Department of Civil Engineering

‘How you can shape the world’

Dr Liz Holcombe & Dr Dimitris Karamitros

Admissions Tutors

University of BRISTOL

Admissions Presentation

Welcome to Bristol

Dr Liz Holcombe & Dr Dimitris Karamitros
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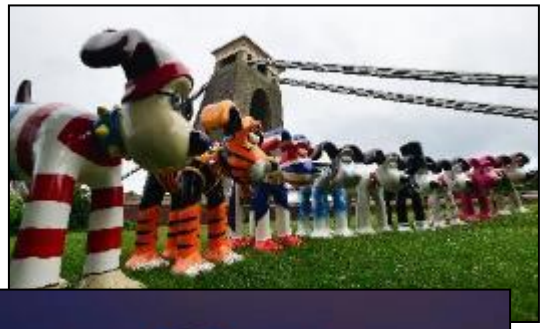
What's it like to live in Bristol?

The Best UK city to live

"great shopping, buzzing social scene and glorious scenery"

"great choice of housing, fantastic transport links, real sense of growing economic importance and creative energy"

The Sunday Times (2015, 2017)



BRISTOL 2015 EUROPEAN GREEN CAPITAL

In it for good

BRISTOL 2017 EUROPEAN CITY OF SPORT

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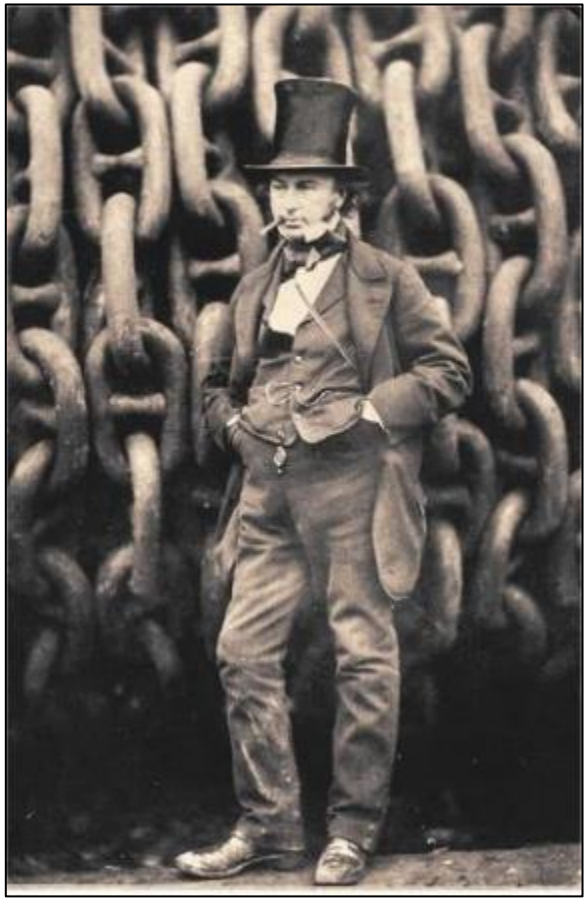
…a city with engineering roots



Isambard Kingdom Brunel
(1806 - 1859)

A city of **engineering inspiration**…

…a city with **engineering career prospects!**

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What's student life like?

Accommodation with a view

https://www.bristol.ac.uk/accommodation/

BRISTOL SU
the best student life

www.bristolsu.org.uk

- ✓ >300 societies
- ✓ Welcome Week
- ✓ SU Lettings
- ✓ **Representation**

Get active

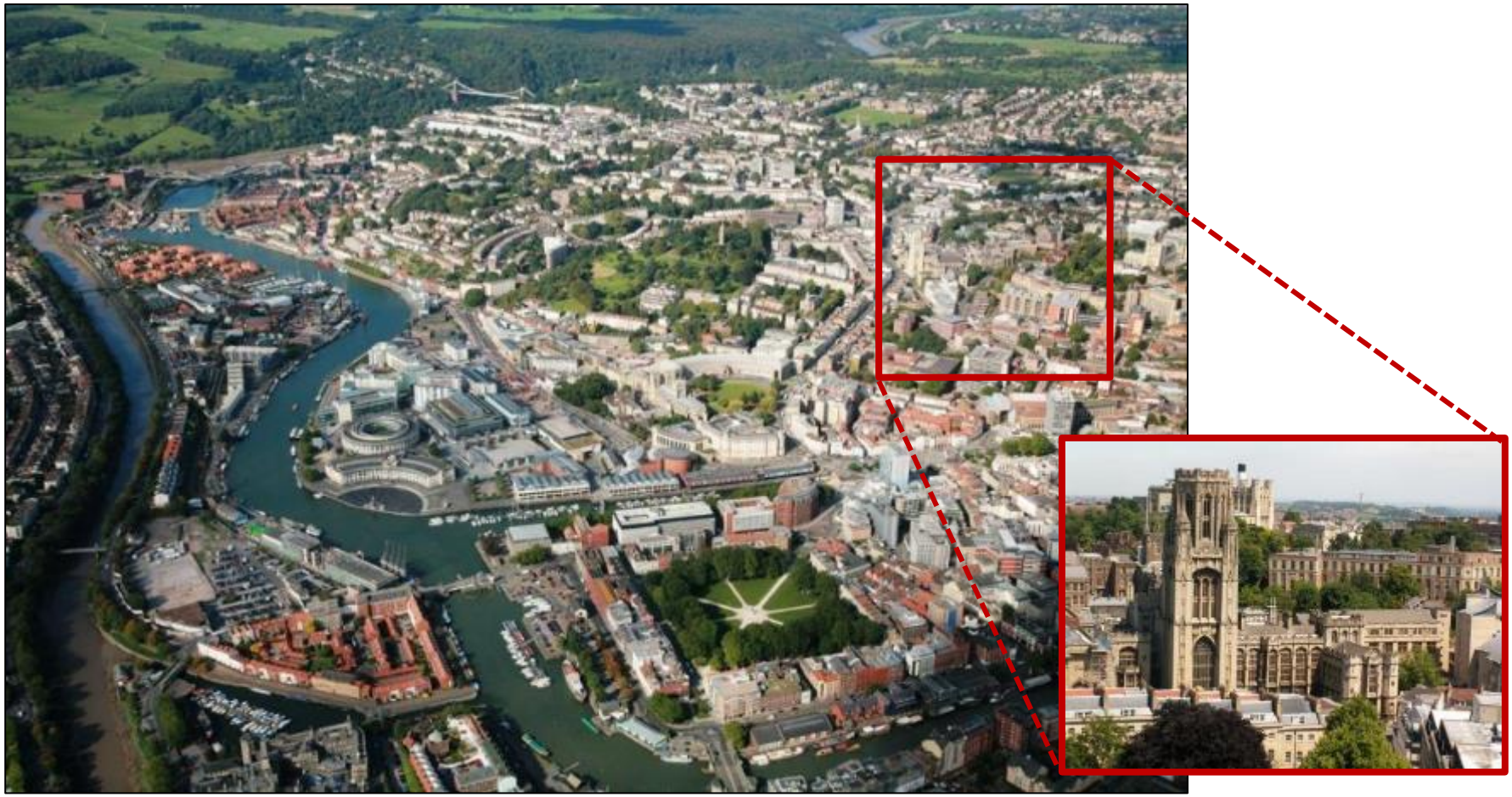
http://www.bristol.ac.uk/sport/

Looking after your wellbeing

http://www.bristol.ac.uk/students/wellbeing/our-approach/

- ✓ Health Service
- ✓ Wellbeing Service
- ✓ Counselling Service
- ✓ Residential Life Service
- ✓ Disability Support
- ✓ Multifaith Chaplaincy
- ✓ **Personal Tutoring**

Bristol University is (in) the “centre of town”…



One in the top Universities worldwide

QS WORLD UNIVERSITY RANKINGS

Top 51 Worldwide
Top 9 UK
Top 8 Engineering UK

THE WORLD UNIVERSITY RANKINGS

Top 26 Europe
Top 9 UK
Top 8 Engineering UK

THE COMPLETE UNIVERSITY GUIDE
INDEPENDENT • TRUSTED

Top 8 Civil Engineering UK

NSS National Student Survey

>90% Student Satisfaction
£27k Starting Salary

HIGH FLIERS 'The Graduate Market 2019'

2nd most targeted University by top UK employers

theguardian

Top 8 Civil Engineering UK

ice Institution of Civil Engineers

Accredited by the JBM
(for Chartered Engineers)

REF2014 Research Excellence Framework

Top 5 for Research UK

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Career Opportunities

Bristol Futures

https://www.bristol.ac.uk/bristol-futures/

- ✓ Personal Development Planning
- ✓ Study Skills
- ✓ Open Online Courses

Careers Service

http://www.bristol.ac.uk/careers/

- ✓ Helping you to plan your future career, target employers and get your first job
- ✓ BristolPLUS Award

Industrial Liaison Office

http://www.bristol.ac.uk/engineering/ilo/

- ✓ Year in Industry Programme
- ✓ (First Year) Internship Scheme
- ✓ Industrial Mentoring Scheme
- ✓ Inside Track Lectures & Seminars
- ✓ Newsletter & Online Social Networks

AECOM
ARCADIS
ARUP
ATKINS
BUROHAPPOLD ENGINEERING
flint neill
highways england
JACOBS Engineering SA
MOTT MACDONALD
NetworkRail
SKANSKA
WSP
PARSONS BRINCKERHOFF

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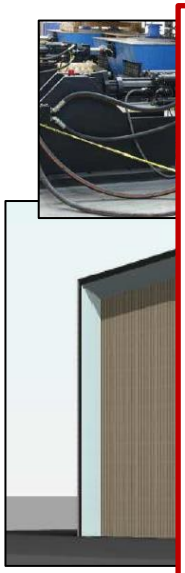
Investing in Teaching, Learning & Research

£19m Engineering Growth Project

Teaching & study space, Labs, Café & meeting space & more!

New £12m Soil-Foundation-Structure Interaction Facility

UK Collaboratorium for Research on Infrastructure and Cities



£300m Temple Quarter Enterprise Campus

Ongoing (Planned to open in 2023)

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What sort of teaching will I get?

- Research-led teaching
- A variety of learning methods
- Industry-relevant and connected
- World-class laboratory facilities
- Accredited so you can become professional qualified as a Civil Engineer

Civil Engineering Programmes

Programme and entry route	Duration
BEng in Civil Engineering (H205)	3 years full-time
MEng in Civil Engineering (H200)	4 years full-time
MEng Civil Engineering with Study in Continental Europe (H201)	4 years full-time, 3rd year at a European University
MEng Civil Engineering with Study Abroad (Entry via H200 or H201)	4 years full-time, 3rd year at a University overseas
MEng Civil Engineering with Year in Industry (Transfer from H200/H201, subject to eligibility criteria)	5 years full-time, 3rd year placement (credit-bearing)

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1st Year units

- Engineering Mathematics *(20cp)*
- Introductory Structural Analysis *(20cp)*
- Properties of Materials *(10cp)*
- Field Methods – *incl. Surveying (20cp)*
- Thermofluids *(20cp)*
- Design and Computing *(20cp)*
- Option *(10cp)*:
  - Sustainable Development
  - Application of Electronics
  - Language *(overseas & study abroad)*

Design Classes

Surveying Field Trip

For more details, see "Course Structure" under:
www.bristol.ac.uk/engineering/departments/civilengineering/

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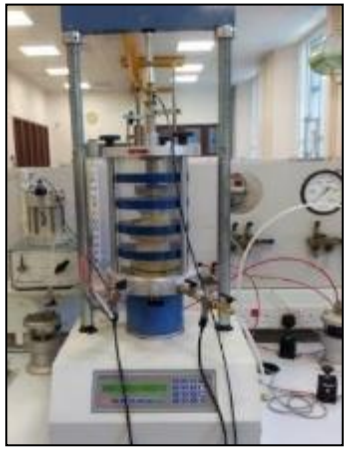
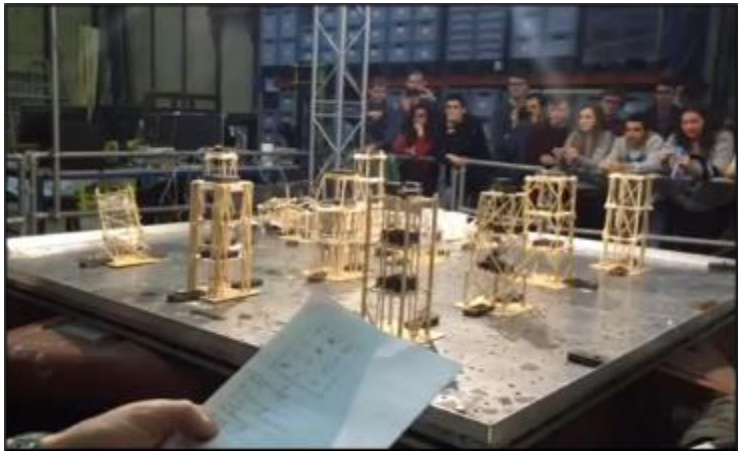
2nd Year units

- Engineering Mathematics *(20cp)*
- Methods of Structural Analysis *(20cp)*
- Geomechanics *(20cp)*
- Water Engineering *(20cp)*
- Structural Materials and Design *(20cp)*
- Option *(20cp)*:
  - Architecture with Building Services
  - Language *(overseas & study abroad)*

Laboratories



Shaking Table Design Competition



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MEng with Study in Europe *(H201)*

Typical countries and universities

Austria:	Innsbruck, Vienna
France:	Grenoble, Lyon
Germany:	Hannover
Italy:	Bologna
Netherlands:	Delft
Spain:	Valencia, Barcelona
Sweden:	Gothenburg

For more details, see “Year abroad” under:
https://www.bristol.ac.uk/global-opportunities/go-abroad/
(Search by subject for Civil Engineering)

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MEng with Study Abroad *(transfer)*

Typical countries and universities

USA: University of California *(Berkeley, San Diego, Irvine, Davis)*
University of Illinois *(Urbana-Champaign)*
Drexel University *(Pheladelphia)*

Canada: McGill University *(Montreal)*

Australia: University of Sydney
University of Western Australia
University of Adelaide

Hong Kong: Hong Kong University

Singapore: Nanyang University

For more details, see "Year abroad" under:
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(Search by subject for Civil Engineering)

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MEng with Year in Industry *(transfer)*

- ✓ Duration: **5 years** full study
- ✓ 3rd year: Formal industrial placement *(Credit bearing)*
- ✓ Entry: Transfer from H200 *(MEng)*, H201 *(MEng & Abroad)*, H205 *(BEng)*

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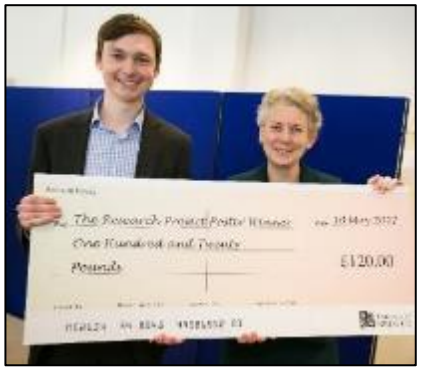
3rd Year units

- Research Project *(40cp)*
- Advanced Structural Analysis
  - *– incl. Finite Element Analysis (20cp)*
- Design of Geotechnical Structures *(10cp)*
- Water Engineering *(10cp)*
- Civil Engineering Systems *(10cp)*
- Concept Design *(20cp)*
- Reliability for Engineers *(10cp)*

Water Resources Project Field Trip

Research Project Showcase Day



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www.bristol.ac.uk/engineering/departments/civilengineering/

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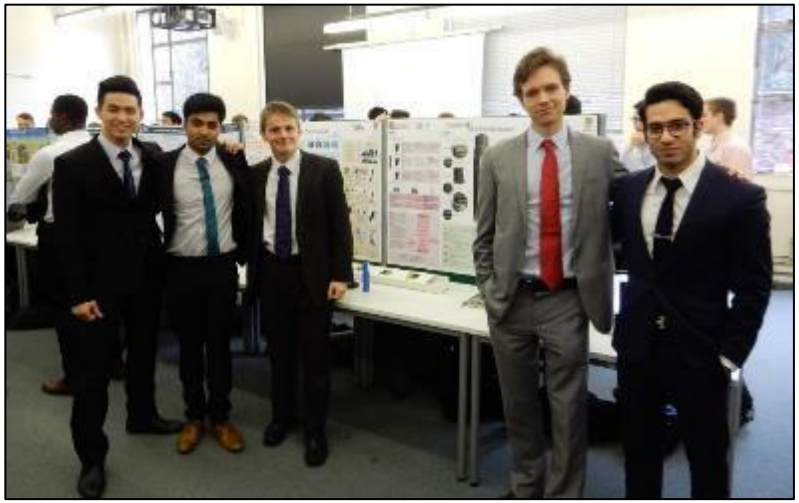
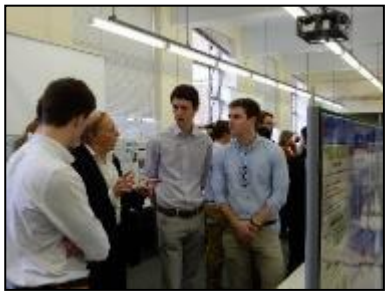
4th Year units

- **Compulsory:**
  - Design Project (40cp)
- **Select a minimum of 20cp from:**
  - Earthquake Resistant Structures *(10cp)*
  - Geotechnical Engineering Practice *(10cp)*
  - Water Resources Risk Management *(10cp)*
- **Select a minimum of 10cp from:**
  - Infrastructure Systems *(10cp)*
  - Sustainable Systems *(10cp)*
  - Asset Management *(10cp)*
- **Select 20-50cp from typically available units such as:**
  - Research Project *(40cp)*
  - Analysis and Design of Structures
  - Timber Engineering
  - Soil-Structure Interaction
  - Soil Dynamics & Earthquake Geotechnics
  - Engineering Seismology
  - Hazards and Infrastructure

Design Project Poster Session





- Smart Cities
- Transport and Mobility Modelling
- Power Generation for the 22nd Century
- Engineering for International Development
- Innovation, Entrepreneurship and Enterprise

Varied teaching and assessment

- **Teaching methods:**
  - Lectures
  - Individual and group work
  - Laboratories (practical and computer)
  - Design classes
  - Tutorials
  - Field visits
  - Projects
  - Small-group or individual project supervision
- **Assessment methods:**
  - Exams
  - Coursework
  - Vivas
  - Posters
  - Presentations
- **Personal tutoring**
- **Student Staff Liaison Committee**

Typical Timetable for Y1

	Monday	Tuesday	Wednesday	Thursday	Friday
9-10	Field Methods (L+Ex)	Option			Structural Analysis (L+Ex)
10-11			Option		
11-12	Engineering Maths (L)	Field Methods (L)	Eng. Maths (L)	Structural Analysis (L+Ex)	Mechanics of Fluids (L+Ex)
12-13		Pers. Tutorial	Materials (L)		
13-14					
14-15	Laboratory			Computing (Lab)	Design (CDO)
15-16					
16-17					
17-18	Eng. Maths (Drop in)	Eng. Maths (Drop in)		Eng. Maths (Drop in)	

Week 7

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How can you shape the world?

*"Today, civilisation relies more than ever on teams of **inventive people** to **design, build and maintain** the sophisticated environment that surrounds us."*

*"Civil engineering is all about **helping people** and **shaping the world**..."* Institution of Civil Engineers

SUSTAINABLE DEVELOPMENT GOALS

Water & Sanitation

Resilient Infrastructure

Sustainable Cities

Clean Energy

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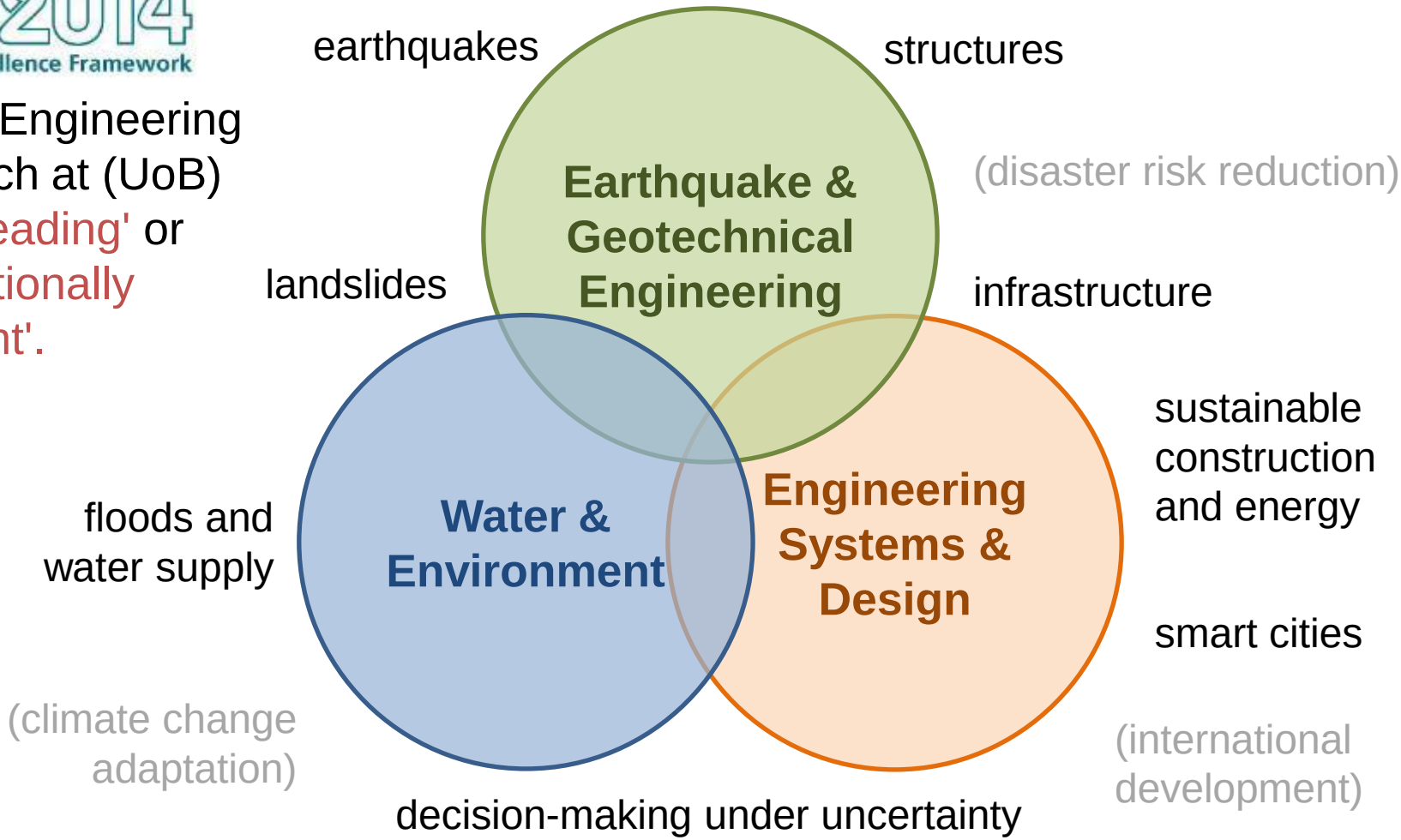
Research that shapes the world

REF2014 Research Excellence Framework

93% of Engineering Research at (UoB) 'world leading' or 'internationally excellent'.



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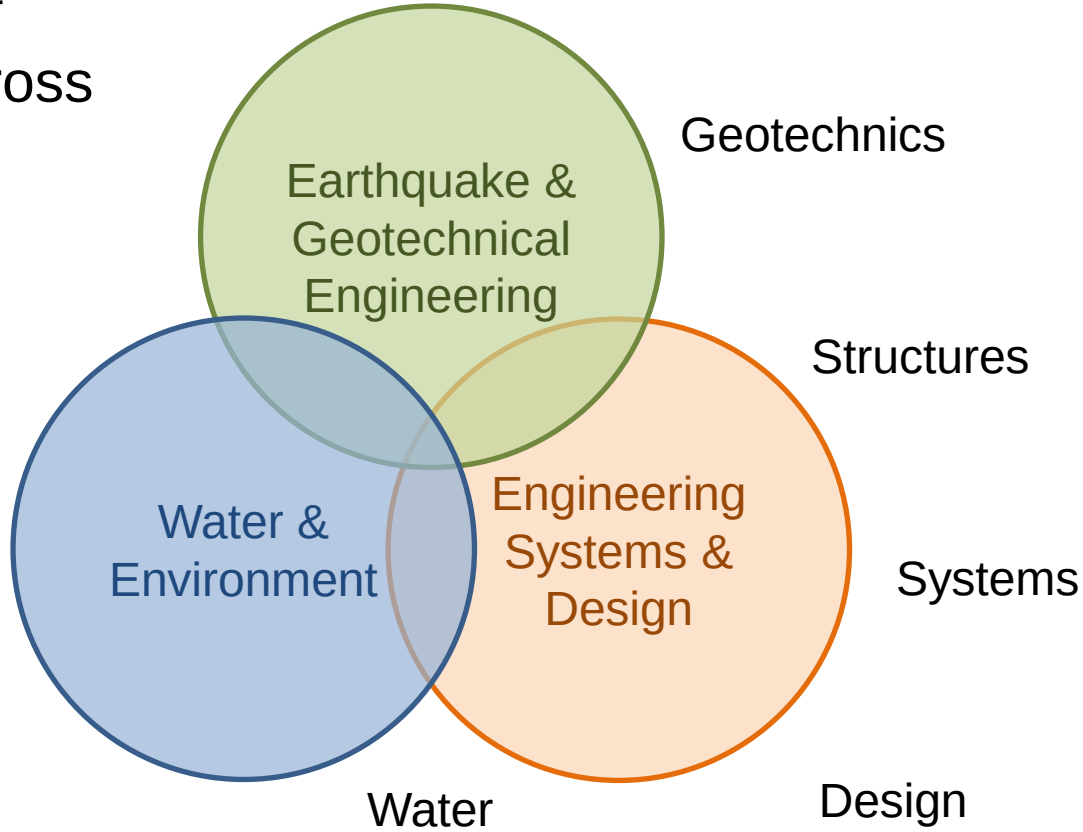
We link research, teaching & practice

About 40 Civil Engineering academics – wide range of world leading expertise across the discipline...



⇨ Research-into-teaching

Year 2 EQ / structures lab

Year 3 research projects

Year 4 optional units

⇨ Putting it into practice

Year 3 Water Resources project

Year 4 Design project

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Earthquake & Geotechnics Lab

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2nd year structures class

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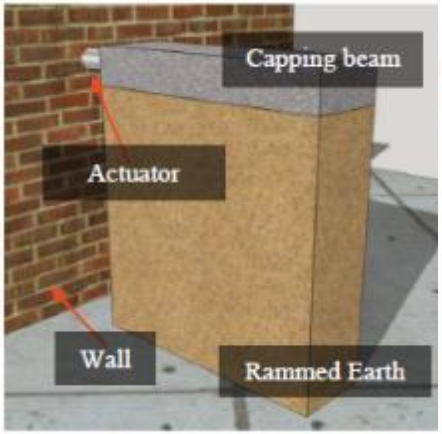
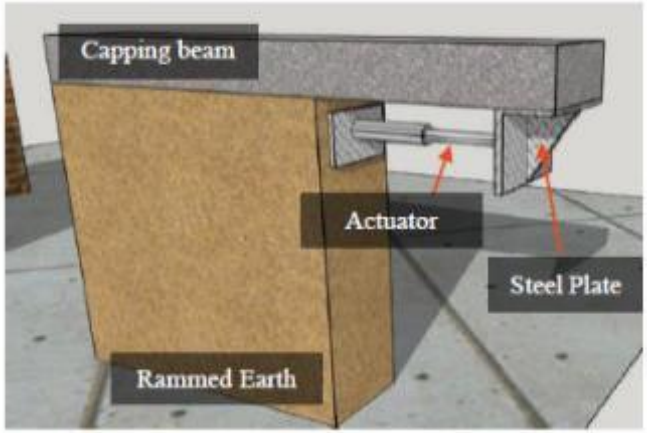
Example student research project

Year 3 undergraduate research project:

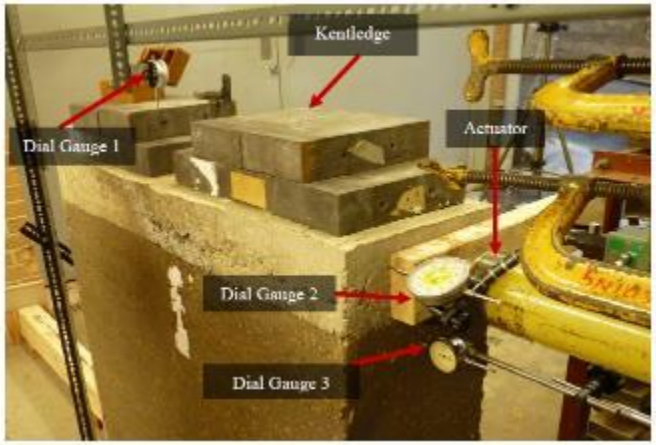
Shearing capacity between rammed earth and concrete capping beams (2014-15)

Experiment design





Experiment performance



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Post-earthquake assessments (Nepal, 2015)

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International development & urban landslides

Cut and fill slopes

Informal construction

No drainage

...Rainfall-triggered landslides

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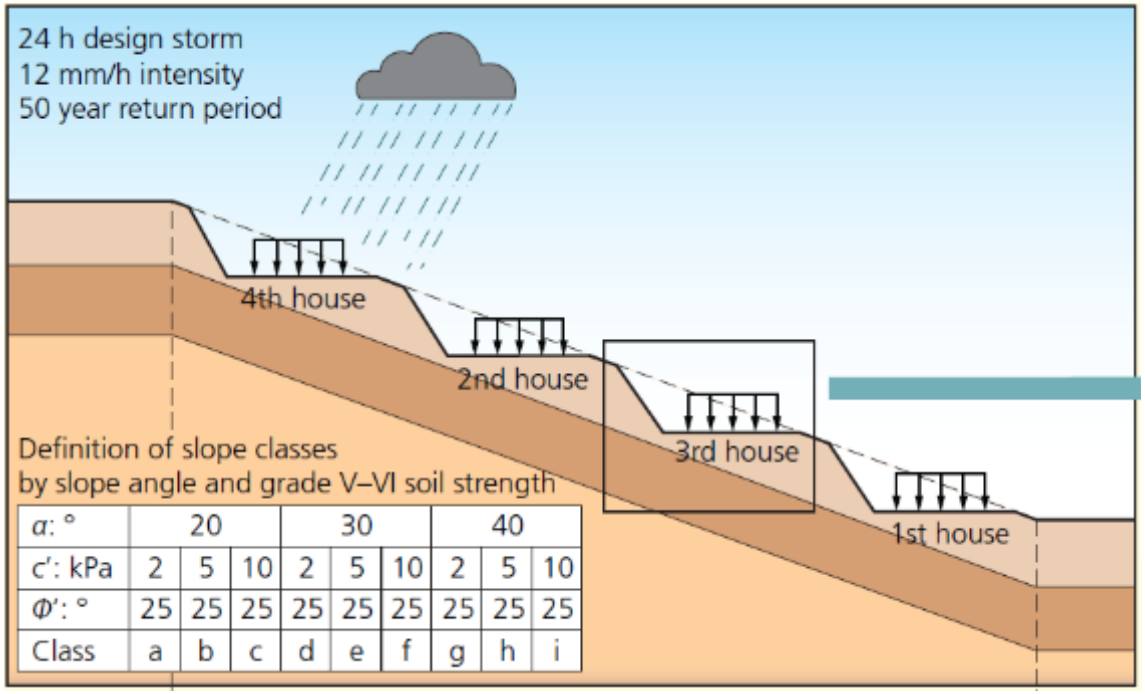
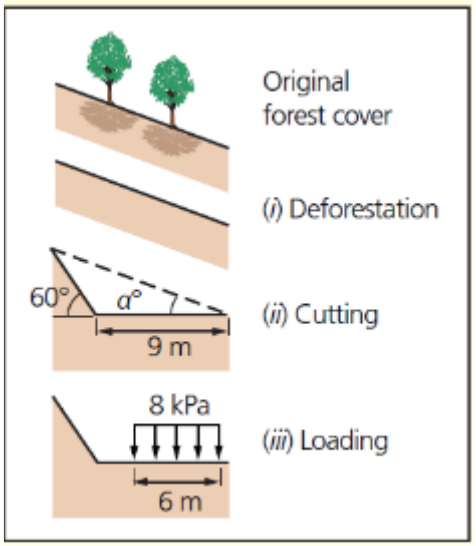
Example student research project

Year 3 undergraduate research project: *Low-cost landslide mitigation measures for urban communities*



α: °	20			30			40		
c′: kPa	2	5	10	2	5	10	2	5	10
Φ′: °	25	25	25	25	25	25	25	25	25
Class	a	b	c	d	e	f	g	h	i



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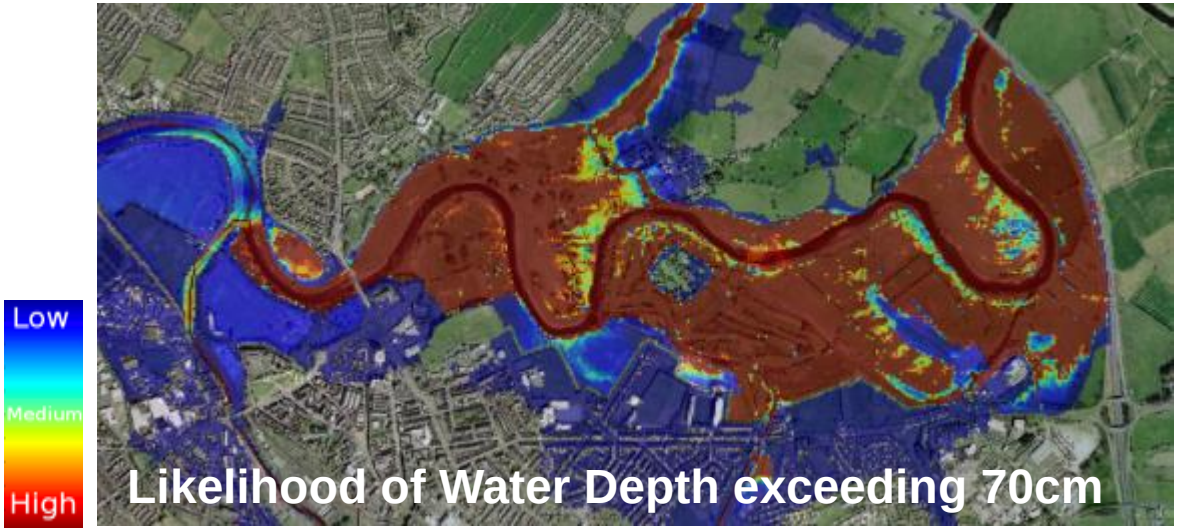
Flood modelling and mitigation



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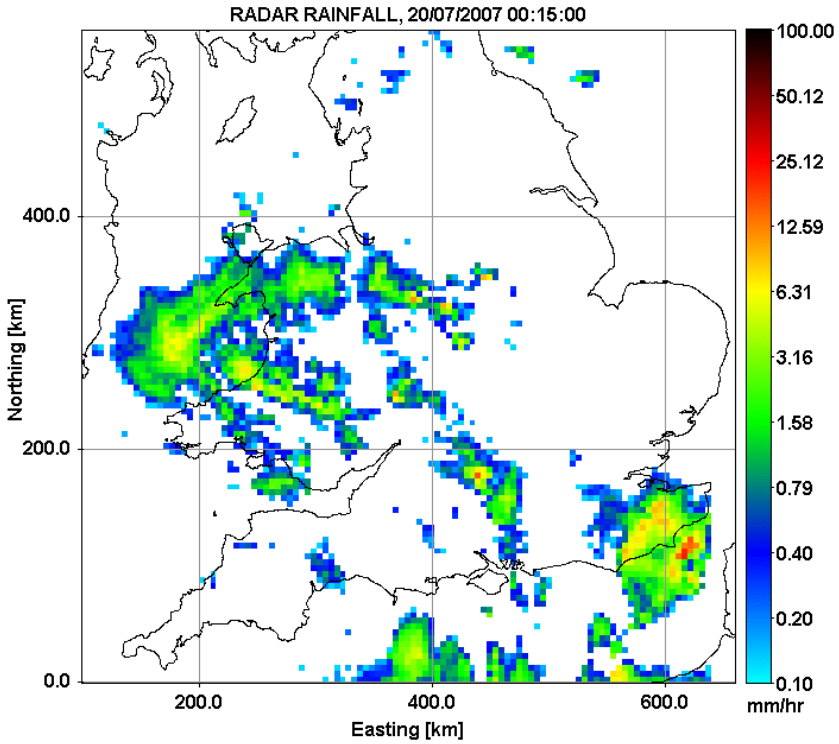
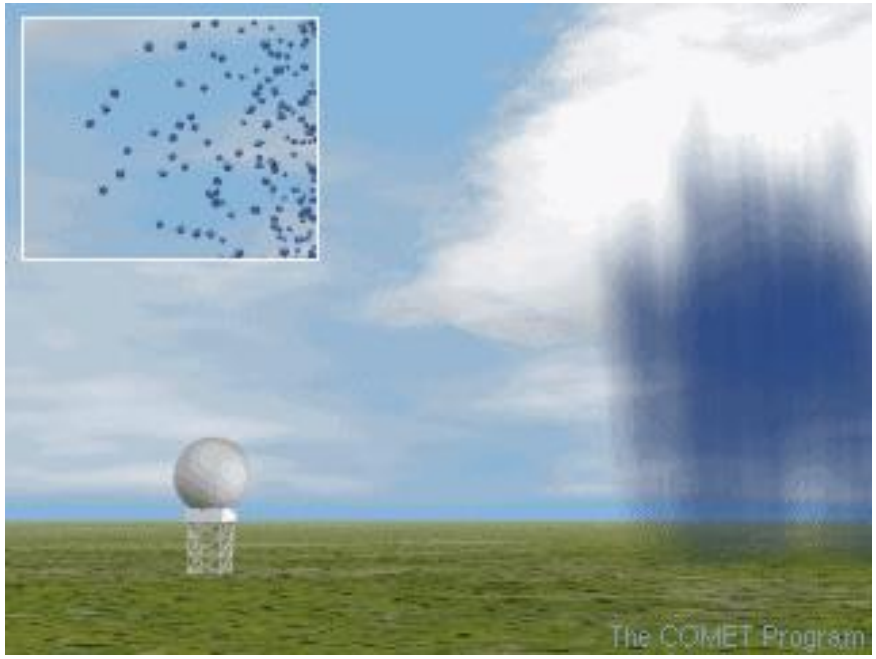
Weather radar for flood forecasting





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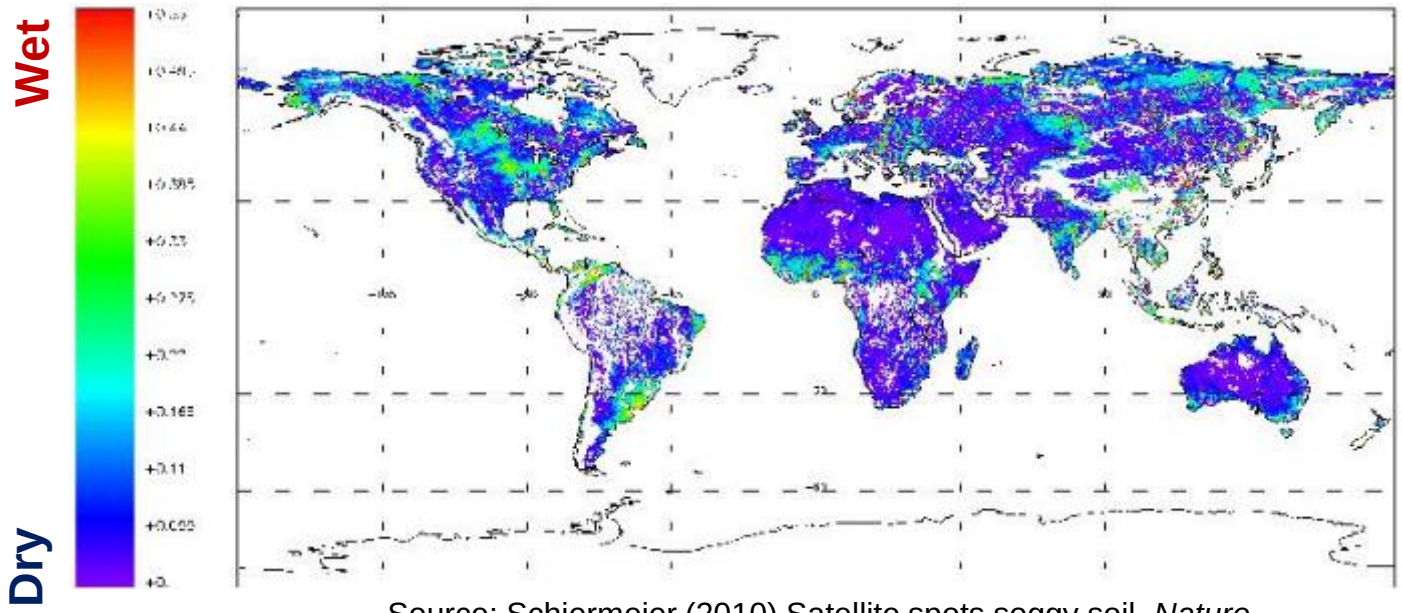
Soil moisture estimation from space

The **SMOS** (Soil Moisture and Salinity Mission) satellite sensor produces products at ~40km grid resolution over the globe.

Accurate measurements of soil moisture are key for flood/drought forecasts



Source: Schiermeier (2010) Satellite spots soggy soil, *Nature*.

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3rd year water resources project

- Geology
- Location
- Materials
- Volume
- Stability
- Water provision
- Env. impact
- Construction
- Costs
- Safety

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Systems, sustainability & smart cities

Use of digital technologies or information and communication technologies (ICT) towards

- Green cities
- Sustainability
- Zero carbon emission
- Improved life quality

Green energy

Bristol Is Open is a joint venture between the University of Bristol and Bristol City Council

Open monitoring of any aspects of city life, including energy, air quality and traffic flows

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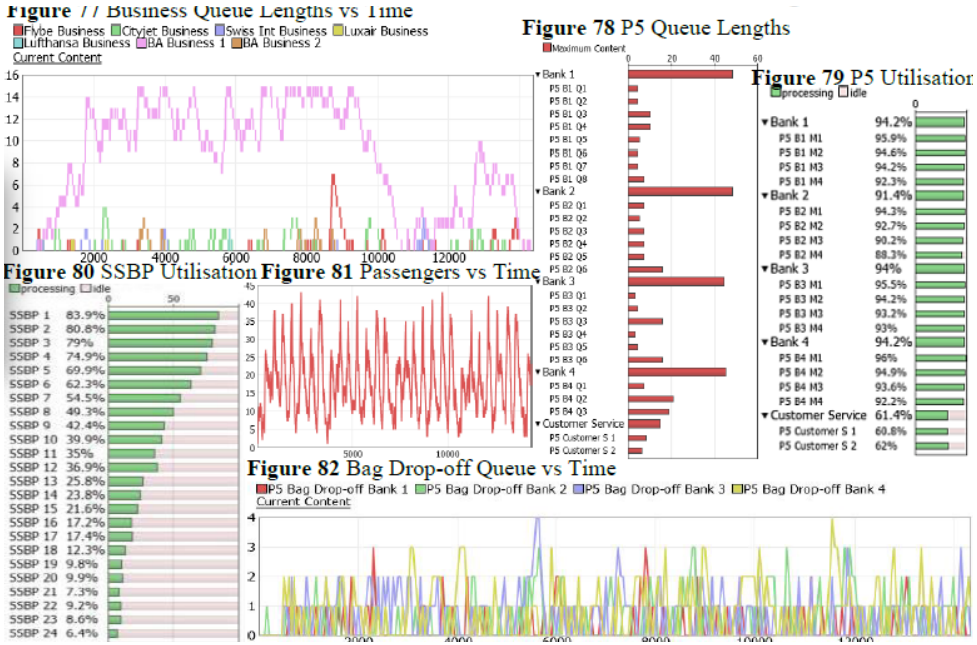
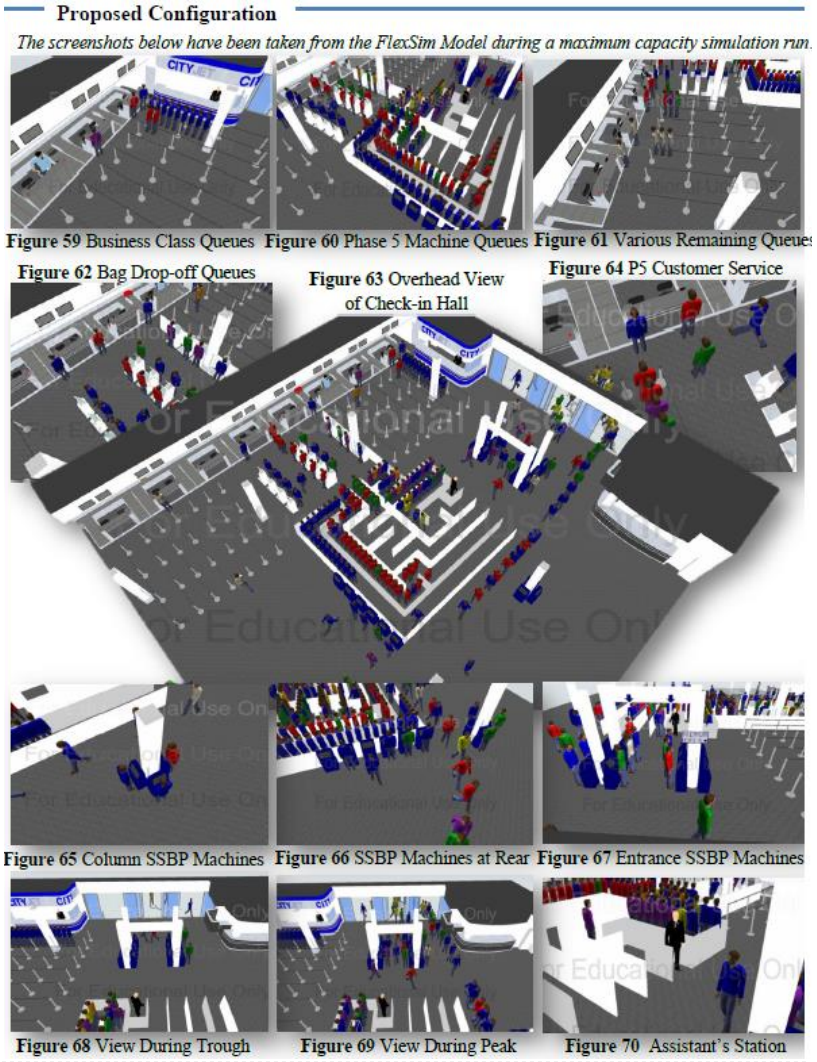
Example student research project

Year 3 undergraduate research project:

Queue modelling – A study into the ability of self-service machines to increase capacity and meet future demands of confined urban service areas





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Research Project Showcase Day

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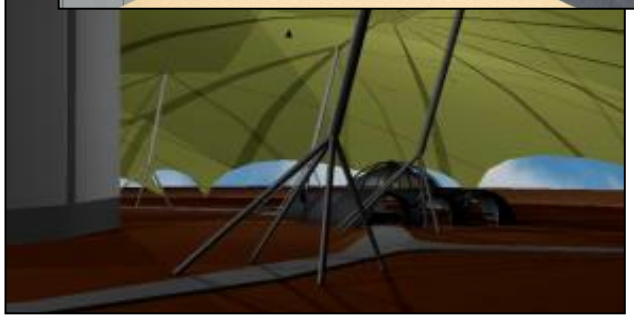
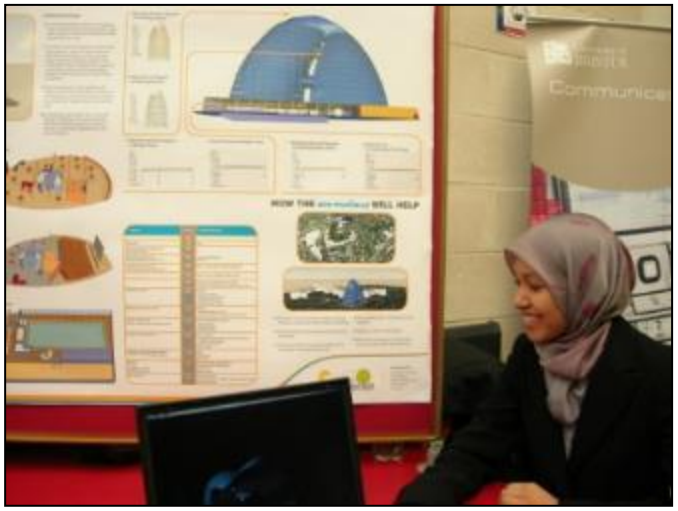
4th Year Design Project

- New Thames Barrier
- Fixed Link to the Isle of Wight
- Eco-house
- Earthquake Resilient Schools in Malawi
- Demountable Exhibition Centre
- Visitors Centre for Thatchers Cider
- Royal Opera House Costume Centre

…and many more!





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⇨ Putting it into practice - design

THE OCEAN SKYSCRAPER

University of BRISTOL

PROJECT BRIEF

Explore the possibility of an **inspirational concept design** for a high quality "Ocean Skyscraper" that rises out of the **Pacific Ocean**, to be used as a **Luxury 5* Hotel**.

This objective can be best achieved through a development which:

- Creates a **landmark** that provides a **visually and aesthetically engaging design**
- Is of **high quality design** and respects the **context of the site**
- Contributes to the sense of **place** and **community** at the chosen location
- **Maximizes** the new development potential with **attention to sustainability** and **ecology**
- Provides the **facilities** expected in a **Luxury 5* Hotel**

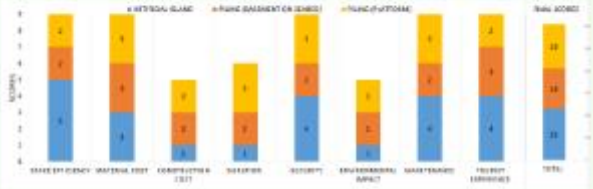
SITE SELECTION

East Asia and **West USA** were considered as **preliminary locations** for the skyscraper. Mainly due to extreme **natural phenomena** and limited **data availability** in East Asia, the skyscraper will be located in **West USA**.

The locations considered were:

1) San Francisco 2) Los Angeles
3) San Diego 4) Oahu

It was also considered that the closer the site to either pole of the planet, the higher its average wind speed.



The selected site for the skyscraper, based on the above considerations, was the **Oahu** island in **Hawaii**.

More specifically, it will be located 400m offshore of Waialae Beach.

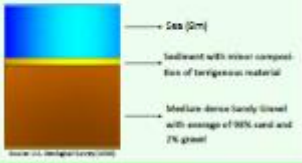
Key Facts

- High tourist expenditure
- Strategic location to cater tourists from both East Asia and West USA
- Breathtaking scenery and hospitality
- Adequate labor power and well established construction industry
- Easily accessible via the Honolulu International Airport

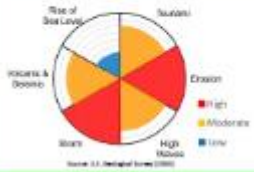
SITE INFORMATION

- To minimize environmental impact the selected site is not located in a marine protected area
- To optimise social impact the hotel fits its surrounding built environment (hotels, golf club)

Seabed Geology



Hazard Assessment



STAKEHOLDER ANALYSIS

RELEVANT CASE STUDIES

BURJ AL-ARAB , DUBAI

- Luxury Hotel on artificial island
- Resembles a sail
- Skin friction piles
- Perforated concrete blocks

THE GHERKIN, LONDON

- Diagrid Façade / Exoskeleton
- Similar floor area and height
- Similar structural system

PALM JUMERIAH, UAE

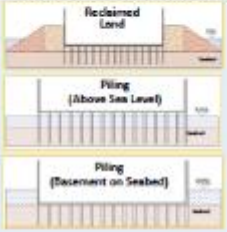
- Breakwater reduce wave impact
- BPS used for reclaimed island
- Vibro-compaction
- Opening in the breakwaters to improve water circulation

CAPITAL GATE, ABU DHABI

- Diagrid Façade
- Pre-cambered core
- World's most leaning tower (18°)
- Big eccentricities and cantilevers

FOUNDATION CONCEPTS

The foundation base is to be constructed 400m offshore of Waialae Beach at an 8m depth in Maunalua Bay



Reclaimed Land

- Slow construction (settlement, compaction)
- High environmental impact (turbidity)
- Low maintenance costs
- Low wave impact
- Adequate safety and security

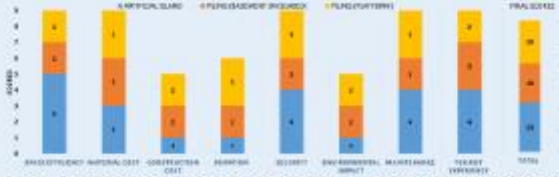
Piling (Above Sea Level)

- Relatively fast construction
- Moderate environmental impact (noise disturbance)
- Moderate maintenance costs
- Moderate wave impact
- Adequate safety and security (pile failure)

Piling (Basement on Seabed)

- Slow construction
- High environmental impact (noise Disturbance)
- High maintenance costs
- Moderate wave impact
- Sensitive safety and security (leakage)

CONCEPT SELECTION



The selected concept for the foundation base, based on the above considerations, was the "Artificial Island"

ARCHITECTURAL CONCEPTS

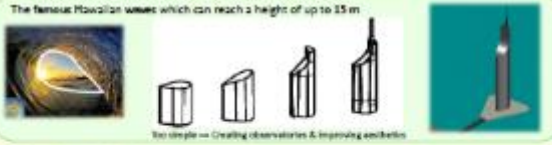
CONCEPT | EVOLUTION | PROPOSAL

FLOWER

Hibiscus, Hawaii's state flower, traditionally worn by Hawaiians girls

WAVE

The famous Hawaiian waves which can reach a height of up to 15 m



WHALE

Resembling a whale rising from the depths of the ocean

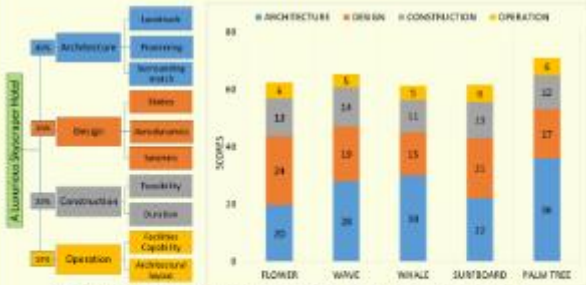
SURFBOARD

Hawaii, the place where surfing was invented

PALM TREE

Skyscraper resembling Hawaii's trademark, the palm tree

CONCEPT SELECTION



The selected architectural concept, based on the above considerations, was the "Palm Tree"

LOUIS WONG NICOLAS HADJIPANTELIS SPYROS AYFANTIS YIH ZHE NG SUPERVISOR: DR. D. KARAMITROS

DECEMBER 2014

⇨ Putting it into practice - design

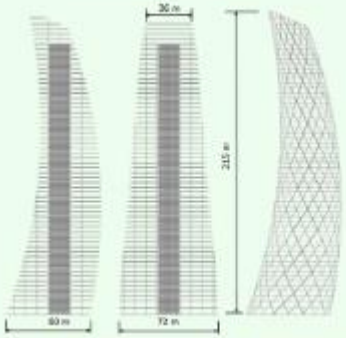
THE OCEAN SKYSCRAPER

UNIVERSITY OF BRISTOL

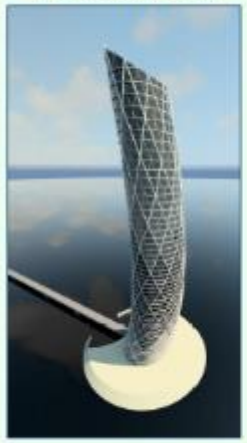
FINAL ARCHITECTURAL DESIGN

THE OCEAN SKYSCRAPER

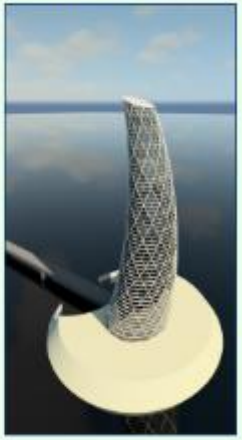
ELEVATION VIEWS



BIRD'S-EYE VIEW



ISOMETRIC VIEW



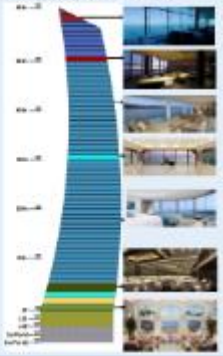
SKYSCRAPER HEIGHT COMPARISON

PRELIMINARY DESIGN

SPACE ALLOCATION

The space for the required facilities was allocated based on the needs of a typical 5* hotel.
A total of 400 suites were allocated, accommodating 1471 guests at full capacity.

TYPICAL FLOOR PLAN



Legend

Facilities	Area (m²)
[illegible]	1141
[illegible]	1141
[illegible]	2122
[illegible]	6171
[illegible]	1070
[illegible]	1070
[illegible]	1800
[illegible]	1827
[illegible]	3056
Carpark	3056

ARTIFICIAL ISLAND DESIGN

An Artificial island with the following characteristics was chosen as the foundation base of the skyscraper:

- It blends into the local environment and enhances aesthetic and visual impact
- It is buildable and expertise is widely available in the industry
- The required dredging material is available at a nearby disposition site (Ideal)
- Underwater bubble curtain needs to be installed around the construction site to reduce noise disturbance.

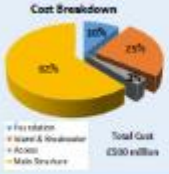
ISLAND SUPPORTING WALL

The island's supporting wall will be constructed around the island's perimeter in the form of a cofferdam to provide protection from wave erosion. The breakwaters will also be constructed using similar materials and construction process.

COST & TIMELINE

Preliminary estimations indicate an overall cost of about £500m during 4.5 years.

Cost Breakdown



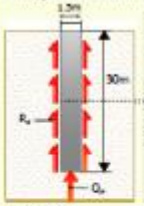
Construction Time Breakdown

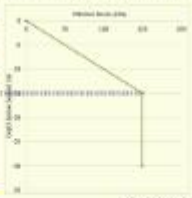
PILED FOUNDATIONS

Estimated Total Vertical Load = 1.7×10^{8} kN; Horizontal Moment@base = 6.72×10^{8} kNm

Shallow foundation design indicated an excessive settlement of 523.67mm, even though it possesses adequate bearing capacity. q'_{all}=1373kPa > q'_{ult}=621kPa.

Thus, piled foundations with the following characteristics are proposed:





R_u=50
ϕ'=35°
K_s=0.7k
δ=$\tan\phi'$
K_b=15MPa
γ'=10.2kN/m³

Pile Resistance

Using DA-2, Single Pile Resistance, R_u = 17396kN

Pile Settlement

Single Pile Settlement = 25.6mm

- According to preliminary estimations, 130 driven piles are needed, with c/c spacing of 5.3m, each measuring 1.5m in diameter and 30m in length.
- The final foundation design is be completed after the structural design is finalised.

STRUCTURAL ANALYSIS

Gravity loads were estimated based on preliminary materials selection which included:

- ASB Composite Slabs
- Steel CHS Columns
- Reinforced Concrete Core
- Double Glazed Glass Panels
- Live Loads (ASCE-7)

Preliminary conservative wind calculations were undertaken based on ASCE-7, where Hawaii is classified as a hurricane prone region. Design wind speed (for 100 yrs) corresponds to a 3 second gust wind including topographical factors, but not building's geometry.

Simplified Model

- Simplified squared section model
- Assumed concrete core 1m thick
- Diagrid structure not considered

Wind Load

- Design Wind speed: 34m/s
- Design Wind pressure: 3kPa @130m above MSL
- Assumed exponential wind profile

Deflected Shape

The final structural design will incorporate the accurate building model.

WHAT'S NEXT?

- **Geotechnical Design:** Foundations, Island - Slope Stability, Ground Improvement Liquefaction, Retaining wall
- **Structural Design:** Accurate building model - core, ABS slab, diagrid, columns, connections
- **Dynamic analysis:** Seismic, Preliminary Wind, Wave, Airplane impact
- **Access design:** Bridge structure, Bridge Foundations, Yacht Marina, Parking
- **Construction planning:** Health & Safety, Timescale, Work Breakdown, Resource Allocation
- **Safety:** Fire engineering, Evacuation plan, Structural Redundancy
- **Architecture:** Building Layout, Island Development

LOUIS WONG NICOLAS HADJIPANTELIS SPYROS AYFANTIS YIH ZHE NG SUPERVISOR: DR D. KARAMITROS

DECEMBER 2014

Bristol Trams 2030

P. Christopher, C. Kennedy, H. Pollock Fraser and T. Webster

University of BRISTOL

BRISTOL TRAMS 2030

Introduction

Bristol Trams 2030 fulfils Bristol's need for improved public transport by integrating a tram network into the city.

Bristol once boasted an extensive tramway system, which was decommissioned after damage during World War II. Recent changes in the local and national political environments have sparked renewed interest in light rail as a viable public transport solution.

Bristol suffers considerably from congestion. Evidence has shown that trams are the most successful means of effecting modal shift away from the private car, due to their improved capacity, comfort and public perception. Furthermore, trams are the most sustainable public transport solution, decreasing emissions within the city centre.

Bristol Trams 2030 goes beyond the scope of existing transport plans, which set out transport developments until 2026, by developing a visionary answer to Bristol's long term transport needs.

Design Considerations

Bristol Trams 2030 aims to accomplish the following:

- Promotion of public transport
- Reduction of traffic levels and congestion in Bristol
- Improved access to key locations
- Seamless integration with the existing transport network

1 **Route** – The cornerstone of Bristol Trams 2030 was the route choice. This was central to all other design decisions.

2 **Phasing** – The final network comprises 7 phases, the first two will be considered in detail.

3 **Stakeholders** – *Bristol Trams 2030* has considered all relevant stakeholders and their needs.

4 **Tram Choice** – Prior to detailed design, the optimum tram vehicle for the network needed to be identified.

5 **Temple Circus** – Temple Circus experiences high traffic volumes and must accommodate three tramlines.

6 **City Centre** – The tramline must navigate this complex junction and high profile pedestrian plaza.

7 **Station Design** – An iconic, repeatable and functional station has been designed for implementation across the network.

8 **Bristol Temple Meads** – This key transport hub is an essential location for tram integration.

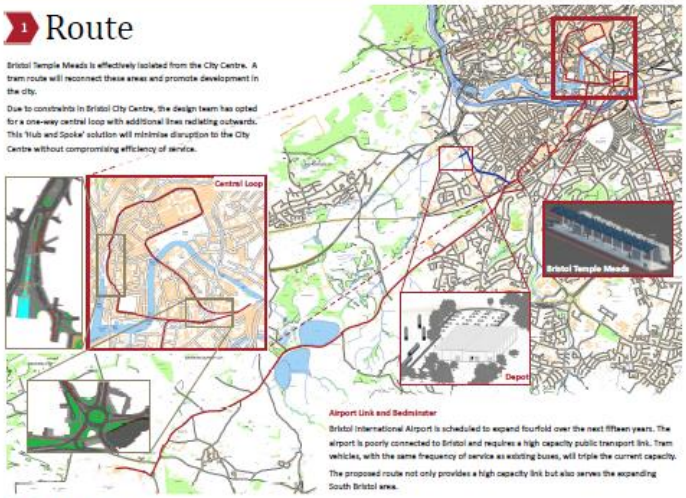
9 **Network Design** – Extensive network analysis has been conducted to optimise the tram route and study demand.

10 **Depot Design** – This essential facility for tram maintenance and storage has been designed.

1 Route

Bristol Temple Meads is effectively isolated from the City Centre. A tram route will reconnect these areas and promote development in the city.

Due to constraints in Bristol City Centre, the design team has opted for a one-way central loop with additional lines radiating outwards. This 'Hub and Spoke' solution will minimise disruption to the City Centre without compromising efficiency of service.



Airport Link and Sedminster

Bristol International Airport is scheduled to expand fourfold over the next fifteen years. The airport is poorly connected to Bristol and requires a high capacity public transport link. Tram vehicles, with the same frequency of service as existing buses, will triple the current capacity.

The proposed route not only provides a high capacity link but also serves the expanding South Bristol area.

2 Phasing

1 **Phase 1: Airport Express** – Public transport to the airport requires improvement. The required capacity is expected fourfold by 2030 and the extra passengers will help support later phases.

2 **Phase 2: City Centre Loop** – The city centre loop links provides the backbone of the system with later phases connecting into it. The loop will be free for both residents and tourists to encourage use of the system.

3 **Phase 3: Cribbs Causeway/Aztec West** – Current links to Cribbs Causeway and Aztec West are congested. This phase will provide a much needed link between the two hubs and the City Centre.

4 **Phase 4: Hengrove and South Bristol** – South Bristol is the primary area of expansion in Bristol and a reliable passenger link will make the area a popular commuter zone.

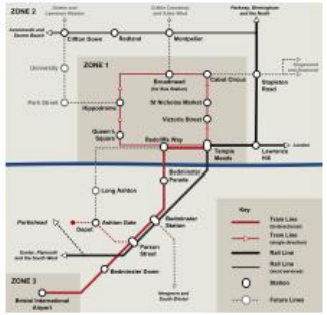
5 **Phase 5: Lawrence Weston via University** – Provides a commuter link to a key residential district via the University and Clifton.

6 **Phase 6: Kingswood/Downend** – East Bristol is poorly connected to public transport. A tram line to these areas will help to connect it with the rest of the city.

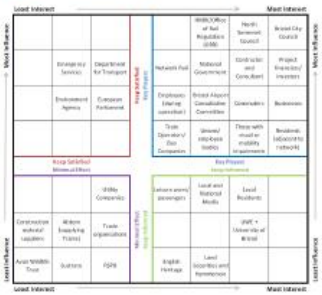
7 **Phase 7: Ashton Gate via Spike Island** – This link will provide a capacity increase for the South Bristol area and a link to the Long Ashton Park and Ride facility.

Proposed

Future Expansion



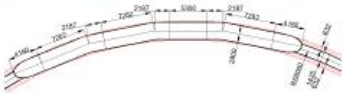
3 Stakeholders



4 Tram Choice

Bristol Trams 2030 will use Alstom's Citadis Dualis Tram. The Citadis Dualis (right) has been used successfully in many European cities. It can operate without overhead electrical lines, using Alstom's APS ground supply system, thus preserving the aesthetic aspect in Bristol City Centre. Furthermore, it has a high passenger exchange rate (Increasing network efficiency) and a modular layout that permits alteration of capacity during service. The Citadis Dualis can operate with a minimum track radius of 25m, however a 50m radius will be used to permit greater design speeds. The tram's

DKE (Developed Kinematic Envelope) defines all highway clearances. This was identified using a swept path analysis (below) and by accounting for track variability and lateral suspension motion.



5 Temple Circus

The Introduction of Bristol Trams will cause minimal traffic disruption at Temple Circus. The tram will cross roads at points that are already signalled, with only minor changes to the location of signal heads. Signal cycle times will be adjusted to minimise tram waiting times whilst optimising traffic flow. Low traffic flow and clear visibility will permit trams to cross Friary at a priority junction. Only minor changes to the existing road layout (shown in orange) will be necessary.

Roundabout Cut-through

The roundabout cut-through will minimise journey disruption during construction and operation. This technique has been employed successfully in many European Cities, most notably in the Netherlands. Yellow boxes shall be used to prevent blockage of the tram path, while stop lines shall be moved backward.

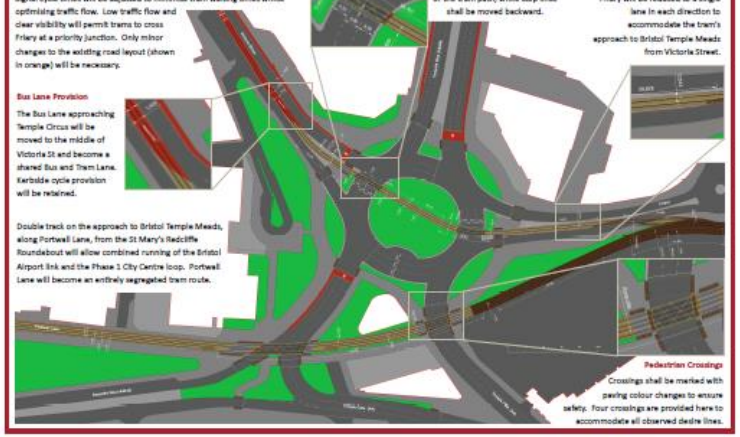
Friary Alignment Changes

Friary is currently a two lane dual carriageway, however peak-hour traffic counts (13/02/14) showed that it only carried 306 passenger car units per hour. Therefore, Friary will be reduced to a single lane in each direction to accommodate the tram's approach to Bristol Temple Meads from Victoria Street.

Bus Lane Provision

The Bus Lane approaching Temple Circus will be moved to the middle of Victoria St and become a shared Bus and Tram Lane. Kerbside cycle provision will be retained.

Double track on the approach to Bristol Temple Meads, along Portwall Lane, from the St Mary's Redcliffe Roundabout will allow combined running of the Bristol Airport link and the Phase 1 City Centre loop. Portwall Lane will become an entirely segregated tram route.



Pedestrian Crossings

Crossings shall be marked with paving colour changes to ensure safety. Four crossings are provided here to accommodate all observed desire lines.

6 City Centre

Carriageway Widening

Colston Avenue will be widened to accommodate a new shared tram and bus lane; cycle provision and the existing bus stops (reduced to 2.7m wide).

Right-Turn Filter Lane

The shared Tram and Bus Lane uses an existing traffic lane so an additional right turn lane will be provided for the small volume of turning traffic.

Cycle Provision at Track Crossings

A cycle path encourages cyclists to cross tram tracks at an angle greater than 60° to minimise risk of injury due to tram rails.

Segregated (Off-Street) Route

Deterrent paving will be used at the entrance and exit of segregated sections, to discourage entry by other vehicles. Segregated, off-street, track will minimise junction disruption (the tram track could not be confined to one lane through the Colston Avenue Intersection, due to track curvature limits). It also facilitates an off-street City Centre station.

Demarcation of Tram Path

Segregated sections will use lighter paving colours and run between kerbs, below the level of the pedestrian plaza.

Track Geometry

20m long transition curves will be used where the track changes from a straight section to a 50m radius curve (as recommended by Mott MacDonald). Transition curve length can be reduced for larger radii.

Widening of Broad Quay

Broad Quay will be widened to accommodate a full width shared bus and tram lane (3.65m) and full width bus stops on each side (3m each).

Segregated Cycle Lanes

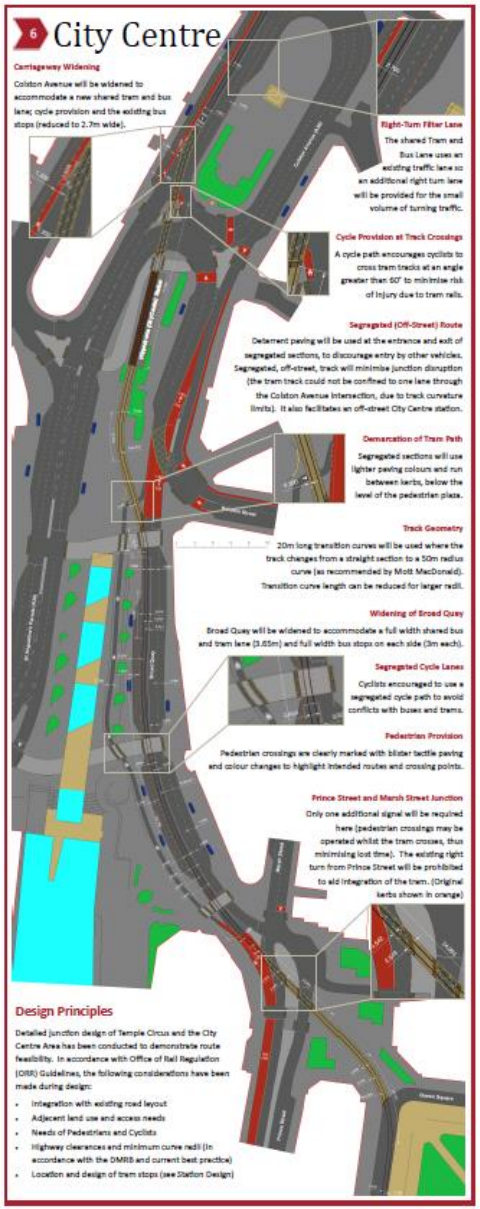
Cyclists encouraged to use a segregated cycle path to avoid conflicts with buses and trams.

Pedestrian Provision

Pedestrian crossings are clearly marked with blister tactile paving and colour changes to highlight intended routes and crossing points.

Prince Street and Marsh Street Junction

Only one additional signal will be required here (pedestrian crossings may be operated whilst the tram crosses, thus minimising lost time). The existing right turn from Prince Street will be prohibited to aid integration of the tram. (Original kerbs shown in orange)



Design Principles

Detailed junction design of Temple Circus and the City Centre Area has been conducted to demonstrate route feasibility. In accordance with Office of Rail Regulation (ORR) Guidelines, the following considerations have been made during design:

- Integration with existing road layout
- Adjacent land use and access needs
- Needs of Pedestrians and Cyclists
- Highway clearances and minimum curve radii (in accordance with the DMRB and current best practice)
- Location and design of tram stops (see Station Design)

Bristol Trams 2030

P. Christopher, C. Kennedy, H. Pollock Fraser and T. Webster

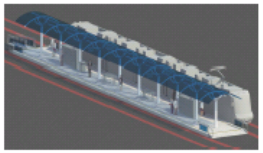
University of BRISTOL

BristolTrams 2030

7 Station Design

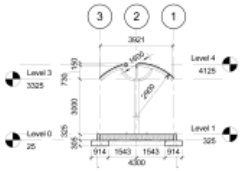
Introduction

The route has 12 stops along its 10 miles of track. To provide a consistent visual identity, the following generic tram station has been designed. This will be adapted to each individual location on a case by case basis.



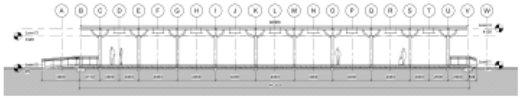
Design

The basic station is designed to be a flexible, yet consistent structure. The core design is a 325mm deep reinforced concrete slab with a tubular steel super-structure supporting a glass roof. There are two station variants, a double track, end-accessed version and a single-track, side-accessed version. Individual elements such as ramps and stairs shall be adapted for each location.



Sustainability

The roof will be made of prefabricated photovoltaic panels, without a solar blocking layer to allow light to pass through. The 160m² roof will typically produce 24kW of electricity which will be stored to power station lighting and services.



8 Bristol Temple Meads

Bristol Temple Meads is the South West's primary rail station and a major node on the tram network. 24,000 passengers use the station every day. The station forecourt was redeveloped in the early 1990s and is now near capacity. A well integrated tram connection to the west of the station, away from the main forecourt, will alleviate this.

Location

The location of the tram station allows passengers to connect easily with the existing station entrance. Routing the tram along Friary provides an efficient connection into the station itself. Although Friary is in a business quarter, its main users are pedestrians and care must be taken to ensure that the trams run in a segregated area where possible.

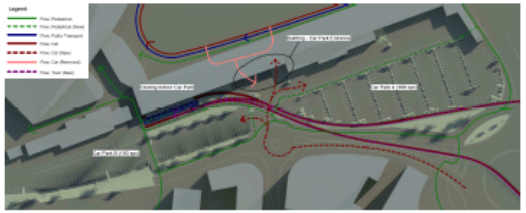
Impact

Bristol International Airport is due to undergo a fourfold expansion by the year 2030. Having a high-speed, reliable link with national rail services will secure its market position in the UK and improve access to the region.

The local loop will allow the station to service a much larger region of commuters and help ease the city's burgeoning congestion problems.

Access and Parking

Access to Bristol Temple Meads is currently under strain, with the forecourt handling large volumes of buses, coaches and taxis. Parking facilities are also accessed via the station forecourt and through the station building. The rear car park is in need of redevelopment and a new car park entrance is proposed from the roundabout on Friary. This would increase the total number of parking spaces from 374 to 562, as well as reducing demand on the station forecourt.



9 Network Design

Design Process

The fundamental design decision at the heart of *Bristol Trams 2030* was the route choice. This decision had to be made at the outset and refined as the project progressed. The network underwent three stages of design (right).

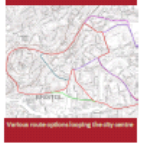
1) Network Area

The team researched Bristol's existing and proposed transport corridors and identified that stronger links were needed between Bedminster, the City-Centre and Bristol International Airport.

Defined study area.

2) Route Choice

Various routes through the City Centre were analysed and transit corridors through Bedminster, Spike Island and Ashton Gate were considered.



Various route options keeping the city centre

3) Network Analysis

The most appropriate route was a loop in the City Centre and a line that replaced the existing A1 bus line. To verify that this route would have sufficient demand, extensive transport modelling was conducted.

Results representing public transport and private car usage.

Model Design Considerations

All modelling was carried out in accordance with the government's Transportation Analysis Guidance (WebTAG) and the Highways Agency's DMRB v.12.

PTV Visum Software was chosen to conduct the analysis.

Model Scope

- The *Bristol Trams 2030* model investigates the impact of a new tramline on traffic flow and passenger demand

Definition of the Study Area

- Stop catchment areas and points of interest are considered within the defined geographical area

Required Capabilities of the Model

- To calculate the mode choice of users and to output the traffic flow under different scenarios

Modelling Risk	Risk Mitigation
False inputs	A team member, independent of the model design, has checked the input data.
False theory	The model was validated using road traffic counts and current bus timetables.
Failure to represent human behaviour realistically	Realism and sensitivity tests were conducted by rerunning the model with changes to the inputs and model parameters (e.g. fare changes).

Model Assumptions and Limitations

- 2014 infrastructure will remain unchanged in 2030
- The model area contains all origins and destinations
- The airport and Temple Meads Station have been assigned artificial populations based on their entrance and exit figures
- HGV trips are not modelled
- The model share of bicycle travel has also been excluded due to licensing limitations
- The model assumes that users travel by petrol car, bus, tram or on foot
- Travel behaviour is assumed for Monday-Friday only and is affected only by generalised cost (G)

$G = W + r$ W = composite Journey time; r = remaining measurable cost (waiting time, fare price, walking time)

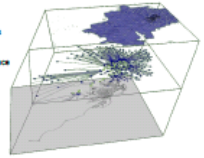
Modelling Process

Network Inputs
- Map, Node and Link Data
  - Open Street Map extracts
  - Ordnance Survey ITN Layer
  - National Street Gazetteer
- Public Transport Data
  - National Public Transport Access Node Database
  - Timetables imported from Traveline
- Zone Boundary Data
  - Lower Level Super Output area boundaries

Origin-Destination Inputs
- Census Data
  - Economic Activity datasets
  - Workplace datasets
  - Car ownership
  - Travel Flows
- Education Department
  - Education places
- Passenger Numbers
  - Office of Rail Regulation
  - Civil Aviation Authority

Travel Behaviour Inputs
- National Travel Survey
  - Trips by time of day
  - Modal Share
  - Vehicle occupancy rates
- WebTAG workbook
  - Value of Time
  - Fuel Costs

Network Model → O/D Model → Behaviour Model



Base Model → Model Calibration → Model Validation → Optimised Base Model → Forecast Growth → Base Model 2030 → Scenario with tram route introduced → Model Comparisons → Optimised Tram System and Results

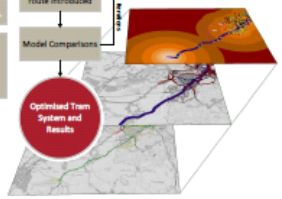
Calibration Parameters
- DfT using traffic count data
- The Highway Agency's Traffic Information System (MCH)

Sensitivity Tests
- Carried out by changing journey and trip impedance values

Realism Tests
- Carried out by changing connectors from zones to the network

Growth Rates
- O-D matrices factored by National Trip End Model growth factors from the DfT's TEMPro software to simulate traffic in 2030

Feedback



Model Calculations

Begin → Trip Generation → Calculate Skim Matrices → PvT Assignment → PuT Assignment → End

Activity Pairs
- Home-Education
- Home-Work
- Home-Retail

Public (PuT) and Private (PvT) Transport Skims
- Scheduled time — PuT & PvT
- Wait time adapted — PuT
- Transfer wait time — PuT
- Number of transfers — PuT
- Fare — PuT
- Trip distance — PvT
- Access & Egress times — PvT

Equilibrium Assignment
Assumes that drivers perceive journey costs in the same way. Traffic flow is adjusted so that no driver can reduce their journey cost by changing route.

Schedule-Based Assignment
Trip allocation was made at mode choice stage. There is good passenger information available to the user.

PvT Assignment
- Trip Impedance
- Trip Distribution
- Mode Choice
- Recalculate Skim Matrices

Iterations

Generalised Cost of Travel
- Invehicle Time
- (Vehicle costs/Value of Time)

Logit Function
Function calculates the distribution by taking the differences of trip impedances. The generated trips are spread over the available destinations using trip impedances.

Logit Function
Demand totals for car & non-car trips calculated for
- Home-Education
- Home-Work
- Home-Retail

using the logit function.

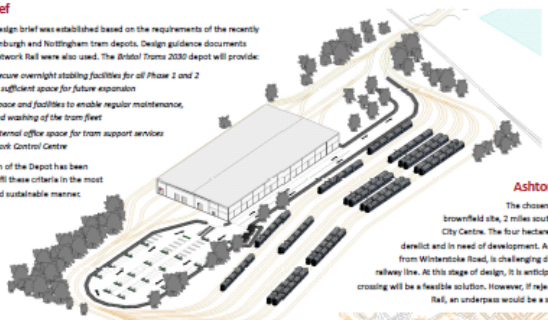
10 Depot Design

Design Brief

The following design brief was established based on the requirements of the recently constructed Edinburgh and Nottingham tram depots. Design guidance documents published by Network Rail were also used. The *Bristol Trams 2030* depot will provide:

1. *Adequate secure overnight stabling facilities for all Phase 1 and 2 trams, with sufficient space for future expansion*
2. *Adequate space and facilities to enable regular maintenance, servicing and washing of the tram fleet*
3. *Sufficient internal office space for tram support services and a Network Control Centre*

A detailed design of the Depot has been conducted to fulfil these criteria in the most cost effective and sustainable manner.

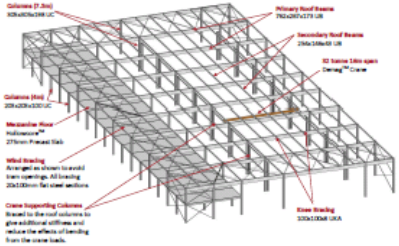


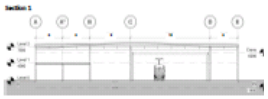
Ashton Vale Site

The chosen site (below) is brownfield site, 2 miles south west of Bristol City Centre. The four hectare site is currently derelict and in need of development. Access to the site from Winterstoke Road, is challenging due to an existing railway line. At this stage of design, it is anticipated that a level crossing will be a feasible solution. However, if rejected by Network Rail, an underpass would be a suitable solution.

Structural Design

The Depot site is located in an industrial area of the city, adjacent to storage warehouses and railway tracks. This has permitted the depot to be designed purely for functional and efficient performance. A steel framed building was determined to be the most cost effective solution.





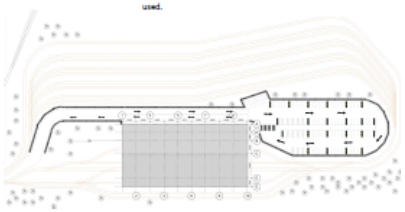
Foundations

The site is underlain by soft silty clayey strata to a depth of 8.5m, below this is stiff Mercia Mudstone. The soft strata is not suitable for shallow foundations, therefore and bearing piled foundations will be used.

Track Layout

The site geometry was the main constraint for the track layout around the depot. The layout has been designed to:

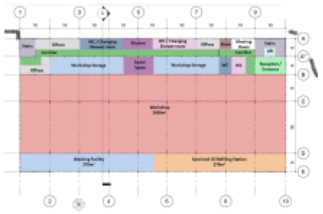
- Minimise disruption in the event of a tram breaking down or failing to start by providing multiple track connections.
- Allow trams at any storage location to enter any part of the workshop, providing greater flexibility.



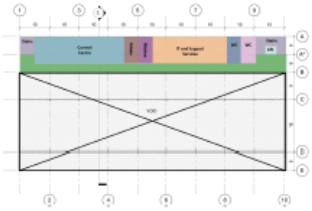
Room Plans

The floor plan has been designed to maximise the space available and to separate the tram workshop and the office space required for support staff. Note that adequate space has been allocated for storage, toilets, offices, and employee social space.

Ground Floor



First Floor



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Example student design project

THE ECO-FARMSCRAPER

University of Bristol
Department of Civil Engineering

March 2016

Group 3

Mohammadreza Haghshenas
Lim Chuin Phin Sebastian
Rushang Mita
Patrick Samengo-Turner
Henryk Taylor

Supervised by: Dr Dawei Han

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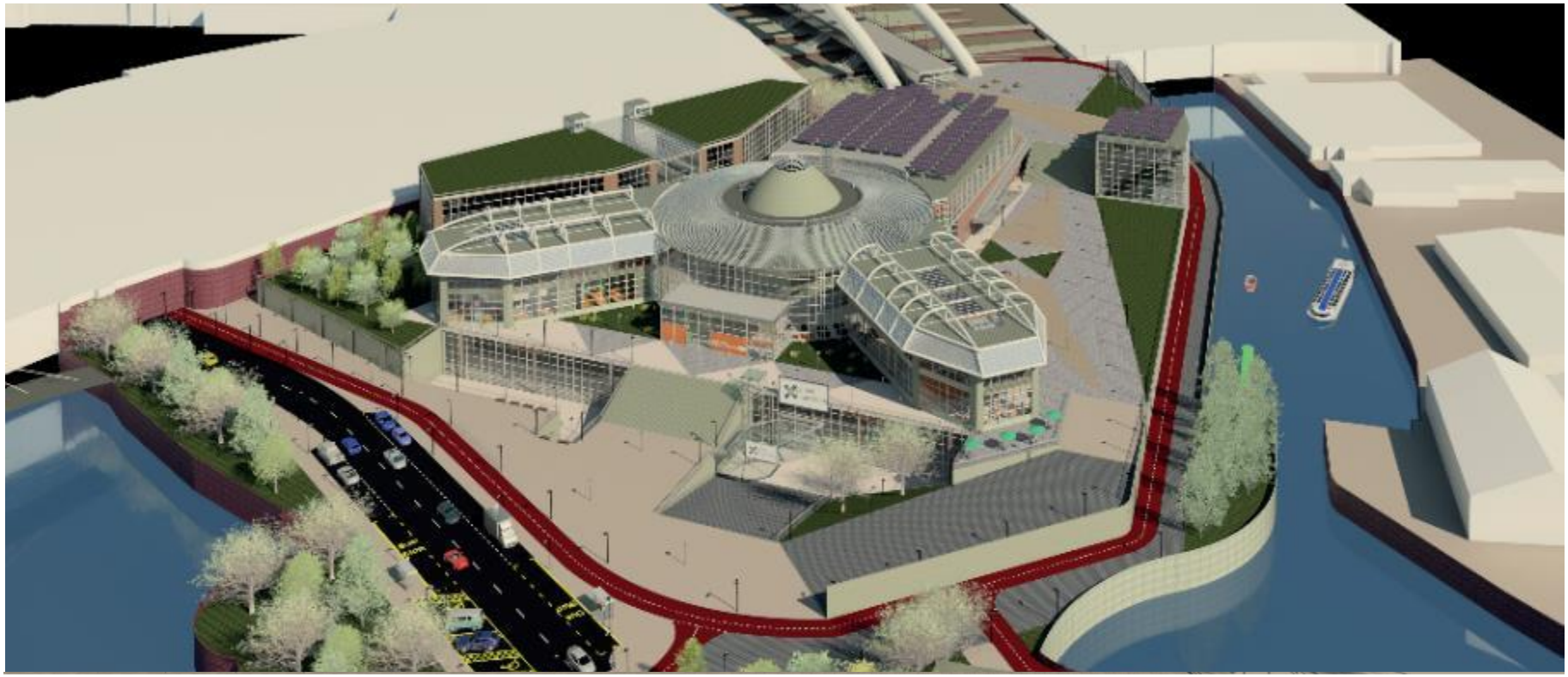

South West Regional Assembly

Bristol Expo Centre

Bristol Concert Hall

Thomas Hall (th1754) | Rob Edwards (re1763)
Katie Letheren (kl1996) | Vicky Malinova (vm1687)
Supervisor: Dr. Erdin Ibraim

University of BRISTOL

Example student design project

CARDIFF CITY FC - HENSOL TRAINING COMPLEX SCHEME

BEN WHITTLE, LUKE FARRAND, HENRY FISHER, WILL JACKSON SUPERVISOR: DR. ADAM CREWE

UNIVERSITY OF BRISTOL, DEPARTMENT OF CIVIL ENGINEERING

University of BRISTOL

Example student design project

Dr Liz Holcombe & Dr Dimitris Karamitros
Admissions Tutors – email: d.karamitros@bristol.ac.uk & liz.holcombe@bristol.ac.uk

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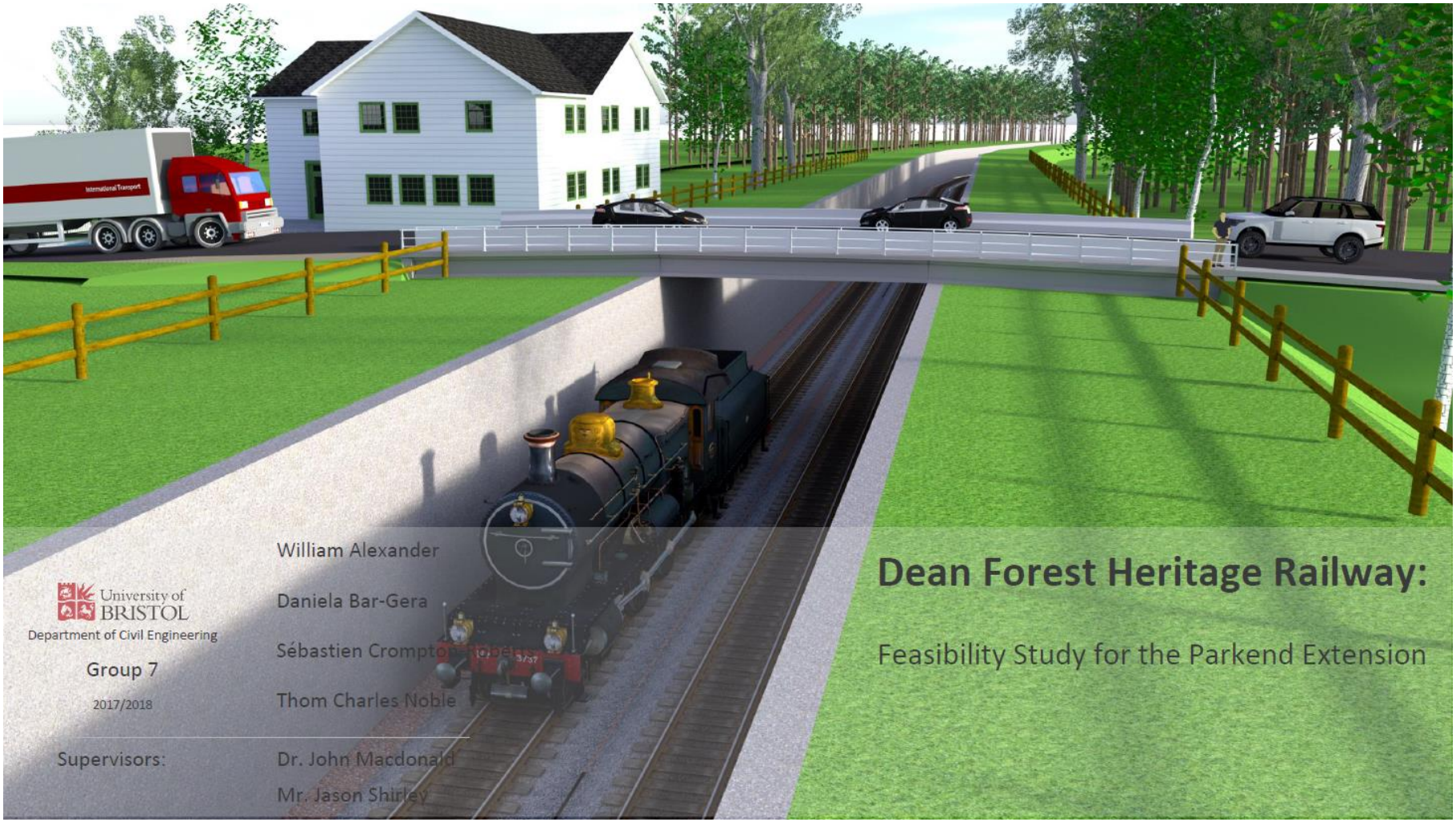
Example student design project

Seismically Base-Isolated College in Kathmandu, Nepal

Joe Beardsley - Reggie Clark - Ted Cross - Maxwell de Podesta - Jack Rushton
Dr Nicholas Alexander – Dr Flavia De Luca

University of BRISTOL

Example student design project



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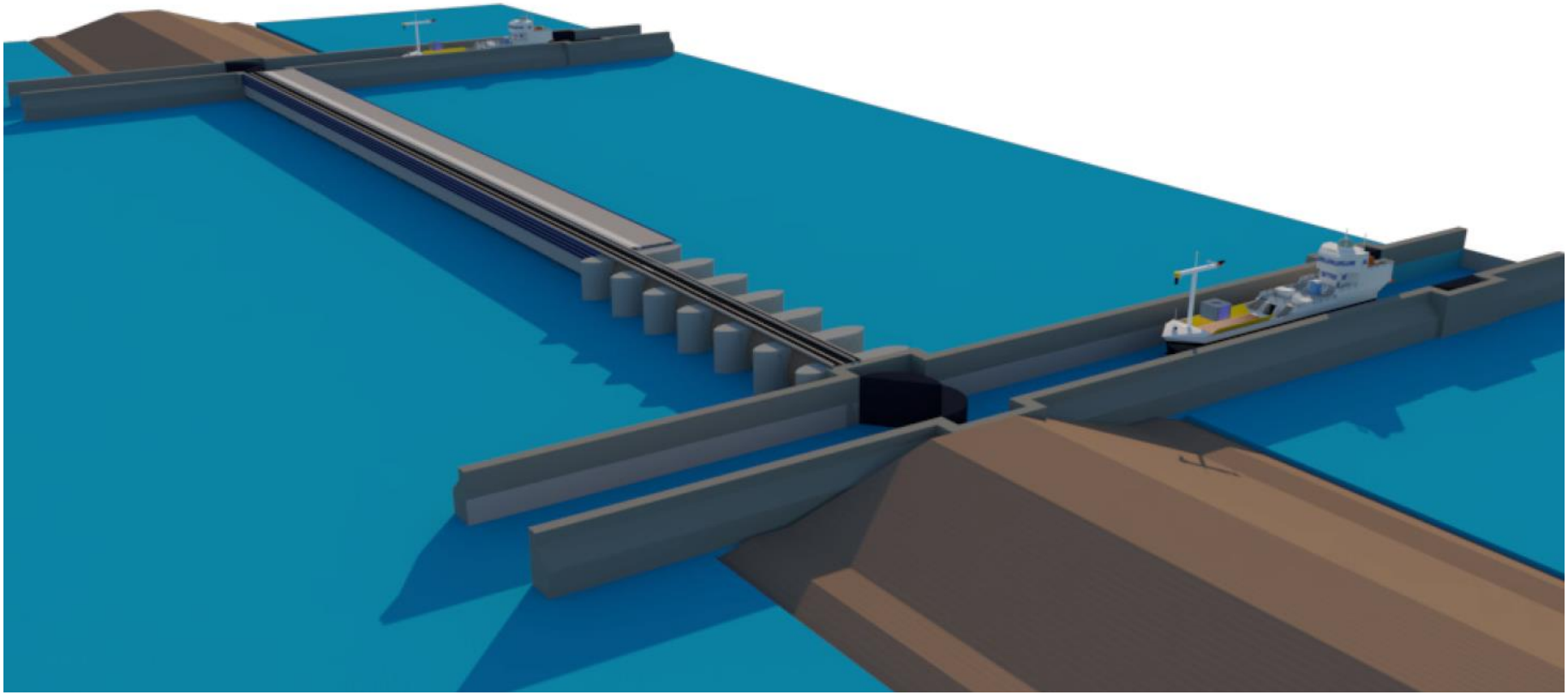
Example student design project

TTB
Thames Tidal Barrage

University of BRISTOL

THAMES TIDAL BARRAGE

Group 6 – George Atkinson, Safak Muslu, Ed Roberts and James Rodney
Supervisor: Dr M. Rico-Ramirez



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Example student design project

LICHFIELD HIGH SPEED RAILWAY BRIDGE

Samuel Bellman, Alexandra Bradford, Francis Gaymond, Marc-Andre Jansen

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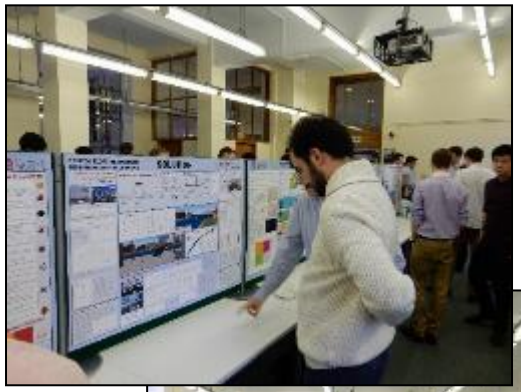
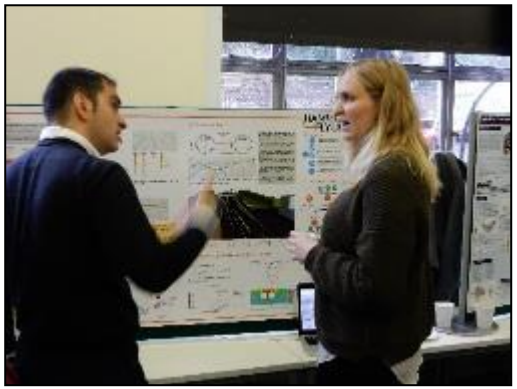
Design Project Poster Session



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Student Prizes

NCE, Civil Engineer Graduate of the Year!

- Brittany Harris, MEng Civil Engineering, Winner in 2016
- Sophie McPhillips, MEng Civil Engineering, Winner in 2014
- Joe Smith, MEng Civil Engineering 2012, Winner in 2013
- Stephen Thompson, MEng Civil Engineering 2011, Runner-up 2012
- Eva Linnell, MEng Engineering Design 2011, Highly Commended 2012

More Recent Prizes and Awards:

- James Pendleton, Stjohn Peters & Juliana Koltermanna da Silva:

  Winners of the Western Timber Association Award (2015)
- Joshua Mudie: Runner-up at

  IABSE Young Designers Paper Competition (2015)
- Maximilian Alexander: Winner of the British Dam Society Competition (2014)

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More recent prizes

Steel Construction Institute

"Regional Assembly Building" - 1st Prize £1200 (*R. Biviji, J. Charlton, T. Tan, A. Yeung)*

"New Railway Station" - 1st Prize £1000 (*R. Langford, D. Luu, D. Norman, M. Rooney)*

Royal Society of Arts Travel Awards

"The Millennium Ride" - £1000 each (*Alex Johnston, Alex Baalham, Colin Davies)*

"New Railway Station" - £500 each (*R. Langford, D. Luu, D. Norman, M. Rooney)*

IAHR Student Paper First Prize

"The Effects of Climate Change on Flooding in South-West England" (*T. Grevatt, T. Koh)*

OASYS Design Awards

Computer generated design poster for a Canal Bridge

(Emma Jenkinson, David Kang Gil, Karn Supaviriyakul, Theodosia Tsoumba)

Royal Academy of Engineering

Leadership Advanced Award - £5000 each (*Eleanor Heath and Alexander Martin)*

How does Civil Engineering shape our world?

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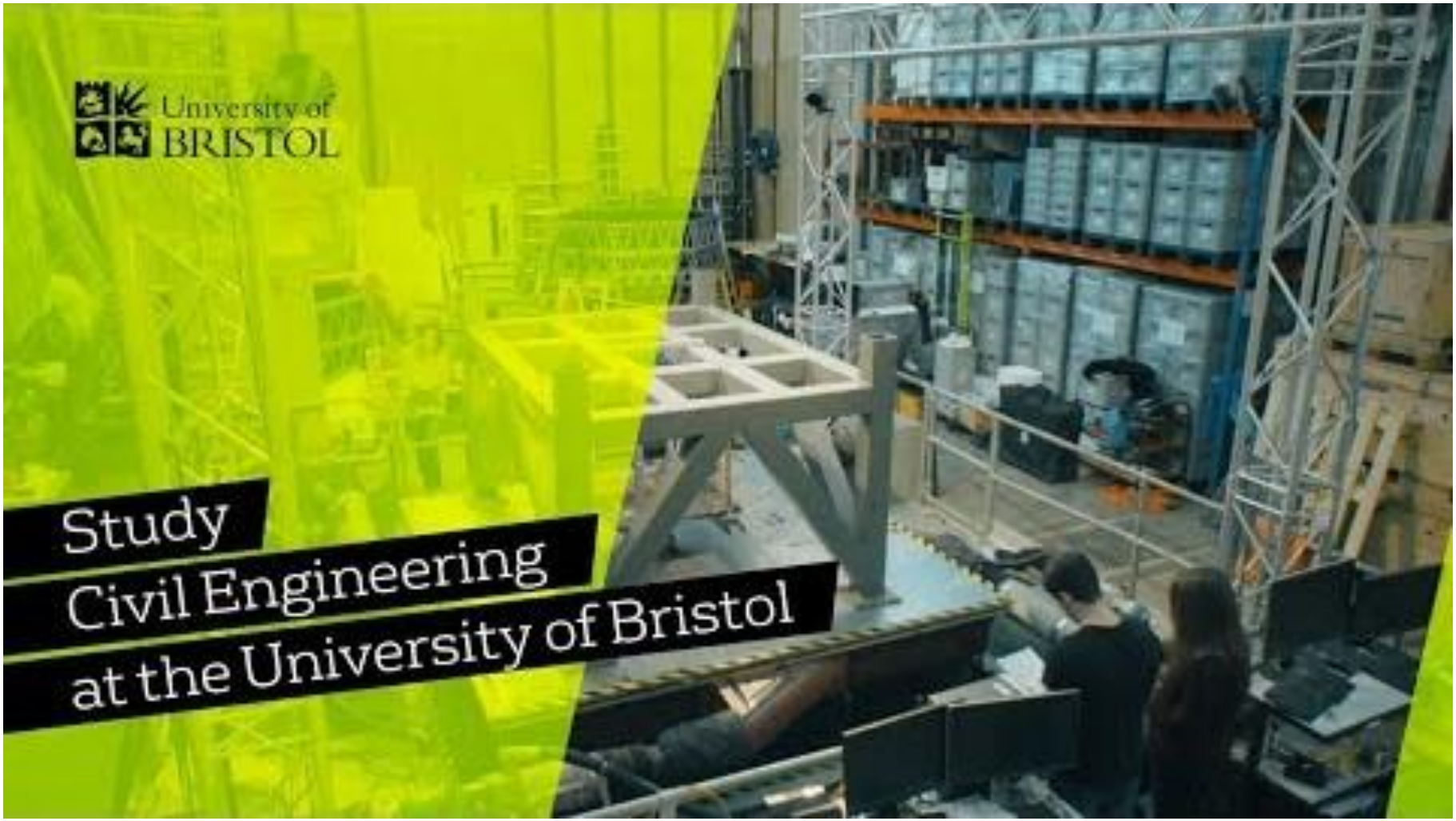
University of BRISTOL

Department of Civil Engineering

Studying Civil Engineering at Bristol



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Civil Engineering

Thank you for your attention!

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