# Reflections on SD Practice

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## Abstract

This paper is a series of reflections and lessons learned from 25 years of practice as a System Dynamics practitioner working in the business and government sectors. The overwhelming lesson is that the quality of the work is secondary to the manner in which projects are managed within organizations.

## Introduction

This paper reflects on a body of work commissioned by commercial clients. While a number of academic papers have been published as a result, this work has essentially been pragmatic and driven by the fundamental consideration of the usability of the models that were developed. The process of making models usable is deeply embedded in the political and organizational processes of the client. This means that reflection on SD practice is about processes much broader than the process of model building itself.

## The clients

The client group has been wide and diverse. The projects have included modelling the capabilities of the Joint Strike Fighter, the use of golf courses, restrictions to blood donor groups, the national superannuation system, the heroin trade, ambulance service demand, patient flows in hospitals, privatised garbage collection, the viability of WorkCover insurers, a call centre, oil and delivery transport systems, case management in the courts and an accident repair centre.

## SD is inherently difficult to understand and the explanations more difficult

The theoretical foundations of System Dynamics are at once the greatest strength and the greatest weakness for our discipline. The strength is that, thanks to Jay Forrester, we have very sure foundation upon which to proceed with our work. We are also fortunate that the body of literature, particularly that produced in the System Dynamics Review, has helped to define the methodology and the field of endeavour.

The downside of this however is that the body of theory that is needed to understand the discipline is relatively complex. For instance, the concept of feedback is commonly interpreted as meaning what people receive on their performance appraisals. Engineers understand feedback and control systems but many other do not. This is complicated by the fact that feedback comes in two forms, reinforcing or balancing, both of which have

quite different impacts on the system in question, clients begin to view the consultant with the degree of suspicion reserved for door-to-door vacuum salesmen and snake charmers. While the feedback concept is relatively easy to explain to an interested audience, the implications of its importance are not as easily understood.

The great power to be able to analyse systems in terms of positive and negative feedback systems rests in the fact that the results of the analysis are often counterintuitive and provides insights that have not previously been possible. The difficulty is that the results of SD analysis can often be at odds with the thinking of managers and decision-makers whose mental processes are essentially linear. Linear thinking is characterized by an assumption that an intervention in a system will have a chain reaction effect uncomplicated by a feedback from unintended consequences.

Our failure to help a client understand these and other principles of SD modelling can have disastrous consequences. A recent presentation to a senior parliamentarian set out the preliminary stages of a large project. As the presentation progressed, signs of glazed eyes and a decreasing attention span became increasingly obvious. The explanation was clearly not getting through and as a consequence of this, one senior decision maker's confidence in the technique was seriously weakened. Within a fortnight, the project had been cancelled. Attributing causation, particular when the causal structures are not well known, is always dangerous. However, it is likely that our failure to communicate clearly contributed to the cancellation of the project.

**The problem of counter-intuitive outcomes**

The more frustrating aspect of the failure to help the client to understand comes when the consequences of the lack understanding become obvious at the end of the project. Clients can be swept up by enthusiasm for a technique that has the potential to make the implications of policy decisions clear, but this is often supported by the hope that it will provide a justification for current policy. As the project progresses and the causal structures that come clearer, it becomes clear that counterintuitive outcomes are not going

to provide support for current policy.  Often the project will be completed, only to be shelved.

A major motor services company that had developed an Accident Repair Centre (ARC) had encountered problems with bottlenecks developing within the system. The problem was multifaceted and involved work scheduling and spare parts availability.  The spare parts problem led to cars being offloaded from the production line to the extent that the whole system became grid locked.  The client required a simulation model to see how the problem could be solved.  The complexity of the model, shown in Figure 1, is an indication of the complexity of the system that had been developed. It was little wonder that it was unmanageable. The most noticeable complexity was the complicated sets of conditions that had to be met before cars could move from one station to another.

Insert Figure 1 here

The as a result modelling can best be captured and the lives of the immortal poet Hillaire Belloc

> The Chief Defect of Henry King
> Was chewing little bits of String.
> At last he swallowed some which tied
> Itself in ugly Knots inside.
>
> Physicians of the Utmost Fame
> Were called at once; but when they came
> They answered, as they took their Fees,
> "There is no Cure for this Disease.
> Henry will very soon be dead."

The design of the ARC, which had cost millions of dollars and was to revolutionize car repair in Victoria, was so fundamentally flawed that it was never going to work properly. This was not what the client had expected. They had hoped that the problem would be solved, not proved to be insoluble. Within a short time, the client closed the ARC and began building a new one.

The tendency of SD modelling to produce counterintuitive outcomes produces significant difficulties for some clients. Given that many organizations do not have an inbuilt capability for Systems Thinking and consequently an understanding of the impact of feedback, it is highly likely that some of the results of modelling exercises will run contrary to the accepted wisdom within the organization.

Some years ago, work with a provider of major emergency ambulance services wished to understand the drivers of demand for emergency ambulance services. The funding model was that ambulances were purchased when projected demand went above current capacity. The purchase of the new ambulance had the immediate effect that capacity went above current demand. The ambulance service was under pressure to use the increased capacity. This was often achieved by using expensive and well-equipped emergency ambulances for tasks such as ferrying patients between hospitals. The consequences of this were that the specialized vehicles took up some of the workload of less specialized vehicles that then had to look for some way to utilize their excess capacity. This meant a knock on effect down through the ambulance services with everybody looking for extra work. Anecdotal evidence existed of emergency ambulances being used to take patients to appointments at outpatients units. Very soon the demand for these services increased so that it was necessary to purchase new ambulances in a variety of categories where demand had been stimulated. Figure 2 shows how new ambulances then went out looking for work.

Insert Figure 2 here

The conclusion was that one of the key drivers of demand for ambulances was the purchase of ambulances and the provision of an increasing range of services. Demand was endogenously driven. This may not surprise the experienced modeller but it certainly came as a shock for the service and provided very little help in their budget submissions.

The first difficulty in this situation is that the model has produced a counterintuitive outcome for the client. This outcome was based on the well-understood principle that systems generate their own behaviour. The client must now face the difficult task of implementing major policy and behavioural changes to bring the system under control. It's very easy for the situations to fall into the "too high basket".

Sometimes the opposite happens. A recent project involved the modelling of the impact of compulsory superannuation in Australia. The work that was conducted in the ATO Superannuation Branch was very successful for number of reasons. The first was the ability of the client group to accept the possibility of the counterintuitive. One of the critical dynamics for the introduction of compulsory superannuation was that it takes 30 to 40 years before people are retiring with a maximum benefits. For significant period of time, people would be leaving the workforce with relatively small amounts invested in superannuation. The question at issue was: "What will these people do in this situation?"

The consensus was that people would make additional payments into superannuation to increase their final benefit. However, it was agreed so there was no empirical evidence to support what seemed to be a fairly logical conclusion. The possibility of this assumption being wrong led to a significant investment in market research. The results of research justified the investment. Not only was it extremely unlikely that people would top up their superannuation, it was extremely likely they would take their superannuation as a lump sum and spend it on a caravan or trip around the world and then go on the pension. As one of the main thrusts of the superannuation policy was to make people less dependent upon government funded pensions, it looked likely that there would be a significant period of counterintuitive outcomes in the superannuation sector. Current policy for superannuation in Australian now restricts the amount of money that retirees are able to take a lump sum and effectively quarantines a proportion for an ongoing pension.

**The problem of the short-term v long term**

By its very nature, SD modelling addresses problems that have a long-term and strategic focus for the organization. Many organizations have difficulty integrating long-term and strategic information into their decision-making. Many organizations are beset by the need to deal with short-term key performance indicators and the immediate effects of a turbulent environment. Some organizations find themselves constantly in "semi-crisis" mode. This is particularly true of organizations where resources are stretched to meet the demands of what appears to be an unpredictable environment. Health services appear to operate in this mode for good proportion of their time. A recent modelling assignment from a major hospital was commissioned as result of a number of the senior administrators completing SD programs at Monash. The discussions to develop a long-term modelling capability to predict and manage demand for hospital beds was frequently interrupted by a quarter-hourly updates on the status of individual patients and a frequent absence of the manager to head off the latest crisis in bed allocation. Unfortunately, stamping out spot fires does not stop a major bushfire. While the immediate and practical reality is that the spot fires need to be fought, the difficulty is that the causes of the spot fires need to be managed. This dilemma is most acute in organizations that become "addicted to crisis". Managers become adept at dealing with the day-to-day crises of the organization. Often their efforts are nothing short of heroic and frequently lifesaving. At a personal level, the hero manager has nothing to gain from improving the structures that provide opportunities for managerial heroism.

A senior medical administrator accounted with great pride how she had spent an entire Saturday searching one of our major cities for a compatible blood donor for dying child. She finally located the child's aunt and brought her in to make a donation that saved the child's life. It is impossible to question the efficacy or importance of what was done in that situation. But when the administrator announced with pride that she was the only person who had the power and authority to do this, two questions inevitably arise: "But what if you weren't there? and What systems do you have in place to deal with that?"

It is a truism that structures determine system behaviour. It is equally true that the heroic efforts of individuals can overcome the influence of counter-productive structures in the short term. It is the heroism of individuals that often stands in the way of long-term strategic thinking. Structural change is time consuming, costly and risky. Often SD modelling indicates the need for significant structural change but when the immediate problems demand attention, managers rarely have time to make the necessary change.

A recent assignment in a major Victorian Hospital was able to deal with this problem in a different way. The hospital was building a short-stay facility and wished to know whether the plans that had been drawn up would meet the performance criteria set by the government. The critical dynamic in this case was that between the operating theatres, which generate patients, and the post-anaesthetic care units (PACU) where they recover. The new facility with its improved procedures was going to make significant improvements on patient throughput. While it is possible to bring about significant improvements in the processes surrounding the operating theatres, it is not possible to get patients to improve their post-anaesthetic recovery times. The issue was one of operating theatre capacity versus PACU capability shown in Figure 3.

Insert Figure 3 here

Patients can only leave PACU when they are fully recovered and walking. Once PACU is full and there is no recovery space available, the operating theatres must stop. Failure to keep the operating theatres working efficiently has a highly detrimental effect on KPIs. This meant that PACU capacity was a key leverage point in the system.

The model simulations indicated that the PACU capacity in the original plans would not be sufficient to cope with all the services planned for the new facility. A decision was made to limit the procedures that would be carried out in the new facility and bring the output of the operating theatres within the PACU capacity.

This application of SD modelling was interesting for a number of reasons. It tested the assumptions of the design of a facility in a way that allowed in the managers to short-circuit potentially problematic situations before they developed. It also combined architectural plans and SD modelling, certainly for the first time in the Victorian health system.

**Internal sponsorship and the rich and famous**

Someone who already has a working knowledge of SD often initiates SD modelling projects. Often, this has been a student who has studied at Monash University. It is very important from the perspective of a consultant to have a very realistic view of the organizational status of the project initiator. Does their budgetary discretion encompass the cost of the project? If this is not the case, then there needs to be a series of presentations to approve the project. This broadens the roles of the stakeholders. The person who approves the budget now becomes the project sponsor within the organization and this role requires careful management on the part of a consultant. The same applies to the person who originally introduced to project the organization who is likely to become the internal project manager.

In every consulting assignment, someone must become rich and famous. It is important to have a very clear understanding of who those people will be. It is the project sponsor, the approver of budgets, who must become pre-eminently famous. The consultant becomes rich but never famous. To achieve their fame, the project sponsor must be in a position to demonstrate the progress, efficacy or importance of the project. They must be brought up to speed about the nature the SD modelling and provided with enough information to be able to speak formally and informally about the benefits of the project. In doing, this they become famous. The consultant takes no role in representing the project in the organization. The emphasis on using the project sponsor and project manager to represent the project within the organization means that the emphasis is constantly on relating the progress and outcomes of project to organizational objectives. It also enables the project manager and project sponsor to take ownership of the project.

The communication processes surrounding the project are as important as the project itself and structures need to be put in place to ensure that they work well. Stafford Beer's "Viable Systems Model", shown in Figure 4, provides an excellent template for structuring the project, and the communication processes that must support it.

Insert Figure 4 here

The project team is Beer's System 1. This is where the work of building causal diagrams and modelling is done. This group will clearly contain the project manager and if possible some members of the organization who have demonstrated enthusiasm for developing SD mapping and modelling skills. It is from this group that a replacement for the project manager must be found if the project manager moves to a new role. Developing requisite variety at all levels of the project serves as a protection against the loss of expertise as a result of staff movement.

The project manager will be effectively a one-person System 2 responsible for coordinating System 1. The project manager and the project sponsor will be members of System 3 which is responsible for maintaining the stability of the project, interpreting policy decisions from system five, allocating resources to System 1 and carrying out audits of progress. System 4 is the intelligence gathering function that will consist of the various stakeholders who have input to the modelling process. System 5 has a policy development role and will ultimately be the user of the models.

Once the VSM has been established within the client organization, it is necessary to establish the membership of the five systems. The critical aspect of the membership of the systems is that membership should be multiple and overlapping. The project manager will need to be a member of System 5. Their expertise and knowledge of SD modelling will allow them to act as mentor to the modelling acolytes. They will also need to be a member of a least one other system, preferably System 3 with responsibility for resource allocation. The project sponsor should also be a member of System 3 and also of System

5 where policy is developed and the model will ultimately be used for scenario planning. Both the consultant and a project manager need to be members of System 4 where the major stakeholders who provide information for model, will meet. This multiple membership ensures that information about the status and progress of the project is held by a number people giving them the ability to influence all parts of the system. This structure has been used in two highly successful modelling exercises, those at the Australian Tax Office (ATO) and the Australian Red Cross Blood Service (ARCBS).

The Federal Treasurer, Peter Costello that superannuation reform was "on the agenda", initiated the ATO superannuation project as a result of a statement. The ATO was keen to become a major player in the superannuation policy debate and saw SD modelling as an alternative to the Federal Treasury's RIM model as a source of policy advice. This political imperative meant that the project sponsor was a Deputy Commissioner within the ATO. The focus of the Deputy Commissioner was on the macro-political elements of the Canberra bureaucracy rather than on any of the technical elements of SD modelling. The project manager was an enthusiastic convert to Systems Thinking in general and modelling in particular. He was also exceptionally politically astute and was able to position himself as a member of all systems within the VSM. The Deputy Commissioner and the project manager were both members of System 5.

System 4 was known as the High Level Modelling Team and consisted of stakeholders from ATO offices across Australia. In addition to this wide exposure that the project had through System 4, the ATO also ran a series of workshops on Systems Thinking and SD modelling techniques. It was from the participants in these workshops that the members of the System 1 modelling team were selected.

In addition to this significant level of organizational support, the modelling team also had a dedicated modelling room in the ATO offices. As the causal diagrams for the superannuation scheme were developed, they were displayed on the walls of the modelling room. ATO staff were free to come and look at the work and a number of presentations to external bodies were conducted in the modelling room. This enabled

members of the modelling team to become moderately famous. The project leader became rather more famous and made presentations to other departments including one to the Assistant Treasurer. The project sponsor presented the work to a number of external industry bodies and later left the ATO to work for a major industry organization. Fame of course comes at a price. The project ended when Treasury offered all of System 5 and the project leader jobs in Treasury. All accepted. The move of these key players out of ATO Superannuation branch effectively removed any policy capability from the branch.

The counterintuitive outcome of the ATO's desire to develop its policy capability in superannuation was that its success led all the key players to move on to policy roles within Treasury. The deputy commissioner had moved to work with a superannuation industry body. Everyone was famous and the consultant was slightly rich.

**The pragmatics of SD modelling**

As an academic and a teacher of SD, it is possible, and indeed necessary, to involve oneself in the more arcane aspects of SD modelling. However, the concerns of the academic community are rarely reflected in the concerns of the business and government sectors. Their concerns focus around outcomes, answers and action. The technical complexity of SD modelling opens it up to the accusation of being "academic", which is one of the more pejorative terms used in the business world. This "outcomes, answers and action" focus was shown in exercise modelling the patient flow in a subacute hospital facility. The project was stopped after the development of the causal diagrams and the early development of the simulation model. The project team believed that they now understood the problem sufficiently to be able to take effective action. The change program that arose from the modelling exercise reduced the patient stay time in the facility from 35 days to 17 with no change in level of patient care.

This experience neatly defines the role that our work plays in organizations. At best, we can be a catalyst for change by providing information for the decision-makers who must ultimately take responsibility for the change. We can provide little information about the way to initiate, implement or evaluate the change. The criteria for our work must be that

we are able to provide information that allows responsible managers to make informed choices about the changes in their organization.

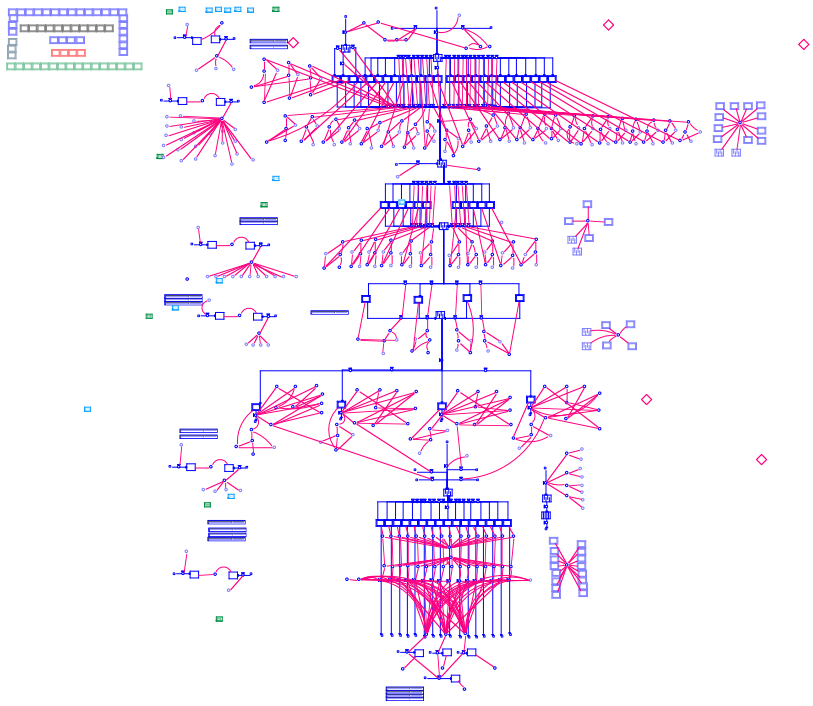

Figure 1: The ARC model

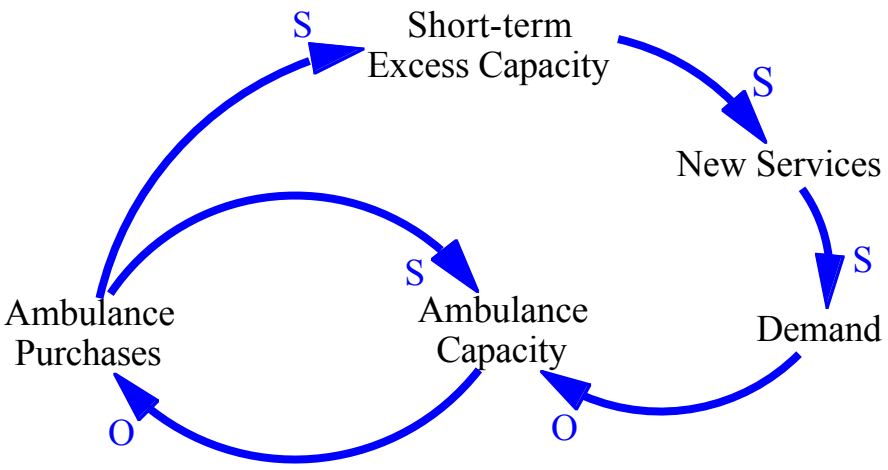


Figure 2: Endogenous ambulance demand. An '*S*' indicates that the causal variable has the *Same* effect on the dependent variable. AS New Services go up then demand for those services also goes up. An '*O*' indicates that the causal variable has the *Opposite* effect on the dependent variable. If Demand goes up then Ambulance Capacity goes down.

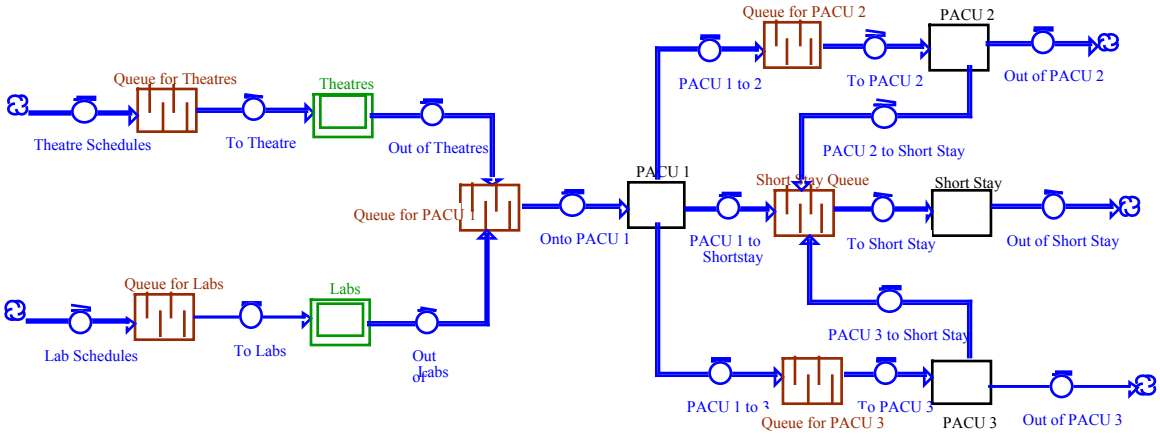


Figure 3: Operating Theatres and PACU.

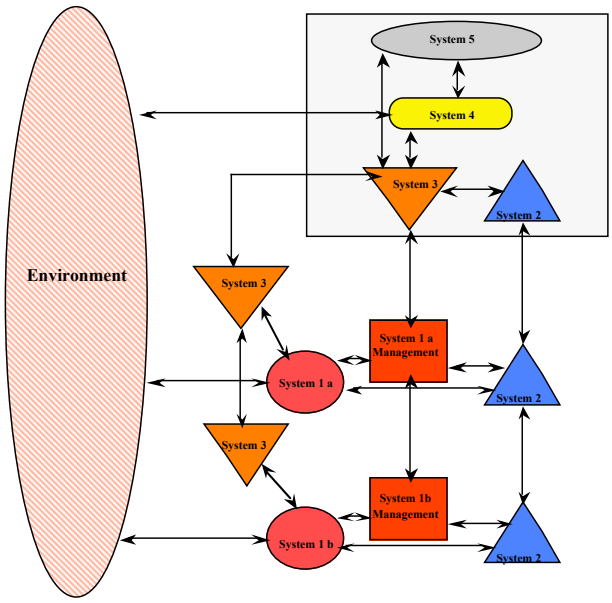


Figure 4: Stafford Beer's Viable Systems Model