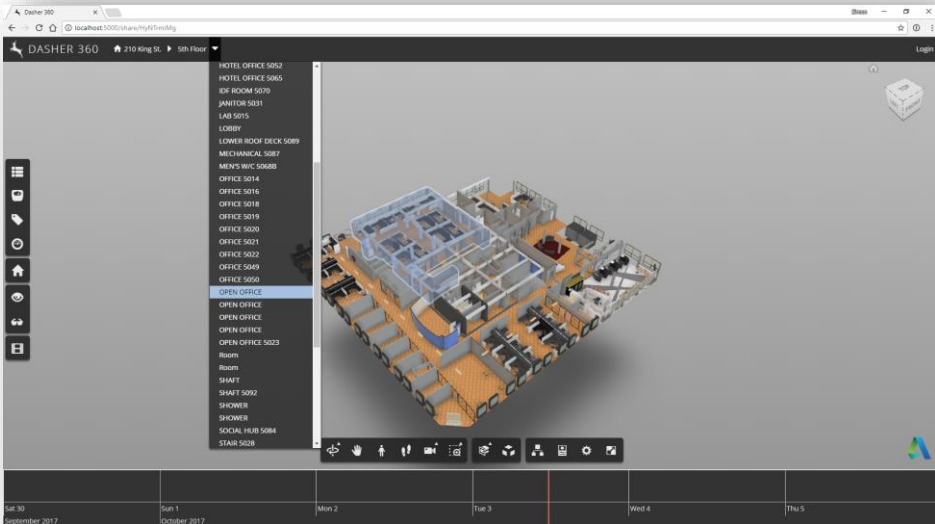
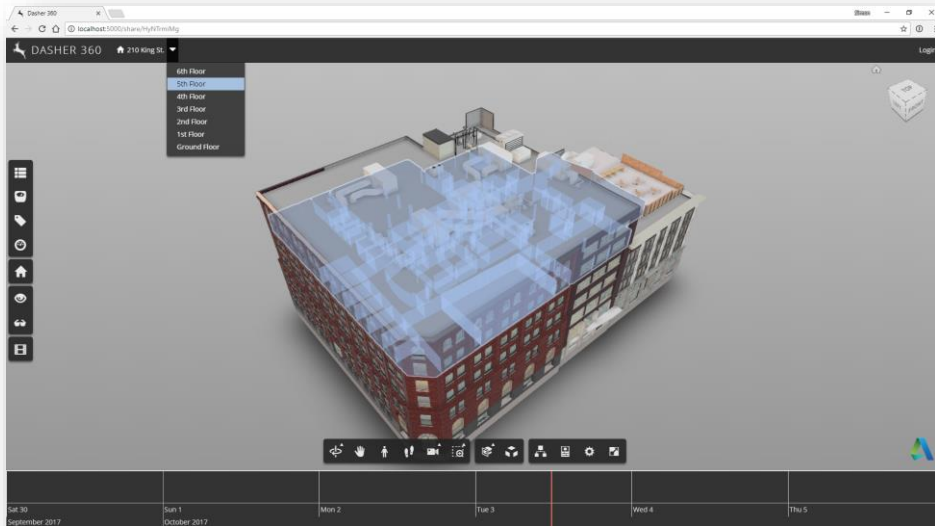
- Breadcrumb navigation widget
- Floor and room hierarchy
- Selection highlight
  - Uses room geometries

```
viewer.select(dbId)  
viewer.clearSelection()
```





# Breadcrumbs: Floor & Room Navigation



- Breadcrumb navigation widget
- Floor and room hierarchy
- Selection highlight
  - Uses room geometries
  - Avoids building redraw by using overlays
  - **WARNING:** Undocumented API, use at own risk!

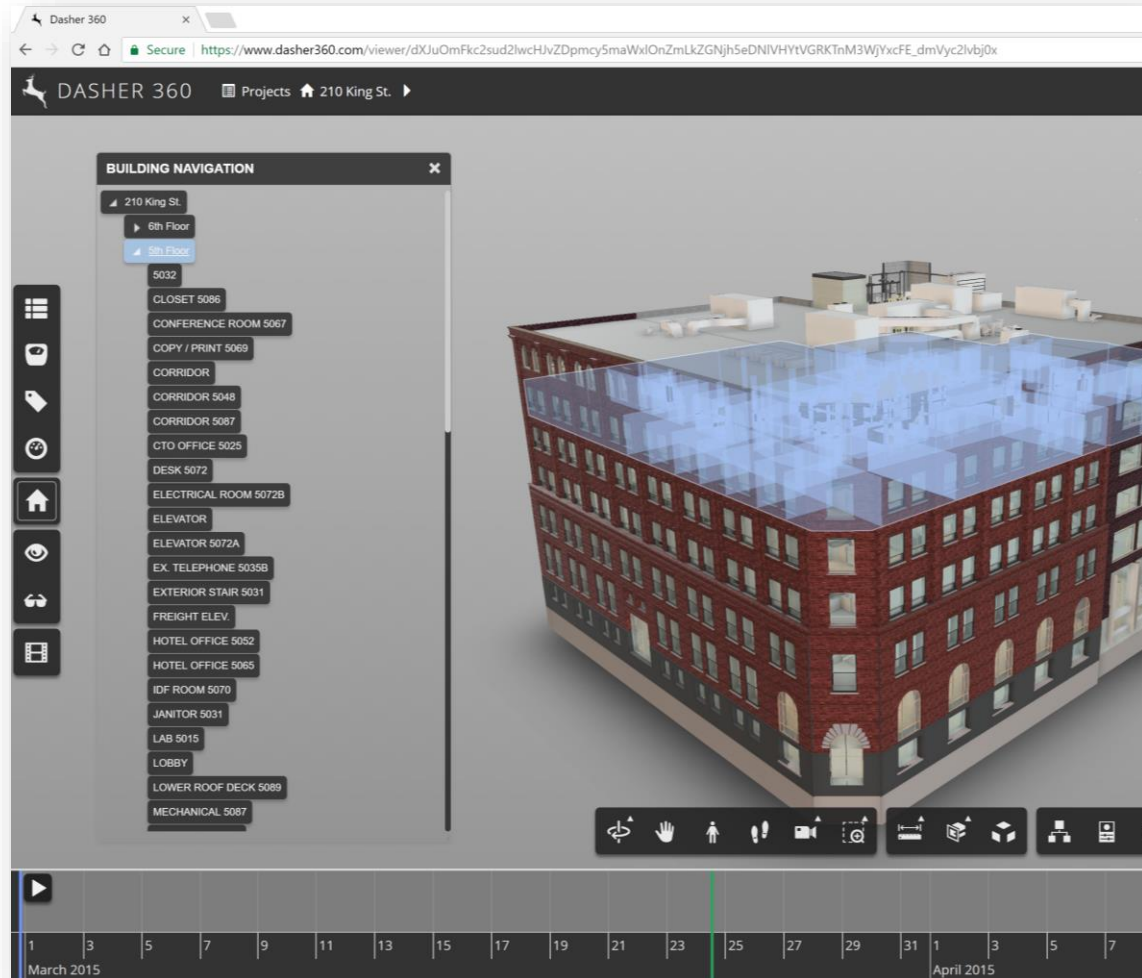
```
let material = new THREE.MeshBasicMaterial(  
  {color: 0x6e98ee,  
   transparent: true,  
   opacity: 0.5 }  
);  
material.depthWrite = false;  
material.depthTest = false;  
viewer.impl.createOverlayScene('CustomSelection');  
  
let renderProxy = this.viewer.impl.getRenderProxy(viewer.model, fragId);  
let meshProxy = new THREE.Mesh(renderProxy.geometry, material);  
meshProxy.matrix.copy(renderProxy.matrixWorld);  
  
viewer.impl.addOverlay('CustomSelection', meshProxy);  
viewer.impl.invalidate(false, false, true);
```



# Building Navigation List

Autodesk.Viewing.UI.Tree

Autodesk.Viewing.UI.TreeDelegate

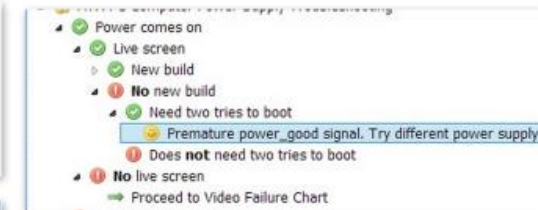
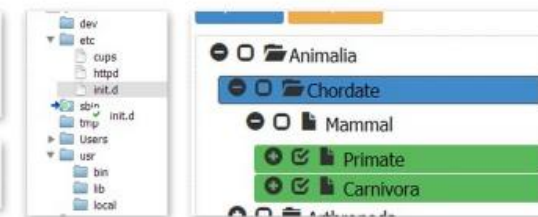
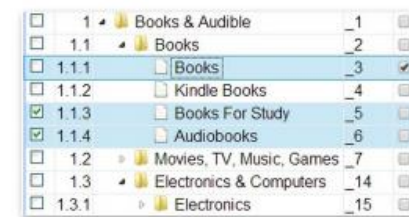
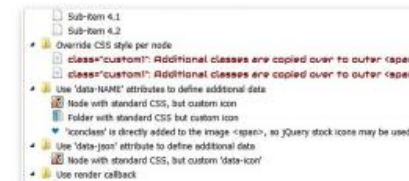
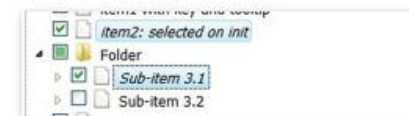
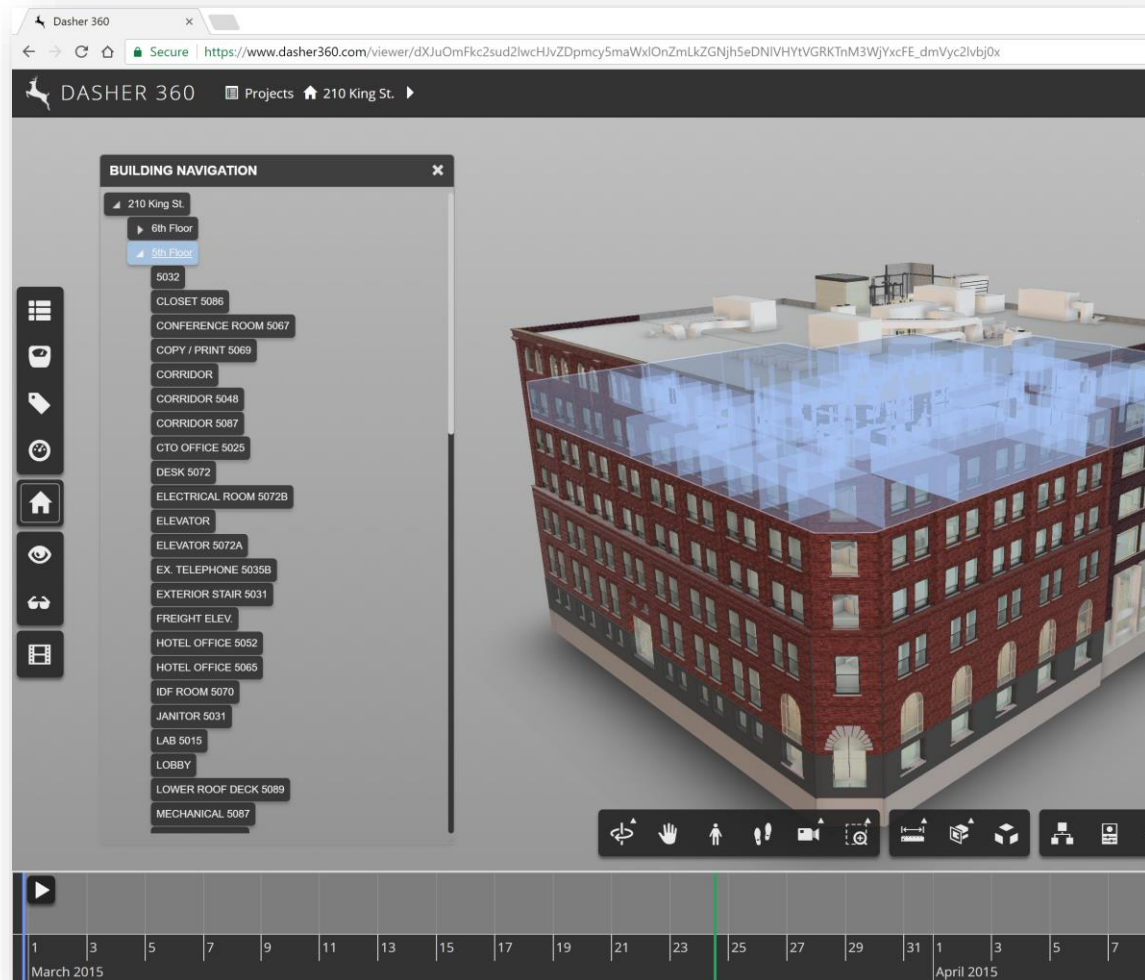


# Building Navigation List

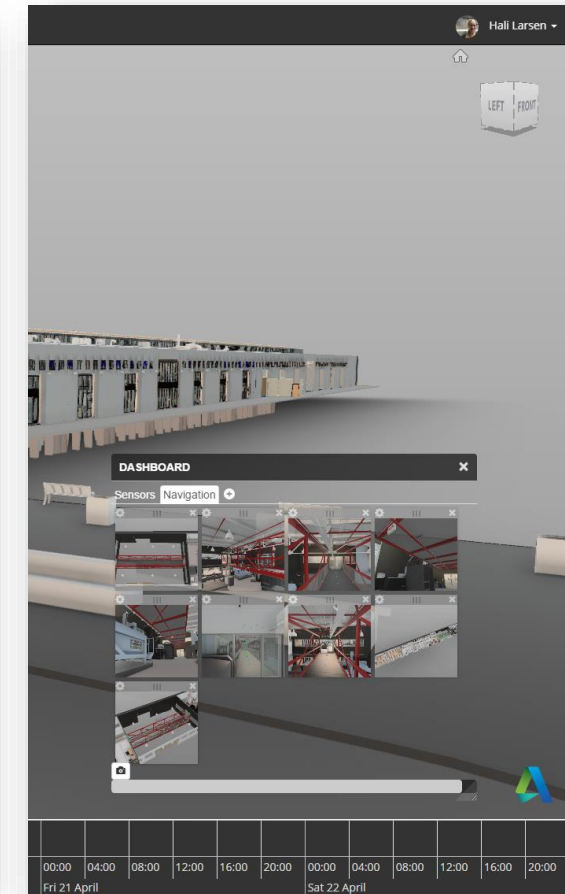
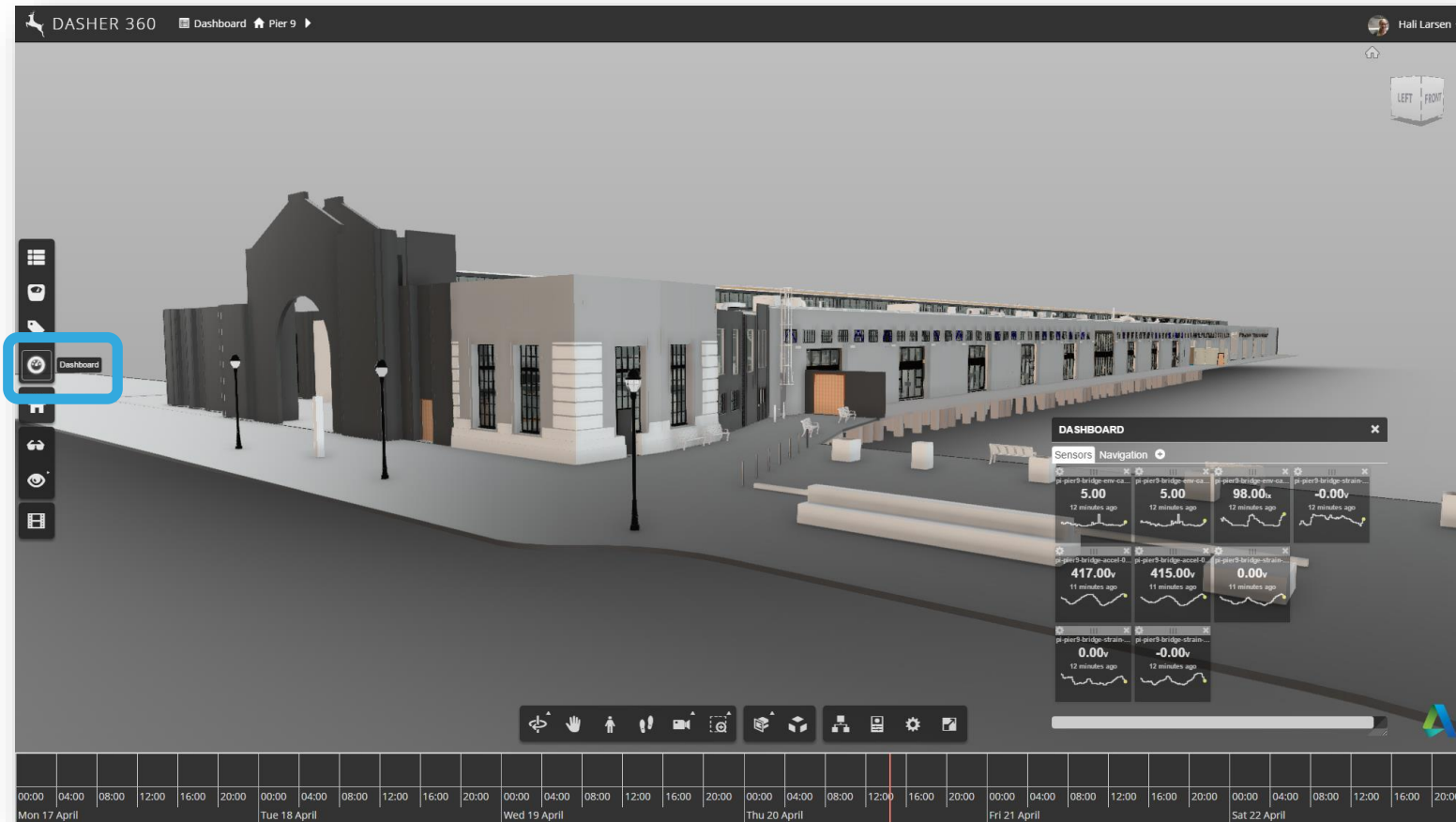
Autodesk.Viewing.UI.Tree

Autodesk.Viewing.UI.TreeDelegate

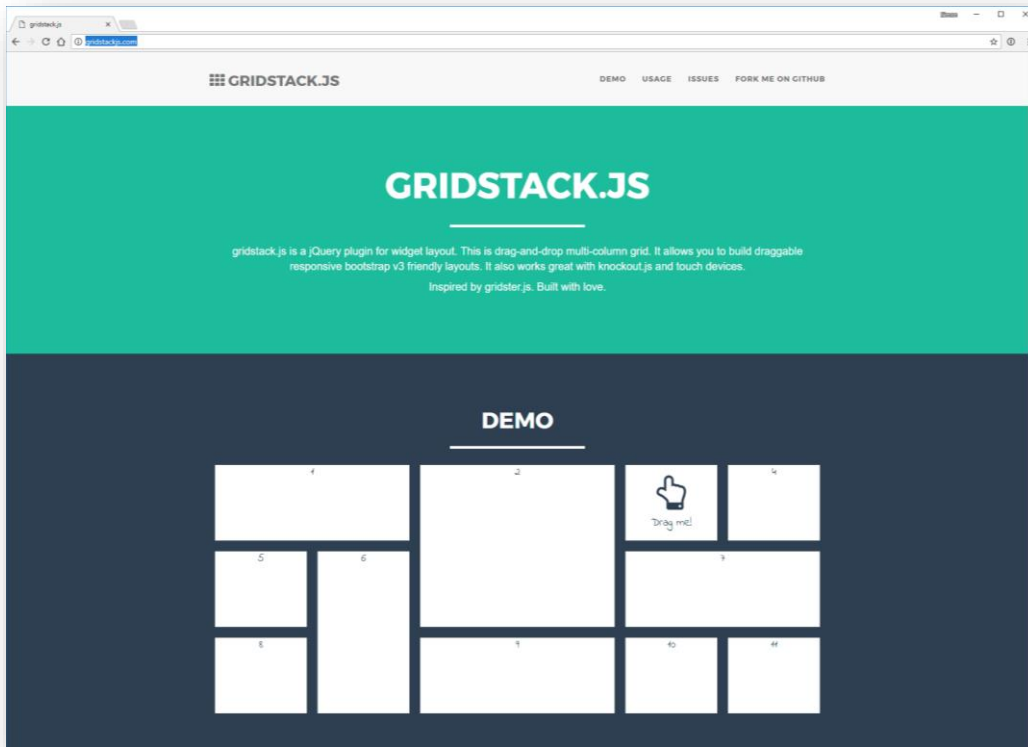
<https://github.com/mar10/fancytree>



# Sensor & View Bookmark Dashboard

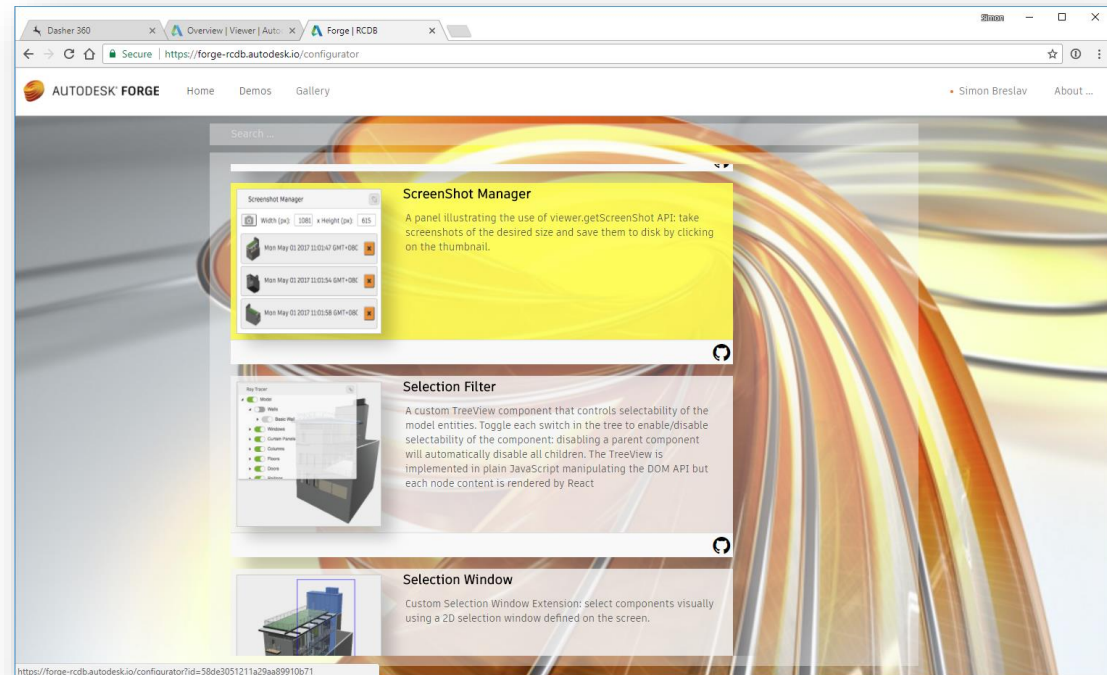


# Sensor & View Bookmark Dashboard



<http://gridstackjs.com>

```
viewer.getScreenShotBuffer(width, height, callback)  
viewer.getState(filter)  
viewer.restoreState(viewerState, filter, immediate)
```





# Sensor extensions (demo)





# Sensor List

The screenshot displays the Dasher 360 web application interface. The browser address bar shows the URL: `forgetest.autodesk.com:5000/viewer/dXJuOmFkc2sud2lwcHJvZDpmcy5maWxlOnZmLk5vRmdWWIo1UWpTUlVxTFpjVDhSOUE_dmVyc2lvcj0x`. The application title is "DASHER 360" and the current project is "210 King St.". The central 3D view shows a red brick building model. On the left, a "SENSOR LIST" panel is highlighted with a blue rounded rectangle. This panel contains a search bar and a list of sensors categorized by type and location. The "Model Sensors (282)" category is expanded, showing various environmental and physical sensors. The "BROWSER" panel on the right shows a hierarchical tree of the building's structure, including levels and rooms. The bottom of the interface features a navigation bar with icons for different views and a calendar at the very bottom showing dates from Sunday to Thursday.

**SENSOR LIST**

Search

210 King St. Historical (944)

Model Sensors (282)

- 5019-Humidity -40.20 %
- 5019-Motion 3.00
- 5019-SensorBoard (8)
  - 5019-Pressure 10.50 kPa
  - 5019-Current1 0.00 A
  - 5019-Current2 0.00 A
  - 5019-Current3 0.00 A
  - 5019-Light1 25.00 lx
  - 5019-Light2 32.00 lx
  - 5019-Sound 44.81
  - 5019-CO2-1 414.00 ppm
- 5019-Temperature 23.11 °C
- 5053-SensorBoard (9)
  - 5053-Temperature 22.89 °C

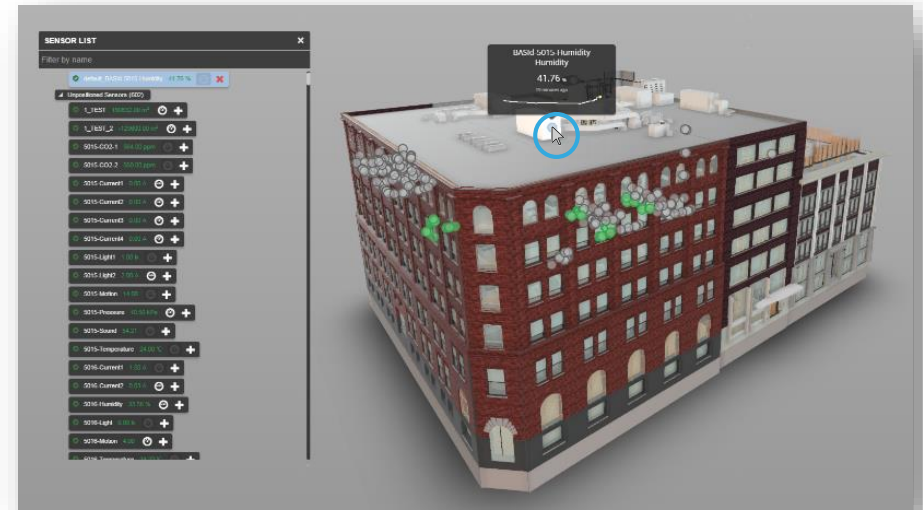
**BROWSER**

Filter by name

- 210\_King\_R2017\_Public\_DEMO.nwc
  - <No level>
  - BLDG 1- BASEMENT FLR. FIN.
    - Doors
    - Floors
    - Rooms
    - Specialty Equipment
    - Structural Columns
    - Structural Framing
    - Walls
    - Windows
  - All-Ground Level
  - BLDG 4- LEVEL 1 FLR. FIN.
  - BLDG 1,2,3- LEVEL 1 FLR. FIN.
  - BLDG 4- LEVEL 2 FLR. FIN.
  - BLDG 1,2,3- LEVEL 2 FLR. FIN.
  - BLDG 4- LEVEL 3 FLR. FIN.
  - 3- THIRD FLOOR
  - BLDG 4- LEVEL 4 FLR. FIN.
  - 4- FOURTH FLOOR
  - T.O. ROOF BLDG 4
  - 5- FIFTH FLOOR
  - Upper Deck Landing
  - 6- SIXTH FLOOR

Sun 1 October 2017 | Mon 2 | Tue 3 | Wed 4 | Thu 5

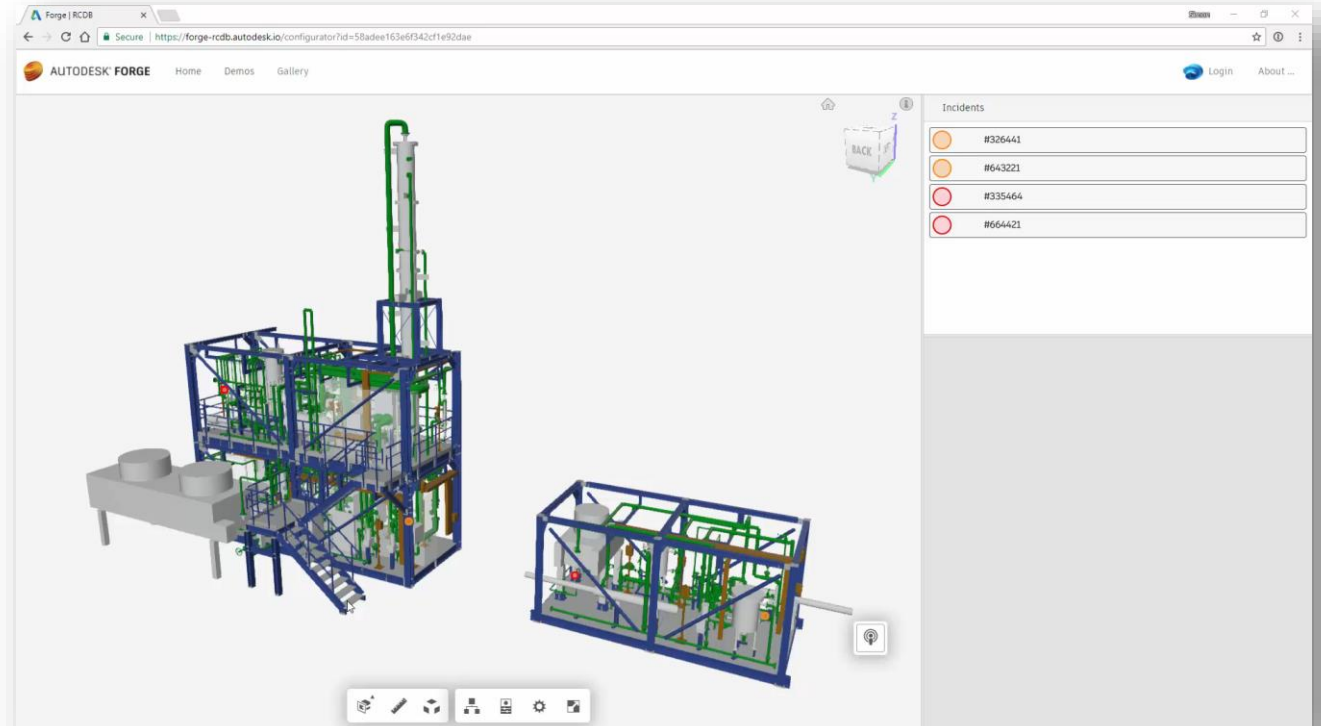
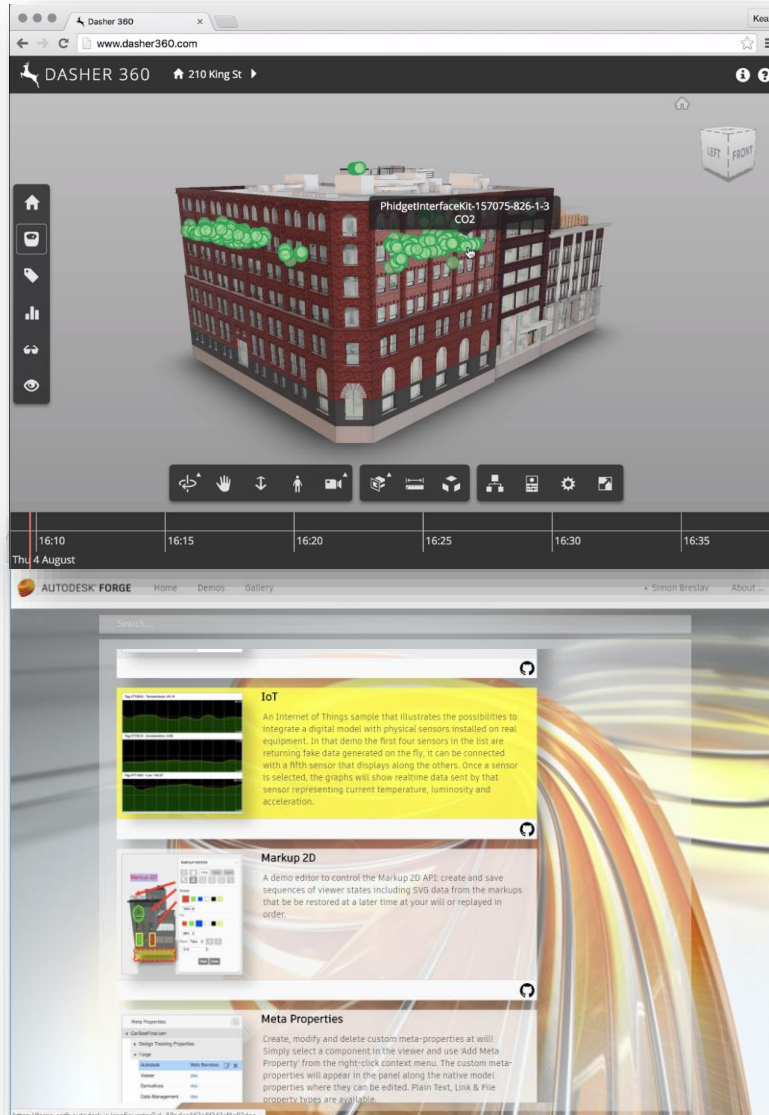
# Sensor List: Placing Sensors



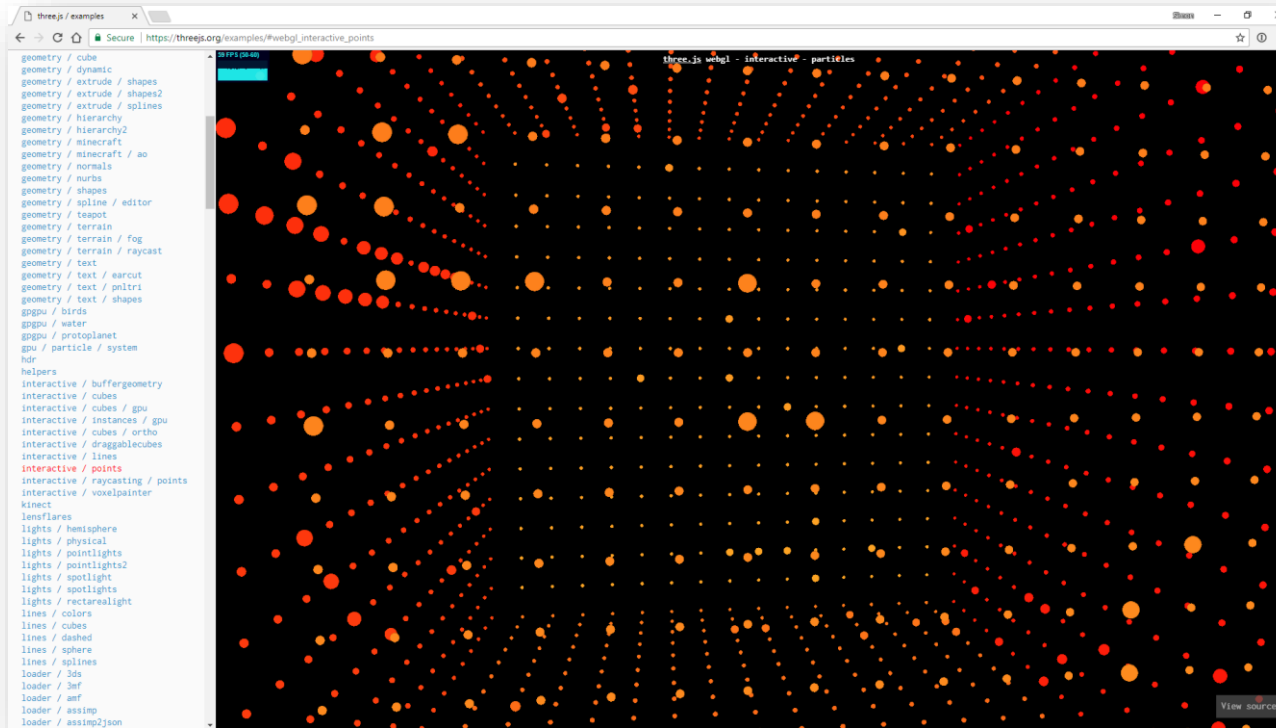
```
viewer.clientToWorld(clientX, clientY, ignoreTransparent)  
viewer.clientToWorld(event.canvasX, event.canvasY, false);
```

# Sensor Dots

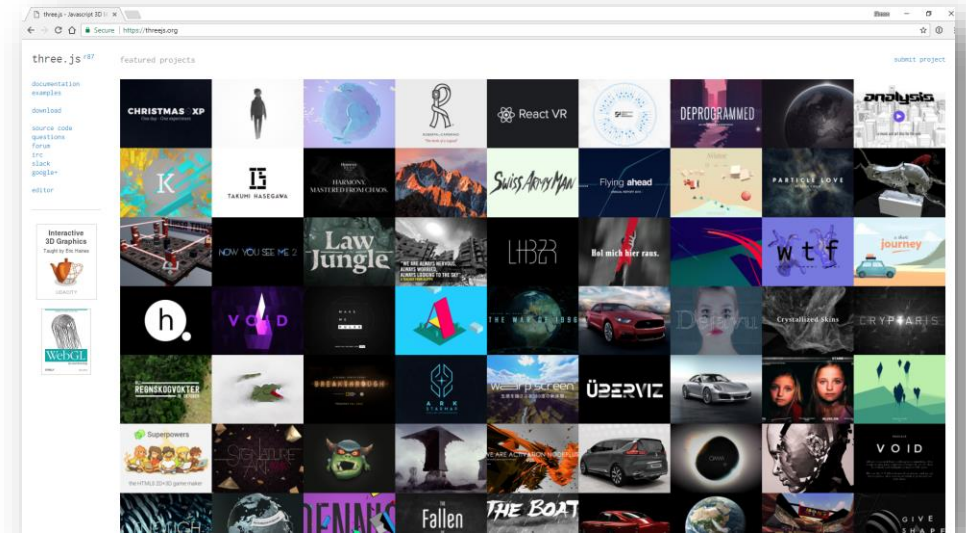
- Sensor Dots were originally SVG elements
  - Easy to animate
  - Easy to make interactive (hover, click)
- Tracks camera movements
- IoT Example: <https://forge-rcdb.autodesk.io>



# Sensor Dots: Particle System/Point Cloud



[https://threejs.org/examples/#webgl\\_interactive\\_points](https://threejs.org/examples/#webgl_interactive_points)



<https://threejs.org/>

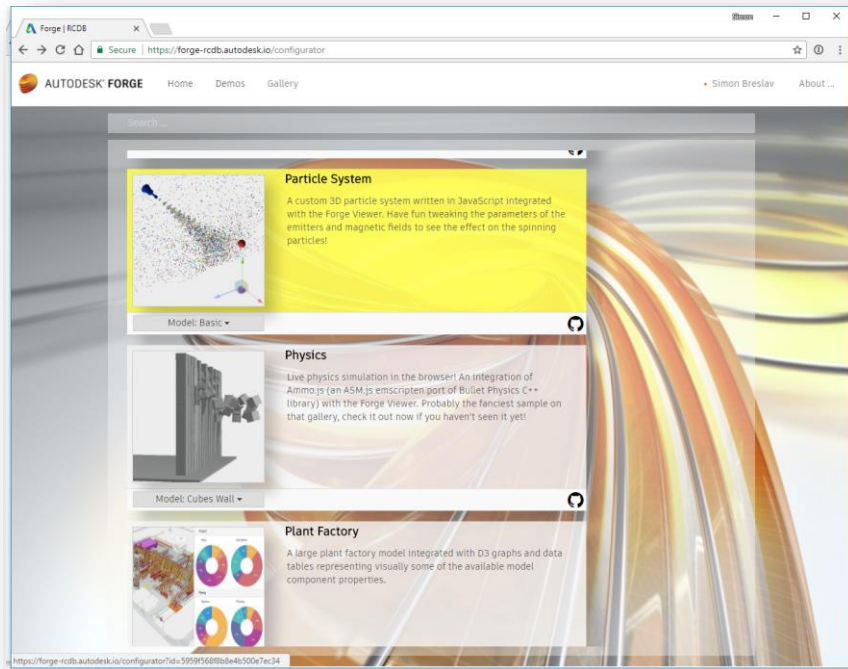
**WARNING:** Check which version of three.js the Viewer is using, old three.js releases are available on GitHub

<https://github.com/mrdoob/three.js/releases/tag/r71>

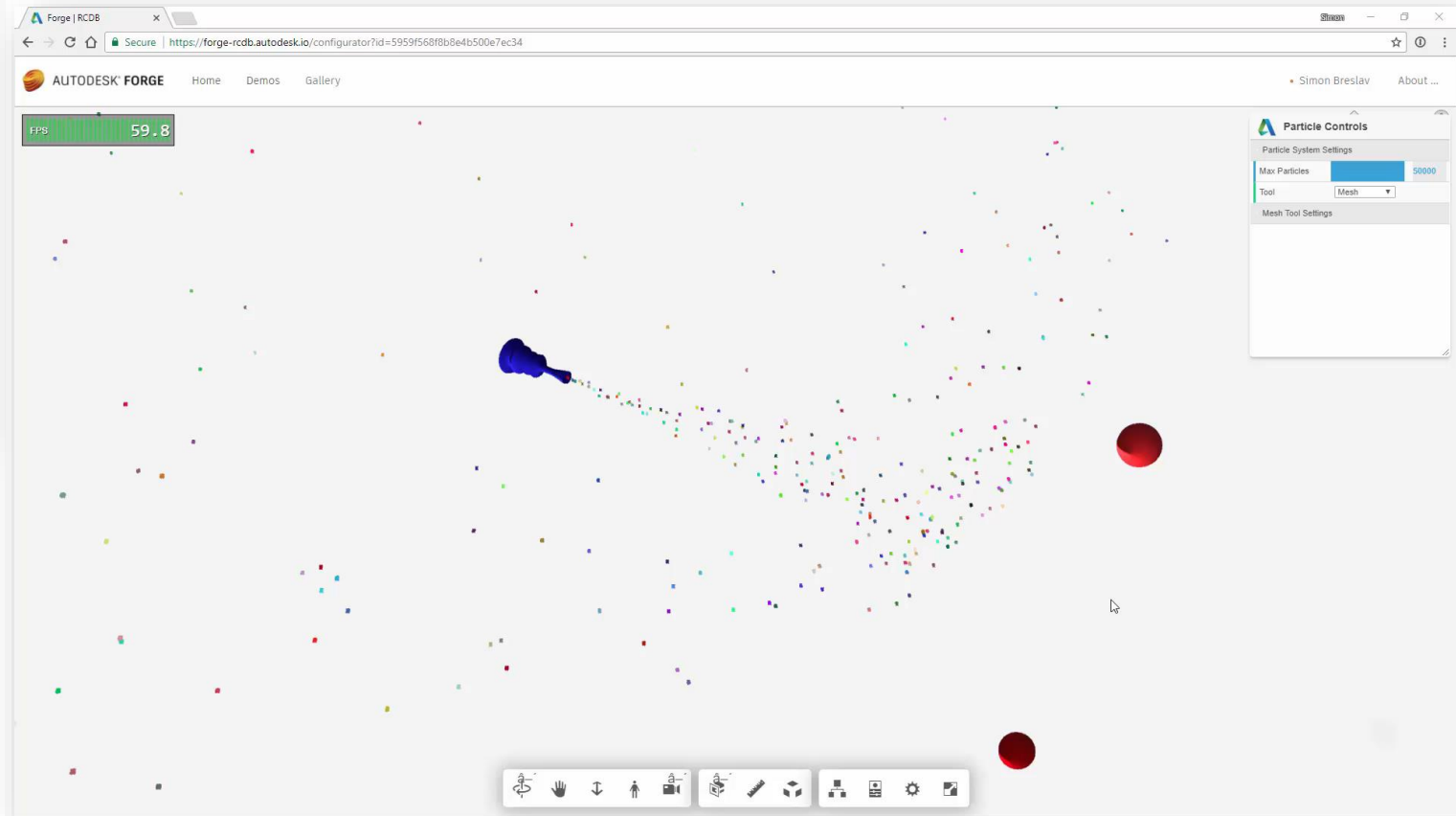
- Release has the docs and examples!



# Sensor Dots: Particle System/Point Cloud

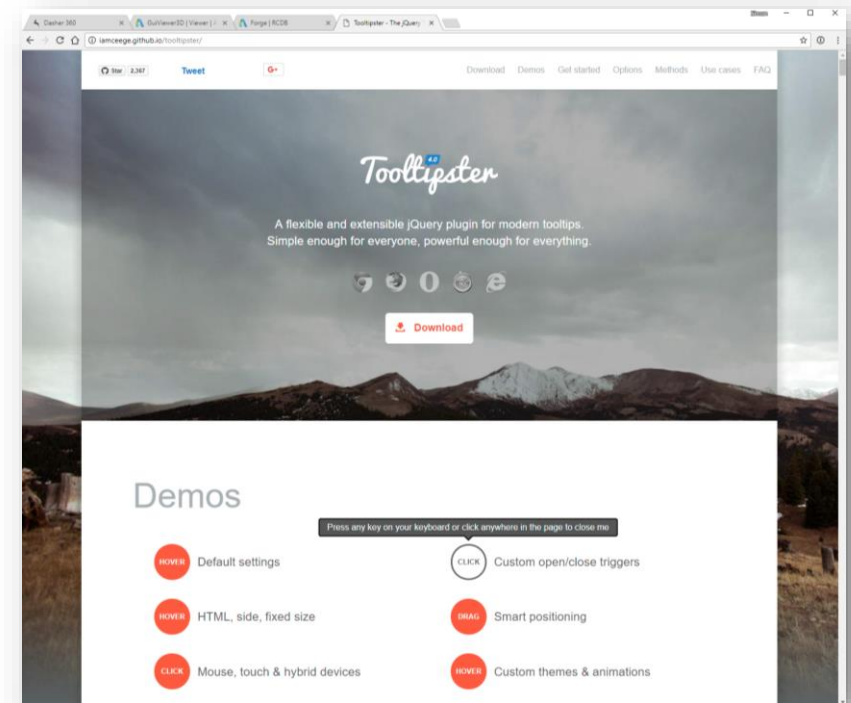
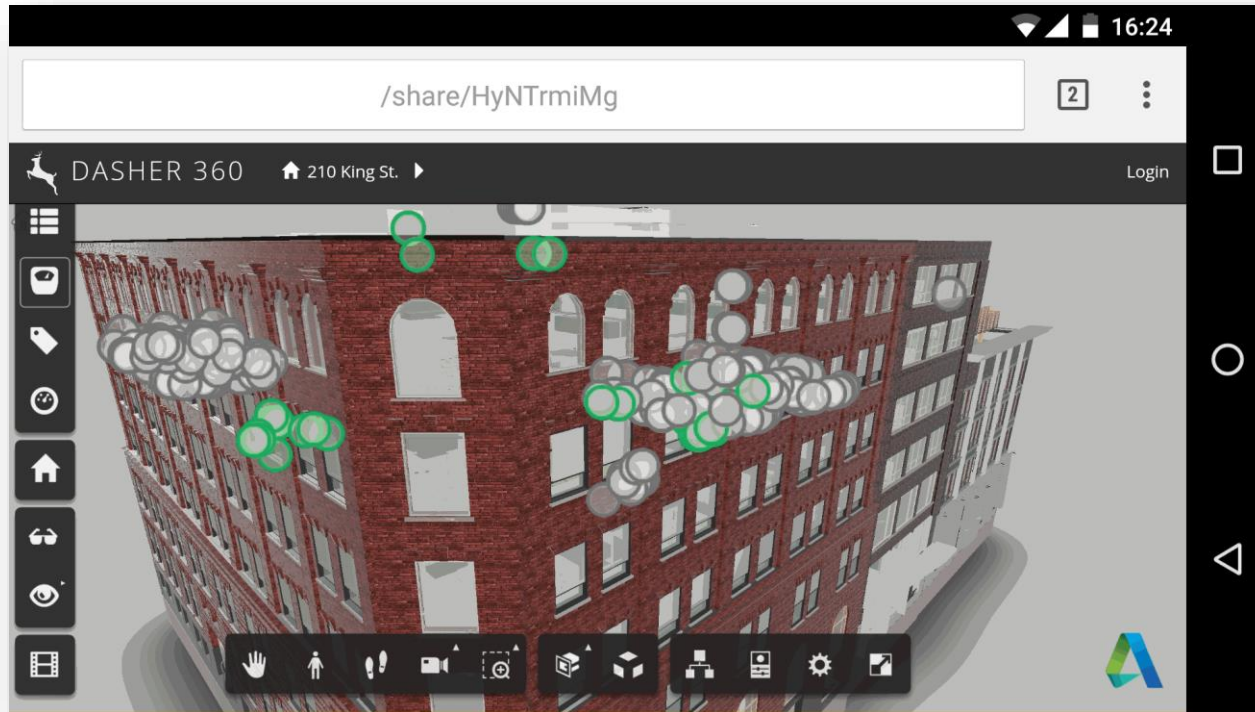


<https://forge-rcdb.autodesk.io>





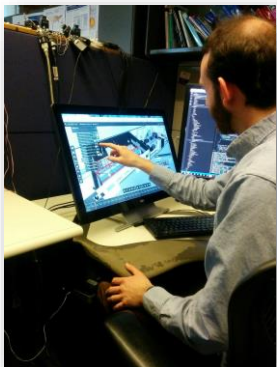
# Tooltips & Touch



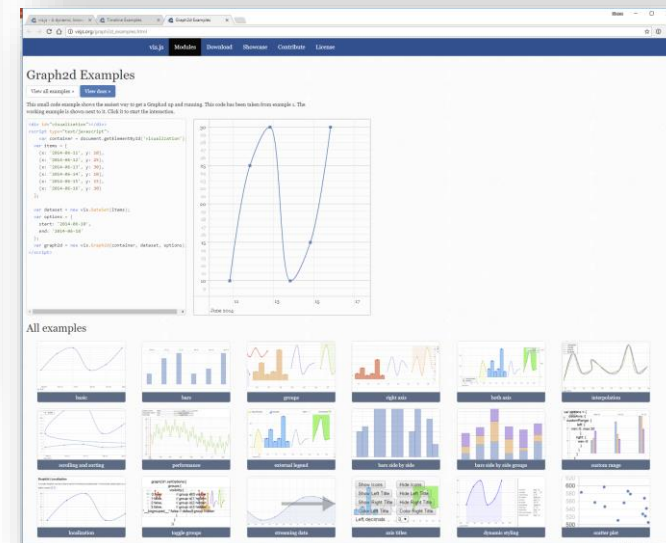
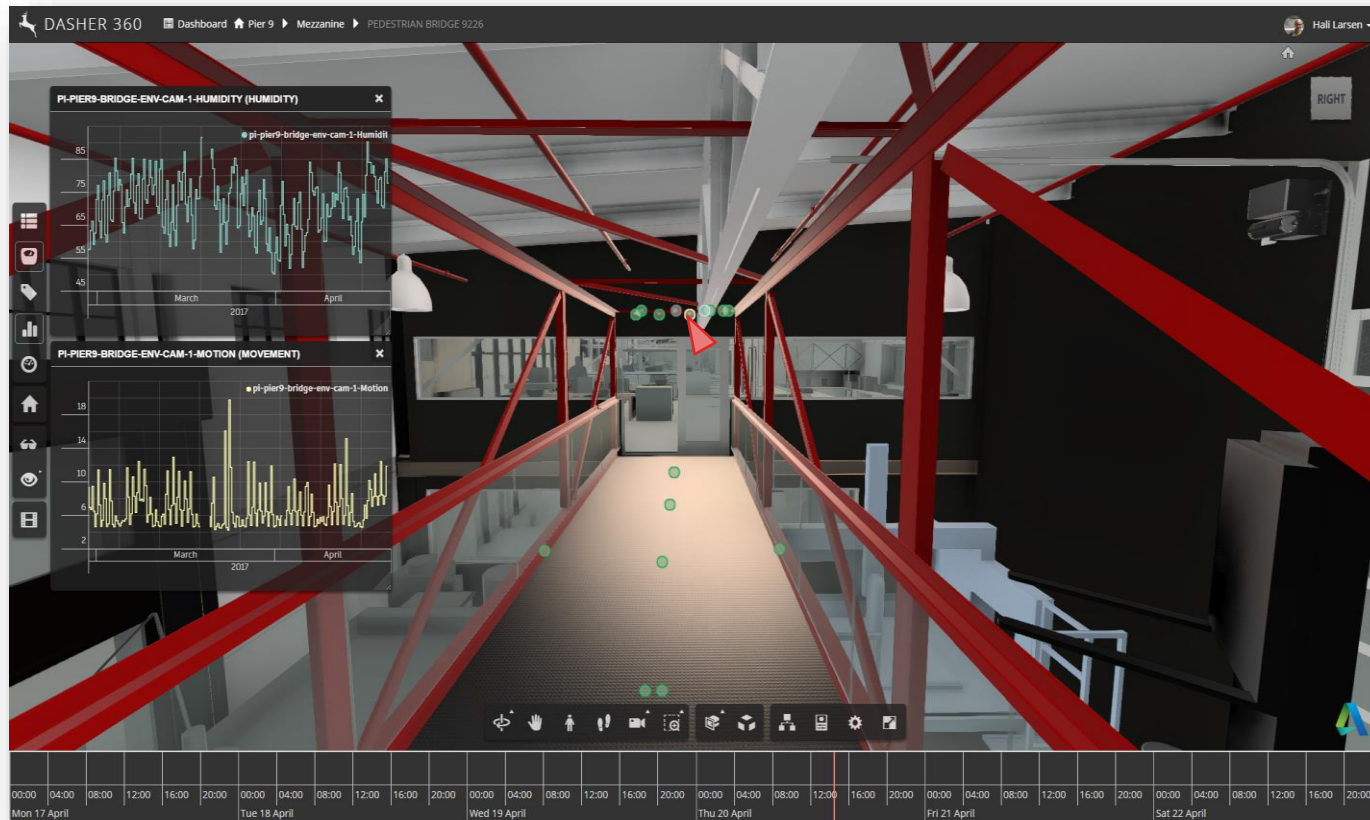
<http://iamceege.github.io/tooltipster>

[Handling both mouse and touch events in Forge viewer applications](http://keanw.com/2017/04/handling-both-mouse-and-touch-events-in-forge-viewer-applications.html)

<http://keanw.com/2017/04/handling-both-mouse-and-touch-events-in-forge-viewer-applications.html>

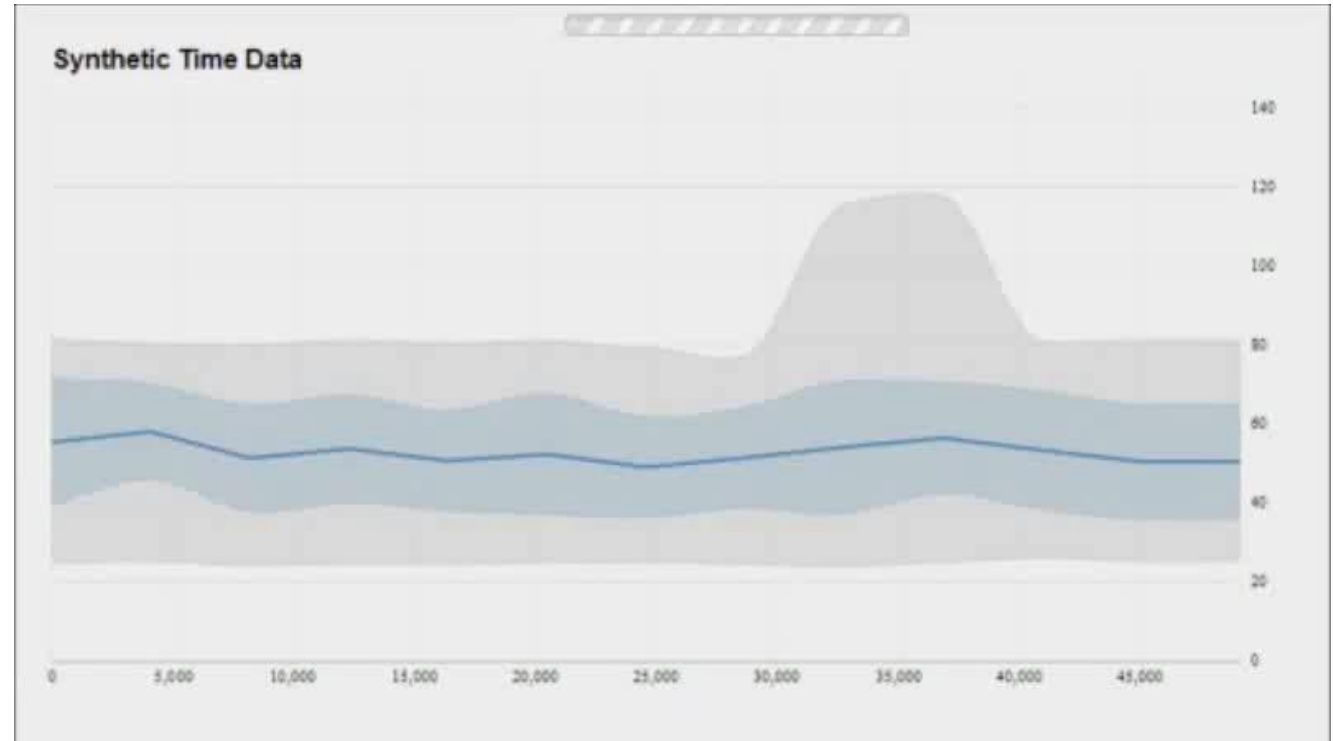
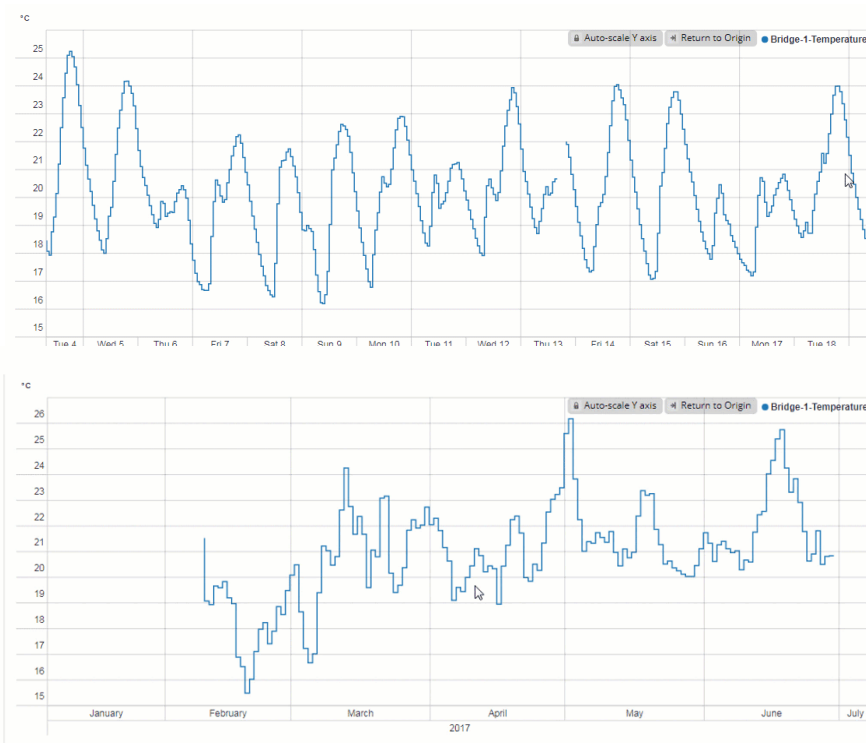


# Charts



<http://visjs.org>

# Charts: Splash



<https://autodeskresearch.com/publications/splash>

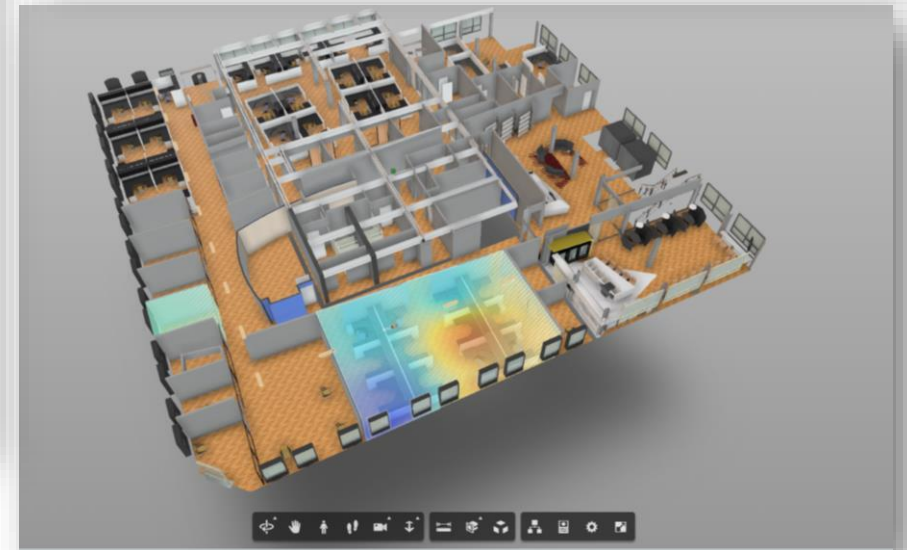
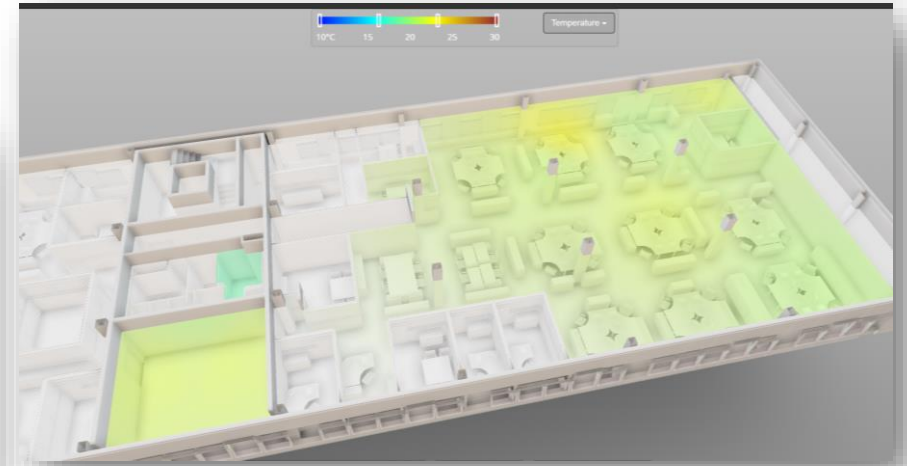
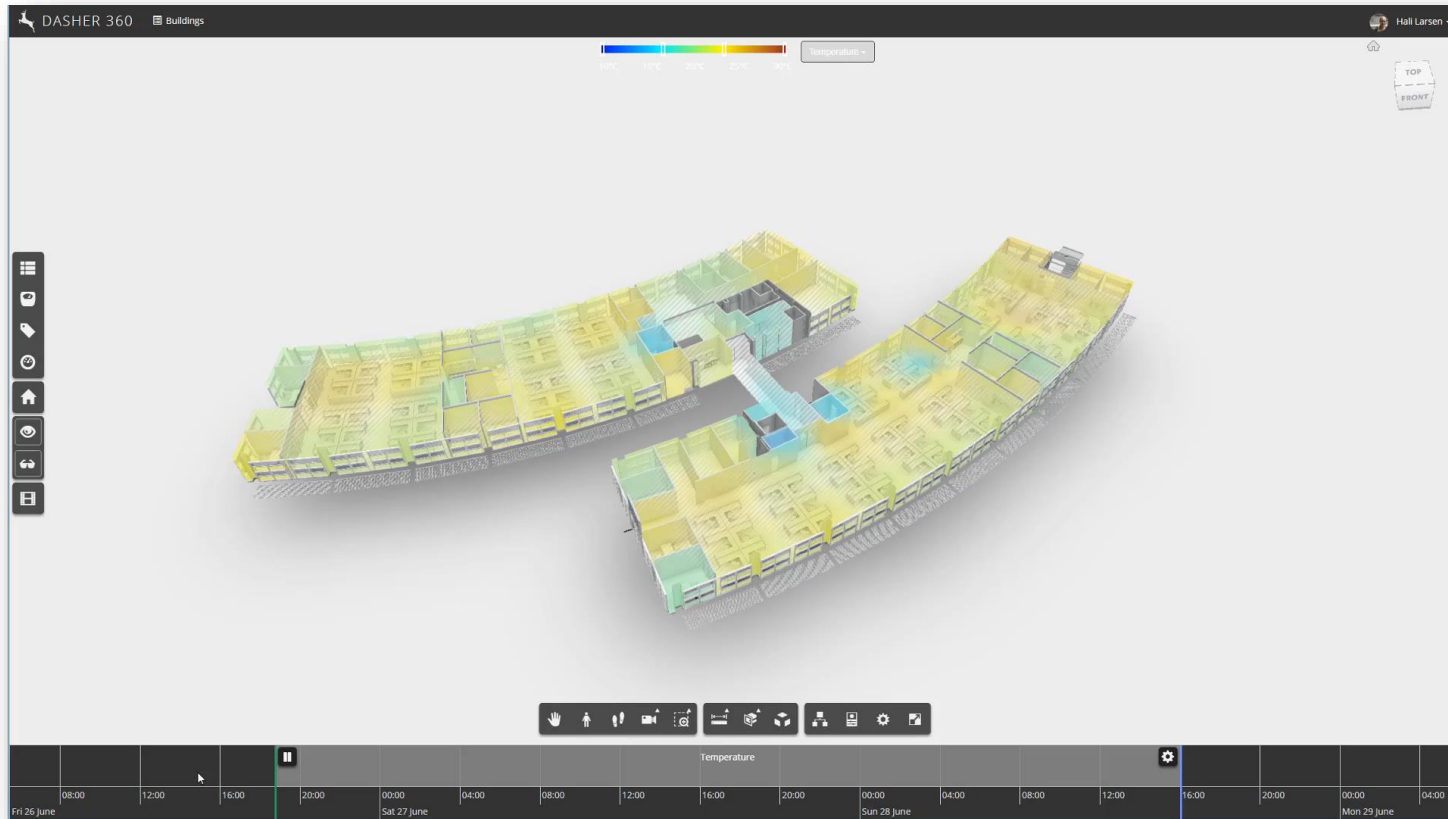
Data is retrieved and loaded at various levels of detail to enable fluid pan and zoom navigation

# Sensor extensions II (demo)



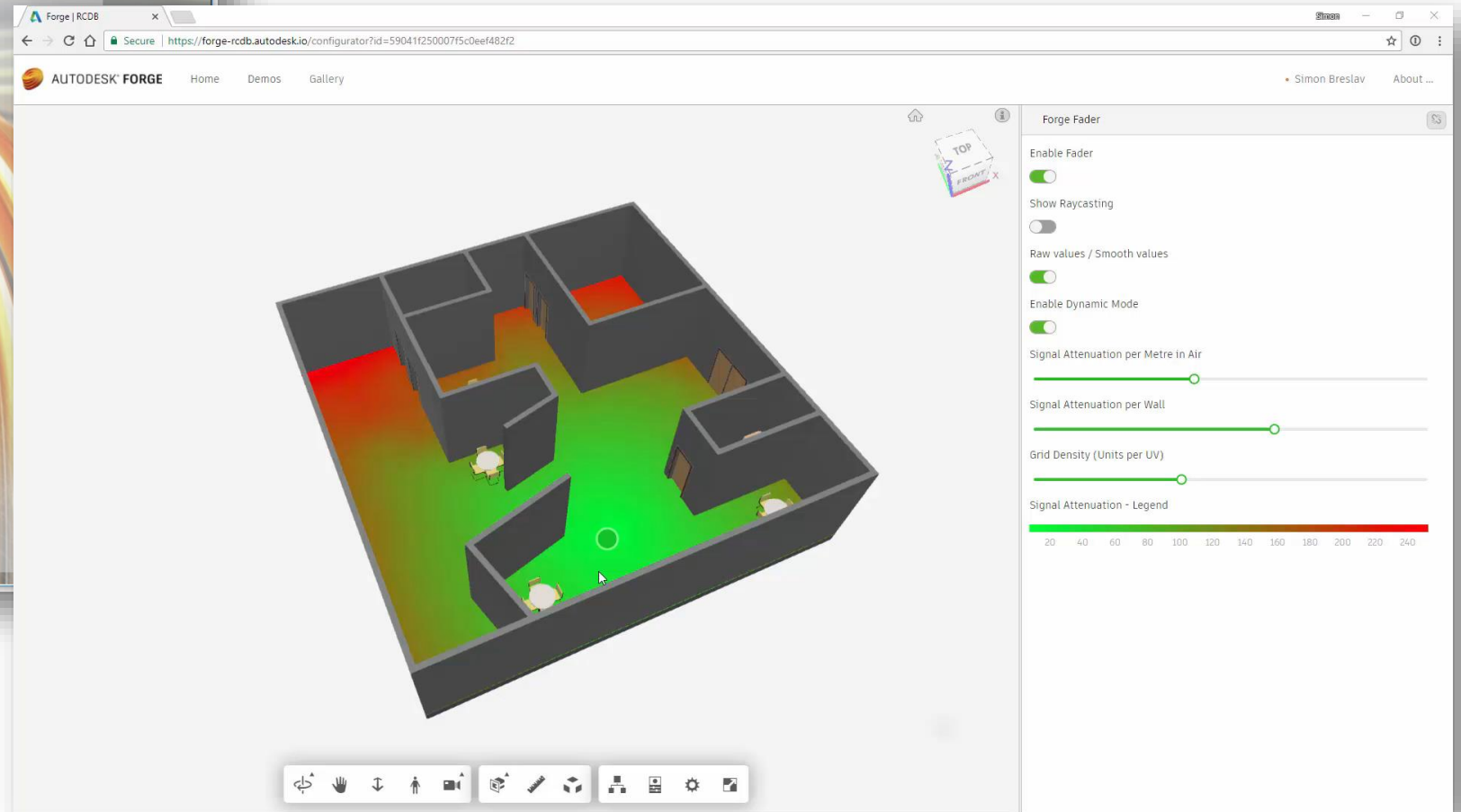
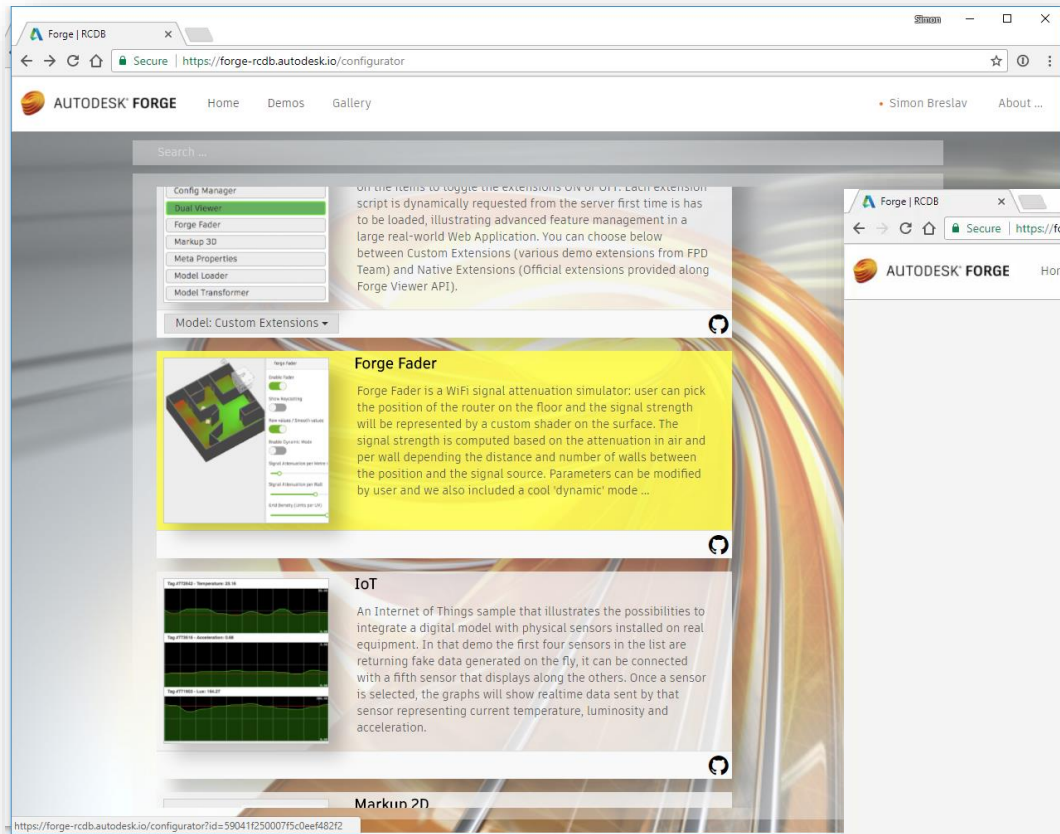


# Surface Shading / Heatmap

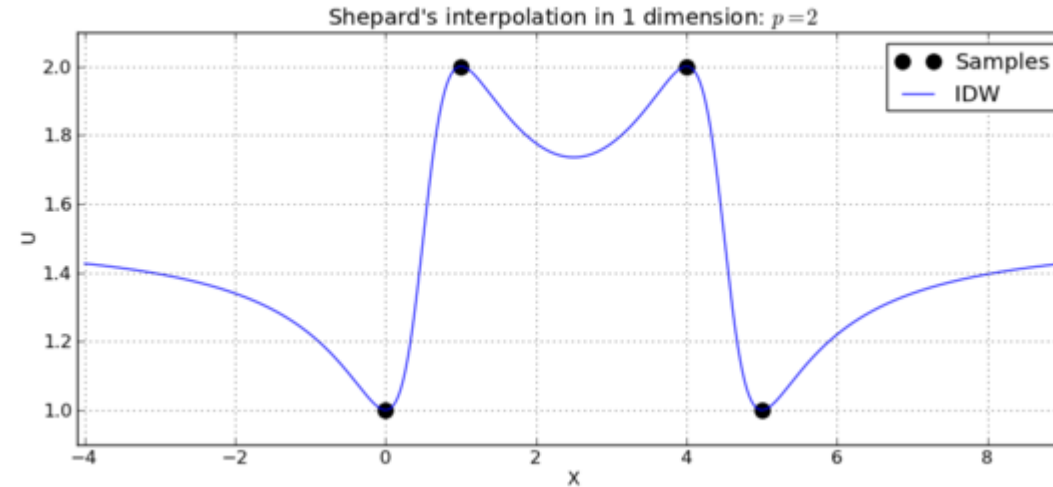




# Surface Shading / Heatmap



# Surface Shading: Inverse distance weighting

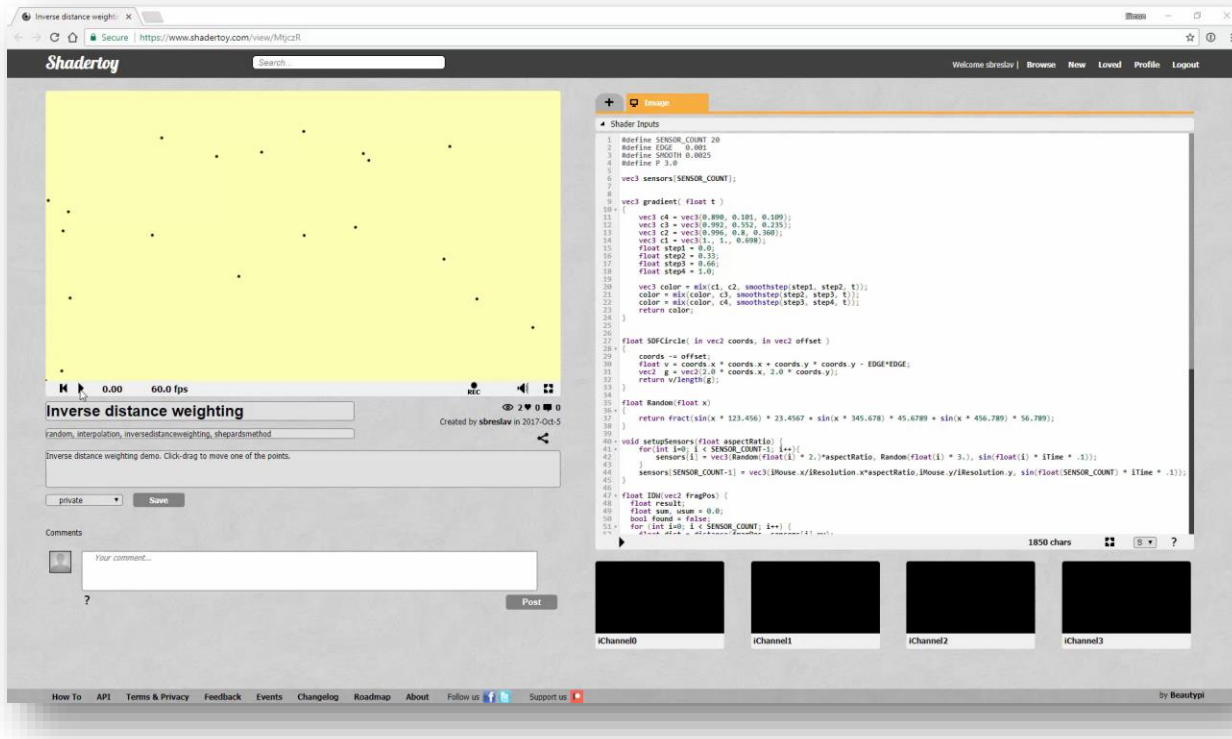


- Inverse Distance Weighting (A.K.A Shepard's method)
  - [https://en.wikipedia.org/wiki/Inverse\\_distance\\_weighting](https://en.wikipedia.org/wiki/Inverse_distance_weighting)
- Shepard, Donald (1968). "A two-dimensional interpolation function for irregularly-spaced data". *Proceedings of the 1968 ACM National Conference*. pp. 517–524.

Lots of other methods to interpolate values:

[https://en.wikipedia.org/wiki/Multivariate\\_interpolation](https://en.wikipedia.org/wiki/Multivariate_interpolation)

# Surface Shading: Inverse distance weighting



<https://www.shadertoy.com/view/MtjczR>

GLSL

```
...  
float IDW(vec2 fragPos) {  
    float sum, wsum = 0.0;  
    for (int i=0; i < SENSOR_COUNT; i++) {  
        float dist = distance(fragPos, sensors[i].xy);  
        if( dist > 0.0) {  
            float w = (1.0 / pow(dist, P));  
            sum += (sensors[i].z * w);  
            wsum += w;  
        } else {  
            return sensors[i].z;  
        }  
    }  
    return sum / wsum;  
}  
...
```

# Timeline: visjs.org



The vis.js homepage features a dark blue header with navigation links: vis.js, Modules, Download, Showcase, Contribute, and License. The main content area has a blue and yellow background with the vis.js logo and a description: "A dynamic, browser based visualization library. The library is designed to be easy to use, to handle large amounts of dynamic data, and to enable manipulation of and interaction with the data. The library consists of the components DataSet, Timeline, Network, Graph2d and Graph3d. Get it over here!". A yellow sticky note on the right says: "We're looking for people to help maintain and improve vis.js. Interested? Click here". Below the header, there are five sections: Network, Timeline (highlighted with a blue border), Graph2d, Graph3d, and DataSet. Each section has a small image, a description, and buttons for "View examples" and "View docs".

**vis.js**

A dynamic, browser based visualization library. The library is designed to be easy to use, to handle large amounts of dynamic data, and to enable manipulation of and interaction with the data. The library consists of the components DataSet, Timeline, Network, Graph2d and Graph3d. Get it over here!

**Timeline**

Create a fully customizable, interactive timeline with items and ranges.

**Graph2d**

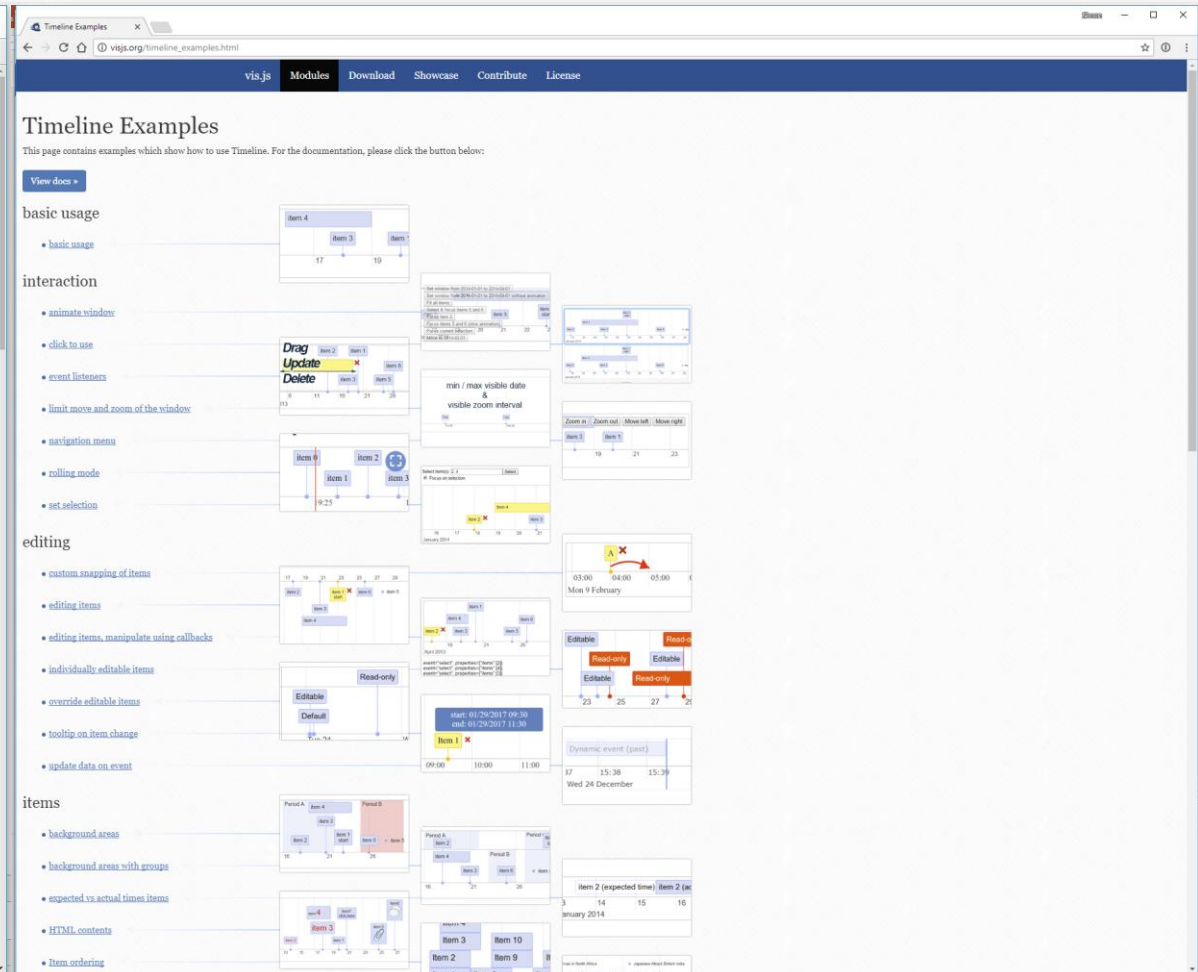
Draw graphs and bar charts on an interactive timeline and personalize it the way you want.

**Graph3d**

Create interactive, animated 3d graphs. Surfaces, lines, dots and block styling out of the box.

**DataSet**

Manage unstructured data using DataSet. Add, update, and remove data, and listen for changes in the data.



The vis.js Timeline Examples page features a dark blue header with navigation links: vis.js, Modules, Download, Showcase, Contribute, and License. The main content area has a white background with the title "Timeline Examples" and a subtitle: "This page contains examples which show how to use Timeline. For the documentation, please click the button below: View docs". Below the header, there are several sections: basic usage, interaction, editing, and items. Each section has a list of examples and a corresponding image showing the example in action.

**Timeline Examples**

This page contains examples which show how to use Timeline. For the documentation, please click the button below: [View docs](#)

**basic usage**

- [basic usage](#)

**interaction**

- [animate window](#)
- [click to use](#)
- [event listeners](#)
- [limit move and zoom of the window](#)
- [navigation menu](#)
- [rolling mode](#)
- [set selection](#)

**editing**

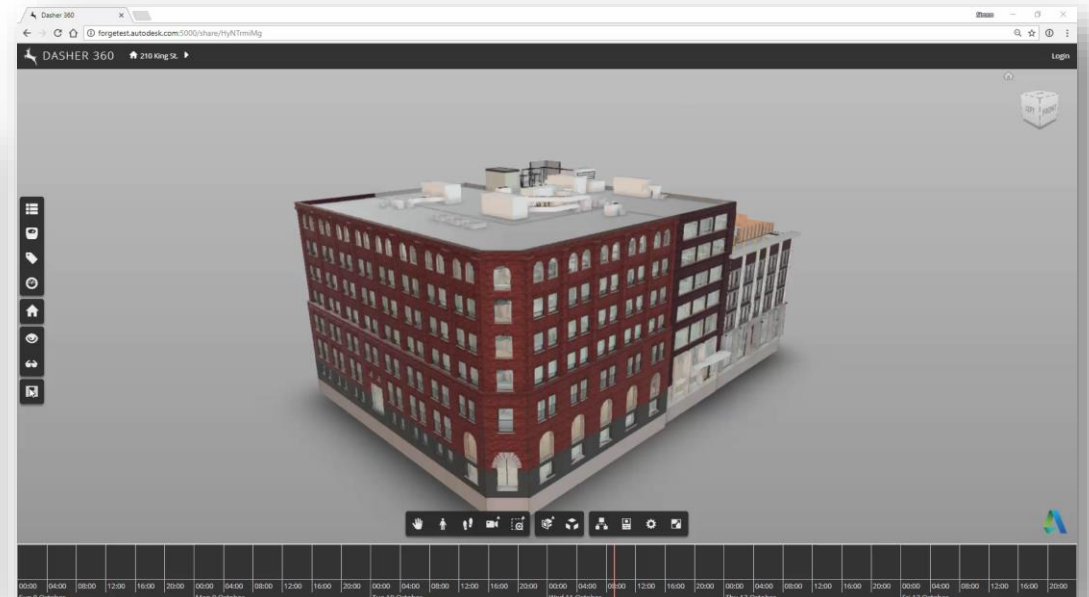
- [custom snapping of items](#)
- [editing items](#)
- [editing items, manipulate using callbacks](#)
- [individually editable items](#)
- [override editable items](#)
- [tooltip on item change](#)
- [update data on event](#)

**items**

- [background areas](#)
- [background areas with groups](#)
- [expected vs actual times items](#)
- [HTML contents](#)
- [item ordering](#)

# Kiosk Mode

- Designed for when you want to leave Dasher 360 in “demo mode”
  - For instance on a large screen in your building lobby
- Displays a fake cursor to simulate the operation of Dasher 360
- Loops through various Dasher 360 features, interruptable by mouse or touch input
- Functional for any screen configuration, view- and model-independent
- Easily extensible





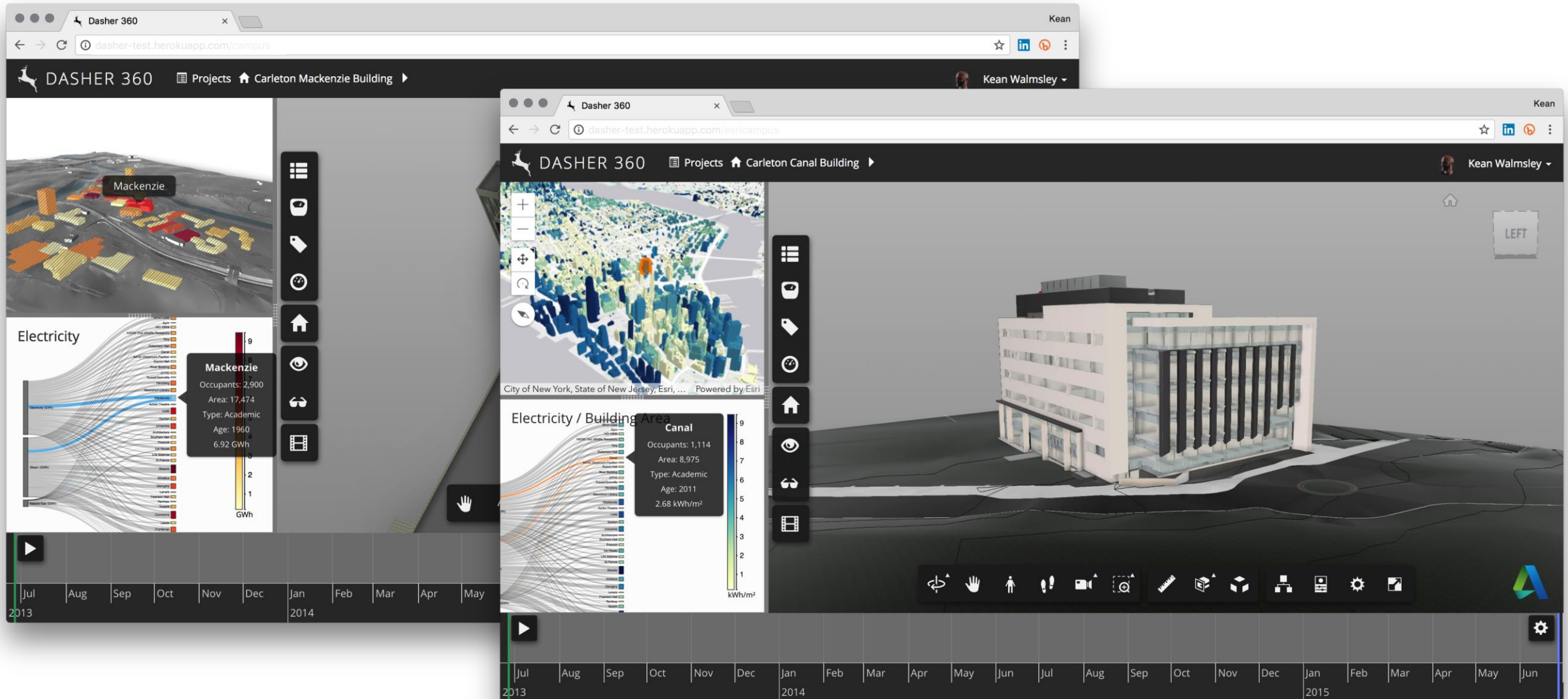
# Kiosk Mode

- [Implementing a demo mode inside the Forge viewer – Part 1](#)
  - <http://keanw.com/2017/03/implementing-a-demo-mode-inside-the-forge-viewer-part-1.html>
- [Implementing a demo mode inside the Forge viewer – Part 2](#)
  - <http://keanw.com/2017/03/implementing-a-demo-mode-inside-the-forge-viewer-part-2.html>
- [Implementing a demo mode inside the Forge viewer – Part 3](#)
  - <http://keanw.com/2017/03/implementing-a-demo-mode-inside-the-forge-viewer-part-3.html>
- Uses a fake cursor
- The various extensions define their areas of interest
  - Location of on/off button
  - Interesting locations where cursor should visit plus actions to perform on hover, click and unhover

# What's next for Dasher?

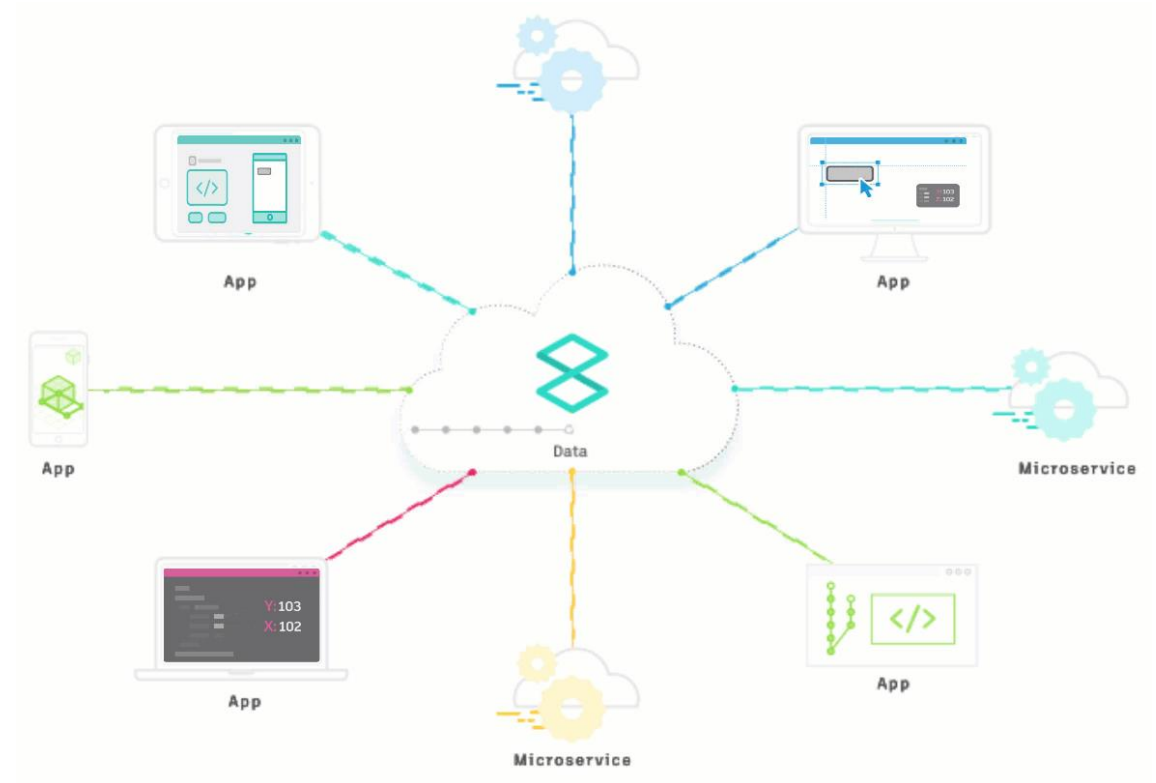


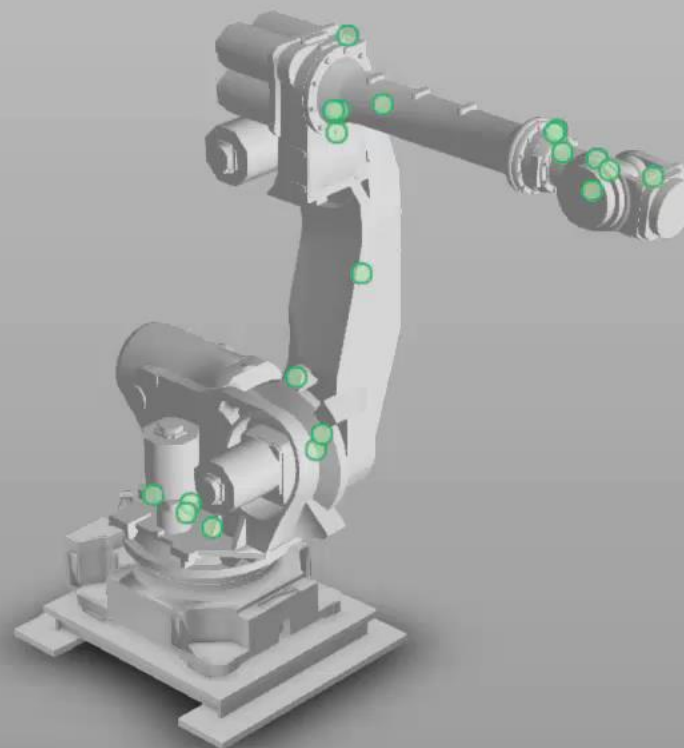
# Campus and City Views



# Forge NextGen

- The Forge team is providing a set of “next generation” services...
  - HFDM
  - App Framework
- A good fit for dealing with “dynamic” data?
  - Models that move or change, over time
  - Sensors that change location, over time
- Needed for dealing with construction and factory use-cases





**DASHBOARD**

Sensors Navigation

Sensor Name	Value	Unit
Current-Sensor-1	9.74	
Current-Sensor-2	9.68	
Current-Sensor-3	10.69	
Temperature-Sensor-1	20.00	°C
Temperature-Sensor-2	20.30	°C
Temperature-Sensor-3	19.31	°C










DASHBOARD

Sensors Navigation





SENSOR LIST

Pillar

PillarTech-42948-8-Dust

9.25  $\mu\text{g}/\text{m}^3$

PillarTech-42948-8-Humidity

36.21 %

PillarTech-42948-8-Pressure

30.17 Pa

PillarTech-42948-8-Temp

72.52  $^{\circ}\text{F}$

PillarTech-42949-8-Dust

144.66  $\mu\text{g}/\text{m}^3$

PillarTech-42949-8-Humidity

35.97 %

PillarTech-42949-8-Pressure

30.17 Pa

PillarTech-42949-8-Temp

71.13  $^{\circ}\text{F}$

PillarTech-42950-8-Dust

19.24  $\mu\text{g}/\text{m}^3$

PillarTech-42950-8-Humidity

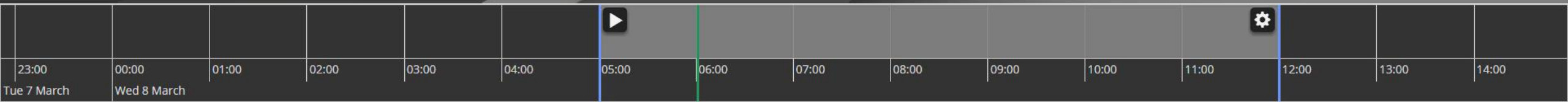
29.98 %

PillarTech-42950-8-Pressure

30.20 Pa

PillarTech-42950-8-Temp

74.17  $^{\circ}\text{F}$



# Conclusions

- Forge helped us move a complex desktop application to the web
  - It was both easy and fun!
- Lots of existing examples were available as references
- We used various, off-the-shelf JavaScript libraries in addition to Forge
- Viewer extensions allowed us to create separate (but sometimes connected) features
  - These can be combined to create versions with different capabilities



# Kiosk mode, Q&A







Autodesk and the Autodesk logo are registered trademarks or trademarks of Autodesk, Inc., and/or its subsidiaries and/or affiliates in the USA and/or other countries. All other brand names, product names, or trademarks belong to their respective holders. Autodesk reserves the right to alter product and services offerings, and specifications and pricing at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document.

© 2018 Autodesk. All rights reserved.

