Transport Games: The Need to Update Our View of Transport Models

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Abstract:

Transport modellers have made considerable steps forward in the development of theory and the incorporation of this theory into models. However, the transport profession still makes little use of them. This may result from a number of reasons: the lack of data, scepticism as to the reliability of the models and the lack of a user friendly environment. The lack of data can only be overcome through a commitment by politicians and the transport profession. The scepticism as to the reliability of the models should be encouraged in that models will never provide a perfect representation of the real world, however, it should not blind transport professionals to the real contribution models have made to planning. Recent developments in computer software provide considerable potential in developing a user friendly environment. The last decade has seen an increase in the community's acceptance of computers. This is primarily due to the development of procedures that remove the tedium from running computer software. Computer games, for instance, have made a considerable impact on the community. They are user friendly, interactive, dynamic, easy to learn, visually stimulating and educational. These dimensions need to be incorporated into transport models. This paper addresses the development of a land use/transport interaction model LAND. In particular it highlights the attempts being made to make this model as acceptable to the transport community as computer games are to the general community. The model is built within the Windows environment using Visual Basic. Visual Basic provides easy access to flexible input procedures, the extended memory capabilities of recent PC's and multi-tasking. The paper introduces LAND and its capabilities. It compares LAND with similar developments in other transport models

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Introduction

Transport models have been with us since transport was first considered: the dawn of time. The desire for improved transport was and still is formalised through peoples perception or model of the transport system. These models were first formalised into mathematical representations of the transport and urban system by mathematicians and transport planners. With the advent of computers in the 1950's the volume of data that could be manipulated increased and the complicated systems that characterise transport could be represented in ever increasing detail. The 1960's and early 70's saw an increase in the number and variety of models. These models were, however, the precinct of computer system engineers and were not readily available to the general public. The models were not used regularly by most transport planners. The late 70's and early 80's saw a decrease in the use of general planning models but continued use of parts of these packages for corridor planning and isolated intersection design. The late 80's and early 90's has seen an increase in interest in more general modelling procedures.

The 1980's and early 90's has seen an increase in the user-friendliness of computer software with developments in microcomputers and colour graphics (Young, Taylor and Gipps 1989). There has been increased use of computers for wordprocessing, data storage, data manipulation and spreadsheet analysis within the transport profession. Almost all transport professionals will have used one of these generic pieces of software. Further, transport planners children are increasingly using computer games and educational software. Even though most transport professionals have used generic software relatively few have used transport models. Transport models are still limited in there use because of a lack of data, scepticism as to the reliability of the models and the lack of a user friendly environment.

The *lack of data* can only be overcome through a commitment by politicians and the transport profession. There are encouraging signs that new data sources may soon be collected. However, given the present mood of cost recovery and user pays it may be some time before these data sources become generally available.

Scepticism as to the reliability of models should always be encouraged. Models will never provide a perfect representation of the real world and should be continually updated as new theories are validated and computer hardware and software improves. However, this scepticism should not blind transport professionals to the real contribution models can make to planning. In particular, it is the responsibility of modeller to develop models that are easy to use.

Recent developments in computer software provide considerable potential in developing a *user friendly environment*. This is primarily due to the development of procedures that remove the tedium from running computer software. Further, computer games have made a considerable impact on the community. They are user friendly, interactive, dynamic, easy to learn, visually stimulating and educational. There is a definite need to incorporate the attractive dimensions of computer games into transport software to encourage their use and to educate the profession in the complexities of the transport system. Some attempts have been made to use computer graphics and menu facilities (Young, Gipps and Taylor 1989). However, the transport research and model development professions obsession with getting the models right has limited the resources that have been allocated to making the models more useable. It is time to spend a little more effort on the user interface and a little less time on the model theory.

This paper outlines the initial formulation and directions of development of a Land Use/Transport Interaction model. The model will assist in the assessment of the impact of transport policy on urban development and greenhouse emissions. The model is called LAND (Figure 1) and is being developed as part of a series of models to study various aspects of transport. The series of models includes a microscopic simulation model of local areas (PARKSIM), a sub-regional model of transport impacts (McPARK/CENCIMM), a regional transport model (MONSTER) and the Land Use/Transport model (LAND).

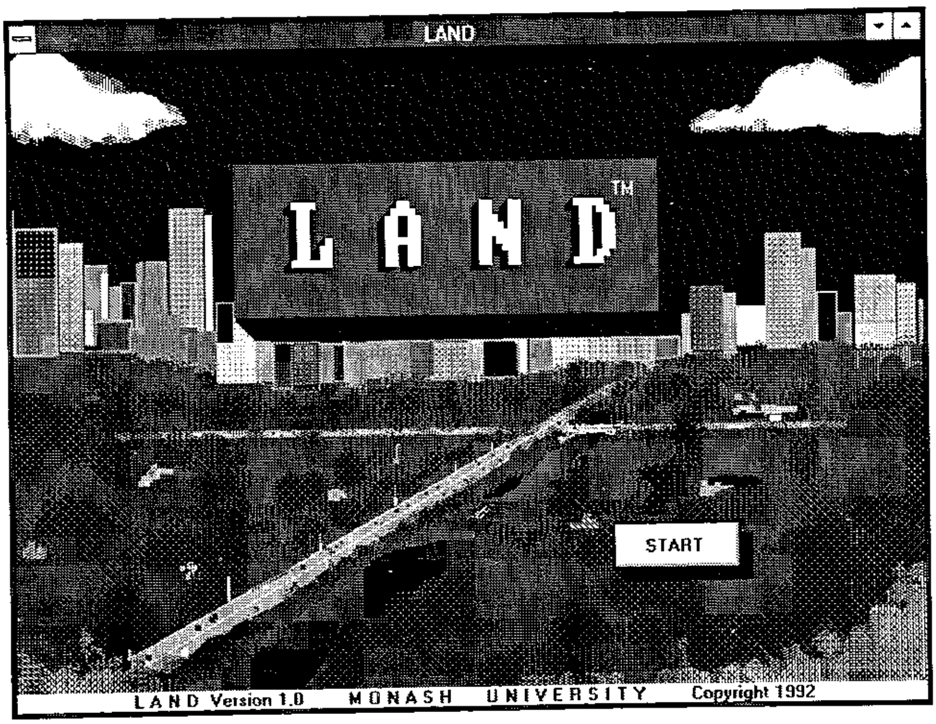

Figure 1 LAND face display

The needs of a game

The development of a high quality of user interface will allow access to transport models by more than just expert modellers. Politicians, managers, local pressure groups, university students, school children and many others will be able to investigate the impacts of transport strategies. To entice these people to use the models it will not only be necessary to develop a high quality user interface, it is necessary to take a new view of models: **the users view**. One approach that may assist in determining the requirement of this approach is the development of transport computer games. Computer games have a number of requirements.

Games require a high standard of user interface. They must allow people with all levels of education and ability access. The user interface should be visual, with an emphasis on colour and motion. Colour graphics displays should be used for data input and results presentation. As discussed above the opportunity to build this interface is now present. The tools have only to be used in an appropriate manner.

A major part of the games user interface is the provision of information about the system. This information can be provided by the good design of the system and the use of menus to guide the user through the model. On-line help should also be provided so that the user can obtain assistance directly upon request. Back up information in the form of a manual should be available.

Games must provide a challenge. The user of a game must be given the impression that they are testing themselves. Further, there is a competitive desire in many sections of our community to win, to beat the opposition, this desire must be catered for in a game. A game must therefore set a problem to be solved, objectives to be met and provide criteria which enable users to assess their performance and to compare it to others. Transport games may use as these criteria the minimisation of pollution, traffic noise, travel cost, fuel consumption etc. The user who could build a city minimising each of these could be pronounced the winner. Points could be allocated to each of the criteria chosen. There may also be a need to develop different levels of difficulty. The level of difficulty could be related to the speed of the system or the complexity of representation of the transport system components.

Games need to be interactive. The user should be able to change elements of the transport and land use systems quickly and easily

Games must provide an acceptable level of user input. Too much input will require the user to spend inordinate amounts of time inputting information. Too little would limit the ability of the model to carry out its tasks accurately. A fine balance is required. Good design of the user interface and the existence of icons allows a reduction in the input effort by the user. This option may allow a reasonable level of complexity in the user interface without increasing the workload of the user to an inordinate amount. When developing games that have a number of functions (eg entertainment, educational and/or planning) the level of user interface becomes particularly important. It may be necessary to develop the games with a number of levels of user input. The main level could be the direct interface with basic default values. A second level could allow the model assumptions to be varied. Other levels could be used to increase the complexity of the model, or allow the used to input more information.

A prime aim of a game is to provide entertainment. To allow people to while away the hours doing something they get satisfaction from. Although politicians and transport managers could use the games, the main market will be the young. This group does not have the political agendas and time restrictions of the politicians, rather they desire entertainment. Further, the opportunities for this group to be fulfilled by work are decreasing rapidly. Since the personal fulfilment associated with work is being removed from some members of the society alternate means of entertainment are required. Games could take on an important role in entertaining such people.

Importantly, from the transport professions point of view, we need to develop games that are educational. The level of understanding of the transport system and how it performs within the general community is guided by limited experience. The complexity of the system is therefore not often understood by all. Games could assist in providing users with this understanding. Children, for instance, could build transport systems and assess how they perform. Concentration on public transport provision could be contrasted with the use of private transport networks. The games could assist the community to understand the different roles of these two transport modes.

As discussed above games must be attractive to the user. They require a minimum of input, a user friendly environment and a challenge. They can be educational or just plain fun. LAND is not a pure game, it is being developed to employ the game concepts without loosing sight of its planning role and the flexibility to allow the user to develop a variety of planning scenarios.

The land program environment

Before considering the LAND model the environment used to develop the model will be discussed. LAND builds on a number of models that have been developed in the past. These models were MONSTER (Taylor 1988) and a version of the Lowry Model (1966). MONSTER was a traditional four step transport planning model developed for educational purposes. It was written in GWBASIC. The Lowry Model develops an interaction between population and employment (Daff 1973). It was written in FORTRAN. Neither of these models (MONSTER and LOWRY derivative) were up to present day developments in the theory and user environment. A considerable amount of theoretical development was required. Existing levels of expectation in the user environment require interactive editing, mouse facilities, pop up menus etc. The acceptance of the package therefore depends on creating such an environment. To facilitate these developments and to provide access to the full memory capabilities of the new PC's available, the LAND program was developed using Visual Basic and the Microsoft Windows environment.

Visual Basic provides an opportunity to use the multi-tasking, mouse and other advantages of the Windows environment. It builds on the developments in the Basic computer language while providing an opportunity to develop user-interfaces that are visually attractive and flexible.

The Microsoft Windows environment provides a number of advantages. It is window driven and the user can call up a number of accessories to print files, present data etc. It automatically provides access to the full memory capabilities of the new range of microcomputers (IBM-PC 386, IBM-PC 486 etc.) becoming available. It is mouse driven and therefore does not require the user to be familiar with tedious verbal operating system commands of MSDOS. Finally, Microsoft Windows allows multi-tasking and hence the opportunity to carry out a number of tasks at the same time. This is important since some transport models may take a long time to run. The user can carry out other tasks while waiting for the model to finish.

The Microsoft Windows environment and Visual Basic provide a mechanism for taking a new look at transport model's user interface. The interface has lagged behind theoretical development in models. This lag is primarily due to the enormous effort that was needed to develop this interface and the professions demand for reality in the representation of the transport and land use systems. Visual Basic allows a high standard of user interface to be developed rapidly. Modellers can still have the time to incorporate reality in their models. The remainder of the paper will discuss the LAND user interface and model.

The land user interface

The LAND program is controlled by a major menu (Figure 2). This menu allows the user to input the program windows that carry out each of the tasks. The major tasks are the run name input, network and land use input, the model, the outputs, opportunities to look at the network and on-line help.

The main inputs into the LAND model are the transport network (road and public transport) and the land use information (land use zones, houses, jobs and households). The user opens the model by providing an existing file name or a new name. The network input (Figure 3) is interactive asking the user to describe the position and type of links, intersections and travel generators. Both public and private transport networks can be described. The travel generators (Figure 4) can then be described in terms of the number of houses, number of jobs and the number of working households. This is the base information required to run the model. It is the minimum input required to provide a reasonable level of accuracy in the model.

The model itself relies on a series of base assumptions. These assumptions relate to the initial age structure of the population, birth rates, death rates, weighting given to the household/zone pairs, etc.

Leaving the input of these to the user could be tiresome and many users may not know typical values for these variables. Therefore the model reads base values for these parameters at the start of a run. Reliance on this base set of assumptions is, however, unrealistically restrictive. People attitude may change, baby booms may take place, recessions may occur from time to time. LAND, therefore offers the opportunity for the user to change these variables (Figure 5). This is carried out using a set up option. This option gives the user the flexibility to investigate a variety of scenarios.

Access to the model is again initiated by the use of a mouse command. Figure 6 shows the view presented while the model is running. The model form is initiated by a mouse command and can be run on a year by year basis of run over a particular period of time.

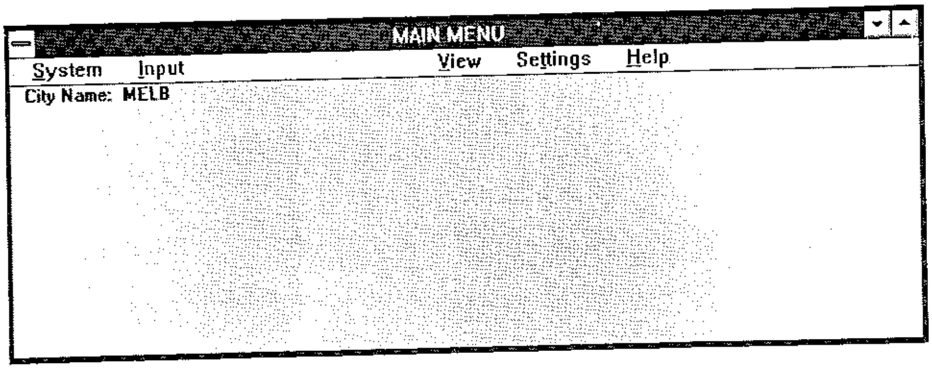

Figure 2 Main Menu Form

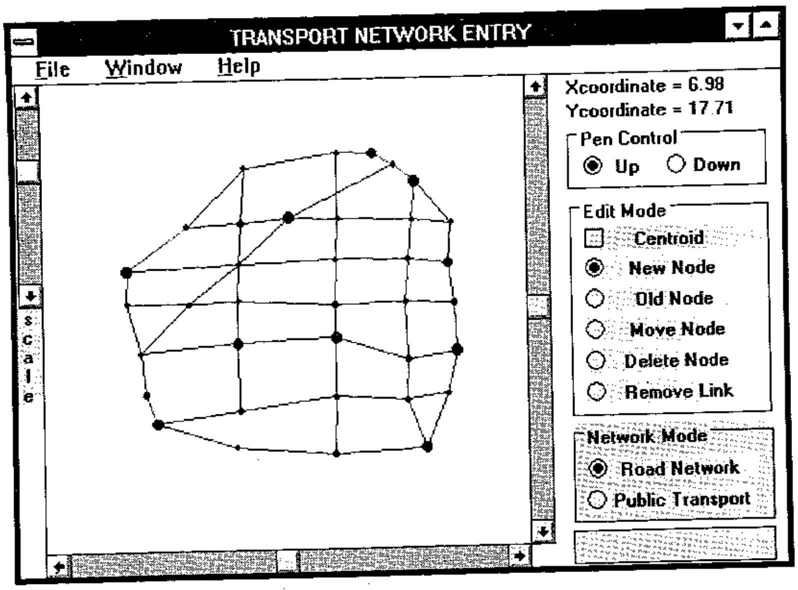

Figure 3 Network input

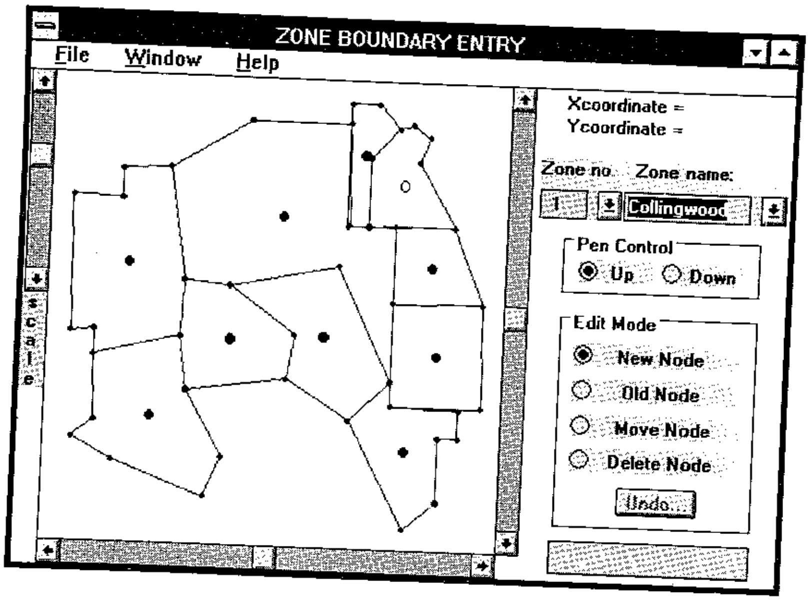

Figure 4a Land use boundary input

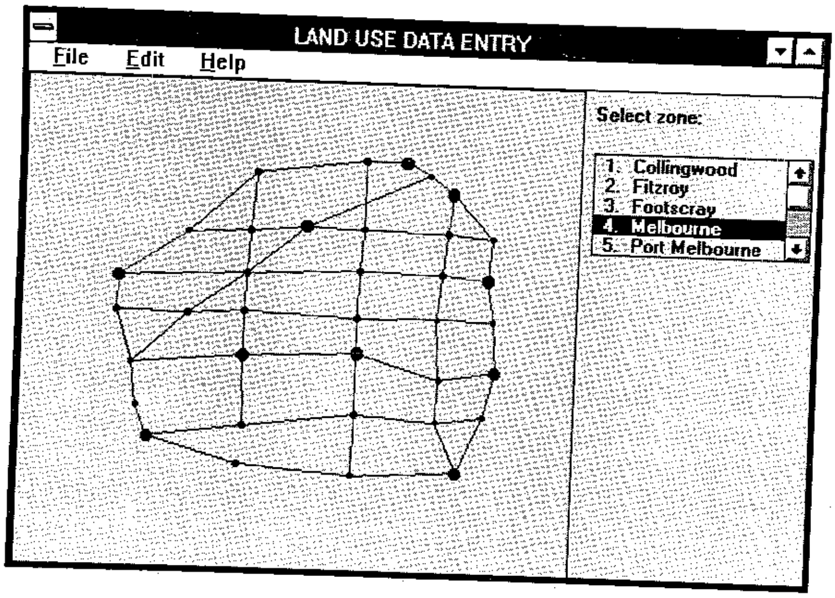

Figure 4b Land use data input

When the model is running the user can study the performance of the city. The user can request information on changes in the city in the form of graphs at any time during the run. Figure 7 shows a number of view that can be requested by the user. The views present information for the base year up to the year prior to the one the model is updating.

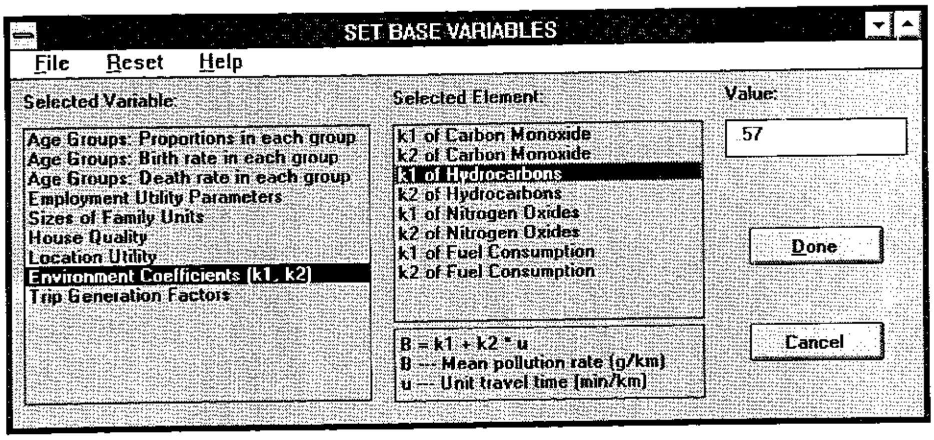

Figure 5 Set up variable changer

More specifically, the user interface allows the user to update and change the land use and transport system and for these changes to be read in at the end of each year. This is important to truly represent the developments that are taking place in a city. In terms of the land use system the user is able to change:

* the availability of housing The number and type of households can be specified and updated each year.
* the type of households. Households are broken down into three work categories, unemployed and retired households. These can be updated each year.
* the location of employment. The number of jobs located in each land use zone can be specified or updated each year.

The transport system can be changed in a variety of ways. The user will be able to:

* introduce new nodes (eg intersections) and centroids (eg trip origin or destination locations). The location of the nodes and centroids are located graphically using a screen arrow controlled by a mouse.

* delete and move nodes and centroids. Graphical procedures are again used to locate, move and delete the nodes and centroids
* create and delete links. The links are given a name (eg Taylor Street) so that the user can relate to them more easily. A description of the link is requested and can be specified by naming the link category (eg Freeway Link). The model automatically describes the category specified, such as free flow speed, saturation traffic flow etc.

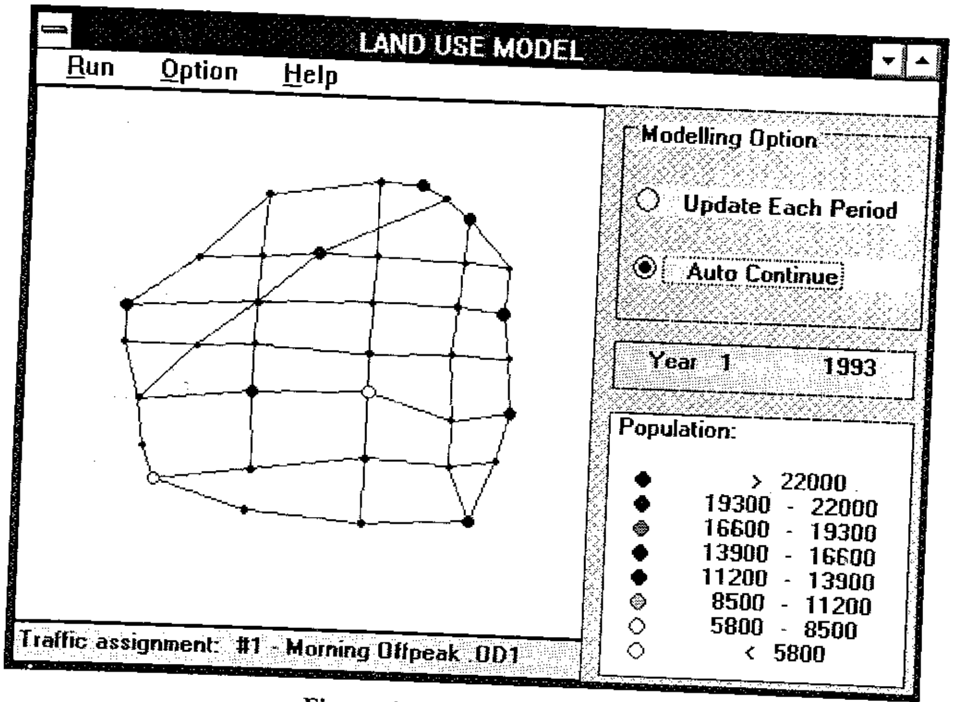

Figure 6 View of model running

These changes are relatively straightforward and are available in most advanced graphics input packages. The model will also allow the user to respecify some of the basic assumptions in the model. These will include:

* the initial age structure of the population,
* the birth and death rates in the population,
* the family composition characteristics,
* the household location choice parameters,
* the industry location choice parameters, and
* the housing stock characteristics

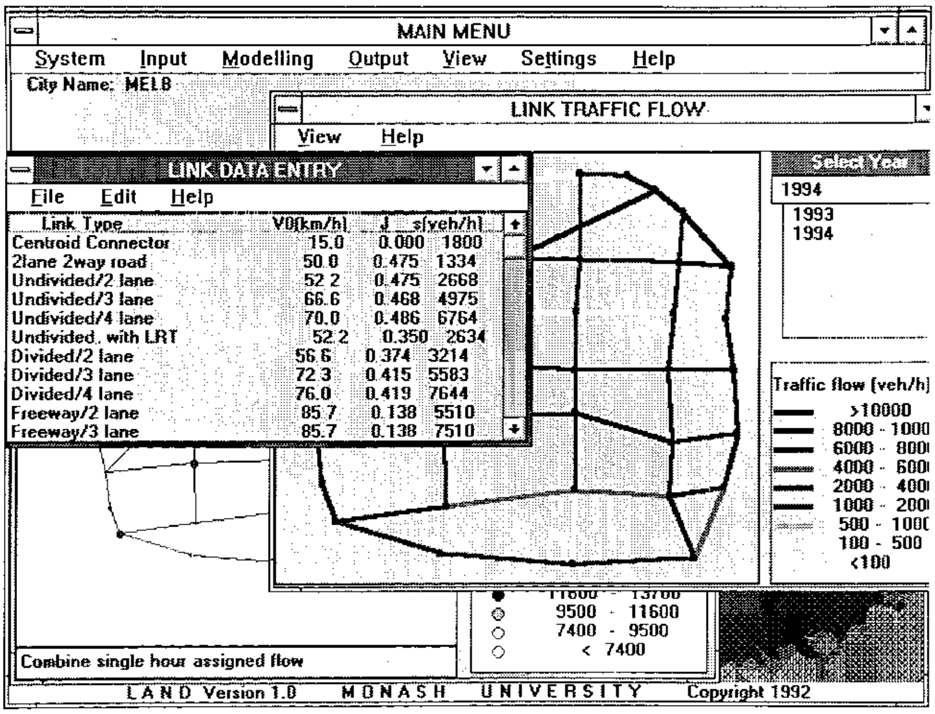

Figure 7 Multiple views indicating the progress of the model

The exogenous inputs into the model relate to the system boundaries. The in-migration or out-migration of population, changes in the type of houses available and the creation or removal of jobs can all be specified exogenously.

Outputs from the model are:

* Traffic flow on each link. This is presented on a spatial map of public and private transport
* Population distribution. This can be displayed over time (Figure 8) or can be looked at spatially
* Industry distribution. This can be looked at over time (Figure 8) or can be viewed spatially.
* Greenhouse emissions. These can be viewed over time for the entire urban area.
* Energy consumption. These can be viewed over time.

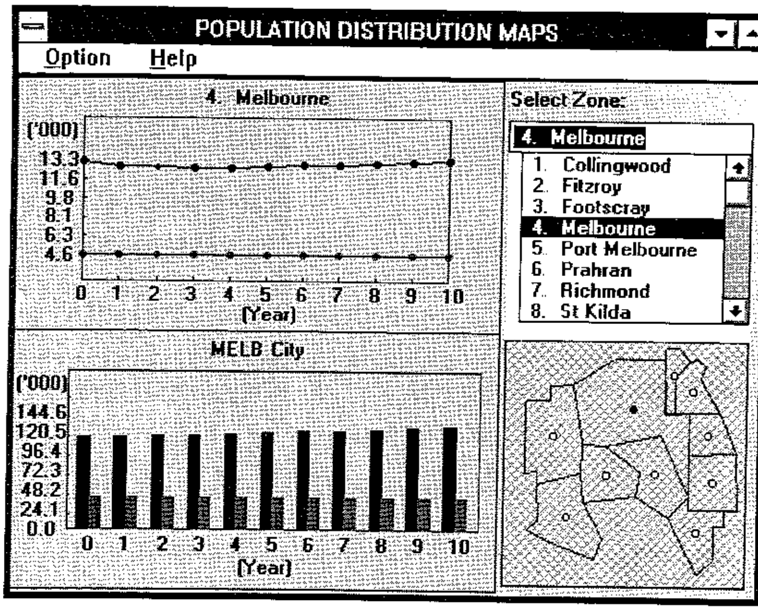

Figure 8 Population change information

The land model

A major development in the LAND package is the user interface. The model itself should, however, stand up to the scrutiny of the profession. This section will introduce the model. It will briefly review the literature then describe the model structure.

Literature review

There have been a number of major streams of development in the land use modelling area. Three general categories were discussed in Young (1982). The first class are used in studies of the spatial structure of cities. These studies range in theoretical content from simply descriptive models (Harris and Ullman 1945) to more complex theories of urban system (Alonso 1964). The second class typically concentrates on the strategic level of planning and works with large data bases. Many have become very complex, with numerous submodels each of which may require a considerable research and empirical effort. Several of these models owe their origins to the work of Lowry (1966). A major comparative study (Webster, Bly and Paulley 1988) of the performance on large urban land use models was carried out in the 1980's by the United Kingdom, Transport and Road Research Laboratory. The study came under the control of the International Study Group on Land Use Transport Interaction (ISGLUTI). The study provides some interesting finding and emphasised the impact of the initial theoretical assumptions on the model results. The final class of models arose from empirical analysis of urban phenomena and rely on equating the supply/demand process. These models include the implicit price approach (Ball 1973) and behavioural models (Lerman 1975). The LAND model is most like the second group but calls on developments in the other models to upgrade it to present levels of theoretical development.

Structure of LAND

Figure 9 presents the general structure of LAND. The structure of LAND revolves around a dynamic updating of urban and land use activities using a one year cycle. The model requests that the base year and transport network for the study be set up. The city can start with no development or a city that is at a particular stage of development can be input. The input of this data is a relatively straight-forward task, provided the information is available. The networks used in setting up the model during testing are a series of hypothetical networks and a course representation of Local Government Areas in Melbourne.

The model is based on the major decision making groups in urban areas. These are the household, businesses, developers, government bodies and governments. Not all bodies are considered in detail. The major detail relates to the household and businesses (employment). The developers are seen to cater for household need so measures of household needs are presented. The developer needs are input exogenously in the form of new housing and employment facilities. The public bodies are considered in a similar fashion. Measures of need will be provided and the user can update this information exogenously. The role of the government is one of controlling land availability. The more complex interaction, the government of the day meeting the demands of the particular interest groups, is not modelled.

The model first considers the household structure. Households are broken up into three stage in life cycle categories. A fourth household group, that of retirees, is also be considered. The age profile is updated simply by ageing the people and then considering the survival ratio. Households are then varied depending on the change in the age structure. There are a number of different household types used in the model.

The movement of households is considered in relation to workplaces. The households will be grouped as moving house, moving job, moving house and job and none of these. The number of moving households is updated by considering the general migration rate within urban areas. Migration into and out of the urban area is be input exogenously.

The number of movers and the household vacancies in the urban area are determined. Households are allocated to the vacancies in relation to the most favourable location. The most favourable location for employment based households is determined on an accessibility to employment. The accessibility to retail activities is used for non-employment based households. The impedance functions are related to the general traffic flow and travel time patterns throughout the urban area.

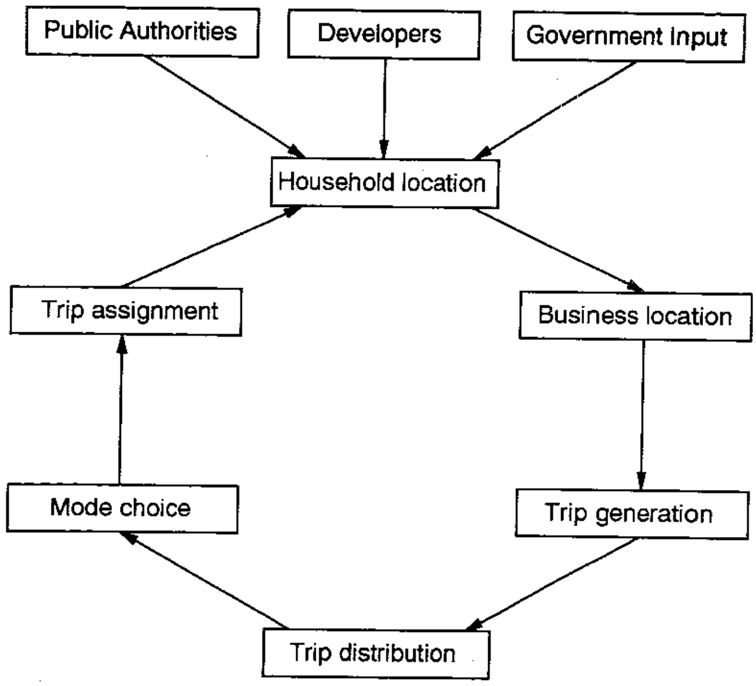

Figure 9 General Structure of LAND

Businesses is considered in a similar fashion to households. Businesses fail or move and new businesses consider the options available. The consideration of the best location will be accessibility to markets and work-force.

The resultant land use pattern (households and employment) is used as a basis for the determination of travel patterns. The travel stage is determined using trip generation, distribution, mode choice and assignment. The assigned network is then used to determine travel times in the urban area which in turn impact location decisions.

After the travel patterns are determined the environmental impact of the transport system on greenhouse emission can be calculated.

Once the new transport demand has been allocated to the network the model provides the option of moving on to the next year.

The process of population location and travel demand estimation can continue for a designated period (eg. 10 years, 20 years etc.). However, it can be interrupted and changes made to the system at the end of each year.

Conclusions

This paper has introduced the need to consider the development of transport models that can be used easily by all members of society. These models can assist in planning as well as educating the community to the complexities of the transport system. They also have an entertainment role. It should, however, be emphasised that no model is ever complete. It can be developed to a stage where it can be used. Refinement of the model assumptions, structure and user interface are required regularly to ensure it keeps pace with the needs of the user. This requires discussion, interaction with the user community and financial support.

The gaming environment set up in the LAND program allows the user to vary the transport systems and assess what would happen. The Questions to be asked of such a model are many and the model can be used in a number of different ways. Possibly the most important addition to the planning profession offered by the gaming approach is the answer to the question "What will it take to ....?"

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References

Alonso, W (1966) *Location and Land Use* Harvard University Press, Cambridge, Massachusetts.

Ball, M J (1973) Recent empirical work on the determinants of relative house prices. *Urban Studies*, 14, 213-33.

Daff, M (1973) The application of the Lowry Model to Melbourne. *Master of Engineering Science Thesis*, Department of Civil Engineering, Monash University.

Harris, C D and Ullman, E L (1945) The nature of cities. *Annuls of the American Academy of Political and Social Sciences*.

Lerman, S R (1975) Location, housing, automobile ownership, and the mode to work: A joint choice model. *Transportation Research Record 610*, Washington D.C.

Lowry, I S (1966) *A Model of Metropolis*. Rand Corporation: Santa Monica

Taylor, M A P (1988) Computer modelling of transport networks: recent advances in the use of PC's. *Proc Third International Conference on Computing in Civil Engineering* 2, 755-62.

TRB (1990) Transportation, urban form and the environment. *Special Report 231, Transportation Research Board*, Washington, D.C.

Webster, F V, Bly, P H and Paulley, N J (1988) *Urban Land-use and Transport Interaction*. Gower Publishing Group: Aldershot.

Young, W, Taylor, M A P and Gipps, P G (1989) *Microcomputer in Traffic Engineering*. Research Studies Press: Taunton, England.

Young, W (1982) The development of and elimination-by-aspects model of residential location choice. *Doctorate Dissertation*, Department of Civil Engineering, Monash University.