System Dynamics Modelling and its Role in Policy Development and Implementation Within the New Zealand Health Sector

David Rees
Director: High Performance Learning Systems Ltd
PO Box 31-503 Milford, Auckland
Ph. 64-9-486-5330 Fax 64-9-486-5440
drees@hpls.co.nz

Paul Malpass
Senior Clinical Advisor: National Waiting Times Project
PO Box 1031 Hamilton
Ph. 64-7-213-234, Fax 64-9-123-4567
paul.malpass@hfa.govt.nz

In 1996 increasing public and professional concern about the length of waiting lists for health services within New Zealand led the Government to instigate significant policy changes. These changes required the health purchasing bodies (Regional Health Authorities) to replace waiting lists with booking systems for secondary services. $NZ130 million was allocated to assist the Regional Health Authorities in this implementation.

There was however, little common understanding amongst health professionals – managers and clinicians - of how a booking system would work and whether the funds allocated would achieve the government targets. A System Dynamics model was developed to assist health professionals understand the key operational dynamics of a booking system and the implications for purchasing patterns and clinical behaviour.

The first phase of the work, undertaken during 1996 and 1997, focused on educating health policy makers and purchasers about the dynamics of booking systems and the operational implications of various purchasing policies. The model highlighted a number of feedback loops within the structure of the booking system which severely limited the effect of increased expenditure. The results of this initial work was used to help refine government policy.

Since early 1998 the authors have been involved in implementing booking systems throughout the country. As part of this work we are now modelling, in more detail, the booking system to assist in unravelling more specific operational issues which are arising during the implementation process. The model development process is incorporating the input from approximately 50 health professionals throughout New Zealand.

The paper outlines the model building process, key findings and the role of both models in assisting health professionals close the gap between health policy and practice. It highlights the role that system dynamics modelling can play in educating

health professionals to improve understanding and co-operation between clinicians and managers in the implementation of new policy initiatives.

1. Introduction

The introduction of booking systems in New Zealand was one of the cornerstones of the Government's health reforms in the early 90s. A report to the National Advisory Committee on Core Health and Disability Support Services in July 1993 recommended:

"Waiting lists should be abandoned and replaced by a Booking System for non-urgent surgery and medical and diagnostic procedures."

Furthermore,

"Criteria should be developed for common non-urgent procedures to be provided 'within the core', based on the principle of patient need and the ability to benefit from the procedure. Patients who meet the criteria at specialist assessment should be booked (given a date) for the procedure, according to their priority within the criteria and the waiting time agreed to be with that priority level. Patients who do not meet the criteria should not be placed on a hospital waiting list, but should be referred back to their General Practitioner for on going follow-up, and referral for re-assessment as necessary."

In 1996 it was recognised that if a Booking System was to be implemented then the backlog of waiting cases needed to be managed. Thus it was that the Waiting Times Fund [initially $130 million] was created to reduce the backlogs of patient needing elective treatment. Although both providers and purchasers welcomed this extra financial resource, there were a number of significant tags associated with it. These tags essentially related to the implementation of the Booking System. Examples were establishing an interim financially sustainable threshold [FST]; introduction of prioritisation tools; marginal prices; and separate accounting and invoicing. Progress was slow with little evidence of true understanding as to what was necessary for a sustainable system. In fact the money was largely used to prop up base contracts which were under significant pressure from other budget demands.

Many people have had concerns about the Booking System concept; particularly questions have been raised by clinicians about the ethics of the introduction of such a system. Despite the limited understanding and concerns, booking systems were and are being introduced throughout the country in the midst of public and professional controversy. Furthermore, those involved in the implementing the Booking System are not completely sure how policy decisions around funding will affect the flow of people through the system. Our concern was, in 1997, that unless managed very carefully the investment of the $130 million would have no significant impact on the backlog of patients waiting for treatment. Our concern, in 1999, is that policies are being developed and decisions are being made in the hope of better service delivery but without a solid understanding of how the Booking system will perform.

This is not an indictment of the intent or the practice. The New Zealand Health sector is attempting to implement major changes that have not been implemented elsewhere and the efforts to date have raised the interest and praise of leading health professionals in the UK and Europe. Rather than an indictment it is a simple recognition of the complexity of what we are dealing with and the challenge we are faced with in continually increasing our understanding. But nobody felt that they had a clear mechanism to resolve these uncertainties. More specifically, those involved in the process wanted to gain a much better understanding of the implications of funding and purchasing decisions upon people being referred for elective treatment?

A System Dynamics model was proposed. It was described as a modelling process that could help capture the key dynamics of the system. A process that could assist health professionals gain a greater insight into the operational dynamics of the Booking System and the implications for purchasing and patterns of clinical behaviour. Work was begun on the initial model late in 1996.

2. The Model Building Process

In building our original model in 1997 we were faced with a situation where the idea was still largely conceptual and, with one or two exceptions, implementation had either not started or was still in the very early stages of development. Furthermore, there was no national consensus on what the key elements of a booking system were. There was very little expertise upon which we could draw and our challenge was to build a model that captured our best understanding of clinical behaviour and the key elements of a booking system.

Building the model in 1999 constituted a very different challenge. There was now a national consensus at the policy level and many examples of booking systems being implemented with varying degrees of success across the country. We now had available much more experience and data on which we could draw.

Because of these differing contexts our approach was different in each case. In 1997 the model was developed by a small group of health professionals from a mix of administrative and clinical backgrounds. We also had assistance in developing the model from Steve DeMello of High Performance Systems in the United States who worked with one of the authors in refining the model and overcoming specific technical challenges. There was no attempt to involve a larger group of health professionals in New Zealand. In 1999, whilst there was still a small core group the structure of the model was developed with input from over fifty health professionals. The core group, using data collected from across hospitals across the country did the enumeration. The involvement of the broader group of health professionals was facilitated by the use of a modified Delphi technique, based on work conducted by Jac Vennix within the Dutch health system (Jac Vennix, 1996). The steps in this process were:

- Development of high level conceptual model — Core Team
- Questionnaire response to conceptual model — 65 responses
- Literature review — Core Team
- Refinement of model — Core Team

- Refined model sent out for further feedback — 53 responses
- Model finalisation and enumeration — Core Team

3. The Focus of the Model Building

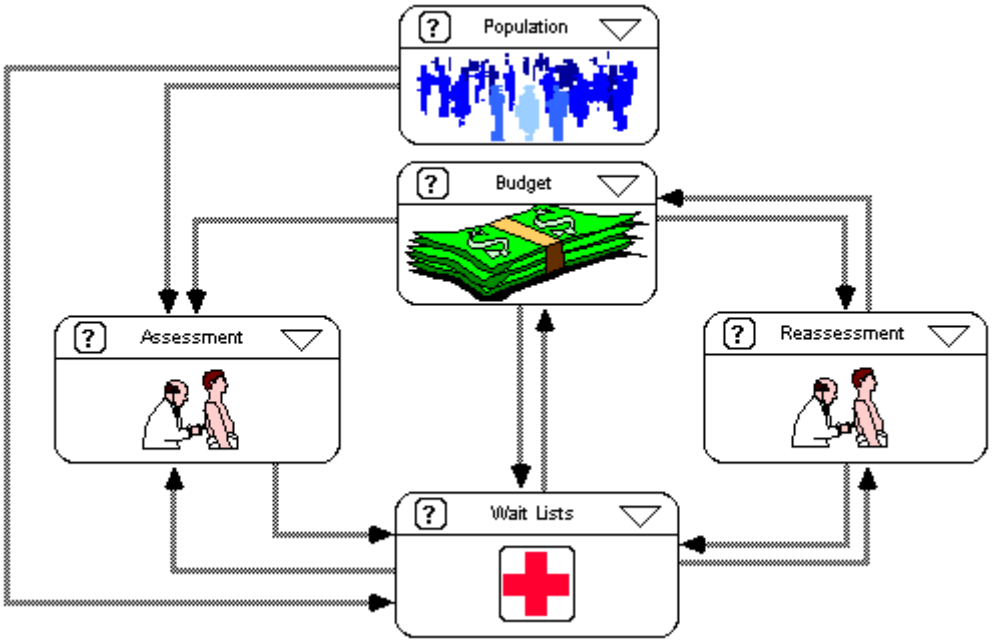
As well as process, purpose was also different in the two examples. In 1997 the purpose was to test two competing hypotheses. The first was that the best way to reduce the numbers waiting for elective treatment was to target expenditure on increasing the number of procedures. It was a simple, compelling hypothesis – increasing expenditure on treatments would reduce those waiting for treatment. The second hypothesis was that increased expenditure on treatment would have little if any impact on those waiting for treatment. The modelling task was therefore to test these hypotheses and in doing so explain the mechanisms that governed the underlying behaviours.

In 1999 the purpose is somewhat different. The concern is now more operational. With booking systems being implemented throughout the country the implementation team want to gain a better understanding about the impact of various policy decisions on core elements within the system. A major specific concern is the impact upon those who, although assessed as needing treatment, are not able to get it due to funding shortages. How is this group likely to grow or decline? Is it possible to reduce these numbers and by how much? How is the interface between public and private likely to influence these patterns. Although the questions are now more operational in nature both modelling tasks share a common educational purpose. In 1997 and in 1999 a major purpose of the model is to assist in increasing understanding of how that system is likely to perform under a range of conditions.

4. Results

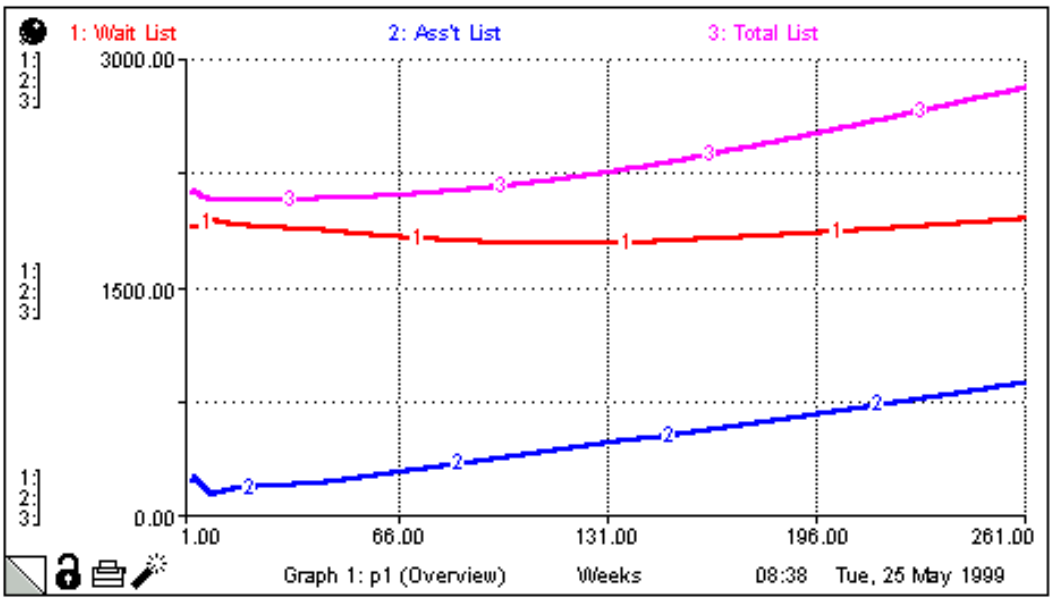
As with many System Dynamics modelling exercises the "results" are a mix of qualitative insights about the system and specific data depicted in table and graphical form. In terms of qualitative insight the first result was simply that of appreciation. At the beginning of the exercise the focus of discussions about booking systems was on the administrative process of booking a patient for treatment. Early on however we changed this perspective and developed a much more comprehensive map of booking systems. A high level map of the system is shown below:

Booking System
High Level Map (1997 version)



Key extensions of thinking illustrated in this map was the incorporation of the population – specifically research on the volume of visits to General Practitioners – and the inclusion of assessment and reassessment procedures. This high-level map broadened the scope of what a booking system was and highlighted the need to look at the broader system. Whilst one of the authors had, for a long time, promulgated this view it was not widely accepted. Once this perspective was accepted however the links within the system became important to understand. Of particular consequence was the link between treatments on the wait list and assessment. The model showed that they were intrinsically linked and focusing on one whilst ignoring the other was not an effective way of managing the system effectively. The following graph shows the default run of the model and highlights this particular point.

Simulation Results (Default Run)
Booking System Model 1997



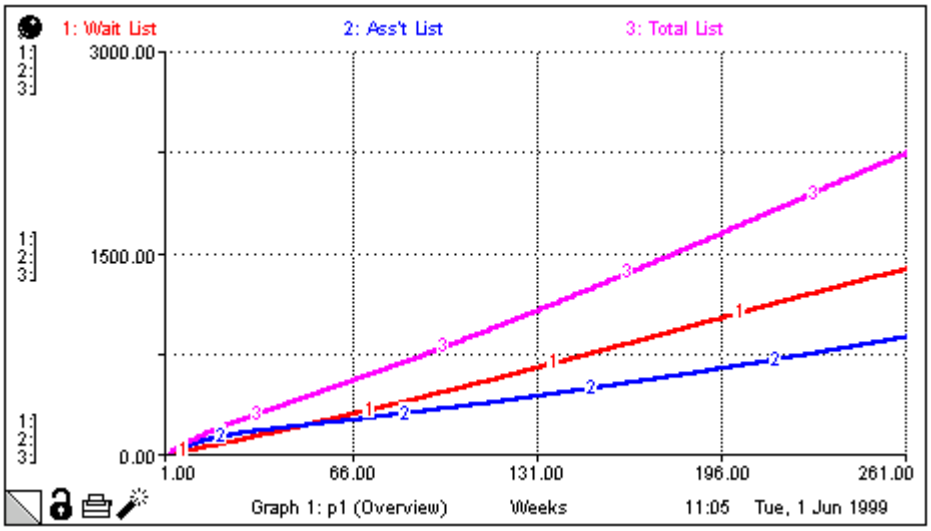
The key point to be made in regard to these figures is that whilst the numbers waiting for treatment (1) went down initially the total numbers increased (3). This is due to the large increase in those waiting for assessment (2). What the model highlighted, and which was not generally appreciated at the time was the intrinsic linkages between treatment and assessment. You cannot take action on one without it affecting the other. They are both part of a closely linked system. Thus we are faced with the paradoxical position that spending money on treatment can in fact increase the size of the Wait List. On the surface this seems a ludicrous position. However, when one appreciates that expenditure on treatment can reduce the number of opportunities for first assessment, due to the fact that clinics will be filled with those requiring follow-up assessments after treatment, a part of the paradox starts to become clear. This is typical of complex social systems and because it is typical should lead us to be more circumspect about predicting the success or failure of any significant social endeavour without true appreciation of its complexity. As Jay Forrester, states:

"There are fundamental reasons why people misjudge the behaviour of social systems. Orderly processes are at work in the creation of human judgement and intuition, which frequently lead people to wrong decisions when faced with complex and highly interacting systems. *Until we come to a much better understanding of social systems*, we should expect that attempts to develop corrective programs will continue to disappoint us." (Jay Forrester 1975) *[italics ours]*

It is this "better understanding" that the model and the model building process aimed to contribute to. Through better understanding we were able to test out a number of hypotheses in addition to the one that provided the initial focus. When confronted with the results shown above some argued that it would be different if there was no backlog of patients already in the system. If these could be eliminated then we would

see a very different pattern. The following graph shows the consequences of eliminating this backlog:

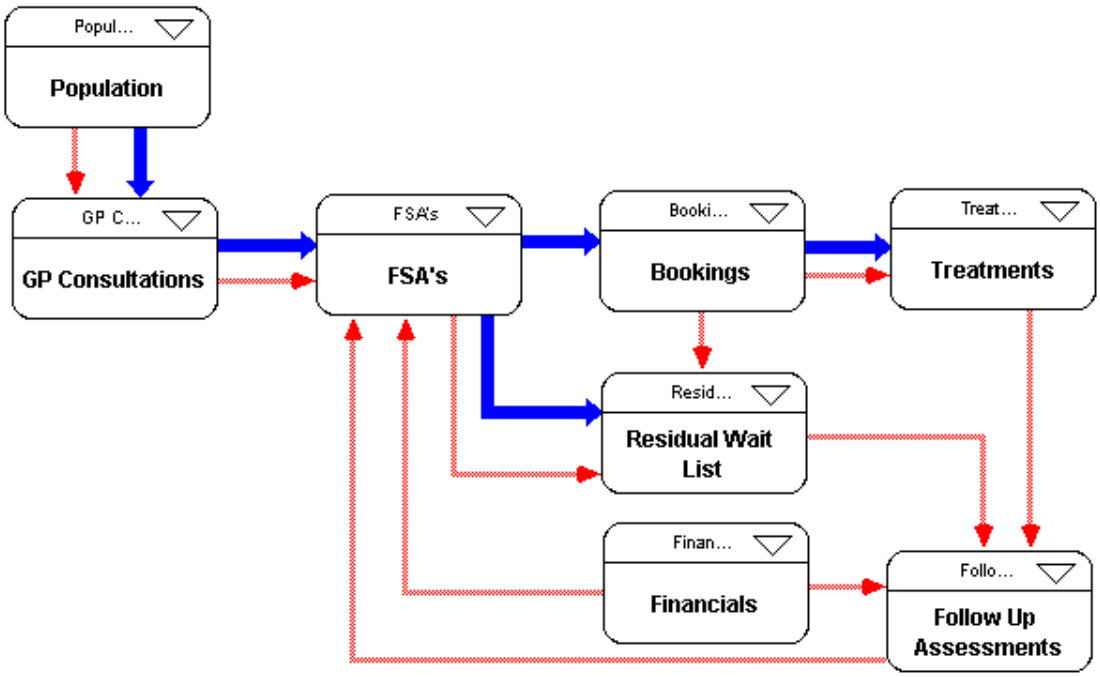
Simulation Results (With Backlog Eliminated)
Booking System Model 1997



These results show quite clearly that eliminating the backlog does little to overcome the problem. The system is such that the level of funding, including the increase is not sufficient, and that both treatments and assessment need to be considered before any approach is likely to be successful. Acknowledging that more treatments will increase the number of follow-up assessments and thereby decrease the number of spaces available for first assessments is key to understanding the dynamics of booking systems.

By making assumptions explicit, patterns of reasoning clearly visible, dynamic models provide a substantial step in the direction of better understanding. However, what needs to be understood changes over time and as mentioned above our current modeling efforts build on the work conducted in 1997 and is more detailed and operational. This is reflected in the high-level map used to structure and scope the system.

Booking System
High Level Map (1999 version)



The map is now more detailed, reflecting both the focus of the team and the level of understanding. It also reflects the success of the modeling process in capturing knowledge from across the field. Using a visual language that cuts across different professional boundaries one is able to map out the system and its linkages. Whether one is a doctor, nurse or administrator the nature of the modelling language enables you to share your insights. As a result we have the possibility then of mapping out the system in a way that, better than most, does in fact bring together the best information we have.

At this stage in our current model the results are hard to quantify. The structure of the model is largely complete and the process of enumeration is underway. Whilst increased understanding has taken place it is largely restricted to the core team and we have to ensure that all those who provided input to the model building process are given feedback and given the opportunity to challenge and explore the model.

It is unlikely that this time around we will produce the ”big shifts in thinking” We aree more into fine-tuning. Helping those who are already underway and informing the policy makers who set the direction and priorities.

We have however obtained a richer appreciation of the behavioural aspects that impact upon the system. We are also clearer about the feedback loops from specialists to GP’s. Furthermore our current attempts to populate the model with appropriate data is showing that much of the data being used to manage and report on performance does not stack up. Whereas in 1997 we had difficult obtaining data we now find in 1999 that some of the data available is questionable. The rigour of the modelling process is highlighting some interesting discrepancies. In modelling terms we are finding it difficult to match the inflows into treatment with the outflows. The

"ether" is still around and there are lots of people disappearing into it. At the time of writing these discrepancies have not been resolved, although they are currently being investigated. As a result we have to use some educated quesswork and hope that in the investigation and communication of the model the discrepancies will be highlighted and resolved.

5. Conclusions

There are a number of conclusions we would wish to draw from our work to date in terms of the model building process.

- Context is fundamental to deciding the process you need to follow. In 1997 there was limited knowledge and experience. In 1999 there are "experts" all across the country.
- High-level maps are very good at obtaining common ground in terms of the shape and scope of the system being studied. In 1997 the high-level map reframed what was considered to be the scope of booking systems.
- Attempts to enumerate the model quickly highlight any deficiencies in the data used to manage the system. In 1997 we found that there was no data available for some key variables that were crucial in determining the impact of increased expenditure i.e. referral rates from GP's to specialists. In 1999 we are finding that hospital data does not match nationally collected data and that in some cases our attempts to match inflows with outflows in the model are revealing discrepancies in the data. Things simply do not match up.
- Despite the complexities of the model and the language of stocks and flows, if given enough explanation, people are able to contribute through questionnaires. The technique does therefore provide a means of broadening the level of input into the model building process.

6. References

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