

Simulation Modelling as a Tool for Evaluation

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Overview

- **To evaluate a program or policy you need to understand what it does and how it works (barring black-box or goal-free approaches)**
- Program or intervention logic is often used for evaluation planning, using chain of logic leading to intended outcomes
- Simulating a complex intervention on the computer lets you identify key assumptions, dynamics within the program, possible unintended consequences, and range of likely consequences
- Simulation represents a potentially valuable addition to the evaluation toolkit

Computer Simulation

- **Simulation depicts a system in some form, and represents the system in operation on a computer**
- **Types of simulations:**
 - System dynamics models: show a system as a set of relationships, with each element affecting other elements positively or negatively
 - Discrete event simulation: shows a system as a set of processes, through which activities happen over a defined space of time
 - Agent-based models simulate the actions of autonomous individuals interacting with each other

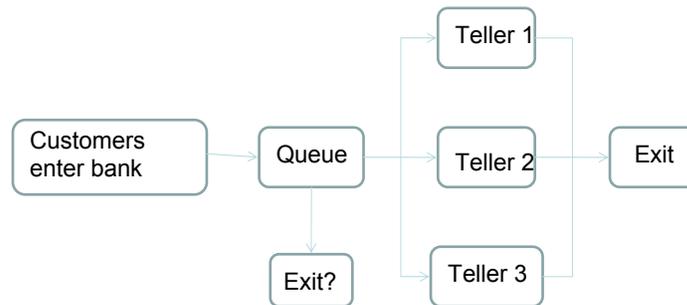
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When to Use Simulation

- Discrete event simulation is useful for representing systems that are *ill-structured* (well structured systems can be dealt with more easily)
- Models show complex interactions of *stocks* (inventories) and *flows* (*inflows and outflows*), and show how individuals wait in queues
- Models are easily amenable to extension by having *base* and *alternative* scenario models where the base is the underlying core model
- Model development is done through a Graphical User Interface (GUI) which emulates the flow of individuals through a system

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Example of a Simulation Model



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How Simulation Extends Program Logic

- **Program logic (theory of action) provides a model of an intervention, setting out the chain of outcomes and logical linkages**
 - Focuses on main path of logic
 - Tends not to show feedback loops
 - Perverse or unintended consequences may be missed
- **Simulation model allows for different behavioural responses to changes, models a system at different levels**

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Logical Model for Simulation

- **Any simulation begins with developing and validating a logical model of a process or system**
 - Can be done with a range of stakeholders
 - Simplifies the system as a whole
 - Requires extensive data on system operation in order to behave realistically

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Application to Evaluation

- **Simulation generally provides an *ex ante* analysis of how changes play out in a complex system, which can help to plan evaluation**
 - Simulation can demonstrate a range of likely outcomes so that an evaluation can be designed to test for changes of the expected magnitude, and to have a reality check for the plausibility of evaluation results
- **Where outcomes are difficult to attribute to specific interventions, simulation can provide estimates of program effects as part of *ex post* evaluation**

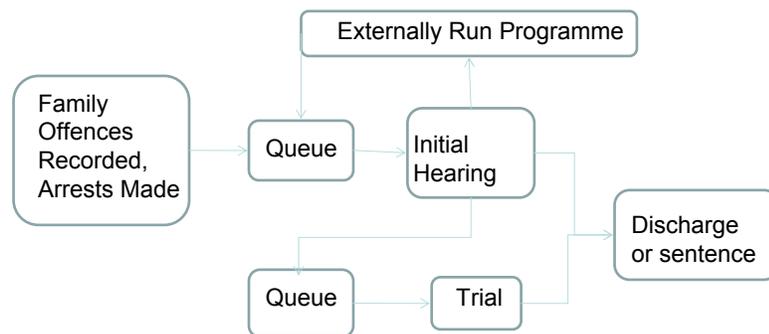
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Example: Family Violence Courts

- **Dedicated courts established to deal with family violence cases on specific days, using the same judges**
 - Intended to hear cases faster to avoid having victims drop charges
 - Encourage offenders to take positive actions to change behaviour, lowering sentences

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Simplified Form of Model



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Use of Court Model

- **Simulation was used to identify key steps in the interventions, estimate the extent of change needed to accomplish program goals**
- **Model estimated backlogs at different stages depending on numbers of new cases and resources such as staff or externally provided programs**
- **Simulation helped validate research questions, evaluation priorities**

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Modelling Criminal Justice Sector

- **Pipeline is a model of the whole criminal justice system, developed to simulate the cross-sectoral impacts of changed policies or delivery strategies in any part of the system on other parts**
- **Pipeline aims to assist policy development by:**
 - Comparing options and evaluating their relative impacts
 - Identifying unintended sector consequences (e.g. bottlenecks, system capacity issues) and evaluating associated remedial actions

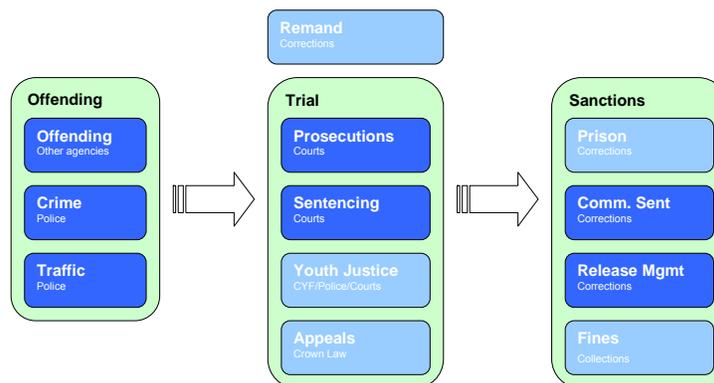
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Pipeline uses Discrete Event Simulation

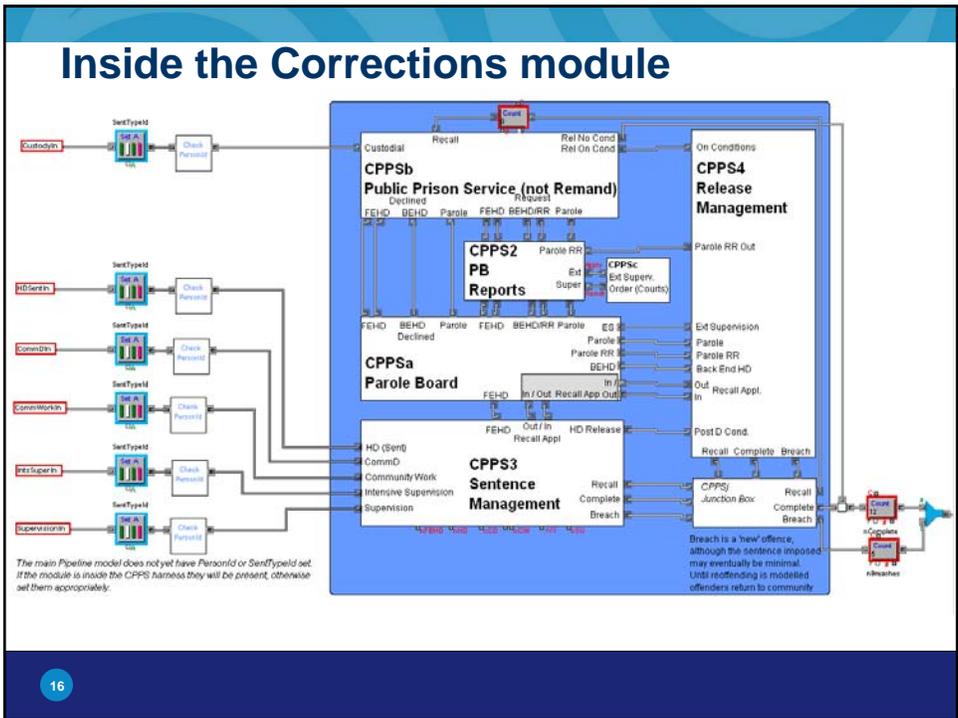
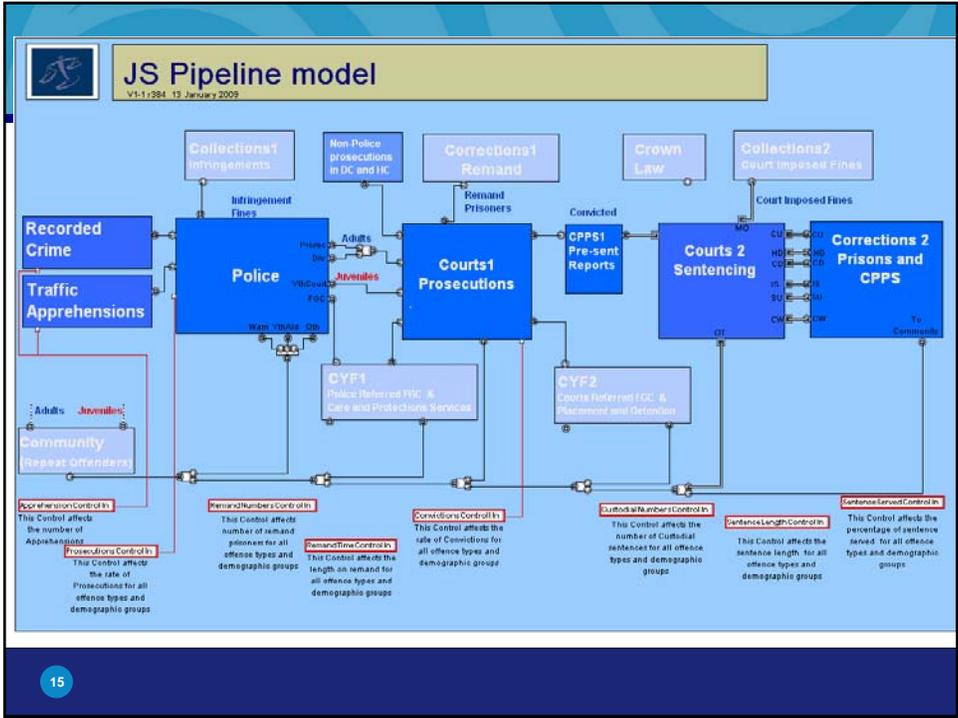
- Follows individual 'actors' through the system
- Each actor has attributes such as:
 - Gender, youth/adult flag, Māori/non-Māori
 - Offence type and location
- Pipeline assigns other attributes such as:
 - Outcome of police apprehension / trial / sentencing
 - Sanctions / time to serve
- The model is complex
 - 200+ tables and 1200+ blocks
 - 60+ attributes per actor
 - 200,000+ actors per modelled year

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Conceptual Overview



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Estimating Impacts of New Sentences

- In October 2007 New Zealand established home detention and community detention as sentences
- NZ prison population dropped sharply after the new sentences were introduced, then rose again
- Attributing the drop to the new sentence types difficult because of other factors such as cyclical trends in prison population, changes in the mix of crimes, and changes in parole or bail requirements
- Simulation gave one way to estimate the impact of new sentence types

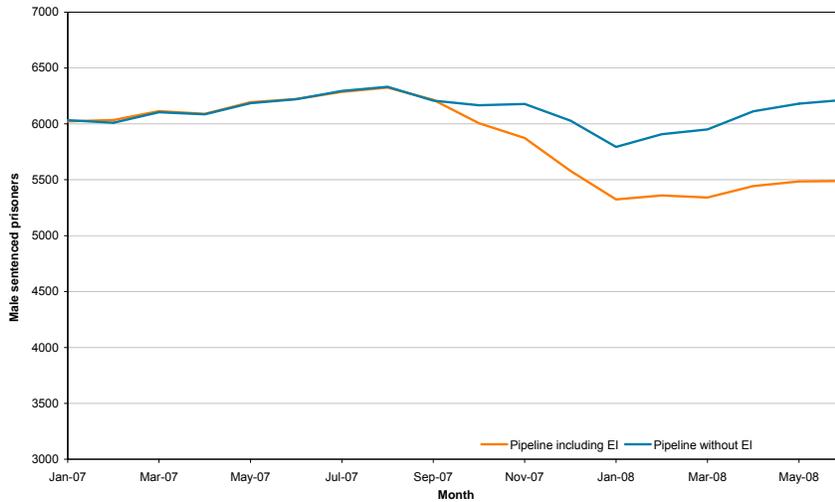
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Simulation of New Sentences

- Pipeline was used to estimate how many prison beds were saved by the new sentences
- The model was run without the new sentences to estimate numbers of people imprisoned, given the number and mix of offences and prosecutions
- The model was run again with the new sentences to estimate the new level of imprisonment, which was compared to actual levels
- The estimated difference was compared to the total change in numbers of people in prison to see how much of the change it accounted for

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Estimated Impact on Prison Population



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Future Use of Simulation in Evaluation

- We have only scratched the surface here in developing simulation as a tool for evaluation, and its use is not evident in the evaluation literature
- As the tools become more available and more people get used to them, the potential for evaluation is there
- Other examples of use would be welcome!

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