Taking the complexity Turn to steer cars off the road

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Introduction

The Scottish Government has a problem. Achieving its ambitious carbon reduction targets will require transformation of infrastructure and of individuals' and organisations' actions and attitudes (Scottish Government 2009, 2010) but individualist, psychologically based 'behaviour change' has proved hard (Scottish Government 2011, Darnton 2004, Jackson 2005, Southerton 2011). A more sociological approach seeks to influence social practices rather than individual behaviours (Shove 2003, 2010, Hargreaves 2011) but practices are shaped and constrained by many historical, technological, material and social factors making change difficult to achieve (Shove 2003, Barr, Gilg et al. 2011). Would an approach applying complexity theory accommodate this multiplicity?

Complexity theory grew out of mathematical and scientific studies of complex systems too big for analysis using classical mathematical methods, such as animal population changes. The non-linear patterns it revealed challenged the standard deterministic scientific method leading to a rejection of the idea that X + Y always = Z, as the result may depend on small changes in the initial conditions X which often cannot be known. Urry (Urry 2005) applies this to the social sciences in 'the complexity turn', which breaks down the previous separation of the physical and the social sciences by seeing them both defined by complexity. Capra (Capra 2005) argues that nature is more like *human* nature than was previously thought – susceptible to history, influenced by the external environment and unpredictable.

A feature of complex systems is that properties of them 'emerge' from the whole that are not derivable from knowledge of their parts. There is '*a fundamental flaw in the analytical method. A complex system is not constituted merely by the sum of its components, but also by the intricate* relationships *between these components. In 'cutting up' a system, the analytical method destroys what it seeks to understand*' (Cilliers 1998).

Byrne (Byrne 2005) argues that complexity theory strengthens the value of comparative studies when social scientists are seeking to provide evidence for policy makers. These acknowledge the importance of the individual case and try to derive more general understandings (rather than proofs or certainties) from individual cases. Complexity theory also considers dynamic systems and change, suggesting it may well be applicable to situations where social change is the aim. It has been used to understand some policy areas such as foreign development (Eyben, Kidder et al. 2008, Ramalingam et al 2008) and education (Eppel et al 2011). However there seem to be few if any projects exploring whether complex social systems can practically be influenced in order to bring about different outcomes.

This paper reports on a project aiming to understand and steer energy demand relating to travel to cultural venues[1]. These form a valuable site of investigation as a cause of significant emissions related to travel by attenders and suppliers. They know and frequently communicate with their regular attenders who have a values-based loyalty. Many are important social institutions with links to influencing bodies such as local authorities. They therefore offer an opportunity to explore the feasibility of influencing the wider complex social system in order to bring about changes in practices rather than focusing on individuals or the practices themselves.

The project uses a case study to understand and influence the complex social system from which emerge the travel practices of audiences. The site is His Majesty's Theatre in Aberdeen (HMT[2]), a large venue in a city with a relatively definable catchment area, high car usage and poor evening public transport services. The wider aim is to consider whether using complexity theory when considering such cases can help in achieving ambitious carbon reduction targets.

Methodology: How to study complex systems?

Using complexity theory to understand this complex system requires an equally complex methodology. The system includes many differing elements including people in control of elements of the theatre or transport system, individual transport users and influencers such as local authority officers; and non-human elements including the geography of and civic boundaries between Aberdeen and Aberdeenshire. Mixed methods ranging from purely quantitative (facts about survey respondents' past behaviour) to very qualitative (personal ethnography) need to be combined to capture how these interact dynamically.

The methodology also reflects the aim of the project, again partly a function of the case's complexity. Proof, certainty or truth are not being sought. The project is by definition studying a complex system with its unique history and the case of HMT in Aberdeen, isolated in the north-east of Scotland with all the factors that make it a manageable case to study, will not be replicated exactly elsewhere. A positivist analysis – 'when this intervention was/is introduced, this effect did/will follow' – will not be possible, nor useful if the aim is to consider what interventions to introduce in a transport system relating to a Welsh hospital or a London theatre. A case study that acknowledges the complexity of the site and yet aims to provide useful experience to guide future interventions in similar situations will be much more useful.

Byrne, whose work focusing on the application of policy interventions is very pragmatic, argues (Byrne 2013) that '*we cannot assert that we can find out what works for changing complex systems. Instead, we have to ask:*

a) *What has worked?*
b) *How has it worked? (Which is to ask: What causal mechanisms have operated?)*
c) *Where has it worked?*
d) *When has it worked?*
e) *Can it work elsewhere?*

[1] The author has been a professional theatre director and artistic director since 1985.

[2] HMT and two other Aberdeen venues are run by Aberdeen Performing Arts, with staff working across the venues. For easy reading, the term HMT is used to cover both the theatre and Aberdeen Performing Arts as an organisation.)

f) *Can it work elsewhen?*' (p219, my numbering).

These questions help provide different sorts of validity (see Seale 2004) and again require different methods. Table 1 below links the methods used with the questions; Table 2 provides more detail of the methods themselves.

Table 1:Methods and their purposes

Question	What validity it evidences	Method used
a) What has worked?	Internal & External	• Surveys of travel behaviours (2 & 8 below) • Focus groups (3 & 8) • Choice of interventions (4)
b) *How has it worked? - ie: What causal mechanisms have operated?*	External	• Surveys (2 & 8) • Focus groups (3 & 8) • Observation of and discussions with bus passengers & staff (5) • Personal experience of bus travel (6) • Interviews with key agents (7)
c) *Where has it worked?*	Measurement & Internal	• Site description (1 & 6) • Surveys (2 & 8) • Focus groups (3 & 8)
d) *When has it worked?*	Measurement & Internal	• Site description (1 & 6) • Surveys (2 & 8) • Focus groups (3 & 8)
e) *Can it work elsewhere?*	External	• Interviews with key agents (7) • Researcher synthesis (9)
f) *Can it work elsewhen?*'	External	• Interviews with key agents (7) • Researcher synthesis (9)

Table 2: Description of methods

Method	Description
1	a) A **'system map'** showing HMT's relationship with various parties and updated following interviews with staff from HMT, Aberdeen City Council and NESTRANS, the local transport partnership. b) A **focus group** held with HMT staff to review and update the system map and learn about both the site and the system.
2	An **internet-based survey** about travel to HMT was sent to HMT attendees with known email addresses between January and March 2014.
3	Four **focus groups** held with travel survey respondents, structured using the survey results, and another with HMT attendees unaware of the survey.

4	Analysis of the results of the survey and the focus groups was used **to identify three interventions** that might influence the system such that attendees' travel choices would change.
5	**Observation and discussion** of the project with HMT staff involved in one of the interventions.
6	**Documentation of my personal experience** of organising and managing the project.
7	**Individual interviews** will later be held with staff of the three main parties in the project to understand the effect of the interventions.[3]
8	Another **travel survey** and further **focus groups** will be used to establish whether travel practices, attitudes or opinions have changed.
9	My **synthesis** will bring together analysis and interpretation of survey and focus group findings, discussion with the various parties, personal experience and observation, participant observation.

The researcher cannot be excluded from the methodology or the system under scrutiny. My judgement around the choice of interventions, setting up the interventions and analysis of comments and discussion with project partners and bus users all influenced the project. I influenced the system in that the project wouldn't have taken place without my involvement.

Results

Mapping the complex system

Figure 1 below shows a very simplified system map of HMT and transport with the main agents in the system and their relationships as drawn after the focus groups and interviews with HMT, Aberdeen City Council and NESTRANS staff and the personal ethnography, participant observation and desk research. Using a list of characteristics of complex systems (Cilliers 1998) the focus groups and interviews confirmed that HMT operates within a system of many complex adaptive agents interacting dynamically and in a rich manner (some agents influence others both directly and through each other). Some interactions are non-linear, displaying tipping points when change occurs (a tour can be suddenly cancelled if sales fall below a certain point). There are feedback loops, both positive (word of mouth increases sales for a popular show as people fear a sell-out); and negative (dark streets discourage walking to the theatre, making the streets feel less safe, discouraging walking to the theatre…). Most interactions are short range (producers work through theatres to sell tickets to audiences). The system is open and responds to other influences beyond apparent 'borders' (fuel prices, road works). It is not in equilibrium but takes a constant flow of energy to maintain from HMT, producers etc. It has a history, which influences its current state and future interactions (producers know HMT and its audiences; audiences know their transport providers). Finally, no one agent has knowledge of the whole system.

[3] The research is being carried out part-time, permitting long time frames.

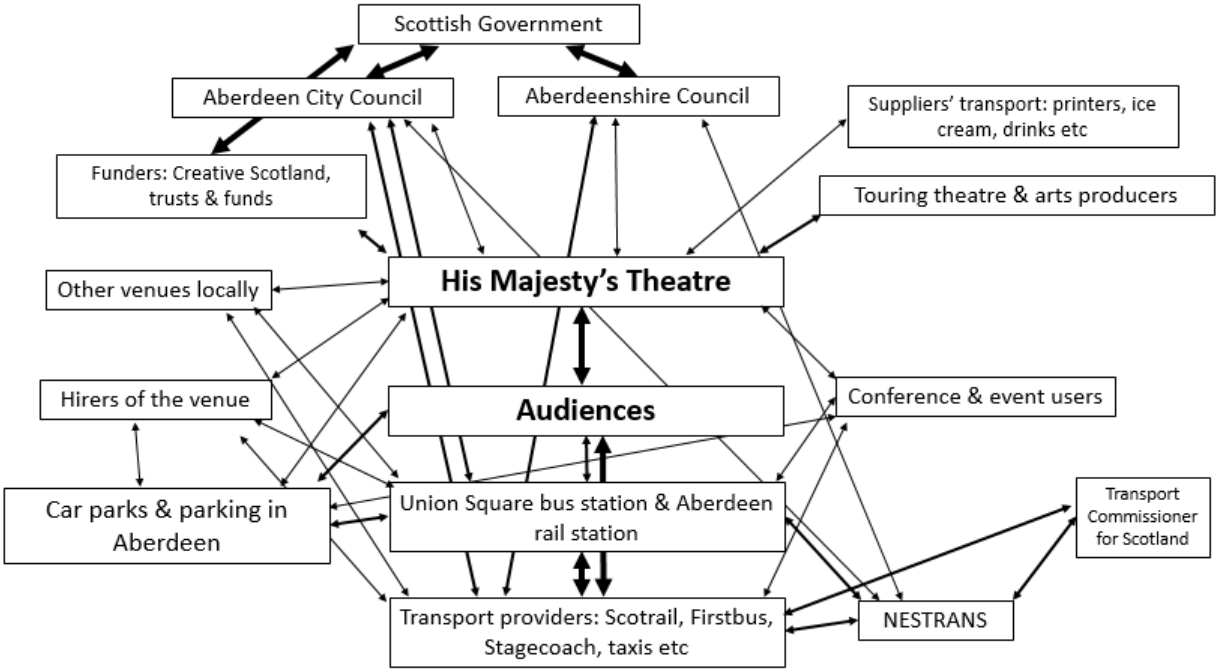

Figure 1: Simplified complex system of HMT relating to transport. Thicker arrows indicate stronger relationships.

The system sketched above is of course bound up and nested within other complex systems: Aberdeen as an oil capital and a city in North East Scotland; HMT as a major UK touring theatre. It could be viewed from different points of view, as if with a fish-eye lens. Using the theatre lens the theatre producers based in London would be more prominent. Using a pure Aberdeen transport lens, FirstBus and Stagecoach would move towards the centre and roads and bus-stops would dominate rather than HMT and audiences.

Understanding travel choices

Survey

An internet survey seeking to understand travel to HMT was sent to attenders with a known email address following their visit asking about:

a) Production attended, day and time and departure point as these could affect travel choices.
b) Actual modes of transport to and from the theatre.
c) Reasons for travel choices, providing more qualitative data for developing interventions
d) Demographic and contact information

The response rate for the survey was high and the results clear. 1,874 responses were received from 7,307 survey invitations sent to audiences totalling 43,569. Consistently across different demographics, days and genres of production 70% of attenders travelled to and from the theatre by car for evening performances. Cost, convenience and the availability of parking were the main reasons cited for their choices, although convenience was also cited by most attenders using other modes. Better public transport, or better coordinated with the times of shows, and cheaper ticket/transport deals were the main reasons people would consider giving up the car.

Focus groups

Backing up the survey results, a more detailed view of in/convenience and the shape of likely interventions became clear. The difficulty of bus travel was a major theme: scarce buses late at night; bus schedules changing regularly; buses departing from different stops at different times; and evening and daytime buses following different routes. But although driving was considered convenient, parking was not. One attendee parked 20 minutes' walk away from the theatre to find a cheap space; another arrived early to bag a space near the exit in the theatre's recommended car park and left quickly after the show to avoid a queue to get out of the car park. Traffic congestion was a common complaint. Multiple agents influence these intersecting issues raised (bus companies, Aberdeen City Council for street parking and congestion, car park operators…) pointing to the challenge to individuals wanting to 'change their behaviour'.

A crucial issue for developing the interventions which wasn't considered in the survey but often arose in the discussions was security or comfort: waiting for a bus on Union Street was considered unpleasant because of the rowdy crowds and the weather. The walk from HMT to the hardly-welcoming bus and railway station (for most journeys to destinations in Aberdeenshire) is unpleasant, quite long and feels risky, passing along dark and quiet, rowdy and seedy streets in sequence. The theatre closes shortly after the show ends, making it impossible to wait for a bus in comfort and safety there.

Development of interventions

The survey and focus groups suggested that high car usage is an emergent property of a system that militates against bus travel and which no single agent is able to change. The two bus companies (timetables, fares, safety on board), the city council (safety on streets, parking charges), Aberdeen's geography (ill-situated bus station with an unpleasant route from the theatre), car park operators (configuration, charges), HMT (prompt closure of the theatre after the show) and other people (drunk youths on Union Street) all contribute to the system and dealing with one of these issues would not solve the problem if the others weren't dealt with simultaneously. This is reminiscent of Shove's 'pinwheel' showing how frequent showering is 'pinned in place' by a range of factors (Shove 2003). The travel-to-HMT pinwheel is pinned in a high-carbon position by all the above factors, but no one agent can free it up: although Shove doesn't mention it, one aspect of a pinwheel is that one pin alone can stop it from turning.

Least of all able to change the situation are the audience members, yet 'behaviour change' interventions tend to focus on the individual and choices or attitudes (Shove 2010). This is where the application of complexity theory becomes useful.

Features of the system indicate its complexity. There are multiple, independently adaptive, richly interacting agents, none of which has control over the system, which is open and has a history. Feedback loops include:

- low evening bus usage leads to reduced evening timetables and higher fares, further reducing usage;
- buses used mostly by younger, drunker passengers feel less safe to older passengers like the focus group attendees, putting them off, exacerbating the problem;
- the dominance of car travel means that HMT does money-saving deals with car parks rather than bus companies.

Travel practices seem to emerge from this whole complex system rather than be caused by single factors. Could HMT sufficiently influence the system from within to change these emergent properties? Complexity theory derives from the natural sciences where scientists stand outside the system (eg movement of starlings in a murmur) and is generally used to describe a situation rather than change it. Discussion of complex systems doesn't usually consider the possibility of deliberately influencing them.

Three interventions requiring action by a number of parties were identified that might influence the system to change the emergent properties:

1. Provide a shuttle bus to the bus and train station
2. Provide buses from directly outside HMT to popular destinations shortly after the show ends
3. Provide real-time bus departure information screens in HMT and keep the foyer open after the show so that bus users could wait safely and walk to the bus stop just in time.

HMT management and I decided interventions 2 and 3 were most feasible. Collaboration with the bus companies and local authorities (who organise real-time bus information) was necessary. Discussions with bus operators FirstBus and Stagecoach, Aberdeen City and Aberdeenshire Councils followed. An opportunity to access Scottish Government funds to lower fares and reduce risk arose, demonstrating the importance of external influences, the additional complexity of the system and the importance of an agent (me) both making connections that might not have been visible to other agents in the system and putting in the effort to make use of them.

HMT therefore entered into an agreement with Aberdeenshire Council (able to access the Scottish Government funds) and Stagecoach. Stagecoach ran buses from directly outside the theatre along three routes into Aberdeenshire exactly 15 minutes after performances ended on busy weekends between September and November 2015. HMT sold tickets in advance to theatre patrons through its box office and checked patrons' tickets (thereby avoiding another aspect of the complex system: problematic regulatory issues relating to standard service buses). Promotion of the service was through email to those who had already booked theatre tickets, the box office website and staff when patrons bought tickets for relevant performances, and print materials. Users of the service, and non-users on the nights when the buses were running, were surveyed by email about the experience. (Intervention 3 is still under development.)

Figure 2: TheatreBus flier

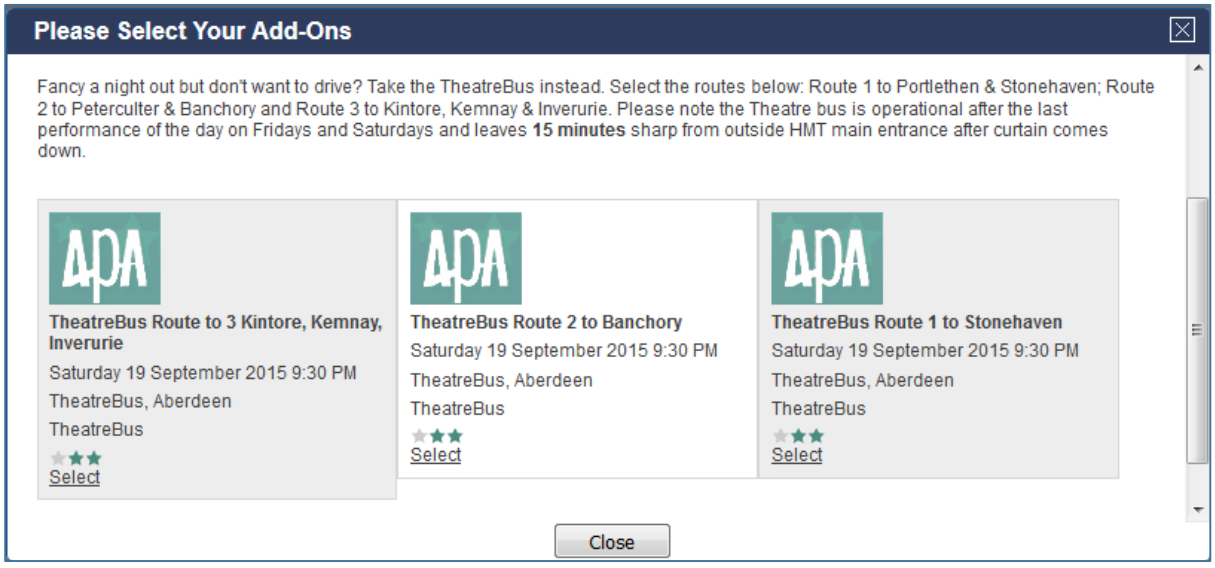

Figure 3: Screen grab of pop-up box allowing on-line ticket buyers to book a TheatreBus ticket

The above paragraphs make the process sound simple. In fact the first attempt was aborted because of the costs to HMT; only when funding became available did the project become feasible. I spent much time and energy in persuading unfamiliar parties to take part, facilitating meetings, coordinating activity down to the level of confirming bus running times, etc.

Hundreds of emails were exchanged. Complex systems have a history (eg of agents not working together!) which influences the present; they may be resistant to change as agents don't necessarily respond to changes elsewhere in the system; each agent has its own motivations and drivers; and so on.

Summary

The results of the *intervention* have been mixed, but there are indications that the *system* may be changing.

Uptake by theatre patrons has been low – a total of 100 users over 20 actual bus runs (when no tickets were booked the bus was cancelled). But that is not necessarily a good measure of the success of the project. The Stagecoach and Aberdeenshire managers are pleased with the project and say that changes to bus use take a long time: an earlier Scottish Government scheme promoting bus travel lasted five years, with finance tapering off as uptake increased (Hall 2015). The response in the follow-up surveys was very positive, suggesting many non-users would take it up in future.

There has been a change to relationships between some agents in the system: staff from HMT, Aberdeenshire Council and Stagecoach. In contrast with the early meetings, a recent meeting between the three agents saw each of them contributing to continuing the project into 2016 beyond its planned end in November 2015, with additional funds being made available by Aberdeenshire Council and marketing effort offered by the Council and Stagecoach. Observation of and discussion with HMT staff, and email threads between HMT and Stagecoach, show that a project that started with glitches and hiccups as the agents were not used to each other's practices, needs and concerns evolved into a smooth system of communication. The agents are now experienced partners. Perhaps most important my own involvement has become less crucial. HMT staff have developed a system for running the project which involves communication with fewer staff internally and with Stagecoach but not me.

Discussion

To recap: the wider aim of this project is to consider whether complexity theory can guide policy making to achieve ambitious carbon emission reductions. More specifically, does this project demonstrate that complexity theory is useful when seeking to influence public behaviours and, if so, does it offer an example that can be used to shape further projects? The first part of this leads back to the first of Byrne's questions (Byrne 2013), which was *What has worked*? The bus service itself is not yet very successful. But there is an interesting change that has taken place to the complex system relating to travel to HMT, in that HMT is now an active agent along with transport providers and a relevant local authority.

The system map in figure 1 above showed HMT at the centre of a system that included Stagecoach and Aberdeenshire Council but without particularly strong interactions with them. The nature of Union Street where bus stops are or the streets and journeys between HMT and Union Square bus and rail stations went unmentioned. Whilst such a system map is informal I drew this one up based on discussions with people closely associated with HMT, transport in Aberdeen and the local authorities. None argued for strong relationships between Stagecoach

and HMT to be highlighted or commented on the lack of a presence for aspects of the geography of Aberdeen.

If I were to draw a revised system map, it would look something like this:

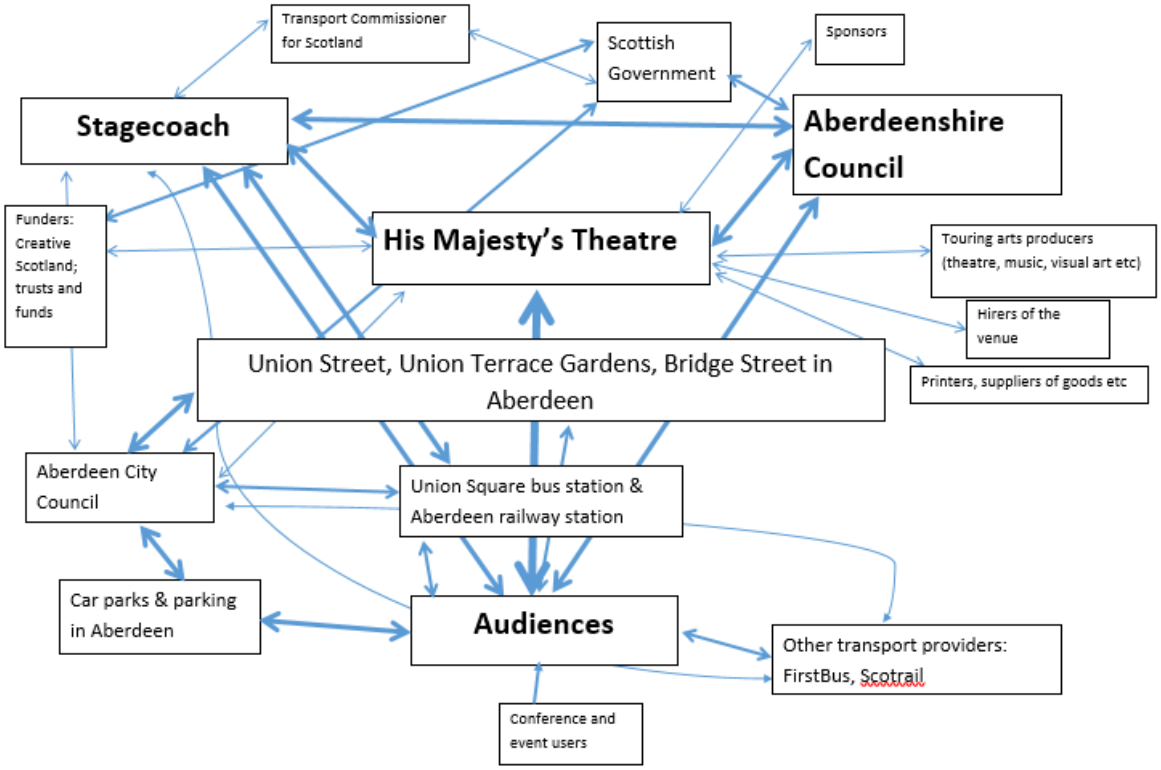

Figure 4: Revised very simplified system map

The relationships between HMT, Stagecoach and Aberdeenshire Council are much stronger. The geography of Aberdeen plays a greater role. Some of these changes are the result of my greater knowledge of the system but what is important here is not the accuracy of the map nor the particular relationships but how HMT is perceived and perceives itself. In Figure 1 HMT was a theatre whose main relationships were with audiences, theatre producers and funders. Relationships with transport providers, the geography of Aberdeen, Union Street and the bus station were not brought up in the various discussions and barely feature. But following the travel survey, the focus groups and the way in which Stagecoach, Aberdeenshire and HMT staff sat down together to organise phase 2 of the TheatreBus service (starting in March 2016), HMT is now playing an active part in transport activities: it provides to others detailed knowledge of likely future transport demand. The Aberdeen geography is also now known to play its negative role, coming between audiences and the theatre.

'*What has worked*', therefore, is arguably not running a bus service but repositioning HMT as an organisation and shifting its own view of the complex systems it sits within. (Aberdeenshire Council and Stagecoach were already involved in transport planning – only HMT is new.)

Answering the question *How has it worked?* (*Which is to ask: What causal mechanisms have operated?)* (Byrne 2013) will need to await further interviews with the key players but it seems

likely that what has led to the change are the business of embarking on a project, having to engage with the question of how the theatre can help facilitate more sustainable travel, and the involvement of a 'protagonist' researcher asking that very question. HMT now has knowledge of who travels how, of how they feel about it, of some of the influences etc. This knowledge, an impetus to act from me and the engagement with the other relevant parties may have combined to make the change happen.

The remaining questions (*Where* and *when has it worked?, Can it work elsewhere* and *elsewhen?)* (Byrne 2013) are more relevant to considering whether the case study is relevant to other circumstances and will require my synthesis using the description of the site, interviews with the local authority and bus operator and the knowledge gleaned from the travel survey and the focus groups. This would enable other projects to understand whether their own sites were sufficiently similar.

Conclusion

It is too soon to say whether this project has succeeded in changing the travel patterns to HMT. But there is already a pointer for policy makers seeking to reduce carbon emissions from individuals' 'behaviours'. In this case study, travel behaviours seem to emerge from this complex system of many adaptive agents, none of which is fully able to influence the system to produce different outcomes. HMT, triggering hundreds of thousands of journeys annually, previously played no direct role in the planning or provision of transport. Yet only HMT has an individual relationship and direct communication with those travellers (most bus travellers are anonymous to the carrier) and detailed information about likely travel patterns (from box-office data). HMT's participation in transport planning with the more usual suspects immediately changes the complex system in both the short term (for this project) and for future planning. HMT has also now begun to think about transport planning as part of its own work and systems; Aberdeenshire Council and Stagecoach may be thinking more about travel to cultural venues. This may in due course affect the emergent travel practices of audiences.

Complexity theory has provided a lens through which to understand and influence the system of travel to HMT, an example of a complex system in which simple linear interventions may not gain traction. In this case study the system has changed and shows potential for changing travel patterns. The suggestion for future projects may simply be that the venues (or sports grounds, hospitals…) should become more involved in transport planning but these systems too will be complex and each will have different, mutually adaptive agents, dynamic environments and emergent properties. The solution in each may not be that the venue become involved in the same way (hospital visits are not planned like theatre trips). But using a complexity theory approach to understand and influence practices by influencing the complex system from which they emerge may prove more fruitful than focusing on individuals.

References

Barr, S., A. Gilg and G. Shaw (2011). "Citizens, consumers and sustainability: (Re)Framing environmental practice in an age of climate change." Global Environmental Change **21**(4): 1224-1233.

Byrne, D. (2005). "Complexity, configurations and cases." Theory culture and society **22**(5): 95-111.

Byrne, D. (2013). "Evaluating complex social interventions in a complex world." Evaluation **19**(3): 217-228.

Capra, F. (2005). "Complexity and life." Theory Culture & Society **22**(5): 33-+.

Cilliers, P. (1998). Complexity and postmodernism : understanding complex systems. London ; New York, Routledge.

Darnton, A. (2004). Driving Public Behaviours for Sustainable Lifestyles; DEFRA 2004 .

Eppel et al (2011). Elizabeth Eppel, Anna Matheson & Mat Walton "Applying Complexity Theory to New Zealand Public Policy." Policy Quarterly **7**(1): 7.

Eyben, R., T. Kidder, J. Rowlands and A. Bronstein (2008). "Thinking about change for development practice: a case study from Oxfam GB." Development in Practice **18**(2): 201-212.

Hall (2015), Personal communication with Martin Hall, Principal officer, Aberdeenshire Council, Public Transport Unit.

Hargreaves, T. (2011). "Practice-ing behaviour change: applying social practice theory to pro-environmental behaviour change." Journal of consumer culture **11**(1): 79-99.

Jackson, T. (2005). Motivating Sustainable Consumption, Centre for Environmental Strategy.

Ramalingam et al. (2008). Ben Ramalingam & Harry Jones with Toussaint Reba & John Young. Exploring the Science of Complexity: Ideas and implications for development and humanitarian efforts. O. D. Institute. London.

Scottish Government (2009). Climate Change Delivery Plan. Edinburgh, Scottish Government.

Scottish Government (2010). Low Carbon Scotland: Public Engagement Strategy. Edinburgh, Scottish Government.

Scottish Government (2011). 10 Key Messages About Behaviour Change. http://www.gov.scot/Topics/ Research/by-topic/environment/social-research/Remit/events/Key-Messages, Scottish Government.

Seale, C. (2004). Researching Society and Culture. London, SAGE.

Shove, E. (2003). Comfort, cleanliness and convenience : the social organization of normality. Oxford, Berg.

Shove, E. (2010). "Beyond the ABC: Climate Change Policy and Theories of Social Change." Environment and Planning A **42**(6): 1273-1285.

Shove, E. (2010). "Sociology in a Changing Climate." Sociological Research Online **15**(3).

Southerton, D. M., Andrew; Evans, David (2011). International Review of Behaviour Change Initiatives: Climate Change Behaviours Research Programme. Edinburgh.

Urry, J. (2005). "The complexity turn." Theory Culture & Society **22**(5): 1-14.