



Transport systems and cities viewed as self organising systems

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Abstract:

For the last 300 or more years, we have viewed the world through what is essentially a Cartesian lens, one based on the world conceived as a machine, able to be separated into parts, each part understandable in itself and the whole equal to the sum of the parts. This view of the world has permeated every field of endeavour, from physics to medicine to management. It has been extraordinarily useful and has yielded many benefits. However, it has come at a cost, as it has also rendered us blind to other important ways of understanding our world.

The notion of systems which have the inherent capacity to organise themselves started to emerge in the 1930s and has revolutionised biology, physics, meteorology and many other fields of science. It is starting to have a profound impact on management practice. We now know that an understanding of the parts does not necessarily lead to an understanding of the whole; that a (whole) system almost always has behaviours that cannot (even in theory) be deduced from the most complete knowledge of the components. A few people have started to apply this approach to the study of human habitations. Their work includes modelling transport system / land use interactions and an understanding of social groupings.

This paper applies this "lens" of self-organisation to transport systems and speculates about the implications for managers of these systems. It comes to some interesting conclusions about how we might "manage" the system. The implications include the shift from the "command and control" paradigm to that of facilitator, the need to identify and behave congruently with the community's values, the crucial role of information, and the way in which connections and relationships are fostered. These conclusions are supported by a case study using the technique of travel blending

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City limits

"In 1957 the first satellite was launched into orbit. It gave us a vantage point from which we could look at ourselves and signalled a new global consciousness, a dramatic change in our relationship with the planet. Seen from space, the beauty of the Earth's biosphere is striking - but so too is its fragility. The plumes of pollution, the wounds of deforestation, the scars of industrialisation and the sprawl of our cities are evidence that, in our quest for wealth, we are systematically plundering every aspect of our life support system

The survival of society has always depended on safeguarding the equilibrium between the variables of population, resources and environment. The neglect of this principle had disastrous and fatal consequences for past civilisations. We, too, are subject to the controlling laws of survival, but we are the first to be a global civilisation and therefore the first to face a simultaneous and world-wide expansion of population, depletion of natural resources and erosion of the environment.

Above us, 400 or so satellites, equipped with weather instruments, study coastal, ocean and polar processes, constantly beaming back scans of vegetation and atmosphere, plotting the effects of pollution and erosion. Their data provides insights into changing geological patterns, global warming and the depletion of the ozone layer. They are witnessing the creation of an environmental catastrophe of a magnitude never before faced by humankind. The exact long-term results of current levels of consumption are not yet clear, but given the scientific uncertainties concerning their precise effects, my contention is that we must apply the "precautionary principle" and ensure that action is taken to safeguard the survival of our species on this planet

It is a shocking revelation that it is our cities that are driving this environmental crisis. In 1900 only one-tenth of the world's population lived in cities. Today, for the first time in history, half the population lives in cities - and in 30 years time it may rise to as much as three-quarters. The urban population is rising at a rate of a quarter of a million per day - the equivalent of a new London every month.

In the United States, pollution from cities has already reduced crop production by almost 10%. In Japan, waste dumped by Tokyo City amounts to an estimated 20 million tonnes every year, waste that has already saturated the entire Tokyo Bay. Mexico City is literally drinking its two rivers dry, while London's massive traffic congestion causes more air pollution today than did the burning of coal in the pre-1956 Clean Air Act period. Cities generate the majority of greenhouse gases, and respected establishment figures such as Sir John Houghton, chair of the United Nations advisory panel on Climate Change, now warn of the disastrous likely effects of current levels of greenhouse gas production."

Edited extract from "Cities For a Small Planet" by Richard Rogers, published by Faber & Faber, 1997

Introduction

From ancient times, cities¹ have been the focal point of activity within a state. They grew as communities of interest focused on defence, production and trade with other states. Often located adjacent to a river, they became the centre of a web of transport links. Many cities were quite large, even by today's standards. Alexandria is reputed to have had more than 500,000 inhabitants and Rome was larger still. Cordoba was the greatest city of the Islamic West and, for a time, in all of Europe.

While some cities were planned, many grew more "organically". Apart from roads and in some cases water, there were no city-wide public "systems" as such and even these two were essentially non-mechanical in nature. Thus these cities could be readily perceived as "living" systems, self-organising in nature, with increasing levels of order and complexity as they developed over the centuries.

Today, at the end of the 20th century, modern cities dominate their regions, both in terms of population and, in many cases, economic activity. They are supported by complex physical systems including those for transport, power, telecommunications, water and waste. The planning, supply and performance of most of these systems is generally centrally controlled, either directly or through contracts and they are influenced by national and in some cases, international standards and protocols.

These systems pervade every aspect of our lives, reaching as they do into our homes, offices, recreation, entertainment and the means to access them. As a result, we are surrounded by artificial (mechanical/electronic) systems - the factory with its robotics and CAD systems; the air-conditioned office with telephone, fax, computer, copier, email; the air-conditioned house with TV(s) connected to optical fibre, the video, computer with internet connection, telephone/ fax/answering machine, burglar alarm linked to a central service; the business person with mobile phone, desktop/palm computer with email and fax making a call on the way to the airport before boarding the plane which, in addition to personal screens showing the latest news and weather, increasingly has facilities for phone/fax and email services in flight; the boat with its GPS, depth sounder, fish locator, weather fax; the sports field with its large electronic screen for replays so the umpire can be proved to be human and fallible in front of the whole crowd and, in time, perhaps even ultimately replaced!

So at one level, we could be forgiven if we reached the conclusion that we live in a city directed by artificial and mechanical systems beyond our influence or control, rather than a living environment responsive to our needs as people. This view is supported in an essay in the series "Apocalypse? No!" where Alistair Mant (Mant, 1992) reported that, when asked the question "*What is Australia for?*", a wide range of distinguished businessmen, parliamentarians, journalists, scientists, homemakers/managers and other citizens answered, **after some reflection**, that Australia is a kind

¹ The word city is derived from the Latin word *civitas*, which denotes a community that administers its own affairs. Throughout this paper, I will use the term generically to include the city and adjacent suburban areas

of large economic contraction, the principle aspiration being that it should "pay its way".

Given their technical training, the concept (or mental map) of a city as a complex artificial construct or "mechanical" system is particularly potent for physical planners and managers, be they involved in transport, power, telecommunications, water supply or land use. Within this mental map, a city can be thought of as a collection of discrete and independent systems, each made up of many parts, all highly predictable according to well established laws of physics and mechanics and able to be designed and replicated as needed. It also ignores the fundamental deep level interaction between these systems and the social sub-systems and furthermore, assumes both are static. Within this mental map or paradigm, I suspect that at times the people who use these systems (i.e., the customers) are at best regarded of secondary importance; in fact, if only they would behave in a similar manner (highly predictable in behaviour according to well established laws), life would be much easier for us! In many cases, the geometric layout of the city and its road (and transport) network adds to this impression.

The actions of planners, designers and managers of these systems have, quite naturally, been an expression of this view and have concentrated on regulation, investment in infrastructure, and day to day management/operation of the system. Education (of customers) has also been used, but mainly to ensure compliance with the system rather than assisting in its intelligent use. In some cases, variable pricing has been implemented, usually to a limited degree and associated with modifying peaks in demand on the system. Often underpinning these actions are models predicated on linear equations that purport, with the use of appropriate k factors, to approximate the real world, at least at the time they are calibrated.

Physical planners are often heard to comment that it will take a long time (say 40 years) for cities to become more sustainable because so much of the physical structure is already in place. This seems to ignore the capacity for behavioural change, for people to make different decisions about their daily activity patterns and mode of travel, to use their city in different ways, all of which is possible without massive changes in the current structure. I will return to this topic towards the end of the paper as there are now practical examples of how this can occur.

At a higher level, the gap between infrastructure providers/managers and human services has often remained wide in terms of both understanding and practice. Despite some efforts aimed at 'whole-of-government' planning, major decisions continue to be made with little regard, if any, to the cross-portfolio and inter-government impacts, particularly those in the longer term. To be fair, this is as much a function of the political structure of government as it is an inability or reluctance to understand the city holistically.

Within Australia, some change is occurring². Lately there has been a greater emphasis on co-operation and integration between physical service providers. This has

² These changes are, of course, not confined to Australia. The pioneering work of the Dutch with their integration of landuse and transport and the widespread concern in Europe about shopping

happened, for example, through joint working groups, co-ordination committees and recently, the formation of 'super' departments of infrastructure and/or planning³ To their credit, *AustRoads*⁴ is struggling with the concept of ecologically sustainable development (ESD) and how the principles of ESD might apply to (road) transport. A major work on the integration of land use, transport and the environment commissioned from Emeritus Prof Hans Westerman (Westerman 1998) by *AustRoads* is also nearing completion.

There is also increasing concern about continued reliance on supply side solutions and a growing appreciation of the role that travel demand management (TDM) might play in the future. Having said this, it would be true to say that most TDM measures are designed and implemented by people with technical backgrounds and little or no training in, or understanding of, the behavioural sciences. Needless to say, few have been very successful as the behavioural dimensions have not been understood and incorporated appropriately.

While the above changes are welcome, they are limited to the extent that our current mental maps limit our understanding of cities. The positive news is that there is a profound change coming, a paradigm shift in thinking that has the potential to completely alter the way we conceptualise the city and hence the way in which we manage what is essentially the most complex human system we have built to date. It is this change, the notion of self-organising systems, that I address in this paper.

The notion of self organising systems

"Our world view is changing. For four centuries the Cartesian-Newtonian vision of a mechanistic and material reality has dominated the scientific world-view, which in turn has permeated all aspects of Western culture. Now a shift is occurring, perhaps one of the most fundamental and dramatic transitions in history. It is nothing less than a dramatic change in the cultural belief-structure of Western industrial society" (Toms 1991)

Based on the established scientific method, there has been the reductionist view (still widespread) that, if we understand all the parts, then we will understand the whole and that the whole cannot exhibit characteristics that are not inherent in one of the parts; that the one true way to know the reality of something is through breaking it down into its component parts. And of course, the parts must be amenable to scientific analysis because if it can't be measured, it therefore cannot exist! The fact that something cannot be measured may, of course, be a function of the limitations in our current techniques and understanding rather than the fact that it does not exist. In addition, there is the assumption that reality is something external to oneself; that is,

centre location and the consequent impacts on transport and town centre vitality are but two examples

³ For example, the creation of the Dept of Infrastructure in Victoria and the Dept of Transport, Urban Planning and the Arts in SA

⁴ *AustRoads* is an association of Australian State, Territory, Commonwealth and NZ road (and in some cases, transport) authorities. Local Government is also represented

the separation of observed and observer is taken as an a priori fact and that there is no interactive effect between the two.

Over time, this view of the world permeated every field of endeavour, from physics to medicine to management. There is no doubt that it has been extraordinarily useful and has yielded many benefits. However, it has come at a cost, as it has also rendered us blind to other important ways of understanding our world. One of these is the theory of self-organising systems.

Although the concept of self-organisation first appeared in the 1930s, it is really the work undertaken by a number of key people since the mid 60s that has advanced our understanding. Among these are the physicists Haken (the theory of synergetics) and Prigogine (dissipative structures) and the work of biologists Maturana, Varela, Margulis and Kaufmann. Of these, Haken and Prigogine have probably had the most influence to date on cities and urban systems thinking (Portugali 1997).

In essence, we now know that an understanding of the parts does not necessarily lead to an understanding of the whole; that a (whole) system almost always has behaviours that cannot (even in theory) be deduced from a complete knowledge of the parts. In particular, we know that a complex adaptive system (one that is open to its environment) can take up a spatio-temporal structure and maintain it in far from equilibrium conditions⁵; that it can create or invent new and novel ways of relating and behaving (this spontaneous appearance of new characteristics in systems has been named *emergence*); that, given the complexity of such (self-organising) systems and the number of parts involved, there is no way to establish the causal relationships between them, and finally, the parts are interconnected in a non-linear fashion by a complex network of feedback loops.

Prigogine's **dissipative** systems theory, that is, the concept of far from equilibrium situations rather than hierarchies in some sort of equilibrium, can be applied to cities where economic activities and interactions result in multiple urban centres. Traditionally, this would be considered an equilibrium state formed by optimizing the sum of its parts. However, taking a self-organising systems approach, the spatial hierarchy among the central places is created, maintained and transformed by means of the interplay between interaction and fluctuations, on the one hand, and dissipation on the other. Within such systems, the spontaneous emergence of new structures and new forms of behaviour occurs at points of instability, called 'bifurcation points', which are the result of fluctuations amplified by feedback loops.

As the name **synergetics** suggests, Haken's theory of self-organisation puts emphasis on the inter-relations, interaction and synergy among the many parts of a system and its overall structure and behaviour. Central to this is pattern formation and recognition, that is, the ability of people to hold a number of patterns in their head simultaneously in a state of multi-stability until a certain order parameter takes over and determines which particular pattern is appropriate in a particular circumstance.

⁵ This contradicts a view traditionally held in physics that systems must be treated as isolated from their environment. According to the 2nd law of thermodynamics, such systems tend to move toward disorder, that is, toward an increased entropy.

Haken and Portugali suggest that the above conceptualisation offers a framework for the study of cognitive maps of cities and regions. These cities and regions can be regarded as large scale patterns which can never be seen in their entirety. As a consequence, a person's cognitive system constructs a map or representation on the basis of partial data. Thus cities can be perceived as self-organising systems which are both physical and cognitive: individuals' cognitive maps determine their location and actions in the city, and thus the physical structure of the city, and the latter simultaneously affects individuals' cognitive maps of the city.

Attention parameters, that is, the order parameters of a specific sub-system composing the pattern, emerge by means of self-organisation. In a state of multi-stability, or in the case of an ambivalent pattern, they determine which aspect of the pattern is seen first. This is of utmost importance in city dynamics. The city is full of patterns, yet individuals are attentive to only a few of them. The latter are the cognitive maps of the city and it is according to them that individuals and firms make decisions and act in the city (Portugali 1997).

"Out of the self-organisation of inanimate material systems emerged applications which portrayed the animate systems of humans and urbanism as open, in the sense that they exchange matter, energy, information and people, with their environment, and complex, in that their parts are so numerous, and changing, that there is no way to describe them in terms of cause and effect (as did the urbanists of the 50s and 60s), nor in terms of probabilities (as did urbanists since the end of the 60s and the regional scientists of the 70s and 80s) Such cities are thus chaotic and unpredictable and they self-organise themselves independent of our scientific predictions and planning rules" (Portugali 1997).

Maturana and Varela posit that a living system interacts with its environment through recurrent interactions, each of which triggers structural changes in the system. However, the environment only triggers the structural changes, it does not specify or direct them. The structural changes in turn alter its future behaviour. Such a structurally coupled system is a learning system. This continual adaptation, learning and development is a key characteristic of the behaviour of all living systems.

The insights of Haken, et al, have profound implications for the models currently used to predict transport and land use and understanding the behaviour of cities. As Prof. Peter Allen has stated -

"... the models (for transport and land use) that are used operationally today are still based on (static) equilibrium assumptions. Locations of jobs and residences, land values, traffic flows etc, are all assumed to reach their equilibrium configurations within say, five years, following some policy or planning action. Such an approach fails to take into account the possibility of any "run-away" processes where growth encourages growth, decline leads to further decline and so on, and where actions simply affect which evolutionary trajectory the regional system may be on, an evolutionary trajectory that does not stop after any particular delay. Similarly, the equilibrium approach supposes that urban form and hierarchy express some maximised utility for the actors, where consumers had minimised distance of travel

for goods and services and producers had maximised profits. This approach assumes that all the actors know what they want, know how to get it, and are doing what they wish - given the choices open to them. Such ideas give rise in reality to a purely descriptive approach to problems, tracing, in a kind of post hoc calibration process the changes that occurred." (Allen 1994)

Accepting the validity of the argument associated with assuming equilibrium conditions, the notion of fully informed actors and cognitive maps has particular relevance for how we might 'manage'⁶ a self-organising system such as a city and I will therefore come back to this later. But let us press on for the moment as there is more that needs to be comprehended before drawing some conclusions about 'managing' the city.

Self-organisation is also regarded by some as a theory about **chaos and order** - of the way systems near the edge of chaos self-organise and attain order. There are two forms of chaos: local or microscopic chaos, and global, macroscopic or deterministic chaos. Local chaos stems from the irregular motion or behaviour of the very many individual parts of a complex system. On the other hand, deterministic chaos arises when, as a consequence of self-organisation, the many individual parts are suddenly attracted by a few attractors, or enslaved by a few order parameters, and as a consequence exhibit a coordinated motion.

In cities the control parameters themselves are self-organising systems and as such are uncontrollable. The notion of self-organisation is essentially a new way of understanding, of realising that self-organising systems, be they human or cities (the manifestation of human behaviour), are essentially and profoundly unstable, chaotic, far-from-equilibrium and unpredictable⁷. From this perspective follows, for example, a new type of action in the city, a new type of city planning, **the aim of which is not to control, but to participate.** (Portugali 1997).

This raises the core point of the paper, namely the nature and effectiveness of our involvement in the management of cities

Fritjof Capra and Morten Flatau also bring out points that relate to this discussion in their paper on *Emergence and Design in Human Organisations* (Capra and Flatau 1997?)

Given that a city is an expression of human organisation, then understanding it (as a complex organisational system) may be significantly increased by paying attention to the different ways in which its patterns of organisation are embodied in physical structures.

⁶ Putting *manage* in quotation marks is to denote that I am using it in other than the normally accepted way

⁷ When time lapse photography is used, clouds that appear almost stationary to our eye swirl about in complex patterns and give life to what appears to be a static system. Similarly, if we could produce a series of 'time lapse photos' or maps of the city charting different factors - employment by type and location, housing density and population, shopping by type and customer throughput, to name but some, we may discover patterns or trajectories that were invisible to us at the moment because we see them as almost static or with short run, straight line predictions.

Whereas a machine's pattern of organisation is embodied in the structure **by design** and the pattern exists independently of the structure⁸, in a living system, the pattern of organisation does not exist independently of the structure in which it is embodied. The latter is a continual process, which cannot be controlled, and which, significantly, involves the spontaneous emergence of new structures and new forms of behaviour. These two distinct processes could be designated "embodiment through design" and "embodiment through emergence". In human organisations (cities), both forms are always present. The former generates the city's formal structures, which are depicted in its official documents - laws, manuals and budgets that describe the formal policies and strategies and dictate established procedures.

However, there is always the latter as well, which generates the city's informal structures - the alliances and friendships, the informal channels of communication, the tacit skills and resources of knowledge that are continually evolving. These emergent structures are embodiments of an informal network of relationships that continually grows, changes and adapts to new situations.

Capra and Flatau (1997?) believe that "*many of the difficulties that are currently experienced in the management of complexity are the results of overlooking the interdependence of emergence and design in human organisations and can be addressed constructively by exploring the relationships between these two forms of embodiment. Such an exploration begins with the fundamental insight that designed structures, regardless of how self-contained they may appear, are always linked to and dependent upon the organisation's emergent features. Designed structures, more than anything else, are embodiments of invitations extended to us by emergence.*"

A design process consists of recognising, selecting, optimising and stabilising relationships that were originally embodied in an emergent structure, thus 'freezing' and isolating it from the process of further becoming. We know, however, that this stabilisation and isolation can never be complete, nor permanent. Redesign, in reality, is the repeated 'tinkering' with the process of emergence.

One consequence of the attempt to focus on stability and design has been to make both cities and individuals increasingly dependent on 'sameness' which in turn makes the existence of 'otherness', the emergence of novelty, more and more problematic. Thus individuals and cities find it harder and harder to adapt and evolve. For example, what is a good idea in one situation could find its way into "Guidelines" which then become "Codes of Practice", finally turning into mandatory standards enshrined in law. The mind set inherent in this approach is in direct contrast to the environment in which much of our business is increasingly being conducted.

Our sophisticated information technologies are truly emergent systems. They are expanding at an exponential rate, becoming more and more interconnected, with very large networks of multiple interlinked 'actors' - individuals, organisations, nations - with interdependent technologies, policies, etc. The new 'web economies' based on these systems constitute the business environment for both private and public organisations.

⁸ As a design pattern in the mind of the designer or in design sketches

As Capra and Flatau (1997?) state: *"The main reason why managers find it so difficult and frustrating to operate in this new environment is that these meta-systems are much more than the sum of their component parts. They are complex adaptive systems, driven by the dynamics of co-evolution. As the term indicates, these complex systems are flexible structures capable of a high degree of learning and thus capable of continually generating and responding to novelty. The 'secret' behind this capacity is that such structures are embodied through the process of emergence. In traditional management theory, adaption has been approached in a top down manner, based on a belief that it is a process that can be planned. In a human organisation, adaption is not achieved through planning and design but through a 'bottom-up' process of emergence"*

In our complex global business environment, purely designed structures simply do not have the necessary responsiveness and learning capability. But the way to proceed is not to discard designed structures in favour of emergent ones. Rather it is to retain both, understanding the inter-relationship and interdependence between these two forms of embodiment.

To nurture emergent structures means to offer the possibility of interaction and participation - genuine interaction and participation where both the rules and the emergent outcomes are negotiated. Such structures cannot be perfectly conceived and developed on schedule. Rather, they must be allowed to spontaneously emerge at any time and place in the system, often through messy procedures of informal learning. However, too great an emphasis on emergence will result in a loss of ability to efficiently produce goods or services and market them to existing or potential customers.

A new way of managing

All of the above indicates that, rather than viewing cities as simple, mechanistic, predictable and largely designed systems, there is now a strong case for understanding them as complex, process-dependent, self-organising and co-evolving systems of an emergent nature. From this it follows that we need to use these insights to develop new ways of 'managing' our cities. As Portugali (1997) stated, we need *"a new type of action in the city, a new type of city planning, the aim of which is not to control, but to participate"*.

And as Maturana and Varela have noted, **you cannot direct a living (self-organising) system, you can only disturb it**. This is a profound learning for those of us who have a responsibility for managing cities or one of the sub-systems. Viewed through this lens, 'managing' takes on a new dimension, one far from the traditional 'command and control' paradigm that we are used to or, indeed, feel comfortable with.

How do governments traditionally 'disturb' the system? As stated previously, a quick analysis would suggest they use four interventions, namely regulation, investment in infrastructure, operation of the system and education. **All are still necessary.**

However, based on what we have learnt from the theories of self-organising systems, what I hope is now apparent is that we can adopt a different mental map of the city and how to participate in its affairs. This approach would require a greater emphasis on information sharing, more explicit participation (and not just consultation), a recognition of the importance of identity, an understanding of the role of 'design' and 'emergent' structures. And if we start with the assumption that it is the citizens of a city who make decisions and have a degree of choice about where they live, work, recreate, shop, study, etc, what would this mean?

Information is one of the three key elements of a living (self-organising) system, the other two being relationships and identity. Information can be regarded as a self-generating, infinite resource from which complex structures can emerge. Governments, by their very nature, are in a unique position to collect, collate and distribute information about the functioning of the city as a living system; information about its health (e.g. air and water quality), consumption of resources (e.g. water, fuel, food, minerals), outputs (both productive and waste), the transport system (e.g. costs, timetables, fares, pollutants, route availability, real time congestion and vehicle operation), community services (e.g. health, police, education, libraries), planning (e.g. personal rights, land zoning, land uses); the list is endless. Information could be treated like the air we breath - freely available in the quantity required to all who need it, rather than a currency to be traded, dispensed and controlled. The means to achieve this is becoming more and more pervasive - the internet, interactive screens in public places, ITS. I suspect that we have only just started to think about what is possible and the implications⁹.

Participation In many cases, government is perceived to have made a decision before consulting the public. And yet if we impose structure, we create resistance; ignore relationships, we create irresponsibility; deny participation, we create anger and resentment; impose behaviours, we create lifeless performance. Most of our activities involve a greater or lesser degree of participation - at home, work, sport, shopping. Should those activities initiated by government be any different? With information freely available, it is more likely that a workable solution will emerge, one that has broader support in the community. In this regard, it is well to remember that *"Life uses messes to get to well-ordered solutions. what at a glance may appear to be messy and inefficient may actually be life experimenting - discovering what is possible"* (Wheatley 1996)

Living systems organise around **identity**. *In human communities, the conditions of freedom and connectedness are kept vibrant by focusing on what's going on in the heart of the community rather than in being fixated on the forms and structures of community. What called us together? What did we believe was possible together that was not possible alone? What hope did we bring forth by linking with others? ... In our observation, clarity at the core of the community about its purpose changes the entire nature of relationships within that community. These communities do not ask people to forfeit their freedom as a condition of belonging. They avoid the magnetic*

⁹ Those ITS that supply information to the driver to facilitate better decision making are fundamentally different to those directed at automated travel. The former is part of an emergent self organising system, the latter an expression of the mechanical command and control paradigm.

pull of proscribing behaviours and beliefs, they avoid becoming doctrinaire and dictatorial, they stay focused on what they're trying to create together, and diversity flourishes within them (Wheatley and Kellner-Rogers 1997)

This last factor is probably the area of greatest challenge and requires a paper in its own right!

Now, what does all the above mean in practice? Many of you will have already reframed past experiences as you read the paper, recalling instances and generating new insights and understandings. For me, one such experience was the recent trial involving IDM in Adelaide.

An intervention into reducing car travel using self-organising principles.

Over the past two years, Liz Ampt and her colleagues have been developing the technique of *travel blending* (Rose and Ampt 1996) to facilitate a reduction in the use of cars in urban areas. The technique involves members of a household:

- *thinking about activities and travel in advance* (i.e. in what order can I do things, where should they be done, who should do them?) and then;
- *blending modes* (i.e. sometimes car, sometimes walk, sometimes public transport etc.);
- *blending activities* (i.e. doing as many things as possible in the same place or on the same journey); and
- *blending over time* (i.e. making small sustainable changes over time - once a week or once a fortnight)

Households form the basis of the approach, since travel behaviour research has consistently shown that travel and activity decisions are strongly influenced by intra-household relationships and inter-dependencies.

A reduction in car use is achieved by a blend of whatever means suits a particular household and its individual members. These include ride-sharing, trip chaining, public transport, walking, cycling and telecommuting. The particular choice can vary from day to day or week to week as circumstances dictate. It can be used for the journey to work, shops, recreation, school - wherever and whenever the opportunity arises.

The results? In a pilot study involving a representative sample of 94 households conducted in Adelaide last year, the overall reduction in car use (as measured by the total time spent in a car), including those who were approached and refused to take part and those who dropped out part way through, was 19%. For those who fully participated, the reduction was 26%. After 5 months, the indication was that a further 8% reduction had occurred (Ampt 1997).

So from a self-organising systems perspective, what was going on?

In travel blending, the intervention (or disturbance) is essentially one of **information** - information about their current patterns and modes of travel, feedback on the proportion of car travel and the consequences in terms of pollution and hours spent in the car, suggested possible ways to reduce car use without reducing accessibility, further feedback on the changes (both positive and negative) and ways to maintain and reinforce behavioural shifts.

Relationships are crucial between those participating - between household members, people at work, friends who might be candidates for ride-sharing - as a degree of co-operation is required for the process to be successful

What would cause us to do this, to take the trouble to change our behaviour? **Identity** (or shared intent) is the third and crucial ingredient (along with information and relationships). In Sydney, it was the need to reduce pollution before the Olympic Games in the year 2000; in Nottingham it was an extension of the commuter plan; in Leeds it was improve the quality of life; and in Adelaide, research showed that it was the value we placed on our quality of life and the perception that the overuse of cars was a major threat to retaining our current level of quality. Identity is all about shared values and beliefs and if these can be marshalled, the intervention will be that much more successful and likely to be sustained in the longer term.

What else can we learn? The way each household chose to reduce the use of their car(s) was completely unpredictable. No two households had the same blend of modes before or after the intervention. Unlike campaigns that exhort people to use more public transport (or ride-share or telecommute or ...), travel blending is about empowering people to make choices, making use of any or all of the modes with the overall aim of reducing car use. It makes an intervention into a self-organising living system, namely the household, focusing on an outcome without being prescriptive about the solution. Having made that intervention, it leaves those in the system to self-organise to achieve a common goal.

Not surprisingly, these are all characteristics of a self-organising system, both at the level of the household and of the wider community.

Conclusions

The paper has by its very nature been long on theory and short on practice. This has been deliberate. It is primarily about exploring a new way of perceiving the city; of sharing the theories that have emerged from and migrated to other disciplines. It is about realising that the city, your city, can be understood in different ways, ways that give you and those you work with more freedom to try new and novel means to achieve community objectives. To proscribe actions would be to undermine the whole thrust of what I have been trying to state.

The integration of land use and transport, whilst important in the physical sense, will not bring about the result that is needed - maintaining accessibility while reducing the

distance travelled. We have known this for a long time but have not known how to bring about the complementary behavioural changes. I would suggest that our attempts to change behaviour have been based on a model of directing (or coercing) people by legislation or exhorting people to change without giving them the requisite information or techniques, nor engaging them in developing a shared intent that was congruent with their values and beliefs. In short, we have tended to operate from a mechanical model of the world rather than one recognising that we are dealing with a living (self-organising) system.

Above all, we need to recognise that cities are living systems capable of learning - indeed they are learning continuously. The real question is - "What are they learning? What are the information sources? Are they accessible, accurate, sufficient and timely? Are we facilitating learning by assisting with information flows or are we part of the problem? A commitment to information sharing would assist in achieving a better balance between design and emergent structures. As Fritjof and Flatau have stated, our world is being increasingly influenced by dynamic self-organising systems such as the internet, which are creating emergent structures every day, for example, in the area of information technology and its associated industries. And yet we currently have a simultaneous trend to more sameness which is the antithesis of spontaneity, novelty and transformation. How can the planning system, for example, facilitate a better balance between design and emergent structures? For the city that can constantly engage in the process of 'becoming' in harmony with its environment is going to have a distinct advantage.

Finally, how can we as managers of the various systems that underpin the modern city, strike the right balance between control and participation, between design and emergent structure? Because we perceive that this might require a change in the balance of power, it might well be the greatest challenge of all! And yet, in a self-organising system, what is the exercise of power? Perhaps it is really the power to influence a living system through genuine participation and information sharing - **power with** rather than **power over**.

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