ACTIVE INFRASTRUCTURE MANAGEMENT (AIM)

Using infrastructure management to deliver sustainable outcomes

Toleman, Roger, Institute of Transport Studies, Department of Civil Engineering, Monash University, Melbourne, Australia

Rose, Geoffrey, Institute of Transport Studies, Department of Civil Engineering, Monash University, Melbourne, Australia

ABSTRACT

The existing institutions and organisation of current transport systems are the result of the historical social, political and technological development of institutions and organisations to meet the goals of society.

Increasing concern for sustainable transport outcomes is now focussing attention on the level of institutional and organisational change necessary to deliver goals that differ from past priorities.

Moving to sustainable transport systems is addressed here in terms of "strong" sustainability. This implies that all the social costs of the network will be directly reflected in use based charges reflecting relevant regulatory requirements, and the organisational system for sustainable transport management should integrate pricing with concerns for safety; reducing emissions to air; reducing greenhouse gases; addressing water runoff and noise; and developing renewable energy sources.

Using the principles of Enhanced Producer Responsibility, this paper develops an organisational scenario in which the existing transport system could be developed towards institutions and structures that support sustainable transport outcomes.

This approach, termed *Active Infrastructure Management* (AIM), proposes that transport infrastructure managers assume greater responsibility for the sustainability of their services, with integrated responsibility for charging, management of safety and a range of environmental impacts, which are then reflected in user charges and appropriate entry and operating standards.

Keywords: sustainable transport; Extended Producer Responsibility; Active Infrastructure Management; institutions; transport sector integration

1. INTRODUCTION

This paper first briefly reviews the current development of thinking on sustainability; its broad relationship to transport policy activity; and the potential development of these developments as they affect the potential for sustainable transport systems.

It then examines the conceptual process and implications of the developing manufacturing sector approach to sustainable production known as *Enhanced Producer Responsibility*.

The paper then considers the potential for and implications of applying this approach to the development of sustainable transport through the concept of *Active Infrastructure Management.*

2. THE CONCEPTUAL STATUS OF SUSTAINABILITY

Current interest in the concept of sustainability first developed from an awareness of the changing relationship between human activity and the geophysical environment. The definitions of "sustainability" are numerous and none yet commands universal acceptance, though it can essentially be characterised as an overarching term for a grouping of social, economic and environmental approaches that support the ability of humanity to "carry on."

In practice, current concepts of sustainability have developed as a complex of ideas, with a range of reference points including opposition, nominal support and action initiatives, the classical economic approach of weak sustainability and the ethically based concept of strong sustainability (Figure 1). However, as Neumayer (2003) notes, even weak and strong sustainability are still non-falsifiable paradigms, since they inherently apply to long-term outcomes.

The conceptual development of sustainability is far from complete. There is an extensive and still developing range of ideas that could eventually reinforce strong sustainability or lead to a human behaviour that Baker (2006) characterises as "ideal" sustainability and Turner (1993) sees as "very strong" sustainability. Social issues in this category include ecofeminism (Warren, 2000); animal liberation and other ethical imperatives (Singer, 2002); the implications of different approaches to decision-making (Plumwood, 1998; Eckersley, 1996; Frey, 1999); as well as environmental justice and the rights of individual citizens (Sax, 1990; Agyeman and Warner, 2002). Major economic implications include questions related to steady state economics and population stability (Sustainable Development Commission, 2009; Victor, 2008); patterns of consumption (Soete, 2009); changes to fundamental economic systems and the regulation of capitalism (Foster, 2008; Porritt, 2005); ecological modernization (Hajer, 2005); full cost accounting (Bebbington et al., 2001) and the need to account for material flows (Ayres, 2008). Philosophers such as Naess (1983) and Bookchin (1990) go beyond these issues into questions of the psychological and emotional relationship between human beings and their surroundings.

The complexities of these concepts make it evident that describing a desirable outcome as “sustainability” must inherently be an ongoing exercise based around a given starting point. In the present case, the concept of strong sustainability forms the starting point for the analysis that follows.

It follows that sustainability must then be translated into component sets of both societal and sectoral goals. A society striving towards sustainability is likely be interested in such issues as equity, disadvantage, justice, economic efficiency, safety, environmental management and material flows that apply to and affect the whole fabric of that society. However, not all of these issues will apply equally throughout any social structure, and may have greater resonance in specific sectors. The current nature and scale of the transport sector, for example, means that pricing and charging, emissions to air and water, noise, safety and renewable energy will tend to have greater priority than the same issues in some other sectors (Government of Denmark, 2002).

It is a pragmatic approach that also requires understanding of the iterative consequences of change throughout the entire social system. As Kemp and Rotmans (2004) note, the approach to sustainability will inherently be a potentially endless and complex series of transitions and temporary equilibria.

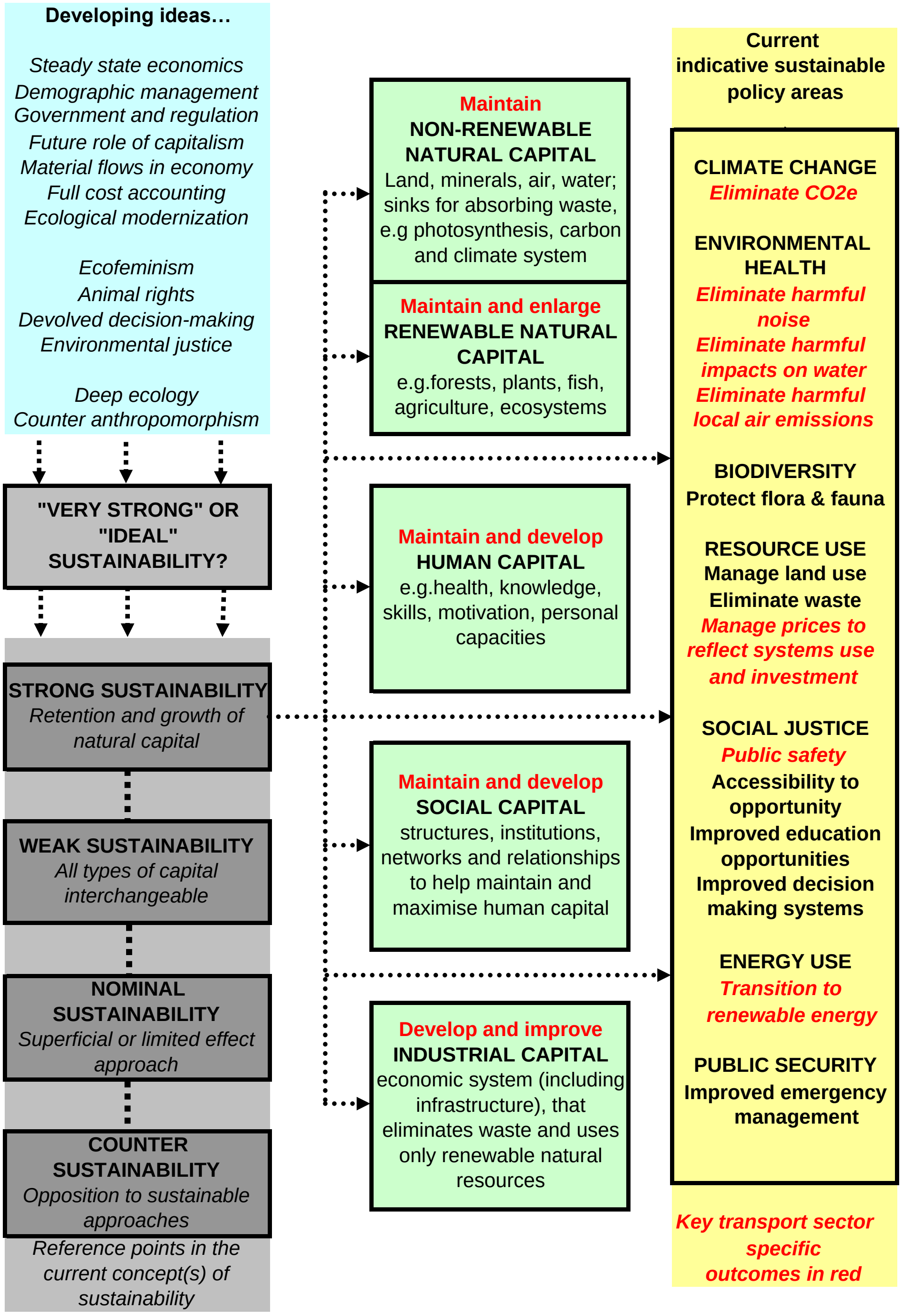

Figure 1 - Present and future implications of strong sustainability

3. CURRENT TRANSPORT SECTOR NETWORKS

In any consideration of transport policy formation and implementation processes, the starting point is the nature and development of contemporary institutions, organisations and systems (Rietveld and Stough, 2005). Each jurisdiction has its own features, but several common elements characterise overall transport policy development in the last fifty years.

Fundamentally, transport policy and its implementation systems have sought to deliver an increasing degree of mobility at a low direct price to the users of all transport modes. The achievement of this goal has commonly involved extensive expenditure from general taxation revenue; direct political involvement in investment and maintenance decisions; widespread use of financial subsidies to many modes (Button, 2005); the use of transport to promote economic development (Black, 2001); and the exclusion of externalities and other social costs from user charges (Myers and Kent, 2001; Nixon and Saphores, 2003). The level of social inclusion arising from these trends remains uncertain (Rosenbloom, 2007; Gudmunsson, 2005).

Transport safety performance has generally, if slowly, improved in the face of increasing mobility, though safety interventions often remain primarily driven by political reactions to specific incidents (Rothwell and Vanderzwaag, 2006). The negative impacts of transport on the natural environment and human health have generally increased e.g. (Brown, 2004; Banister, 2005; Vidal, March 3 2007). In this area, many aspects of transport policy still tend to rely on new technology that may be unable to deliver all that is expected (Moriarty and Honnery, 2008).

Transport policy formation and implementation remains locked within modal and even sub-modal systems. Conceptual frameworks that apply across the whole transport sector remain rare. As van Essen (2003) notes, this lack of an overall approach to outcomes has often led to the redefinition of policies based on iconic “good” and “bad” modes, further moving policy issues away from an overall view of transport as a single contiguous activity e.g.(Adams, 2006).

In structural terms the transport sector remains a web of public and private strategic, regulatory and operational organisations within regulated public frameworks. These structures encompass behaviours from basically commercial markets through to the complexities of trying to manage the ocean commons in a world increasingly centred on property rights and their consequences (Lodge and Meere, 2005).

To whatever degree sustainability may be the desired outcome for the transport sector, the existing nature of the sector mean that such refocussing will be a complex process of change.

4. EXTENDED PRODUCER RESPONSIBILITY

The learning process associated with moving towards more sustainable outcomes is not confined to the transport sector. In particular, new approaches to manufacturing in the last twenty years have already generated a body of experience that has significant relevance to the complexities of the transport sector.

Research into structures and systems to reduce the environmental impacts of manufacturing has particularly focussed around fundamental changes to industry operating responsibilities.

Lindhqvist formulated “Extended Producer Responsibility” (EPR) in 1990 at the level of individual enterprises (Van Rossem et al., 2006). Related approaches to the same problem had developed in terms of “ecological modernization” in the 1980’s (Jänicke, 2008); and “Green Industrial Policy” (Nill et al., 2001). This strategic concept is supported by an extensive literature on specific aspects of implementation (Ravi et al., 2005; Ilgin and Gupta, 2010). This developing framework (henceforward described as EPR) addresses the issues of environmental pollution from industry by establishing a number of basic principles:

- Environmental externalities must be incorporated into the basic decision-making structure of business, making the environment a manageable factor of production (Cerin, 2006) and beneficially affecting consumption patterns.

- Competitive structures across “level playing field” market sectors should continually drive innovation and benefit innovators to improve environmental outcomes *throughout* the entire production and use process rather than the so-called “end of pipe” approach.

- Manufacturing businesses must also be accountable for disposal of their products at the end of their life, either by direct responsibility for recovery or by setting aside funding for third parties to undertake such recovery

- “Smart” regulation by government, which will be necessary to drive these processes, should be designed to allow producers to more efficiently manage their own operations using statements of desirable outcomes rather than rely on “command and control” regulations.

This core set of ideas, which Hajer (1996) characterises not just as technical modernisation, but as incorporating natural systems into cultural politics, has continued to develop. The product-service system extends the basic principles to networks of separate businesses around the longer term leasing of services by consumers rather than simply product purchase (Mont, 2001; Mont and Lindhqvist, 2003). The concept of “Cradle to Cradle” further extends the framework to the position that the end products of manufacturing are the basis of a subsequent manufacturing cycle - the “Triple Top Line” effect, which seeks to completely eliminate waste (Mcdonough and Braungart, 2002).

EPR began with a strong focus on total production systems in given sectors as being easier to influence through regulation than individual consumer choice (Geyer-Allély and Zacharias-Farah, 2003). This collective approach generated such sector wide innovations as the Danish Product Panels (Traberg, 2003), and the German Green Dot approach (Mckerlie et al., 2006). EPR has now evolved to place greater emphasis on the recognition that, in competitive environments, it is individual firms rather than a sector as a whole, that more effectively innovate and lead change. In turn, this “upstream” approach has developed into a wider concept of the way in which “downstream” consumer demand influences and is influenced by production systems (Lenzen et al., 2007).

This emphasis on individual enterprise to drive innovation and greater environmental responsibility is particularly evident in the European Union Waste Electrical and Electronic Equipment Directive (WEEE) 2003 and the California Electronic Waste Recycling Act 2003, which embody the principles of EPR as a responsibility of each individual manufacturer (Lindhqvist and Lifset, 2003).

Though there is general agreement on the core principles, EPR is not without its critics. Clift (2006) has predicted that the WEEE approach will founder on the complexities of cell phone ownership and leasing. Fishbein et al (2000) note that the current focus of the EPR approach on new relatively high value goods, means that the problems arising from many low value high waste products have yet to be tackled.

While there are a number of high profile examples of EPR as a voluntary exercise by individual businesses e.g.(Anderson, 2009), together with the ISO14000 environmental management process, it is clear that without Government regulation the process is unlikely achieve its full potential. As Michaelis (2003) notes, without specific regulation, most businesses simply respond to the existing rules of the game – it is Governments that ultimately define and redefine business and the market place.

5. THE TRANSPORT SECTOR: ACTIVE INFRASTRUCTURE MANAGEMENT

The basic principle of Extended Producer Responsibility is that internalising factors of production in a competitive environment leads to upstream product innovation and management that changes downstream consumer use and improves ongoing environmental outcomes. How could this apply to the transport sector in terms of overall sustainable outcomes?

Applying EPR to some manufacturing elements of the transport sector has already begun in a limited way. A number of European countries have introduced producer responsibility for road vehicles, especially in terms of recycling (Lindhqvist and Lifset, 2003). Further extension of EPR to other transport systems, such as the recycling of ships, is also attracting increasing attention.

However, if EPR was more widely applied to promote sustainable transport, a number of significant policy issues related to the structure and interrelationship of transport systems would need to be considered.

EPR inherently relies on the external setting of outcomes to guide competition within a defined and commercially structured sector, thereby promoting innovation. However, the current transport "sector" generally consists of a complex of widely disparate modal systems built around differing commercial and non-commercial structures. There is certainly competition between modes, but it is often based on significant variability in internalised factors of production, as reflected, for example, in Chester's (2008) work on life cycle costs in

US passenger transport. The EPR approach to defining a core market inherently implies that the principle of system comparability has to be applied to the *whole* transport sector so that each mode operates within a consistent structural framework in order to focus on what it does best in terms of the *overall* sector's movement of passengers and freight.

In such a comparable framework, EPR – whose fundamental principles can be widened to include such transport issues as safety – might then be independently applied to two main manufactured elements of any transport system – network infrastructure and vehicles. This approach, however, raises the further question of how to manage the range of issues where these elements are closely interrelated. Issues such as safety or noise from transport systems, for example, have to be managed through a combined approach involving both the downstream operating characteristics of the vehicle concerned (e.g. the aircraft or the road vehicle) and its working relationship with the upstream network infrastructure systems (e.g. airports and the air traffic control system or roads and traffic management). Furthermore, issues such as emissions to air, safety or the quality of water impacts are all, in some degree, related to each other in that improvements in one area may be negatively reflected in other outcomes.

In these circumstances, a clear system of accountability for delivering on transport outcomes is needed for sustainability, providing leadership and direction across given systems. Traditionally, accountability for a range of transport outcomes has been divided among various government agencies and transport operators with only very limited overall for overall results and impacts.

The EPR model of producers and consumers could be developed in the transport context to apportion accountability for production factors. This could be achieved by enhancing the responsibilities of network infrastructure managers for the *overall* management and use of transport networks.

The concept, here described as Active Infrastructure Management (AIM) (Figure 2), begins with the clear governmental responsibility for setting expected outcomes (rather than detailed technical standards) from the overall transport sector. In terms of the principles of strong sustainability noted earlier, these outcomes should initially cover at least safety, all emissions to air, noise and water impacts and fuel sources, together with the obvious requirements for operational and financial systems and delivery.

Network infrastructure managers – as the literal foundation of any transport system – would then be held responsible for the delivery of the financial, environmental and social outcomes arising from the development and operation of their networks as defined by the public strategic and related regulatory frameworks. Network managers would be able to set flexible and innovative technical and operating requirements for users of their networks within government outcome standards, and would be financially and managerially responsible for investment, maintenance and operations, and the relevant share of social costs arising. Recovery of this expenditure would be through user charges that reflected individual vehicle performance.

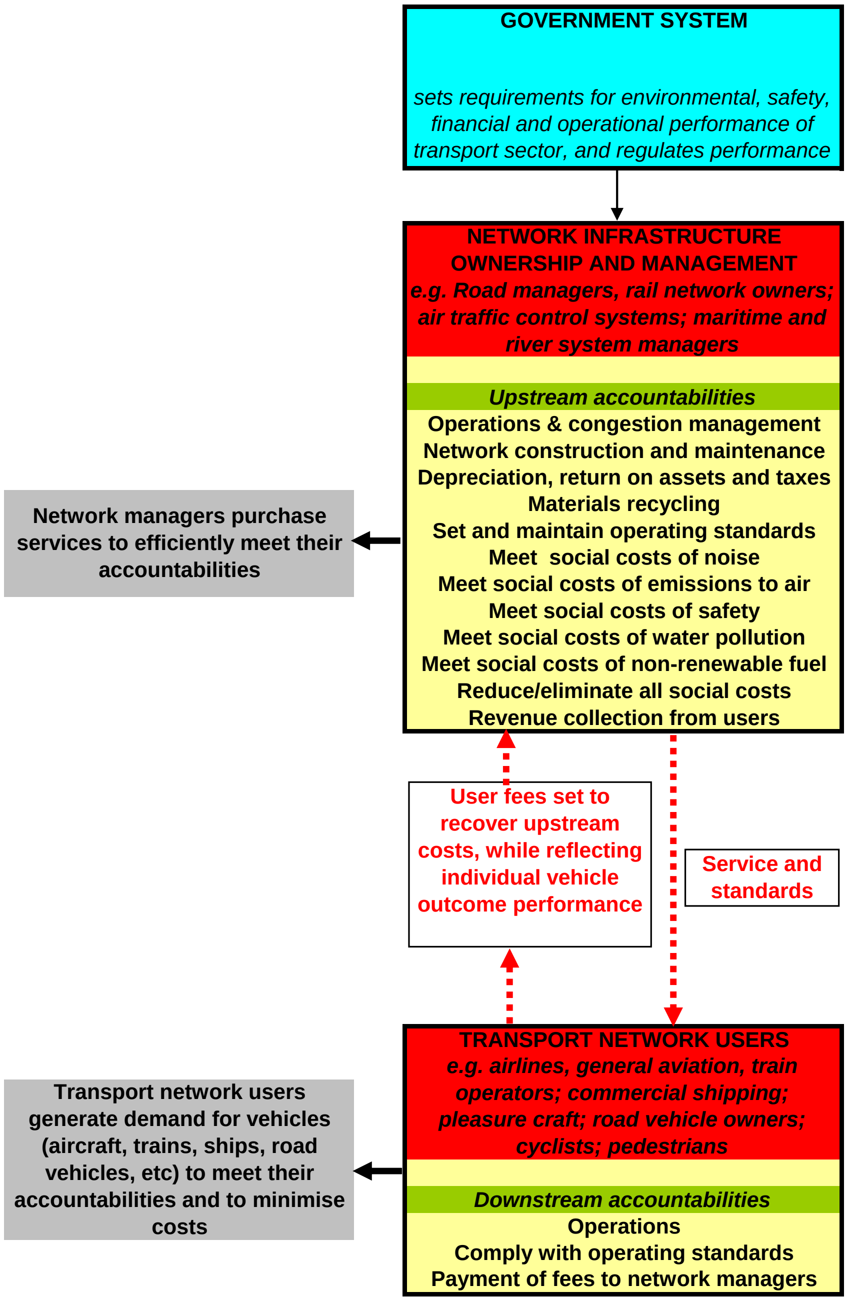

Figure 2 - Principles of Active Infrastructure Management

Within this framework, users of transport networks would remain responsible for their own vehicles in terms of their activity patterns and the consequences within such a framework. In their turn they would influence the demand for network services and vehicles that offered the most cost-effective means of meeting network requirements and overall desired outcomes.

Essentially the AIM concept develops the principle of shared (but distinct) consumer and producer responsibility (Lenzen et al., 2007) for the specific circumstances and desirable accountabilities of the transport sector and is structured to deliver the comprehensive product life cycle management that Cerin and Karlsen (2002) see as the ultimate goal of EPR.

6. THE ROLE OF GOVERNMENT

The desirable scale of government activity in the management of society has been a focus of debate from the mid Twentieth Century. While public involvement in ownership of infrastructure and other transport assets generally decreased over this period, Levi-Faur (2005) notes that the principal fundamental trend in government functions was actually a significant *extension* of the structures of regulatory capitalism to counteract reduced opportunities for direct operational management. As already noted, the EPR process requires fundamental government involvement to set the basic parameters of business activity. Reflecting the extent of the transport sector, the AIM concept similarly implies the development and modification of a number of areas of government activity.

The initial governmental role focuses on direction setting. The establishment of the broad concept of a single strategic outcome approach to the transport sector - rather than a plethora of often inconsistent modally based interventions - is the obvious basic requirement in this context e.g. (Nooteboom and Van Der Heijden, 2007). There is a growing trend to translate such strategic outcomes into formal legislative structures that provide greater long-term directional certainty than traditional strategic or administrative policy documents (Toleman and Rose, 2010 forthcoming).

Many observers (Graham and Marvin, 2001) have been critical of the perceived growing “fragmentation” of transport infrastructure such as rail or road networks in terms of the number of operators and users. Yet, if the goal of transport policy is to promote sustainable outcomes, the real point of criticism should be the absence of effective and coherent regulatory structures that seek to deliver comparable outcomes through innovation across the whole transport sector.

If governments, acting in the AIM context, are to be successful “large picture” managers as envisioned (e.g. (Jackson, 2009), then regulatory formats will need to progress from the traditional “command and control” approach of detailed technical regulation and individual project management. In an innovative world with growing levels of mobility, “smart” transport regulation becomes a matter of setting outcomes for air, noise, water quality or safety; incorporating existing externalities into trading frameworks and providing appropriate market-based incentives (Jordan et al., 2005). It will also be a significant challenge for governments and their communities to acknowledge that non-linear results may occur in this process and that new unforeseen activities may “spin off” over time; as well as having the capability to monitor the results in a continual learning process (Sanderson, 2002). Figure 3 uses the Dutch TRANSUMO structure (Smokers, 2008) to summarise this approach to sustainable transport outcome management.

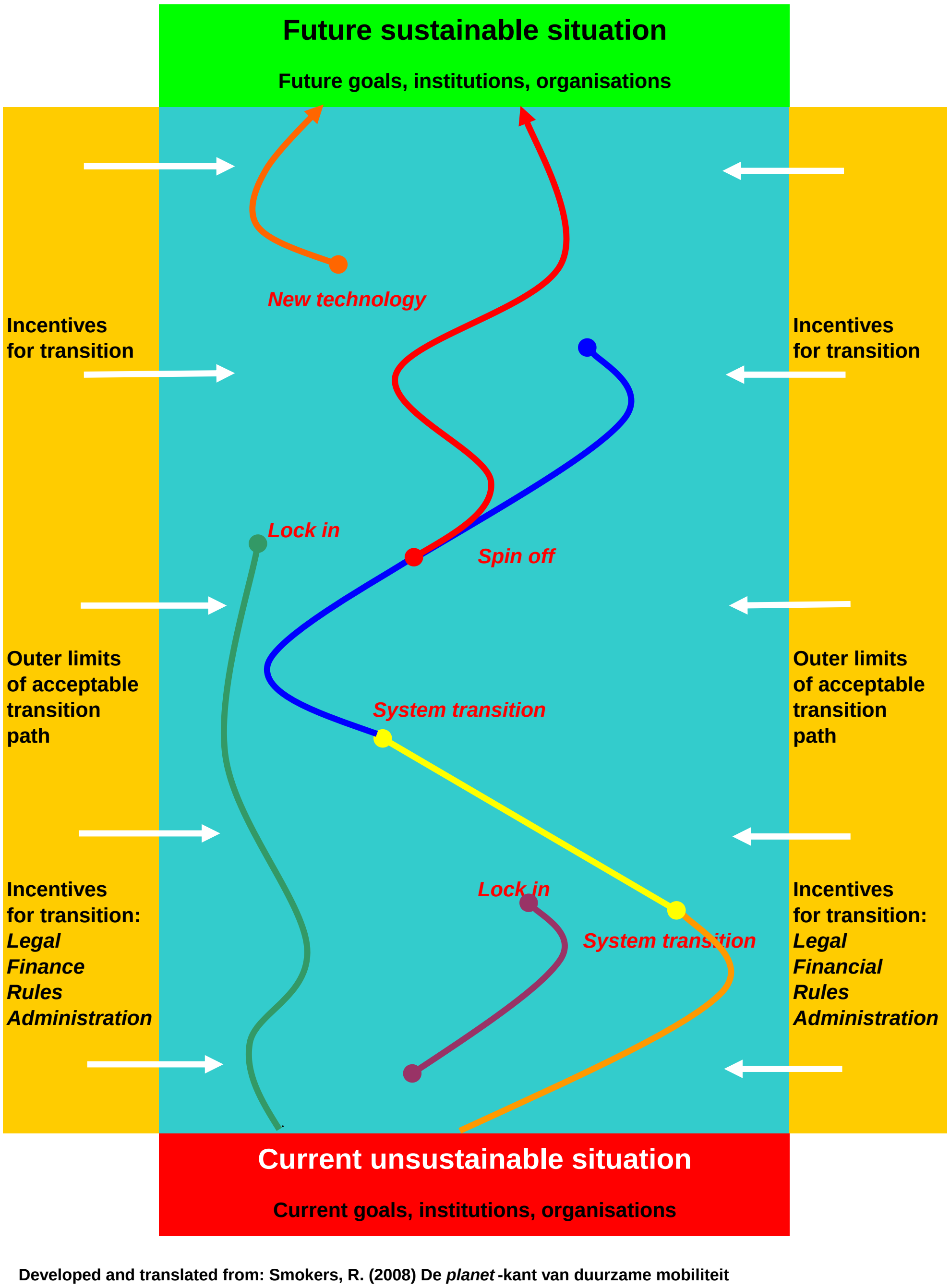

Figure 3 - The transition to sustainable mobility

The AIM concept involves major refocussing of the financial structures of government. During the implementation stages, existing indirect taxes and charges would be transferred from the present range of general taxation systems to use based charges imposed by infrastructure operators, including provision for the recovery of externality costs currently met through various forms of taxation. As this process developed, existing operating subsidies would be the subject of review and reform.

Infrastructure networks are most commonly natural monopolies, so that questions of government regulation remain significant. Whether infrastructure operators are structured as government businesses, private companies, public-private franchises or other corporate forms, the monopoly regulatory issues are basically similar (Newbery, 2001). Public regulators will need to address issues such as the management of sunk capital, pricing policies and rates of return, and the level of performance in delivering the wider range of outcomes implicit in AIM (Owen, 2006). In this context, in particular, there will also be ongoing issues related to the ownership and regulatory functions of government. Everett and Pettitt (2006) identify the importance of clear separation between the operational management of individual infrastructure networks and the public ownership of most infrastructure assets.

It is obvious that public agencies will retain a key role in the structure, functioning and ongoing management, of a sustainable transport system based on the AIM principles. Managing the transition to such a system is likely to be the most demanding task of all.

7. TRANSITIONS

Like EPR in manufacturing, AIM starts from the current status of the transport sector. It is certainly a commercially structured approach, though it is not a “market solution” in the usual sense of that term. Essentially AIM rests on the basic assumption that sustainable transport will only develop when the relevant business and administrative frameworks support that outcome (Bleischwitz et al., 2004). If the transitions implied in this paper seem extensive and difficult to implement, then that is perhaps a measure of the lack of sustainability of the present transport system.

AIM is ultimately a directional approach for governments to manage ongoing change in the present transport system rather than a detailed timetabled plan. It is a path towards delivering the potential benefits of a sustainable transport system in which all mobility has value to society (Gudmunsson, 2005). Examples such as Schade and Rothengatter’s work on German land transport (2004); Maibach’s (1993) study on the potential restructuring of Zurich’s passenger transport; and Greenberg’s work on new approaches to insurance payments (2009) demonstrate that even intermediate staged approaches that are potentially congruent with the overall AIM concept, could deliver very substantial social, economic and environmental benefits.

The core policy issue for governments and their agencies will be maintaining the long term direction of the AIM approach in terms of a number of key transitions.

The importance of the multimodal approach to the whole transport sector has already been emphasised, but the transition to such a goal also requires careful management. As the impacts of energy price rises in recent years demonstrate, change in the financial and management structures of the transport sector will alter the relative tasks of particular technologies and the consequential demand on infrastructure networks.

AIM is a systems approach to the transport sector that relies on building the skills to support the creation of sustainable multimodal decision-making frameworks. The impressive transport complexities of the celebrated yoghurt pot (Böge, 1995) reflect fragmented transport policies developed from the political or bureaucratic micromanagement of modal mobility projects and policies. As Glazebrook's study of the Sydney rail network (2009) demonstrates, restructuring transport systems to include social costs and factors of production - however difficult - fundamentally changes investment, pricing and management approaches towards sustainable outcomes.

The principle of strong sustainability that underlies AIM is ethically based, but for governments this frequently translates into financial system management. Key studies of current cost structures (Booz Allen Hamilton & Institute for Transport Studies University of Leeds, 2005; Delucchi, 2007; Ecorys Transport & Mettle, 2005), all demonstrate that improving the management of social costs in transport significantly involves the recycling of current general government taxation into direct user charges. Managing this recycling process in a way that improves economic and social equity; gives a high degree of financial clarity to users through such processes as revenue hypothecation; while materially improving sustainability is a complex political and administrative process. The long term management of subsidies as modes change their transport tasks; infrastructure operator profits; and the possible eventual reduction in user costs as sustainable outcomes improve are also variables that enter this complex financial task. Addressing social impacts in this process is further complicated by the social inequities that are embodied in existing systems (Rosenbloom, 2007).

The AIM structure is flexible enough to support changing technologies and a range of implementation options, but still requires cost-effectiveness in policy responses within the basic system accountabilities. As Cerin and Karlson (2002) recognise, effective systems of this sort rely on the efficient allocation and use of property rights. In terms of addressing carbon emissions, for example, Bird and Lockwood (2009) identify the high administrative costs of proposed personal carbon trading approaches compared to systems that AIM would incorporate in infrastructure operators' user charges.

The largest public task in the transition will always be the successful selling of ideas. Each step in this socially instituted process of adaptive change will not be easily imposed since it will challenge existing institutions and dependencies, generating active new combinations of support and hostility. As noted earlier, the overall scale of change is substantial, and if meaningful progress is to be made on the way to sustainability, then it will inevitably proceed in stages. Kemp (2001) sees success depending on a process of gradual opportunity and demonstration or "strategic niche management". The introduction of road pricing in Stockholm, which was eventually accepted only after a formal trial, changes in public opinion and a general vote, may be more of a future model than was perhaps seen at the time (Eliasson et al., 2009; Schuitema et al., 2010).

8. FIRST STEPS AND BUILDING BLOCKS

AIM is a strategic approach that seeks to incorporate all transport operations within a single structural framework, ensuring that each technology maximises its contribution to an overall sustainable outcome. Given the realities of the current transport sector, however, this process of change has to be built out of existing modal systems in a structural progression. This section briefly reviews the initial potential for such development.

The structure of air traffic control already lends itself to the AIM approach. The rights and responsibilities of international Flight Information Regions are delegated to national air traffic control operators by the International Civil Aviation Organisation, and cover most of the world. Many air traffic control organisations are already commercially structured or at least have administrative separation from political systems, recovering fees for service from users. Though the system is certainly not sustainable in the terms used in this paper, air traffic management functions are focussed on delivering safe and efficient traffic flows, with a slowly increasing emphasis on minimising environmental impacts such as noise and emissions. While efforts to create a single regional air traffic control operator in Europe have made slow political progress, the concept offers substantial potential for improved airspace management (Janić, 2007).

In contrast, management of the maritime transport sector exists in an uncomfortable relationship between various forms of limited national management (such as Port State Control and Particularly Sensitive Sea Areas) and weak international systems based on the rights of free passage embodied in the United Nations Convention on the Law of the Sea (UNCLOS) deriving from the much older tradition of Grotius and “mare liberum”. Even basic compliance with Vessel Traffic Services systems in heavy traffic areas remains essentially voluntary, while the impact of Exclusive Economic Zones on maritime transport remains unclear (Valencia and Akimoto, 2006). A growing body of research (International Council on Clean Transportation, 2007) has identified substantial growth in the pollution of both air and water by maritime traffic, yet Uggla (2007) records fundamental public and national frustration at attempts to actively manage such environmental issues even in limited national waters.

Criticism of the present maritime transport management system is extensive and fundamental (Kovats, 2006) and is enmeshed in wider issues related to the management of ocean and seabed resources (Johnston, 2006; Lodge and Meere, 2005). The pressures for structural reforms to establish property rights and obligations are considerable but change is likely to be slow and piecemeal in a classic example of commons management within a path dependency framework dominated by special interests.

The land transport sectors show a changing range of management structures, though responsibility for management of safety and environmental issues remains very diverse. The AIM producer and consumer relationship is partially evident in corporate public and private business structures increasingly relying on user fees which are now a growing feature of road management in many jurisdictions, often in response to the unwillingness of public agencies to incur additional public debt (Toleman and Rose, 2008). Proposals for entire networks to be managed in this way (Mclay, 2006; Newbery, 1994) have yet to be implemented. However, the problems of road traffic congestion have led cities such as Singapore, London and Stockholm to introduce direct charging in urban road pricing schemes. Management congestion and resource problems with key national networks as well as the declining effectiveness of energy taxes in the face of new vehicle propulsion technology have caused Germany, Switzerland, Austria and the Netherlands to institute various forms of distance and time based charging systems. While the British cycle and walking infrastructure provider Sustrans is legally a charity, it may represent an intriguing step towards some form of greater distinction between types of land corridor providers, even along adjacent corridors.

The parallel separate management of rail infrastructure to encourage open access competition still forms a developing policy issue in many jurisdictions such as Europe (Nash and Matthews, 2009), and Australia with safety, environmental and other regulation generally remaining in traditional public structures. However, while the USA and other administrations, still retain track and trains under a single management structure, recent United States Congressional concerns over monopoly pricing, the development of joint infrastructure initiatives such as the Alameda Corridor in Los Angeles and increasing State funding of rail infrastructure suggest that past certainties beginning to shift.

Though it also identifies areas where sustainability seems a distant prospect, this brief review suggests a number of key areas where transport structures and systems could offer significant potential for practical experimentation and development of the AIM approach as a path towards sustainable transport.

9. CONCLUSIONS

The goal of sustainable transport is a complex and continually developing target, and the complexities of the current transport system inherently preclude any quick solutions.

In this context, the principles of Active Infrastructure Management, as they have been developed here out of the Extended Producer Responsibility approach, seek to provide a long term flexible framework for change in a wide variety of circumstances and environments. It is based on incorporating all the relevant factors of production into an overall transport sector built around the fundamental concept of the specific relationship between producers and consumers. In this way, it encourages ongoing technical and managerial innovation while working towards the ultimate goal of a system built around the concept of strong sustainability.

AIM is an aspirational process and a path to address the unsustainability of the present transport sector. It recognises the reality that change in any society will often be a lengthy process of discussion, experimentation, promotion and development of existing institutions and organisations as part of an overall learning process leading towards particular goals. In particular, it also recognises that such change will not occur without a significant refocussing of the roles and activities of government agencies as leaders, regulators, owners and managers of transport operations.

As with the parent concept of Extended Producer Responsibility, Active Infrastructure Management builds on existing initiatives and opportunities to generate frameworks for future change that better align individual and organisational opportunities with overall societal concerns.

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