New technologies for the old: potential implications for independent living and travel demand

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Abstract
Assistive technologies for older people, such as personal tracking devices and community alarms, can facilitate living independently for longer. Where older people live – whether in their own homes, those of relatives or in residential care homes – will affect patterns of travel associated with their lifestyles and needs. Such assistive technologies represent an example of developments and their social uptake outside the field of transport which may, nevertheless, have an indirect impact on travel demand and one which may be quite substantial. This paper aims to improve our understanding of which technologies that affect the health and well-being of older people are emerging, how these influence people’s ability to live independently for longer and hence, their demand for travel. To this end, interviews have been carried out with experts from the field of ageing to yield insights into the array of latest technological developments able to support living in later life. In addition interviews with transport experts have been undertaken to explore the following three issues (with an orientation towards assistive technologies for older people): (i) the extent to which the impacts of non-transport technologies are being considered within the transport sector; (ii) how important or relevant it is for such consideration to be given; and (iii) ways in which such impacts can be accounted for in travel demand analysis and policy decisions. What emerges is that these experts recognise that such indirect impacts are very important but rarely are developments in domains outside of transport (with the exception of land use developments) examined for their potential implications for transport. The transport experts noted various ways of increasing the integration between transport and other domains, with several seeing more emphasis on these issues in the education of transport professionals as an important starting point. The paper puts forward the case for using scenario planning as a means to emphasise how the living arrangements for older people, facilitated through assistive technologies, could produce distinct and significant consequences for travel demand.

1 Introduction
Personal travel is generally understood to be a derived demand, a means to an end, the end being the opportunity to participate in activities at the destination. It follows that travel demand is strongly related to developments in other sectors, such as employment, retail, leisure or healthcare, as these developments have a strong influence on the activities people need or want to perform, and where they perform them (Stead and Banister, 2001). In short, people’s lifestyles and social practices, framed by their resources, priorities and constraints, substantially govern their travel behaviour. In a previous paper (Hubers et al, 2011) we have gone further to highlight how social practices are shaped by the affordances of technological developments – with such developments often occurring outside of the transport sector. There is an implied sequence of non-transport technologies affecting social practices that in turn affect travel. What follows is an assertion that in order to understand past, present and future travel demands one needs to be able to take account of the technological shaping of social practices. However, it is far from clear that present day decision making by policymakers is well supported or supported at all by methods of examination that look to address such issues. To illustrate some of the shortcomings implicit in decision making processes of policymakers, Lyons (2008) has examined the law of unintended consequences and highlighted a number of examples of
where transport policies have unintended consequences for transport and for other sectors and where non-transport policies have unintended consequences for transport.

This paper looks to take further forward the contention that non-transport technologies through their impacts on social practices should be accounted for in analysis of travel demand. It does so by focusing upon the case of assistive technologies for living in later life.

Maintaining the wellbeing and quality of life of our ageing population is likely to require considerable changes in the way in which care is provided. High costs of residential care combined with the preference of older people to remain living in their own homes for as long as possible have cultivated not only the desire but also the need to ‘age in place’. It is expected that developments in the field of assistive technologies will enable more and more people to live in their own homes for longer, aided by a combination of technological and personal assistance. What is changing, however, is the sheer scale of the demand for this technological and personal assistance in the light of the growing number of older people; the sphere of the technologically possible is also expanding. Allied to this are the aspirations to achieve active ageing – delaying the onset of health problems through maintaining a fulsome lifestyle.

The paper’s ultimate focus is to trace through with this ‘case study’ focus from looking at technological developments through to how they may affect living in later life and in turn travel demand. The paper aims to then go further to examine the extent to which account of this is likely to be taken in current approaches to informing policy decisions and to critically reflect upon why this extent may be too limited and what remedial suggestions might be offered.

In order to take this approach, the paper draws upon a series of expert interviews that were undertaken for this purpose. Both ageing and transport experts have been consulted.

The next section of the paper provides further context by both illustrating the relevance of the notion of ‘wicked problems’ as well as briefly outlining some of the existing insights relating to an ageing society and living in later life. The following section explains the interview methodology. The main section of the paper then presents the results of the interviews. The final section of the paper discusses these results and makes the case for scenario planning as a key means of reconciling unavoidable uncertainties about the future derived from the complex interplay between technologies, social practices and travel demand with the need to offer some form of robustness of insight to inform present day policy decisions.

2 The wicked problem of understanding living in later life

Almost 40 years ago, Rittel and Webber (1973) argued that within social policy, having dealt with most relatively simple and ‘tame’ issues, the complexity of the problems that were now being faced had increased greatly leading them to label them as ‘wicked problems’. In their 1973 treatise, they stressed that such wicked problems could not be dealt with in the same way as tame problems, but warranted a different approach. According to Seidensticker (2006, page 45) wicked problems “have complex cause-and-effect relationships, include human interaction, and imply inherently incomplete information. They require compromises.” As our understanding of the relations between non-transport technologies, practices and travel demand ticks all of these boxes, it is fair to say that this paper deals with a wicked problem too. Similarly, Langmyhr (2000, page 681) argues how

“transport problems have developed from tame to wicked. Traditional ‘predict and provide’ solutions are cast in doubt, because problem comprehension involves a larger transportation-land use system than before, as well as an expanded set of societal values.”

Once we accept that the wickedness of transport problems has increased in the past decades, the question then becomes whether our ways of confronting them have changed accordingly? Judging
from a recent paper by Schwanen et al. (2011) evaluating the methods of scientific research on climate change mitigation in transport, a wicked problem pur sang, the majority of this research still uses methods and approaches developed for tame rather than wicked problems. They argue that within transport there is still a “predisposition towards quantitative modelling and technology, pricing and infrastructure oriented interventions in transport systems” (page 993) to the neglect of social science theories that “are non-positivist in nature and imagine climate change mitigation as complex social processes” (page 1003).

One of the distinguishing properties of wicked problems is that the way in which a wicked problem is defined, has very important implications for the solutions that are found for these problems. Therefore by defining transport problems as resulting from developments occurring in other domains, this opens up new solutions to these problems. By deepening our understanding of the determinants of travel demand, this paper seeks to uncover alternative ways of dealing with travel demand. To this end, it seeks to expose how developments in non-transport technologies and changes in the associated social practices can be of influence on travel demand.

**Definition of non-transport technologies**

Non-transport technologies are those technologies that at the moment of invention were not intended to influence travel demand but which nevertheless may affect travel demand in an indirect way through how they shape social practices. Attention centres on technologies that do not directly substitute for travel. Acknowledging that whether a technology can be considered to be more or less transport-related depends on the context in which it is used, it is emphasised that there is no strict distinction between transport and non-transport technologies. Rather there is a continuum in between these two extremes and depending on whether a certain technology is nearer to the non-transport extreme determines its inclusion in this study. Furthermore, the definition of technology adopted in this paper is inspired by the writings of Arthur (2009, page 28) who states that “a technology is a means to fulfil a human purpose” and that “[a]s a means, a technology may be a method or process or device.” The focus is thus not solely on emerging artefacts or devices, but also on the processes of designing these technologies and of making the resulting products and services available to older people. Using this broad definition of technology, the methods and processes of transport research and policy making themselves can also be seen as technologies that may be influenced by developments occurring in other domains. Indeed, a possible example of this will be described in the results section.

**The choice for older people as a case study**

The choice for technologies aimed at improving the health and wellbeing of older people was given by the fact that there is a sense of urgency around the ageing of the population and the various kinds of consequences this may have. The demand for social care is estimated to increase by 44% over the next 20 years due to the expected increase in life expectancy, but importantly also because the healthy life expectancy is expected to lag behind the overall increase in life expectancy (Plum Consulting, 2010). It is deemed very unlikely that the formal care supplied by the state and informal care provided by friends and relatives will be able to meet this 44% increase in demand. Because of this widening gap between the demand and supply of care, much is expected of technology’s potential to bridge this gap. These technologies have the potential to accommodate the activities older people need or want to perform and how they perform them. Therefore in this paper we will look at how certain emerging healthcare technologies may change the activities older people and their carers undertake. Consequently, we will discuss which indirect impacts these healthcare technologies are therefore likely to have on travel demand.

The transport world seems to approach the issue of an ageing population from the viewpoint of how to develop transport technologies that enable older people to drive safely for longer, or how public transport provision can be improved to cater for the needs of the ageing population (e.g. by providing wheelchair access on trains and buses et cetera). However, there does not seem to be a critical assessment of why older people or their carers will want or need to travel in the first place, and whether interventions in other sectors might affect the need to travel, either positively and/or negatively. The question of where these people will live, for example, will inevitably be of
consequence for the trips they generate. Assuming that the travel demand of older people living in their own homes differs from those who live in residential or nursing homes, the trend towards independent living demonstrated in Figures 1 and 2 is bound to have all kinds of implications for transport.

3 Interview methodology

In order to create a better understanding of the technological developments that are taking place around the care for older people and living in later life, six experts from the field of ageing were interviewed. The emphasis in these interviews was not so much on the specifics of the emerging technologies, but more on how the experts expected them to be used and how using them might relate to changing everyday activities and practices of older people and/or their carers. Particular effort was made to expose possible unintended or unanticipated consequences of the use of these technologies. The ageing experts were also asked in what way they thought the behaviour that might result from using particular technologies could impact on people’s mobility.

Six additional interviews were held with experts from the field of transport. The transport experts were also asked to think of technologies for ageing that might have an indirect impact on travel demand. With these assistive technologies in mind, they were then asked to consider the following questions: (i) How important it is that we give consideration to such non-transport technologies within travel?; (ii) To what extent we already give consideration to them, both implicitly and explicitly?; (iii) If we do not consider them at the moment, why not?; and (iv) How could we give consideration to them given the need for empirical evidence?

Based on the feedback from piloting it was decided to provide interviewees with the main interview topics and questions in advance so that they could think of a technology beforehand around which to
focus in the interview. The interviews were semi-structured and where appropriate, interviewees were asked to reflect on issues that had come out of previous interviews.

The ageing experts were identified with the support of transport and ageing researchers within the Centre for Transport & Society as well as through recommendations from early interviewees themselves or individual experts who were unable to participate themselves. The transport experts were selected from the network of personal contacts of the authors. The main consideration for inviting a transport expert for an interview was their judged ability to “think across borders”. For both the ageing and the transport expert interviews we had four male and two female experts. The ageing experts had a variety of backgrounds ranging from academia, the private sector and a charity. The transport experts also worked in academia and the private sector, but some had also previously worked for the UK Department for Transport.

The interview participants were invited via email. Most interviews took place at the workplace of the expert, one in the home of the expert, two in public places and another two via videoconference. All interviews were carried out by the first author. In one interview the second author participated as a co-interviewer. After each interview field notes were taken evaluating the interview itself and the general insights gained from it. Interviews lasted on average about 1 hour and 15 minutes. They were taped and transcribed verbatim. Transcripts were then sent to the interviewees and they were offered the opportunity to make revisions by either changing or removing parts of the interview. Only one interviewee actually made use of this offer to amend the interview transcript. Ethical approval was given for the approach taken by UWE’s Research Ethics Committee. As part of protocol, interviewees were asked to sign a consent form at the start of the interview. We have agreed to preserve anonymity for the individuals concerned.

4 Results
We now present the findings from the interviews. These are organised in a sequence of sub-sections reflective of the combined structuring of the two sets of interviews. This begins with an illustrative examining of emerging assistive technologies. This is followed by considering how technology use relates to the needs and practices of older people. The next sub-section explores the possible transport consequences. The sub-section after this looks at the accounting for the effects of assistive technologies in terms of travel demand analysis.

4.1 Emerging technologies
Through inviting interviewees to select and discuss emerging technologies that they thought were going to have an important impact on older people’s health and wellbeing, the diversity of possibility was revealed. This encompassed support of both physical and mental health and wellbeing alongside the role of technology in supporting the lives of those supporting older people.

Monitoring, tracking and guiding
Technologies are evolving that provide functionality from monitoring individuals’ vital signs, through tracking their movements to guiding them in their actions – both inside and outside of the home. Vital signs monitoring of glucose levels, blood pressure, heart rate, body temperature etc links through to the possibility of triggering a call for emergency care. ‘Smart garments’ can have integrated electronics for such monitoring outside the home including triggers for remedial action such as an in-built warming device or fall detection linked to emergency call out. Complex in-home movement tracking systems are under development, such as fully sensoroed kitchens which can be used to monitor and analyse, for example, the cooking activities of an older person with dementia and provide them with prompts to help them prepare a meal when they forget how to continue with it themselves. Out of home tracking through GPRS devices can assist older people and their carers, for example allowing: “people who manage or care for older people who have dementia or cognitive impairment to create ... a boundary, a territory beyond which if an older person moves alarms get triggered and they get made aware of the fact” (Ageing Expert 1). Monitoring and tracking of individuals also allows the development of diagnostic algorithms that can pinpoint whether, for example, movement
patterns are changing, slowing or needing more prompts which in turn may signal changing health conditions that warrant attention.

Preventing healthcare deterioration and prolonging wellbeing
The examples above point towards coping mechanisms that can counter an individual’s deteriorating health and seek to prolong independent living. However the ageing experts stressed the role for technology in helping to prevent deterioration in health – “active participation in life, mental and physical stimulus ... improves mental and physical wellbeing, it’s well proven” (Ageing Expert 4). Easy to use and high quality video interaction can, for example, supplement an individual’s set of activities with further opportunity for interaction and engagement.

The technology of home design itself
Relevant technologies extend beyond the electronic form to include for instance building design. One interviewee (Transport Expert 4) referred to involvement in a project working with architects designing larger, flexible dwellings with moveable internal walls (shuttering) to accommodate different household compositions at different life stages – from young children and teenagers through to elderly relatives. This could facilitate increases in inter-generational households if encouraged by other societal drivers such as cost of living: “[it] gave the younger members of the family their confidence to carry on living as a three generational family. They saved a lot of money because some of these places [residential care homes] are expensive and really the older person preferred it because they still perceived it as being in their own home with their family so it was win:win all around really” (Transport Expert 4).

Tailoring technology to users’ needs
There is perhaps a growing awareness of the importance of accommodating user needs into the design of emerging products and services, moving beyond a simple ‘technology push’ approach. Co-design, for example, engages with users in the design and development process, for instance revealing what older people are willing to wear and use which can be at odds with designers’ presumptions (Ageing Expert 3). Smart phones are epitomising new processes of technology design and service delivery where the technology artefacts are mass produced to set designs but these then provide platforms for highly flexible applications’ development that manifest in what services users actual employ, with look, feel and functionality tailored to their needs and tastes. In stark contrast the current provision of assistive technologies for older people is governed by a limited range of standardised ‘functional’ products from specialised manufacturers, constraining the capacity to accommodate the highly diverse and changing personal needs of older people. One interviewee considered the baby boom generation would not settle for this as they move into later life: “they will make a big difference to the market because they don’t put up with what they are given, you can’t offer them a suite of kit that looks like a nasty fox that they are going to put in their beautiful living room, they are going to want something that looks good next to their hi fi” (Ageing Expert 2). Smart phones’ applications offer the prospect of replacing hitherto clearly distinguishable assistive technologies.

Market drivers for assistive technologies
While specific technologies were referred to across the interviews, the system of care for older people overall might be seen as a form of technology or a process for which technology provides the enablers. This begins to point strongly towards the types of society and lifestyle that we are moving towards. On the one hand, there is the prospect of what is referred to as ‘ageing in place’ – remaining in one’s own home or that of one’s family; on the other is the reliance on residential institutions that provide homing and care for people as they grow older. The prevalence of each of these will both govern and by governed by the fortunes of assistive technologies. It might be assumed that ‘ageing in place’ provides a stronger overall driver for assistive technologies and indeed there may be societal as well as economic drivers for ageing in place: “in the end that is an agenda that is driven primarily by financial and economic considerations. Because the whole AT [assistive technology]-business is providing, I mean it’s about stimulating the economy, stimulating manufacture and it is also simply because with the ageing of the population, it’s simply not possible to put everyone in an institution” (Transport Expert 2).
Summary
The interviews reveal and underline the art of the possible in terms of technology making a contribution to the lives of older people. The march of modern technology is rapidly gaining pace as it penetrates the fabric of modern society. However, whether or not this is incidental or instrumental to how people lead their lives in terms of where they live and what activities they participate in and what dependencies with others they have, is another matter. It is this which holds much greater significance for consideration of travel demand implications. The next sub-section continues further into examining how and why technologies are or may be used in support of living in later life.

4.2 Needs, uses, practices

Conflicting needs
As observed by Fischer (1992: 18) “the consequences of a technology are, initially and most simply, the ends that users seek.” However, people tend to seek multiple ends at the same time, and often there is a certain level of conflict between these. The need for privacy, for example, can be in conflict with the need for independence, if the latter implies being constantly monitored. This conflict played a considerable role in the technological development of the kitchen (referred to earlier) that could provide older people with dementia with prompts to help them in undertaking their everyday activities: video technology might be most effective for monitoring but is considered invasive, hence the need to revert to installation of networks of sensors attached to household appliances. This begins to resonate with Maslow’s hierarchy of need – monitoring may help support a base level of existence but matter of privacy and self-esteem are important factors in wellbeing.

Needs will of course vary across individual older people. However, there are also the needs of third parties to consider – those of the people involved in caring for older people – as well as the needs of older people themselves, and these could be in conflict. For example carers may look to monitoring and tracking technologies as a means to reduce the frequency of visits to the older people while older people’s wellbeing (and health) may derive in part from their desire for human contact and interaction that carers provide. Indeed, conflicting needs can lead to unintended consequences of technology – as in the case of personal alarms: “one of the things that people have sort of noticed with a lot of telecare devices is often people are raising the alarm actually just because they need a chat, you know, so they are using the pendant, the alarm system really as a kind of telephone, as a call for help but in an entirely different sort of way” (Ageing Expert 1).

Getting on with life aside from an obsession with health
Co-design (as referred to earlier) helps to provide reminders that people’s own hierarchies of need may differ from those presumed by designers, as illustrated in the case of smart clothing and wearable technologies. Individuals have an interest in how such technologies can help support their social participation while designers may fixate on vital signs monitoring: “[t]he actual electronics can help them go out and perhaps feel that they’re safer. They’re not going to get lost as easily. They might have an alarm. In terms of motivation, it will probably help them to think, ‘Oh, I’ve been further than yesterday, or I’ve been further than my friend.’ And a key one is communication. They want to be able to communicate with others in the group. You know they don’t want to get lost and they don’t want to lose communication with others in the group... our techie guys on vital signs, they just assumed people would be interested in vital signs and health. Well, no, that was down in the bottom, the fear of getting lost was high up” (Ageing Expert 3). Similarly “most older people tend to do most of their trips during daylight rather than going out in the evening, because they don’t feel very secure going out in the evening... If you took a technology that operates... outside of the home so that if you press the button it gave a GPS fix or something and alerted someone very quickly, that might give people more confidence to go out in the evening” (Transport Expert 3).

The centrality of human interaction
While ‘ageing in place’ in one’s own home may be seen as more desirable to moving to a residential care home this may very much depend upon the degree of human interaction both entail. If
individuals’ mobility outside of the home is increasingly limited then their reliance on episodes of external visits into the home (real or virtual) may be greater. This could be at odds with technologies that are seen by their carers as enabling more independence though less visits. As one interviewee put it succinctly, “sensors don’t give you social interaction” (Ageing Expert 4). Hence although monitoring technologies may enable people to live in their own homes for longer, if they replace important social contacts of older people their quality of life may actually worsen. However, one must distinguish between more and less desirable interactions as one interviewee reflected in relation to her own mother: “[w]hat you wouldn’t want to do is to take away other people who come into her life, but I would argue that the cardiologist is probably not the person she would really want to have a chat to and a cup of tea with, so I think that is a different set of arrangements and we shouldn’t really confuse the two” (Ageing Expert 2).

Whether external ‘visits’ into the home are real or virtual is a moot point. On the one hand, easy-to-use video interaction with others to provide virtual contact may be important in terms of providing mental and/or physical stimulus which improves wellbeing. However, if this comes in place of real contact rather than as a supplement to it then social interaction overall may deteriorate in its quality and stimulation. An intriguing example was given of both supplementing real contact and achieving mental and physical stimulation: the use of video equipment in one community centre to allow people there to participate in a gym class that was taking place in another centre – “[t]his has actually enabled us to come together somewhere locally to take part in something desirable, which is actually physically taking place elsewhere” (Ageing Expert 4). Such example highlights how the interactions between real and virtual can be complex and interwoven.

An important facet of social interaction is feeling useful – one of the interviewees lamented the risk of technology being seen as principally about helping older people to survive. Quality of life comes from people having a sense of purpose, a meaning to their lives: “what comes through loud and clear through interviews with a whole range of people and looking at a large amount of secondary research globally, is people want to be useful, people want to feel useful, that means different things to different people, and what you can actually do and how you actually do it varies depending on your constraints” (Ageing Expert 4).

Summary
What becomes strongly apparent is the need to extend beyond ‘functional thinking’ (Geels and Smit, 2000) and not merely consider what technologies can do but how they interface with the lifestyle needs and aspirations of older people. Assistive technologies for living in later life relate to an agenda that is much broader than healthcare – they concern wellbeing that is derived from social interaction and self-worth. The next sub-section moves on to give more attention to how these technologies, through their adoption in society, can give rise to (indirect) effects on travel.

4.3 Assistive technologies’ consequences for travel
All interviewees were asked in what way they thought the behaviour resulting from older people using technologies may have an impact on mobility and travel.

Households as trip attractors
Traditionally in transport planning, households have been considered as the tripmaking unit – i.e. the originator of trips. However, one interviewee emphasised the distinction between the individual travelling to the healthcare and the healthcare coming to the individual. Travel surveys have tended to focus upon trips originating from (and returning to) the household rather than households as trip attractors. For healthcare coming into the home then associated levels of tripmaking have not been receiving the same attention – they are less monitored and hence their effects more poorly understood. Yet it seems reasonable to assume that people living longer in their own homes generate more trips than people living in residential homes. One interviewee remarked how even a simple technology like a personal alarm has the potential to generate trips. Her own father in law lives in a facility for older people where access to help was through a button which usually calls an ambulance. Apparently “he’s always calling the ambulance out, and so that just, that generates a trip that probably isn’t needed, if
we still cared for people in either our homes or in care homes, but because we want to give people independent living, we might be generating more problems” (Transport Expert 5). In other words, ‘ageing in place’ may come at a greater overall cost to society in terms of the overall transport demands it imposes.

Happy minds, healthy bodies, more travel

Technologies to support the desire for social interaction may well perpetuate more social interaction that moves from the virtual to the physical and, through improved wellbeing from such interaction, enable yet more of the same over a longer period: “when people are actually, can actually interact it actually increases the likelihood that they're going to physically get together, that increases the stimulus, the outward looking... Happy minds, healthy bodies, more travel” (Ageing Expert 4). Thus, not only does travel derive from the need to attend to individuals health problems in terms of household generation or attraction of trips, but travel derives from healthy ageing that involves people leading full and active lives. In other words if people are living for longer and living actively for longer then it may be presumed that as individuals they will make greater contributions to society’s overall demands on travel.

However, such reasoning makes the assumption that as individuals grow older they necessarily wish to live outbound lives to such an extent. One interviewee pointed to two explanations for observed decline in activity in later life – one concerning constraints and impediments (with an implication that these might be overcome through technological or other means) and the other concerning ‘activity disengagement theory’, “people don’t have the urge to go out as much, and it’s more like, it’s almost like it’s a choice to stay at home, because of changes in preferences, beliefs, values and so on” (Transport Expert 2). This said, active ageing may delay an individual moving into the phase of not wishing to be as active (and thus perhaps engaging in less travel).

Ageing motorists

Notwithstanding the impact that concessionary fares may have had on older people’s uptake in using public transport, the fact remains that successive cohorts of individuals moving into later life will be doing so with greater collective reliance upon and experience of using the motor car and: “will not necessarily, will not be very inclined to give up on driving and will remain wedded to the car until very, very advanced old age... [with] all kinds of problems in terms of road safety” (Transport Expert 2). This, the expert suggests, will create a societal tension and accordingly a push towards assistive technologies to prolong safe driving. The car offers more than a functional role – it symbolises independence which may reinforce a reluctance for giving up driving. This said, another interviewee provides a reminder that many car trips are derived from how our land use planning has developed. Just as the earlier example of fitness classes in community centres illustrated, it may be possible to create neighbourhood hubs of social engagement that are facilitated through communications technologies but which are accessible on foot or by bike, thus diminishing the sense of dependence on the car.

Remaking patterns of travel

Interviewees pointed to different ways in which technologies and their use would result in a reformulation of tripmaking. Perhaps most significantly, if technologies facilitate multigenerational housing and households then less reliance on public sector transport provided by social services may result as the needs of older people are absorbed and catered for by the households in which they reside as household members co-ordinate the use of household vehicles and the household’s tripmaking needs to create trips or trip chains with multiple purposes (akin to the handling of dual paid work and childcare responsibilities). Allied to this will be the technologies that can either obviate the need for a trip to a hospital or doctor’s surgery through remote monitoring or could limit the tripmaking involved: “there is lots of talk now about whether you can use broadband so that people just visit their local doctor and be diagnosed there rather than having to go to a major hospital, so reducing trip lengths and so on” (Transport Expert 3). The effects of such technology uses could be to free up older people’s time. The question then becomes, how will this time be used? One use could be to make further (discretionary) trips that promote their social participation, sense of purpose and,
ultimately, wellbeing. Thus travel may not be reduced overall but instead ‘remade’ in a way that contributes to quality of life and prolonged healthy ageing (thus extending, as noted earlier, the resulting travel demands). Similarly, for informal carers (family members and close friends), technology may reduce the (functional) need for as much travel directly associated with supporting an older person but such travel may have been suppressing other desired discretionary travel for their own quality of life – a latent demand that is realised once time is freed up.

**Summary**

While assistive technologies are likely to significantly influence travel patterns, there is a general expectation that total travel would not reduce if ‘ageing in place’ prevails and indeed may increase. However, more specific insights into travel demand consequences are challenging to pinpoint because they are not necessarily intended, anticipated, direct or first order effects that emanate from the starting point of assistive technologies’ take up. Travel consequences of living in later life will be affected by the residential form of living, the amount of care needed, the way care is provided and flexibilities and desires in relation to discretionary travel.

4.4 **Accounting for assistive technologies’ effects in travel demand analysis**

If the non-transport technologies to assist people living in later life are shaping patterns of living and significantly influencing travel demand, as is indicated above, then is this a matter that is being accounted for in the transport sector and receiving the attention of transport planners and policymakers? In short, does the transport domain take sufficient account of the effects emanating from non-transport technologies and from non-transport sectors? The interviews with transport experts examined this. All these experts saw the importance of accounting for these effects.

**Should these effects matter?**

One interviewee reasoned that analysis of route choice and (to a somewhat lesser extent) mode choice was largely a matter of issues within the transport domain; but “[o]nce you go back to the distribution of trips or the number of trips, it seems to be there that using the transport system with all its explanatory variables becomes less and less satisfactory” (Transport Expert 3). This interviewee provided a reminder that travel is principally a derived demand – derived from people’s needs and desires to participate in activities at alternative destinations. It follows that assistive technologies that are influencing how older people meet their healthcare and social participation requirements must be significant for travel demand analysis. “[I]t always seemed to me a bit anomalous that, we think we can model travel demand with not looking at these other drivers that are affecting the sectors that actually generate the demand for movement... the fact that growth in mobility has stopped now, and we don’t really understand why indicates that obviously our transport models are not predicting that” (Transport Expert 3). It was suggested that to avoid considering such other drivers may have major implications for the effectiveness of investment decisions: “if you are not aware of those possibilities and developments then you will be surprised and big investments may become either more necessary than they might otherwise have been, or you may have made big investments that turn out to be a waste of money” (Transport Expert 1).

Given the complexity of the root causes of travel demand once one seeks to become more encompassing, a cautionary note was sounded by one interviewee “I think we simply don't know whether it’s a, you know, there are the primary things that qualify demand, and, I guess this qualifies as secondary, but, you know, how big is it? Is it a 1% factor or is it a 10% factor? If it’s a 10% factor then it needs to be understood” (Transport Expert 6). In other words, since one cannot expect ever to have a complete a full understanding of causes and effects, there is a need to focus upon those for which most is know and/or where the effects or impacts are greatest. The question remains as to how much explanatory power is lost from analysis that foregoes consideration of non-transport technologies.

**How well addressed are these effects?**

Most interviewees acknowledged that there is not enough joined up thinking with a lack of integration between government departments, between the public and the private sector, between policy
development and policy delivery, between academic disciplines and between the academia and the public sector. Even where there have been attempts at integration such as that between land use and transport, there remain considerable doubts over our capacity to interpret: “even if you did have fairly reliable information on future land uses that doesn’t necessarily help because for example if you were forecasting ten or twenty years ago shopping patterns in 30 years’ time, even if you had very good forecasts on where supermarkets are gonna be located in relation to residences, that wouldn’t take account of internet shopping” (Transport Expert 3). This observation points to the fact that knowing where older people will be living will not provide us with a sufficient amount of information to assess their travel demand. For this we need to know how they will be living too: how much travel will be required to fulfil their needs and desires, who will be doing the travelling, when, and how?

Some experts did describe examples of where they had been able to bring possible negative unintended consequences of non-transport policies for transport onto the agenda during the policy formulation process. For example, Transport Expert 5 explained how they managed to get the transport consequences polyclinics (replacing the need to go to a hospital with consequent potential closure of some hospitals and GP practices) on the agenda insofar as at least confirming that the transport consequences had not been fully thought through. Such examples were characterized by a superficial level of analytical follow-up. A structural process of thinking through the possible unintended consequences of policies and developments for other domains is lacking.

Why are these effects not well addressed?
Granted that the effects of non-transport technologies are complex to follow through. However, if they are potentially significant why are they not at least given greater consideration? One interviewee rather starkly offered some possible insights: “I do find it a very insular world, the world of transport, dominated by men, dominated by engineers and allegedly with quite a lot of networks within it which lead to insularity at best and corruption at worst ... the current way in which transport institutions run attracts a certain type of personality. So people that like to have things fairly self contained, and measured and so on and battened down I think are probably attracted to transport. I certainly seem to meet a lot of them of that kind of personality, very narrow. Very clever a lot of them you know but clever in the sense of being train spotters if you like” (Transport Expert 4). This interviewee suggested that many of those in transport wish to see technical, scientific, contained and soluble problems within their domain. In turn it was suggested that as any apparent boundaries between sectors and with the march and pervasiveness of technologies across sectors that such individuals would get stuck in middle management in a world where top jobs would go to those able to transcend apparent boundaries and see multiple perspectives.

Some of these sentiments were shared across interviewees alongside a collective acknowledgement of the sheer complexity and difficulty involved in creating a better understanding of the interconnections between transport and other domains being a major obstacle. Such an obstacle acknowledged at a personal level by one interviewee: “I think very few people are equipped with the tools, so both say the techniques and the software as well as the conceptual tools and the creativity to actually make sense of these enormous streams of data that you create, it is just too, it just becomes too complex. And that flies right into the face of the transport studies community, which I think is very much committed to a Cartesian reductionism, keep things simple, look for the basic laws. Focus on those” (Transport Expert 2).

But even if those lucky few would manage to come up with policy recommendations based on their analysis of these highly complex interconnections, then the next problem would be that current policy evaluation tools are also based on the reductionist view that it is possible to identify the contribution of one single variable. Approaches based on the idea that most things are interconnected and complex, on the other hand, would argue that it is almost impossible to indentify the contribution of one specific variable exactly because they are interdependent and interconnected with other variables. Besides, some interviewees referred to the ambiguity surrounding the question of how big an issue it actually is. How relevant is it to understand the linkages between transport and other domains, and do the costs involved in increasing this knowledge weigh up against the benefits of doing so? The fact
that many of these relations are “not always amenable to quantification” (Transport Expert 2), partly due to their complexity and partly due to a lack of available data, hamper our ability to provide an unambiguous answer to these questions. Especially in the current climate of funding cuts, in which “people are very busy dealing with what’s already on their desk. Until someone comes along with some evidence and says, ‘Do you realise that?’ then attitudes will change” (Transport Expert 6).

Transport Expert 5 also pointed to the overriding ‘transport is here to serve’ mentality as a root cause of failure to account for non-transport technologies and developments in other sectors when considering travel demand analysis. Transport is seen to be responsive to the needs of society – the demands society places upon it – rather than being something that should be considered in conjunction with the ongoing shaping of society – master planning of land use has tended to be followed by transport planning.

**Pitfalls in current approaches**

In general, the strong emphasis on trend extrapolation and modelling in current examination of transport in the future was judged to have serious limitations because of a tendency to assume stability. The current levelling off of car use is not necessarily in line with model expectations prompting questions around the stability of assumptions relating income, car ownership and traffic levels. Transport Expert 4 pointed towards the example of wheelchair access on trains and the fact that national standards are not recognising the changing size of people and their wheelchairs. Transport Expert 5 built on this to suggest that we are not even questioning whether medical developments may mean in the future that wheelchairs are not even needed for mobility with the prospect of bionic limbs. This example points to unavoidable uncertainty in one respect (wheelchairs versus bionic limbs) and instability that can be accounted for (more) predictably on the other (the changing size of people).

Transport Expert 2 see the inability of many transport experts to appreciate the importance of framing a technological development – i.e. to see it beyond its narrow intended domain-specific purpose and appreciate how it will interact with and be taken up within social practices as it becomes embedded or ‘domesticated’. Without such framing, complex though this itself is, the prospect of making anything resembling sensible predictions is limited. This interviewee is frustrated by what they see as the trap of incremental thinking – trend extrapolation that is not geared towards grappling with the potential for step changes driven by environmental imperatives if not societal desires.

**Alternative approaches for addressing non-transport technologies in travel demand**

Given a sense of the limitations of trend extrapolation, interviewees gave attention to the prospects of closer monitoring of current behaviours and practices as a means yielding more or complementary insight into future trajectories. It can be argued that there are indeed ‘tastes’ of the future available in small pockets in the present. The challenge, however, is still to be able to determine which such pockets change in scale to become dominant forces in future. A further challenge is that looking at the present and present day older people cannot easily account for how older people themselves may change in successive cohorts of ageing, associated with different attitudes, beliefs and values; different norms of social practice and different affordances of mental and physical health and of mobility. One interviewee referred to the different ‘heart rates’ of development which made any predictions difficult – for instance while technology itself may evolve rapidly other forms of development, social and institutional, may be much slower to change: “I mean law still takes five years to produce... Accounting systems still take a year, large scale civil engineering still takes three to five years to deliver something significant” (Transport Expert 1).

Transport Expert 2 suggested that more attention might be paid to small practical pilot or ‘performance’ studies (perhaps in conjunction with ethnographic methods) to gain a richer understanding into how people respond to technological possibilities as they seek to combine these with their lifestyle practices and underlying needs. Transport Expert 4 favoured greater attention being paid to retail and consumption patterns to yield evidence of trends with implications for transport. In addition they suggested closer examination was needed of projects that failed to launch
because they ignored human aspects of technologies – in other words learning from the past in order to appreciate how the future may unfold beyond the limited gaze of ‘Cartesian reductionism’.

Overall, there was general agreement that the inherently complex and dynamic nature of transport and non-transport technological developments and behaviours requires new methods in order to be better understood. Close monitoring of such developments and especially behaviour was seen to be essential, but immediately raises the question of how one determines what to monitor exactly?

**Resistance is futile, you will be assimilated**

Hitherto the discussion has mainly concerned how academics and policy makers can improve the integration between transport and other domains. This has largely neglected what might prove to be the elephant in the room – the (non-transport) private sector. Transport Expert 4 suggested that it was not just non-transport technologies and information that may have relevance for the transport sector, but that the non-transport sector itself is becoming increasingly interested in transport technologies and information: “now the people who are interested in a lot of the new technologies are not anything to do with transport really... a good example of that would be all the people who are interested in the possibility of road pricing and it’s nothing to do with road pricing it’s because of the information base that they can then develop and use in all sorts of other interesting ways. So [big players are] pushing for public acceptance of road pricing for very broad reasons you know... if you have got the database from road pricing you’ll know exactly where everyone goes, when, how, why” (Transport Expert 4). The implications here are that big corporations from the non-transport sectors could move into the transport sector and see the value to their own businesses of running the transport systems such that they can monitor patterns of movement allied to other (consumption) behaviours: “actually I think that the transport industry will be left behind and that other industries will take it over and transport professions will be downgraded, left at middle management level and just won’t be part of these new developments probably” (Transport Expert 4). In other words, much of what we consider today to be the preserve of the transport profession may be subsumed by the roles performed by players in other sectors. Whether and how social practice and wellbeing would co-develop (or not) alongside commercial drivers in the shaping of the future and the role therein of Government would remain to be seen.

5 Discussion and conclusions

The thesis behind our paper is that technologies shape social practices and social practices shape travel. It follows that in order to understand how the patterning of travel is continuing to evolve over time it is necessary to understand how social practices are being influenced by technologies. Through the twelve interviews we have explored this for the particular case of living in later life – a matter pertinent to societies that are ageing. This examination has underscored that trying to anticipate change as well as its consequences is indeed a wicked problem. There are many factors at work that are conspiring to influence not only where older people live but how they live. A number of different ‘rhythms’ of change are at work with varying tempos: successive generations of older people will enter later life with different life histories, experiences, values and norms; technologies are evolving rapidly (increasingly so) such that the art of the possible of today will be overshadowed by that of tomorrow; mobility affordances face change in relation to energy supply, economic conditions and dexterities in later life; social behaviours are evolving in terms of the life roles of older people and their relationships and interactions with other generations of family and friends. Taken together, these constitute a myriad of factors (known and unknown) that are changing and interacting in unpredictable ways to create a multitude of permutations of cause and effect. At the level of individuals we may be able to make some sense of this in terms of studying present day behaviours in detail. However, projecting this forward and scaling it up to determine the consequences for society as a whole would appear to defy the employment of reductionist approaches of analysis.

What the interviews do reveal is our ability to misjudge or overlook the consequences of technological developments for social practice and in turn travel. It may be helpful to reflect on this through what Sinek (2009) refers to as the ‘Golden Circle’ as a means of making sense of behaviour and being able to exhibit effective leadership. He refers to the importance of getting to heart of *why*
we do things rather than starting with or confining our thinking to how we do things or what, specifically, we do. This is illustrated in Figure 1. In seeking to understand how living in later life will unfold it can be tempting to fixate upon the art of the possible – the technologies that will enable us to do things and thus may define how we will live (e.g. monitoring and tracking technologies allowing us to live in our own homes in the face of deteriorating health). However, the ‘what’ is arguably rather superficial in that the explosion in the scope of technologies means that what we do not only changes over time but the range of options of what we can do expands – e.g. from letter, to telegram, to phone call, to email, to tweeting. In some cases the ‘what’ amounts to old wine in new bottles. For example being able to use Facebook for social networking does not mean social networking was not alive and well in other forms before Facebook. Use of technologies, like using transport can predominantly be a means to an end. That end becomes more evident when we look at why we do things. Here the interviews have highlighted the importance of older people having a sense of purpose and self worth. When we look to the future we face two considerations: how can policy decisions be effective in their response to a changing world and how can policy decisions be effective in playing their part in shaping the world. For the latter we need to pay close attention to the why if we are to meet people’s needs and support quality of life. For the former we need to grapple with the fact that the ‘why’ will become manifest through the ‘what’. In fact both technology use and travel reflect the ‘what’ – with significance for production and consumption and for service provision in society including transport.

Figure 1. An illustration of Sinek’s Golden Circle – the importance of starting with the ‘why’

According to the collective view of our interviewees, we are far from having a comprehensive grasp of the implications of living in later life for travel demand and patterns of travel – and this applies to the present as well as to the future. Further still our mindsets and the ‘tools of the trade’ that have been central to analysing transport developments may mean that better understanding eludes our grasp, unless we open up to a wider set of approaches.

One such approach is that of scenario planning. It is distinguished from other techniques for looking to the future such as prediction and forecasting which can tend to mask uncertainty through assumptions in that it embraces and exposes uncertainty. Scenario planning aims to highlight the multiplicity of different futures that could unfold dependent upon the nature and interaction of a large number of drivers for change. Scenario planning is helpfully summarised as follows (Government Office for Science, 2009, page 5):

“Scenarios are stories (or narratives) set in the future, which describe how the world might look in, say, 2015 or 2050. They explore how the world would change if certain trends were to strengthen or diminish, or various events were to occur. Normally a set of scenarios are developed (between two and five) representing different possible futures, associated with different trends and events. These scenarios are then used to review or test a range of plans by drawing and policy options: the conclusion generally being that different plans are likely to work better in different scenarios. Alternatively scenarios can be used to stimulate the development of new policies, or as the basis for a strategic vision. They are also a useful means of identifying ‘early warning’ indicators that signal a shift towards a certain kind of future.”

We conclude this paper by suggesting that an appropriate means of further examining the potential implications for living in later life and travel demand in a structured manner that can help stimulate
and inform policy debate in this area would be the use of scenario planning. It is our intention to pursue this ourselves in due course. However, we now offer a thumbnail sketch of such an exercise by way of illustration. In this we have identified two major influencing factors in order to frame a set of four scenarios (shown in Figure 2): (i) the availability of and engagement with assistive technologies; and (ii) the extent of independence from others in how older people lead their lives.

Figure 2. Future scenarios for living in later life

The following pen portraits of narratives for the four scenarios are offered (though these would be much more fully developed in a full scenario planning exercise).

**Home ties**
Due to the ageing of the population, it is no longer affordable to care for the elderly in residential care homes. Contrary to the high expectations at the beginning of the 21st century, assistive technologies have failed to accompany the growing trend towards elderly people living independently for longer. Although many prototypes were developed, hardly any made a successful market entry. Many assistive technologies were judged to be either too expensive, too invasive, or simply did not meet the greatly varied personal needs and capabilities of the older consumers. As a result, most older people depend on the informal care provided by their social networks. Those who have children or other family members or friends living nearby, often manage to remain living in their own homes and are visited frequently by their informal carers. Others whose children or other potential informal carers lived too far away to enable them to visit them on a regular basis have seen themselves forced to move closer to their carers. Multigenerational homes have become the main housing type.

**Home alone and wired**
The great shortage of care workers and simultaneous increase of older people have made both residential care homes and personal care at home unaffordable. Fortunately a huge selection of assistive technologies was developed just in time to meet the increased demand for care. The lack of care workers means that most care is now provided either remotely, or via care-robots. Due to the close monitoring of people’s conditions, trips to GPs and hospitals for routine checkups are now a thing of the past. And so are trips to the pharmacy as the latest developments in 3D-printing enable people to print their own drugs at home (but only after this has been authorized by their GPs via Facebook). Single households are now the most common household type.

**Communal call-out**
Although the number of older people needing care has increased immensely over the past decades, the number of formal care workers has remained stable. However, the fact that many simple but time consuming tasks that used to be performed by care workers have been taken over by assistive
technologies has meant that care workers are still capable of meeting the demand for Face-to-face care work. Experiments with ‘care-robots’ providing care work failed miserably. After an initial increase in the number of ‘care miles’ that resulted from the greater number of older people living in their own homes rather than in residential care homes, the mileage has remained the same over the past decades.

State dependency
Growing up in a society based on individualism has meant that older people don’t want to be a burden to their friends and families. Besides, there are many practical reasons why most older people cannot count on informal care. Often they only have one or two children who in general tend to live both far away and in houses that barely have enough space for their own nuclear families. For a long time it was hoped that emerging assistive technologies would be able to meet the increased demand for care. However, in the deployment phase of these technologies it was soon realised that they relied too heavily on the availability of informal carers to respond to alarms. A middle ground between independent living and residential care homes was sought and found in sheltered housing. In these purpose built service flats, older people live independently but close to one another. This close proximity enables a single carer to look after a greater number of older people when they lived all over town. And instead of each individual house being equipped with assistive technologies, there is a communal building where such technologies can be used. This also helped to decrease the level of isolation experienced by many older people living independently. In order to use the technology they needed to get out of their houses which consequently created opportunities for interaction with other people.

We close this paper through an analogy with the monitoring and tracking systems for older people discussed earlier by calling for the need for transport planning and policymaking to pay more attention to ‘monitoring vital signs’ of society. We should ensure we have sensors in place but also that we are thinking through how to develop appropriate response systems to react to the signs of social and technological change. We look to scenario planning as part of the approach to assisting the transport profession in its later life.

6 References