

Foresight: the place of social science in examining the future of transport

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Abstract

Until recently a predominant assumption of policymaking has appeared to be that transport exists to serve society. Yet in practice transport shapes society and is shaped by it. Thus transport should be seen to support society. These are subtle but significant distinctions. In January 2006 the OSI's Foresight Programme launched the report of its examination of the future of transport to a 2055 horizon, entitled Intelligent Infrastructure Futures. The project and its reporting are receiving widespread interest across government departments. 'Intelligent Infrastructure' could easily imply a dominant physical science and technology flavour to the initiative with a here to serve mentality. However, two of the four 'science experts' enlisted for the study were chosen to represent social science or 'society'. In turn five from 18 science reviews commissioned as part of the study concerned 'society'. The outcome has been a consideration of the future as strongly shaped by social context as by technological possibility. This paper provides a brief summary of the Foresight Programme and its role in informing policy. An overview of the structure and outcomes of the transport study is given with specific discussion of how social science input has shaped the study. What emerges strongly is that 'intelligence' is not a trait attributable to science and technology but is demonstrated through how they are used in a social and behavioural context.

Note: The Foresight Programme is now part of the Office of Science and Innovation (OSI) which was formed on 3 April 2006. OSI is a result of the merging of the DTI's Innovation Group into the Office of Science and Technology (OST). The authors of this paper have been two of the four 'key science experts' in the OSI's Foresight Project 'Intelligent Infrastructure Systems' which launched its report in January 2006. The views in the paper are those of the authors and do not necessarily reflect those of the OSI.

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Introduction

Transport as a sector or as a discipline of academic study might be perceived as being principally concerned with the movement of people and goods from one place to another. This in turn involves investment in and the study of the infrastructure, vehicles and users of the transport system. The goals of such endeavour have been to ensure the efficient and effective operation of the system in ways that seek to offer fast(er), (more) reliable and safe(r) journeys. Journey speed has, for decades if not centuries, been an imperative that has driven progress which has seen motorisation take us from a horse-drawn world to one of trains, planes and automobiles. A strong theme in transport policy of the past if not the present has come to be known as 'predict and provide'. This has been particularly associated with road traffic whereby predictions of future traffic growth have informed investment decisions to expand the capacity of the road network to accommodate that growth.

A brief selection of statistics highlights how transport has 'evolved' (placed in inverted commas to question the positive connotation of the term) in recent times (ONS, 2006). In Great Britain the distance we travel annually has increased massively in the past half a century. In 1961 the figure was 295 billion passenger kilometres. By 2004 this had increased to 797 billion passenger kilometres. Domestic air travel, by distance, has increased by some ten times over the same period. The car has come to be and remains by far the dominant mode, accounting, in 2004, for 85 per cent of all recorded distance travelled. In 1961 69 per cent of households did not have regular use of a car – by 2003 this figure had reduced to 26 per cent (with 30 per cent of households with two or more cars). This inexorable growth in motorised mobility has come to represent, in many people's view, a losing battle in the sense that providing and managing transport system capacity cannot keep pace with the demand to use the system. The familiar adverse effects of congestion and pollution have tended to be seen as the most evident and troublesome consequences and indeed 'solving congestion' (Goodwin, 1997) has become a holy grail of the transport profession.

Looking back a little over 80 years, at the early stages of the motor age, the presence of congestion was already being faced. The experimental solution of the time to address this was to paint the first white line in a London street (see Figure 1).



Figure 1. First white line in London (image reproduced from Morton, 1934)

If only our contemporary endeavours could be as simple as this! Existing as we do in the early stages of the information age and faced with transport challenges much greater in scale than in 1924, we have looked increasingly to new technologies and telecommunications in a bid to help address the ongoing development of our transport systems. Many national and international programmes of research and implementation initiatives have looked to science and technology in a bid to further improve the efficient movement of vehicles (and people)

through our transport systems and to gather data and transform that data into information and knowledge that can positively assist the decisions of policymakers, transport system operators and system users.

However, the information age is also, it seems, bringing with it an age of social science in relation to transport. At the highest level, Government now realises that it can no longer hope (or afford) to build its way out of congestion (DfT, 2004). Accordingly, increasing attention has been given to demand management – addressing and influencing where, when and how we travel in an effort to better match transport supply and demand. In essence, demand management is about carrots (e.g. better public transport) and sticks (e.g. road pricing) which seek changes in individual behaviour. To change behaviour requires an *understanding* of behaviour and an understanding of *why* we travel. Social and environmental policy has also exerted greater influence on transport policy objectives with climate change and social exclusion as key concerns. Transport more so perhaps than ever before is expected to play its part in creating a more sustainable and inclusive society. The need to understand how people think and behave, the attitudes and beliefs they hold, the social practices in which they engage and the physical organisation of society is receiving growing attention.

Against this backdrop the then UK Government's Office of Science and Technology, along with the Department for Transport as the sponsor, embarked upon a major study to look at the future of transport in order to inform and influence key public and private sector decision makers. An important feature of the ensuing 'Intelligent Infrastructure Systems' (IIS) project under the Foresight Programme was its early recognition of the need to place transport in its social context. This paper's authors were two of the individuals enlisted to play a part in the study in this regard.

The aims of the paper are as follows:

- to provide an insight into the 'Foresight' approach to facilitating evidence-based policy and strategy;
- to summarise key features of the IIS project and its findings and outcomes; and
- to critically reflect upon the project's social science dimension and its importance.

At the outset of the paper it is appropriate to clarify its specific reference to social science. A recent commission into the state of social sciences in Britain (Commission on the Social Sciences, 2003) acknowledged that there is "not a simple or unambiguous specification of the social sciences". It viewed social sciences as "disciplined curiosity about societies in which we all live' leading to the creation and sharing of social knowledge." The commission referred to "the old-style view – still present in some thinking – that sees social sciences as a 'back-end fix' to the problems arising from new scientific developments". In this paper the intention is to underline a (continuing need to) move away from the back-end fix mentality in transport. In order to do so, a rigorous and prescriptive definition of the heterogeneous array of disciplinary elements deemed to constitute social science is not necessary. Instead the following is offered as a guide to the reader: *in contrast to technology and data driven advances levelled at the transport system associated with the disciplines of engineering and physical science, social science in this paper is taken to refer to a discipline of thinking that aims to place transport in the broader system of society and social practices and to enforce a view that advance is derived from human behaviour – facilitated by rather than achieved through scientific development.*

The next section of the paper provides some further background concerning Foresight and the evolution of transport studies. The IIS project itself is then described, indicating the methodological process followed and summarising the materials and messages that emerged. The paper's concluding discussion then focuses upon a selection of issues that relate to the social science 'discipline of thinking' and which have featured in discussions which have shaped the Foresight project and which it is hoped will continue to receive due attention in the formulation of policy and strategy.

Background

Foresight

The Government's Foresight Programme introduces itself as follows: "Foresight, and its associated horizon scanning centre aims to provide challenging visions of the future to ensure effective strategies now. It does this by providing a core of skills in science-based futures projects and unequalled access to leaders in government, business and science" (<http://www.foresight.gov.uk>). With its aim of improving "the relative performance of UK science and engineering and its use by government and society" the focus is upon identifying opportunities for science and technology to address challenges facing society. The Foresight Programme "brings together key people, knowledge and ideas to look beyond normal planning horizons to identify potential opportunities from new science and technologies and actions to help realise those opportunities".

Foresight is currently in its third round. The Technology Foresight Programme was initiated in 1994 following the Government's White Paper 'Realising Our Potential: A Strategy for Science, Engineering and Technology' (1993). The first round was comprised of 16 sector-facing panels consisting of experts from academia, industry and government. The remit was to look 20 years ahead examining emerging market and technological opportunities and associated research priorities. Following published visions and recommendation for action in 1995, four years of development and implementation followed. Reporting for the Transport Panel noted that "the growth of personal mobility in particular is a story of remarkable success for transport and expanding opportunity for suppliers and operators"¹ but went on to acknowledge it had come at a price – congestion delays, accidents and environmental impact. The opportunities for technology were highlighted including the prospect of the information age reducing the need to travel and assisting in the undertaking of travel. It was suggested that the greatest challenge was to develop more eco-friendly vehicles to be able to meet demand for mobility and meet environmental targets. Many of the Transport Panel's priorities focused upon three "innovative ideas": The Informed Traveller (providing integrated multi-modal travel information to the traveller); Foresight Vehicle (stimulating the UK car industry to produce more environmentally friendly vehicles suitable for the mass market); and Clear Zones (creating more liveable urban centres).

The second round of the Foresight Programme began in 1999. This round again centred upon sector (and thematic) Panels looking 20 years ahead. The Built Environment and Transport sector Panel ran until 2001 and involved three Task Forces including the Social and Motivational Behaviour Task Force. The Chairmen of this Task Force noted that "This Task Force was established to examine the social dimension of future transport technologies. Simply looking at the technological advances in the transport sector without considering the social and in particular, the behavioural and motivational dimensions is incredibly wasteful."²

¹ http://www.foresight.gov.uk/Previous_Rounds/Foresight_1994__1999/Transport/index.html

² http://www.foresight.gov.uk/Previous_Rounds/Foresight_1999__2002/Built_Environment__Transport/Reports/Physical%20World%20in%20a%20Virtual%20Age/social.htm

It looked at three groups in society: people aged over 65, one-person households and those on low income. By examining literature, technology projects and considering two case-studies (involving smart cards, travel information and online shopping), the Task Force's concluding recommendations were as follows: improvements to public transport; greater transparency for the public about the transport system; more research into the impacts on travel behaviour of demographic change; greater flexibility of smart card payments; and greater consultation with users in the design of new technologies.

The Commission on the Social Sciences (2003) observed that "the government's two large Foresight exercises differed dramatically: the first was very largely technologically-driven whilst the latest one incorporated somewhat more social science in the setting of the starting point and in various scenarios". According to the available summarising text concerning the treatment of transport in the two rounds, the first round is firmly centred upon the technological possibility of facilitating mobility while ameliorating the adverse environmental effects. The second round is somewhat more attentive to behaviour, attitude and variation across social groups though in its recommendations appears still to concentrate quite narrowly on the enabling technologies themselves and seems not to place transport in its wider social context.

The third (current) round of the Foresight Programme follows a review of the Programme in which it was determined that greater focus was needed to direct attention to where it was most needed. The Programme has thus moved away from its panel structure to instead concentrate upon a rolling programme of projects which began in 2002. The IIS project began in September 2004. Within the Foresight Programme, consideration of transport has thus spanned over 10 years. The third round, has underlined a further and quite pronounced increase in the significance of social science input to envisioning the future of transport within the Programme.

Transport studies

The field of transport studies itself has also not stood still as priorities have changed. Defining the scope of 'transport studies' is as difficult as to do so for social science. However, for nearly forty years an umbrella organisation for UK academic research in transport has existed called the Universities Transport Study Group (<http://www.utsg.net/>). The activity of this community offers an instinctive sense of scope and its members have, over 40 years, often provided the intellectual voices inputting to the ongoing transport policy debate. As one of the founding figures in this research community, Professor Richard Allsop recently undertook a review of four decades of papers presented at the annual UTSG conference. This offered a crude but valuable and effective means of charting how the content and focus of transport studies has changed over this period. He observed that there "has been a substantial shift of emphasis towards the behavioural, social and environmental aspects of transport studies alongside continuing activity concerned with engineering, technology and operational aspects of transport systems" (Allsop, 2006).

The UTSG community has offered the most substantial UK academic voice on transport issues. However, it is not the only voice – there are, for example, overlapping communities of transport economists and transport geographers. There has also been a recent 'awakening' of sociology and other dimensions of social science to the merits of transport becoming the subject of greater study. However, here the term 'mobility' dominates and is seen to represent much more than the physical travel from origin to destination with which the term 'transport' is associated. The recently formed Centre for Mobilities Research (CeMoRe) at Lancaster

University is a significant focal point of an evolving 'new mobilities paradigm'. Its website suggests the following. "The concept of 'mobilities' encompasses both the large-scale movements of people, objects, capital, and information across the world, as well as the more local processes of daily transportation, movement through public space, and the travel of material things within everyday life"³. Sheller and Urry (2006) offer an exposition of the new mobilities paradigm within which a number of characteristics can be identified (and expressed in a disciplinary language and style rather different to that of transport studies):

1. All social relationships involve diverse 'connections' that are more or less 'at a distance', more or less fast, more or less intense and more or less involving physical movement. Social relations are never only fixed or located in place but are to very varying degrees constituted through 'circulating entities'.
2. These connections stem from five interdependent 'mobilities' that produce social life organised across distance and which form (and re-form) its contours: corporeal travel of people; physical movement of objects; imaginative travel of images upon multiple print and visual media; virtual travel often in real time; and communicative travel through person-to-person messages.
3. On occasions and for specific periods, face-to-face connections are made as a result of the corporeal movement of one of more participants. People travel to connect face-to-face but this face-to-faceness is a contingent, embodied performance occurring within certain spaces and times. It is this contingent meetingness that drives physical travel.
4. Social life is made up of heterogeneous material objects (including 'nature' and 'technologies') that directly or indirectly move or block the movement of objects, people and information. Such objects themselves travel; there are objects that enable people to travel forming complex hybrids; there are objects that move other objects; there are objects that move that may mean that people do not move; there are objects and people that move together; there are objects that are reminders of past movement; and there are objects that possess value that people travel often great distances to see for themselves.
5. In particular there are various 'mobility-systems' that distribute people, activities and objects in and through time-space, such as the road system of the Roman Empire, the mediaeval horse-system after the invention of the stirrup, the cycle-system in twentieth century China, the paved pedestrian system of modern cities, the rail system, the car system and so on. Historically most societies have been dominated by one major mobility-system, the dominant 'mode of circulation' we might call it, in an evolving and adaptive relationship with that society's mode of production and state. These systems produce substantial inequalities between places and people, rendering some less than full citizens.
6. Modern states 'govern' populations. Such governmentality from the early nineteenth century involved not just a territory with relatively fixed populations but mobile populations moving in, across and beyond 'territory'. The 'apparatuses of security' involve dealing with 'population' at a distance, on the move and being statistically measured, plotted and tracked, beginning with the humble passport.
7. Such mobility-systems can endure; organised through time such systems may demonstrate path-dependency or lock-in. The car-system best shows such path-dependency. New systems then have to find their place physically, socially and economically within a 'fitness landscape' that is structured by the configuration of existing systems.

³ <http://www.lancs.ac.uk/fss/sociology/cemore/>

8. Such systems are based on increasingly expert forms of knowledge. Such mobility systems are increasingly based upon computer software that drive, monitor, regulate and in cases repair the system in question. The user is alienated from the system and yet is simultaneously dependent upon such systems.
9. As people and objects move around further developing individual life projects if not spending more time on the move, so much about them gets left behind in traces. These reconfigure humans as bits of scattered informational traces since individuals increasingly exist beyond their private bodies as information relating to them is highly mobile.
10. Some such systems are self-organising, co-evolving and interdependent, extending and reorganising time and space and generating dynamic system characteristics. While other systems, such as the railway system, are more like military machines focused upon the hierarchical delivery of rail services little able to adapt and co-evolve in relationship to especially the self-organising car-system.
11. Mobilities do not just to enable other activities but are in part activities in themselves. Different modes entail different kinds of practice, different pleasures and costs, different performances and affordances. Mobilities are more than getting from A and B.

It would seem that the nature of transport, or now transport and mobilities, study is changing or expanding in a way which is bringing to the fore a greater diversity of thinking and perspectives. This is not to suggest that the importance of science and technology within such study is diminished but rather that a greater richness of understanding is evolving as contemporary practice and debate concerns itself with a new interpretation of transport. It may once have been sufficient to believe that transport was here to *serve* society in an era when constructing new infrastructure and managing the flows of people and vehicles on it was the business of the transport profession. However, as the problems of a mobility dependent society are faced, a more sophisticated understanding of transport has been unfolding. We must now recognise that far from merely supporting society and social practices, transport *shapes* them as in turn they shape transport. With such recognition comes a need for new endeavours in policy and practice that seek to ensure transport *supports* society, social patterns and practices in an appropriate manner (Lyons, 2004).

We would suggest that of the many transport visioning exercises that have taken place, the IIS project has proved to be one of the most progressive in its engagement with social science. Social science has been embedded in the project from its early conception. This is important since the “social sciences contribute best to central concerns of society ... by being involved in ‘big questions’ from the very outset, rather than as a ‘back-end fix’” (Commission on the Social Sciences, 2003).

The paper now turns to examine the IIS project itself in terms of its approach and considerations.

Intelligent Infrastructure Systems

The stated aim of this project has been to “explore how science and technology may be applied over the next 50 years to the design and implementation of Intelligent Infrastructure Systems that are robust, sustainable and safe”⁴. The project’s title and indeed the aim itself do not evidently point towards an exercise that will look at the future of transport and accommodate a social science dimension. The project initially defined ‘infrastructure’ as any platform used in the delivery of shared services to people. The transport system connects

⁴ http://www.foresight.gov.uk/Intelligent_Infrastructure_Systems/Index.htm

people to opportunities, social networks, goods and services (Kenyon et al, 2002) and was taken to constitute the infrastructure system in question. The title of the project might then have been ‘Intelligent Transport Systems’ (ITS). However, this phrase has been the long-adopted label of a specific facet of transport that sees technology at its heart. A recent Government framework document has set out the role of ITS in supporting the delivery of transport objectives (DfT, 2005). This answers the question ‘what are Intelligent Transport Systems?’ as follows. “Combinations of information processing, maps, databases, communications and real-time data from a range of sensors, to produce solutions that enable:

- infrastructure owners and operators to improve the quality, safety and management of transport networks;
- individual travellers, drivers, hauliers, transport operators and authorities to make better informed, more ‘intelligent’ journey decisions;
- network operators and ‘third party’ service providers to supply advanced information services, increasingly on a multi-modal basis, to all types of traveller; and
- road users to drive safer, ‘smarter’ vehicles.”

Such issues are important but they align more readily with a ‘transport is here to serve’ perspective than with one of ‘transport is here to support society’ in relation to how new advances in science and technology can be put to good effect. The IIS project has certainly embraced ITS but only as part of a broader outlook.

Methodology

The research process within the project has involved a number of strands and nearly 300 people in different capacities. There is not the space within this paper to provide a comprehensive description of the project structure and process. Such information is, however, available on the project website⁵. We focus here on two of the core activities within the project, namely the development of a set of state-of-research reviews and the production of a set of scenarios. These have been core in the sense that they constitute a substantial proportion of the published material from the project in their own right and also because it is from the act of creating the reviews and scenarios (alongside also the production of a technology forward look report⁶) that the thinking of key figures within the project has evolved and enabled in turn the creation of an overview report which seeks to capture the essence of valued considerations and messages that have existed and evolved within the project as a whole.

At this point it is important to clarify the purpose of this and other Foresight projects. The intention is not to develop policy or strategy or to attempt to foretell what the future will have in store. For some this has perhaps appeared a surprise or a frustration and it might seem that the project in not so doing is evading confronting the pressing challenge of mapping an effective way forward towards a better (transport) future. However, the very strength of the project approach is to underline that the future is not predetermined and waiting to happen – it is ours to shape. The task of shaping must rightly fall to decision makers who face the challenge of reconciling often competing objectives in making choices. The purpose of the project therefore is to provide a resource of both state-of-the-art knowledge and a way of

⁵ http://www.foresight.gov.uk/Intelligent_Infrastructure_Systems/

⁶ http://www.foresight.gov.uk/Intelligent_Infrastructure_Systems/Reports_and_Publications/Intelligent_Infrastructure_Futures/Technology_Forward_Look.pdf

thinking and assessing that knowledge that can then be used to engage key decision makers to enable them to make better informed choices.

A total of 18 science reviews were commissioned by the project. A team of commissioning editors was responsible for overseeing this process, including this paper's authors. The reviews were grouped at the launch of the project into 'society', 'environment', 'technology', 'information' and 'policy and economics'. There were five reviews in the first grouping⁷:

- *social factors in travel* (Axhausen, 2006) – this examined the consequences of a world in which costs of travel and communication are reducing, highlighting not only the changes brought to where we live, work and shop but also the importance and our limited understanding of how social networks impact upon and are impacted upon by personal travel;
- *the social impacts of intelligent infrastructure on transport* (Little, 2006) – this paper considered the role of social science in studying and understanding both the possibilities that technologies can deliver and the needs that we would, knowingly or otherwise, like them to fulfil ('user pulls');
- *the psychology of travel* (Stradling, 2006) – this review examined the question of why people travel and challenged the simple notion of time/cost minimisation in travel choices by highlighting the (un)welcome expenditure of physical, mental and emotional effort associated with making journeys and how this can differently affect people's aspirations and decisions;
- *the role of information in decision making in transport* (Lyons, 2006) – this considered the importance of individuals' strategic and tactical decisions in determining patterns of travel and the place of information provision in supporting or influencing decisions but it also highlighted the significant barriers to technological possibility in this regard of satisficing behaviour and habit; and
- *public perceptions of risk* (Eiser, 2006) – this review considered how the public respond to uncertainty in their daily lives and in the face of change and innovation and examined the notions of trust, caution and cognitive heuristics as well as social amplification and social attenuation as determinants of evolving public behaviour and thus the nature of science and technology's impacts on society.

The reviews' preparation fed into the scenario planning exercise within the project. Scenario planning exposes uncertainty about the future, highlighting the multiplicity of different futures that could unfold dependent upon the nature and interaction of a large number of drivers for change. The development of scenarios must not be confused with the preparation of a vision. The latter is an end-state towards which one is seeking or aspiring to work; the former are outcomes which together can illustrate the diversity of future possibility and assist decision-makers in considering policy formulation that is likely to be either most effective or most resilient in the face of the different possibilities. Looking ahead to the year 2055 and considering varying extents of people's acceptance of intelligent infrastructure and extents of transport's environmental impact, four scenarios were developed and given the following

⁷ In fact at the stage of the reviews being commissioned, papers by Goodwin and by Banister and Hickman were also under the 'social science' umbrella which is reflected in their content – these papers are referenced later in this article.

names: ‘perpetual motion’, ‘urban colonies’, ‘tribal trading’ and ‘good intentions’. Table 1 summarises the four scenarios⁸ or ‘sociologies of the future’.

Table 1. Summary of four IIS scenarios, reproduced from main project report (OSI, 2006)

<p>Good Intentions</p> <p>The need to reduce carbon emissions constrains personal mobility.</p> <p>Traffic volumes have fallen and mass transportation is used more widely.</p> <p>Businesses have adopted energy-efficient practices: they use wireless identification and tracking systems to optimise logistics and distribution.</p> <p>Some rural areas pool community carbon credits for local transport provision, but many are struggling.</p> <p>Airlines continue to exploit loopholes in the carbon enforcement framework.</p>	<p>Perpetual Motion</p> <p>Society is driven by constant information, consumption and competition. In this world, instant communication and continuing globalisation has fuelled growth: demand for travel remains strong.</p> <p>New, cleaner, fuel technologies are increasingly popular. Road use is causing less environmental damage, although the volume and speed of traffic remains high. Aviation still relies on carbon fuels – it remains expensive and is increasingly replaced by ‘telepresencing’ for business, and rapid trains for travel.</p>
<p>Tribal Trading</p> <p>The world has been through a sharp and savage energy shock. The global economic system is severely damaged and infrastructure is falling into disrepair.</p> <p>Long-distance travel is a luxury that few can afford and for most people, the world has shrunk to their own community.</p> <p>Cities have declined and local food production and services have increased.</p> <p>There are still some cars, but local transport is typically by bike and by horse.</p> <p>There are local conflicts over resources: lawlessness and mistrust are high.</p>	<p>Urban Colonies</p> <p>Investment in technology primarily focuses on minimising environmental impact.</p> <p>Good environmental practice is at the heart of the UK’s economic and social policies: sustainable buildings, distributed power generation and new urban planning policies have created compact, dense cities.</p> <p>Transport is permitted only if green and clean – car use is energy-expensive and restricted.</p> <p>Public transport – electric and low energy – is efficient and widely used.</p>

During the course of the project, a high level of liaison with different government departments and key decision makers was forged with the intention of both informing the project development but also of engaging key individuals and organisations in the process of Foresight. The launch event for the project in January 2006 then marked the end of one process – the generation and documentation of thinking and knowledge – and the beginning of another – the pursuit of an action plan working with many of those engaged and making use of the material generated.

⁸ For the full report “The Scenarios – Towards 2055” go to http://www.foresight.gov.uk/Intelligent_Infrastructure_Systems/Reports_and_Publications/Intelligent_Infrastructure_Futures/the_scenarios_2055.pdf

Findings

Perhaps the very essence of the project has resided with the term ‘intelligence’. There is a danger when the term is used in association with technological advance – it can bestow undeserved anthropomorphic qualities on the technology itself. Intelligent can often implicitly refer to technological sophistication rather than the efficacy of the technology in achieving a greater good. It risks raised expectations of effect. Technology itself is not intelligent, it is enabling. Intelligence comes from how the technology is used. What follows is that the pathway of adaptation will be governed less by the technology than by the policies, control mechanisms and choices it enables. This concern about the treatment of ‘intelligence’ was acknowledged at a relatively early stage in the project. Project reporting (OSI, 2006) then chose very fittingly to return to the matter of intelligence as a key focal point. It identified a need to invest in intelligence on four levels. “We need:

- **intelligent design**, minimising the need to move, through urban design, efficient integration and management of public transport and local production
- a system that can **provide intelligence**, with sensors and data mining providing information to support the decisions of individuals and service providers
- **infrastructure that is intelligent**, processing the mass of information we collect and adapting in real time to provide the most effective services
- **intelligent use** of the system where people modify their behaviours to use infrastructure in a sustainable way”

These are important principles to abide by and strongly associated with what science and technology can *enable* rather than (only) associated with technological endeavour itself. However, espousing such principles and putting them into practice presents a need to confront the many more detailed considerations that have been summarised in the main project report.

The project has of course given substantial consideration to the technological capabilities of the future and what they can enable in pursuing intelligence. This includes: vast networks of tiny and inexpensive sensors to monitor the use of the transport system; data mining capabilities to yield nuggets of knowledge and understanding from gigantic sets of data; software agents capable of investigating travel and other options on behalf of their ‘owners’; complex modelling and simulation; major advances in the speed of transfer of information (e.g. allowing feature-film downloads in seconds); speech interfacing with computing; and complex information systems able to self-monitor for signs of instability. Seen in isolation such a list might suggest an overshadowing of social science input.

However, the reporting notes, in relation to such technological advance the following. “Historically, when we have improved the transport system and reduced costs, people have travelled more... A key issue is how to use the technologies to ensure that we not only improve efficiency, but also deliver sustainable and robust solutions” (ibid). A number of ‘softer’ issues are highlighted accordingly and interposed with technological capabilities, including: a recognition of fundamental human needs to travel; an understanding of the positive utility of travelling itself; the need to consider lifestyle decisions (such as where we choose to live) that impact upon travel rather than only travel decisions themselves; the unexpected uses of technology compared to those originally intended (Goodwin, 2006); an overriding importance of using spatial planning to prevent excesses of motorised mobility dependence (Banister and Hickman, 2006); the greater achievement of access through virtual

communications as an alternative to physical travel and the need for increased travel costs as well as increased telepresence capability for such potential to be realised; the realisation that sustainability now deserves as much attention as economic growth (Köhler, 2006); a need to consider charging for the full cost of travel in conjunction with education and public awareness raising to achieve fundamental changes in behaviour; a realisation that communications are no longer restricted to connecting from place to place but are often now from person to person in a mobile world; an underlining that travel opportunity transforms from luxury to necessity; an understanding that travel enables social change and expanding and sustained social networks; and recognising that human resistance to change that can sometimes subvert optimisation and rationality.

This ‘rebalancing’ of the place of science and technology and of social science in examining the future of transport is evident in the project report’s examination of delivering intelligence:

“Tempting as it may be to see the delivery of IIS in terms of technology, and technology will certainly be important, we have to remember that it is people who travel, not their cars, for example. So, delivering IIS will be as much a matter of understanding the psychology of travel, the social circumstances of the travelling public and of influencing their decisions as it is about technological development.”
(OSI, 2006)

Concluding discussion

What has been so refreshing about this Foresight exercise has been its determined effort to take an holistic view in examining the future of transport. It underlines the complex system within which our transport system continues to evolve and of which it is part. Specifically for this paper, the authors have prepared a ‘systems of systems’ diagram (see Figure 2) to offer an overview reminder of the need to carefully situate any specific debates or opportunities for advance.

The diagram cannot pretend to be comprehensive. Notably, it is not possible easily to fully portray the complex and poorly understood patterns and flows of cause and effect – certainly these will seldom be linear or unidirectional. What the diagram is intended to illustrate is the array of sometimes conflicting inter-dependencies around which cause and effect are occurring and across which choices are being considered and decisions made. The outer layer of the diagram depicts society and its social practices as a whole and three of the main aspirations deemed to signify societal wellbeing. Meeting all three of these aspirations simultaneously is far from easy with many trade-offs occurring and seemingly conflicting priorities. The next layer points to the different forms of societal governance that interact, with their own (sometimes conflicting) objectives. Governance plays a significant part in determining whether and how societal aspirations and society itself evolves. It also significantly defines how three of the core systems within society operate and evolve. Importantly, the three systems themselves are strongly inter-dependent in their evolution and this is something which has been well recognised in the IIS project. It is in the context of such inter-related and interacting systems that transport itself operates with the movement of people and goods (and information) and the associated movement of vehicles. At the centre-point of this system of systems is the largest set of actors within the system – the general public. Importantly, while they are impacted upon by the decisions and developments associated with the outer layers, the general public emanate a significant outward set of impacts through the other layers as they make not only transport choices but a wider array of lifestyle choices. Thus each layer impacts upon every other layer. A key deduction is that

effective decision-making in any one layer needs to have a sufficient understanding of the whole system if there is to be a reasonable understanding of the consequences of actions.

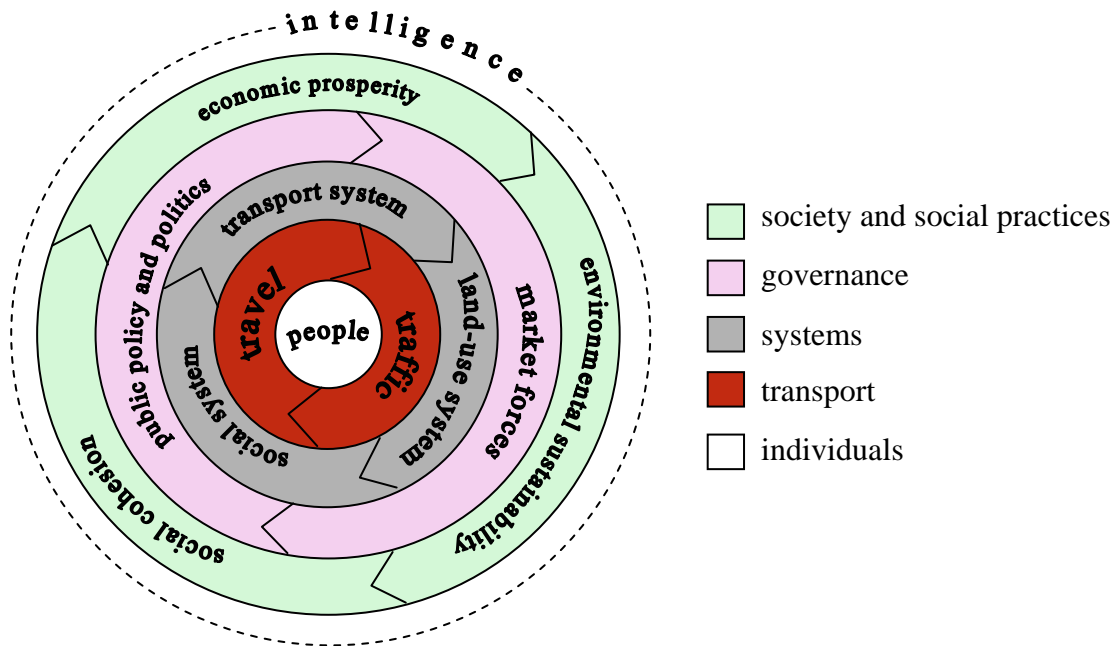


Figure 2. The ‘system of systems’ embodied by the pursuit or application of intelligence

It is of course relatively easy to conceptualise such an overview interpretation. Joined-up-thinking in practice is well recognised as a much more challenging goal to pursue. However, it is a goal that must be pursued if we are to avoid deflecting from integrated decision making towards disintegration and disarray. Unintended consequences are ever waiting in the wings if policy and strategy are not sufficiently well thought out and informed. Such a warning emanated from social science itself 70 years ago. A paper by the sociologist Merton (1936) is seen by many as a seminal article which first framed the notion of unintended (or ‘unanticipated’) consequences. Merton identified five limitations to “successful social prediction and planning” and “a correct anticipation of consequences of action”: ignorance or lack of adequate knowledge; error; imperious immediacy of interest; basic values and self-defeating prediction. Geels and Smit (2000) offered a highly instructive insight into why many *visions* about transport futures have been wrong. They focused specifically on transport technologies and highlighted a number of pitfalls and lessons. These are shown in Table 2.

The previous paragraph reminds us that social science has or should have a central part to play in shaping the future of transport. However, this may be a message that will need to be driven home repeatedly in the face of the very real difficulties of thinking holistically and thoroughly - especially in the context of the more focused day-to-day activities of individuals in their professional lives. Bringing about change at the level of key decision makers takes time and effort and one can never assume that a once a point is made or principle agreed upon that it will endure in the course of future decision-making and balancing of priorities. For example, it took a period of many years to fully acknowledge the flaws in the predict and provide approach to transport policy. While we now have policy statements appearing to endorse a move away from this, there are also some stark indications that it remains an embedded orthodoxy. For instance, the Highways Agency in the UK is now to trial the use of

the hard-shoulder on motorways to create an extra running lane at times of congestion⁹ (Chase, 2006) which to many appears to be an alarming encouragement of predict and provide. Likewise, once we acknowledge the social consequences of cheaper and more readily available air travel – sustained international social networks, long distance business and leisure travel etc. – then it becomes clear that air travel is moving from a luxury to a necessity such that plane dependence may be the new alternative to car dependence. Accordingly it could be seen as alarming that predict and provide appears to remain an accepted practice for the aviation industry.

Table 2. Key features that have shaped images of the future role of new technologies in transport (adapted from Geels and Smit, 2000)

Contemporary concerns and hopes	Perceptions of the future are shaped and coloured by current problems and aspirations resulting in optimistic rather than plausible scenarios
New technological trajectories	The pathway of technological innovation and product development may significantly change introducing new possibilities and expectations concerning the role in, and impacts on society of the technology
New for old substitution	The role of a new technology is often phrased in terms of replacing or substituting the old technology whilst in reality old and new technologies often co-exist, serving different markets, circumstances or purposes.
Social practices neutral	It is often wrongly assumed that the pool of social practices and needs remains unchanged thereby implying that new technology will (only) substitute certain social practices. In reality the pool of social practices can increase.
Narrow functional thinking	Through only functional thinking, new technologies can be judged capable of enabling the purpose of an activity to be fulfilled. This neglects to consider other social and psychological aspects of an activity that may not be addressed.
Societal embedding	The process of societal embedding of new technologies can be viewed as unproblematic when in practice many social and institutional adjustment processes have to take place which may not be straightforward and can take some time to achieve.
Hopeful monstrosities	Promoters in particular of an emerging technology can voice unrealistically high expectations. This may be to serve the purpose of creating a ‘breathing space’ for investment and development to continue. It may also be a consequence of neglecting the co-evolution of technology and society, and underestimating the practical difficulties and resulting slowness of processes of societal embedding of technology.

Perhaps one of the challenges for social science is that it aligns less readily than physical science and technology with industry and the private sector. Science and technology can thus ‘enjoy’ strong support in the governance and systems rings of Figure 2 such that technology push rather than user pull can be at risk of prevailing. This said, in concluding one must be careful not to leave a sense from this article that it is believed that science and technology are not important. Far from it. They provide incredible opportunities. The information age in

⁹ <http://www.highways.gov.uk/knowledge/1353.aspx>

which we now live is substantially permeated by a use of and reliance upon a myriad of technological advances. The enduring concern is that science and social science must *both* feature significantly in our examination of the future and the formulation of policies and strategies. Foresight has contributed greatly to addressing and vocalising this concern. At the time of writing the action plan of the project is being implemented and we wait with interest now over the coming months and years to see to what extent decision makers will respond to and account for the project's messages and the part therein played by social science.

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