How useful is the Multi-Level Perspective for transport and sustainability research?

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Introduction

Interest in socio-technical transitions has grown exponentially in recent years. A desire to understand, and also stimulate, sustainable, low-carbon innovation has contributed to a proliferation of academic and policy studies applying the transitions framework. Socio-technical transitions is a multidisciplinary framework which draws on several disciplines and literatures (notably evolutionary economics, Science & Technology Studies and innovation studies; see Geels, 2005), and offers an integrative, system-wide view, particularly appropriate for complex problems of unsustainability. Many (though by no means all) of these studies use the Multi-Level Perspective (MLP) to analyse topics such as climate change (Anderson et al., 2005), transport and mobility (Whitmarsh et al., 2009; Nykvist & Whitmarsh, 2008; Whitmarsh & Wietschel, 2008; Shove, 2003), domestic energy (Nye et al., 2010), housing (Bergman et al., 2008; Smith, 2006), water (van der Brugge et al., 2005), and food (Shove, 2003). In this paper, I reflect on the strengths and limitations of the MLP, focussing in particular on experiences applying the MLP in the domain of sustainable transport research. In doing so, I aim to address two questions: to what extent is the MLP useful for transport and sustainability researchers; and how might the MLP be improved to overcome present limitations and better address transport and sustainability research needs?

Multi-Level Perspective (MLP)

The MLP was originally developed by Rip and Kemp (1998) and theoretically elaborated by Geels and others (Kemp et al. 2011; Grin et al., 2010; Verbong & Geels, 2007; Geels, 2005; Smith et al., 2005; Rotmans et al., 2001). The MLP is so called because it identifies three levels within societal systems (e.g., the transport system): niches, in which radical innovation emerges; the regime, which comprises dominant institutions and technologies; and the landscape, which represents macro-level trends and contextual drivers and barriers to change. The main dynamics of change occur within and between the regime and niche levels, which may interact synergistically or antagonistically (Geels & Schot, 2007). Most often, change at the regime level is incremental due to sunk investments, vested interests, habits, bureaucracy and other factors which afford stability but at the same time constrain flexibility and opportunities for radical change. At the niche level, on the other hand, actors are much less constrained by dominant institutions and the status quo, and can experiment with radical alternatives to solve societal problems and address pressures at the landscape level. The landscape is understood to be the environmental, socio-economic and cultural context in which actors and institutions are situated, the contours of which make certain trajectories more likely than others (Smith et al., 2005).

The MLP describes the structure and dynamics of socio-technical systems. The term 'socio-technical' reflects the dependencies and co-evolution of infrastructure and institution, technology and society. MLP researchers are interested in how such factors interact in order to produce both stability and change, often with a particular interest in *radical* change (i.e., a 'transition'), defined as a structural transformation in a particular socio-technical system (i.e., in type and arrangement of technologies, behaviour, legislation and standards, skills, infrastructure and so on; Weaver & Rotmans, 2006; Avelino, 2009). Examples of such transitions include sailing ships to steamships and horses to cars (Geels, 2005). Further details on the MLP and its key features can be found in Geels (this issue).

Uses and Utility of the MLP in Sustainable Transport Research

Experience with the MLP shows it to be a useful analytical framework for *understanding transitions,* which highlights the precursors, dynamics and complexity of both incremental and radical innovation. This moves beyond more economic focussed models of technical change which have focussed on innovator characteristics and adoption dynamics (Rogers, 1995) or industry characteristics and innovation decision-making (e.g., Dosi, 1982). Applying the MLP, Nykvist and Whitmarsh (2008), for example, analysed current mobility systems within the UK and Sweden using the MLP. This analysis focussed on three areas of innovation: transport technologies, modal shift, and demand management. The results indicated a take-off in alternative technologies most closely aligned with the regime (hybrid-electric, low-emission and biofuel vehicles), but no diffusion (yet) of more radical technologies (e.g., battery-electric, hydrogen-fuel cell vehicles). Trends in the other areas were less encouraging: we observed a growth in car sharing, ICT for shopping and working, but no growth in use of slow modes or other evidence of a shift to a radically different behaviour. Overall, we identified determinants of emergence and growth of sustainable mobility at all three levels of the MLP for these areas of innovation. Firstly, there were evident landscape pressures – environmental (e.g., climate change), economic (e.g., oil prices, automotive and ICT markets) and cultural (value/behaviour change) – that in turn impacted on policies at national and European level. At the niche level, there was interest in exploiting opportunities arising from these trends (e.g., amongst agricultural and emerging biofuel industries). Networks were beginning to emerge in some areas (e.g., biofuels), where supported by a favourable policy system (notably in Sweden). Regime actors were also beginning to respond to landscape pressures, and exploit technological opportunities and new markets (e.g., biofuels, HEV, and small fuel efficient cars). However, the regime was limited in its capacity to respond to landscape pressures: for example, existing refuelling infrastructure and automotive expertise are not compatible with hydrogen transport technology development. Our findings were consistent with previous MLP analysis by (a) highlighting the limited adaptive capacity of regime actors due to infrastructural and institutional lock-in (Smith et al., 2005); and (b) indicating that such barriers to a transition could be partly overcome through 'hybridisation' and niche co-evolution (Geels, 2005). New hybrid solutions have both the existing standard and the advantages of

new solutions (e.g. hybrid and flexi-fuel solutions), while co-evolution between innovation areas opens up further radical development (e.g., transport service providers acting as incubators for new technologies; congestion charging being used to promote new technologies as well as modal shift). This study is also consistent with much other MLP research in highlighting the importance of innovation governance which encourages participation and experimentation, rather than 'picking winners' and thus constraining adaptive capacity (Foxon et al., 2009).

Taking this further, modelling studies have attempted to project innovation processes into the future in order to identify policy, social or economic levers which might *stimulate sustainable transitions*. Whitmarsh et al (2009) and Kohler et al (2010) developed a coupled system dynamics and agent-based model to simulate different mobility transitions, including technological and behavioural change pathways. The most detailed analysis focussed on a hydrogen fuel cell transition, in which the critical role of charging infrastructure was highlighted (Kohler et al., 2009, 2010). Consistent with our empirical analysis using the MLP framework (Nykvist & Whitmarsh, 2008), the model results showed that radical technological innovation (hydrogen or electric vehicles) was only likely in the longer term, once economic and infrastructural barriers were reduced through niche adopters (e.g., public sector fleets) and hybridisation (e.g., hybrid electric vehicles).

In related work, we have also found the MLP to be a valuable tool for *stakeholder analysis*. Specifically, the MLP differentiates regime and niche actors, who may be seen to behave in different ways and offer different perspectives on societal problems of unsustainability (although this distinction is not absolute, and regime players may support niche projects; Avelino, 2009). For example, we found that niche groups (e.g., environmentally-concerned citizens) favoured modal shift and demand management policies; while regime groups (e.g., energy and automotive firms) unsurprisingly preferred technological innovation (Whitmarsh et al., 2009). This categorisation of 'regime' and 'niche' actors should not simply be used to confirm the dominant status of certain actors (Avelino, 2009). Critically, the presence of niche level actors within a research project or policy process can ensure that alternatives to the status quo are considered within analysis and decision-making. Niche actors can thus help 'reframe' problems, as Whitmarsh et al (2009) found in their research on mobility. Rather than restricting our analysis to hydrogen-based transport as a solution to rising transport emissions (as originally intended), they broadened it to encompass a range of technical *and* behavioural options for addressing unsustainable mobility. In this way, they avoided only considering a 'techno-fix' transition in which there was a simple reproduction of current power structures and the continued dominance of personal motorised transport, and instead also considered radical technological, institutional and behavioural reconfigurations of mobility systems. As mentioned above, this broader focus elucidated cross-sectoral innovation and niche co-evolution, which are critical for socio-technical innovation. At the same time, it promoted social learning (i.e., challenging assumptions) amongst researchers and stakeholders involved in the research (Tuinstra et al., 2008).

Stakeholder-based, action research using the MLP may ultimately aim to achieve a re-categorisation of actors; by empowering niche actors and bringing them into decision-making processes, they may reconfigure regime membership, resources and lines of power (Avelino, 2009; Smith et al., 2005).

The MLP thus affords benefits for researchers because of its broad system-wide focus and consideration of 'outsider' and radical perspectives in order to identify recommendations for policy-makers, industry and other actors interested in bringing about social change. This is important for transport researchers because of the inadequacy of incremental approaches for tackling intractable (so-called 'wicked'; Brown et al., 2010) environmental, economic and social problems associated with current mobility systems. The techno-fix solution favoured by regime actors will at best only address a sub-set of such problems (e.g., local pollution), but may in some cases exacerbate or create others by failing to tackle their root/systemic causes. For example, electric and fuel cell vehicles reduce air pollution but do nothing for climate change unless energy supply systems are transformed, and biofuel vehicles put further demands on land use and threaten food supplies (e.g., Royal Society, 2008). Similarly, investment in transport infrastructure, such as light rail systems, may produce *undesirable* modal shift (e.g., cycle to tram; Schwanen et al. 2004; Lee & Senior, 2011); while park and ride systems can actually generate *more* car use (Goodwin et al., 2004). MLP research, with its multidisciplinary, long-term and systemic approach, appears better able than much traditional innovation and transport analyses to identify these unintended consequences and feedbacks, and to highlight the diversity of processes and actors involved in social change (e.g., Schwanen et al, 2011).

Improving the MLP

While the MLP does well at characterising actors and institutions at regime and niche levels, the macro-level remains less clearly conceptualised or operationalised. A distinction is drawn between certain assumed societal factors which might drive or inhibit change at the 'macro' level, such as global economic or cultural conditions (e.g., recession, climate change concern), and the actors and institutions who respond to these factors at the 'meso' (regime) and 'micro' (niche) levels. While attention is focussed on these lower regime and niche levels, the landscape remains something of a 'black box' in which anything that does not readily fit at lower levels is placed. Within the transport transition modelling studies mentioned earlier, the landscape was implemented as exogenous signals – for example, 'oil price', 'climate policies' and 'environmental awareness' – within the set-up for each model run, while the regime-niche dynamics were endogenous variables. This clearly represents a limitation in understanding societal systems, since global, long-term trends (e.g., in GDP) are far from separate from institutions implementing local, everyday decision-making (e.g., investing, policy-making). On the contrary, the two are inextricably linked and causality is bi-directional. Only environmental factors appear to fit unambiguously within the landscape. But this then means environmental and social-economic factors are separated, which ignores important feedbacks

between natural and human systems (e.g., climate change impacts which is likely to influence policy and public opinion; e.g., Spence et al., 2011). Currently, the MLP and transitions literature integrates several social literatures, but a fruitful avenue for further research would be to integrate natural and physical science and geographical perspectives, too.

Yet, even from a social science perspective, there are important gaps and biases within the MLP and transitions literatures. As noted by Shove and Walker (2007, p.768), 'for all the talk of socio-technical-co-evolution, there is almost no reference to the ways of living or to the patterns of demand implied in what remain largely technological templates for the future'. This is perhaps because of the supply-driven focus of much socio-technical transition literature (Shove & Walker, 2010). Similarly, Smith et al. (2005) criticise the 'social' aspects of the transitions perspective as excessively functionalistic, ignoring the agency of actors and the importance of social context at the expense of explaining technological processes. In transition modelling studies, 'culture' has so far been relegated to the landscape level and considered exogenous (e.g., Haxeltine et al., 2008). Yet the public is neither homogenous nor passive, but rather represents a range of interests and activities with considerable potential for creativity. Geels (2011) argues that the 'niche' level does represent agency and creativity (e.g., through experimentation), yet there remains a tendency in studies using the MLP to assign the public the role of technology consumers and users, rather than citizens or members of communities. This tendency in both policy-making and much socio-economic research to cast the public solely as individual consumers and ignore their roles as voters, members of interest or community groups, parents, friends, employees or employers, has long been criticised by sociologists and geographers (e.g., Burgess et al., 1998; Nye et al., 2010) and, most recently, by transport scholars (Schwanen et al., 2011).

Yet, while individual vehicle purchasing and use is certainly an important contributor to transport systems (and their socio-environmental impacts), individuals can alter their behaviour in far more non-technological or social ways. Indeed, decarbonised transport systems cannot be achieved with technical measures alone (e.g., Grubler & Riahi, 2010) and we know that transport behaviours are amongst the most difficult to change (e.g., Whitmarsh & O'Neill, 2010). At the individual and household level, one might choose to live close to the workplace, shops and services in order to reduce the need for travel (although, in fact, there is rarely a straightforward relationship between residential location choice and travel choices; see Schwanen & Mokhtarian, 2004; and transition models have yet to be made spatially explicit). Such local lifestyles and active travel choices can offer important social and health benefits (e.g., work-life balance, social support, reduced obesity) but may pose economic threats (e.g., transport industry employment) hence their lack of support amongst regime actors (Whitmarsh et al., 2009). Understanding such tensions between niche and regime actors, along with potential synergies, in the context of sustainable travel behaviours is a priority for future MLP research. One particularly promising avenue for study might draw on recent work on

travel habits. Habits have been described as 'behavioural lock-in' or inertia (Jackson, 2005) and may mitigate the efficacy of 'soft' (particularly information-based) transport policy measures (Verplanken et al., 1997). Yet, structural changes (e.g., freeway closures, worker relocation) offer windows of opportunity in which travel habits (e.g., driving) are disrupted and must be renegotiated – this may lead to sustainable modal shift either without (Fujii et al., 2001) or with targeted policy interventions (e.g., personal travel planning, free one-month bus passes; Bamberg, 2006). Applying the MLP here, we might conceptualise this as public transport and slow mode niches exploiting automotive regime failures or gaps. Analysis might then focus on what modal shift (or broader lifestyle change) might occur without versus with policy support (emergent transformation versus purposive transition; Smith et al., 2005), and how various geographical factors (e.g., distance to workplace, cycling culture) may be relevant (e.g., Hodson & Marvin, 2010; Whitmarsh & Köhler, 2010).

The public can also act in other ways to exert influence on transport systems, including through political engagement (e.g., lobbying or voting for green transport systems), community or workplace action (e.g., organising walking buses, car sharing), at the household level and through social networks (e.g., recommending public transport options to friends, coordinating travel plans within the household to reduce total trips; Whitmarsh et al., 2010). These 'public-sphere' (i.e., socio-political; Stern, 2000) behaviours and social-behavioural niches are likely to be at least as significant to understanding societal transitions as 'private-sphere' (i.e., consumer) behaviours and technological niches. This is for two reasons: first, as noted, there is the potential for behavioural changes to address a wider range of transport problems (e.g., obesity, social exclusion) than technical measures can do; and second, given the emphasis in MLP research on structural change, the engagement of various social actors (including both state and non-state actors, such as publics) in challenging prevailing structures (e.g., by lobbying or protesting) becomes a key locus of innovation. Furthermore, highlighting the socio-political role of publics forces us to consider geographical context and level (local, national, trans-national) at which radical innovation within transport systems and sub-systems occurs and could effectively be fostered. For example, policy regimes, opportunities and barriers to political participation, population density, infrastructure, markets, and so on, vary widely across regions and cultures leading to very differently shaped and configured landscapes, regimes, and niches (Wells & Beynon, 2011; Whitmarsh & Köhler, 2010; Späth & Rohracher, 2010; Ockwell et al., 2009). There is considerable scope, then, to enhance the MLP by integrating insights from the sizeable literatures on habits, heuristics, norms, social learning, social movements, human geography, governance, evidence-based policy, practices (though see Geels, 2010, on ontological challenges), and so on. While initial work has been done to further this agenda (e.g., Geels, 2011; Elzen et al., 2011; Nye et al., 2010; Shove, 2010; Coenen et al., 2010; Coutard & Rutherford, 2010) much remains to do, including within transport.

Here, though, perhaps we should be cautious about how far we can take the MLP. The socio-technical transitions framework was derived primarily from analysis of historical (primarily technical) transitions, such as sailing boats to steamships and horses to cars (Geels, 2005, 2011). In most if not all cases, the transition involved a transition to different, but also *more,* consumption of technical innovations and of resources. A sustainability transition – within transport or any other domain – is likely to be a transition to *less* consumption (e.g., Urry, 2011). Perhaps it is inappropriate to expect a conceptual framework based on evolutionary economics and innovation and technology studies to inform us about radical social and cultural change; rather we might look instead to socio-economic paradigms based on well-being instead of growth (e.g., Jackson, 2004; 2009). More precisely, recent debates focus on the distinction between 'hedonic' (pleasure, affect) and 'eudaimonic' (self-actualisation, meaning) aspects of well-being; whereas the former is closely aligned to consumer culture, the latter is based on fulfilment of basic psychological needs (autonomy, relatedness, purpose, etc.; Nax-Neef, 1991) which may well be undermined by modern society's emphasis on consumption and materialism (Crompton & Kasser, 2009). 'Consumption becomes a substitute for the genuine development of the self' (Hanlon & Carlisle, 2009, p.28). It remains to be seen how the socio-technical transitions literature can responds to this challenge, and whether the MLP might be adapted to consider the full range of human needs, values and potentials (Rauschmayer et al., 2011) and sustainability criteria (Kemp & van Lente, 2011).

Conclusion

To conclude, I have highlighted the significant contributions which the MLP has made to transport and sustainability modelling and social research by providing a more integrated and systemic perspective on socio-technical change, based on detailed historical (and some contemporary) case studies and theoretical literatures. There is considerable scope to integrate natural, behavioural and political science insights to expand and improve the MLP to elucidate how behavioural-institutional change might occur. This is particularly critical for transport research given the expressed and observed public resistance to changing travel behaviour. Also critical for transport research, the spatial dimension of transport might be better reflected in the MLP. It remains to be seen, though, whether the MLP and transitions framework themselves require more radical adjustment to be able to predict the changes needed to support a transition to a sustainable society.

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