AU London | The Future of Architecture

BDP | Alistair Kell, Principal, Information, Technology and Process
Autodesk | Jon Van Benthem, Industry Strategy Manager, Architecture

AUTODESK

Jon Van Benthem

Industry Strategy Manager for Architectiure

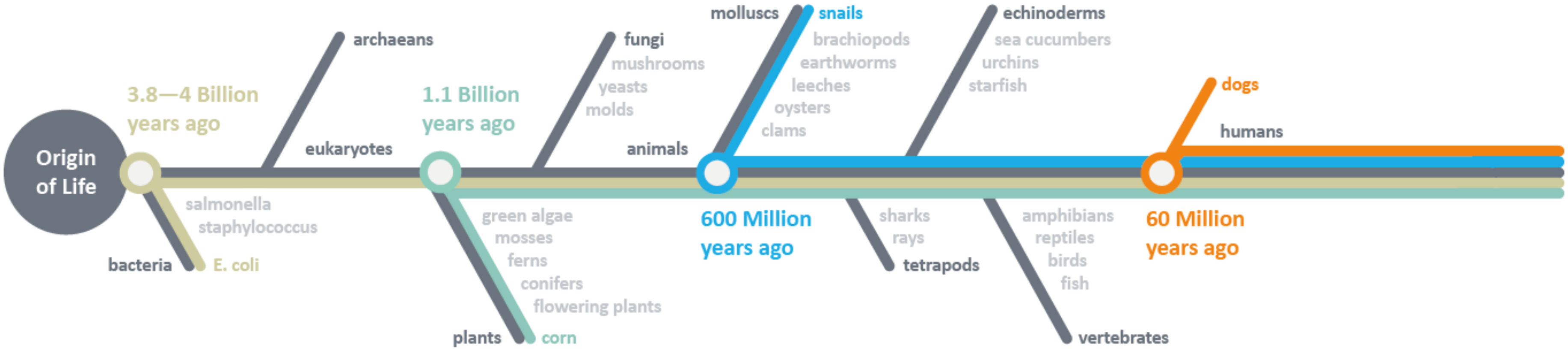
- *Licensed Architect (Colorado, US)*
- *25 years in AEC Industry (20+ years pre-Autodesk)*
- *Former business owner, Entrepreneur*
- *Advocate for the Architectural Profession*
  - *“In the Middle” among Clients, Product, Sales & Consulting*
  - *Building partnerships with 3rd party developers*
  - *Responsible for investment in Architectural solutions*
  - *Manage expanding services globally*

Alistair Kell

Principal: Information, Technology & Process

- *Director of Information & Technology since November 2010*
- *Previously Architect Director in Glasgow Studio*
- *19 Years with BDP*
- *Experience in large scale retail design and delivery*
- *RIBA Plan of Work, BIM Toolkit (Level of Detail), BIM Certification*

How have we gotten here?



Origin of Life
3.8—4 Billion years ago
archaeans
eukaryotes
salmonella
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1.1 Billion years ago
fungi
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600 Million years ago
sharks
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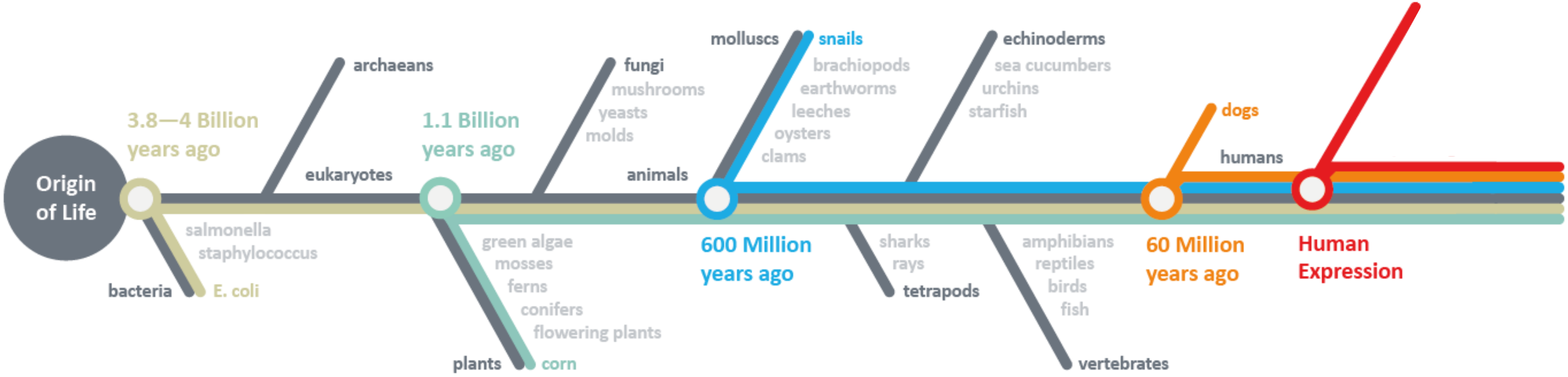
60 Million years ago



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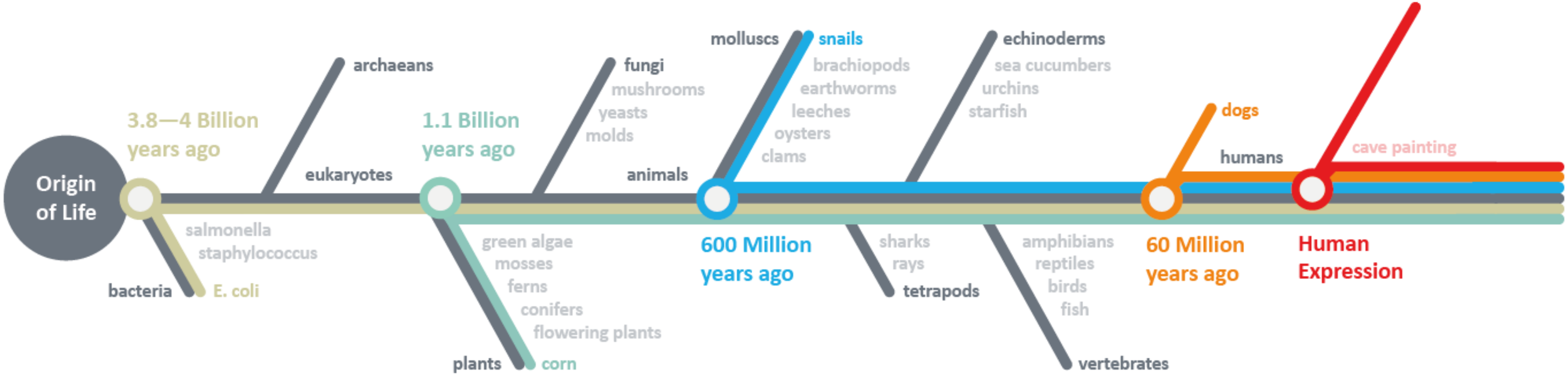
Human Expression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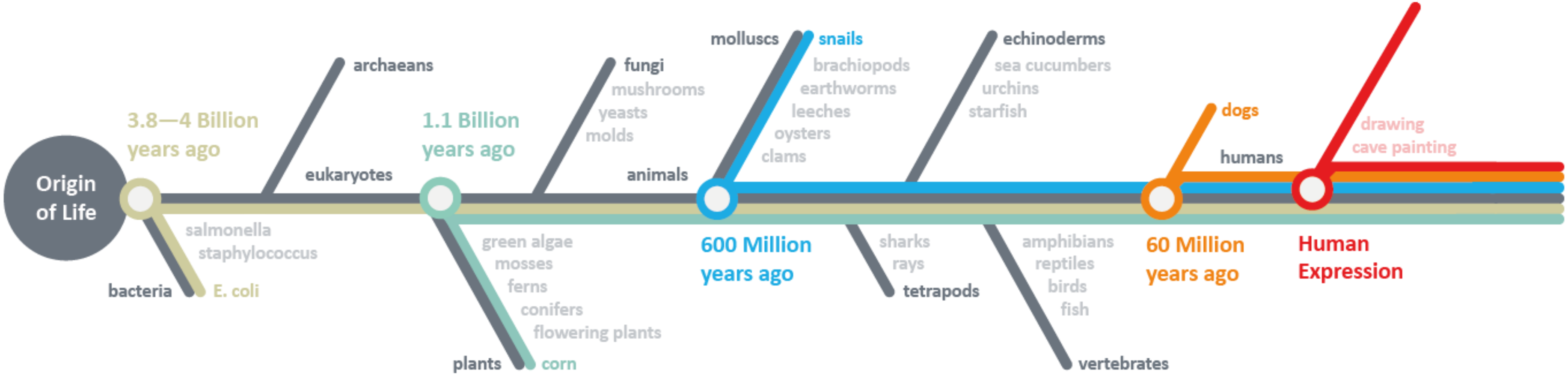
Human Expression


the beginnings of human expression



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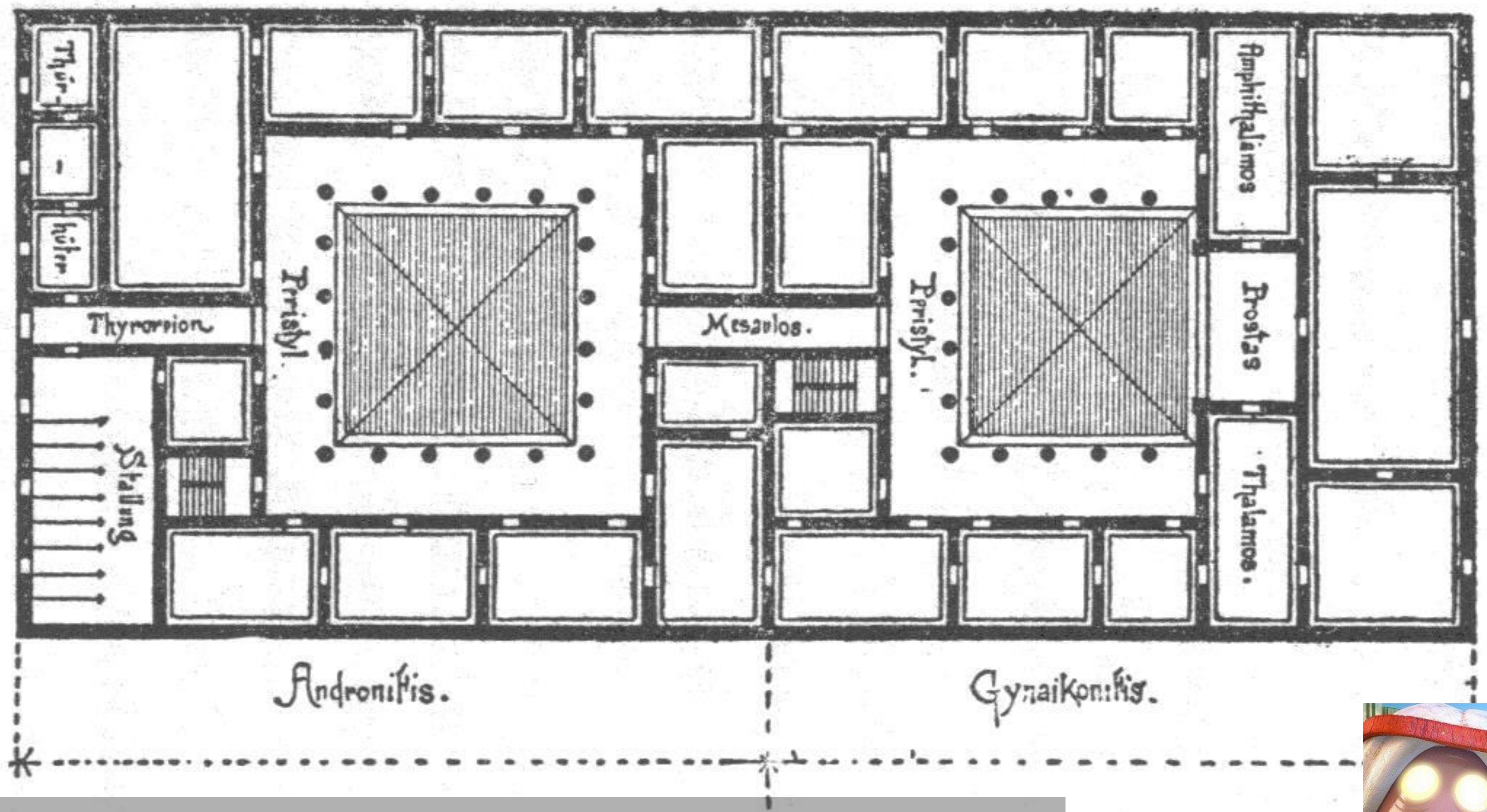
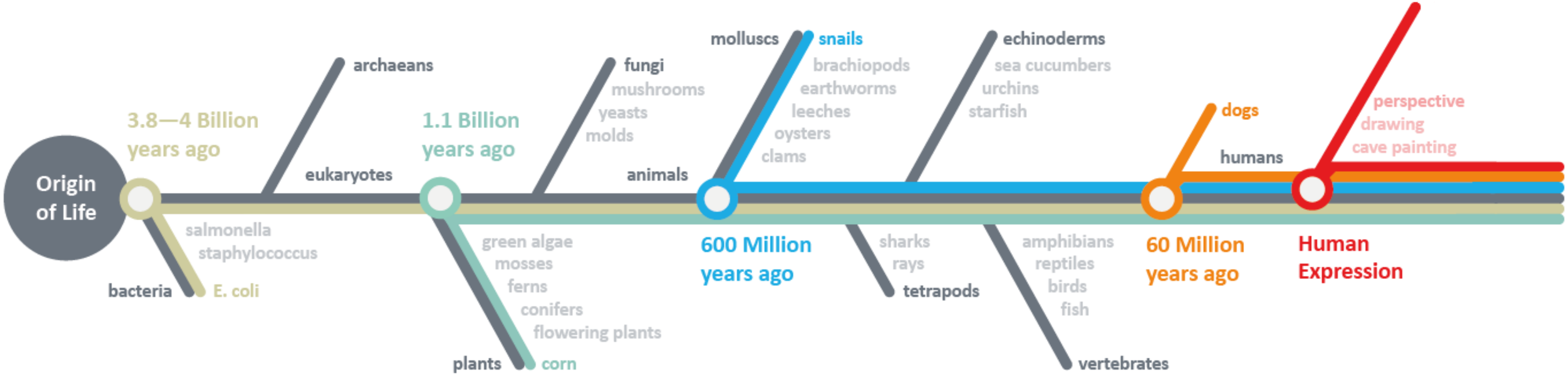


Vitruvius and Architectural Principles



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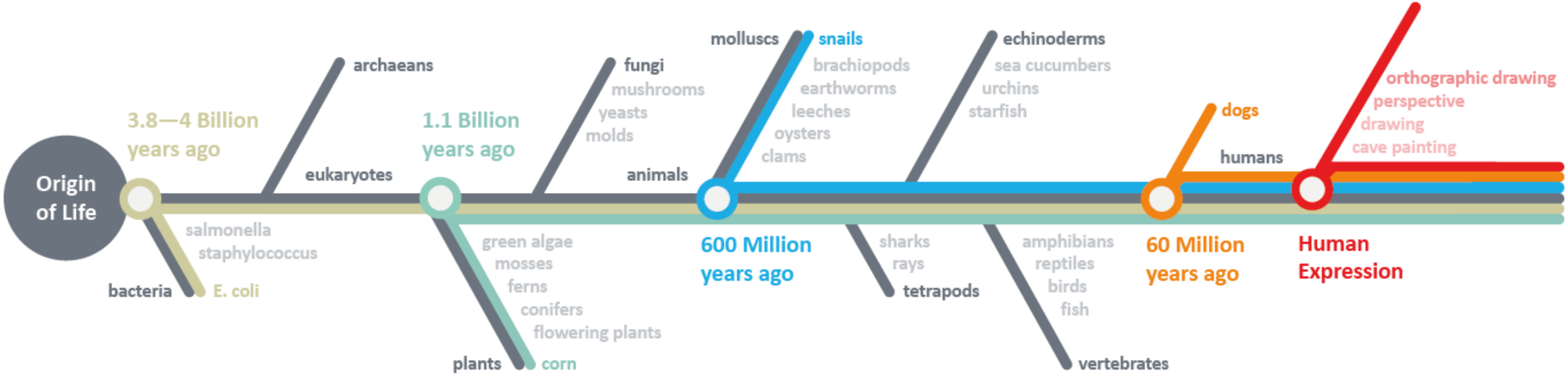
The enlightenment and perspective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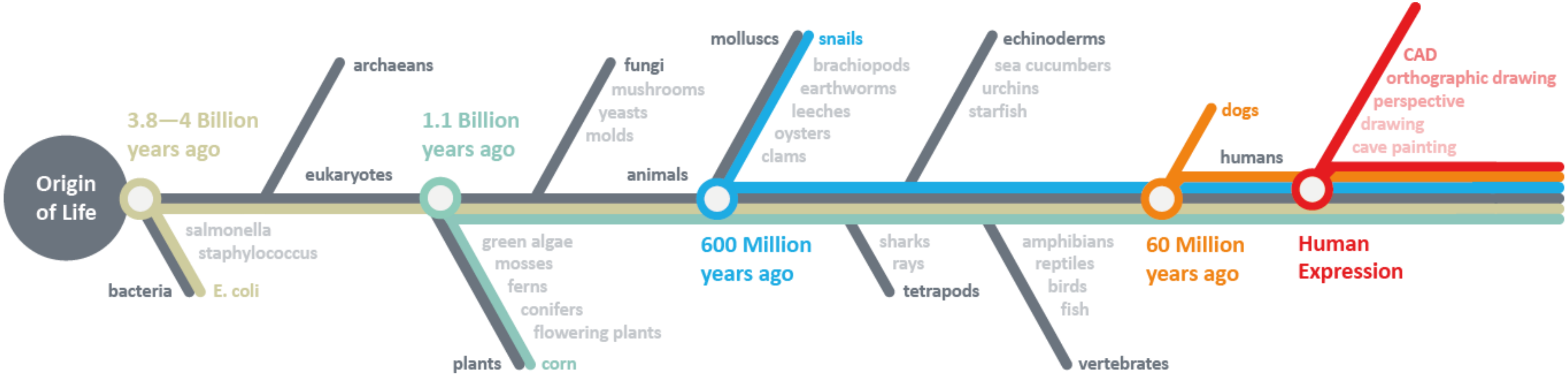
Human Expression

Orthographic Drawing



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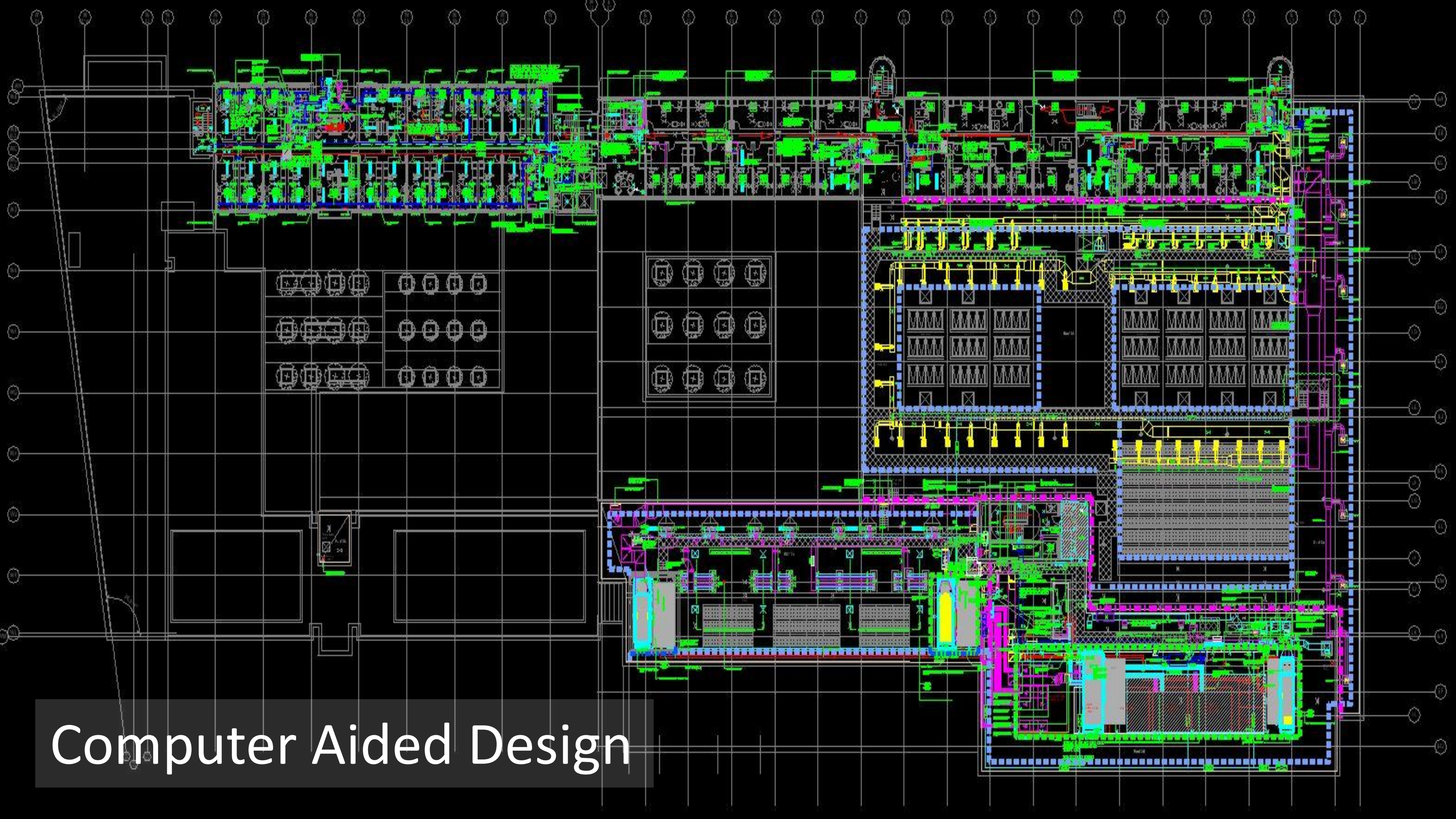
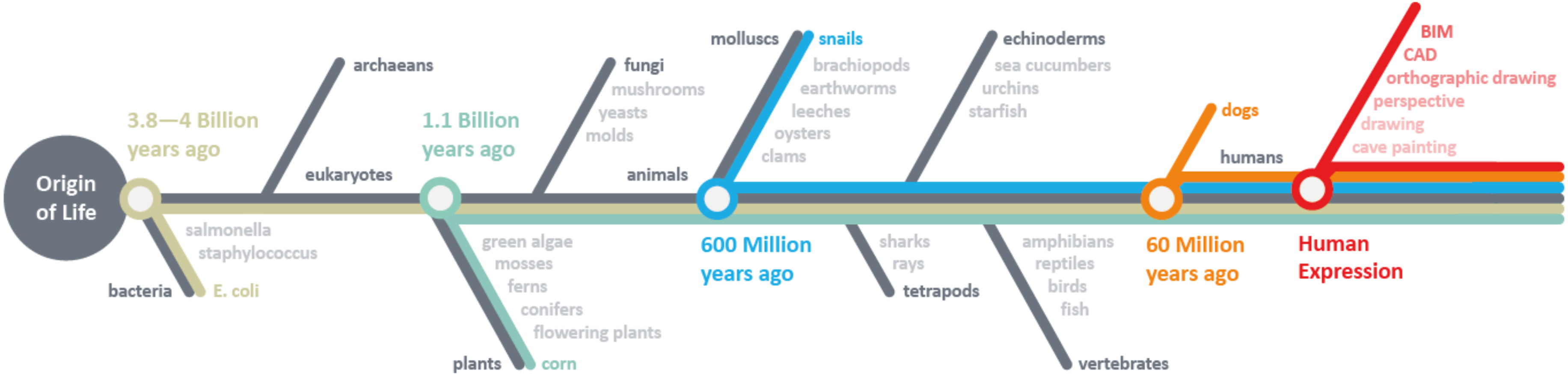


Computer Aided Design



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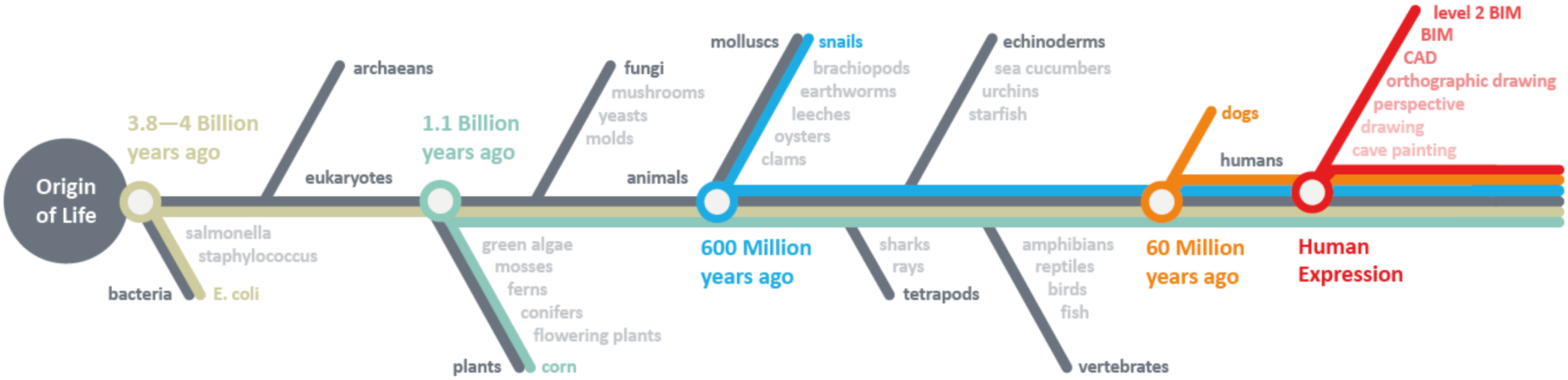

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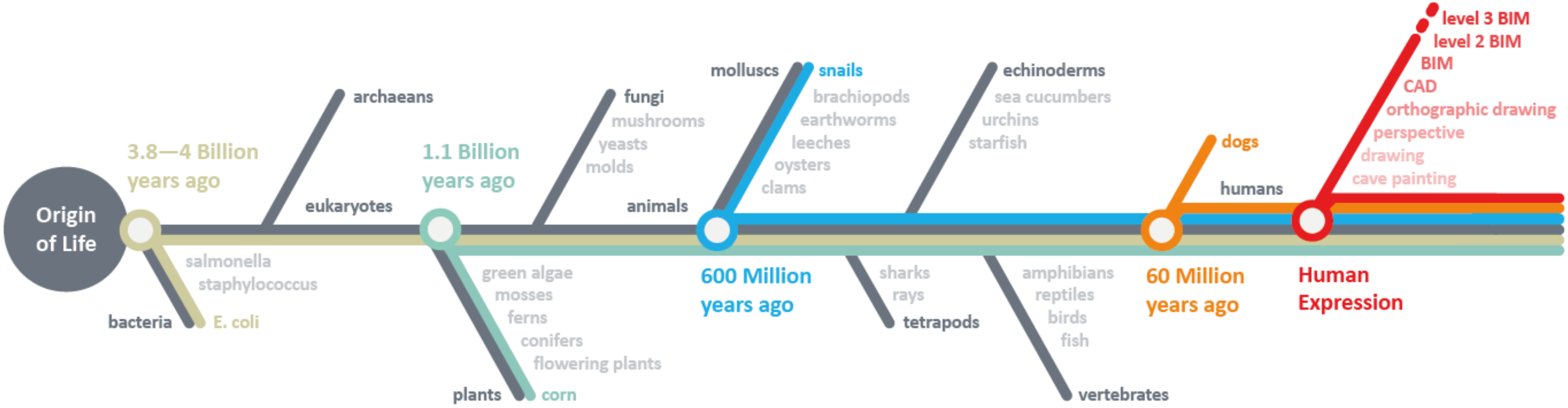
Human Expression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level 2 BIM
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Human Expression

LOWER COSTS

33%

reduction in the initial cost of construction and the whole life cost of build assets

FASTER DELIVERY

50%

reduction in overall time, from inception to overall completion of new build and refurbished assets

LOWER EMISSIONS

50%

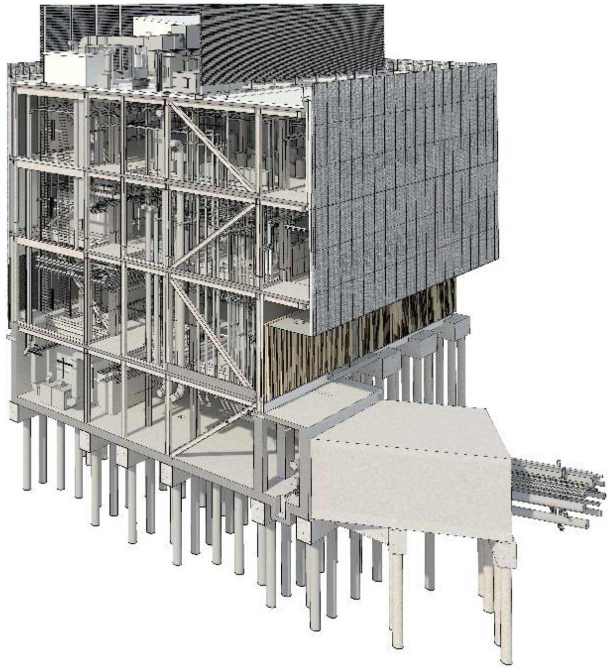
reduction in greenhouse gas emissions in the build environment

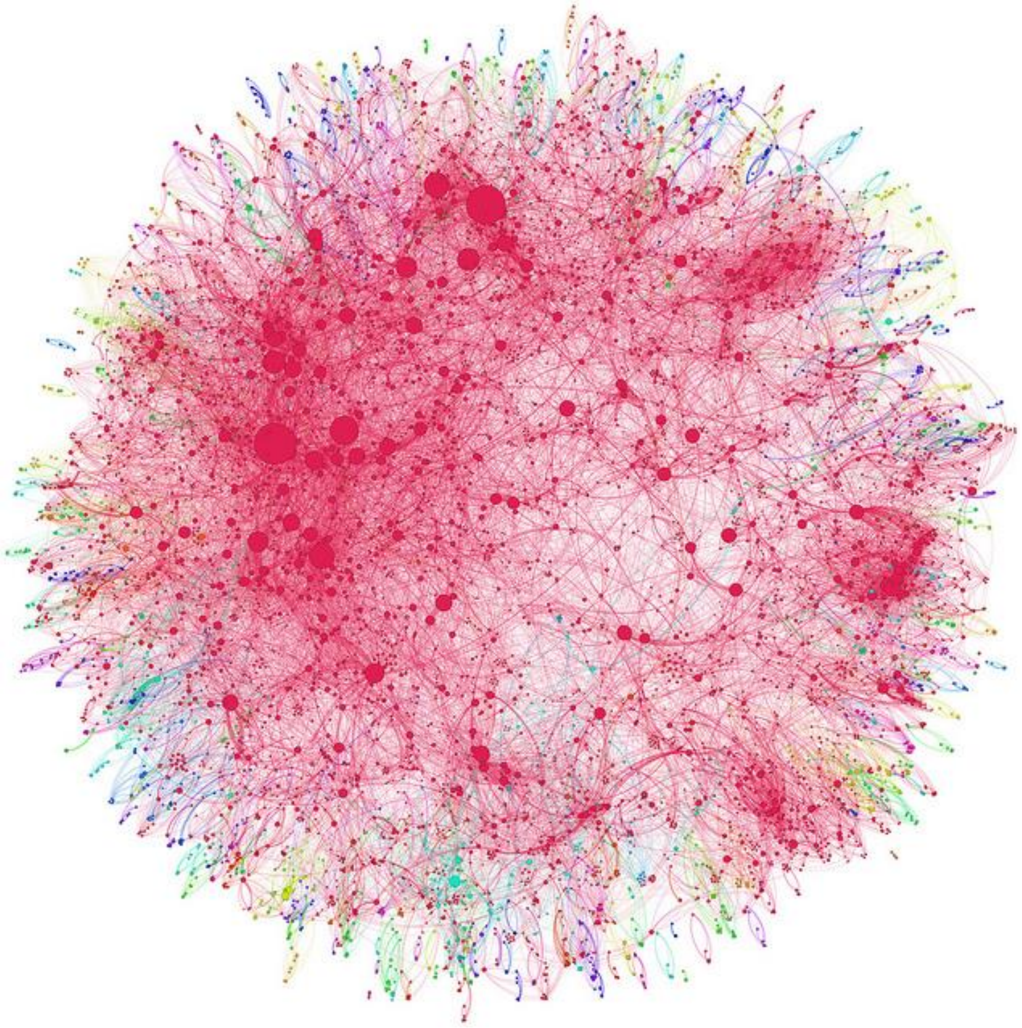
IMPROVED EXPORTS

50%

reduction in the trade gap between total exports and total imports for construction products and materials

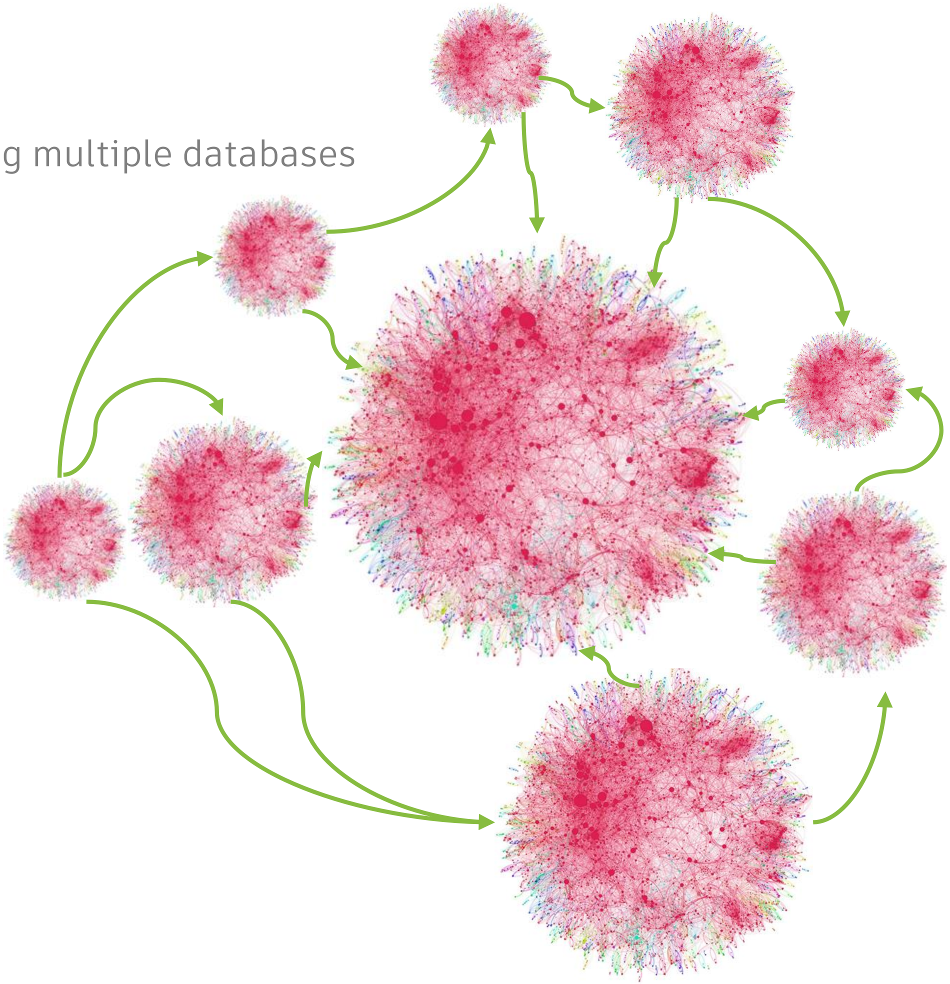
CONSTRUCTION STRATEGY 2025





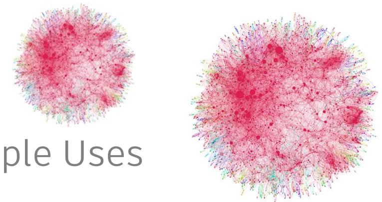
BIM

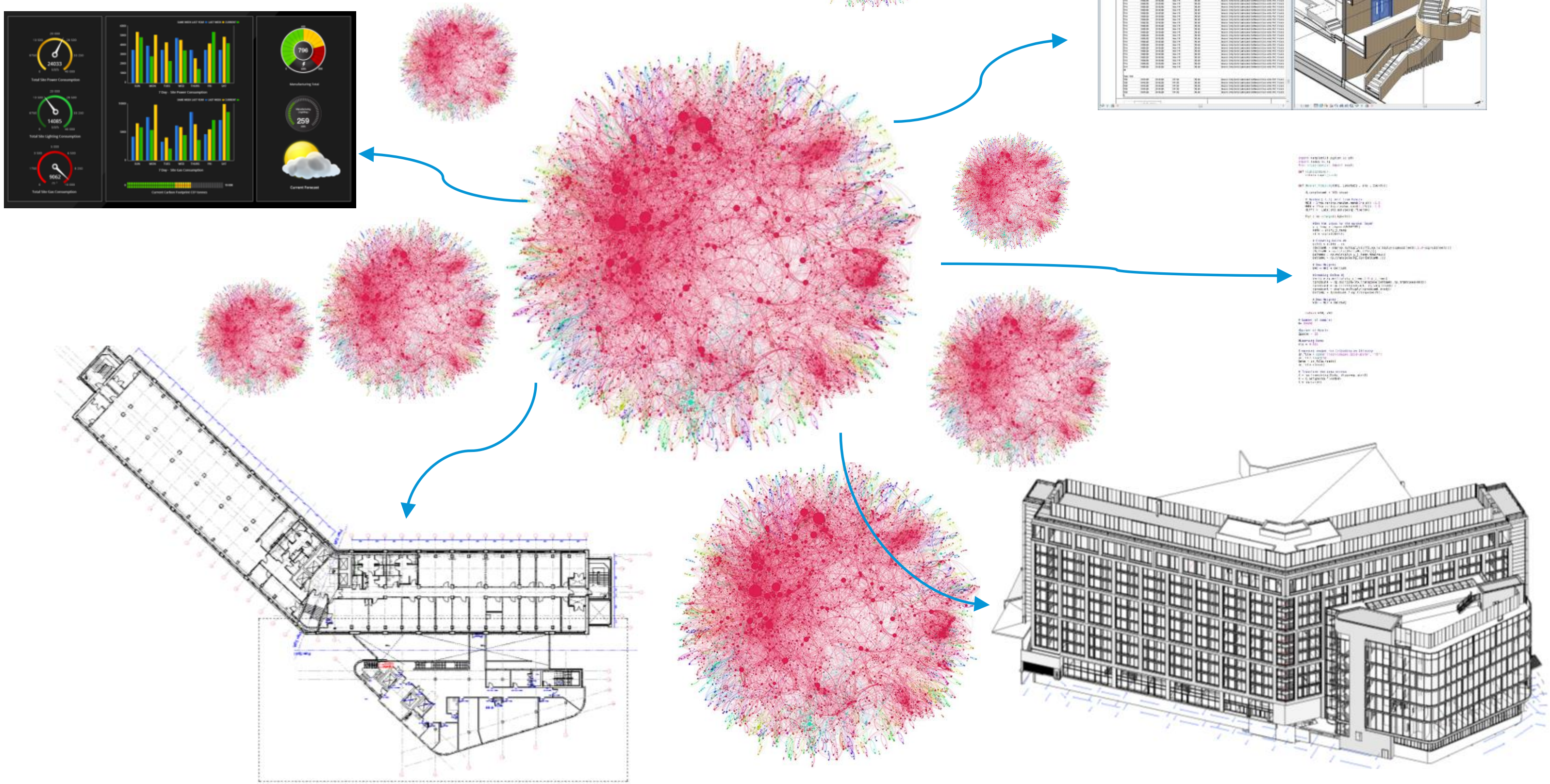
Referencing multiple databases



BIM

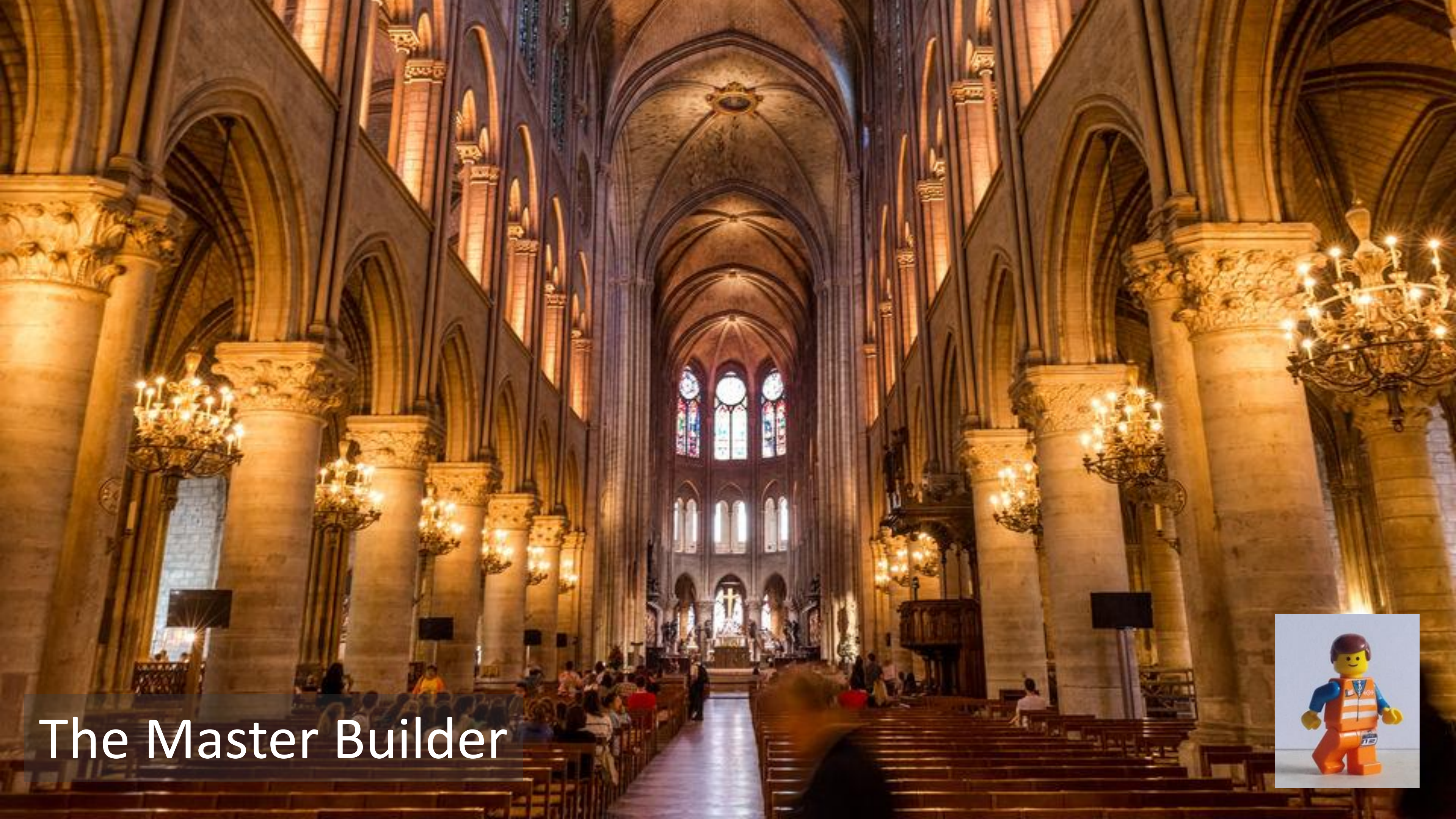
Single Source of Information, Multiple Uses



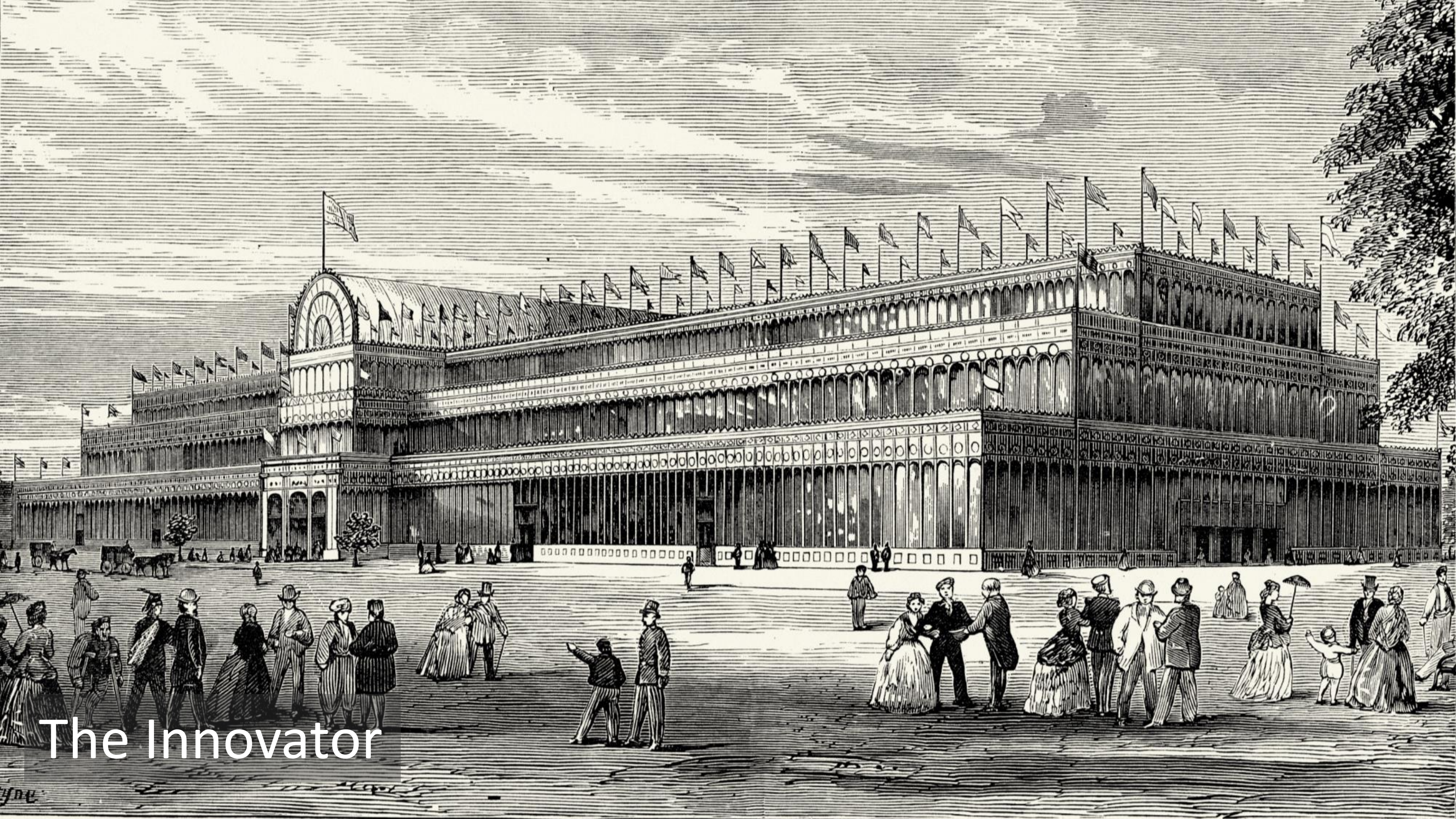


Technology ***drives change*** at an ***ever increasing*** pace

What's here,
what's *near*,
and ***what's next*** ?



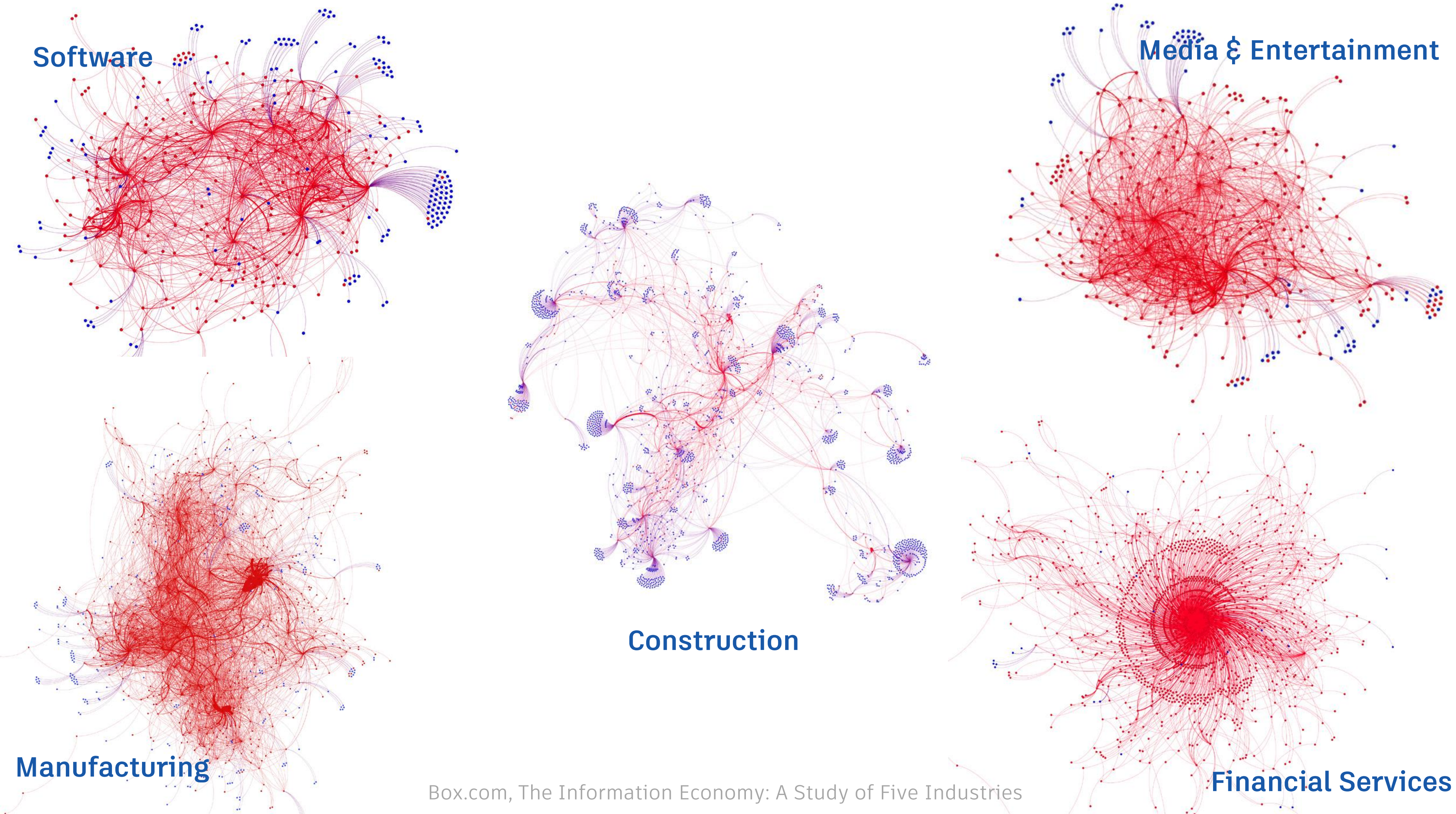
The Master Builder


The Innovator

The Modern Master Builder

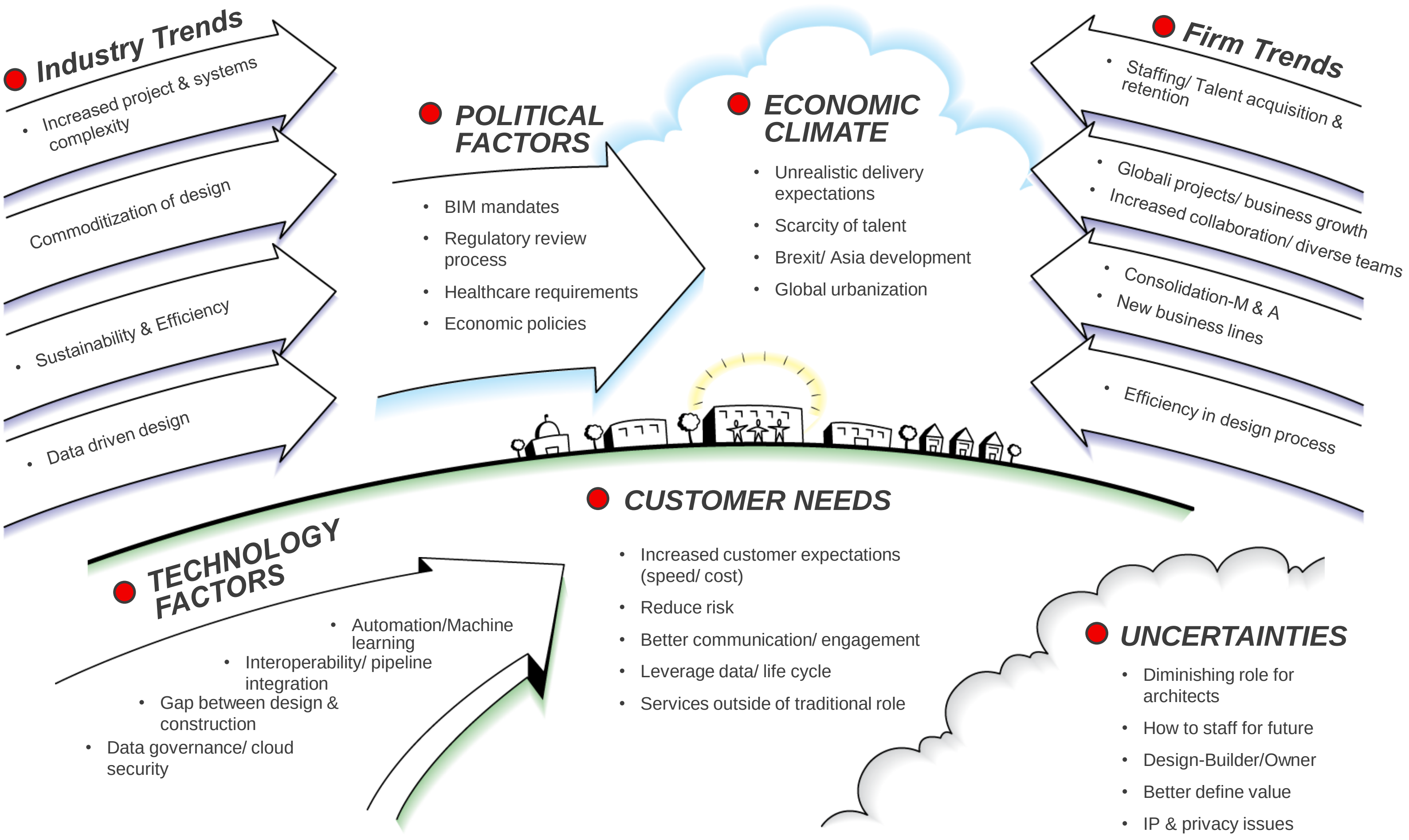
OK…so how did we get ***here…***?

“Necessary Evil”

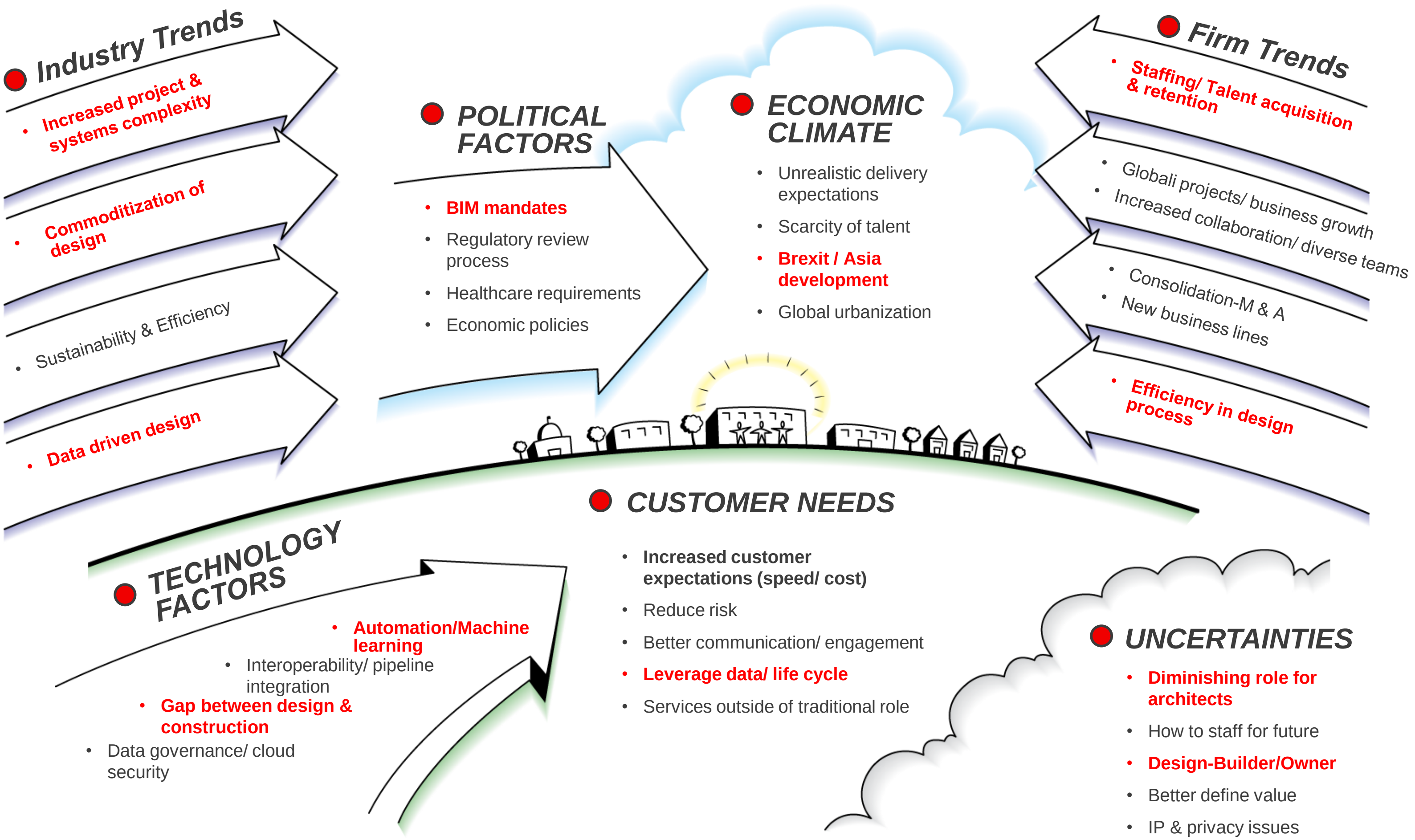


Box.com, The Information Economy: A Study of Five Industries

Architecture Business Context Map



Architecture Business Context Map



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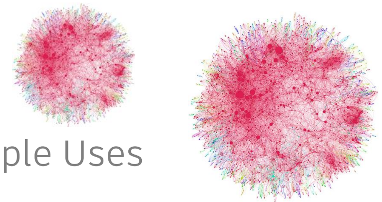
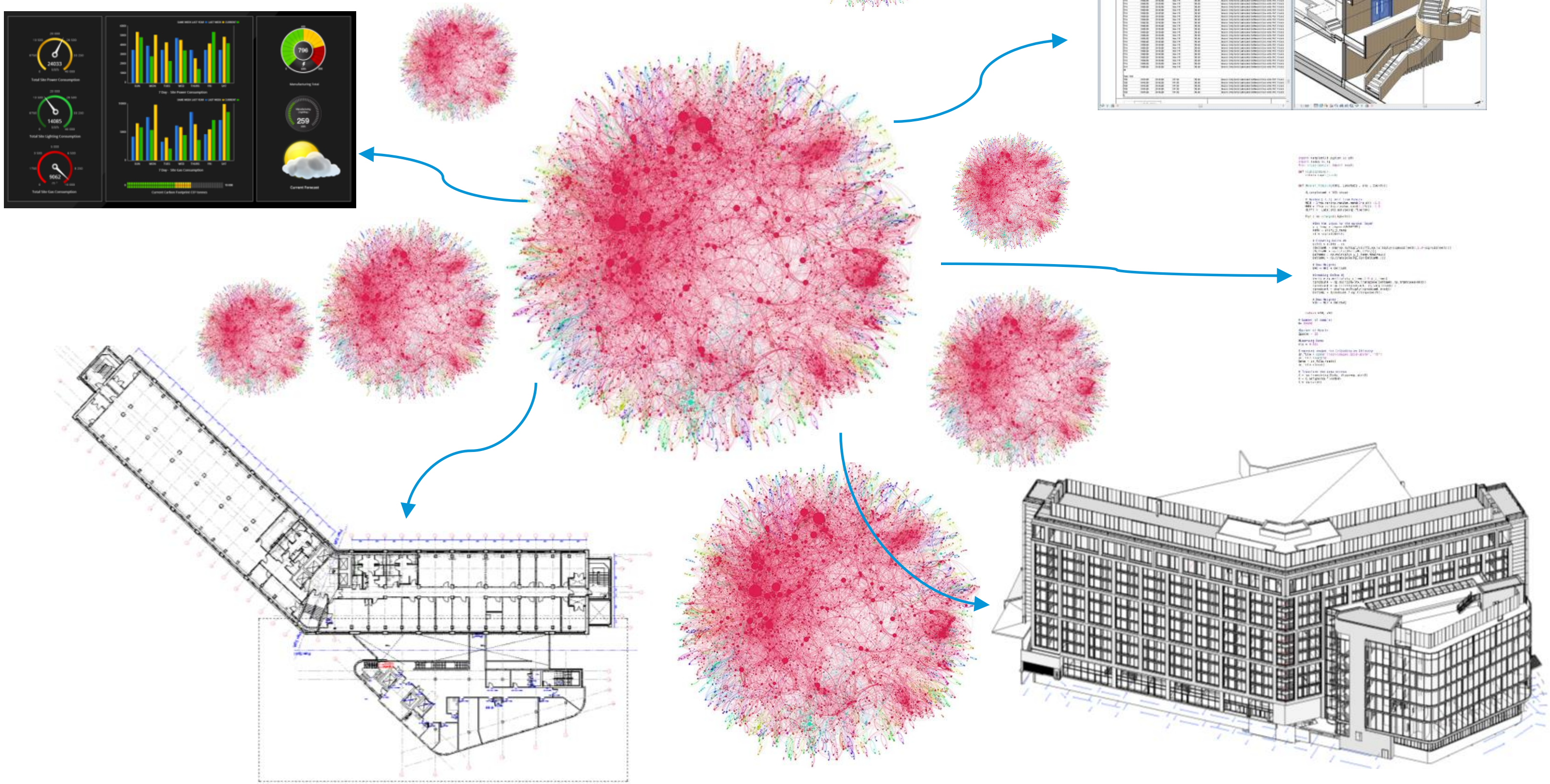
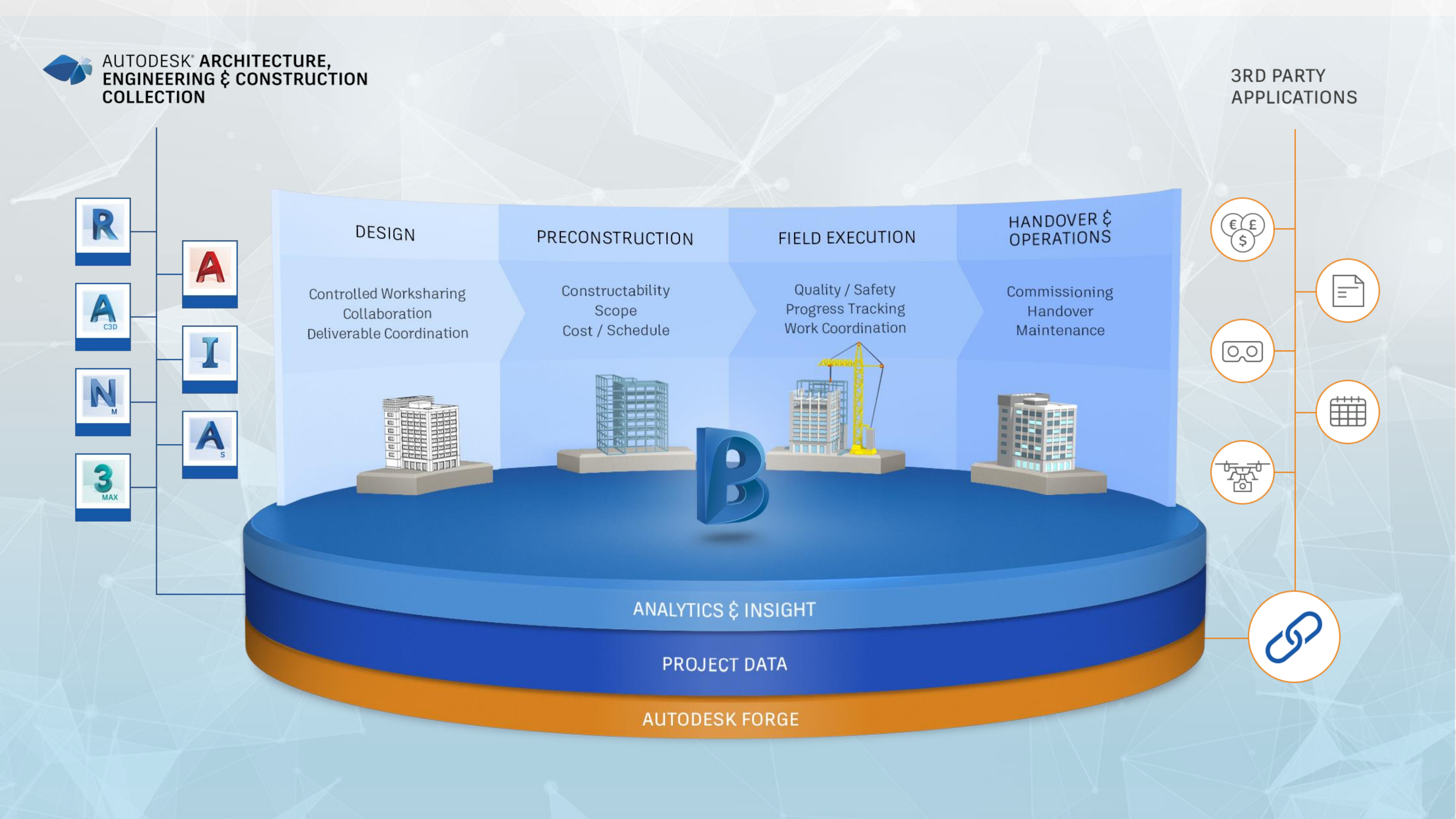




The Modern Master Builder

Architect as Conductor


AUTODESK® ARCHITECTURE, ENGINEERING & CONSTRUCTION COLLECTION
3RD PARTY APPLICATIONS
DESIGN
Controlled Worksharing
Collaboration
Deliverable Coordination
PRECONSTRUCTION
Constructability
Scope
Cost / Schedule
FIELD EXECUTION
Quality / Safety
Progress Tracking
Work Coordination
HANDOVER & OPERATIONS
Commissioning
Handover
Maintenance
ANALYTICS & INSIGHT
PROJECT DATA
AUTODESK FORGE

Architect as Curator

Design Collaboration

Architect as Programmer

Autodesk has invested in building the platform that powers the future of making things.

01 Connection

Forge streamlines the complexities of business workflows by connecting people and data.

02 Technology

With Forge, Autodesk provides companies with the technology and expertise that Autodesk uses to build their cloud solutions.

03 Integration

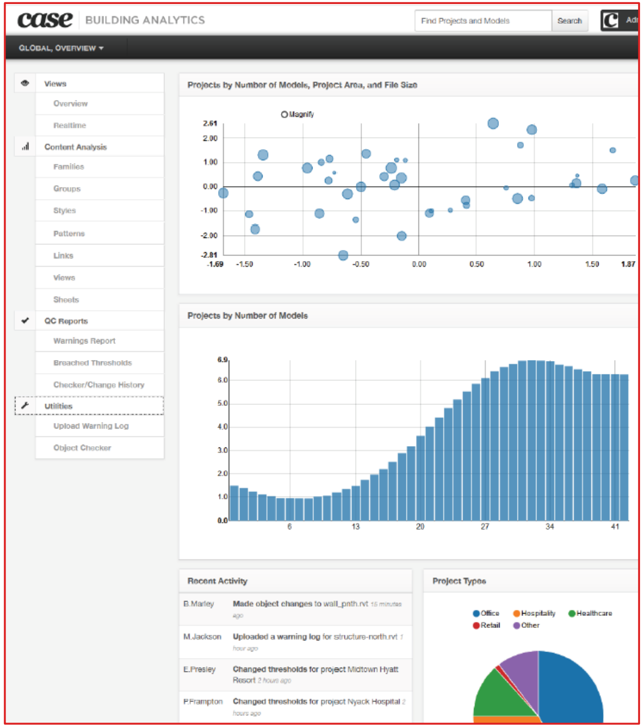
Easily integrated Forge services with your existing applications, systems and enterprise processes.

04 Infrastructure

Companies can get started quickly and use what they need precisely when they need it, all without having to maintain the underlying technology.

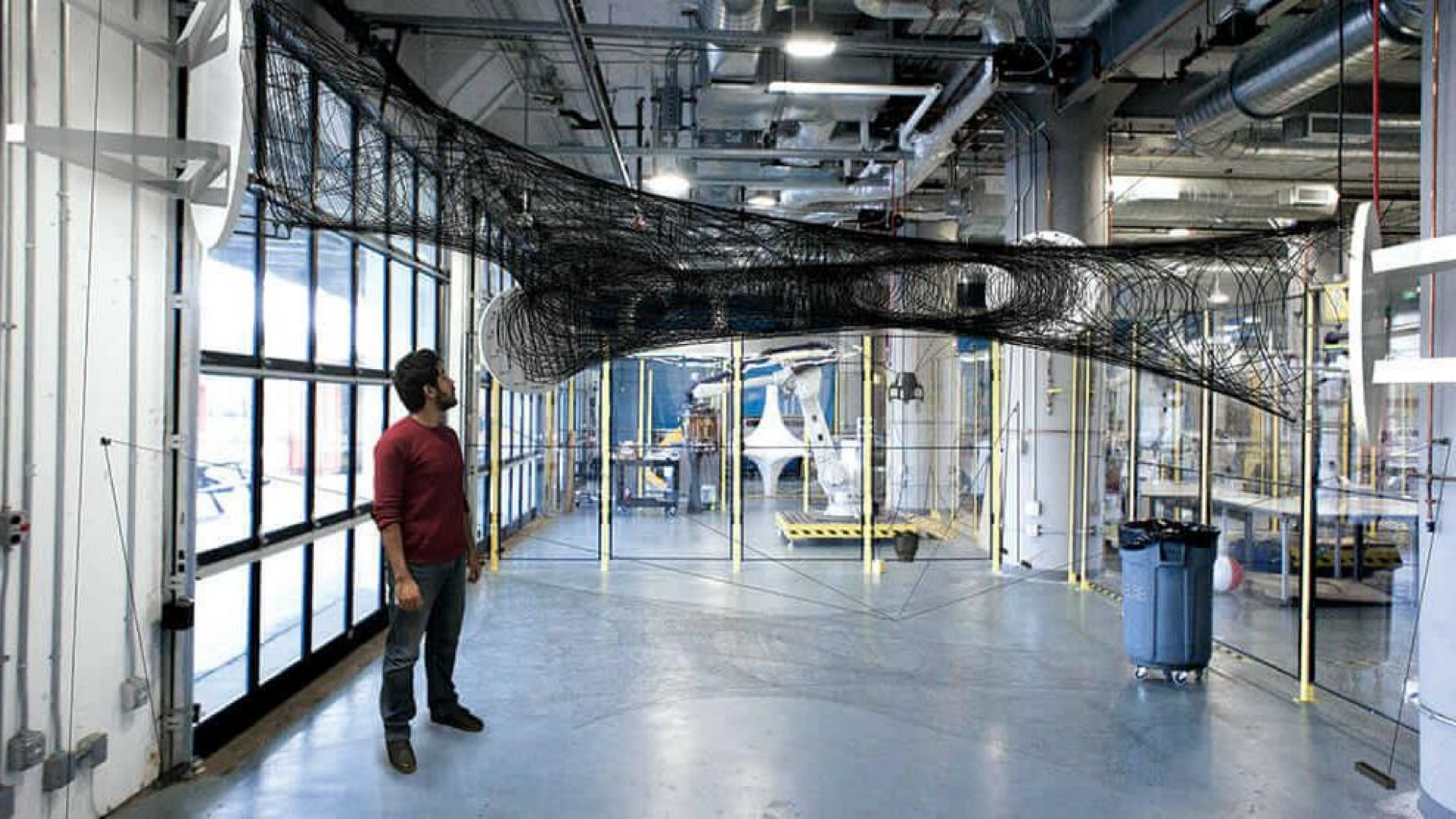
Architect as Analyst

Data Analytics



CASE INC.

Architect as **Maker**

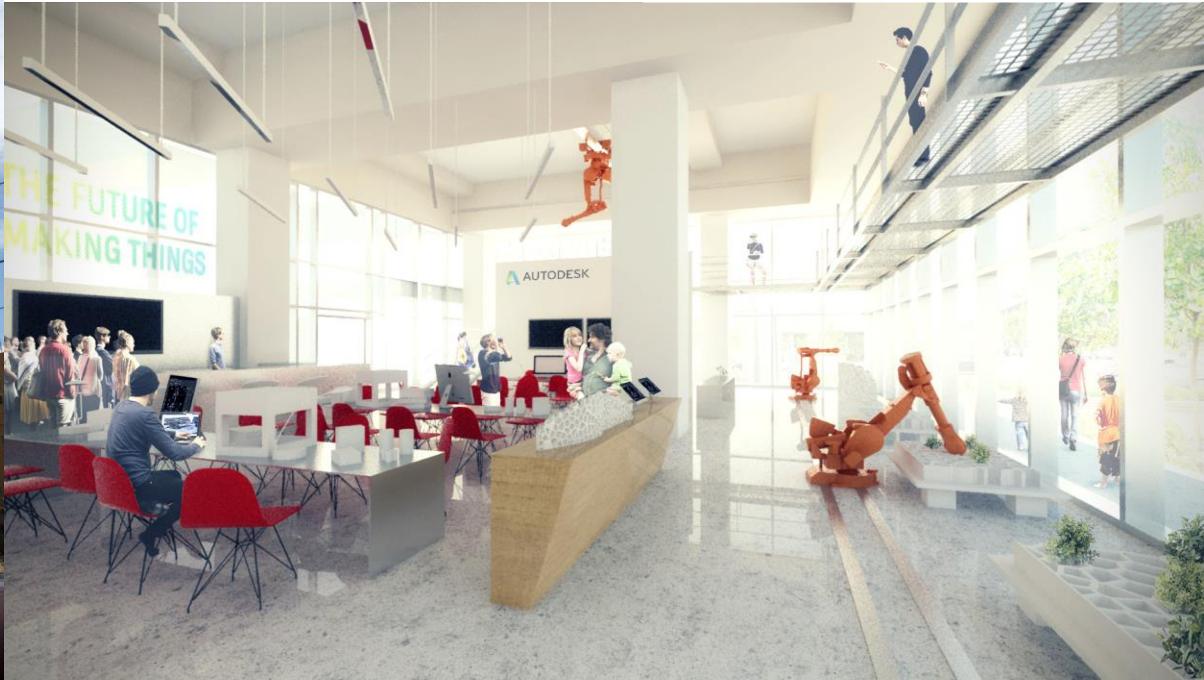


Architect as Mathematician

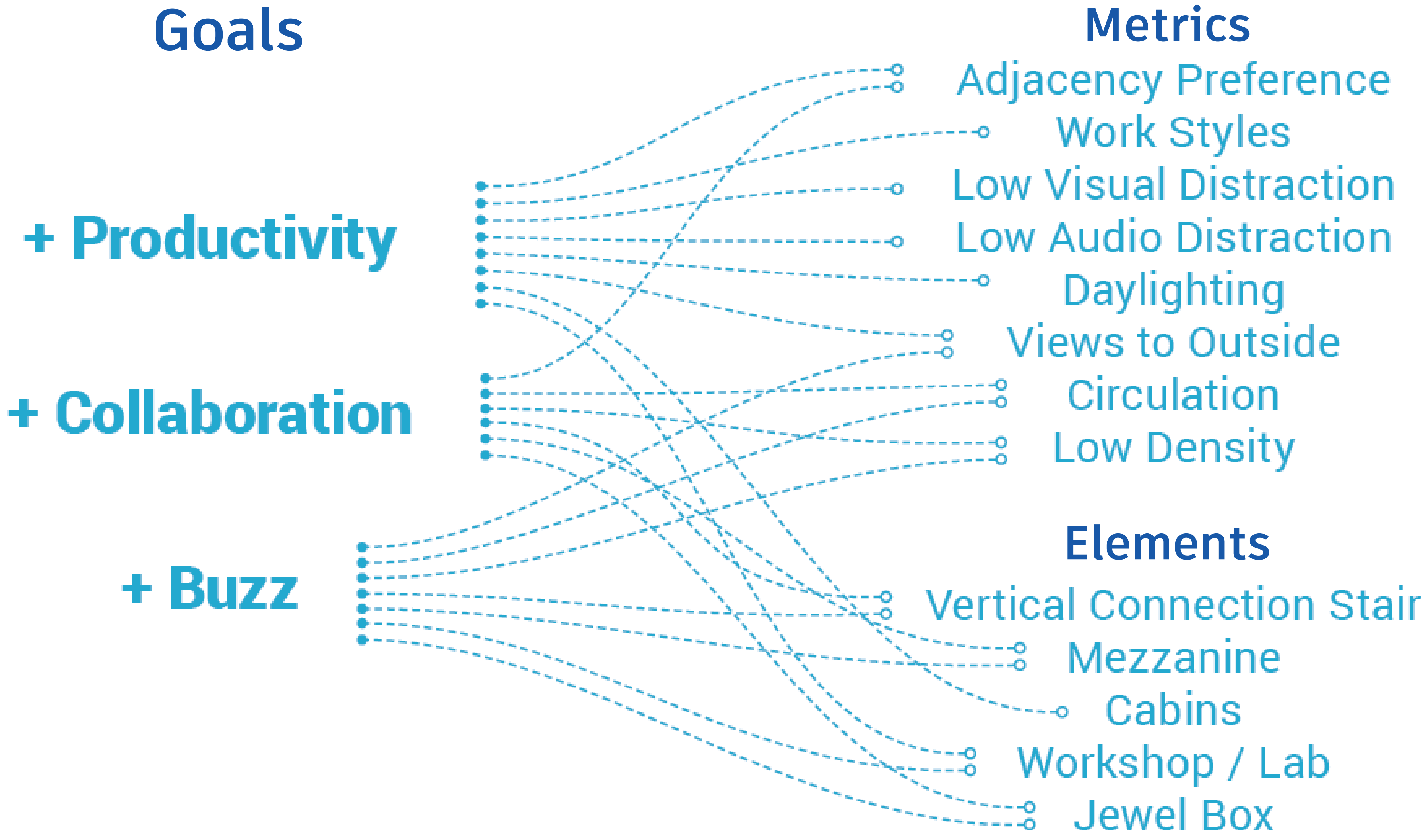
AUTODESK®

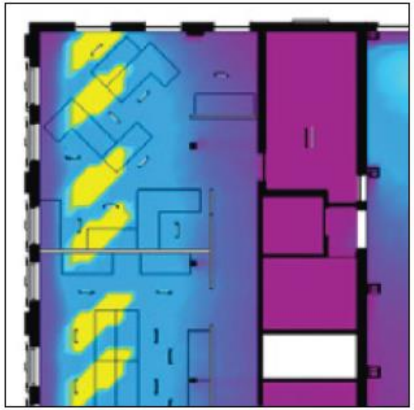
MaRS

THE LIVING

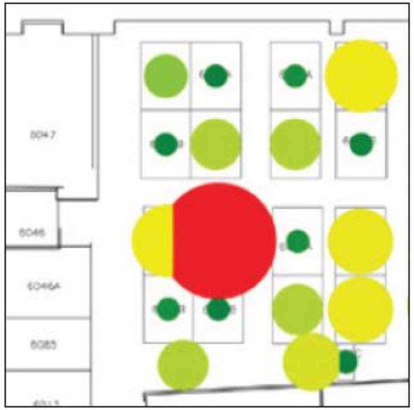



Eating our own
Dog Food


Goals
+ Productivity
+ Collaboration
+ Buzz
Metrics
Adjacency Preference
Work Styles
Low Visual Distraction
Low Audio Distraction
Daylighting
Views to Outside
Circulation
Low Density
Elements
Vertical Connection Stair
Mezzanine
Cabins
Workshop / Lab
Jewel Box

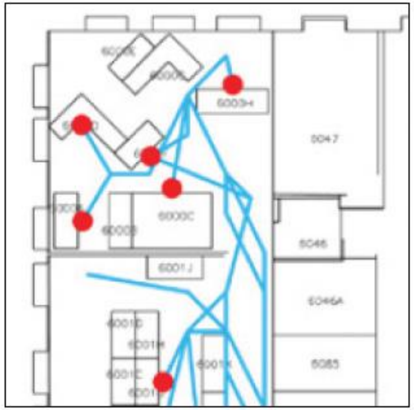


1. Daylight

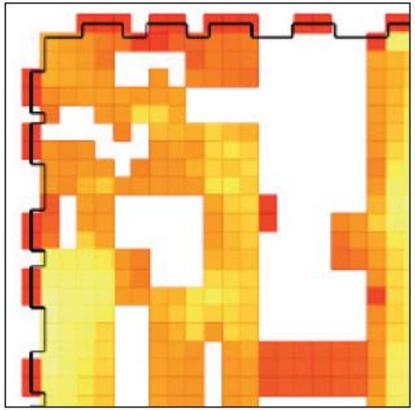


2. Low Visual Distraction

3. Views to Outside



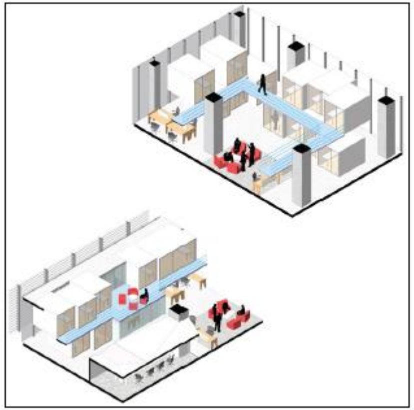
4. Adjacency Preference



5. Circulation

6. Work Styles

7. Low Acoustic Distraction



8. Low Density

LOW VISUAL DISTRACTION

Measurement of negative visual activity from workspaces.

SCORING EQUATION

$$\text{DISTRACTION} = \frac{\sum[\text{Normalized Count of Visible Coworkers per Workspace}]}{\text{Number of Workspaces}} \times 10.0$$

INPUTS

+ 2D Space Model (Geometry, including Obstructions)
+ Workspace locations and orientation

COMPUTATION METHODS

+ Field of view (200° horizontal)
+ Upper distraction limit: 15 coworkers visible
+ Isovist polygon generation per workspace
+ Point inclusion in isovist

OUTPUTS

+ Individual desk scoring (from 0 to 10)
+ Per floor aggregated scores (from 0 to 10)
+ Global distraction score (from 0 to 10)

SCORE RANGE

+ 0.0 SCORE (WORST CASE) : All employees at or above upper distraction limit
+ 10.0 SCORE (BEST CASE) : All employees have zero visible coworkers

6TH FLOOR

5TH FLOOR

4TH FLOOR

ADJACENCY PREFERENCE

Measurement of travel distance to preferred neighbors and amenities.

SCORING EQUATION

$$\text{ADJACENCY} = \frac{\sum[\text{Shortest Path Length} \times (1 + \Delta\ \text{Floors} \times \text{Vertical Multiplier})]}{\text{Number of Shortest Paths}} \times 10.0$$

INPUTS

+ Visibility graph (curve-based graph of possible travel)
+ Individual neighbor adjacency preferences (JSON-formatted survey data)
+ Individual amenity adjacency preferences (JSON-formatted survey data)

COMPUTATION METHODS

+ Geometric shortest path algorithm (curve-based)
+ Horizontal travel distance limit: 100 ft
+ Vertical travel distance limit: 11.5ft (210 King floor-to-floor height)

OUTPUTS

+ Individual adjacency scores (from 0 to 10)
+ Per floor aggregated adjacency scores (from 0 to 10)
+ Global adjacency score (from 0 to 10)

SCORE RANGE

+ 0.0 SCORE (WORST CASE) : All individuals have highest cost travel (max horiz. and vert. distance)
+ 10.0 SCORE (BEST CASE) : All individuals have lowest cost travel (adjacent and same floor)

6TH FLOOR

5TH FLOOR

4TH FLOOR

CIRCULATION

Measurement of congestion. Determined by cross-referencing simulated movement paths with computed traversability data for given space.

SCORING EQUATION

$$\text{CIRCULATION} = \frac{\sum(\text{Traversed Grid Values})}{\text{Traversed Grid Count} \times \text{Max Value}} \times 10.0$$

INPUTS

+ Adjacency Preference Shortest Paths (Geometry - from Adjacency Metric)
+ 2D Space Model (geometry, including solid obstructions)

COMPUTATION METHODS

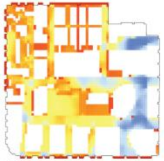
+ Generate analysis grid of relative traversability (range of possible moves from given point)
+ Identify and sum values of intersected grid tiles for every shortest path

OUTPUTS

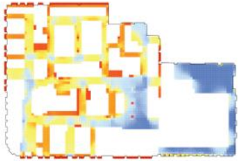
+ Per floor circulation scores (from 0 to 10)
+ Global circulation scoring (from 0 to 10)

SCORE RANGE

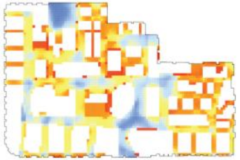
+ 0.0 SCORE (WORST CASE) : All movement through high congestion areas
+ 10.0 SCORE (BEST CASE) : All movement through congestion-free areas



6TH FLOOR



5TH FLOOR



4TH FLOOR

VIEWS-TO-OUTSIDE

Measurement of exteriors views from circulation and workspaces.

SCORING EQUATION

$$\text{VIEWS-TO-OUTSIDE} = \frac{\sum[\text{Views from Sample Point}_n > 1]}{\text{Number of Sample Points}} \times 10.0$$

INPUTS

+ 2D Space Model (geometry, including solid obstructions & windows)
+ Workspace locations (geometry, as points)
+ Circulation path (geometry, as curves)

COMPUTATION METHODS

+ Generation of target points (curve subdivision of windows)
+ Generation of circulation sample points (curve subdivision of paths)
+ Sample ray occlusion testing (sample points to target points with solid obstructions)
+ Count number of unobstructed view rays

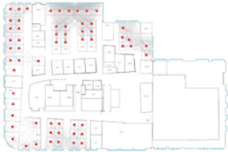
OUTPUTS

+ Per-floor aggregated views to outside score(from 0 to 10)
+ Global views to outside score (from 0 to 10)

SCORE RANGE

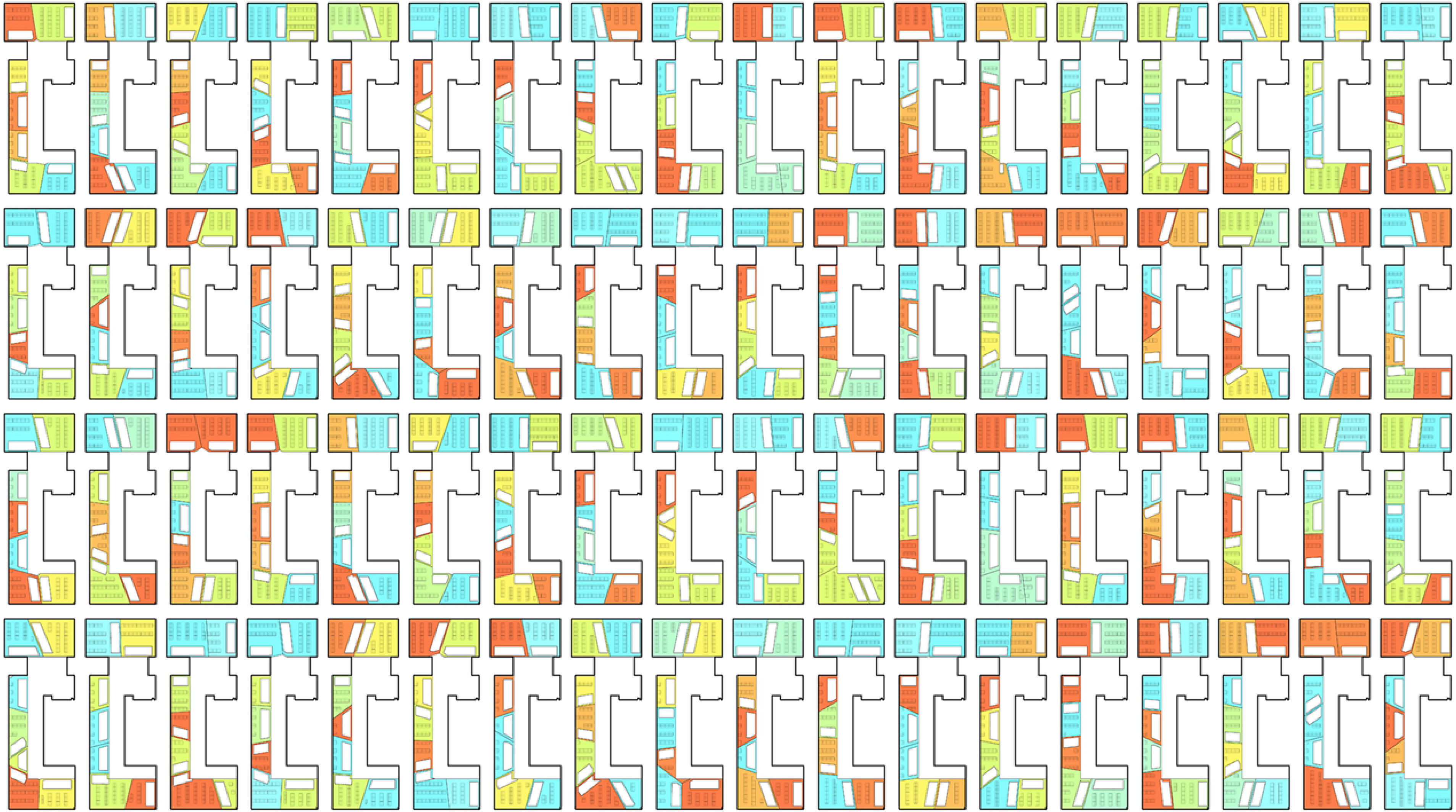
+ 0.0 SCORE (WORST CASE) : No sample points have views to outside
+ 10.0 SCORE (BEST CASE) : Every sample point has views to outside

6TH FLOOR

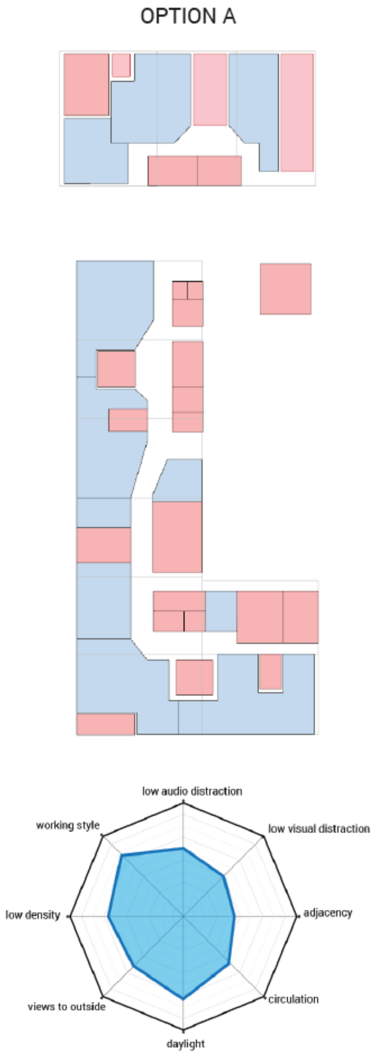


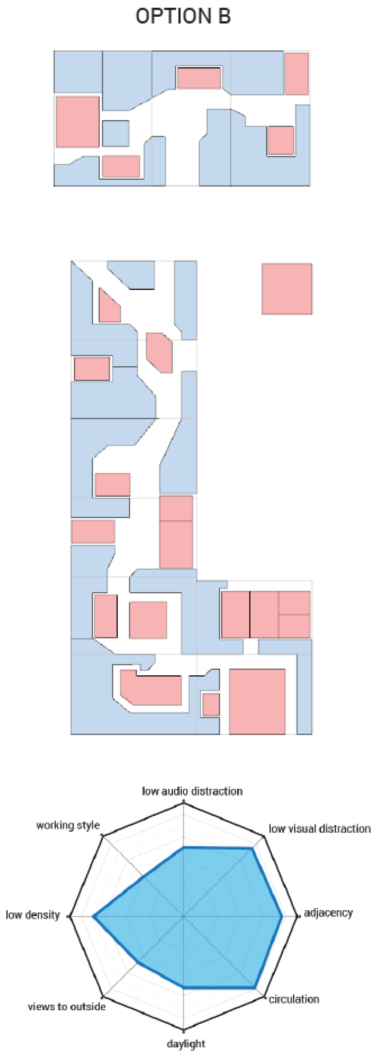
5TH FLOOR

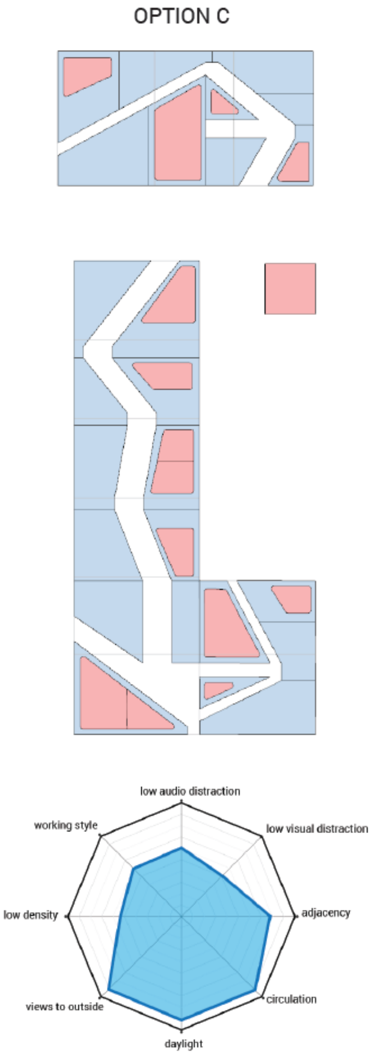
4TH FLOOR



Architect as Partner

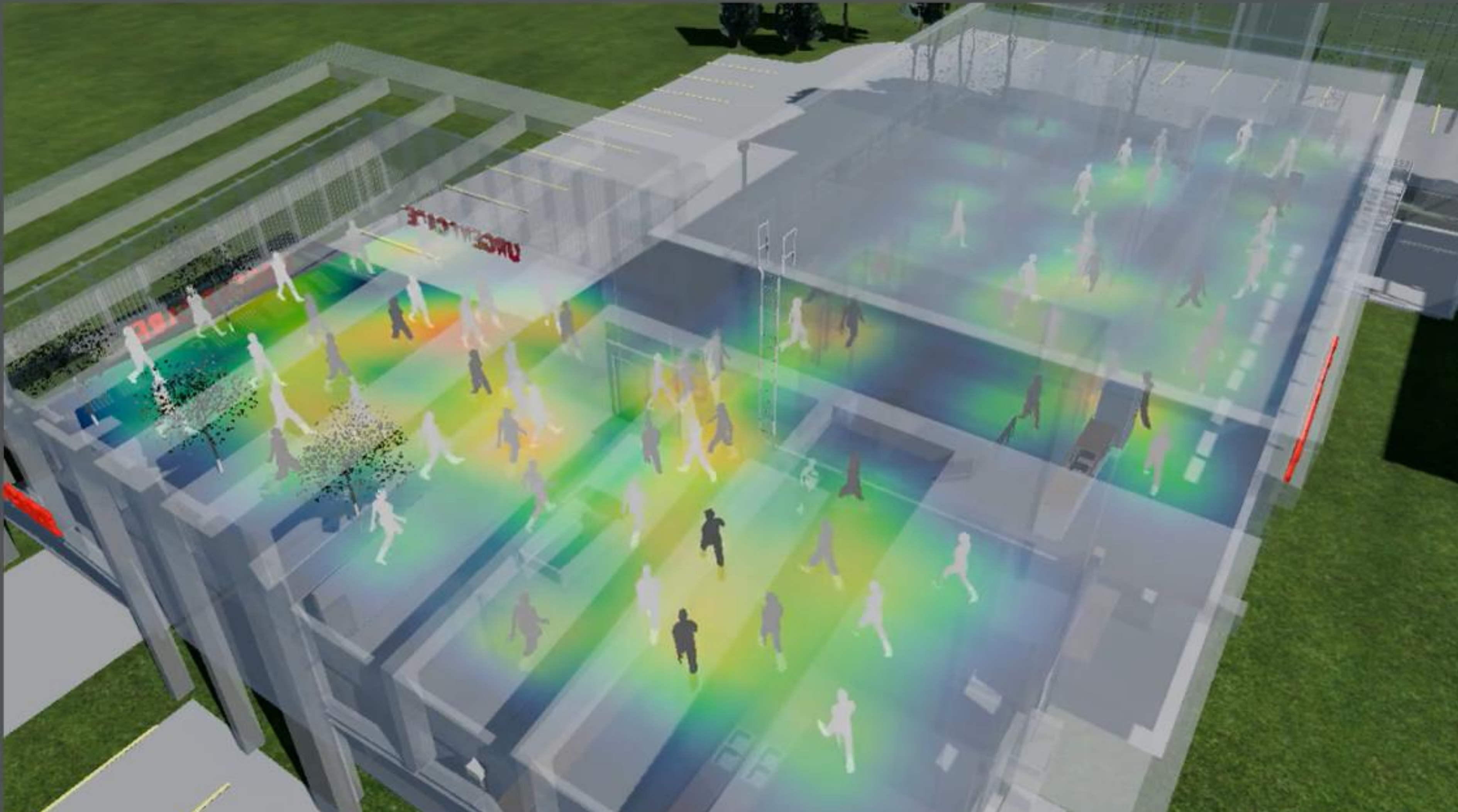






Checkpoint:

- Computer suggests "candidates"
- Architect reviews results
- Architect & Client evaluate
- Revisit assumptions
- Check inputs
- Select path forward



Generative design is the process of **defining high-level goals and constraints**, and then using the **power of computation** to automatically explore a wide design space and identify the best design options.

Architect as Storyteller

So what is BDP doing……..?

Finding Value within Data

Innovate UK funded R&D project led by PCSG

- Addressing the energy performance gap within buildings
- Empowering building occupants
- Changing behaviour

Innovate UK
Technology Strategy Board

PCSG

kn-i knownow

BDP.

Finding Value within Data

The problem:

- Gap between building energy performance design and installation is often 3.5 x original estimate (Innovate UK)
- Staff are unhappy and under-productive when they are uncomfortable
- Government targets for carbon reduction – 80% from 1990 levels by 2050

'There is not much evidence of energy efficiency improvement and much potential remains unexploited.' Committee on Climate Change

Innovate UK
Technology Strategy Board

PCSG

kn-i knownow

BDP.

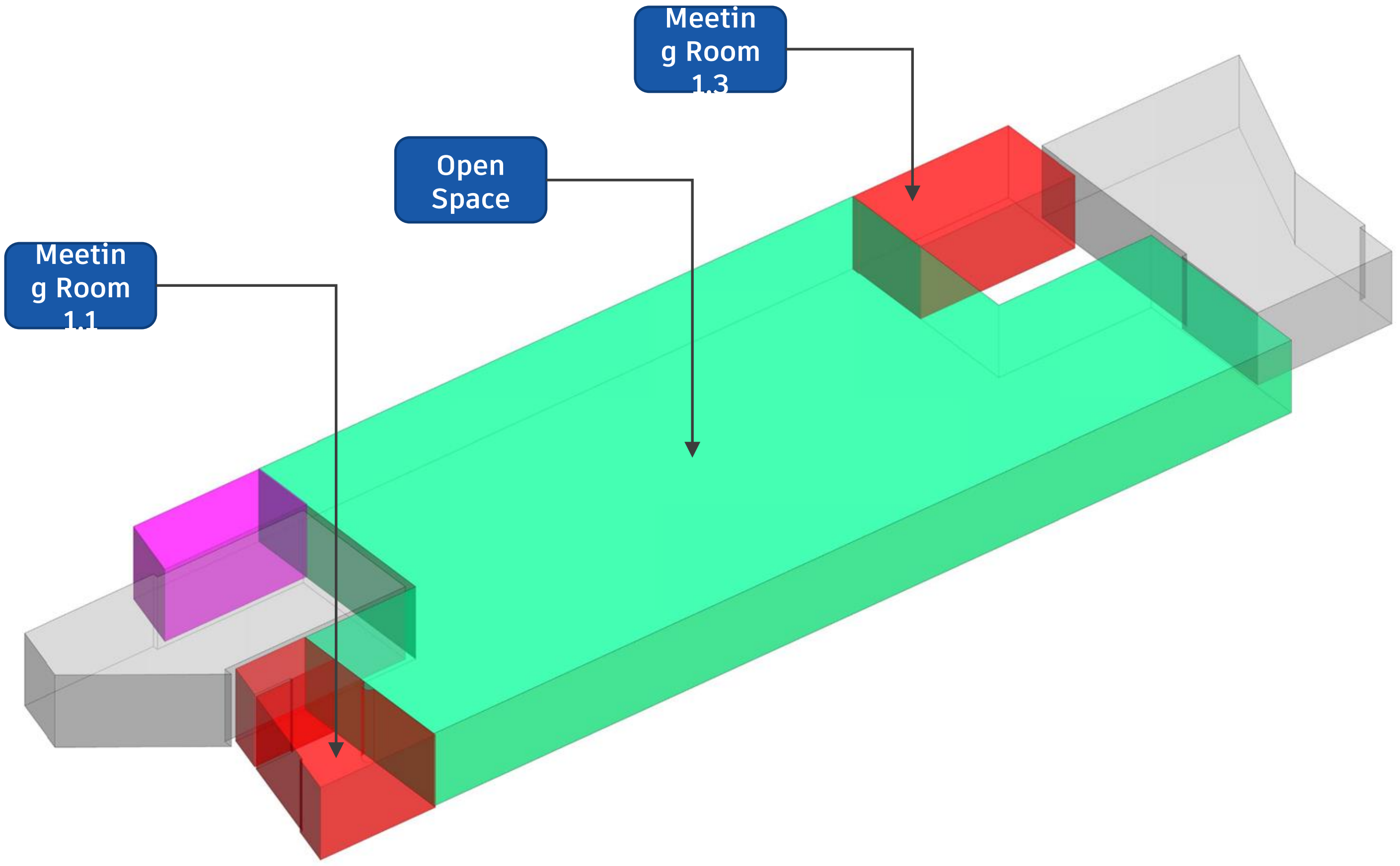
Finding Value within Data

The solution:

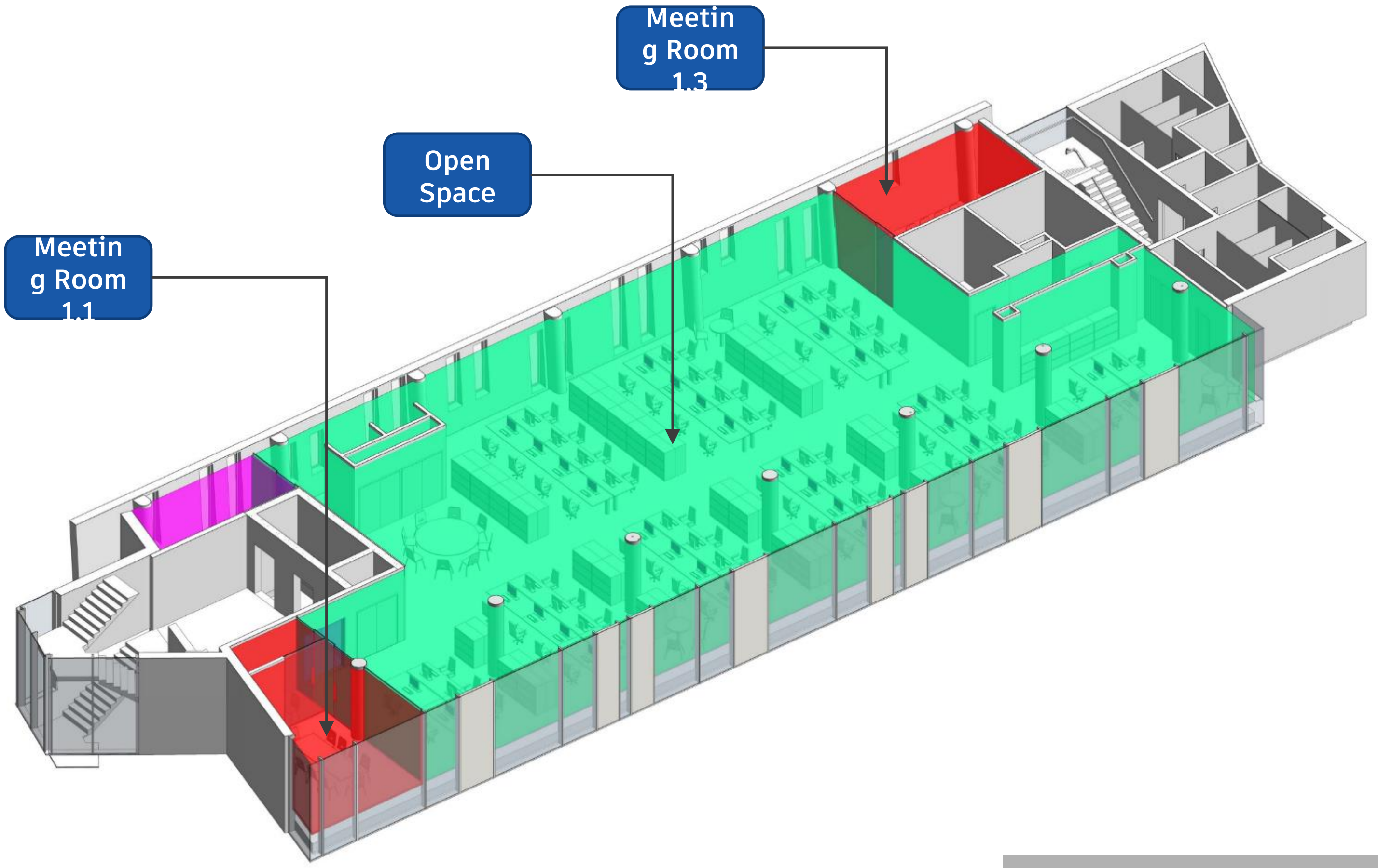
- Capture BMS data on energy use
- Monitor internal environmental conditions within office spaces
- Aggregate external environmental data
- Poll staff on perception of comfortable conditions within the office
- Intelligent adjustments to BMS
- Suggestions to staff on changing behaviours
- Recommendations for long term changes to BMS and occupant behaviour

Prove the working building design against original parameters

Innovate UK
Technology Strategy Board
PCSG
kn-i knownow
BDP.



First Floor Studio



First Floor Studio

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8:03 PM
Home
21.0
PRESSURE
1003
FEELS LIKE
22
HUMIDITY
59
TUE
WED
THU
FRI
SAT
22.2
570
LIVELY
57
HUMIDITY
68

Finding Value within Data

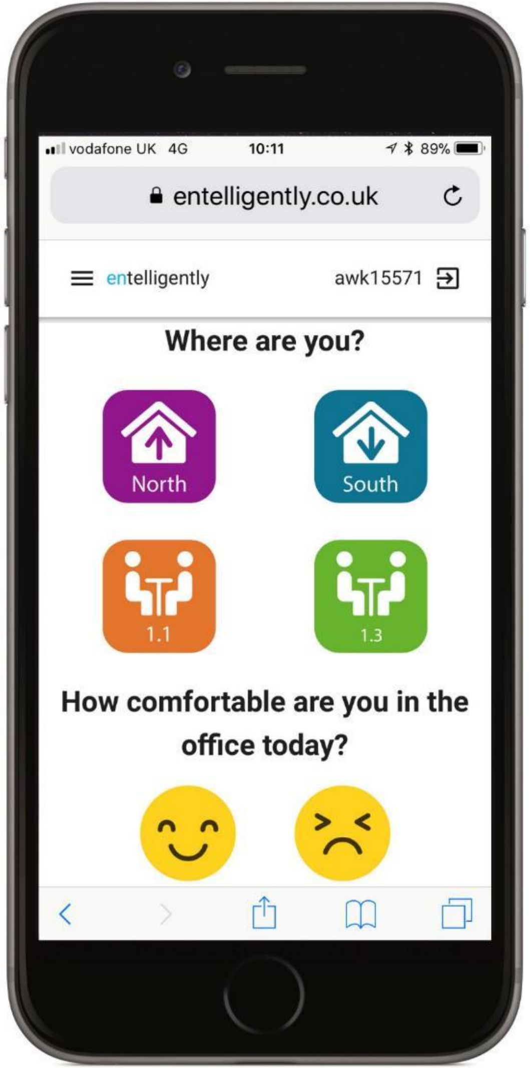
iPhone App.

- Give users the ability to record perception of comfort

Finding Value within Data

iPhone App.

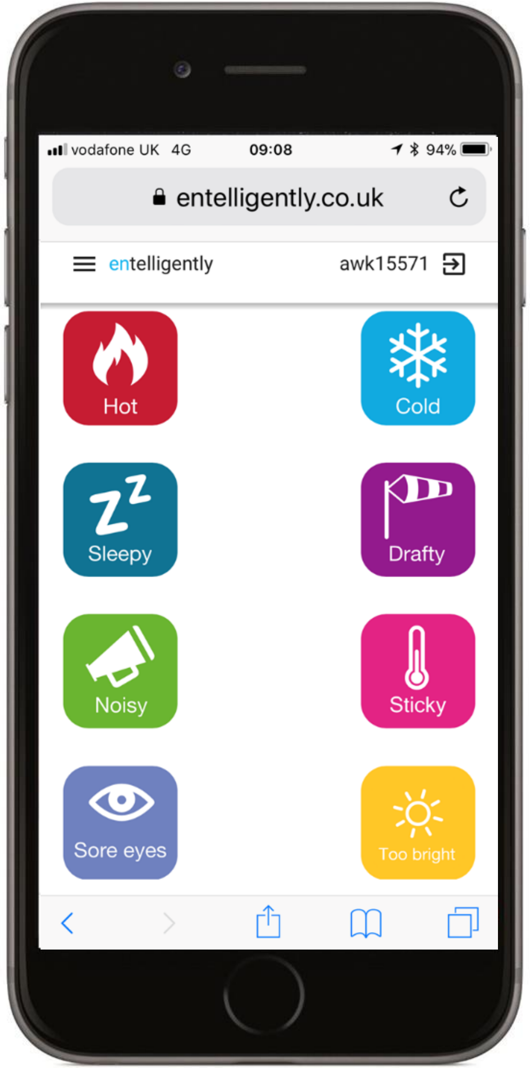
- Give users the ability to record perception of comfort



Finding Value within Data

iPhone App.

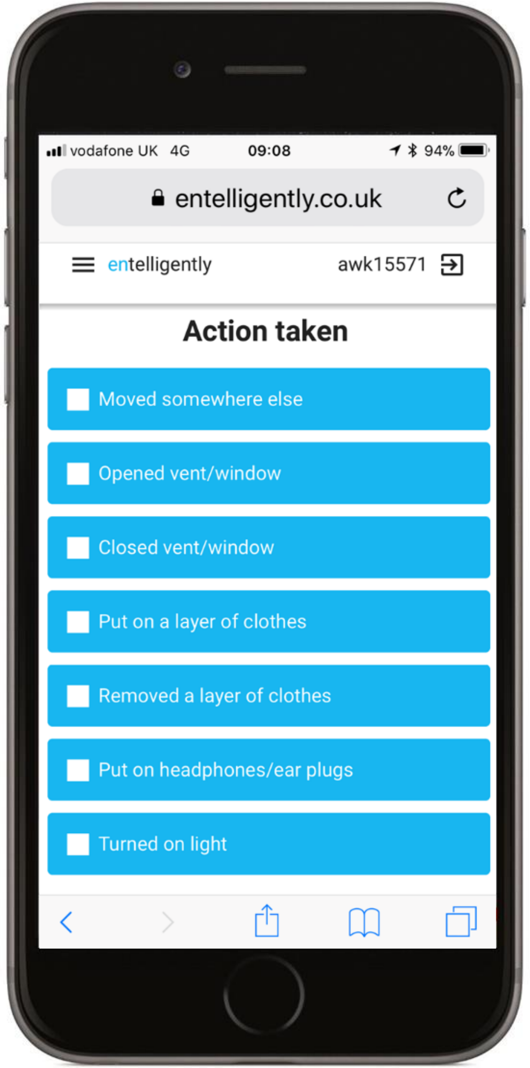
- Give users the ability to record perception of comfort



Finding Value within Data

iPhone App.

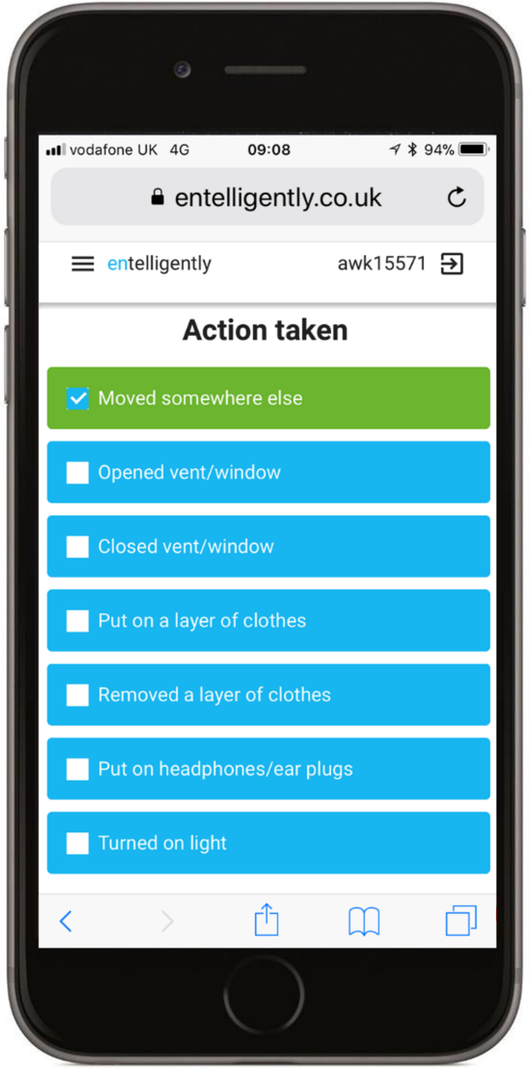
- Give users the ability to record perception of comfort



Finding Value within Data

iPhone App.

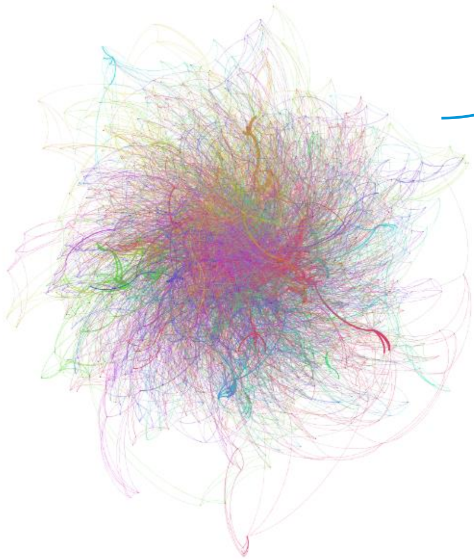
- Give users the ability to record perception of comfort



Finding Value within Data

Aggregation of data:

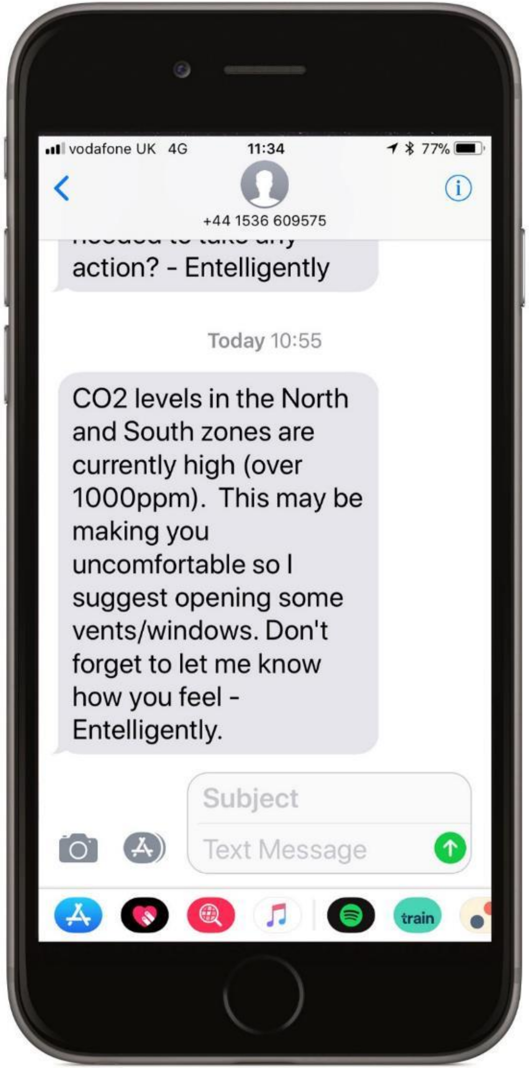
- BMS
- Environmental monitors
- User perception



```python
import matplotlib.pyplot as plt
import numpy as np
from scipy.special import expit

def sigmoid(eval):
    return expit(eval)


def Neural_Training(Y01, Labels01 , eta , Epochs):

    d,samplenumb = Y01.shape

    # Random [-1,1] init from Haykin
    WIH = 2*np.mat(np.random.rand(2*d,d)) -1.0
    WHO = 2*np.mat(np.random.rand(1,2*d)) -1.0
    difft =  Labels01.astype(np.float64)

    for i in xrange(1,Epochs):

        #Get the input to the output layer
        y_j_temp = sigmoid(WIH*Y01)
        netk = WHO*y_j_temp
        zk = sigmoid(netk)

        # Creating Delta Wk
        diff1 = difft - zk
        tDeltaWk = eta*np.multiply(diff1,np.multiply(sigmoid(netk),1.0-sigmoid(netk)))
        tDeltaWk = np.tile(tDeltaWk,(2*d,1))
        DeltaWk = np.multiply( y_j_temp,tDeltaWk)
        DeltaWk = np.transpose(np.sum(DeltaWk,1))

        # New Weights
        WHO = WHO + DeltaWk

        #Creating Delta Wj
        dnetj = np.multiply(y_j_temp,1.0-y_j_temp)
        tprodsumk = np.multiply(np.transpose(DeltaWk),np.transpose(WHO))
        tprodsumk = np.tile(tprodsumk, (1,samplenumb) )
        tprodsumk = eta*np.multiply(tprodsumk,dnetj)
        DeltaWj = tprodsumk * np.transpose(Y01)

        # New Weights
        WIH = WIH + DeltaWj


    return WIH, WHO

# Number of samples
N= 60000

#Number of Epochs
Epochs = 20

#Learning Rate
eta = 0.001

# opening images for [r]eading as [b]inary
in_file = open("train-images.idx3-ubyte", "rb")
in_file.read(16)
Data = in_file.read()
in_file.close()

# Transform the data stream
X = np.fromstring(Data, dtype=np.uint8)
X = X.astype(np.float64)
X = np.mat(X)
```

Finding Value within Data

Prompts to building users……



Finding Value within Data

Prompts to building users……

Finding Value within Data

Prompts to building users……

What are we finding……

What are safe levels of CO and CO2 in rooms?

What are safe levels of CO and CO2 in rooms?

CO2

250-350ppm	Normal background concentration in outdoor ambient air
350-1,000ppm	Concentrations typical of occupied indoor spaces with good air exchange
1,000-2,000ppm	Complaints of drowsiness and poor air.
2,000-5,000 ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present.
5,000	Workplace exposure limit (as 8-hour TWA) in most jurisdictions.
>40,000 ppm	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death.

CO

9 ppm	CO Max prolonged exposure (ASHRAE standard)
35 ppm	CO Max exposure for 8 hour work day (OSHA)
800 ppm	CO Death within 2 to 3 hours
12,800 ppm	CO Death within 1 to 3 minutes

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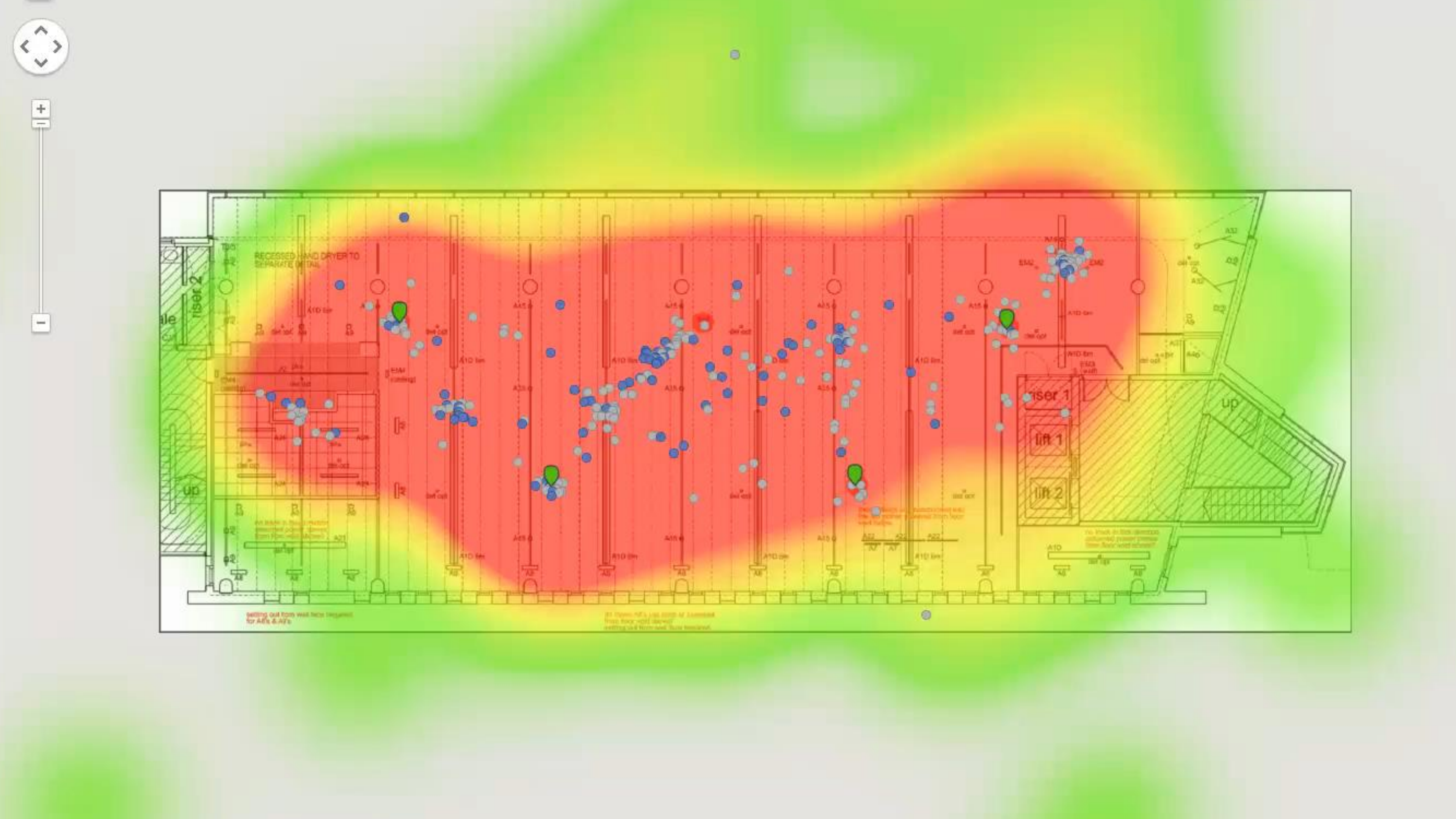
Looking forward……


riser 2
riser 1
lift 1
lift 2
up
up


Top Open...
10:09
Sum of Amount by
Stage Name
0
20M
40M
60M
80M


Walking + Running Distance
1.89 km
Daily Average: 5.08
Today, 13:25
15
0
9 Feb
16
23
1 Mar
8
Flights Climbed
3 floors
Daily Average: 8
Today, 13:22
30
0
9 Feb
16
23
1 Mar
8
Heart Rate
74 bpm
Min: 42 Max: 121
Today, 13:28
140
Dashboard
Health Data
Sources
Medical ID


29
30

We all talk about asset management……

....but forget that people
are our greatest asset.

Discussion…

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