Integrating Land Use and Transport: An Evolutionary Perspective[*]

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1. Introduction

The integration of land use and transport can be seen in any number of European cities, although what we see is a selective snapshot in time. We could consider the case of Stockholm as a classic positive model of integration, with its compact, pedestrian-friendly old town – *Staden Mellan Broarna* or 'city between the bridges' – surrounded by water (and water-borne transport); the grid of commercial streets of the inner city, and the residential suburbs and satellite towns connected by public transport (Andersson, 1998). Similarly, Lisbon has a combination of a compact pedestrian-friendly central business district served by a web of public transport routes including ferries and rail based modes – and even vertical transport by *elevadors* (Oliveira and Pinho, 2010), while London has seen both expansion by 'transit-oriented' suburbs as well as planned satellite towns to form a vast polycentric mega-city region (Hall and Pain, 2006).

Then again, these same cities also suffer from 'Eurosprawl' (Marshall, 1995), and we could consider a contrasting type of 'integration', which could occur on the periphery of any modern city. Let us consider an out-of-town leisure park, featuring a multi-screen cinema and drive-thru' restaurant, accompanied by a car park and of course, cars. Together this set of land uses and transport provision works as a package, as people from across the suburbs can converge on a one-stop entertainment 'centre'. While this format may be criticised for its car orientation, in a sense it is integrated and symbiotic too. It provides a single destination where a trip for the cinema and dining out may be combined. It may even be an efficient transport package as it could involve groups of cinema-goers – such as a car full of teenagers on a night out – which could be relatively high occupancy vehicles at a given time and location.

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[*] Chapter in Alves, R. A. and Vale, D. S. (2018) *Integração de usos do solo e transportes em cidades de média dimensão* (Integration of Land Use and Transport in Medium-sized Cities). Lisbon: Livros Horizonte. Available online at: http://inlut.fa.utl.pt/InLUT_2018.pdf

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And so, while a city like Stockholm may habitually be considered an exemplary case of integrated planning and sustainable urbanism (Cervero, 1998; Hall, 2013), the out-of-town drive-thru' as an example of integration of land use and transport is not generally considered exemplary or 'sustainable' in a conventional sense and may not be favoured by policy-makers. This is because the out-of-town centre, surrounded by car parks and loop roads, may be poorly served by public transport and have disjointed or missing pedestrian connections. This is, of course, not simply a matter of infrastructure or even efficiency but of equity, if the centre excludes the poor, the elderly, and others who do not have access to a car.

Nevertheless these examples show contrasting alternative interpretations of what integrated land use and transport could mean. The question becomes about how integration may come about, and more specifically, how does the planner or public policy-maker intervene to get one kind of integration rather than the other. This requires understanding of the land use and transport system, and how integration came about historically. In this chapter we look first at a historical sketch of integrated planning, then examine in more detail the dynamics of land use and transport interactions, leading to an evolutionary interpretation, from which implications for integrated planning are drawn.

2. Integrated planning: a historical sketch

The history of integrated land use and transport planning is inextricably bound up with the history of town planning. As such, almost any form of town planning could be said to involve integrated land use and transport planning. Ancient cities laid out on regular grids of streets could be said to illustrate the rational provision of wide and straight streets as a framework for enclosing blocks of urban land uses. In the most ancient cases, we may be guessing to what extent these settlements were 'planned' in a conventional sense. In the neolithic settlement of Çatalhöyük we have the ultimate pedestrian oriented city, where 'travel' was across the flat roofs and people clambered down from those 'shared surfaces' though trapdoors to access the land uses below (Hodder, 2005). Vitruvius' planned city had a regular radial pattern of streets (1999) and any number of renaissance planned cities followed suit. Leonardo da Vinci even envisaged arcaded buildings with separate passages for pedestrians and vehicles – a prescient integrated transport and urban form package (Anderson, 1978).

It was the advent of railways and tramways that brought in more recognisable modern versions of integrated land use and transport planning. Arturo Soria y Mata envisaged urban development strung out along a tramway spine, giving rise to a *Ciudad Lineal* or linear city that could stretch from Cadiz to St Petersburg, or Brussels to Beijing. In Soria's vision of integration, all development was within close range of a tram stop (1892). Ebenezer Howard's social cities formed, in effect, a polycentric cluster of settlements linked by railways (1904). These and subsequent 'garden cities' assumed a certain degree of self-containment: people could be assumed to live and work in the same town, in principle, minimising commuting.

The rise of the automobile also stimulated new urban forms. The easy accessibility of the motor car allowed Le Corbusier's *Ville Radieuse* to forego a conventionally focused city centre, but to scatter land uses across a grid-like framework of elevated roads with a ground surface prioritising pedestrians (1964). His *Ville Contemporaine* saw dedicated highways and futuristic skyscrapers, with an airport at the centre of the city – we could call this a sort of aviation-transit-oriented development on a grand scale. Lloyd Wright's Broadacre City foresaw the dispersed settlement patterns enabled by ubiquity and multi-directional accessibility of the motor car. Meanwhile Jellicoe's *Motopia* (1961) was devised to seamlessly integrate urban form with motor travel – in this case, featuring a supergrid of contiguous apartment blocks with circulation of vehicular traffic on the roofs – a motor age echo of Çatalhöyük.

Indeed, newly planned settlements are perhaps the most visible indication of how a society expresses itself in terms of accommodating the needs for land use and transport planning in an integrated manner. When it came to planning of British new towns in the post-war era we saw the realisation of many of these principles. Even an idea as basic as creating a new town with a 'town centre' doubling as a centre of accessibility could be seen as replicating a traditional land use–transport model of settlement form. Roads were planned so that the flow of traffic would balance out between people heading between the industrial estates to the residential areas in both directions. In some cases innovative transport solutions were proposed – the plan for North Bucks New City proposed 'pods' of development along a monorail route like beads on a string. (That particular futuristic city was never built, but the more prosaic solution of Milton Keynes – a new settlement on a nearby location – was based on conventional road transport). The New Town plan for Irvine in Scotland envisaged a 'central communications corridor' which could accommodate "any form of public transport – taxi-train, monorail, hovercraft, or some at present unknown development" (Irvine Development Corporation, 1971). In reality, local public transport there was provided by buses, while dedicated busways were also a prominent feature of Runcorn new town.

But town planning is, of course, not simply about provision of infrastructure to accommodate transport modes, whether conventional or unconventional. It is about accommodating people's patterns of living in space and time. In the post-war era of town planning, self-containment was a key theme, assuming the town as a whole could provide work for its population. Back then there were certain societal assumptions – lower car ownership, and perhaps households where one person (typically male) would go to work while another (typically female) would stay at home, and look after any children (Wilson, 1991). Meanwhile children would typically go to the local school. Neighbourhoods were typically planned around the provision of a primary school. So children would, naturally enough, walk to school (all without the specific encouragement of transport planners).

In the last couple of decades, there has been much emphasis on 'sustainable' transport: a means of providing for travel in a way that is environmentally-friendly, socially inclusive and economically viable. Or in some cases, the intention is to plan to minimise or avoid travel in the first place – encouraging alternatives to travel (Banister and Marshall, 2000), or 'planning more to travel less' (Banister, 1999). In this period, visionary urbanism has been more likely to invoke the merits of walking and cycling than expedite motor cars or hovercraft. We have seen a renaissance in rail-based travel – the reopening of railway lines and provision for new lines, and new or reintroduced light rail systems. Cities such as Manchester and Edinburgh that tore up their tramways in the 1960s now see modern light rail equivalents along their streets. Visionary urbanism is as likely to target car-free cities as to accommodate cars (Crawford, 2000). The 'pedestrianisation' of city centre streets has become commonplace – streets that were once the busiest for traffic now throng with people – typically shoppers and tourists.

Transit-oriented development (TOD) perhaps epitomises the modern form of integrated transport and land use planning, in the sense that it consciously envisages a package of land uses in connection to transport provision – dense, mixed use centres connected up by high capacity public transport (Calthorpe, 1993). There are several variants of the basic idea, whether seen as 'transit villages' (Bernick and Cervero, 1997), the vision for a polycentric city region (Calthorpe and Fulton, 2000), or applied in the context of transect planning (Payton and Hawkes, 2012).

By now we could be gaining the impression that land use transport planning could be simply a matter of realising a set formula, putting the right things in the right places. Situating local shops around a public transport stop seems naturally logical, just as an architect might plan a house with the dining room placed next to the kitchen. It is simply the natural order of things and simply a matter of good 'planning'.

However when we look closely we see things are not so simple as an 'architectural' solution. Were things this simple, we would always have integrated land use and transport planning – we could settle for a Vitruvian ideal city and land use and transport would be integrated indefinitely. But as we know things are more dynamic than this. The land use-transport system is not static: it is not a matter of the provider simply laying down the infrastructure and then everything else falling into place and staying there. The urban system is not like a model railway layout, whose designer can put certain arrangements of tracks and building in place, go away, and come back and continue as before, with nothing else unchanged (Marshall, 2009).

Rather, we have to add people into the mix: the restless human agency of a free society, where people have choice of where to live and work and go to school, and where they generally have a choice of travel modes, and often the ability to choose between travelling or not travelling to undertake various activities – to shop online or work at home. And these patterns change over time. People not only reside and travel but move house. Businesses start up and open new branches. Land values rise and fall. People procreate and migrate. Cities grow suburbs and form conurbations. This brings a dynamic into things which we must consider more explicitly.

3. Land use–transport interactions

Land use and transport work together in an ongoing dynamic system with a complex set of relationships between agents and outcomes occurring at different rates of change (Table 1). We can see this system conceptualised and modelled in many ways. Here, we will refer to three models for illustrative purposes,. The first two are simplest – one primarily land use-related, the other primarily transport related – but although simple, represent fundamental relationships that can be most transparently tracked. The third is a more complex model – although still a simplified outline of reality – which has the benefit of addressing explicitly both land use and transport, and also reflects the logic of integrated land use–transport modelling.

Table 1. Interactions between transport and urban change processes

	... causes change of ...	Net-work		Buildings				Agents			Location					Transport			Environ-ment			
		Road network	Public transport	Industrial buildings	Retail buildings	Office buildings	Housing	Firm lifecycles	Household lifecycles	Person lifecycles	Industrial location	Retail location	Office location	Labour mobility	Housing mobility	Vehicles	Freight transport	Travel	Energy, CO_2	Air quality	Noise	Land
Net-work	Road network	░									◍	◍	◍			●	●	●	●	●	●	●
	Public transport		░													●		●	●	●	●	
Buildings	Industrial buildings			░							◍					●	●	●	●	●	●	●
	Retail buildings				░							◍				●	●	●	●	●		●
	Office buildings					░							◍			●	●	●	●	●		●
	Housing						░					◍	◍	◍	◍	●	●	●	●	●		●
Agents	Firm lifecycles							░	◍	◍	◍	◍	◍	◍		●	●					
	Household lifecycles						○		░	◍					◍	●		●				
	Person lifecycles						○		◍	░					◍	●		●				
Location	Industrial location			○							░		◍	◍	◍							
	Retail location				○							░	◍	◍	◍							
	Office location					○							░	◍	◍							
	Labour mobility													░		●		●				
	Housing mobility						○					◍	◍	◍	░	●		●				
Transport	Vehicles	○														░	●	●				
	Freight transport	○									◍	◍				●	░	●	●	●	●	
	Travel	○	○										◍	◍	◍	●		░	●	●	●	
Environ ment	Energy, CO_2										◍	◍	◍	◍	◍				░			
	Air quality											◍	◍		◍					░		
	Noise											◍	◍		◍						░	
	Land														◍							░

● Fast impact ◍ Medium-speed impact ○ Slow impact

(Source: Wegener, 2007)

First, we can consider *von Thünen's model* (1966), or variants based on bid-rent theory, where different land uses bid for use of land, with different prices at different distances from a central point. Those land uses prepared to pay the highest rent at the centre locate there, and this mechanism is repeated at progressively greater distances from centre, in each case the land use bidding highest being the land use manifested on the ground. We can regard this as a model of transport as well as land use in the sense that a transport network and associated travel costs are implicitly part of the model. Specifically, it in effect presupposes a network providing homogenous accessibility and a focal point that is the centre of accessibility for the region. Assuming the existence of that centre of accessibility in the first place, with homogeneous accessibility evenly in all directions, we get a pattern of concentric rings of land use – which could apply to different urban and agricultural uses.

Secondly, let us consider the *gravity model*, as applied in the transport sphere. This is a generic kind of model which posits that the attraction – hence travel – between locations is proportional to the product of their populations while inversely proportional to the distance between them. This has obvious and conscious parallels with the Newton's 'inverse square law' of gravitation in physics, although in the case of transport-related gravity models, distance is typically replaced by a more generalised cost, and the deterrence of distance (cost) is not necessarily defined by a power of 2 but may vary with circumstances (see for example, Ortúzar and Willumsen, 2011). The model in any cases typically uses many other factors, with less direct analogous relation to physics, and these factors may include different land uses, rather than a homogenous 'mass' of population and activity. The point here is that this relation implies that once one knows the population (or land uses, activities, etc) at all locations and the distances (or costs, etc) between them, one can calculate the attractiveness and hence the travel between each pair of locations.

Finally we can refer to the *land use–transport feedback cycle* presented by Michael Wegener to illustrate typical understandings of behaviour that underlie several land use and transport models (e.g. Wegener, 2004; 2014). Here, the relationships between land use and transport have been characterised as a cycle, whereby transport networks influence accessibility, hence location of development, while in turn location of development influences travel, hence stimulating provision of transport links. Within the transport part of this cycle lie typical concerns of transport planners and modellers, whereby travel times, distances and costs influence car ownership, trip decisions, destination choice, mode choice and route choice, which gives rise to a pattern of demand which in turn stimulates supply of transport services and infrastructure. Within the land use part of the cycle, accessibility can directly stimulate changes of activities' locations, with or without the provision of new development.

We can see some of these mechanisms playing out historically. For example, in the case of London, it is possible to trace the pattern of urban development along main roads and close to public transport routes and stations developing over time (Stanilov, 2013). Indeed, we could cite many examples of cities in Europe and Asia as *de facto* cases of transit-oriented development, or 'TODs growing wild', when this format or pattern was a natural way of urban growth without needing particular acts of planning to achieve transit-orientation.

Now in each of these cases – the von Thünen model, gravity model and land use–transport feedback cycle – the patterns of land use and transport we observe are reached through dynamic interaction of many actors, and are not simply the created artefact of an all-powerful designer or planner. However, there are limitations to what these models depict over a longer term historical trajectory. For example, in the von Thünen model, it is simply assumed that a range of different land uses exists; the explanation for how that division of labour came about is absent. And in the gravity model, we simply arrive at a picture of a stable travel pattern between fixed centres of demand; the settlements and transport links do not change.

Even Wegener's land use–transport feedback cycle, although useful as far as it goes, appears somewhat like a sub-routine in a larger program, not least because it is presented as a cycle that is intrinsically dynamic and can loop around indefinitely – also containing its own internal 'sub-routines'. Land uses and transport modes are assumed to stay the same – or at least, there is no explicit account of these changing. To be fair, the model could be modified to allow new land use types and transport modes to be introduced. But in a sense this seems more like the upgrading of the model, with the 'new, improved' version needing to be supplied with more features, rather than the variability of the elements being part of the model. The upshot is that for any given version of the model, no matter how many cycles is operated, we will still see patterns of development based on the original set of land uses and transport modes, and the original types of traveller and trip purpose, and so on. This is not unreasonable for the purpose of the cycle as a conceptual model, which serves to illustrate the logic underlying assumptions about (computational) land use–transport models, but it draws attention to the limitations of all such models based on such considerations. In a sense, all land use transport models based on (only) this kind of cyclical logic will be limited to extrapolating a version of the past into the future; in reality the trajectory of history is more like an open-ended spiral, structured by the hitherto unseen dimension of time.

Hence, although all three cases considered here have a dynamic aspect, it is in effect the same elements and rules applying over time. It is as if the elements and relationships are fixed, but as the variable *time* is applied, we get 'more of the same' – more people, more vehicles, more roads, more locations developed, and hence larger settlements, larger networks, and so on. This is fine as far as it goes, but in the reality of history, the *kinds* of element and their relationships also change over time. This means that the ordered pattern is disrupted by new technologies and new social practices – most obviously seen in the advent of new transport modes, new kinds of transport infrastructure, and new kinds of land uses. These 'disruptive' interventions can affect the land use–transport relationship fundamentally and 'change the program'. This invites us to consider the longer term transformation of the land use–transport system, going beyond the foregoing models.

4. An evolutionary perspective

In *The Transit Metropolis*, Robert Cervero surveys a selection of cities and their transport systems around the world, and notes the "… tight 'hand in glove' fit between their transit services and settlement patterns. In particular, these places are highly adaptive – either their cityscapes are physically and functionally oriented to transit or transit is well tailored to serving their cityscapes." (1998:xi). He suggests that these places have been "superbly adapted, almost in a Darwinian sense" (1998:5).

Hence we can interpret the notion of 'modal fit' where each mode of transport is adapted to its urban environment, and has to some extent co-evolved with it: the mode shapes the environment, and the environment shapes the mode. 'Modal fit' can be used as a shorthand for the relationship between a transport mode and its 'environment' – which is interpreted here as the physical environment of infrastructure and urban form and land use, but which might also include wider interpretations of cultural, political, institutional or financial 'environments'. The implied relationship is dynamic, and (co) evolutionary.

Effectively, each mode of movement can be seen to occupy an 'evolutionary niche' in the urban environment. For example, metro systems thrive in densely packed cities, along corridors of high demand, and are competitive where street-based modes subject to congestion are not. However, the bus is more flexible than the metro for penetration of the more diffuse outer suburbs, though in the lowest density areas it may find only meagre sustenance. Cars, however, are well suited to the dispersed suburbs – as well as helping to create them in the first place: cars are symbiotic with sprawl.

Cycling and particularly walking are confined in range, and are disadvantaged by the long distances of suburbia, but are versatile and can find niches beyond the reach of other modes. The limited speed and range of walking is compensated by the fact that the pedestrian has the widest possible accessibility, right up to the doors of building, and onwards inside.

In some cases, new modes have evolved to fit the new urban conditions. Demand-responsive transport (e.g., dial-a-ride services) can be seen as an 'evolutionary response' to the creation of dispersed suburbs which cannot support conventional public transport. Similarly, the guided bus may be seen as an adaptive response to the combination of congested inner city areas (where a segregated route is a competitive advantage) and dispersed suburbs (where flexible routeing can allow penetration to maximise access closer to more destinations).

Finally, we see how some transport modes become 'extinct' – the horse-drawn tram combines the disadvantages of low speed and inflexible routeing. It only exists as a museum piece.

This 'almost Darwinian' adaptation suggests some sort of evolution at play. In fact, we can invoke here a very specific evolutionary interpretation that is analogous to biological evolution. That is to say, when using the term 'evolution' here we mean something more specific than just something 'changing' or 'developing' or 'transforming' over time, or something that it is just gradual or incremental or 'natural' or unplanned. We mean more specifically that it is adaptive, involving feedback from the wider 'environment', over successive iterations of change where one generation differs slightly from the generation before, and is subject to selective forces (Ziman, 2000; Vermeij, 2004; Marshall, 2009).

It is a collective population that evolves over time, rather than an individual; in the case of human-made artefacts, that 'population' could be represented by a type, from which that population is generated: for example, a particular type of vehicle could be said to evolve, where the type represents the collective set of vehicles generated from the same model.

More specifically, we can say that different transport modes and technologies evolve, and different land uses may be said to evolve. We can interpret the modern cinema as the evolutionary descendant of the theatre – originally the picture house was typically a theatre adapted to project films on a screen. The modern private car evolved from the first internal combustion engine vehicles known as 'horseless carriages', whose antecedents were horse-drawn vehicles of various kinds (Marshall, 2009).

From this perspective, the out-of-town cinema multiplex (set in a sea of car parks) is an *adaptation* of the traditional (street-fronting) cinema; or an evolution from it – just as in a previous era the cinema itself was an adaptation from the theatre, with the addition of moving picture technology. Similarly the drive-thru' restaurant is an adaptation, of a conventional restaurant or fast food outlet, to mass car use. These land use types evolved with the private car to produce the (in its own way) 'integrated' landscape of Eurosprawl.

Similarly the streetcar suburb or railway suburb could be seen as adaptations to public transport – a previously unprecedented urban form, comprising a local high street, public transport stop or station, a set of local shops, which in some cases was not coalescing around a pre-existing village, but in its pure form, a direct creature of the public transport.

In each case the 'integration' is the result of increments of development which were perhaps the product of private entrepreneurs – railway entrepreneurs or developers, whose aim was not necessarily to create a suburb as such, far less an exurban 'edge city' (Garreau, 1992). Similarly the case of Amsterdam's Zuidas district – in effect a European edge city – was driven originally by private sector interests and only later the public authorities stepped in to help add co-ordination to something that was happening anyway (Bertolini, 2007). In these cases – the transit metropolis, the out-of-town centre and edge city – the 'integration' as such was more of a coming together of complementary impulses, rather than necessarily being due to integrated transport land use planning policies as such – although in some cases, as with 'Metroland' in London, the railway companies did deliberately co-ordinate the development of residential neighbourhoods with the provision of suburban railway services.

The evolutionary perspective can take us back as far as we like in history or pre-history: to the first transport modes, the first settlements, the first land uses, the first societies, the first ambulant humans. An evolutionary interpretation takes account of changes in technology, society and cities – indeed, the relationship between transport, urbanization and the genesis of cities in the first place (Clark, 1958; Antrop, 2004). It accommodates the transition between the classic models of the compact dense pedestrian oriented city, the radial public transport oriented city and the dispersed car-oriented city – a transition which is not accommodated by models based on the conventional land use–transport feedback cycle. That is to say, such models do not within them account for the advent of new transport modes and technologies, the division of land uses, and so on. No amount of iteration of the cycle can generate the effect of the invention of the wheel, the internal combustion engine or the internet on land use and travel. This is because the elements and relationships are not static but change – often unpredictably and irreversibly – over the long term. This puts policy-makers in a different position because here it is not just a matter of tuning the system, to get a bit more development 'here' rather than 'there', but the very kinds of development and transport modes themselves are transformed.

With reference back to biology, a key point about urban or technological evolution is that it is not like an organism growing or unfolding over time as if following a roughly foreseeable developmental programme, but change can go in any direction, unpredictably (Marshall, 2009). The evolution is based on many different subsystems evolving in their own way – hence the evolution of vehicles types, technologies, land uses, social practices, and so on. Each responds with feedback from the environment – an environment constituted by all other elements (all other vehicle types, land uses, and so on). The element of natural selection acts on the multiple variants of different formats, where the viable ones prosper and multiply (according to consumer preference and marked forces, availability of resources, and so on), while others fall by the wayside. Evolution is typically regarded as being irreversible but there are always likely to be backtracking or other unpredictable eventualities – such as the reintroduction of trams or the renaissance of the bicycle. These reversals and revivals are lessons from history that demonstrate there is not a foreseeable progressive transition to the next stage. Otherwise, we might have had hovercraft taxis in London, rather than trishaws.

Taking all of the above into consideration, the question then becomes how should policy-makers intervene in such a dynamic, evolutionary system, to achieve integration?

5. Implications for integration

Approaching the topic of integration, or intervention in general, implies we have a model for 'how the world works' into which our policy interventions are placed. If we had a static, 'architectural' model, where the designer or planner simply needs to provide a fixed solution to accommodate society, then integrated land use and transport planning would simply imply that a planner could decree that this land use shall go *here*, and another *there*, and transport provided to serve each, and the whole would work like clockwork thereafter. For example, in a static, 'architectural' solution to urbanism, we would maintain a concentric urban format in perpetuity; we would simply not have out-of-town centres, as they would not fit the idea of a 'town centre'. (Taken to its logical conclusion, historically, we would not either have had radial public transport, or motor cars). However, in reality it is understood that land use and transport form a dynamic system, and intervention towards integration necessarily takes this into account.

For example, in terms of the von Thünen concentric ring model, a policy-maker could adjust the cost of transport in such a way to make one land use more competitive to another relative to the city centre. Or, the land could be taxed in some way, to have an effect on the land use and hence the pattern of travel accessing it. New investment in radial public transport could increase the relative accessibility of certain corridors (e.g. radial corridors or, alternatively, orbital routes) making them locally more accessible and changing the pattern of, for example, office and retail uses along those corridors. Hence, the threshold zone where shops and offices give way to residential uses on the periphery of town centres could shift inward or outwards, or along transport corridors, and in doing so affect travel patterns in turn.

In terms of responding to the gravity model, integration of land use and transport could mean location of certain land uses in relation to each other to minimise the collective distances travelled between all origins and destinations. For example, it could imply distribution of local services through an urban area to create a 'city of short distances'.

In terms of responding to the land use transport feedback cycle, the planner could introduce a variety of land use measures – controlling for mixed use, density, location of development – to influence trip generation, mode choice, route choice, and so on. Transport policy-makers could intervene with provision of bus services to access out-of-town centres, and to provide paths for pedestrians to access those centres on foot. Or more particularly, integrated policies would anticipate where demand for development was arising and help steer development to where good public transport existed or was being developed, and/or provide new transport infrastructure or services where the new development was arising. Taken together, the result of these dynamic models could yet be a polycentric city including out-of-town centres and local sub-centres.

When it comes to responding to the evolutionary perspective, we need to think via a slightly different mindset, that is alert to the potential for adaptive and evolutionary transformation. From consideration of biological evolution, we can learn a number of lessons for policy (Marshall, 2009) from which two ideas are highlighted here.

The first lesson from evolution is to discard inappropriate or moribund models: the future is not the same as the past, nor a simple foreseeable progressive development of the past. A new town need not resemble an old town; and just because traditional towns have 'town centres' does not mean that future new settlements should have 'town centres' – or even be 'towns' in a conventional sense. In other words, when steering solutions (even while based on understanding of the conventional land use–transport cycle) we should consider critically what the desired future model should be, and the reasons for it, which does not necessarily mean following old models of the past.

For example, an evolutionary perspective would recognise the rise of the shopping mall as a new format – an evolution from the traditional arcade, perhaps, but extracted to a greenfield site surrounded by car parking – whose attractiveness could differ from conventional shops, the package being more than the sum of the parts. Then again, shopping malls are not universally replacing traditional urban formats, and there is a renaissance of some central area streets that combine high accessibility with high quality physical and retail environment with historic identity, whether in the form of pedestrianised central streets or waterfront developments (the centres of Stockholm, Lisbon or London could be examples). So integrative policy is not just about steering conventional land use and modal combinations towards one or other of those solutions based on conventional assumptions about how towns and cities work, but must accommodate both while critically re-examining what our ultimate transport and land use objectives are, and why, when targeting integration.

The second lesson – the other side of the coin – is to avoid suppressing unsolicited novelty. Some innovations – possibly from outside the transport and land use sectors – could be gateways to viable future pathways. In this case the transport or land use planner needs to be alert to new trends, including new types of mobility (such as driverless cars, 'flying cars' and deliveries by 'drone'), new technologies (such as new navigational devices and smart apps), new social trends (such as health-conscious people deliberately incorporating walking and cycling in their daily travel, rather than simply choosing modes and routes to minimise travel time). These eventualities need to be anticipated and built into our thinking as soon as they practicably can be. Meanwhile, new solutions and their combinations should be tested – with a diversity of alternatives generated, and successful ones selected and propagated as best practice exemplars – to create a new generation of land use and transport understanding and practice.

6. Conclusions

Transport and land use may find themselves integrated and adapted to each other, over the long term, as in the case of traditional 'transit metropolises' such as Stockholm, London or Lisbon. However, this degree of integration may be slow to evolve, and not all outcomes are necessarily the 'right' kind of integration, if this means the 'integration' of car use and sprawl. Hence there is a prerogative for targeted planning for the desired kind of integration. For this targeting, evolutionary history suggests that we need to consider critically what our aims are, and why – and not simply project once-viable patterns of the past into the future.

As for policy interventions themselves, these can affect any part of the land use–transport cycle – hence integrated packages of policies can target both the land use→transport and transport→land use interactions. But we must also look beyond this cycle – which may be regarded as just a sub-routine within a longer term evolutionary trajectory – and consider factors that could 'change the program', such as new transport modes and new means of organising land uses. Here we also need to be alert to a wider range of influences – new technologies and social trends, including future leisure, health and retail scenarios – that could be fruitful areas for future adaptation and integration. Planners should anticipate these and encourage integration within policy models. Perhaps we could yet end up with a mix of futuristic solutions and traditional human urbanism – 'flying cars' and home delivery drones alighting on city rooftops, for utilitarian travel, linked by *elevador* to a ground surface kept free – like in *La Ville Radieuse* or *Motopia* – for active, healthy and happy ambulant humans.●

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