



Data Driven Design

Foundations of **Data-Driven** Approaches in Architecture

Start

Definition &
Introduction

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Part One.

Definition ↗
Intro

↓ What is Data-Driven
Design

Next

Agenda

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↗ What is Data-Driven Design

↗ Data: Everywhere & Everything

↗ Driven: Decisions, Not Just Drawings

↗ Design: Solutions to Problems

↗ A Glimpse of History

↗ Data Journey: Unveiling Information

↗
Let's Play
Semantics



Let's Play Semantics



Data

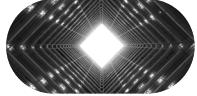


Driven

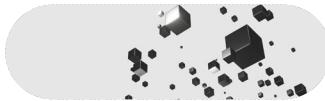


Design



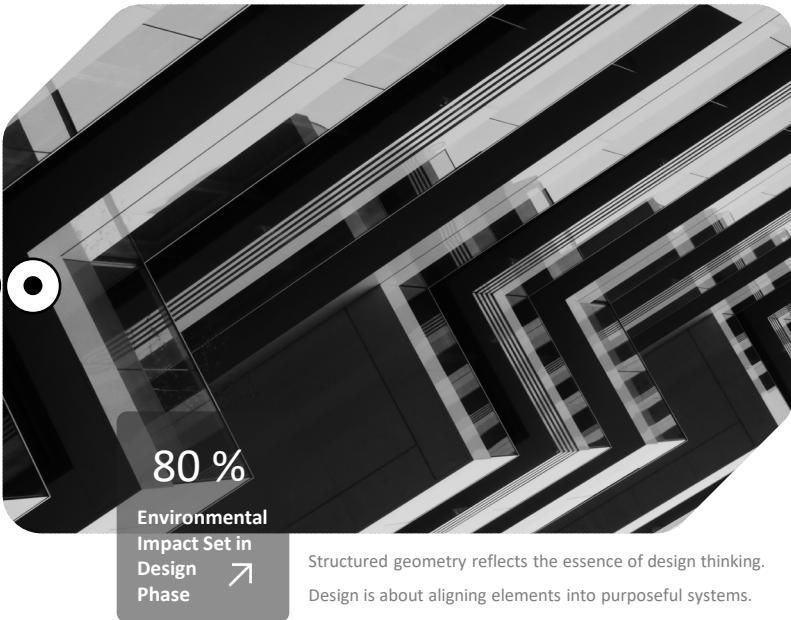


Design is A Systematic Approach



To Problem -Solving





20-30%

Better Energy Performance on Buildings
with Benchmarking. Source: INJ Architects

15%

Reduced design-phase timelines with
Benchmarking Practices. Source: INJ Architects

25%

Waste Reduction on Construction Site Utilising
Performance Metrics. Source: INJ Architects

Design Essence

Design is a systematic process of formulating and organising elements to create solutions for a problem or fulfil a need.

It integrates theory, research, and practice to achieve effective outcomes.





Data: Everywhere & Everything

Dimensions

Materials

Environmental Factors

User Preferences

Costs

Cultural Contexts

Statistics

You'd be surprised how much data is
in a pixel



A Pixel can carry an enormous amount of Data

Colour Information

Depth Perception

Texture Detail

3D Positioning

Tensors (Used in AI for Visual Data Analysis)

Global Data Explosion



194ZB+
By
2024

Geographic Information Systems
(GIS)

Mapping and Analysing Spatial Data to Plan Cities
or Manage Resources.



Sumerian Cuneiform Tablet 2038 BCE

From the structured atoms, the bricks of life, to DNA's script, the story of existence, to the words we carve in history—data is all around us, weaving the tapestry of life, shaping what makes us.

Photogrammetry as An Example

Capture (From Light to Sensory Pixels)

Convert Pixels as Numbers (Colour, Depth, Texture)

Extract (Depth, 3D Positioning Algorithms)

Reconstruct (Generate Model Based on Data)

Utilise (Spatial Analysis, Design, Simulation)

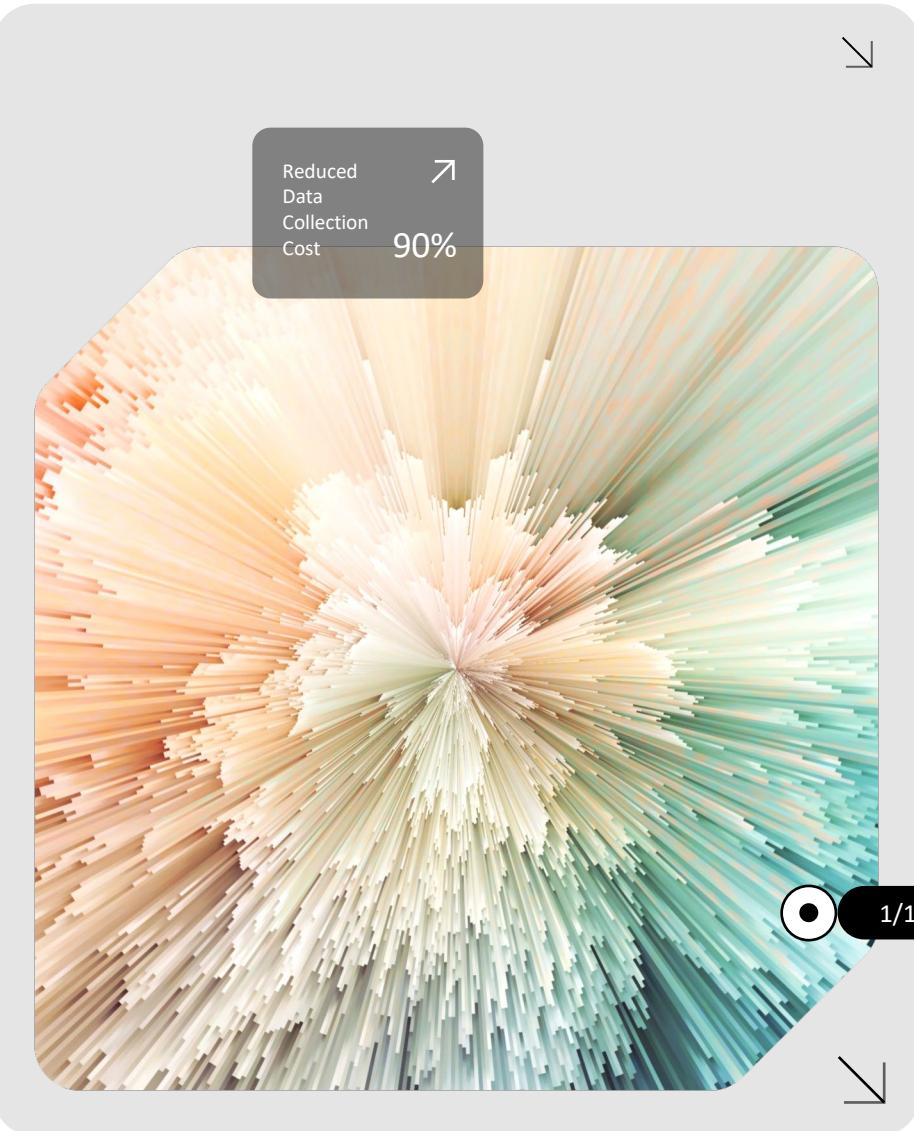
Data Journey

From ancient carvings to modern-day digital information, data has always been the foundation of knowledge. The process of data acquisition and extraction was developed over thousands of years, shaping the way we understand and interact with the world.

Beyond Pixels

The Hidden Layers of Information

A Pixel is one of the smallest units of digital representation, carrying visual and spatial information. Photogrammetry is an excellent example of how pixels are captured and transformed into 3D reconstructions for spatial analysis and design applications.





Driven:

A Catalyst for Change

Purposeful

Direction

Clear goals drive meaningful progress.



Let Data-Backed insights guide the way.



Informed Decision

Working together amplifies results.



Collaboration and Synergy

Striving for tangible, measurable success.



Outcomes

Focused

Whether in design, data, or innovation, being 'Driven' is all about having a clear goal and purpose.



Data Driven Design.



A Historical Overview

Tracing the development of design decisions shaped by data.

From early measurements to modern algorithms, showcasing how data continues to inform and refine decisions.



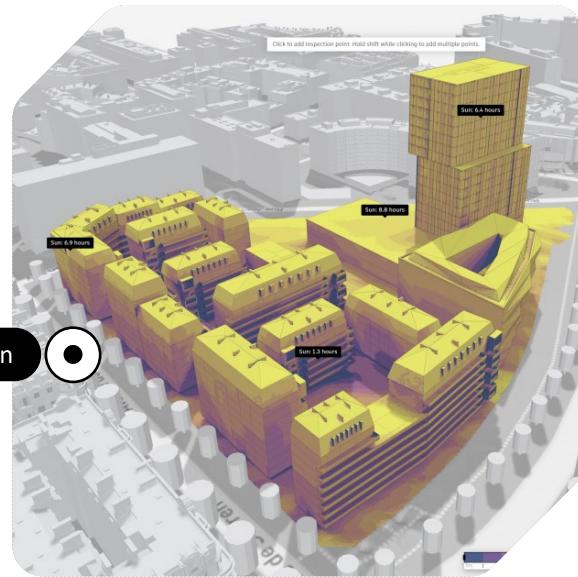
Play

↗
80%

Decisions
Based On
Data

Productivity
Increased

35%



3%

9%

Energy Saving Achieved by Implementing Smart Energy Analytics.**Fault Detection and Diagnostics**

Source: Better Buildings Solution Centre

50-80 % Energy Savings through
Passive Design

Source: New York Post

Informed Design

Data and Innovation in Modern Architecture

Informed design uses data to solve problems and meet needs.
From identifying challenges to evaluating solutions, asking the
right questions is the key to success.

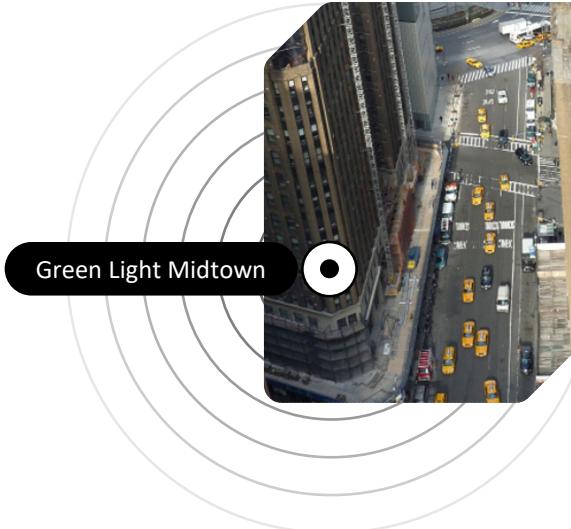




Decisions, Not Just Drawings

Design is **more than aesthetics**—it's about making **informed decisions** that optimise building performance (**energy, structure**), enhance user experience (**comfort, accessibility**), guide site selection, and address social and cultural needs. Data fuels this process, turning drawings into **actionable solutions**.

Green Light Midtown



Implications of Form & Function

Balancing design intent
with practical outcomes.



Design Like
You Give
A Damn

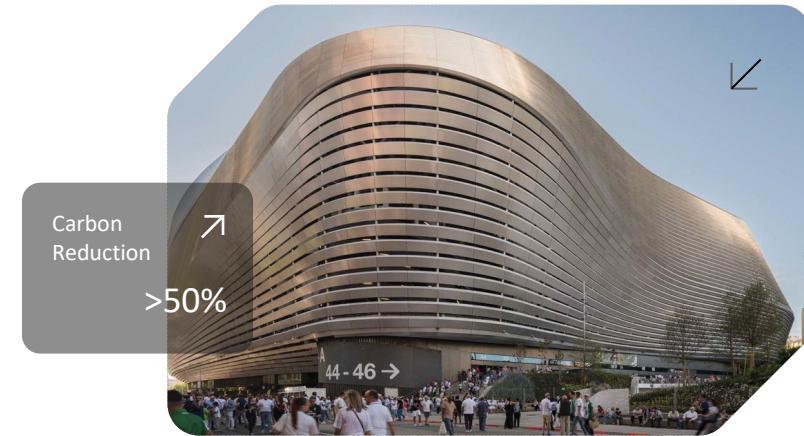




Contemporary Example

Santiago Bernabeu

Achieving a compliance audit score of 95%, indicating adherence to industry standards and regulations.



+13,000 Panels
Analysed and Optimised





Times Square before Green Light for Midtown.

New York City. Source: Design Like You Give A Damn

Pilot Testing and Evaluation:

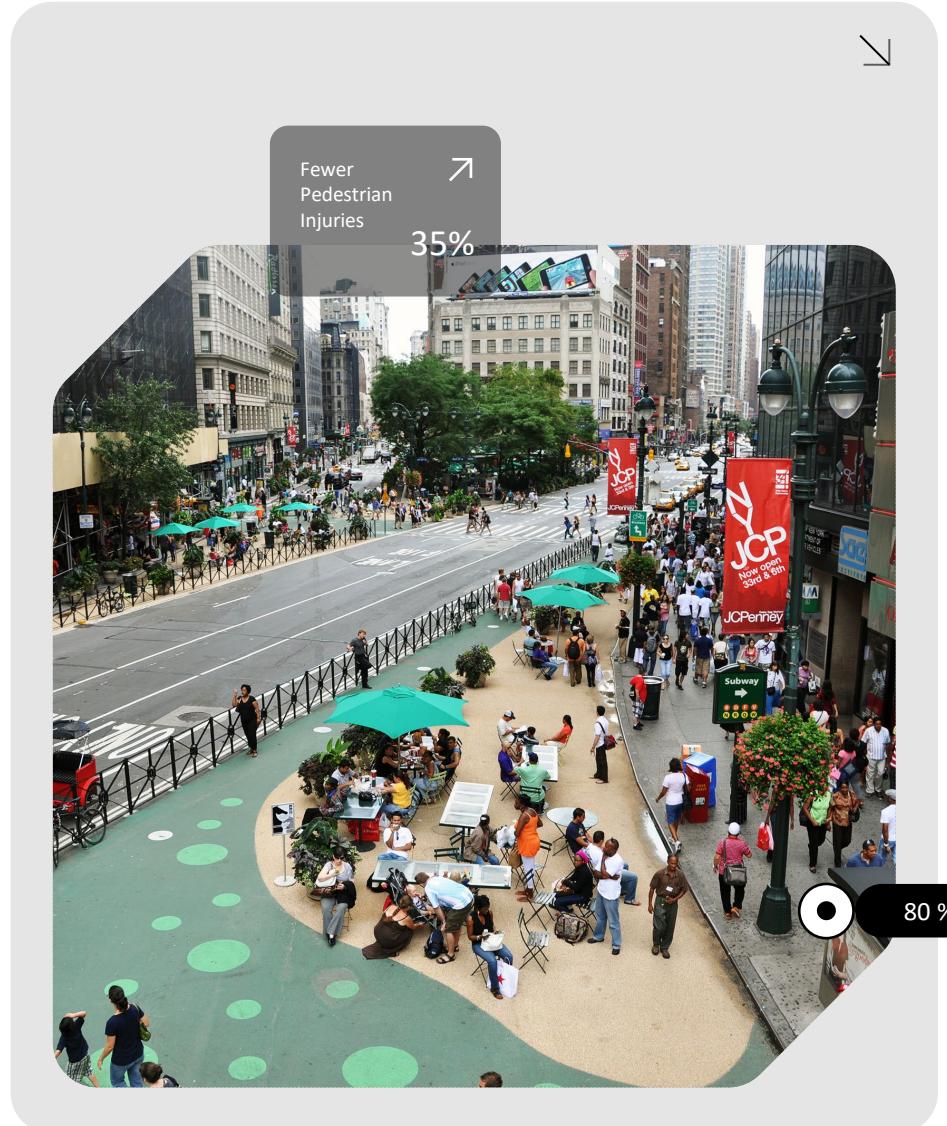
Temporary closures of Broadway to vehicular traffic provided measurable results: 35% fewer crash-related pedestrian injuries. An 80% reduction in people walking in the street. A 4% improvement in traffic times.

Adaptive Feedback Loop:

Data collected during the pilot phase informed the decision to make the plazas permanent in 2010. Continuous monitoring shaped the redesign by Snøhetta, incorporating new features like event infrastructure and security measures.

Cross-Referencing Global Case Studies:

Successes in other cities, such as Seoul's Cheonggyecheon River project, reinforced confidence in the approach.



Green Light For Midtown Project

Problem Identification through Data:

- Surveys like the 2003 Times Square Office Worker's Survey highlighted congestion as a major issue (68% considered it a reason to leave).
- Crash statistics (91 vehicle-pedestrian collisions from 2002–2004) and pedestrian counts (163,215 on a single day) underscored the safety and overcrowding concerns.

Evidence-Based Solutions:

The project leveraged Braess' Paradox, supported by mathematical and game theory studies, to counterintuitively demonstrate that reducing road capacity could improve traffic flow.

This project highlights the power of collecting, analysing, and applying data to solve urban design challenges, showing how evidence-based decisions can make cities safer, more efficient, and better for everyone.

Reduced People Walking
in the Street

4%
Traffic Time
Improvement



Statistics

When asking the relevant
Question matters

01 Building Materials & Carbon Emissions

Data for Development

WorldBank.org



02 Floor Plans, Collaboration & Productivity

Statista.com

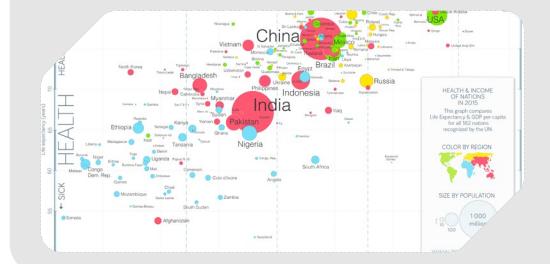
Sources: "Asking the Right Questions Articles"
<https://shorturl.at/gUMJJ>
<https://shorturl.at/PLeCp>

03 High Rise Buildings & Wind Effect

Kaggle.com

04 Green Spaces & Urban Well-Being

Gapminder.org





Biomimicry

Biomimicry is the process of decoding nature's implicit data and patterns to solve human challenges.

01

Slime Mold

Tokyo Train

"Compute" the most Efficient pathways
based on Nutrient availability.

Railway Network Optimisation 

02

Termite Mounds

Eastgate Centre

Regulate Temperature Naturally
Through Material Choices and
Structural Design

Embody Environmental Data 



Nature uses data implicitly.

Biomimicry extracts it.



03

Eden Project.

Statistics uncovers hidden truths in human systems, Biomimicry finds them in Nature—Data not written in spreadsheets, but in forms, behaviors, and ecosystems.

Geodesic Biomes 

04

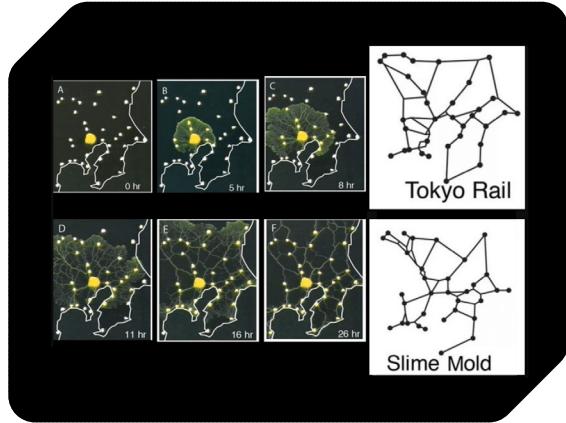
The Gherkin.

Where Statistics quantifies human-made systems, biomimicry reads the data of nature to inspire them.

Structural Inspiration 



Energy Efficiency 



Tokyo rail network formation with *Physarum polycephalum*

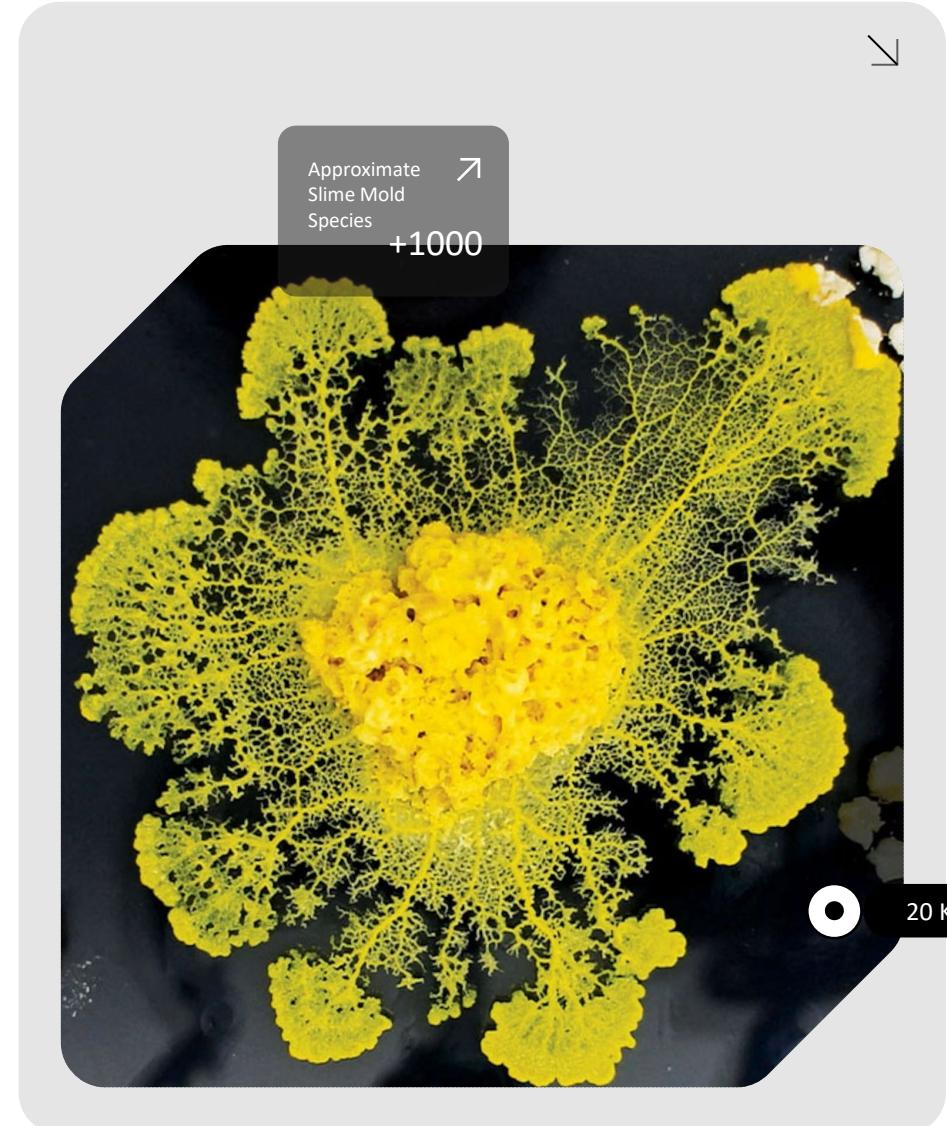
Source: ResearchGate, <https://shorturl.at/SKgFL>

Electricity Distribution:

Researchers developed a slime Mold-inspired algorithm to generate large-scale electricity distribution networks efficiently. This method offers a time-effective alternative to traditional optimisation routines. Source: <https://shorturl.at/MuaNA>

Optimization Algorithms:

The Slime Mold Algorithm (SMA), introduced in 2020, addresses high-dimensional, nonlinear optimization challenges in engineering. Despite its effectiveness, enhancements are being made to improve its convergence speed and ability to avoid local optima. Source: <https://shorturl.at/wwNF3>



Brefeldia Maxima Mass Formation Weight.

Slime Mold

Slime Mold (*Physarum polycephalum*) has inspired various design and optimisation strategies across multiple fields such as Network Optimisation, Engineering Design, Graph Optimisation and Subway Network Design.



The Edge

PLP Architecture, Amsterdam



28,000

Sensors Enabling
Real-Time Adjustments

Smart Sensor Network:

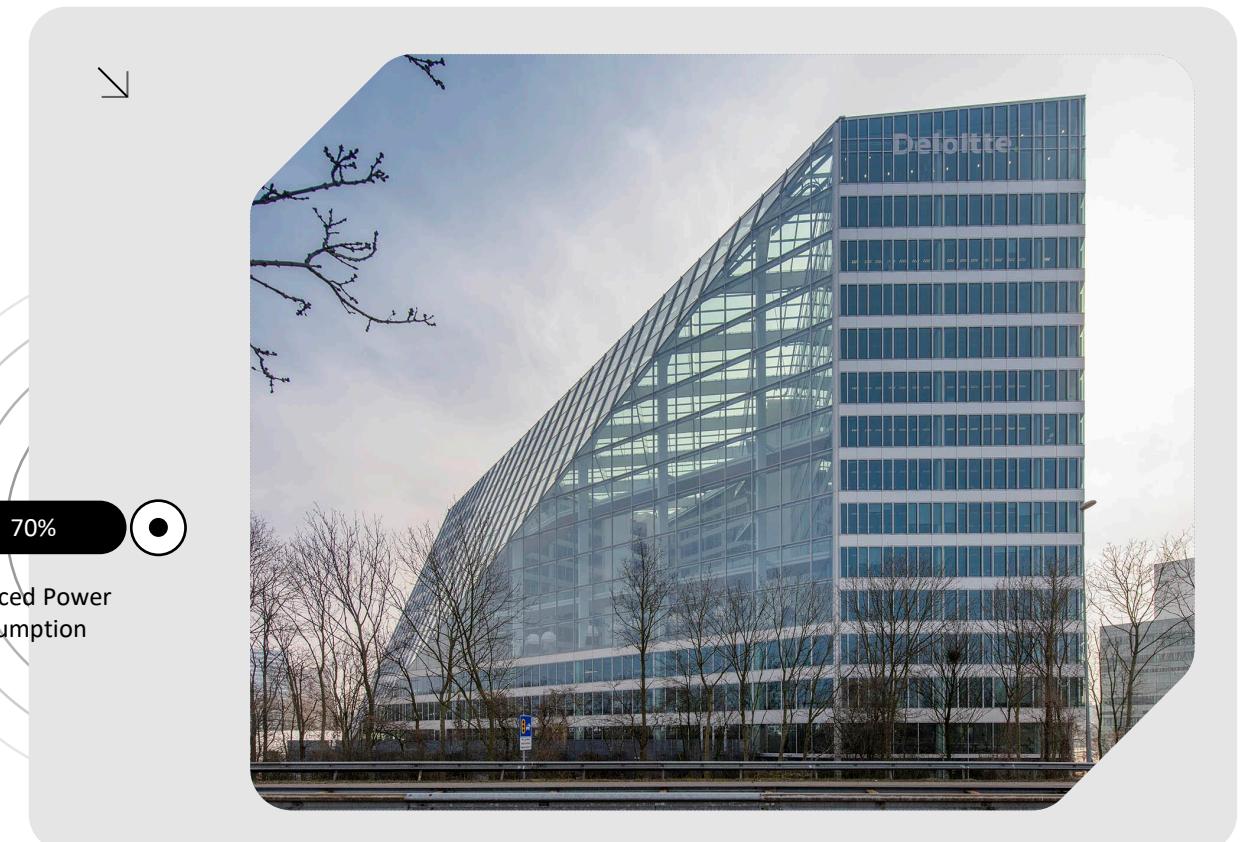
Equipped with approximately 28,000 sensors, The Edge monitors various parameters such as light, temperature, humidity, and occupancy. This extensive data collection enables real-time adjustments to enhance energy efficiency and occupant comfort.

Energy Efficiency:

The building's design, informed by data analytics, optimises natural light utilisation and climate control systems. This approach has led to a significant reduction in electricity consumption—about 70% less than typical office buildings. Additionally, the integration of solar panels allows The Edge to generate more energy than it consumes, achieving a net-positive energy status.

Occupant-Centric Design:

Data analysis of employee work patterns informed the creation of flexible workspaces, enhancing productivity and satisfaction. The building offers unassigned desks and various collaborative areas, accommodating diverse work styles and promoting efficient space utilization.





Provoke and Incentivise

Q & A Session

How Far Can Data Take Design?

- What if nature could design our cities?
- Could slime Mold teach us smarter, faster, and more efficient ways to plan infrastructure?
- Are we truly maximising the potential of data to reshape the built environment?

Cost Savings
But At What Trade-Off?

18%

Have We
Considered
the Outliers?

Reducing
Injuries
Further

35%



Only 25% of organisations
trust their data.

How do we become part
of the trusted minority?

25% Data Trust

Leaders Prioritise Data.
What About The Bias
Within?

100%

90%

Reduced Data
Collection Cost

Numbers Don't Lie!
But they can be
Contaminated.





References

Books

فقه العمران
خالد عزب

Algorithms to Live By

Brian Christian, Tom Griffiths,
Thomas L. Griffiths

Entangled Life

Merlin Sheldrake

Architecture and Disjunction

Bernard Tschumi

Design Like You Give A Damn

Cameron Sinclair



Online Resources

Storytelling with Data | Cole Nussbaumer Knaflic | Talks at Google
youtu.be/8EMW7lo4rSI

The beauty of data visualization - David McCandless

Design Like You Give A Damn – Architectural Responses to Humanitarian Crises

Data Science and Social Impact: Using Data for Good

The Power of Asking the Right Questions in the Data Scientist's Toolbox

Slime Mold Inspired Distribution Network Initial Solution

A novel improved slime mold algorithm for engineering design

Biomimetics for innovative and future-oriented space applications - A review

Data-Driven Urban Design
youtu.be/M18EZlQe8ec

Nature-inspired architecture | Austris Mailitis | TEDxRiga
youtu.be/40ieXxoJwZw

Research Papers & Articles

DATA-DRIVEN CONSERVATION ACTIONS OF HERITAGE PLACES CURATED WITH HBIM
Tuğba Sarıcaoğlu, Gamze Saygılı

DIGITAL TECHNOLOGY TO LOCATE THE WATER CATCHMENT SYSTEM OF THE “CUADRADO” FOUNTAIN IN MONTILLA (CORDOBA, SPAIN) IN THE 19TH CENTURY

Pilar Carranza-Cañadasa, Manuel Baena-Sánchez, Rafael Hidalgo Fernández, Paula Triviño-Tarradasa.

APPLYING A GIS TO THE UNDERWATER ARCHAEOLOGY OF MENORCA

Fernando Contreras, Adrian Fernández

polipapers.upv.es
Universitat Politècnica de València



Statistics Datasets Resources

1600 Indicators
217 Economies
50 years time series

worldbank.org

1 Million Statistics
170 Industries
+150 Countries

statista.com

↗ 13,230 Charts
120 Topics
ourworldindata.org

gapminder.org

Fighting global misconceptions.

The Home of the U.S.
Government's Open Data

Data.gov

datacommons.org

world's public data

↗ Social Issues
pewresearch.org

Structural Failures: The Imperative of Data-Driven Design

Tacoma Narrows Bridge

Collapsed due to aeroelastic flutter caused by wind-induced vibrations

Millenium Bridge

pedestrian bridge experienced unexpected lateral vibrations on its opening day, causing it to sway excessively

CNA Building

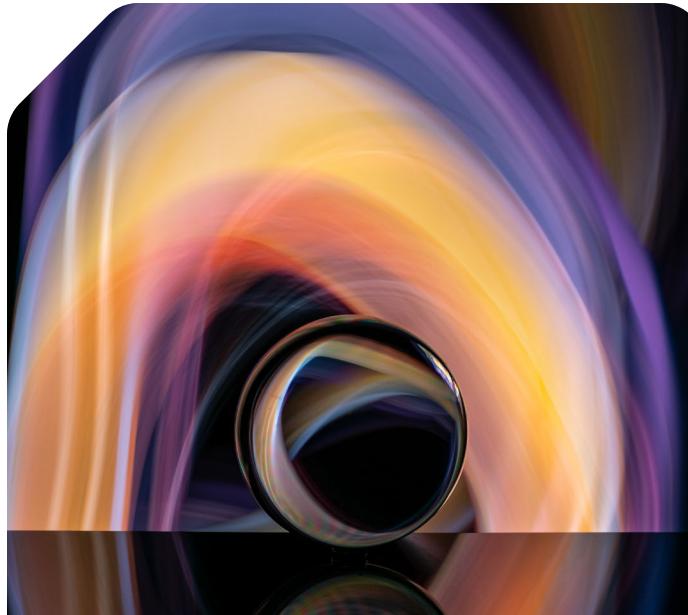
The design didn't fully consider thermal stresses, and wind loads on the glass panels, leading to these dangerous failures.

youtu.be/Z4VoyfdMGeA





For Your Time and
Consideration



Thank You

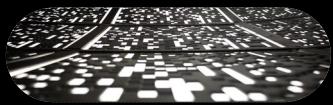


Up Next





Data Driven Design Tools And Implementation



Credits:

Emir Akan

Saleh Alenzawe

Asem Al Bunni

Owais Hommos

Yousef Haykal

Tareq Khanji



+44 116 255 7103 | info@lavartstudio.com

lavartstudio.com

Pentland Close, Leicester

England, LE2 7QR

About IAvArt

