Energy, Transport and Waste in Birmingham: Building the Foundations for Tomorrow's Engineering Strategies

Chris Bouch, Susan Lee, Joanne Leach, John Urry and Chris Rogers

Executive Summary

Having the right infrastructure in place will be crucial to achieving the liveable city of the future; however, much of the existing infrastructure has many years of life left in it, and represents a significant 'sunk cost'. This means engineers cannot start designing for the future with a blank sheet of paper; they must take account of the existing infrastructure systems, resource flows and operational practices already in place. This case study describes work the EPSRC-funded Liveable Cities project has done to model aspects of Birmingham's energy, transport and solid waste management systems, with the aim of providing engineers with a foundation for their future designs.

Success Metrics

- System mapping: the case study has provided objective maps and descriptions of aspects of Birmingham's existing energy, transport and solid waste management infrastructure systems.
- Knowledge transfer: stakeholders were given insights into objective and repeatable methods of modelling their existing energy, transport and solid waste systems, including use of the Designed Urban Systems Modelling Tool (DUSMot).
- Stakeholder engagement: all of the case studies involved collaborative working and the sharing of data and ideas between researchers, the City Council and other principal stakeholders.

About

Researchers from the University of Birmingham and Lancaster University have been studying the infrastructure systems, resource flows, and operational practices relating to energy, transport and solid waste management in the City of Birmingham. The aim has been to understand and map aspects of these in order to provide key stakeholders in the City with the data, information and knowledge they need to plan and implement now the radical engineering strategies necessary to make Birmingham a liveable city of the future.

Clockwise from top left: Birmingham city centre; Brindley Basin; Refuse collection vehicle; Electrical sub-station.

Challenges

Determining the system boundary: When considering energy, transport and solid waste management, it is difficult to define a clear boundary between the City and its wider environment: Birmingham draws its energy resources from around the world; people travel many miles to work in the City; and, international legislation on packaging affects waste management. A method developed by Fenton was used to define Birmingham's hinterland: the place outside the 'core urban area' whose primary economic orientation is towards the city. [Fenton, A. Urban Area and Hinterland: Defining Large Cities in England, Scotland and Wales in Terms of Their Constituent Neighbourhoods. Available online: http://tinyurl.com/q7upk76 (accessed on 9 August 2017)]

Model granularity: Having established boundaries the next challenge is to decide how deeply to dig into the workings of the City. In other words: to decide at what level of granulari-

ty should the City be modelled. There is a trade-off to be struck between a highly detailed, costly analysis and the benefits that might accrue from the resulting model. There is no right answer to this; the decision can only be made in consultation with the stakeholders about the questions they want the model to help answer.

Data availability, quality and access: Questions of model granularity will be decided to some extent by the availability of data, its quality and access to it, which are crucial to effective research. In the case of this study, one challenge has been lack of access to data regarded as commercially or reputationally sensitive, requiring estimates to be made. Another has been the availability of data at the national scale, but not at the City scale, requiring the City data to be estimated based on the national figures.

Goals

- To carry out objective, scientific analyses of Birmingham's existing energy, transport and solid waste management systems to provide data to support the future design of infrastructure necessary to facilitate Birmingham as a liveable city of the future.
- To present the data gathered on energy and other city flows in a visual form that is easily accessible by engineers and planners.
- To provide Birmingham with a detailed report describing its current transport ecosystem.
- To integrate the data gathered on Birmingham's solid waste management system to create a system model to provide a baseline for future design and a virtual test bed on which to explore the potential impact of new designs.

How has this research helped?

The research on waste has identified for the City Council the publicly available documents from which the requirements for the new system will need to be elicited; it has demonstrated how those requirements and other system data can be integrated to create a system model; and it has demonstrated how to create a simple model of household waste collection, which can be updated to reflect proposed changes and 'run' as a simulation to assess their potential impact. The research findings were presented in a paper authored jointly by Birmingham City Council and the University of Birmingham, delivered to the International Council of Systems Engineering (INCOSE) International Seminar 2015 in Seattle.

The research on energy and other flows into, within, and out of Birmingham has given the City Council a clearer picture of the City's 'urban metabolism'. It has shown that there are some gaps in the data, but to provide an overview, these were 'patched' by extrapolating from national data. The research has pointed to flows that can be targeted to reduce carbon emissions and provides confidence that further work to produce greater granularity of resource flows within the City would be valuable.

The transport research has provided Birmingham with a detailed report describing its current transport ecosystem alongside proposals as to how the city might move towards a car-free future environment. The latter emerged from a thought experiment in which research about car-free cities was applied to the Birmingham context, including redesign workshops where experts on mobility worked alongside architecture students to explore what might be involved with car-free designs in four different parts of the city. The outcomes are a valuable insight into the City's current dependence upon private cars, the challenges and opportunities afforded by its public transport system and how redesigning the urban environment, sometimes in quite small ways, can encourage people to abandon their cars.

Clockwise from top left: Birmingham's energy from waste plant; Birmingham coach station; Midland Metro tram; City skyline from the south east

Results

This research has provided the important data, information, knowledge and models that Birmingham needs to support its journey towards becoming a liveable city of the future.

The research has engaged with key stakeholders to build an understanding of the existing flows, infrastructures and practices around energy, transport and waste management in the City.

"It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so." 'The Big Short' with apologies to Leo Tolstoy, 'The Kingdom of God is within you', 1897.