



UNIVERSITY OF
BIRMINGHAM

Robotic and digital asset management and their applications on road safety

Dr Mehran Eskandari Torbaghan

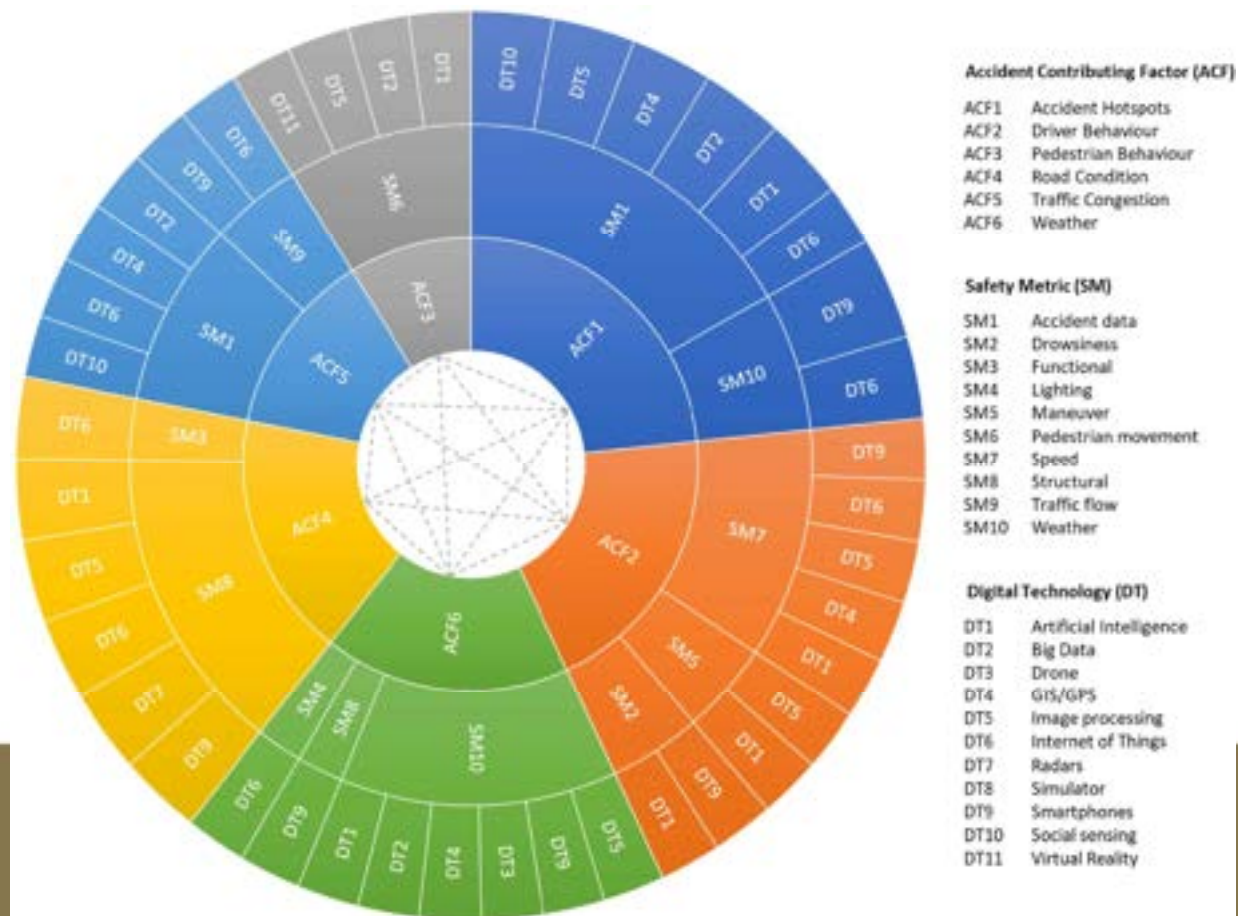
My background

- BSc. Civil Eng
- MSc. Construction Management
- PhD. Risk based approach for managing linear infrastructure
- Lecturer in Infrastructure Asset Management
- MSc Road Management and Engineering Convenor



Understanding the potential of emerging digital technologies for improving road safety

Mapping the applicability of digital technologies (DT) for collecting, monitoring and predicting information on different safety metrics (SM) associated with accident contributing factors (ACF). The dotted grey line linking the ACFs portray their interdependency.



Self-Repairing Cities Project: The Problem

- A pothole is filled every **21 seconds** in the UK
- In 2018 Poor road condition costs **£22.8 million** in compensation in England and Wales
- Costs of streetworks disruption > **£600 million** per year
- **14 road workers were killed and over 300 were seriously injured between 2006 and 2016**
- Congested traffic, such as that caused by streetworks, emits **4** times as much pollution as free-flowing traffic and contributes to the estimated **40,000** premature deaths
- *Is this a sustainable management?*



Self-Repairing Cities Project

- Funded by Engineering and Physical Science Research Council (EPSRC)
- Grand Challenge: Balancing the impact of City Infrastructure Engineering on Natural systems using Robots

*Vision: **ZERO DISRUPTION FROM STREETWORKS BY 2050***

- Project Partners:
 - University of Leeds (PI)
 - University of Birmingham
 - University of Southampton
 - University College London (UCL)



UNIVERSITY OF
BIRMINGHAM

Self-Repairing Cities Project

- ❑ Aimed at a resilient infrastructure where autonomous robots will maintain the crucial infrastructure that we rely on in our daily life.
 - Reduce downtime
 - Reduce disruption to services
 - Reduce risk on the safety of the workforce
 - Reduce cost of inspection and maintenance
 - Increase quality and reliability of infrastructure services
 - Better quality of life



UNIVERSITY OF
BIRMINGHAM



SELF REPAIRING CITIES

Self-Repairing Cities Project: The Problem





Inspection Drone

- *Installation of a visual inspection system based on hyperspectral and normal cameras*
- *The system has the ability to detect crack and potholes and build a 3D model of the detected anomaly in real-time.*
- *Allows inspections of high structures.*
- *The drone has the ability to detect defects as part of an autonomous infrastructure maintenance operation.*



Inspection Drone



UNIVERSITY OF
BIRMINGHAM

Inspection Drone



UNIVERSITY OF
BIRMINGHAM

Inspection Drone

Crack!



UNIVERSITY OF
BIRMINGHAM

Deployment of ground inspection robot

- ❑ *Rapid deployment of ground rover*
- ❑ *Designed for rover deployment and retrieval*
- ❑ *Allows inspection for long periods of time*
- ❑ *Provides a detailed inspection platform*
- ❑ *Allows inspection where UAVs cannot fly*



Drone Delivery of Metal Bridge Inspection Robot

- Aims:

- Reach obstructed areas under the bridge

- Assess the damages to bridge bearings from all sides

- Perform non-destructive tests

- Proposed solution:

- Use a drone to deliver and retrieve an inspection robot to the bridge underside



UNIVERSITY OF
BIRMINGHAM

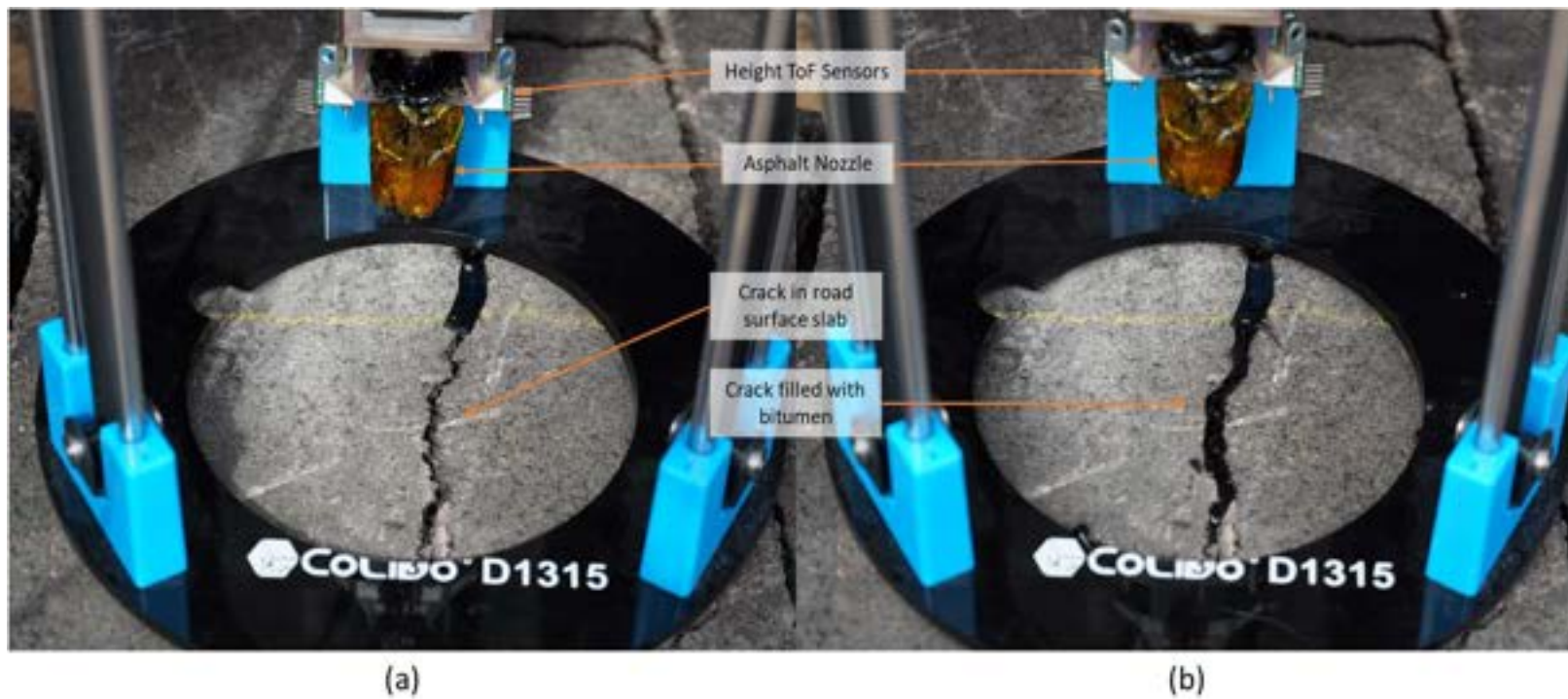


3D Printing Drone

- Installation of a 3D printer on a drone.
- Ability to fill-up holes/cracks as part of an autonomous infrastructure maintenance operation.
- Why Drone?
- Working on using multiple material (pothole repair)
- Robotic and Larger Platform



3D Printing Drone



(a) Irregular crack to be filled (b) Crack autonomously filled with asphalt



Perching and Manipulation on a Street Lamppost

- ❑ Autonomously perching on a street lamppost,
- ❑ Performing sensor (camera)
- ❑ (Un-)installation on the lamppost with its on-board robotic arm
- ❑ Disaster response

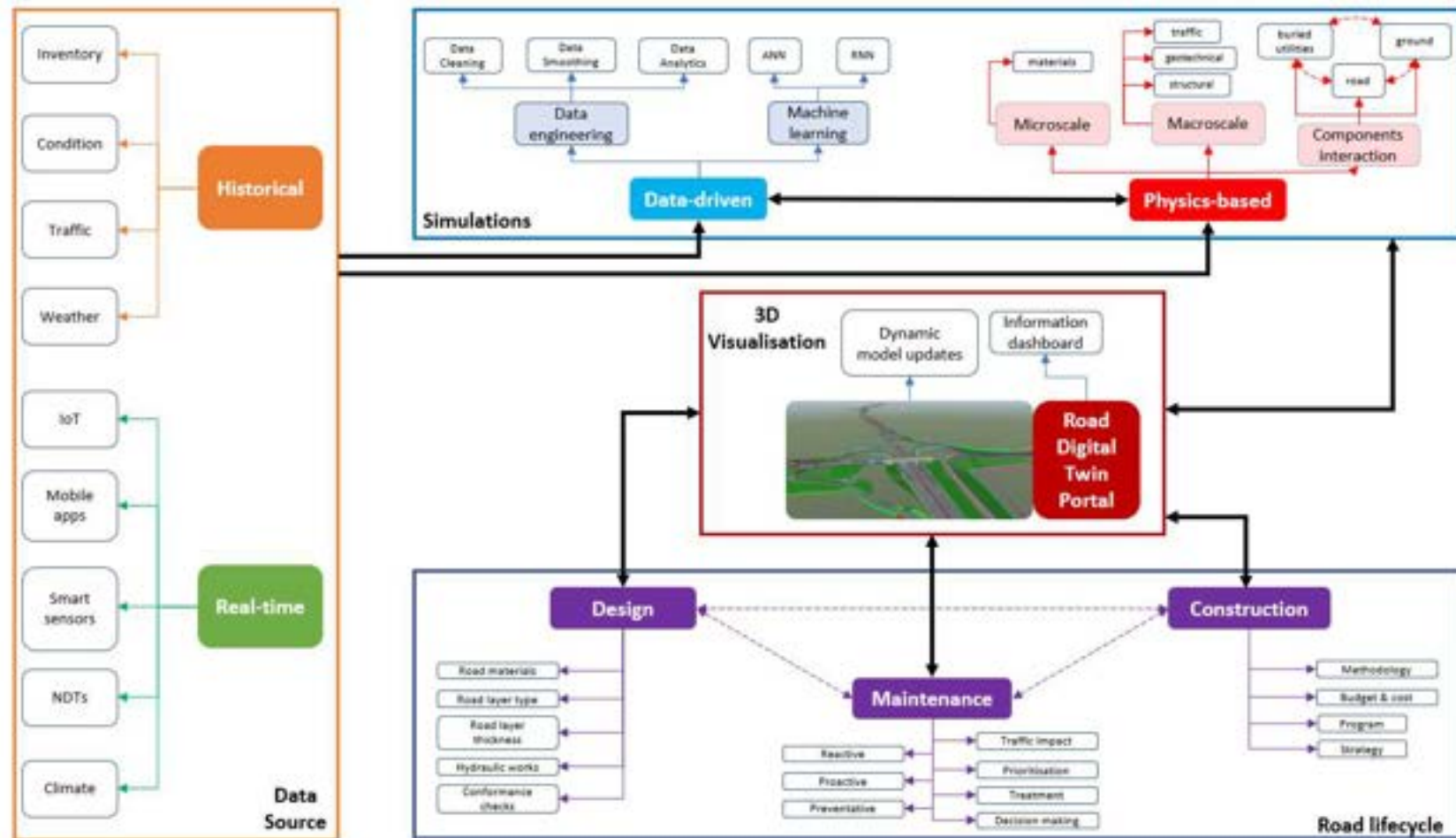


Source: University of Southampton

Automatic Perching on Lamppost

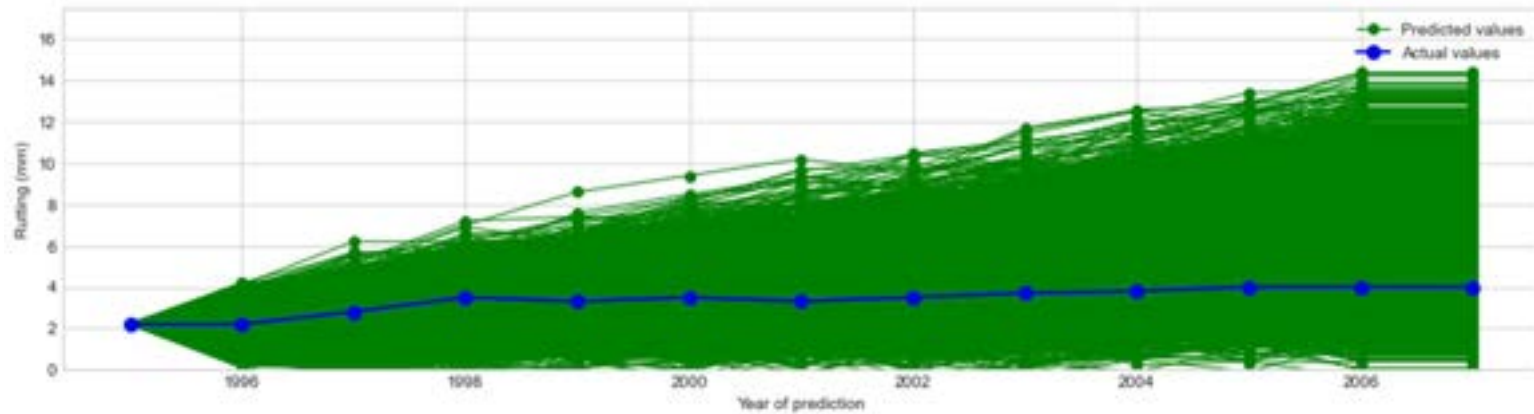


Current Research; Digitalisation of Road Network

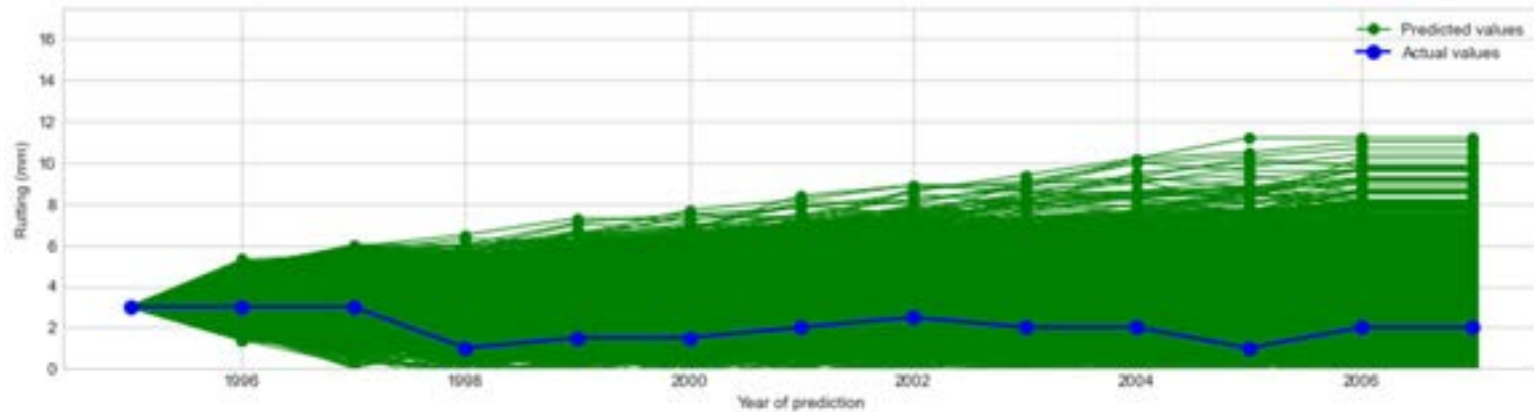


Multi-year Probabilistic predictions

Data-driven



**Coupled
Data-
Physics-
driven**

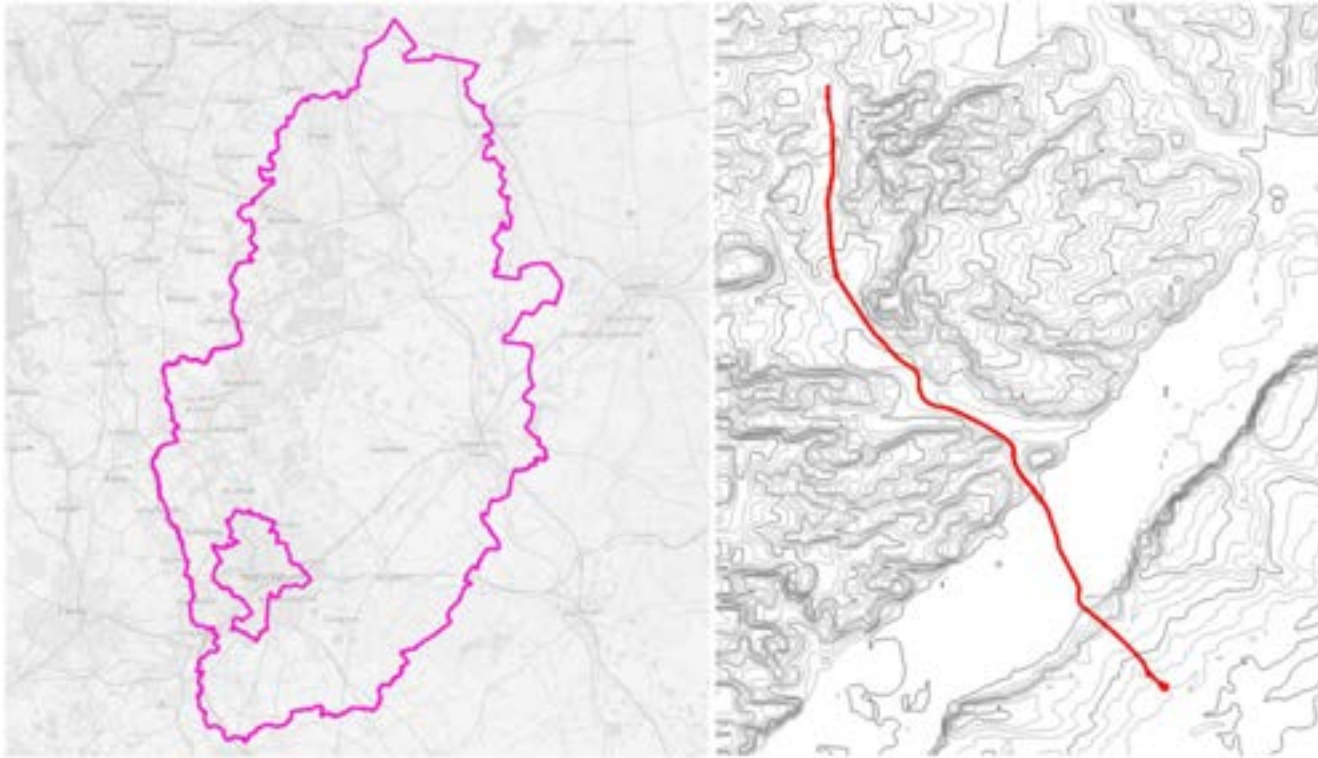


UNIVERSITY OF
BIRMINGHAM



The University of
Nottingham

Working with Nottingham County Council



- ~250km of major roads managed by Notts.
- Initial trial section A6097, ~17km long
- Arterial route north-south; alternatives are the M1 or the A1
- The A6097 is a key crossing for the River Trent.

Contextual information from terrain models



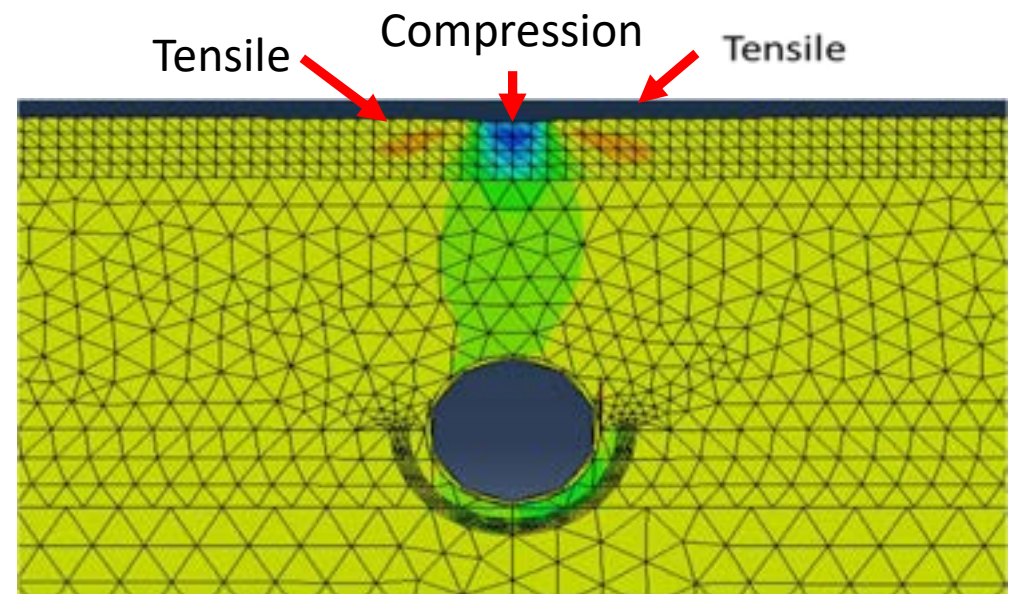
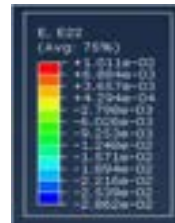
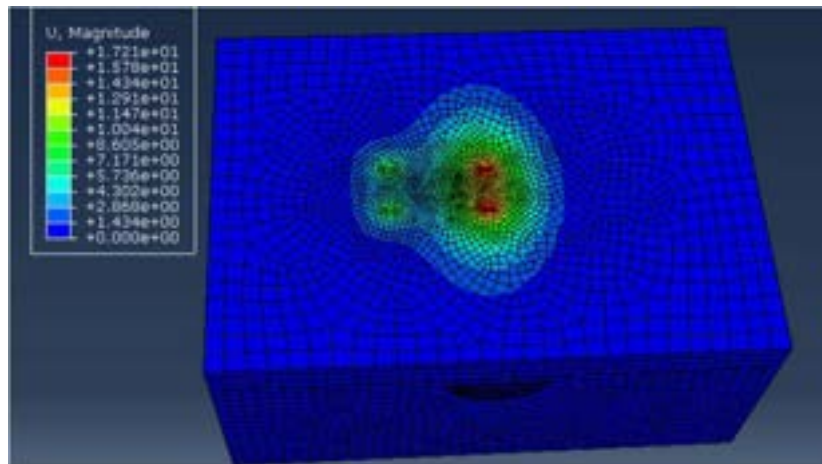
Context for the network - topology, drainage (left) and geomorphology (right) from EA terrain models, spatial extents and networks from OS data. Geology from BGS.

Combining Context and Condition



Combining the condition data (SCRIM and SCANNER) with the context (roughness, slope, drainage) to build models that can predict condition parameters.

Road, Ground and Surface interaction



Road, Ground and Surface interaction



Cold pavement layer

Sensors: Strain gauges,
fibre optic, pressure cell,
lidar, LVDs



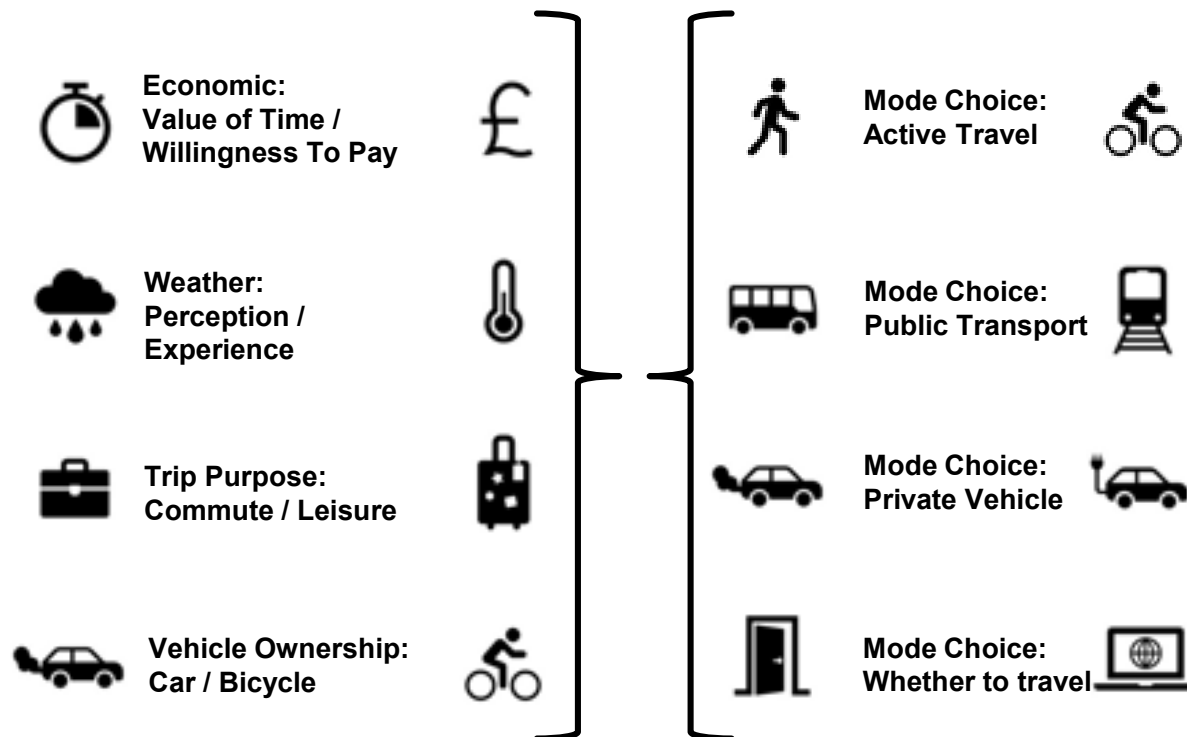
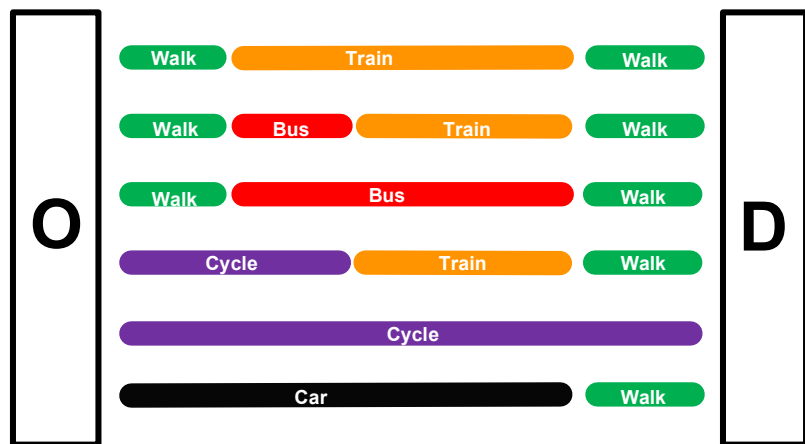
The buried pipe with 40cm cover depth



The instrumented pipe with fibre optic and strain gauges

Using data to understand road user behaviour

This research project explores the complex relationship between an individual's travel experience, their mode choices, and impacts on/of commercial/government decision-making.



UNIVERSITY OF
BIRMINGHAM