Meeting User Needs in Transport Modelling - Some Personal Observations

Glen D'Este

Senior Research Fellow
Centre for Transport Policy Analysis
University of Wollongong

Abstract:

Models of transport systems have a reputation of being incomprehensible black boxes that consume vast amounts of money and resources and produce mountains of printout in a largely unintelligible form. Modelling has largely been the province of the expert researcher and, in many cases, users have been excluded from the development, operation and interpretation of the model.

This paper examines the relationship between researchers and users of models in the transport environment and addresses the following issues:

- what is a model and why develop models
- what are the user's needs and expectations
- are these needs and expectations being met
- what is the future of modelling

Contact author:

Dr G D'Este
Centre for Transport Policy Analysis
University of Wollongong
P O Box 1144
WOLLONGONG NSW 2500

Telephone (042) 213224 Fax: (042) 264257

Introduction

Modelling is often viewed as an esoteric art with limited application in real-world transport enterprises. This is a very narrow view of both the scope of modelling and its relevance to transport management and operations. This paper presents some personal observations on transport modelling with an emphasis on the assessing the current state of play from a user perspective.

There have been many reviews of transport modelling - for a summary of the Australian experience see Newton and Taylor (1985) and Newton et al (1988) - but most studies have focussed on technical aspects rather than on the needs and expectations of the user. In particular, reviews have tended to focus on one or both of the following aspects :

1. technical discussions of particular models or group of models; with or without discussions of applications of the model;
2. information on available models, perhaps with some comparative analysis and evaluation of relative performance

However it is also important to consider what areas are not being adequately addressed and to assess how well researchers are responding to the needs of users. In this paper, I have attempted to take a step back from the technical world of modelling and examine some of the simpler yet more fundamental issues such as the need for modelling in the first place, the needs of users, whether they are being met, and where we go from here.

Transport Modelling

What is a model?

It is very difficult to develop a definition that succinctly encompasses all of the possible manifestations of the concept of a model. In essence, a model is a representation of the principal elements of something. This representation may be in purely conceptual terms or it may be implemented as a miniature, as a set of mathematical relationships, as a computer program, or in a mixture of mediums. A unifying feature is the aim to extract the essential characteristics and represent them in a way that easier to handle and/or understand

In general, any model that can be handled without the use of computers is of academic interest but is probably too esoteric and/or simplistic to be of practical value in real world situations. Bearing this is mind, a pragmatic definition of a model as seen by the user is :

"a model is a computer program that does more than just record and organise facts"

This is a negative definition, in the sense that it says what a model is not rather than what it is. The aim is to capture the sense of extending the facts through the use of behavioural relationships, without being unduly prescriptive. In general, the definition excludes data management systems - such as accounting packages, reservation systems, CAD/CAM and EDI - but will include modules that extend the raw data for the purposes of prediction or drawing conclusions. For example, a reservation system is not a model but a yield management module is. Similarly, plotting survey points does not involve modelling but surface rendering does.

What types of models are there?

In the transport sector, there are two principal categories of models :

1. Operational Models
   Models that focus on representing and improving the operational performance of a particular transport system. These models tend to be normative and oriented towards engineering applications and solutions, with little or no human element. Examples include scheduling, engineering design, performance optimisation etc.

2. Policy Models
   Models that focus on representing the behavioural dynamics of a particular transport system. These models tend to be positive in nature, oriented towards 'what-if' analysis, and dominated by the human element of the system. Examples include planning tools, market impact models, choice models, forecasting etc.

It is also useful to classify models on a second dimension according to their scope of use. A *personal* model is one that has been developed for the sole use of the development team (or a single individual); traditionally most models have fallen into this category. A *public* model has been developed for users that are not members of the original development team. Since this discussion concentrates on the user perspective, it is predominantly concerned with computerised models that have been made available for public use.

Why develop transport models?

This is a fundamental question that is asked all too infrequently. The simple answer is that in most transport situations it is impractical to conduct experiments, and the operational and/or physical dynamics of transport situations are usually too complex to rely on a purely mental picture of the system.

The classical scientific approach to investigating the response of a system to different conditions is to conduct an experiment. In transport we rarely have the luxury of being able to conduct an experiment so in most cases the best or indeed only way to evaluate the impact of planned changes is to construct a model. Further, a computerised model allows the user to manage and process large amounts of data and large numbers of relationships with a degree of thoroughness, consistency, accuracy and dispassion that is otherwise impossible.

The alternative to modelling is to use judgmental methods. There is no doubt that experts rely on extremely subtle mental models and can include certain types of influences - e.g. political and organisational factors - that cannot be satisfactorily included in a computer model. However even an expert can normally only take account of first-order effects. In many cases the scale is overwhelming and it is very difficult to keep track of the full gamut of second and third order effects, feedback effects and intricate interrelationships. This is where a computer model can be an invaluable tool. The two sides should be seen as complementary with the user and the computer model each doing what it does best; the computer model taking care of information processing and number crunching, and the user supplying the subtle judgement and making the decisions.

Users and their needs

Having established what a model is and satisfied ourselves that there is a role for modelling, the next step is look at modelling from the user perspective

Who are the users?

In this discussion, the term user will be used to refer to the ultimate end-users. That is transport operators and administrators who are the focal point of the application of the models to actual transport problems. Users will sometimes also be model developers but in general, the two groups are distinct. There are three main categories of potential users :

1. Operational Staff - those persons involved in the day-to-day operation of the transport enterprise,
2. Technical Experts - mostly engineers and planners, but also accountants and some administrators,
3. Management - senior executives, and other administrative staff who are not directly involved with operational matters.

What are the user's needs?

In general, employees in transport enterprises are like employees in any organisation; they want tools that will enable them to achieve more, in less time, with the same or less resources. Managers want to be manage efficiently and effectively which means not spending all of their time on routine or purely reactive tasks, and not making decisions on the basis of inadequate information.

Users want tools that process information in a way that aids and complements their own abilities, and makes their job easier. They do not want to give up the high level decision function and feel redundant or subservient to a machine, instead users want tools that feed the decision process in an accurate, timely, and economical fashion. In practical terms this means :

- easy to use and intuitive
- cheap to obtain and maintain

- generates results quickly
- sophisticated but not purporting to be too intelligent.

How then do these general requirements relate to transport modelling? Within these broad guidelines, the modelling needs of the three user groups are somewhat different

Operational Staff - need tools that are extremely easy to use and perform a specific repetitive task quickly and efficiently. The key characteristics are a small range of tasks, repetition of the same task with slight variations, real-time response and economy of input and output. The input and output must be simple but it cannot be assumed that the model itself will be simple The needs can be summarised as

Simple Input → [Sophisticated Model] → Simple Output

Technical Staff - need sophisticated tools for significant projects but a particular model might only be used once. The key characteristics are complexity, wide range of tasks, little repetition, fast but not necessarily immediate response, and detailed data input and output. The needs can be summarised as

Detailed Input → [Sophisticated Model] → Detailed Output

Management Staff - need tools that are extremely easy to use and perform a wide range of tasks quickly and efficiently The key characteristics are ease of use, flexibility, fast response, and economy of input and output. In many respects the needs of operational and management users are similar, and quite different from the needs of technical users.

What are the user's expectations?

Again this varies with the user type. Non-technical users generally know what they want but not how to translate these requirements into modelling terms In effect, operational and management users typically do not know what they want from transport modelling because they are unaware of what it is and what it can offer. In most cases it is only the technical staff that have any expectations of modelling and their expectations are generally high

Technical users want ever more sophisticated models, and want them to be quicker, cheaper and easier to use. The standard has been set by micro-computer software, such as spreadsheets, and as the computer-literacy of users increases so do their expectations of transport modelling software Although transport modelling software may never be as cheap as other packages due to the relatively small market and high development costs, users have every right to expect similar standards and performance.

Researchers should shoulder much of the blame for the lack of awareness of modelling amongst non-technical users In many cases useful techniques and models exist but the results of research are not being effectively communicated to non-technical users. There needs to be more emphasis placed on making the results of research accessible to a wider audience and on presenting it in a form that is directly relevant to the day-to-day needs of users.

Are these needs and expectations being met?

There is no simple answer to this question; the answer will depend on the category of user. Researchers appear to be meeting the needs of technical users but not of operational and management users

Researchers are themselves technical experts so it is not surprising that they have a rapport with technical staff within transport organisations. In addition it is not unusual for technical staff to move back and forth between public, private and academic sectors, and between being a model user and developer. As a result, researchers tend to be aware of the needs and expectations of technical users and direct their efforts in that direction. Further, technical users are more aware of the availability and potential contribution of modelling and are more likely to seek a modelling solution to their transport problems. Technical users expect ever more sophisticated models and processing power at their fingertips, and in general these expectations are being met

Conversely there are relatively few model developers who have worked on the operational side of transport, or have been transport executives in either the public or private sector. The opportunities for staff movement between these areas is limited compared to the technical areas Therefore researchers are less aware of the needs of operational and management users, and this is compounded by the low level of awareness of modelling amongst these user groups Further, applications in operations and management are generally less technically demanding and consequently tend to be of less interest to researchers There is more excitement and peer recognition in ground-breaking technical research than in applying standard techniques, no matter how important the application may be.

Thus specialisation and the compartmentalisation in the workplace, in conjunction with personal and other organisational factors, have tended to concentrate awareness and use of modelling into the technical areas The need for modelling in the operational and management areas is not fueled by user expectations so there is relatively little stimulus to expand the use of modelling in these areas In these areas it is especially important that the realisation and impetus come from the user, rather than have a system imposed upon them. For any modelling solution to be successful it must have the support of its users.

Changing Times

In the past, modelling has been a rather elitist realm populated by technical experts on both the development and user sides. This situation is unlikely to continue. There are many factors contributing to a likely widening of the scope and application of modelling concepts

Changes in the profile of users

Managers are becoming more computer literate and are developing a greater appreciation of the contribution that quantitative techniques can make to efficient and effective management. This results from a combination of computer technology becoming more accessible and easier to use, better education, and the rise of younger managers to positions of power and influence. In the past, managers have tended to use a largely intuitive approach and transport models have only been developed for the big projects. A management environment is emerging that is more receptive to transport modelling for a wide range of tasks.

The impact of computer technology has not been restricted to technical and management groups. Staff at all levels have become familiar with the use of computers and much of the mystic and apprehension has worn off. So much so that in many cases familiarity has bred contempt. Rather than being in awe of computer technology, many users - especially non-technical users - are frustrated that computer technology is not delivering more.

Technology

Changes in computer technology are another significant factor. The emergence of extremely powerful desktop computers will enable modelling to be more widely applied in the workplace. Increases in processing speed

- allow results to be obtained quicker, while enabling an increase in model realism and sophistication,
- enable the use of friendly user interfaces.

Thus models can be easier to use and can quickly produce usable results. In conjunction with significant decreases in the cost of computing, new technology is making desktop modelling a viable option for transport enterprises.

Software design

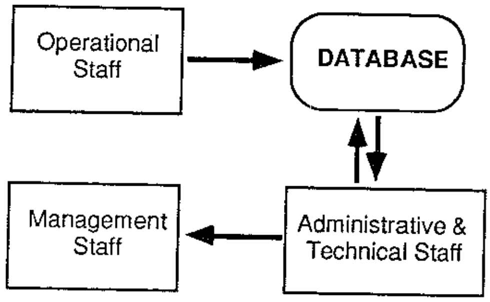
As noted above, increasing in processing power are making it possible to offer user-friendly software interfaces. There is plenty of evidence that when software is easy to use, users tend to make greater use of it, make fewer mistakes and overall have considerably higher productivity. Further there has been considerable research into the man-machine interface and software design. So there is no excuse for computer models being difficult to use or restricted to experts.

Unfortunately the design and implementation of a convenient interface takes as much and often considerably more time and effort than the development of the core application. This is a significant problem in the field of modelling. Most model developers view the model itself as the key element and focus of their interest, and a flashy user interface as a time-consuming luxury. However if modelling is to be taken to a wider audience, software design and the user interface are important issues. In many respects non-technical users demand a higher standard of software performance than do technical users.

Advances in networking and distributed processing also present an opportunity to extend the use of models and to integrate the model more closely with other computer systems in the transport enterprise.

Where to from here?

During the 80s, most transport enterprises computerised their operational areas but in many cases, this computerisation has not reduced the workload of staff directly involved in the movement of goods or people, nor has the full benefit filtered through to senior management. The benefit has accrued further down the line, particularly to accountants and other administrative staff. In most organisations the flow of data is currently as shown in the following diagram



It is now possible to collect and process vast amounts of data, but in most cases this data is not being converted into information that makes the day-to-day work of managers, policy makers and operators any easier. The challenge of the future is to convert data into information and put it to work at all levels of an organisation.

Modelling is a way of making these information resources work in a way that can benefit all categories of users. As noted above, the modelling needs and expectations of technical users are largely being met so the following discussion will concentrate on opportunities in the non-technical domain, and in particular on four areas; Executive Information Systems, knowledge-based systems, logistics and simulators

Executive Information Systems

An EIS is normally seen as a sophisticated software package that distills detailed business records into performance indicators at a summary level. The aim is to provide a management tool that is quick and easy to use, and allows executives to keep track of what is going on in their organisation. But an EIS can be much more. It can provide simple modelling capabilities, particularly in the areas of forecasting and what-if analysis.

The challenge for researchers is to simplify the operation of the models and to integrate them into the underlying database and EIS. This represents a change in direction for most researchers since it implies a move away from ever greater detail, and towards simplification even at the expense of comprehensiveness and accuracy. At an EIS level, the models can only be sketch planning models but the value of sketch planning models at a senior management and policy development level should not be underestimated. Researchers should be aiming for a hierarchy of models with a range of levels of detail and accuracy. The *Transport Planning Microscope* as described by Taylor (1989) is a good example of this approach

Knowledge-based Systems

A special type of model that appears to have considerable scope for application in the operational and management areas of transport is a knowledge-based system. According to ASTEC (1987),

> "Knowledge-based systems are computer programs derived from work in artificial intelligence (AI). Unlike conventional computer programs, knowledge-based systems process knowledge, not information. They are user friendly and are able to manipulate words and rules directly .... Knowledge-based systems encompass 'expert systems', intelligent manuals (programs based on written rules and procedures) and 'intelligent system managers' (programs which act as managers of complex processes seen in factory scheduling and production or in telephone networks) among others."

Therefore the objective of knowledge-based systems is to capture human knowledge and expertise, and in so doing replace, or at least reduce, the human input into a given task. However as stated by ASTEC, "... they deal with very narrow areas of knowledge ... (and) applications must be carefully chosen to fit the present limitations of the programs".

Knowledge-based systems can be applied to situations in which it is possible to define a consistent set of rules or procedures that are robust enough to apply in a wide range of circumstances, or subtle enough to adapt to changing conditions. There are many operational and engineering areas of transport that lie within this scope of applications, in particular, scheduling, routing and simple management and engineering tasks. Australian applications of knowledge-based systems in transport include :

- speed zone determination in Victoria,
- rating of funding proposals under the Victoria Traffic Management Services Program,
- preliminary bridge design,
- ambulance despatch in Adelaide
- estimation of car values by the NRMA

For a summary of the application of knowledge-based systems to transportation engineering in Australia see Hadgraft and Young (1988), and for an international perspective, see Ritchie and Harris (1987). The major applications for knowledge-based systems in transport are

- preliminary scanning of options on an intelligent basis, which includes diagnostic systems,
- intelligent checking of data for consistency, and
- facilitating consistency across a system.

The key is the identification and imposition of consistent rules. As a result, knowledge-based systems can take the contribution of computer systems one step further and relieve the user of more of the well-defined routine, preliminary or component tasks.

More of the mundane workload is then transferred to the computer system and the user is freed to work on higher-level tasks

So on an operational level, knowledge-based systems are likely to make a valuable and increasing contribution. However on a policy level, it is unlikely that they will make significant impact in the foreseeable for three main reasons :

1. current systems cannot deal with the complexity and subtlety of the policy formulation process and it is likely to be a long time before they can
2. it is difficult to define consistent rules, and many of the relationships are indistinct and tenuous The predominance of human influences and subtle value judgements make it very difficult to develop a robust policy development tool
3. it is unlikely that policy makers would be willing give up any of their own input into the policy In addition to the political and ethical issues, it would be extremely difficult to demonstrate and verify the success of a knowledge-based system in a policy environment.

The what-if type modelling that can be incorporated into an EIS is a more appropriate approach.

Logistics

One of the greatest transport challenges of the 90s is in freight logistics, that is, in making the most of the available transport opportunities and technologies, and taking an integrated view of the entire transport chain and cargo-handling. There appears to be a lack of good operational and management tools in this area. In modelling terms, this translates into an opportunity for the development of a user-friendly yet sophisticated micro-computer package for storing, analysing and modelling logistic chains

Freight transport, even at the technical area, is an area of modelling that has received relatively little attention from researchers. In part this is due to freight being a predominantly private enterprise operation As a result the amount of research funding has been small compared to that available for passenger transport, especially transit, and road design It is only natural that researchers tend to direct their efforts in areas in which funding is readily available. Over the past five years the Australian Government has recognised the importance of efficient freight operations so this situation is changing. In the 90s it is likely that the importance of research into freight operations will continue to grow and logistics and modelling will be at the forefront of this research.

Simulators

In a very real sense, these expensive and highly sophisticated machines are the ultimate in computer models. We are all familiar with flight simulators but there are many other current and potential applications; there are now shipping and driving simulators, and even container crane simulators. Simulators are basically a means of training operational staff and allowing them to hone their skills and experience a range operating conditions that would be impractical and/or too expensive to offer in any other way. Overall computers have not proven successful as a means of direct teaching, but simulators offer a more practical approach to machine-based training and testing, and can be fun for the user The introduction of computer-based testing of road rules and elementary driving skills in NSW is a small step in this direction

The most familiar simulators are designed for learning practical skills but there are also examples and opportunities in management and administration In these areas, simulations generally take the form of games that extend and test the user's ability to assimilate information, draw conclusions and make decisions There are many examples of simulation games in business, management and public policy but relatively few in transport The Australian Maritime College is experimenting with simulation games in shipping management but overall, the use of simulation games in transport is in its infancy With increases in the power and availability of micro-computers, there is scope to make greater use of models as powerful and enjoyable training tools.

Conclusions

Overall, it would be fair to say that researchers are attuned to the needs of technical users but have left non-technical users a long way behind In part this is due to a lack of effective communication between researchers and non-technical users

Researchers have already developed a formidable array of modelling tools that could have a significant impact on the management and operation of transport enterprises in Australia However in most cases the results of their research are not being effectively communicated to non-technical users or presented in a form that is directly relevant to the their day-to-day needs. Transport modellers need to place greater emphasis on translating their research into practical tools applicable in a commercial environment, and to making the results of their research accessible to a wider audience. For their part, most non-technical users are aware of their needs but are currently unaware of how these needs can be addressed using modelling tools

The main trend in transport modelling in the 90s will be a move from an elitist to an egalitarian approach to the application of modelling Aspects of this trend are summarised in the following Table

	The Past	The Future
Major User Group	"Experts"	All Categories
Application Type	Technical	Operational, Technical, Training & Policy
Task Orientation	Project	Ongoing
Task Size	Major studies	All Scales
Computer Technology	Mainframe	Desktop
Response	Slow	Real-time
Interface	Formidable Dumb	User-friendly Semi-intelligent
Overall Assessment	Elitist	Egalitarian

To a significant degree, the popularisation of modelling goes hand in hand with advances in computing technology. The emergence of extremely powerful desktop computers has made it possible to put sophisticated modelling tools in the hands of end-users. Modelling in the management and operational areas will be important growth areas in the 90s and four especially promising applications were singled out; EISs, knowledge-based systems, logistics and simulators.

In summary, the conclusion is that modelling can make a contribution to all facets of a transport enterprise and microcomputer technology is enabling this potential to be realised. Model developers should be looking outside the technical areas and applying their skills to the operational, policy and management areas of transport. The achievement of the 80s was to bring desktop modelling to engineers and planners, the challenge of the 90s is to do the same for managers and operators

References

ASTEC (1987) *Computerised Assistants New Tools for Society.* Australian Science and Technology Council, AGPS, Canberra

Hadgraft,R. and Young,W. (1988) *Knowledge-Based Systems in Civil Engineering.* Symposium Proceedings, Dept of Civil Engineering, Monash University.

Newton,P.W. and Taylor,M A P. (1985) *Microcomputers in Local Government Planning and Management.* Hargreen Publishing, Melbourne.

Newton,P.W , Taylor,M A P. and Sharpe,R. (1988) *Desktop Planning; Micro-computer Applications for Infrastructure and Services Planning and Management* Hargreen Publishing, Melbourne.

Ritchie, S J and Harris, R A (1987) *Expert systems in Transportation Engineering.* in "Expert Systems for Civil Engineers" (Edited by M.L. Maher), pp 129-143, American Society of Civil Engineers, New York

Taylor,M (1989) *The development of TPM A "microscope" for the transport planner* Proc. of the 14th Australasian Transport Research Forum, Perth, 205-225