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BIM GATHERING 2019

Delivering **better outcomes** for Irish Construction

4th CitA BIM Gathering 26th September 2019, Galway, Ireland.

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"THE POST - OCCUPANCY DIGITAL TWIN"

A Quantitative Report on Data Standardisation and Dynamic Building Performance Evaluation

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Supervisor: Barry Kirwan

Research Area:
Digital Twin Technologies

The aim of my research was to determine if…

Replacing existing information exchange processes with Digital Twin Technology can

a) Improve building to operations information transfer
b) Improve efficiency in the post-occupancy operational phase of BIM Level 2 projects in Ireland?

Research Objectives

Critical analyses of…

- Soft Landings Framework 2018 & RIBA Plan of Work 2013
- Comparison of actual & proposed building performance data
- BIM Level 2 information exchange requirements & deliverables

Methodology

- Literature Review, Interview Questionnaire, Online Survey, Roadmap

Term has become popular over the past few years

Gartner Emerging Technology List: 2017-2020

What is a Digital Twin?

Developed by NASA in the 1960's as "Mirrored Systems"

Associated with BIM & IoT since 2010, New buzzword relating to BIM 2020?

"A virtual model of a process, product or service"

"Pairing of the virtual & physical worlds"

How do you define a Digital Twin?

"Real time digital representation of an object or system"

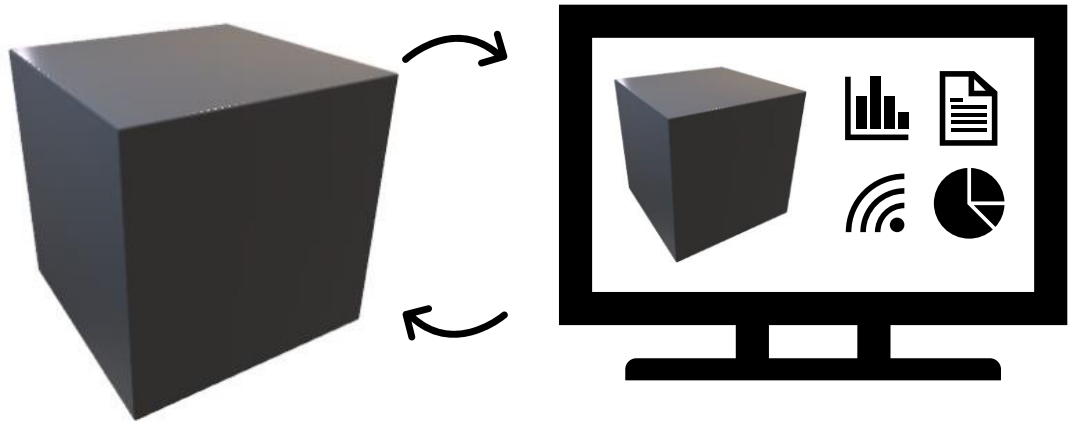
"Virtual representation of a physical object or asset across its life-cycle"

Digital Twin = Real-Time Monitoring & Analysis

Elements required for Digital Twin

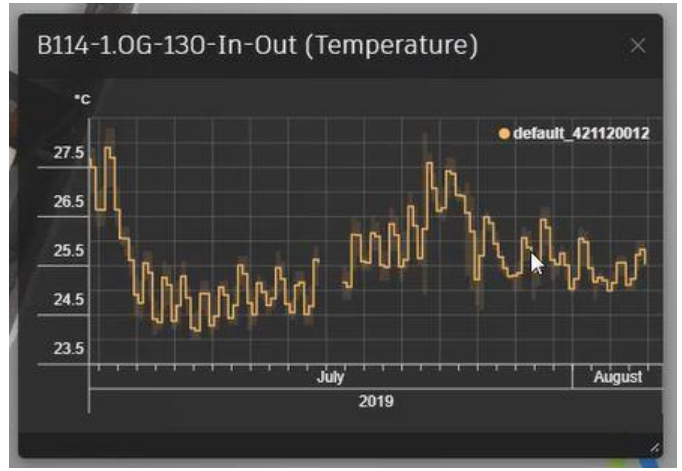
1. Physical object
2. Virtual representation of object
3. Interconnecting network of sensors

"The Performance Twin"



Sensor data viewed in Dasher 360

- Bi-Directional Updating of Data
- Virtual and Physical (Mirrored)



Temperature (Degrees)

Timeline (Months)

Assets are delivered in compliance with BIM Level 2

Alignment with PAS 1192, ISO 19650

Is BIM classified as a Digital Twin?

One requirement of a Digital Twin is a physical asset

BIM enables the virtual representation of a physical asset

Requirement 1: Physical Asset

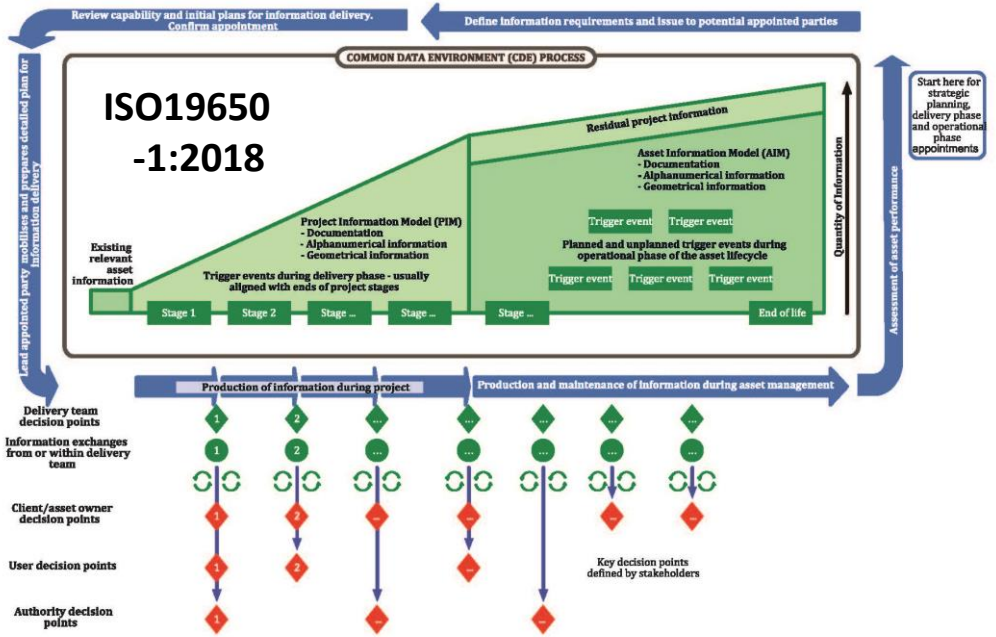
RIBA Plan of Work 2013

Information Exchanges (Data Drops)

- PDF: Drawings, reports, specifications
- Excel spreadsheets
- IFC: Interoperable file format

Static Information

- Does not represent current conditions
- DT requires Bi-Directional updating of data.



Static Information (Outdated)

Smoother transition period following building handover

3 Year POE phase following project handover

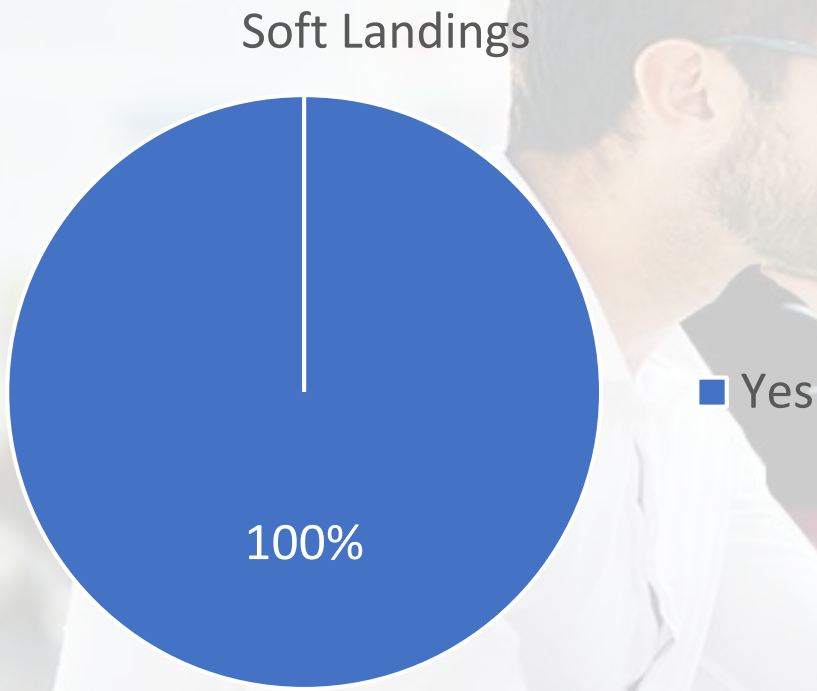
What are Soft Landings?

BPE to analyse building operational data

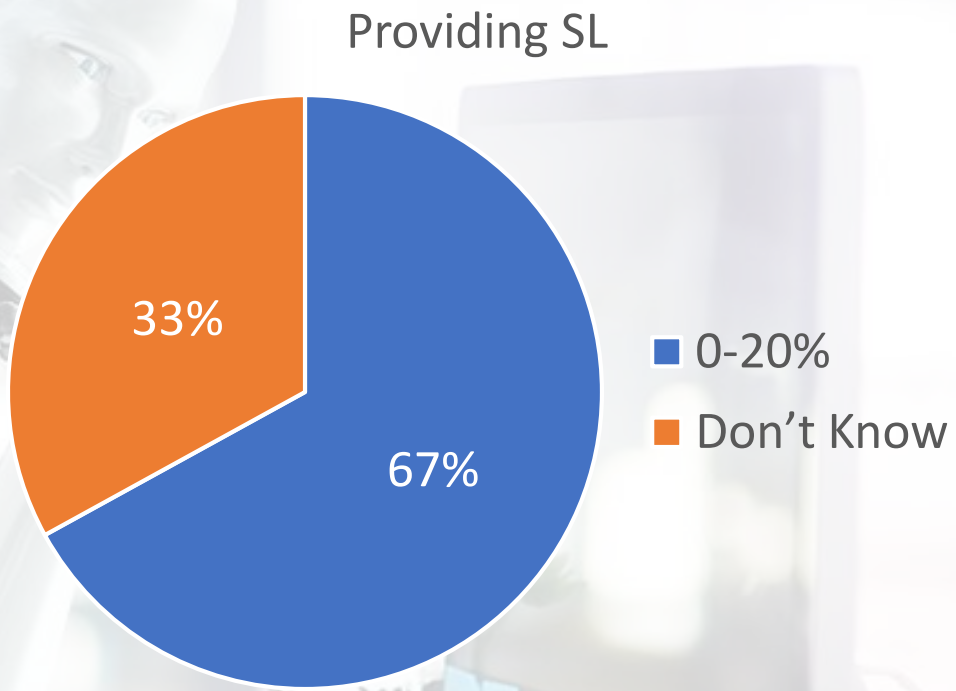
Outdated evaluation methods producing static information

Interview Results: Soft Landings

Q. Are you familiar with Soft Landings?



Q. What percentage of BIM Level 2 projects are providing SL information?



Requirement 2: Virtual Representation

The Gemini Principles

Centre of Digital Built Britain

- Published: December 2018
- Roadmap: May 2019

3 Categories, 9 Principles

- National Digital Twin

Principle No. 5: Openness

- Interoperability (ISO 16739:2013)
- Classification (ISO 12006-2:2015)

THE GEMINI PRINCIPLES		
PURPOSE	**TRUST**	**FUNCTION**
1. Public Good	4. Security	7. Federation
2. Value Creation	5. Openness	8. Curation
3. Insight	6. Quality	9. Evolution

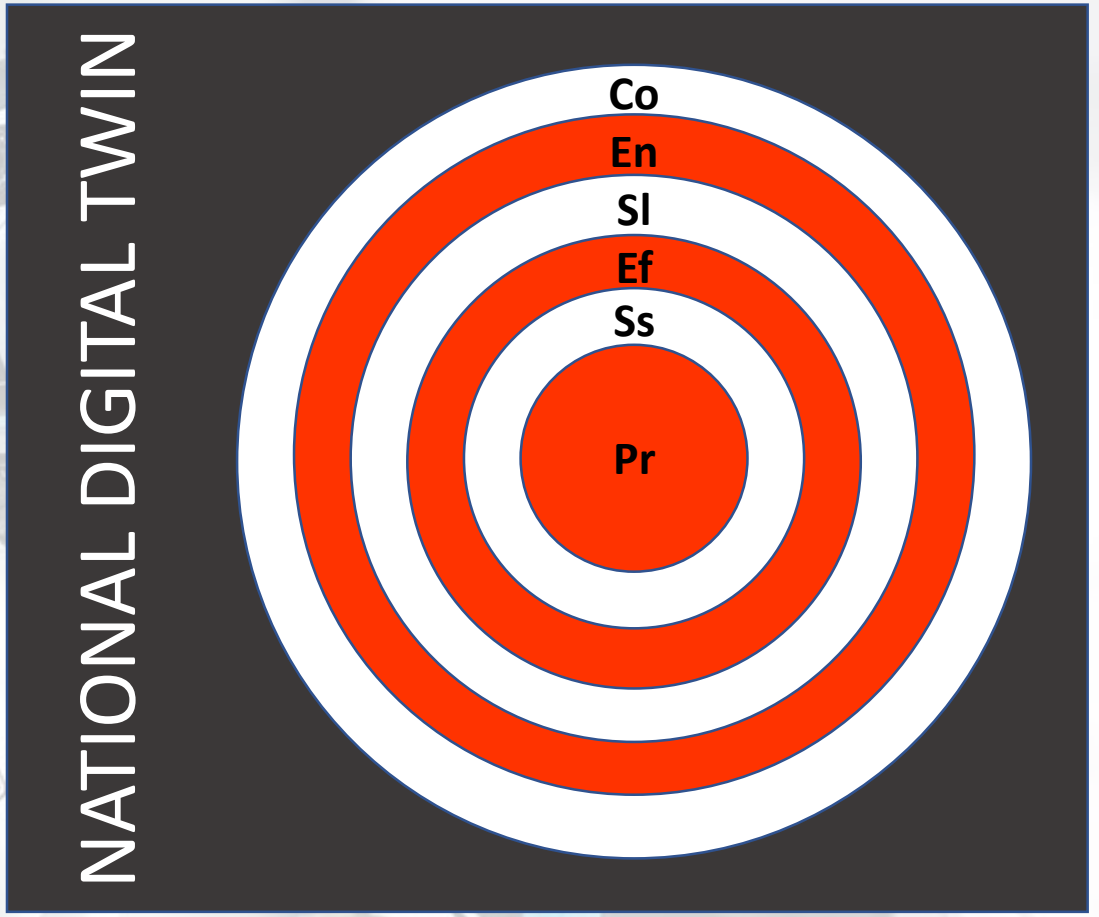
Classification

Uniclass 2015

- Code: Group_Sub Group_Section

Example

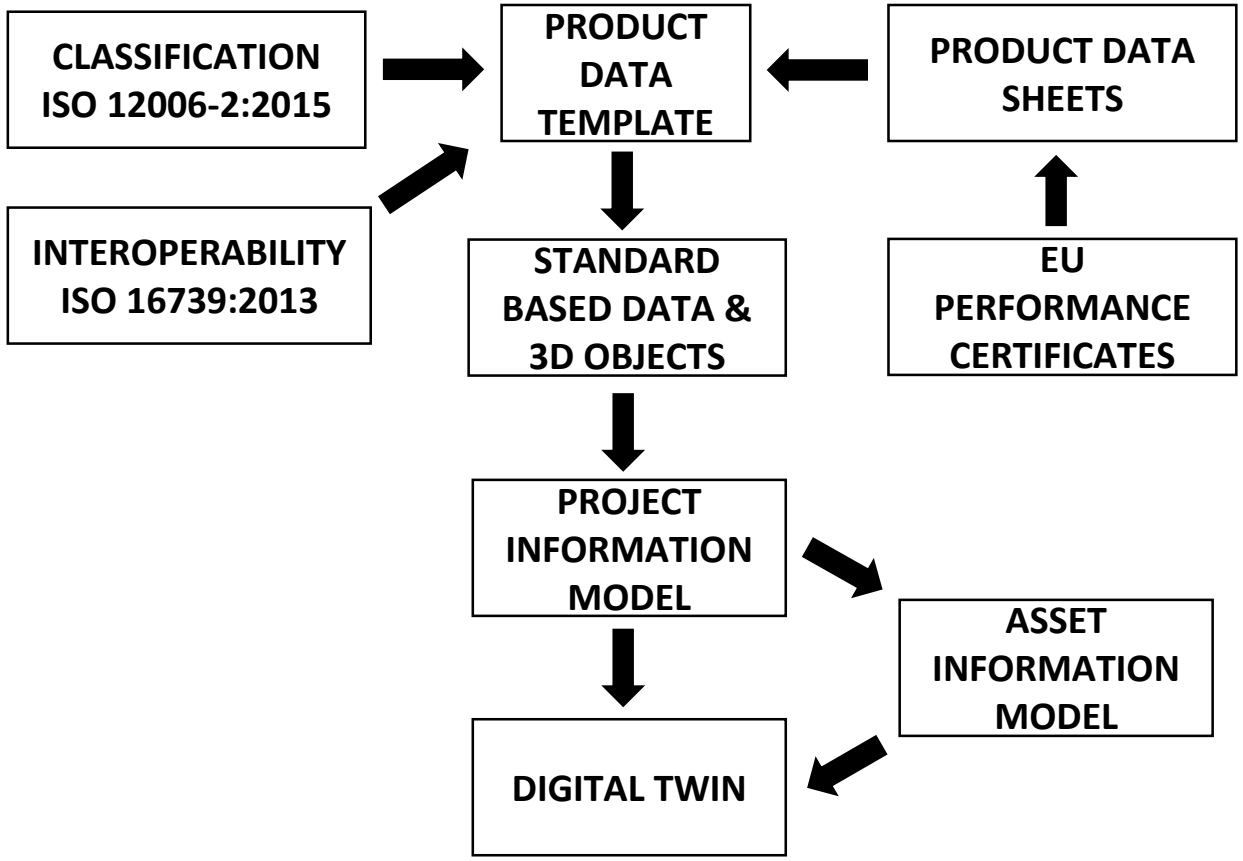
- Complex: CO_Gr_SG_Se
- Entities: EN_Gr_SG_Se
- Space: SL_Gr_SG_Se
- Elements: EF_Gr_SG_Se
- Systems: SS_Gr_SG_Se
- Products: PR_Gr_SG_Se



Standardised Product Data

Product Data Templates

- International Definitions
- Performance Certificates
- International Standards
- Product Information



Standardised Data and Objects

- Project Information Model
- Asset Information Model
- Digital Twin

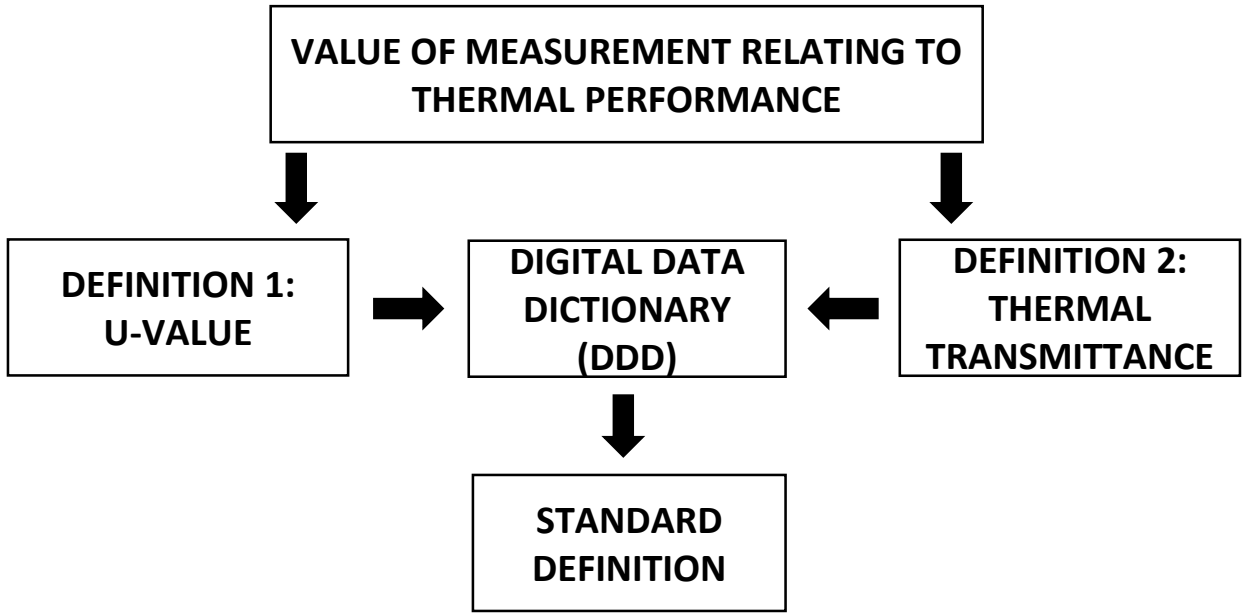
Digital Data Dictionaries

A value is defined

- Example = U-Value

Different definitions

- Ireland = U-Value
- Europe = Thermal Transmittance



Common Language / Standard definition

Requirement 3:
Interconnected Devices

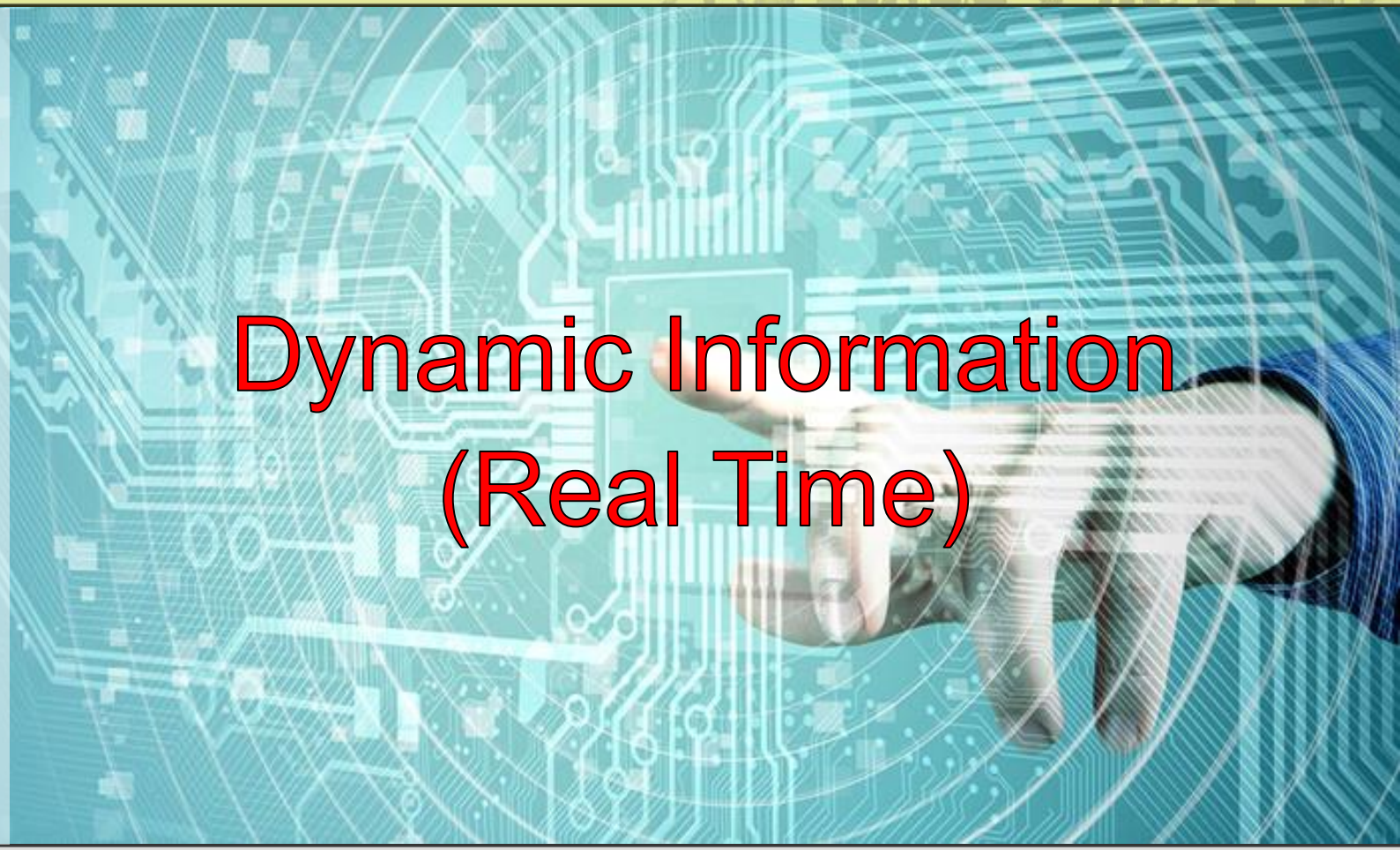
Internet of Things

Industry 4.0

2020: 20 - 50 billion connected devices

April 2019: World Population = 7.7 billion

4 - 7 devices per person



Addressing the Performance Gap

Cognitive Environment

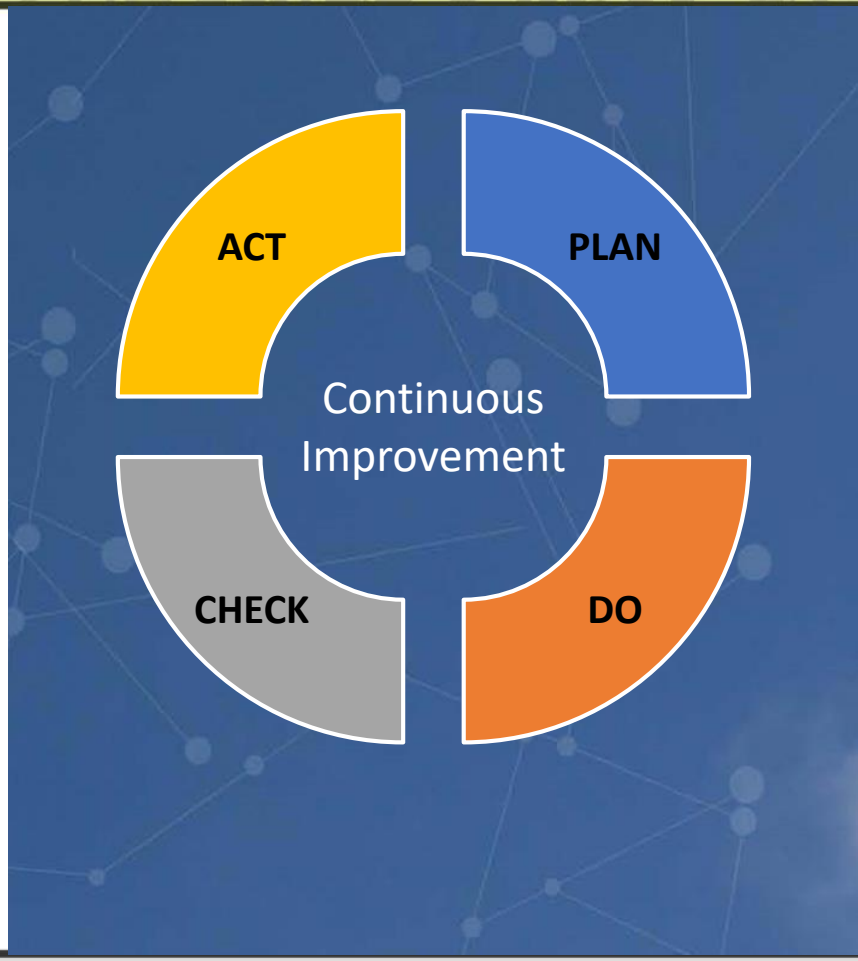
- Static (BIM) + Dynamic (IoT) data

Preventative Maintenance

- Adapting and reacting to surroundings
- Continuous learning from previous tasks
- Predicting when elements require maintenance

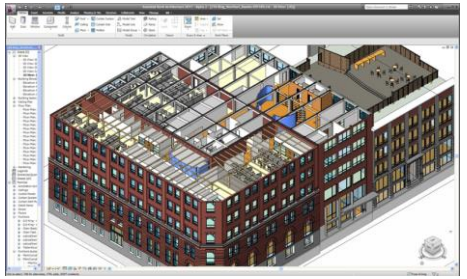
Actual vs Proposed Performance Data

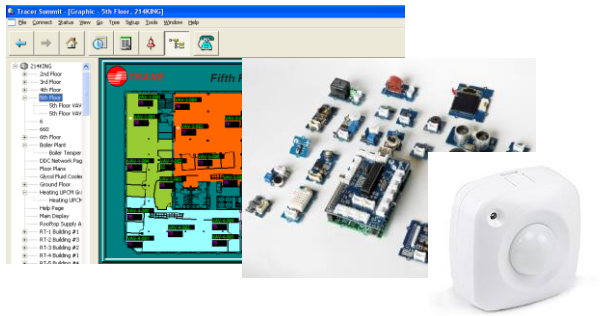
- Real-time environmental conditions.



Autodesk Dasher 360

- Began in 2009 as a Research project by Autodesk
- Visualisation & analytical tools for building and IoT data
- In the context of Building Information Models (BIM)





Project Dasher = As-Built BIM + Building Data

AUTODESK FORGE

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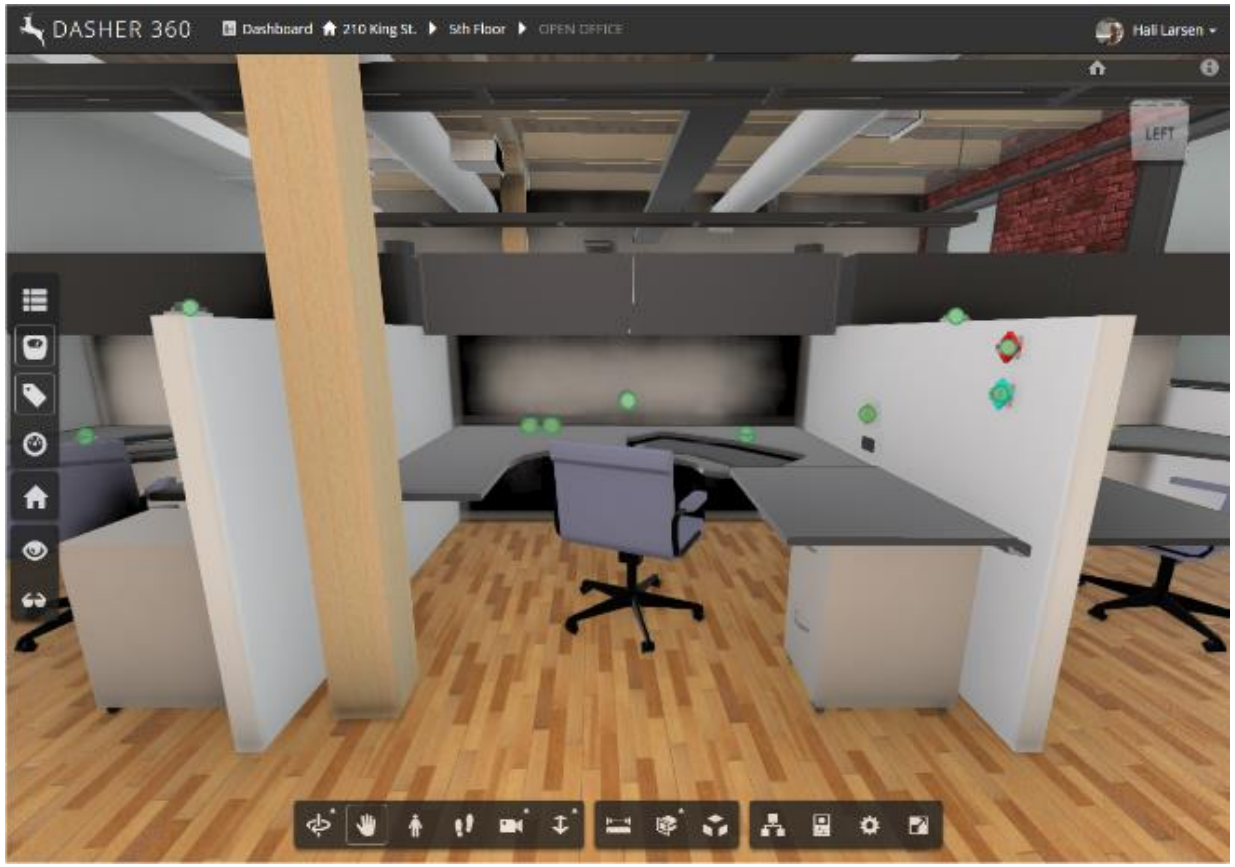
210 King Street, Toronto



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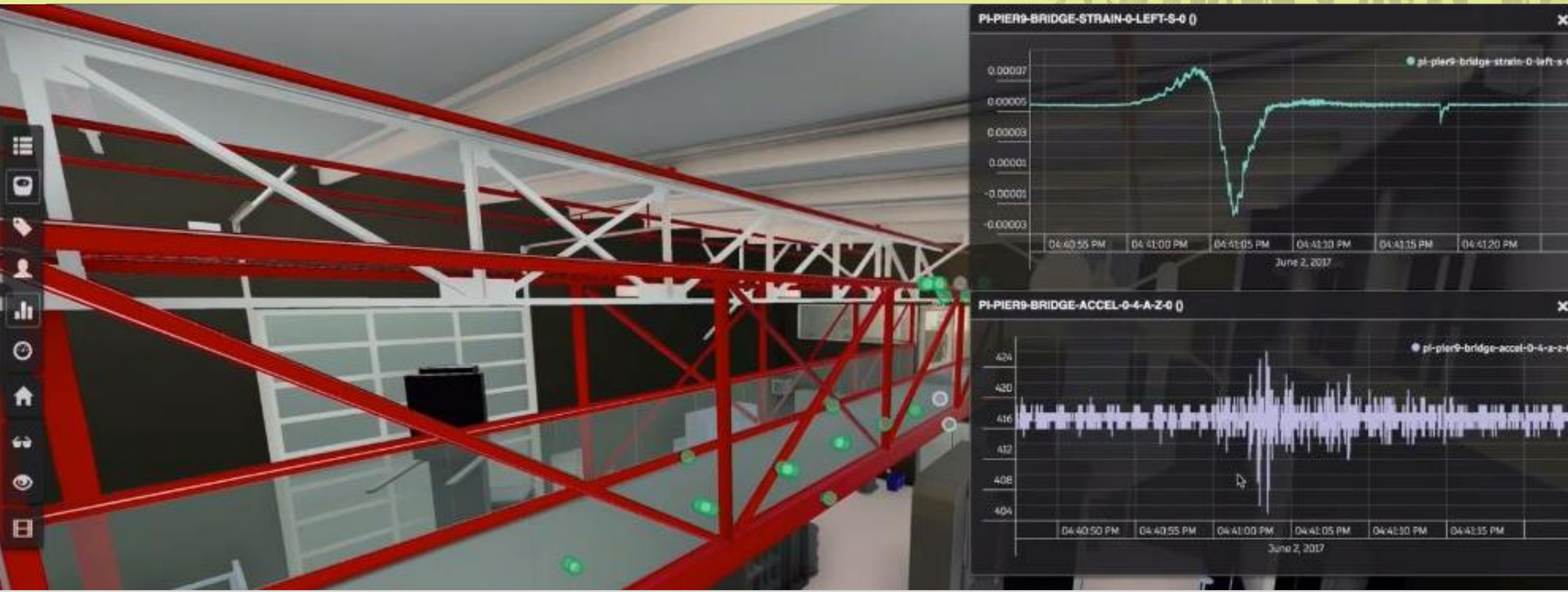
Autodesk Pier 9, San Fransisco



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MX3D Smart Bridge, Holland

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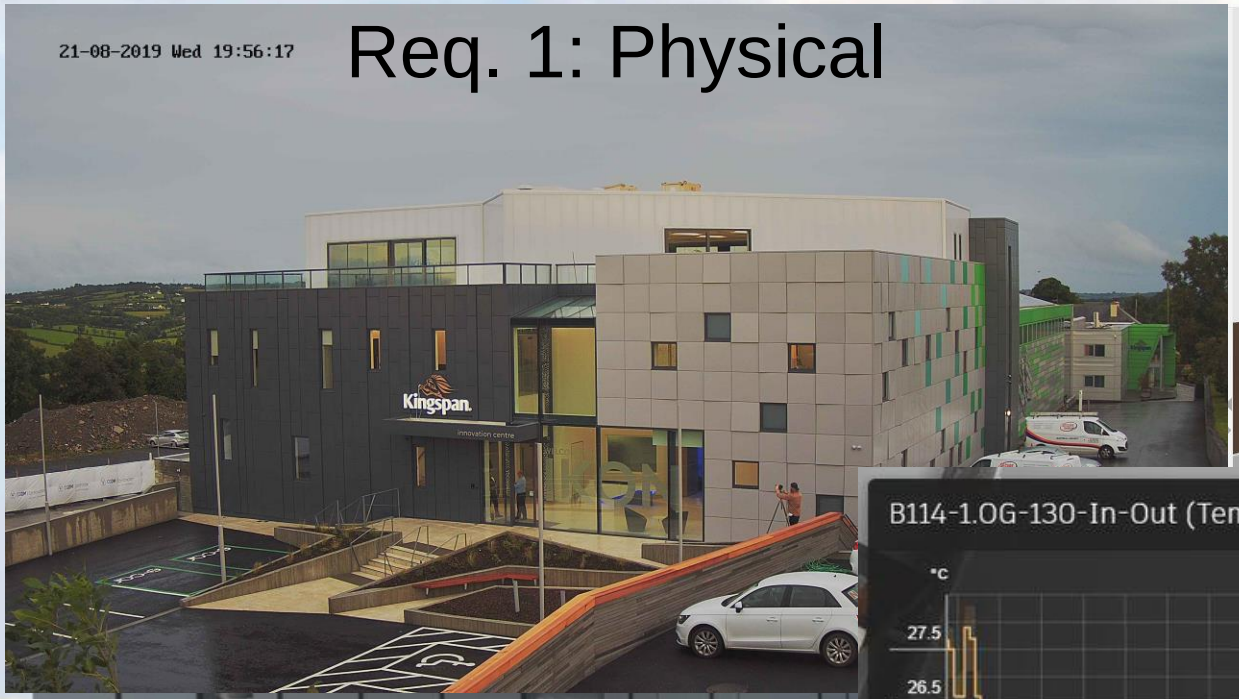
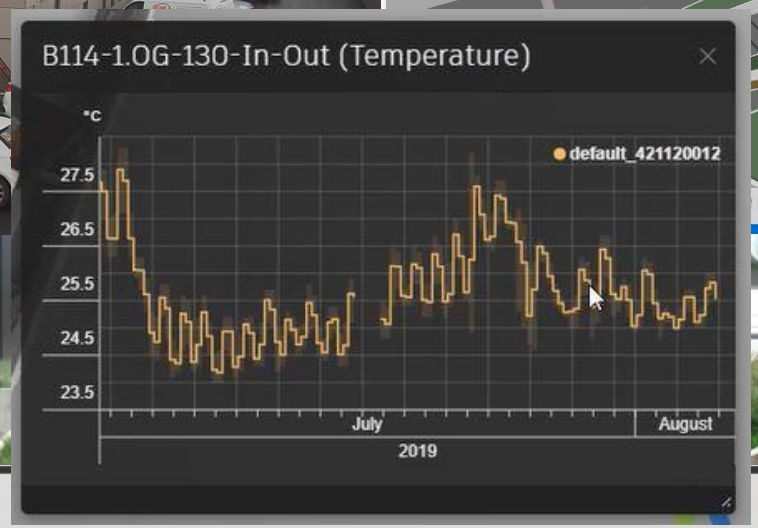
Theory into Practice:
Kingspan Innovation Centre

Req. 1: Physical



Req. 2: Virtual



Req. 3: IoT

Kingspan

invicara

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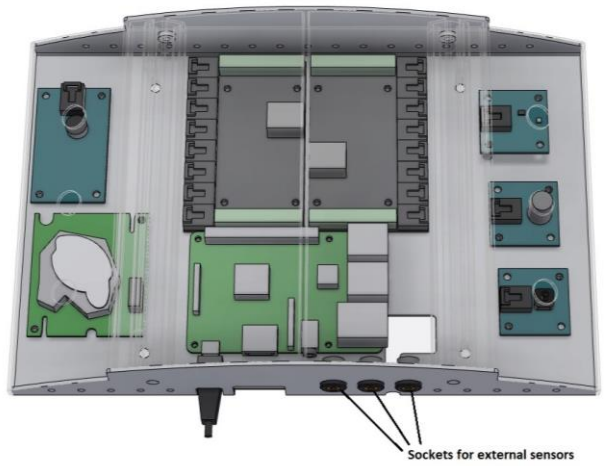
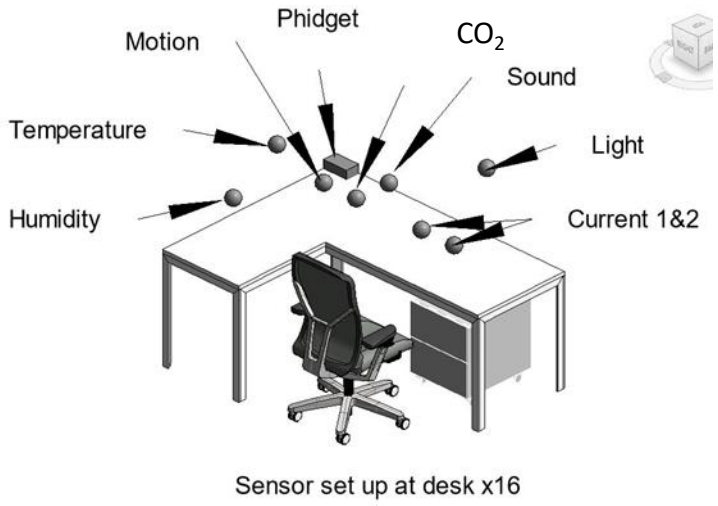
IKON Dasher: Modelled Sensors

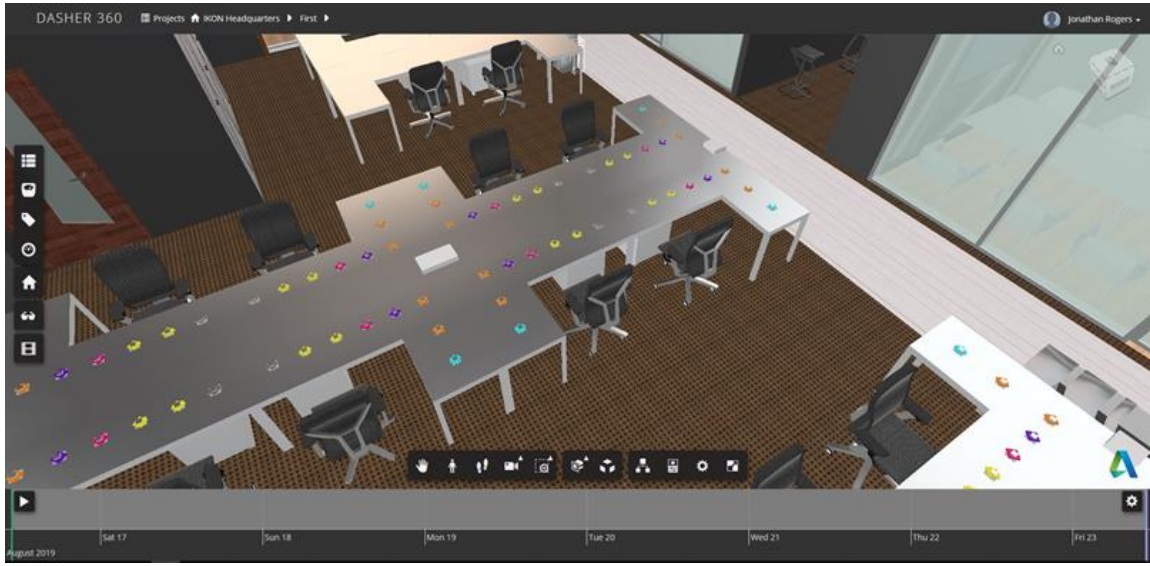


Sensor housing concept



Sensor set up at desk x16

IKON Sensor Arrangement



Sensors displayed in Dasher 360 connect to the database and display in correct location

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IKON Dasher:
Data Display Modes

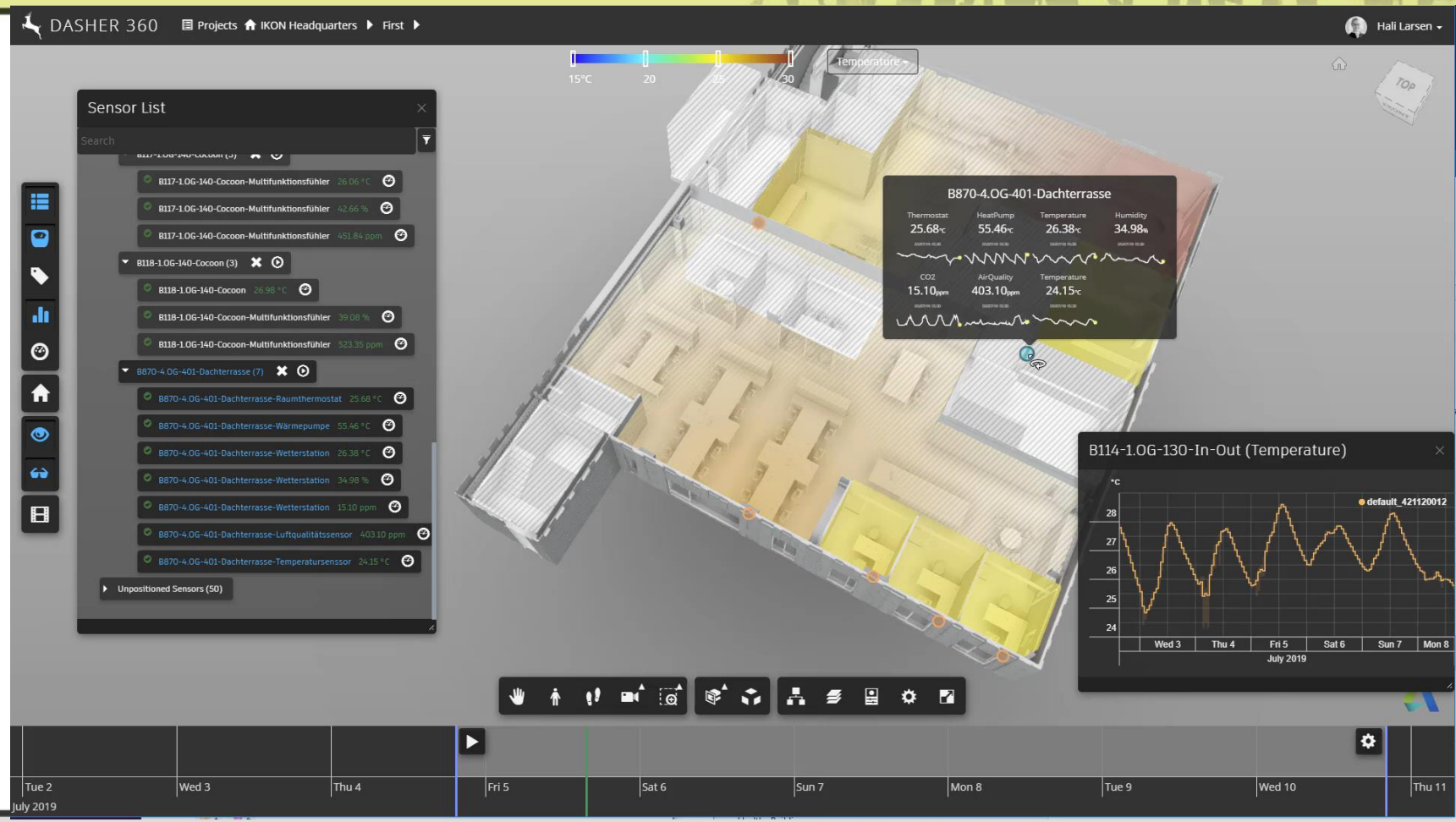
Data Visualization

Sensor Categories:

1. Humidity
2. Temperature
3. Motion
4. CO_2

Visualisations

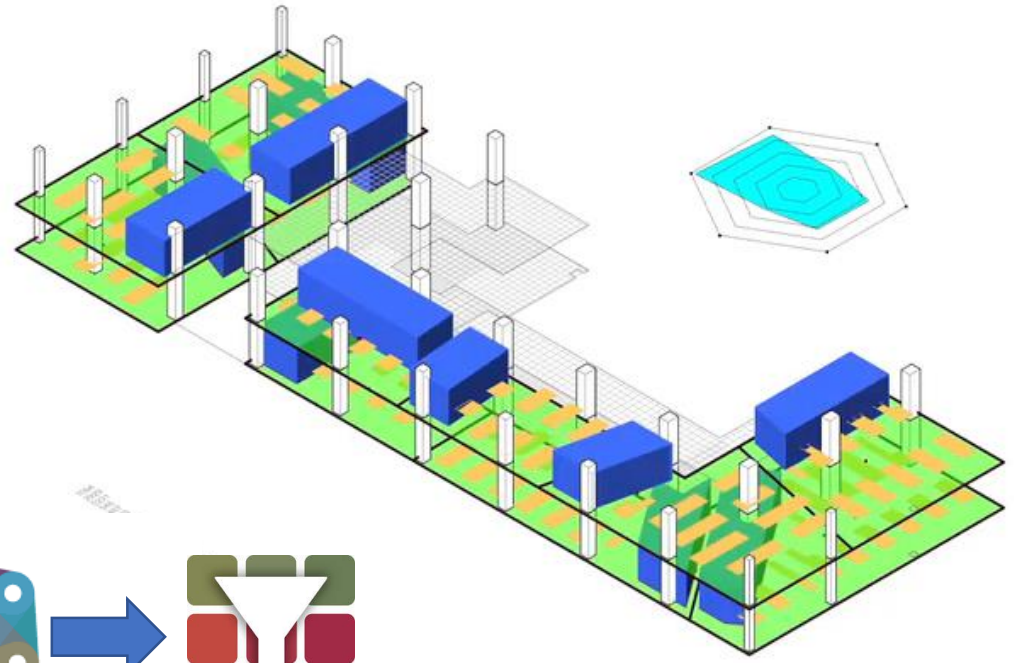
- Day / Hour / Minute
- Surface Shading



Computational Design

"What is Generative Design?"

- Automated workflow
- Mass production
- Alternative options



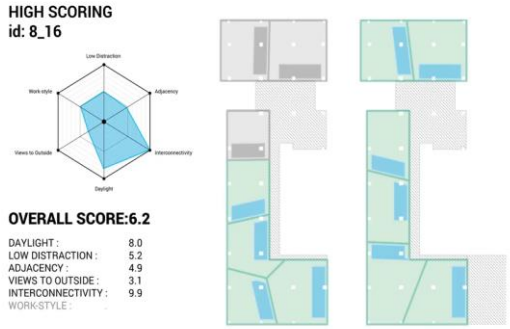
Generative Design Process

- Generate - Revit
- Evaluate - Dynamo
- Evolve - Refinery

Generative Design: Requirements

To create a Generative Design:

- Input
- Output
- Design Goals



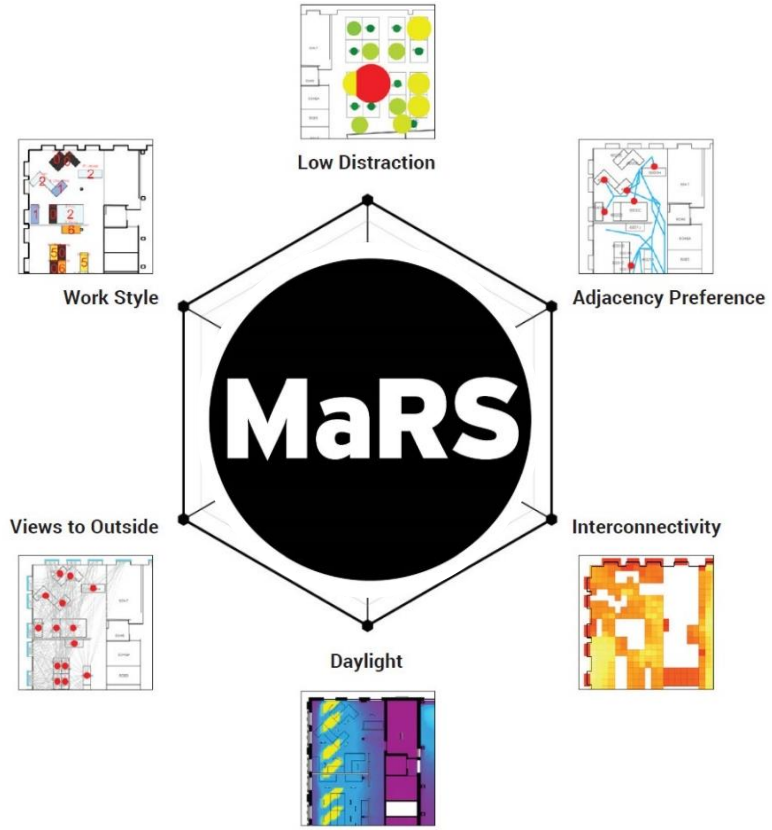
"What are Design Goals?"

- Distraction, Views, Work Style, Adjacency

MaRS Project

- Autodesk Toronto Interior Layout

Design Goals - Examples



Dynamic Building Performance Analysis

Current Building Analysis Methods

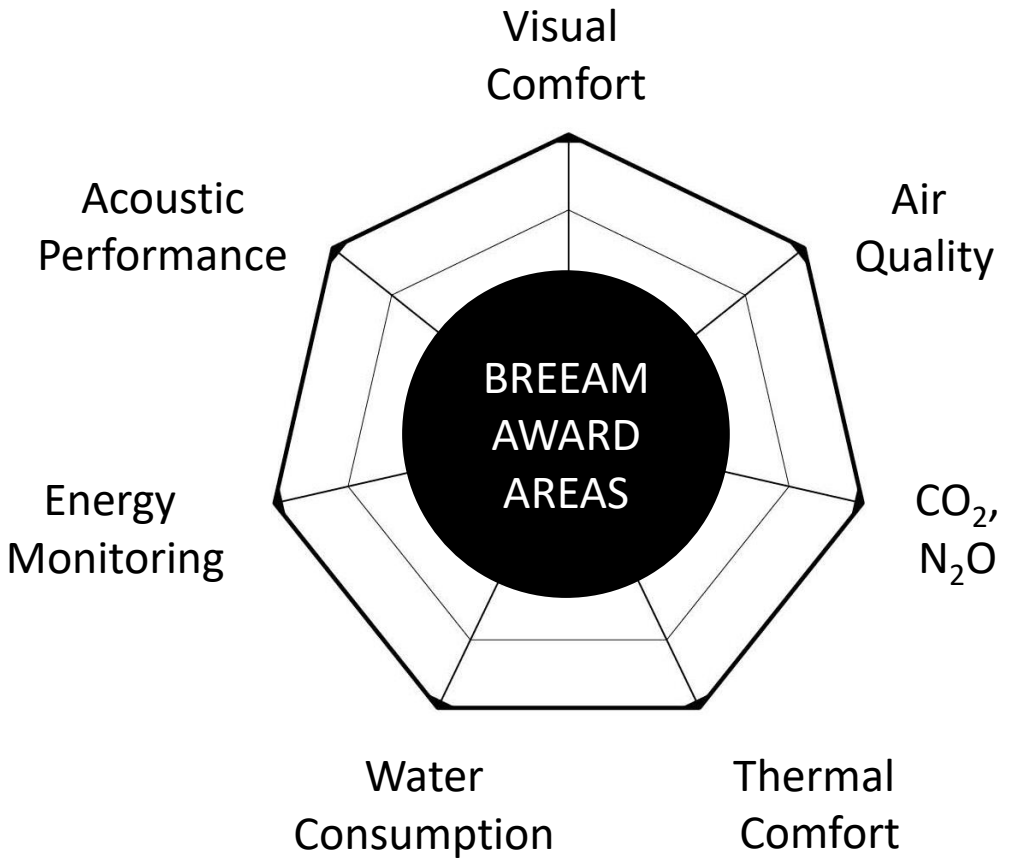
- LEED and BREEAM calculations
- Three-year re-certification period

Pre-Determined Design Goals

- Thermal comfort, Acoustics, CO_2
- Static Data = Design Goals
- Learn from previous projects

Dynamic Building Analysis

- Addressing the Performance Gap



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Structuring and Standardisation of Data

Bi-Directional Updating of Data

Conclusion and Recommendations

Learning and adapting Soft Landing's information for Generative Design Goals

Underperforming Assets – Blockchain / Smart Contracts

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Thank you for your time

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