

# System Dynamics Modelling and its Role in the Development of the Booking System in New Zealand

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## Introduction

The introduction of booking systems in New Zealand was one of the cornerstones of 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 reassessment 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 need. 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.<sup>1</sup> 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 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 work.

This is not an indictment of the intent or the practice. How many of the really important and challenging things we do in life – whether in terms of government policy, clinical decisions or our own personal life choices – are made with full knowledge and total confidence? 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 how do we do this? More specifically, how do we increase our understanding about the implications of funding and purchasing decisions upon people being referred for elective treatment?

One way is to build a model. A model that captures the key dynamics of the system. A model that assists health professionals gain a greater insight

into the operational dynamics of the Booking System and the implications for purchasing and patterns of clinical behaviour.

## What is a Dynamic Model?

Dynamic computer models are caricatures of reality. They simplify the world in which we live, focusing on those aspects with which we are concerned. The result is that the model's weaknesses are transparent and the limitations glaringly obvious. However, the invisible models inside our minds are implicit and hidden from scrutiny. They form the basis of our decisions, yet are not often open for debate and challenge. Despite their limitations, computer models, by making their assumptions explicit, by making their pattern of reasoning clearly visible, provide a step in the direction of better understanding. And, if we are to behave in an ethical manner, surely one of the pre-conditions is understanding. To paraphrase the well known legal dictum, 'ignorance is no defence against unethical behaviour.'

A useful analogy in looking at the use of computer models in policy development and implementation is that of the flight simulator. No pilot is allowed near a plane, let alone one filled with passengers, until he has shown he can fly a 'model' of the plane under a variety of conditions. Using the model he learns how the real plane will perform. Using the model the pilot also learns about how he performs under a variety of conditions. This also applies to the aircraft designer. Great pilots do not like flying bad planes and no plane is built without extensive model development. Playing with models gives designers and pilots insight into how the real plane will perform.

Computing power and recent software developments mean that we now have the capability to build our own 'flight simulators'. On the one hand these could be clinical models –

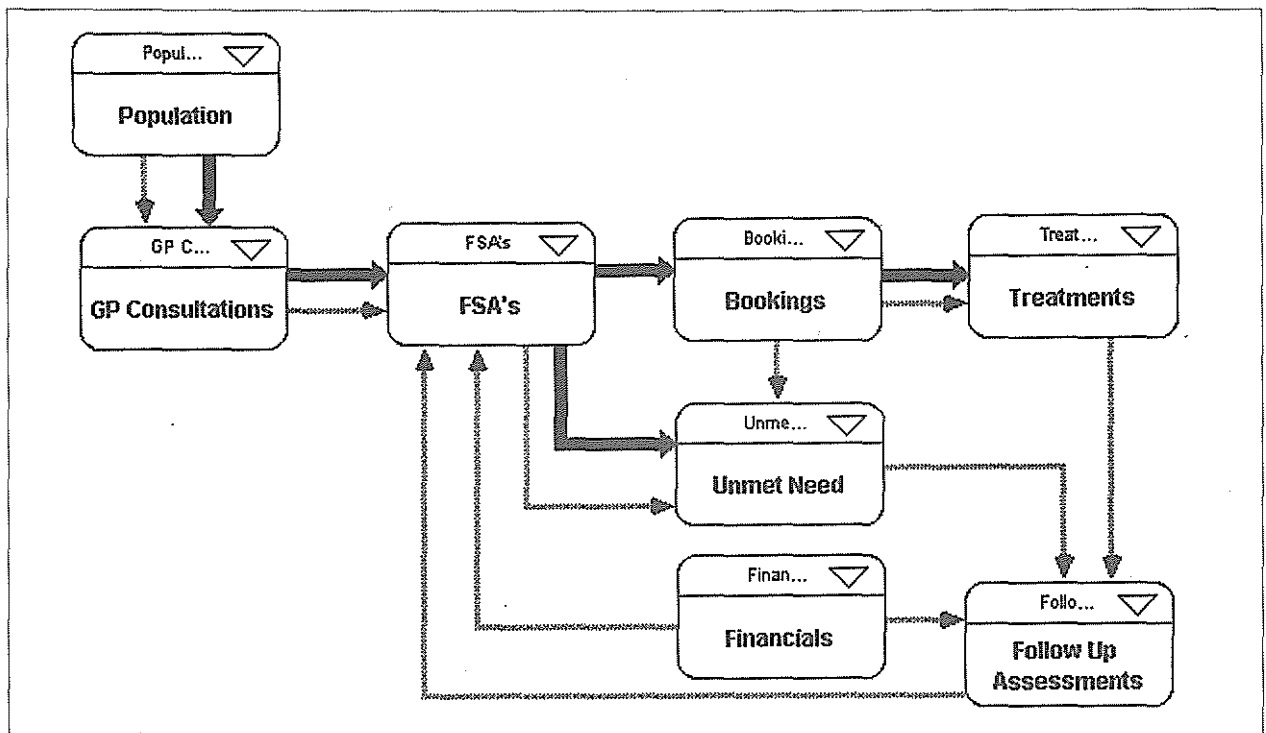


Fig 1: Booking system high-level map.

simple models of the four-chambered human heart constructed to highlight how it responds to changes in blood demand and disease – designed to educate students or, as in the above example, designed to test the performance of a pacemaker. On the other hand they could be management models – models that capture key aspects of the system providing an explicit description of what is involved and a tool to test its performance un-

der a variety of conditions. The Booking System Model is one of the latter types and at its highest level of aggregation involves at least 8 key elements, as shown in the above diagram.

We can observe a small glimpse of the complexity of the system from this high-level perspective. Agree with our map or not, at least you are aware of what we, and those who have been involved in constructing the model, consider to be the main aspects of the

system. We now can be open to challenge. At the next level down we begin to see some of the actual operational detail that makes up a Booking System. In the example below we have extracted some details from the model that looks at First Specialist Assessment (FSA).

Thus, in the model so far, the number of people waiting for first specialist assessment (FSA) is affected by two main factors: referral rates to the spe-

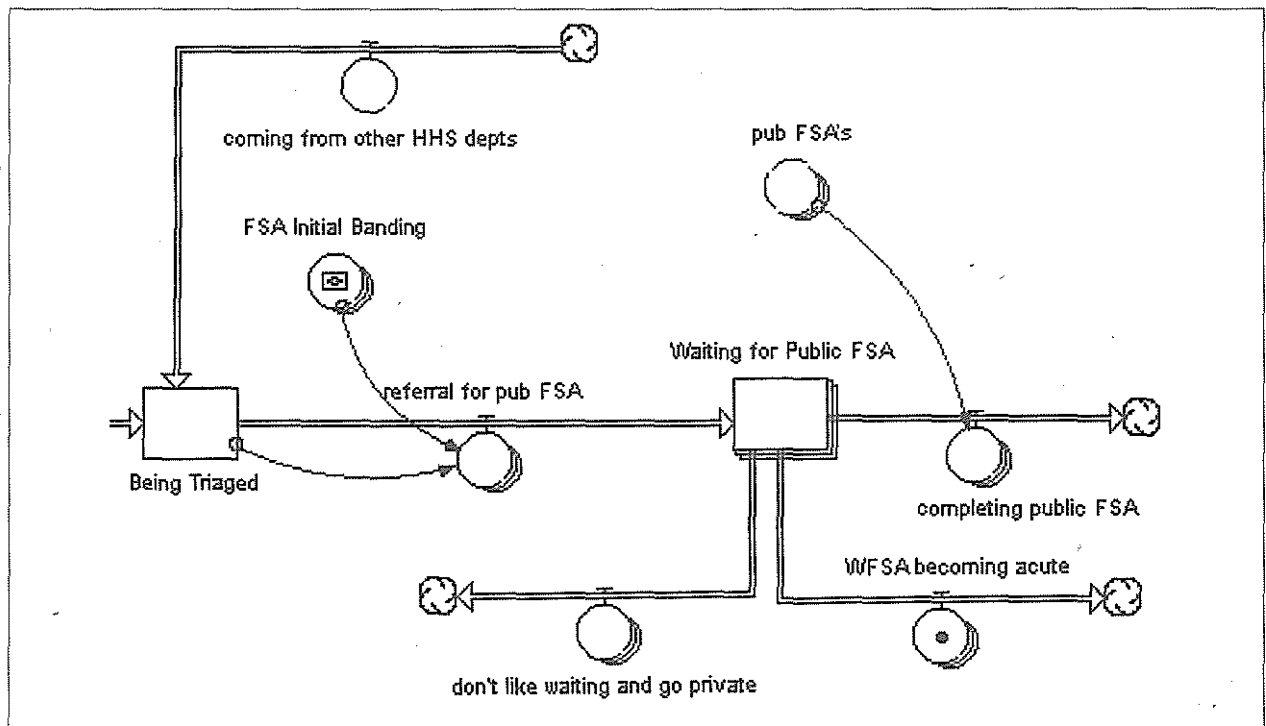


Fig 2: Extract from booking system model.

cialist service which are essentially from other hospital departments and GPs. Secondly, the outflow, which is basically the completion of the FSA. This latter factor may in turn be influenced by such patient events as: becoming acute; dying; moving out of the area; going private; etc. It is this web of complexities and relationships that the model is attempting to capture. (In the model depicted, for simplicity, only four patient factors are included.)

The value of such models is that they provide a means of capturing the best knowledge of professionals in 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.<sup>2</sup>

A second benefit is the ability it provides to test out how the system will behave. So, in our original work we tested out the impact of the increased funding. The result, as shown in the following graph, was not what the policy expected.

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, 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, unless that also obtains increased funding, 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, the distinguished MIT professor, 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.*<sup>3</sup> [italics ours]

It is this ability to explore the whole system and its linkages that makes modelling such a powerful tool in supporting our attempts at greater understanding.

### The Model Building Process

One of the criticisms of some models is that they can become 'black boxes' in which the logic of the model builder

is hidden. To overcome this we have taken great pains to involve a large number of health professionals in the building of our current model. This stands in stark contrast to our first endeavours, which involved a small group of five. Using the Delphi technique we have involved over 50 health professionals to input their understanding into our model building process.<sup>4</sup> The steps involved were:

- A small group of people came together to develop a highly simplified conceptual model. The aim was to capture the key elements and provide a mechanism to obtain feedback.
- This simplified conceptual model was sent out to over 100 health professionals. Replies were received from 61. The model was sent out in a questionnaire form asking for feedback. Given the complexity of the task and the fact that we were asking people to respond to a visual map using a language with which most would be unfamiliar, we provided an introduction that worked through some examples to illustrate the modelling language. The fact that we achieved over a 50% response was pleasing given the size and difficulty of the task. How difficult it was for the respondents is illustrated overleaf.
- In parallel with sending out the questionnaire we conducted a review of the literature.
- We further developed our conceptual model based on the feedback from the questionnaire and what we learned from the literature review.
- This refined model was sent out

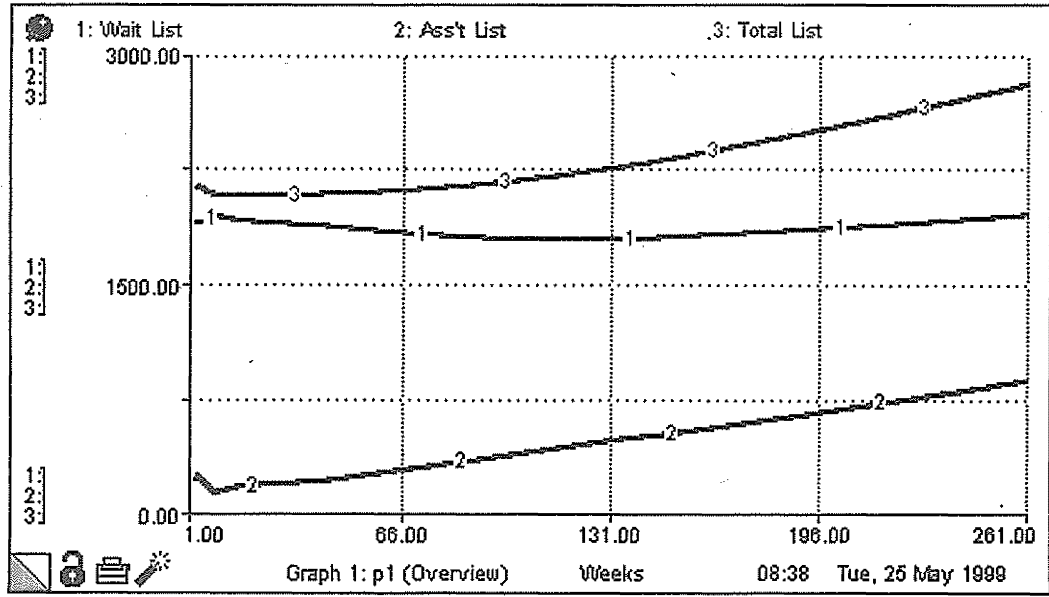
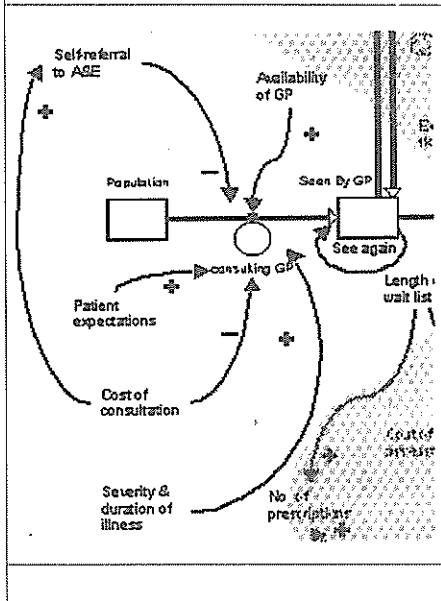


Fig 3: Simulation results (default run), booking system model 1997.

## SECTION 1: Consulting the General Practitioner



The part of the model that is relevant to this section is shown below. The questions in this section are concerned with gaining feedback on the factors that affect the number of people consulting their GPs. In part 1 we ask you to comment on those factors we have included in this preliminary model. At this stage they represent our early thinking and are clearly open to debate. Following that we ask you to add any other factors which you consider important and finally to list what you consider to be the three most important factors from those we have included and any of those you have added.

Extract from questionnaire.

- again to obtain further feedback.
- This feedback was then integrated into our thinking to develop the model to a stage where data could be incorporated into it for testing and exploring ideas about the behaviour of the Booking System under a variety of conditions.<sup>5</sup>
- It is then planned to hold a workshop with a number of health professionals to test the model and the implications it has for our understanding of how the Booking System will work.

### How will it Assist?

We believe that our current modelling will assist us initially by:

- providing a mechanism to elicit current understanding about the Booking System amongst health professionals;
- a means of communicating that understanding;
- providing a visual picture of the Booking System;
- establishing the boundaries of the system;
- clarifying the key elements;
- articulating the key linkages between these key elements.

Once populated with the necessary data it will allow us to:

- test out how the system would perform under a range of funding and purchasing scenarios;
- explore how changes in funding levels affect those on the Wait List;

- explore how much funding is required to close the gap between those who need treatment and those who are able to receive it and what the implications of that are.

Models such as the one we are building focus on trying to help us gain insight into how the system works. They are not designed to be predictive forecasting models. By using the model to explore the behaviour of the system we are better placed to make decisions that are more likely to give us the results we intend.

### What have we Learned?

In building our original model we became very clear about the danger of attempting to reduce waiting lists without understanding the processes around referral and specialist assessments. We also became aware of the fact that we could obtain very different results within the same bucket of money. Where and how the money was spent did produce different outcomes. We also learned that some of the most important variables that affect waiting lists are variables about which we have no data. For example, referral rates from GPs to specialists; percentage of FSAs requiring treatment; percentage of private FSAs that require treatment in the public sector. All these factors have a large impact upon the size of the Wait List yet are factors about which we know very little. In our current modelling, although still at the qualitative stage, we have learnt a lot more about the

behavioural aspects affecting the performance of the system and the links back from the booking procedure to ongoing review.

### Where to Next?

Our most important task is to complete the current model and focus our investigation on exploring how funding and purchasing decisions will affect the flow of patients throughout the whole system. As part of this we also wish to explore what is required if we wish to eliminate the Waiting Lists.

It is during this next stage that we will bring together those health professionals who helped us develop the model. We will use the model to look closely at Booking System performance. We hope not only to obtain a better understanding of how the Booking System is likely to perform under a variety of conditions but also to communicate this understanding, through the use of the model, to key health professionals.

It is this understanding that provides the core reason for undertaking the task. It is only through a better understanding of the Booking System, and health systems in general, that we are going to be able to develop more effective and more ethical policies for guiding our future.

### Notes

- Evans and Price: *The Ethical Dimensions of the National Waiting Time Project*.
- For another example of this within the healthcare sector see, Steven DeMello, *Systems Thinking and Strategic Planning in Healthcare*.
- Forrester, Jay, W. 'Counterintuitive Behaviour of Social Systems'.
- This builds on work conducted by Jac Vennix at the University of Nijmegen on participative model building within the health sector.
- At the time of writing this is the stage we have reached.

### References

- DeMello, S. 'Systems Thinking and Strategic Planning in Healthcare', *The Systems Thinker*, Vol 4, No. 9, Nov 1993.
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- Forrester, J. 'Counterintuitive Behaviour of Social Systems', *Collected Papers of Jay W. Forrester*, Wright-Allen Press, 1975.
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