

GOVERNING THE RACE TO AUTOMATION

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Abstract: Automated vehicle technologies dominate many visions of future systems of smart mobility. This chapter uses the approach of Transition Management to explore the multi-actor governance processes around automated vehicle technology in the UK, with specific attention being paid to the role of the UK government. It shows the relatively comprehensive approach to automated vehicle innovation that has been adopted by the UK government, emerging across multiple domains including the creation of positive discourses around automation, and facilitation of network building and demonstration projects. Framed by the Transitions Management cycle of strategic, tactical, operational and reflexive activities, the chapter argues for greater integration across the levels of the cycle, and experimentation that moves beyond technological capability, to include the heterogeneous publics, in a more diverse set of roles than the current framing of ‘potential technology adopter’. The chapter points to the techno-optimism displayed by governments participating in the international race to automation, often with dual roles as both producers and consumers, and suggest that greater inclusivity, democracy, diversity and openness in the innovation process may contribute to context sensitive implementation.

Keywords: Automation; Transitions Management; Autonomous Vehicles; Automobility

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1. INTRODUCTION

Automated vehicles have become central to visions of future mobility. It has been proposed that the transition to automated mobility will be the most significant change to the system of mobility since the internal combustion engine enabled motorised mobility. Advocates of automated vehicles (also known as ‘driverless’, ‘self-driving’ and ‘autonomous’ vehicles) claim that these innovations will revolutionise the way people and goods move within and between towns and cities. Claims abound of environmental, social, and economic benefits arising from these innovations contributing to greater quality of life, and thus highlighting their potential to transition mobility towards sustainability in its broadest sense. Nonetheless, the emergence of automated vehicles is situated within the system of automobility (Urry, 2004) which prioritises and rewards private motorised transport. And while automated vehicles have been framed as disruptive technologies by some (e.g. Arbib & Seba, 2017), others have argued that smart and automated innovations may further cement the longevity of automobility (Schwanen, 2016) and thereby reinforce many of its negative externalities. In addition to questions of *disruptiveness*, the race to automation has brought with it a range of questions about the suitability of traditional systems of governance.

As (sustainability) transitions are systemic and by definition complex, uncertain and contested, traditional governance processes are poorly suited. Reflexive governance has been identified as one way through which complex issues can be understood, integrating a range of perspectives, expectations and strategies (Voß & Bornemann, 2011). Different designs of reflexive governance have emerged. Transitions Management (TM) analytically frames transitions as structural changes in complex, societal systems. TM suggests that by better understanding ‘the origin, nature and dynamics’ of transition processes, actors will be able to both anticipate and adapt with potential to influence the speed and direction of transition (Loorbach, Frantzeskaki, & Huffenreuter, 2015). In this chapter, we suggest that TM’s concepts and ideas can be used as a heuristic framework with which to interpret and evaluate currently unfolding governance processes in automated mobility. While the ability of automated technologies to contribute to *sustainability* transitions are, as yet, unclear, the transformation towards automation can still fruitfully be analysed using TM because of the complexities and uncertainties involved in the emergence and potential diffusion of the technology within the socio-technical system of mobility.

2. TRANSITION MANAGEMENT, REFLEXIVE GOVERNANCE AND EXPERIMENTATION

Both *top-down steering by government*, i.e. social change through government policy, and the *free-market approach*, i.e. social change by way of market forces, are broadly ineffective in producing

sustainable societies (Loorbach, 2010), yet the importance of both in the governance of societal change has been documented (Meadowcroft, 2005). Thus, new modes of governance are required that balance state, market, and society (Loorbach, 2010). While articulated goals, knowledge and power differ between approaches, it is broadly agreed that participation, experimentation, and collective learning need to be central features of governance processes (Voß & Bornemann, 2011). From this perspective, societal change is seen to result from a range of different forces, and reflexive governance approaches seek to embrace the heterogeneity and multi-dimensionality of problems, and the range of possible futures.

Transition Management was introduced as a new governance approach for sustainable development (Loorbach, 2010) and as a form of reflexive governance. It is a governance framework that aids instrument choice (Kemp & Loorbach, 2003), and shapes innovation processes and structural transitions within socio-technical systems, such as mobility (Kemp, Loorbach, & Rotmans, 2007). TM is not, however, focused on achieving predefined outcomes through processes of planning and control but rather at goal-oriented modulation (Kemp & Loorbach, 2006). It focuses on influencing 'persistent societal problems' (Rotmans & Loorbach, 2008) and asks fundamental questions of whether transitions can be managed. Emerging from complexity theory, management in this sense speaks of influencing processes of change, from one state to another (Rotmans & Loorbach, 2008). While some have identified TM as 'incremental politics', others have situated it "in the middle ground between planning and incrementalism" (Voß & Bornemann, 2011: 8; Rotmans, Loorbach, & Kemp, 2007).

Transitions are not the result of a single change (e.g. policy or technology) but emerge from developments across domains including, but not limited to, technologies, the economy, user practices, cultural values and meanings, and knowledge. The TM cycle (Fig 1.) translates the basic principles of the management of transitions into four operational governance activities that exhibit distinct characteristics, including types of actors involved and levels at which they operate (Loorbach & Rotmans, 2010):

1. *Strategic*: societal system levels, with long time horizons relating to problem structuring, activities at the establishment of a transition area and visions of alternative futures;
2. *Tactical*: sub-system level activities which construct or destruct system structures, activities include the development of coalitions, transition agendas and images;
3. *Operational*: short-term and everyday decisions and actions, including the mobilisation of actors and the execution of projects and experimentation; and
4. *Reflexive*: use of debate, research and assessment to evaluate the various levels and their interplay by way of monitoring, evaluation, and learning.

While these stages are often depicted as a sequence of events, it is the need for connection between the events rather than the order in which they are completed that is important. TM plays out over the different levels and time scales, with a focus on long-term processes of learning. From experimental applications of transitions management, a number of guiding principles have emerged including; inclusivity, democracy, diversity and openness, speed of change, social learning and capacity building, the resilience of the regime, context-specific learning, and empowerment of frontrunners (Loorbach et al., 2015). These principles can help to develop context sensitive implementation across different settings (e.g. urban to rural, local to national, energy, mobility,

education and welfare).

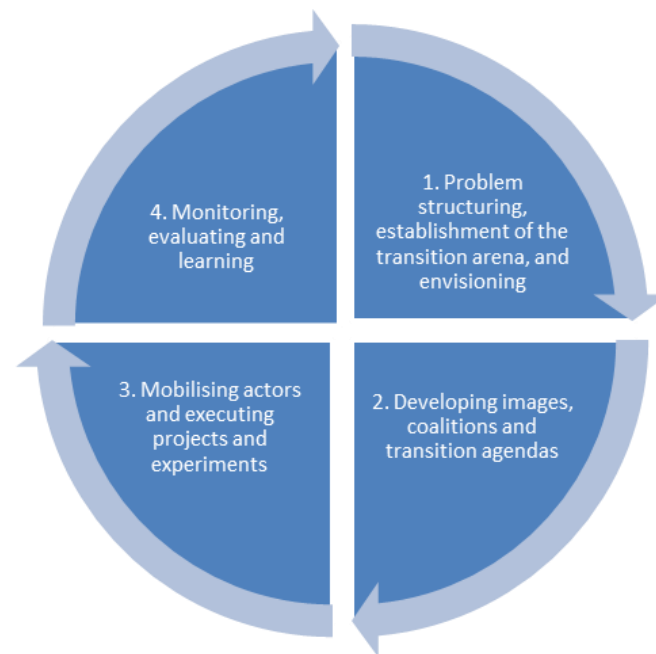


Figure 1. The Transition Management Cycle. Adapted from: Loorbach & Rotmans, 2010: 238

Experimentation is a critical feature of TM, particularly in the pre-development phase of transition (Kemp & Loorbach, 2003). Transition experiments require both time and resources to establish within niches before becoming embedded in existing regimes. Strategies to achieve this consist of learning from the experiment (deepening), repeating based on earlier learning, experimenting in a different context (broadening) and applying the successful experiment at a larger scale (scaling up). Transition experiments are taken to be “high-risk” with high chances of failure, but social learning objectives can contribute to systemic sustainability goals and transitional pathways (Loorbach et al., 2015). Demonstration projects have become an important part of the experimentation process, and can be practiced in different ways, for instance, by *showing* a (near) completed artefact to a particular audience, or as a stage in the developmental process. TM suggests that a multiplicity of experiments form a portfolio that works to reinforce one another (Loorbach et al., 2015), and develop collective and shared learnings, thereby contributing to the predetermined sustainability objectives in detectable and measurable ways. Local experimentation, it is argued, needs to inform national policy and system innovation, with coordination amongst policies across scales (Kemp & Loorbach, 2003).

3. AUTOMATING TRANSPORT IN THE UK

The future of transport has been a technological and socio-cultural fascination for at least the last century. This fascination has been fuelled by Sci-Fi imaginaries from popular entertainment (e.g. The Jetsons, The Fifth Element), with visions including robotic, automated and autonomous systems in different forms and with a range of capabilities. Testing and experimentation of automated vehicles has been occurring in the UK, albeit intermittently, since the 1960s, when government-funded projects trialled “drive-by-wire” technologies that enabled driverless, fully automatic vehicles (Reynolds, 2001). Trials and demonstrations were conducted on both private and public roads including a section of the M4 motorway, with the hardware embedded into the infrastructure as the M4 was constructed. The experiments adapted existing vehicle models – a Citroen DS19 saloon, a Standard Vanguard estate, and an Austin Mini – with different automated technologies. The research by the Crowthorne Laboratory, at the time a government agency, was predicated on anticipated motorway congestion, and part of a suite of experiments to pre-empt contemporary transport problems. Their research suggested that automated technologies could increase road

capacity by fifty percent, and prevent forty percent of accidents. However, funding for the research was withdrawn in the mid-1970s when, in the context of economic recession, the technologies were deemed “unnecessary and unaffordable” (Reynolds, 2001).

More recently, advances in deep machine learning by ICT providers and software companies, have stimulated a new wave of interest in so-called ‘driverless’ technologies. Automated innovations have emerged from incumbent car manufacturers (e.g. Volvo), new actors (e.g. Tesla), and partnerships between incumbents and new entrants. Examples include Daimler partnering with Uber, General Motors purchasing the start-up ‘Cruise Automation’ in 2016, and Ford announcing a US\$1 billion investment in ‘Argo AI’ (Murphy, 2017). These partnerships respond to the need for hybrid expertise of traditional vehicle manufacturing processes, economies of scale, and new demands for ICT know-how, code and algorithms. Incumbent vehicle manufacturers, including BMW, Volkswagen and Nissan, have also been working on automated vehicles themselves for more than a decade. These efforts have been accelerated and extended in recent years under pressure of the new entrants such as Waymo and Uber.

The rise in public consciousness and subsequent hype about the capabilities of automated vehicles has been coupled with real-world trials and attention from the mass media. Robotics, Artificial Intelligence and automation are also envisaged by the UK government as a centrepiece of the post-Brexit economy (HM Government, 2017). The focus on automation including research and development, manufacturing and adoption can also be seen as a response to the post-Global Financial Crisis (GFC) economy, domestic regional inequality, and the dismantling of indigenous vehicle manufacturing during the 1980s (Harvey, 2005). Consequently, the government has been actively involved in a range of activities, including:

- future visioning and the creation of positive discourses around automation;
- facilitation of network building between incumbents, start-ups and other actors; and
- creation or amendment of domestic legislation (e.g. licensing and insurance);
- development of a Code of Practice for testing of automated vehicle technologies;
- engagement with international agencies to create or amend international standards and/or legislation; and
- technology trials and demonstration projects.

In short, the UK government has adopted a relatively comprehensive approach to automated vehicle innovation, with activities emerging in multiple domains. The merits of this approach can be reflected on more critically using TM as heuristic framework.

4. TRANSITIONS MANAGEMENT AND THE RACE TO THE FUTURE

We will now adopt the four stages of the TM cycle: strategic, tactical, operational and reflexive, depicted in Figure 1. to structure our evaluation of the race to automation.

4.1. Strategic

At a strategic level, the government’s focus on problem definition, the establishment of a transition arena, and vision building have been articulated in key publications (e.g. HM Government, 2015a; 2017). These documents communicate the government’s position in harnessing benefits from automation technologies both as producers and consumers, and the various roles the government has taken, and intends to take to this end. In 2015, the government released two reports outlining the “Pathway to Driverless Cars” (Department for Transport, 2015a, 2015b). These documents serve as action plans with a driverless future predetermined: one report is a more general summary characterising the technology, and identifying challenges and the opportunities to development and adoption (Department for Transport, 2015a), while the other is a detailed report examining regulatory frameworks (Department for Transport, 2015b). Both reports are focused on overcoming barriers and situating the UK as a centre for technology development, testing and demonstration, largely achieved by way of comparison with other regions, countries and states competing in the

global race (e.g. USA – particularly the states of Nevada and California, Germany, Sweden, Japan and South Korea).

The Industrial Strategy Green Paper (HM Government, 2017) consulted on ten pillars by which the modern industrial strategy can ‘increase productivity and drive growth across the whole country’, but also on the technologies which could be supported by way of the Industrial Strategy Challenge Fund. In particular, the Industrial Strategy Green Paper views automated vehicles as a way through which the *productivity gap* can be tackled, and as a mechanism to drive growth. These documents make explicit the underlying motivations of the UK government relating to the development of niches with less importance given to the claims of contributing to environmental or social sustainability. Thus, the UK government’s response has been centred on a producer logic of creating conditions for technology emergence and diffusion, rather than system-wide, long-term visioning, and a critical analysis of the role automation may play in future mobility¹.

4.2. Tactical

The tactical level focuses on processes of agenda and coalition building, which occur at the sub-system level. This includes negotiations between key stakeholders and actors. Activities at the tactical level often include transformations of existing structures and institutions in line with articulated strategic goals. The development of networks and coalitions is important to activities at this level as these linkages can provide mechanisms for change. Innovate UK and the Transport System Catapult² have helped to bring together key industry actors, but their remit, and subsequent coalition building efforts appear to focus on expert dialogue and the harnessing of established capabilities to compete in the global race to automation. Processes of agenda building, negotiating, networking, and coalition building are also the concern of the Centre on Connected and Autonomous Vehicles (CCAV), part of the Department for Transport and the Department for Business, Energy and Industrial Strategy, which was established in 2015 to work across government to aid early market entry for automated vehicle technologies. This partnership of departments somewhat tellingly points to the intention of the UK government to be active in the business development and innovation of automated vehicle technologies. Indeed, the remit of the Centre is to “help ensure that the UK *remains* a world leader in developing and testing connected and autonomous vehicles” (HM Government, 2015a, emphasis added). Thus while new coalitions, partnerships and networks may be enabled by the tactical processes of TM, the selectivity in coalition building evidenced here may work against TM principles of inclusivity, democracy, diversity, and openness (Loorbach et al., 2015).

4.3. Operational

Experimentation is central to the TM literature, and a key part of the race to automation, evidenced in the UK and elsewhere not only by industry actors but also governmental approaches to automated vehicle development. Public investment in demonstration projects and field trials has been noted in other innovation pathways including renewable energy sources, with government funding “in a little understood ‘black box’ process to effect technology improvements and change the complex industry, market and regulatory barriers” to new technologies (Harborne & Hendry, 2009: 3581). The operational phase of TM, through the mobilisation of actors, and the execution of projects and experimentation is underpinned by the funding rounds provided by the UK government. These have worked to develop partnerships across industry, research and government,

¹ The House of Lords Science and Technology Select Committee (2017) conducted a thorough assessment review of connected and autonomous vehicles however it is unclear the impact this has had or will have on public automated vehicle discourse.

² The Transport Systems Catapult is a not-for-profit organisation overseen by Innovate UK, with a vision of “global leadership in Intelligent Mobility, promoting sustained economic growth and wellbeing through integrated, efficient and sustainable transport systems”.

but the degree to which learning feeds into, or is informed by, other stages of the TM cycle is not evident.

The UK government has provided funding to stimulate domestic innovation, including driverless car trials, and three Connected and Autonomous Vehicle (CAV) competitions (2016, 2017, 2018) offering matched industry funding. In 2014, Innovate UK, the UK's innovation agency, led a competition for £19 million funding, and identified four sites of demonstration constituting partnerships between private companies, consultancies, universities and local authorities, and culminating in three trials lasting between 18 and 36 months. Bristol, the Royal Borough of Greenwich (South-East London), Coventry and Milton Keynes were selected as sites for learning and experimentation at the “frontline of new economic, cultural, political and societal configurations in cities” (Karvonen & Van Heur, 2014: 389) – for automated vehicle innovations and with the intention of establishing “the UK as the global hub for the research, development and integration of driverless vehicles and associated technologies” (Innovate UK, 2014).

The funding for demonstration projects was recognised by then Business Secretary Sajid Javid as a “further sign of our commitment to making sure we’re creating opportunities for UK businesses to thrive and attract global investment in world-class technology” (Innovate UK, 2014), pointing to the economic motivations underlying the demonstrations, and their role in the international race. In addition to the government-led trials, other industry-led demonstrations are underway, for instance from technology developing start-ups, and incumbent manufacturers, including Volvo’s “Drive Me London” programme (Table 1). The use of geographically dispersed and diverse demonstrations fits with the TM philosophy. However, while multiple technologies are tested in experiments involving different actor constellations, it is notable that to date, all government-funded demonstrations are located in southern England, which may reinforce the asymmetric economies of the south of England and the remainder of the United Kingdom.

Table 1. Public Demonstration Projects and Trials of Automated Passenger Vehicles

Name	Time frame	Places & Sites	Technologies	Actors	Government funding
LUTZ Pathfinder Project	2014-2016	Milton Keynes, Pavements.	Passenger pods.	Oxbotica, Oxford Robotics Institute, Transport System Catapult, Milton Keynes Council.	Transport System Catapult.
Venturer consortium	2016-2018	Bristol and South Gloucestershire, University Campus, Urban Public Roads	Connected and autonomous passenger vehicles.	University of Bristol, Bristol City Council, AXA, First Group, University of the West of England, Atkins, Fusion Processing, South Gloucestershire Council, Williams, BAE Systems, Bristol Robotics Group.	UK Driverless Car Trial Competition.
Autodrive consortium	2016-2018	Nuneaton, Coventry and Milton Keynes	Driverless passenger pods and adapted private passenger vehicles (Ford,	ARUP , AXA , Coventry City Council , Ford , Gowling WLG , MIRA , Jaguar Land Rover , Milton Keynes Council ,	UK Driverless Car Trial Competition.

			Jaguar Land Rover and Tata Motors).	RDM Group, TATA Motors, Thales, The Open University, Transport Systems Catapult, University of Cambridge, University of Oxford.	
GATEway consortium	2016-2017	Shared environment with pedestrians and cyclists, Greenwich London, and Heathrow.	Passenger & freight: Passenger pods, public driverless shuttles, autonomous-enabled Toyota.	TRL, Royal Borough of Greenwich, Royal College of Art, Greenwich University, RSA, O2, Oxbotica, Imperial College London, Heathrow Airport, GoBotix, Commonplace, Westfield, Shell.	UK Driverless Car Trial Competition.
MOVE_UK consortium	2016-2019	Greenwich, public roads.	Passenger vehicles with Automated Driving Systems (ADS).	Bosch, Jaguar Land Rover, Direct Line Group, The Floow, the Royal Borough of Greenwich, TRL.	Intelligent Mobility fund ³ .
Volvo Drive Me London	2017-2018	West London Public Roads	Adapted Volvo XC90 (4x4)	Volvo	Not clear.
Streetwise consortium	2017-2019	London	Autonomous and connected vehicles (SAE 'level 4' ⁴).	FiveAI, Direct Line, the University of Oxford, Transport for London and the Transport Research Laboratory.	CAV2.
DRIVEN consortium	2017-2019	Oxford to London, RACE – private testing space, and motorway.	Autonomous and connected vehicles (SAE 'level 4').	Oxbotica, the Oxford Robotics Institute, XL Catlin, Nominet, Telefonica, the Transport Research Laboratory, UKAEAs RACE facility, Oxfordshire County Council, Transport for London and	Innovate UK & CCAV.

³ In 2016, eight projects were awarded £20 million of funding to develop automated vehicle technologies through the Intelligent Mobility Fund. This included some public demonstrations and technology trials (e.g. MOVE_UK) and mobile platforms (e.g. i-MOTORS).

⁴ The Society of Automotive Engineer (2014) levels of automation, ranging from zero to five, depict the varying degrees of motor vehicle automation in relation to human control of driving functions.

				Westbourne Communications.	
Insight consortium	2017-2019	Birmingham. City centre environment.	Autonomous shuttles.	Birmingham City University and Westfield Sportscars Ltd, Heathrow Enterprises Ltd, Fusion Processing Ltd, Creative Example Ltd and Conigital Ltd.	Intelligent Mobility fund.

Places of experimentation, and the role of users present two concerns at the operational level. There has been a focus to date on urban experimentation of automated technologies, however given the complexities of urban transport systems, urban traffic may well be the most difficult to automate (Schwanen, 2017). Perhaps in response to this, there have been steps towards experimentation on motorways for both passenger vehicles (e.g. DRIVEN consortium) and freight vehicle platooning. A clear absence in experimentation is the active participation of the public, who are effectively configured as ‘future technology adopters’. As the trials have progressed through time, there has been more recognition of users as part of the innovation pathway, and thus the potential for a broadening of learning and opportunities for greater inclusivity. For instance, the Insight consortium research focuses on accessibility for independent travel, and other user-centred projects funded through the same ‘Intelligent Mobility Fund’ mechanism (e.g. Flourish, <http://flourishmobility.com/>) are highlighting the need to better understand the social equity dimension of automated vehicle innovations. However, there remains a clear prioritisation of experts from government, industry and academia in discourse relating to robotics and automation and little public engagement beyond public perception surveys (Schoettle & Sivak, 2014; Kyriakidis, Happee, & de Winter, 2015), consultation on the Industrial Strategy Green Paper (HM Government, 2017), and exposure to the technologies through public trials. As previously reported with electric vehicles (Bergman, Schwanen & Sovacool, 2017), a wider range of roles, including as citizens, is not currently envisaged by automated vehicle experimentation.

4.4. Reflexive

The *reflexive* stage in the cycle is not yet well articulated, with learning appearing to relate to international government policy and regulation, and industry developments. For instance, the UK government Pathway to Driverless Cars regulatory review (HM Government, 2015b) provides a detailed examination of international government regulations to driverless vehicle technologies, to aid the development of domestic policy. This provides some evidence of the competitive stance taken by the government with relation to gaining domestic innovation, research and development, and demonstration projects. It appears that discourses of international competition and economic significance and the frame of a race towards automation have created a sense of urgency that results in a privileging of implementation of legislation and cutting of ‘red tape’ over public participation in the innovation trajectory.

So-called ‘development rounds’ are important steps in the transition management process involving monitoring and evaluation of the experimentation (Kemp & Loorbach, 2003). Part of the learning achieved in this process is an evaluation of whether the transition objectives have been achieved. This critical and self-reflexive process offers opportunities for restructuring the problem framing. The diversity of private sector actors, and overlap between demonstrations in terms of technologies (e.g. vehicles, sensors) used, and consortium partners (Table 1.), may suggest learnings between projects and collaborative development of technologies. Insofar as lessons have been learnt, these are not widely circulated and not in the public domain, no doubt in part because of commercial sensitivities

and the perceived importance to not advance the position of perceived competitors. Moreover, as far as automated vehicle developments in the UK are concerned, there appears to be little space for critical interventions, big picture thinking, reflexivity, nor indeed failure. This can be attributed at least in part to the way in which the smart mobility transition is framed in the context of neoliberal ideals and dependence on private sector interests.

4.5. Interconnections

The interconnections between the four TM levels are important to long-term learning and other TM outcomes. There are multi-level dynamics, whereby strategic activities can influence tactical, operational, and reflexive activities through top-down processes, yet experimentation and learning from the operational and reflexive levels can also put pressure on the strategic level by way of bottom-up forces. With automated vehicles in the UK, the TM stages do not appear to be well aligned and integrated. It is not immediately clear how the monitoring and evaluation of the demonstration projects will contribute to wider learnings and reflexive governance of the transition to automated vehicles. These insights point to the need for multi-level coordination with local experimentation informing the development of national policy, and coordination across scales, including with international policies as “go-it-alone policies” can be harmful unless there are clear first-mover advantages (Kemp & Loorbach, 2003).

5. CONCLUSIONS

The frame of a *race to automation* enforces the need to participate, or risk being left behind. The innovation race can reinforce techno-optimism, particularly in national economies, like the UK, that remain scarred by the 2007/8 financial crisis. At present, the diversity of actors and demonstration projects in the UK offer opportunities for learning, albeit within the selective coalitions. The current transition experiments are focused on ‘deepening’ learning from demonstrations and trials, with a need for ‘broadening’ and ‘scaling up’ of the experimentation. This should move beyond technological capability, and frame public input in a more diverse set of roles (beyond ‘adopter’). Nevertheless, notions of inclusivity and democracy, which are guiding principles of TM, are conspicuously absent from the current approach to automated vehicle innovation in the UK and need to underpin experiments as they occur in different contexts and at wider scales.

At a minimum, democratic discussions with due consideration for potential winners and losers across spatial and temporal scales are required at an early stage of development. There is an apparent ‘post-political’ consensus (Mouffe, 2005; Swyngedouw, 2010) about the centrality of markets and expert judgement that forecloses radical dissent (Schwanen, 2017), and which seems set to steer the development of automated futures in ways which the TM literature suggests may be sub-optimal. Further consideration of the (post-) political and TM is required to underscore the political dimensions of automated vehicle transition dynamics. Robust interconnections between activities across the four levels (strategic, tactical, operational and reflexive) could enhance or accelerate a transition to automated mobility. Nevertheless, critical questions about whether an automated mobility future can respond to the environmental, social and economic challenges created and reinforced by automobility remain unanswered.

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