Policies designed to halt activity dispersal, reduce car dependence, and meet sustainability targets

Simon EDWARDS & Mike BELL
Transport Operations Research Group
University of Newcastle Upon Tyne

1 - SYNOPSIS

Road-use charging and workplace parking levies are under consideration to manage urban travel demand (DETR 1998c). The impact of such policies on activity allocation is modelled.

2 - ABSTRACT

For much of the 20th Century UK planners and policy-makers have rejected the compact city and have sought to provide space for living and other activities by means of decentralisation. This paper outlines that philosophy and investigates the ever growing opinion that it is flawed for environmental reasons (the UK transport white paper (DETR 1998a) for example states that: the *"overall approach to planning is aimed at containing the dispersal of development, so reducing the need to travel and improving access to jobs, leisure and services"*). It then looks at policy methods by which:

- the need to travel (particularly by private car) may be reduced; and,
- activity location may be influenced.

A system dynamics model of an urban area is constructed to investigate the long term effects of implementing policies aimed at restricting travel (such as a cordon toll) on allocation of population and employment, the aim being to see whether decentralisation trends may be influenced in line with current thinking regarding regeneration and revitalisation of central urban areas, and protection of the green belt. The premise is that management of private travel demand and control over activity location using such policies has positive implications for indicators of sustainability such as urban vitality, land-take, energy usage and pollutant emissions.

3 - THE GREENFIELD UTOPIA

UK urban decentralisation has always been residential sector led. From a planning perspective there are four main reasons for this:

- concern over compact urban areas on social and environmental health grounds;
- major housing shortages after both world wars;
- changing demographics, including rising living standards - particularly since 1945; and,
- increased mobility.

Howard (1902) was the first planner (with proposals for 'garden cities') to suggest *planned decentralisation of activities* to reduce the squalor and overcrowding of high density urban living. Unwin (1912), suggested that working class housing density should not exceed 12 per acre. The middle classes, though, led the way in decentralising to escape the poverty and overcrowding of central locations. By 1939, 12.7 million registered dwellings existed in Britain, nearly a third of which were privately occupied (Cherry 1988). *Suburbanisation* and *decentralisation* of population were key trends, particularly as land for development was cheap.

Calculations of a housing shortfall of 500,000 dwellings after the 1914-18 war resulted in legislation such as the 1919 Housing Act (which enabled lower density public house construction through central government subsidy. This construction revealed the first evidence of urban sprawl with new-build concentrated into *conurbations* of lower density housing *further away* from the city centre. A post Second World War housing shortage combined with an increased marriage rate resulted in a wave of public sector house construction with rent controls and subsidies: by 1953 1.3 million new houses were built, mostly on the outskirts of urban areas. Despite policies of slum clearance in the 1950s and 1960s, and their replacement with modern houses and apartments, homes continued to decentralise faster than jobs (between 1961 and 1981 Inner London lost 1 million people (Barke 1986)), resulting in worsening traffic congestion in central urban areas as commuting distances lengthened.

Table 1: *Number of Homes in Britain (Source: Cherry 1972; Green et al 1998)*

Year	Number of Homes (Millions)
1901	6.7
1966	15.4
1998	20

By the 1950s UK population growth had largely stagnated and rural to urban migration had slowed. Disaggregation of the family unit due to an increasing divorce rate and an increasing number of people in further education or flexible service based careers increased pressure on the housing supply. The service sector of the economy continued to expand at the expense of the basic sector (heavy industries such as coal, steel, shipbuilding), with a simultaneous growth in female employment (the male to female employment ratio in 1951 was 1.9:1; in 1971 it was 1.5:1, today it is near 1:1(Office of National Statistics 1998). This has served to increase the complexity of commuting possibilities as service sector jobs are not as locationally fixed, and nor is the workforce.

4 - PLANNING DECENTRALISATION

Post 1945 Britain was seen as ‘containable’ within a pre-determined land-use pattern (Cherry 1988). The Barlow Report (1940) recommended that concentrated urban areas should be relieved and the regional economy boosted by redevelopment of congested urban areas, decentralisation of industry, and regional industrial development (for example Abercrombie’s Greater London Plan (1943)). *Planned* decentralisation of congested urban areas was therefore the consensus. The New Towns Act (1946) enabled self-contained satellite towns of approximately 50,000 population to be built outside commuting distance of the parent city on greenfield sites. Outside London a 5 mile green belt (see Green Belt (London and Home Counties Act, 1938) separated the new towns from the parent metropolis. In addition, the Town Development Act (1952) gave local authorities financial assistance to plan overspill in existing urban areas.

Decentralisation of industry became a key trend with industrial estates and Development Areas set up on urban fringes (see Special Areas Act (1935); Distribution of Industry Act (1945)).

Increased mobility through growing car ownership went hand in hand with activity dispersal, and ultimately destroyed the objectives of planned decentralisation. More complex and greater numbers of trip patterns could take place, longer journeys were made as commuting distance lengthened, and pressures on urban roads and car parks grew. By the 1960s emphasis was on traffic management and the improvements to public transport (see Buchanan (1963)). The 1968 Transport Act set up Passenger Transport Executives in the major conurbations to operate and subsidise public transport operations and integrate public and private transport.

Gillespie *et al* (1996) suggest that the process of dispersal has accelerated (certainly in a more fragmented, less planned, manner) since the 1970s, largely as a legacy of the free-market, state-influence free approach of government since 1979 which undid policies of centralisation. The contemporary 'Post-Fordist' city is characterised by decentralised housing and retailing, a new institutional framework, de-integration of public transport services and increasing car dependency. Continuing social trends, such as disintegration of the family unit (for example single parents increased by 330,000 between 1984 and 1997 (DETR 1998b)), an ageing population, an increase in higher education uptake, and trends towards house dwelling (as opposed to flats - the number of households living in houses increased by 1.5 million between 1984 and 1997 (Green *et al* 1998)) have resulted in projections of an additional 5 million homes being required by 2016, thus increasing the pressure on green belts and the transport infrastructure.

5 - CONTROLLING DECENTRALISATION: MAKING THE CITY SUSTAINABLE

The process of land use dispersal has accelerated since the breakdown of the post-war central planning era. This has resulted in central urban decline, pressure on greenbelt land and increased car dependency. At the same time national and international policy has changed as environmental awareness has grown, with the World Commission on Environment and Development (1987) coining the term 'sustainable development'[1] This has since had repercussions for urban policy making, including transportation and planning. Sustainability requires *integration* of different interacting factors at a micro-level (such as different transport modes) and at the macro-level (such as interactions between transport, land use and energy consumption). Trends of activity dispersal are considered unsustainable, particularly because of increased car dependency. Sustainability objectives appear to be concerned with restricting the need to travel and improving the vitality and viability (DOE 1994) of central urban areas. Newcastle City Council (1993) is aiming to achieve sustainability by reducing the need for consumption of energy and natural resources, and the environmental impact caused by their use, without compromising the city's economic vitality. The aims are to:

- reduce CO_2 emissions by 30% of the 1990 value by 2005;
- reduce the need to travel by encouraging mixed use development and the close relationship between new development and public transport routes; and,
- to minimise environmental damage and pollution of new developments and transportation proposals.

With these objectives in mind a simple system dynamics model of a city (Newcastle Upon Tyne) was constructed, building in policy options that might be introduced by a local authority to achieve such objectives. The hypothesis is that by introducing policies that lead to a *re*-centralisation (or at least halt decentralisation) of activities, the need to travel may be reduced - particularly car dependent trips - thus reducing energy consumption and pressure on the green belt. This model is explained below, with assumptions, following a summary of system dynamics as a modelling tool.

6 - SYSTEM DYNAMICS

Travel behaviour is a dynamically complex process controlled by a wide variety of constraints, attitudes and preferences, many of which have little to do with travel itself (Bradley 1995). System dynamics can incorporate transport *and related* sectors, whereas most transportation studies input land-use, socio-economic and demographic forecasts exogenously. The emphasis is thus on qualitative behaviour of a system and its components over time, rather than quantitative predictions or extrapolation of trends (as obtained from more traditional gravity models or flow-capacity models). In the case of the spatial interaction model presented here, the emphasis is on *directional* changes across the system, rather than changes in *magnitude*. In terms of system dynamics, a sustainable system is one that is in a state of dynamic equilibrium, which is when all of a system's stocks are at their desired levels simultaneously, and all inflows are exactly balanced by outflows from its stocks.

7 - A SYSTEM DYNAMICS MODEL OF NEWCASTLE UPON TYNE

The model presented in this section was constructed using a system dynamics computer package, Powersim. It is a spatial interaction model where population is allocated to zones according to service employment and service employment is allocated to zones according to population; the flow of activities between different zones is measured and the summation of those flows defines activity location (see Lowry 1964, Garin 1966, Wilson 1974). The distribution of homes and jobs is determined by the cost of the commuting round trip. The basic model consists of population, employment and travel costs. The key feature is a congestion sub-model incorporating road capacity, car dependency, and delays caused by marginal trips. According to Wilson (1974), once the framework of population, employment, travel cost, and activity rate (the proportion of population in work) has been defined, the logical structure of the model can be expressed in terms of several simultaneous equations and associated inequalities. The simple, unconstrained, form is:

$$T_{ij} = gE_j f\,(c_{ij})$$

where,
T_{ij} = the number of people living in zone i and working in zone j
g = a constant
E_j = the given number of jobs in each zone j
f = a decreasing function
c_{ij} = cost of travel from i to j.

The model has been expanded to include several component parts (*sub-models*). These features are explained below. There are three objectives attached to the development of this model:

1. to find out whether locationally specific policy levers can reduce travel and thus pollution emission levels in city centres;
2. to find out if locationally specific policy levers will lead to people moving into city centres or vica-versa;
3. to develop a **decision support tool** which allows policy makers to explore alternatives.

It is now necessary to look at the features of the model in more detail, paying special attention to assumptions concerning travel cost, congestion and car dependency.

7.1. Features of the TORG Model
This model is intended to be generic so that it can be used as a decision support tool by local authorities. Underlying the model is the assumption of the urban area as formed of concentric rings radiating from a central point. These rings represent *zones*, as shown in the simplified diagram below (Figure 1).

The TORG model simulates the interaction between *three zones*. The urban area represented using real data is Newcastle Upon Tyne **-** however, it must be stressed that this model is intended to be generic and the level of data input is not complex. In theory, many more zones or sub-zones could be modelled to imcrease the representation ability of the model. Zones were defined according to local authority wards (distinct electoral districts within an urban area), and specific initialising data concerning allocation of population, employment and retailing in those wards was obtained from the 1991 census. In the census 17 categories of socio-economic group (SEG) are defined, based on employment. For this model the categories were merged into two.

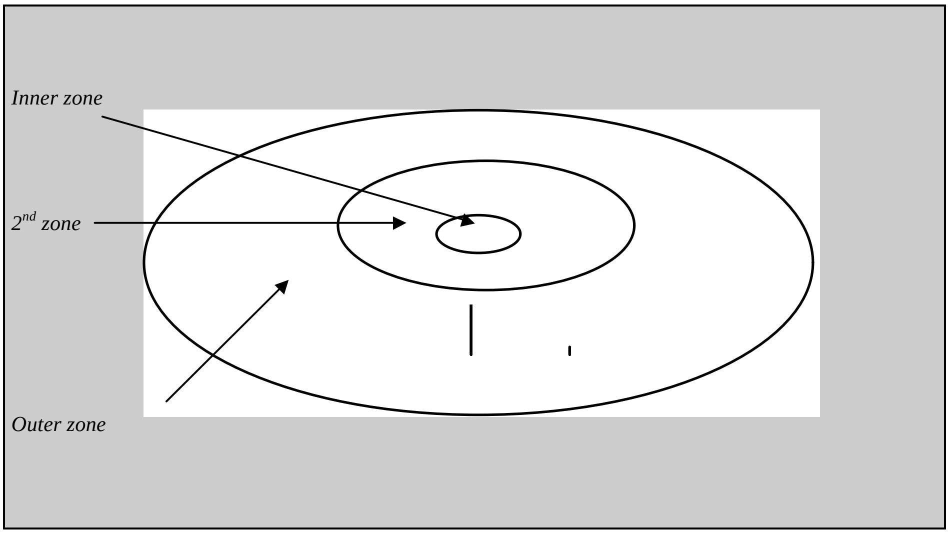

Figure 1: *Concentric Zones*

These are: *high income* (consisting of non-manual, professional and managerial employees) and *low income* (consisting of manual jobs **-** skilled and unskilled). The initial ***population allocation*** is as follows:

Table 2*: Zonal Population by SEG*

Total Population	SEG 1 (non-manual)	SEG 2 (manual)
Zone 1	9,853	5,076
Zone 2	104,167	53,661
Zone 3	54,104	27,871

*N.B. the **total working population** of Newcastle Upon Tyne is 115,506 people out of a **total population of a working age** of 156,181. (Source: 1991 Census Return). Activity rates are (total working population as a proportion of total population) 40% in SEG 1 and 21% in SEG 2; two further types of activity rate are defined to represent shopping trips. One shows shopping trips per head of population, and the other shopping trips per worker. These are both disaggregated by SEG.*

The concept of ***congestion*** is important to derivation of the total travel cost function. This is represented by the perceived cost of travel, the components of which are explained below. Commenting on congestion, Newman *et al* (1989) suggest that the benefits to individual vehicles from free flowing traffic is short term and illusory (see also Mumford (1961)). Road building policies, designed to free up traffic will result in long term land use changes causing car dependency to increase, along with greater energy use, emissions, and increased travel times, and reduce viability of public transport. Thus congestion should be 'planned' and used as a tool to progress towards a less car dependent and lower energy use city. This requires an integrated approach involving land use decisions and investment in other modes. Land use changes combined with traffic restraint measures can reduce car dependence. The DETR (1998c) anticipate hypothecation of revenues from restraint measures based on charging towards public transport improvements: as Newman *et al* (1989) conclude, perceived problems of congestion are offset by real gains in access through new transit systems and centrally located housing.

Zonal travel cost is modelled though no network is represented. Wilson (1974) recognised that cost of travel in the central zone is generally less than the cost of travel between zones, and, in turn, that the cost of travel between zones is less than the cost of travel in the outer zone. This is because in the inner city people may be assumed to be less *car-dependent*, whereas in an outer zone, where distances are greater, cycling and walking are less realistic alternatives and public transport may be scarcer, thus increasing car dependency. ***Generalised costs*** form a proportion of total travel costs. These include a fixed cost of travel (representing undelayed travel time, fuel costs, etc.) which increases with distance travelled, a fare for public transport trips only (which increases with distance), and a toll for car trips. Because the commute trip is a round trip, a separate auxiliary variable representing this is considered, in order to observe the effect of implementing a workplace parking charge.

Car dependency is thus a key feature of the Newcastle model. According to Newman *et al* (1989)), low density areas under 20 to 30 persons per hectare *generate* car dependence due to a combination of factors including greater distances to travel and little option to walk or use public transport. There is an exponential increase in car use as density declines. Where car dependency is high, commuters are captive to the car, so more trips lead to more car traffic, greater congestion and slower travel speeds. Where car dependency is low, trip-makers are assumed to have the option of using other modes, which in general have greater capacity in terms of numbers of trips. Even though in theory low density zones suffer less from congestion than central zones (because of greater space availability for transport infrastructure improvements), growing car dependency impinges upon all zones due to the greater number, and complexity, of journeys which take place.

A key feature of the model is that the increase in travel cost resulting from each marginal trip depends on the level of car dependency. Where car dependency is low, the marginal trips are assumed to have a negligible effect on travel costs, because of the availability of adequate capacity on the non-car modes. Where car dependency is high, the marginal trips add to the cars on the road, increasing expected delay and therefore perceived travel costs. However, car dependency is a very difficult factor to quantify short of undertaking highly detailed micro-simulations of household utility and choice. The figures used are therefore derived from alternative mode dependency, which in turn is derived by ward using the percentage of households not owning a car. Clearly those people not owning a car are dependent on other modes for mobility. However, as distance from the centre increases incomes generally increase (and therefore car ownership is higher) and soft modes and public transport are less viable. The proportion of non-car owners in Newcastle, by zone, is shown in Table 3:

Table 3: *Non-Car Owners in Newcastle by Zone*

Non-car owners	**Population**	**Percentage**	**Proportion**
Zone 1	11785	79%	0.8
Zone 2	85958	54%	0.5
Zone 3	39502	48%	0.5

However, those people who own a car are not necessarily dependant on it - there is an element of choice as to whether they use it or not; this element of choice is subjective. A further complication with the way car/alternative mode dependency is measured in this model is that it is not measured on a zonal basis, but on a trip basis: in other words it measures a proportion of trips constrained to go by car/alternative modes. Thus car dependency figures are crude and contain two features:

- they increase with length of trip (and implicitly with distance from the centre); and,
- they contain an element of modal choice which decreases with distance from the centre as alternative modes become less viable (or available) and as trip length increases.

As a result, certain further assumptions have to be made:

- data were not available linking income group to car ownership, so no distinction between either socio-economic group is made;
- that all journeys *originating* in a zone are tied to that zone's breakdown of journeys by car or alternative mode; and,
- overall, between 5% and 15% of journeys across the zones have an element of choice attached to them. The modal dependency figures are shown in the following table:

Table 4: Mode Dependency in Newcastle

	Zone 1	**Zone 2**	**Zone 3**
Alternative Mode Dependency	0.8	0.5	0.4
Car Dependency	0.05	0.4	0.55

From these calculations, total road traffic is defined as road share (by mode) multiplied by new flows in the system, and is thus calculated in the Powersim package. Once all relevant parameters are in place a crude cost function can be defined:

$$c_{ij}=a_{ij}+\lambda t_{ij}/s_{ij}(s_{ij}-t_{ij})$$

where,
c_{ij} = the perceived (mean) cost of travel from zone i to zone j [£ per trip]
a_{ij} = the fixed cost of travel (the cost of undelayed travel time, and fuel where car is used)
t_{ij} = the mean number of trips from i to j by all modes [trips per unit time]
s_{ij} = the mean maximum flow taking car dependency, mode and capacity into account [trips per unit time]
λ = the value of time [£ per unit time].

The cost function thus represents the *expected cost of delay* per road-based trip, based on the assumption that each origin-destination movement is a single server queue with random arrivals and random departures. As mean flow tends to zero, mean delay tends to zero; as mean flow tends to capacity, mean delay tends to infinity.

The importance of ***density*** has already been observed in measuring social and environmental characteristics such as overcrowding and car dependency. It also reflects the value of land. Cities below 30 people/ha. exhibit an exponential increase in car use (Newman *et al*, 1989). Zonal area and density for Newcastle is shown in Table 5:

Table 5: **Zonal Area and Density**

Zone	Area (m^2)	Area (ha)	Persons/ha
Zone 1	7,210,000m^2	721ha	20.7
Zone 2	38,120,000m^2	3,812ha	41
Zone 3	65,460,000m^2	6,546ha	12.5

Parking demand is measured by a shadow price mechanism. That is, the *value* of each parking space is measured, not its actual price. In other words the parking price is still paid, but the shadow price shows *willingness to pay* for that space. So, if demand for parking is greater than supply, the *value* of the parking space increases. The objective of creating this market for parking is so that the supply can be limited or increased in order to observe how various pricing policies affect the market. In the model zonal parking supply is one of the key variable factors. Newman *et al* (1989) suggest that city centres which restrict parking and provide incentives for public transport use and residential development, will be moving towards a less car dependent, human orientated future - that there is a trade-off between population and parking in terms of space utilisation. Parking controls are thus a necessary policy, but there must also be a concurrent policy of improvement to public transport, housing, cultural attractions, urban design, pedestrianisation and commercial activity, in order to allow the city centre to compete strongly with suburban areas where easy - and free - parking may be available.

Rental value is derived from the density of population, employment and retailing in each zone (determined as a function of available space in m^2) times a rate figure which is different for each sector (a residential rate, a retail rate and a business rate). Rents increase as density increases by a given rate, up to a certain point; a shadow price mechanism shows disutility of locating in a zone. Following on from this the cost of rent, is added to the *minimum expected cost of travel* in the model:

$$allocation = exp(-\beta(emincost + rate \times density))$$

A ***distance matrix*** is represented as part of the mode choice model. Traffic *internal* to Zones 2/3 is represented: it is assumed that 50% of trips will take place within those zones.

Table 6: **Fixed Costs and Public Transport Fares Within and Between Zones with Distance Defined**

TRIPS/ZONE	(1,1)	(1,2)	(1,3)	(2,1)	(2,2)	(2,3)	(3,1)	(3,2)	(3,3)
Fixed Costs (£)	1	2	3	2	1	2	3	2	1
Fare (£)	1	2	3	2	2	2	3	2	1
Distance (Miles)	**1**	**3**	**5**	**3**	**4**	**3**	**5**	**3**	**4**

Within the congestion sub-model the individuals' ***value of time*** is defined by socio-economic group. SEG 1 has a value of time of £15 per hour, SEG 2 a value of £8 per hour. Finally, ***road capacity*** values are given. These are derived from daily average vehicle flows over radial routes into Newcastle during March 1998 (Source:

Traffic and Accident Data Unit, Gateshead MBC). Road capacity is defined in the model as the point at which congestion occurs, therefore the average peak hour flows were the ones input into the simulation.

7.2. Running the Model

System dynamics is a useful tool for modelling policy options because of the ability to include easily adjusted parameters representing flexible behavioural data and policy preferences. Many of the previous assumptions are themselves subject to policy-led adjustment (such as rental rate and public transport fares), but for the purposes of this model they are assumed fixed in the short term. This section explains parameters which are to be subject to alteration in order to test possible policy combinations.

Parking Charge (increase): implemented in zone 1. This is set at £2 and is doubled after time period 300 (this is the dynamic element of the model; the time-scale is not defined, as the model is concerned with directions rather than magnitudes. The length of run therefore holds no implications for results).
Cordon Toll: a cordon toll is implemented for car journeys from zone 3 to zone 1 and from zone 2 to zone 1. This is set initially at zero, but is introduced after time period 300. The toll is set at £2.

The numerical inputs associated with the system dynamics constant variables are subject to alteration, in order to test different combinations and priorities. The combination of these inputs contribute to the calculation of the cost function, and thus perceived costs. Perceived costs, in turn, have a time period on time period effect on allocation of homes and jobs.

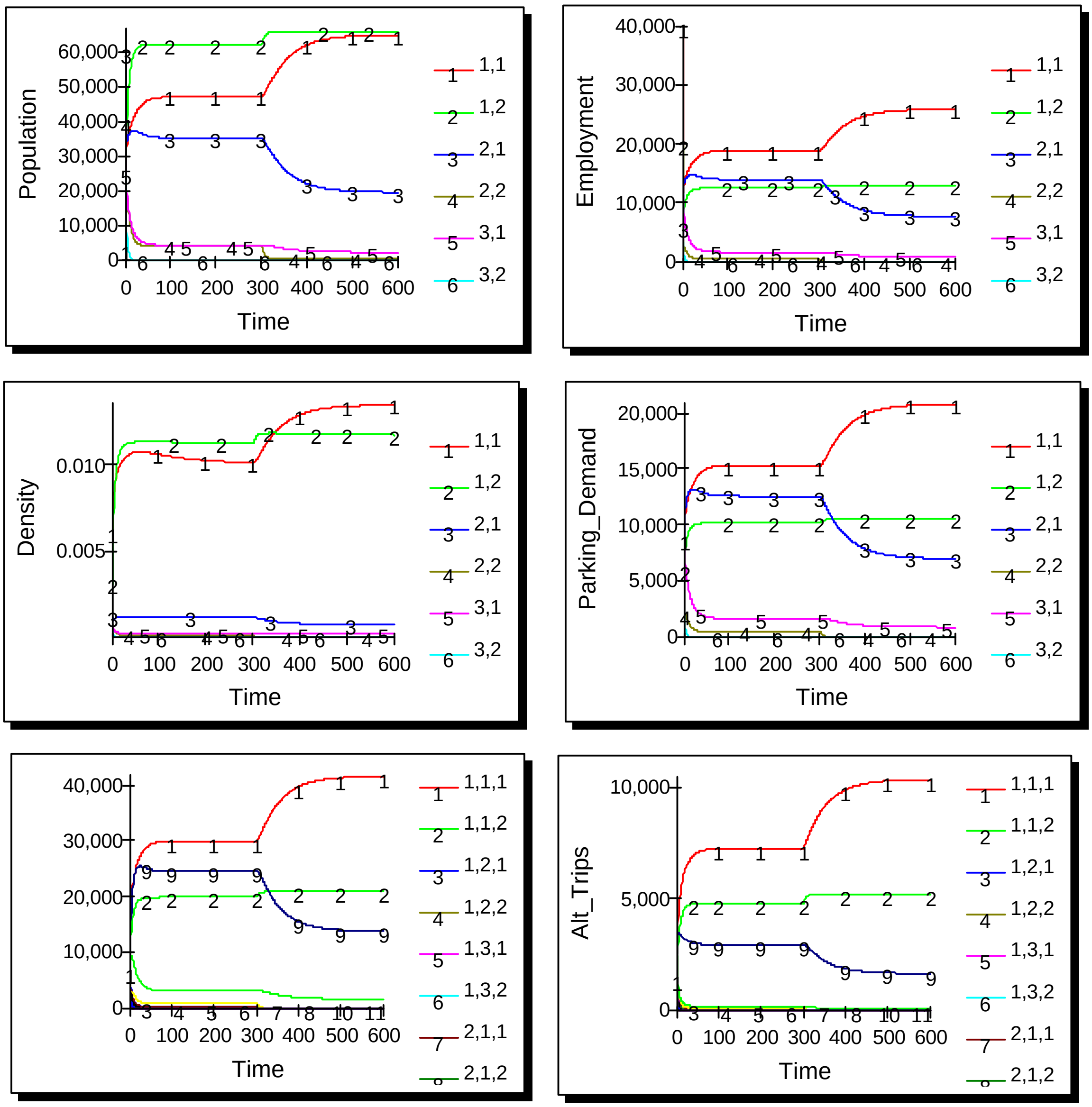

Figure 3: *Selected outputs from running the model (imposition of a cordon toll)*

7.3. Findings

Figure 3 (above) shows selected output from running the model with a cordon toll implemented. There is a recentralisation effect as a result of implementation of such a toll for entering the central urban zone after time period 300.

On the diagrams lines 1 and 2 represent the central zone (SEG1 and SEG2 respectively); lines 5 and 6 represent the outermost zone. Clearly population and employment are seen to increase in the central zone and decrease in zones 2 and 3. There is also an increase in density in the central zone. Parking demand in th e central zone is seen to increase following imposition of a toll.

The effects of increasing parking charges (not shown here) lead to a modal switch. Thus when the two policies are combined the centralising effect takes place, generating more trips by both modes (as shown in Figure 3); the parking charge increase leads to a subsequent shift in trips to the alternative mode. This reduces parking demand. The implication is that the activity concentrating effect reduces car dependency.

In a previous version of the model with two zones and two activities, Bell *et al* (1998) found that:

- imposition of a toll as a sole option has a concentrating effect on activities, but may increase road congestion in zone 1;
- doubling the parking charge as a sole option has no real concentrating effect, but decreases road congestion in zone 1;
- the two policies together concentrate activities and suppress road congestion in zone 1;
- both policies individually or in combination reduce total distance travelled by car, which would yield environmental benefits; and,
- total distance travelled (public and private) falls when a toll is imposed, due to its concentrating effect.

8 - COMMENT ON ASSUMPTIONS AND LIMITATIONS

System dynamics has little history of use in land use/transportation modelling. This model is not therefore presented as an immediate alternative to conventional models. It is simplistic in terms of its structure and assumptions and to a large extent is experimental. With additional modifications system dynamics could make a telling contribution to this type of modelling. Clearly more zones need to be defined and transport networks could be modelled. Testing of the model suggests the SEG aggregation is too narrow. Car dependency is an important variable, but it is necessary to refine its calculation - perhaps by a more micro-based piece of research using household travel diaries. It is already planned to enlarge this model to represent Tyne and Wear as a whole, incorporating the five major urban areas contained within (Newcastle, Sunderland, North and South Tyneside, Gateshead). However, the value of the model as it currently exists is in its representation of directional changes, and its illustaration of the scope of system dynamics in building in features often regarded as exogenous to more conventional models.

9 - CONCLUDING REMARKS

It appears that the fear that the imposition of cordon tolls and increased parking charges might increase the dispersal of activities, with corresponding repercussions for the vitality and viability of central urban areas, green belt development, energy useage and pollutant emissions, is dispelled. The results appear, in fact, to suggest the opposite effect with the most obvious outcome appearing to be a *re*-concentration of homes and jobs, and a reduction in travel distances with consequent reductions in energy use and emissions. This is clearly in line with thinking on sustainability in urban planning.

10 - ACKNOWLEDGEMENTS

Thanks go to EPSRC, who funded this research through the Sustainable Cities programme, and to Professor Patsy Healey, Professor Andy Gillespie and Neil Thorpe, who also participated.

11 - ENDNOTES

[1]The WCED definition for sustainable development is well known: to "meet the needs of the present without compromising the ability of future generations to meet their own needs".

12 - REFERENCES

BARKE, M. 1986, *Newcastle/Tyneside 1890-1980*. Ch.8 in Gordon, G., *Regional Cities in the UK 1890-1980*. Harper & Row Publishers, London

BARLOW, A.M. 1940 *Report of the Royal Commission on the Distribution of the Industrial Population*. HMSO

BELL, M.G.H. & EDWARDS, S.J.F.1998, *Controlling Dispersal Of Urban Activities Through Policies Designed To Increase The Cost Of Car Trips*. International Travel Demand Symposium

BRADLEY, M. 1995, *System Dynamics Modelling of Changes in Travel and Activities*. Paper in Eindhoven Activity Modelling Workshop

BUCHANAN, C.D. 1963. *Traffic In Towns. (Reports of the Steering Group and Working Group Appointed by the MOT)*. HMSO London

CHERRY, G.E. 1972, *Urban Change and Planning*. Alden Press

CHERRY, G.E. 1988, *Cities and Plans: the Shaping of Urban Britain in the Nineteenth and Twentieth Centuries*. Edward Arnold

CENSUS COUNTY REPORT 1991, *Tyne and Wear Part 1*. HMSO

CITY OF NEWCASTLE UPON TYNE 1993, *Unitary Development Plan*. Newcastle City Council

DETR 1998a, "*A New Deal For Transport: Better for Everyone", The Government's White Paper on the Future of Transport*

DETR 1998b, *Housing and Construction Statistics 1987-97 Great Britain*. DETR

DETR 1998c, *"Breaking the Logjam" The Government's Consultation paper on fighting Traffic Congestion and Pollution through road User and Workplace Parking Charges*. DETR, Dec 1998

DOE 1994, *DoE Planning Research Programme(1994), "Vital and Viable Town Centres: Meeting the Challenge"*. URBED/HMSO, London

GARIN, R.A. 1966, *A Matrix Formulation of the Lowry Model for Intra-Metropolitan Activity Location*. JAIP,32, pp361-364

GILLESPIE, A.G., HEALEY, P., ROBINS, K. 1996, *Movement and Mobility in the Post-Fordist City*, in Banister, D., *Transport Policy and the Environment*. Chapman and Hall

GREEN,H., DEACON,K., DOWN,D. 1998, *Housing in England 1996/97.* ONS/DETR

HOWARD, E. 1902, "*Garden Cities of Tomorrow"*. Faber and Faber

LOWRY, I.S. *Locational Parameters in the Pittsburgh Model Papers and Proceedings of Regional Science Association* 11 1963, pp145-165

MUMFORD, L. 1961, "*The City In History"*. Penguin

NEWMAN, P AND KENWORTHY, J.1989, *"Cities and Automobile Dependence, An International Sourcebook"*. Gower

OFFICE OF NATIONAL STATISTICS 1998, *Key Trends*. The Stationery Office, London

UNWIN, R. 1912, *"Nothing Gained By Overcrowding!"*

WILSON, A.G. 1974, *Urban and Regional Models in Geography and Planning.* Jn Wiley & Sons.

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT 1987, *"Our Common Future"*. OUP