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Let's Beat Diabetes Diabetes Model

Counties Manukau District Health Board

6th November 2007

- What is System Dynamics modelling?
- Why was it used in LBD?
- The process of building the model
- Model outputs
- What was learnt

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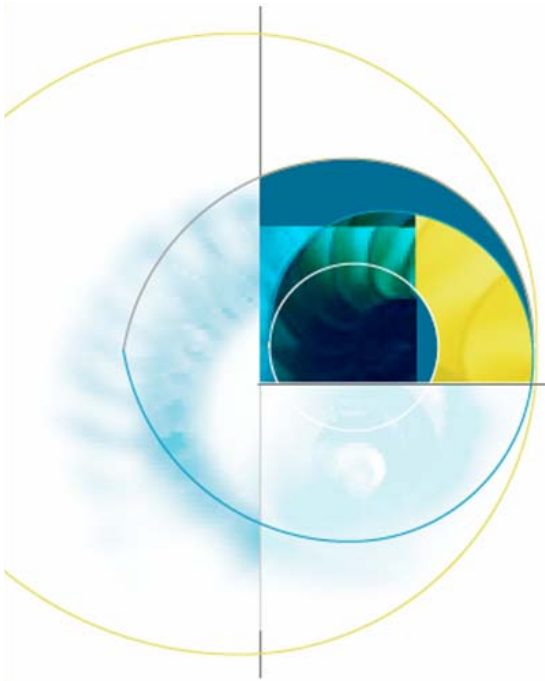

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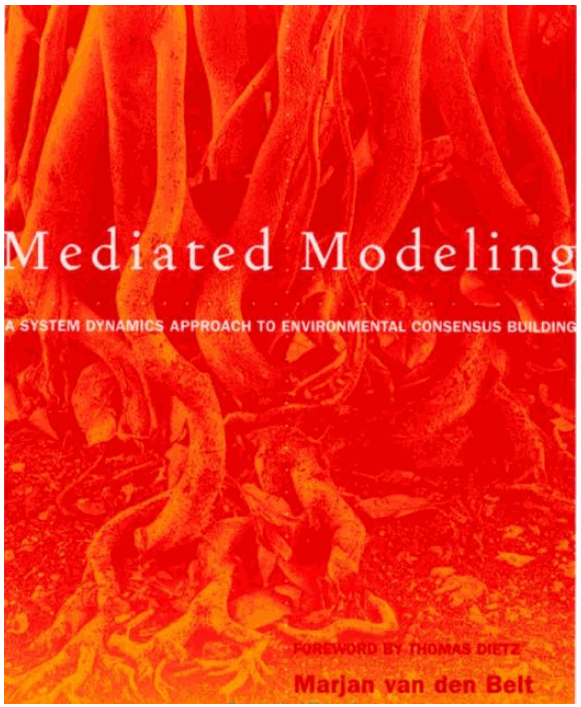
What is System Dynamics Modelling?

Counties Manukau District Health Board
6th November 2007

Science & Public Discourse



- How can the public be engaged in a way that leads to competent deliberation using the best available science?
- How can the science be engaged while taking proper account of the limits of our knowledge and the uncertainties inherent in even the best analysis?
- How can a process make use of quantitative information while giving proper weight to qualitative information?
- How can discourse proceed in ways that are respectful of all viewpoints while encouraging learning and change on the part of individuals and groups?

Thomas Dietz
Chair of US National Research Council Committee on Human Dimensions of Global Change
Michigan State University
Forward to: Mediated Modeling by Marjan van den Belt

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What We Know About The Demands on Decision Making in Complex Situations

Complexity

- Complexity is the label we give to the existence of many interdependent variables in a given system. In such systems we must not only keep in mind the many features but also the influences among them.

Dynamics

- Dynamics systems do not wait for decisions to be made. They move on their own and this creates time pressure. We cannot wait before we act and we often have to act with incomplete information. We cannot be content with observing and analysing single moments but must instead try to determine where the whole system is heading over time.

Transparency

- What we really want to know may not be visible. We may have no direct access to required information.

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Dietrich Dorner
The Logic of Failure
1989

What We Know About Decision Making Behaviours

Poor decision makers tend to:

- Act without prior analysis of the situation
- Fail to anticipate side effects and long-term repercussions
- Assume that the absence of immediately obvious negative effects mean that correct decisions have been made
- Allow over involvement in 'projects' blind them to emerging needs and changes in the situation.
- Focus on one solution to solve complex problems
- Rather than generating hypotheses that can be tested they generated 'truths'

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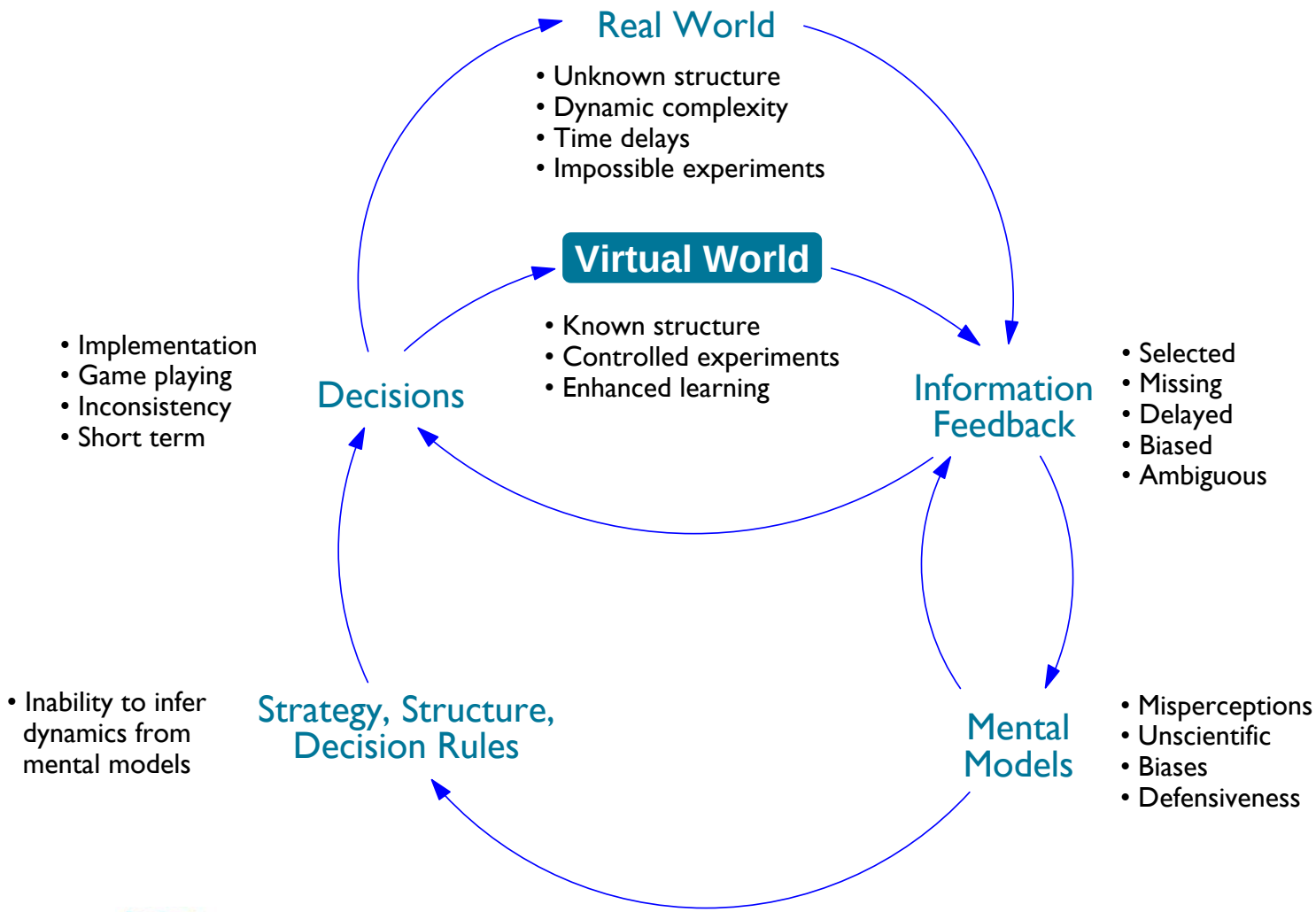
Dietrich Dorner
The Logic of Failure
1989

Learning In and About Dynamic Systems



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Sterman JD. Learning in and about complex systems. System Dynamics Review 1994;10(2-3):291-330.

Sterman JD. Business dynamics: systems thinking and modeling for a complex world. Boston, MA: Irwin McGraw-Hill, 2000.

Structural Knowledge in Virtual Worlds

- We must do more with information that simply gather it. We need to arrange it into an overall picture, a model of the world we are dealing with
- We need a cohesive picture that lets us determine what is important and what is unimportant, what belongs together and what does not i.e. what our information means
- This ‘structural knowledge’ allows us to find order and pattern within complex systems.
- System Dynamics is one tool that helps us build ‘structural knowledge’.

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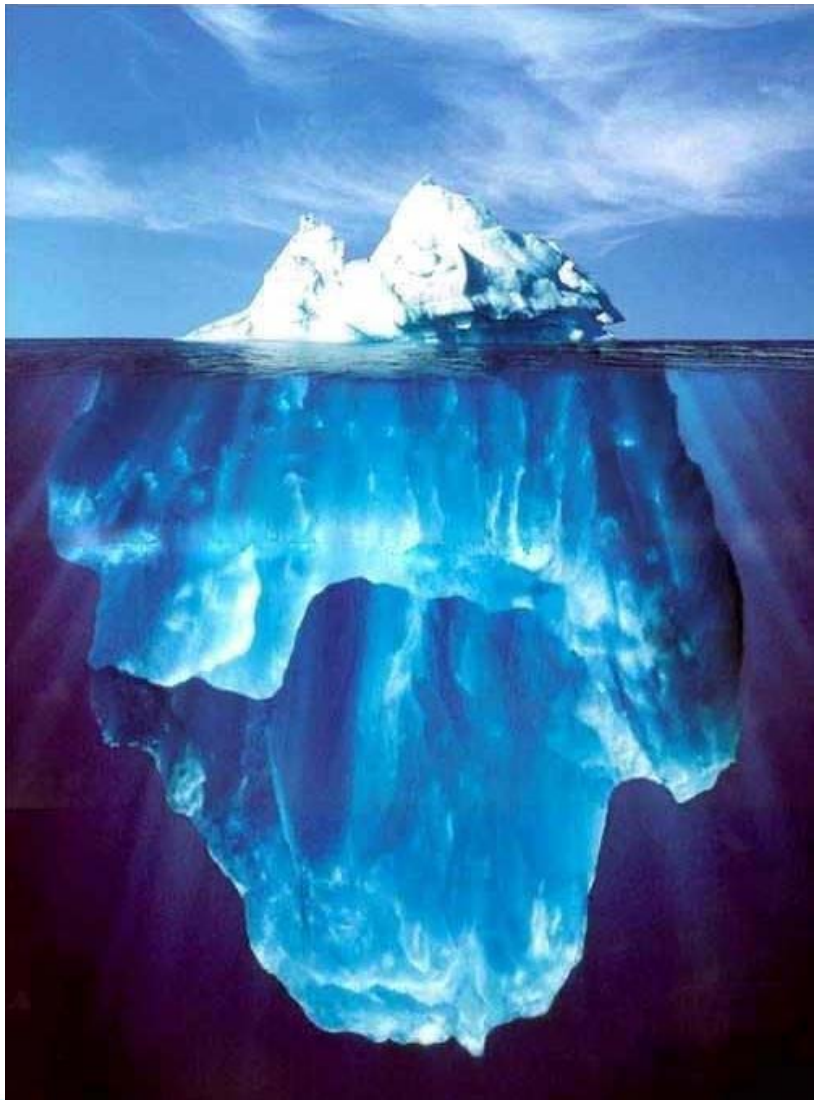
Dietrich Dorner
The Logic of Failure
1989

Increasing Leverage



EVENTS

PATTERNS

STRUCTURE

MENTAL MODELS

VALUES

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The Focus of System Dynamics Modelling

- Systems dynamics is concerned with understanding the broad trends and patterns rather than point prediction. It is concerned with how things change over time rather than how they exist at a point in time.
- SD models provide a causal rather than a quantitative solution and are of great value when numerical data is imprecise or unavailable.
- When the purpose is intervention, well constructed SD models can help improve understanding of the the system, and the design of feasible interventions.
- Learning occurs from building the model AND experimenting with it.

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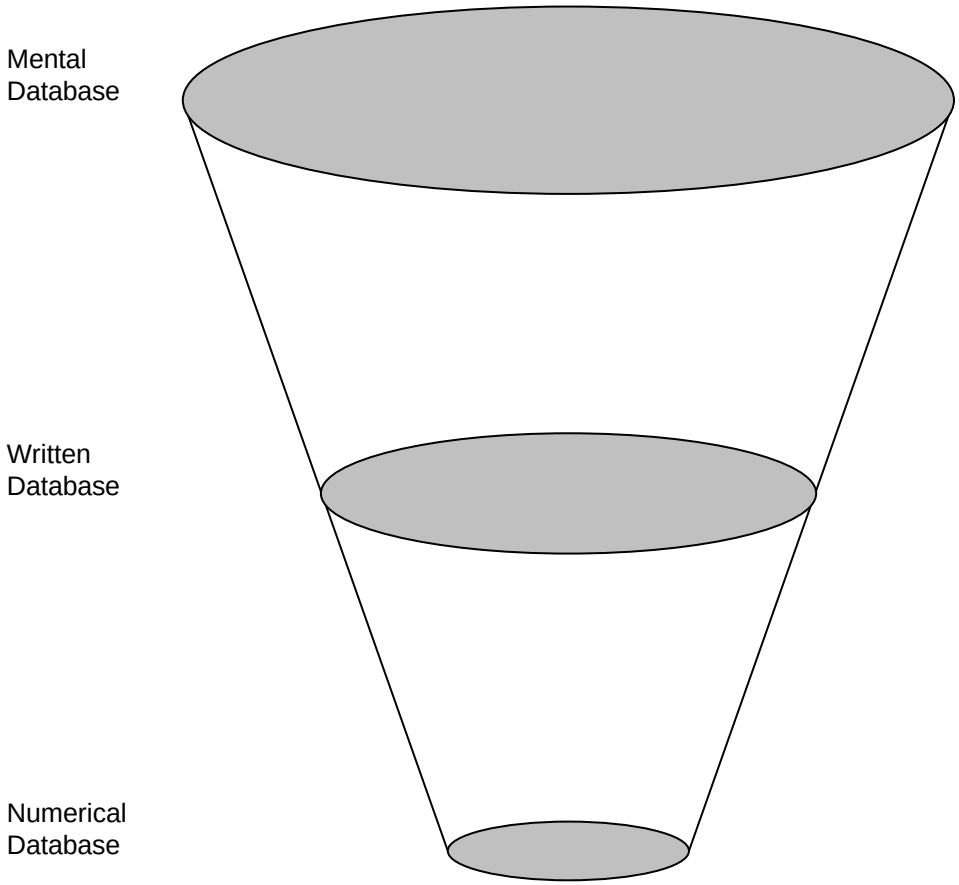
Sources of Data



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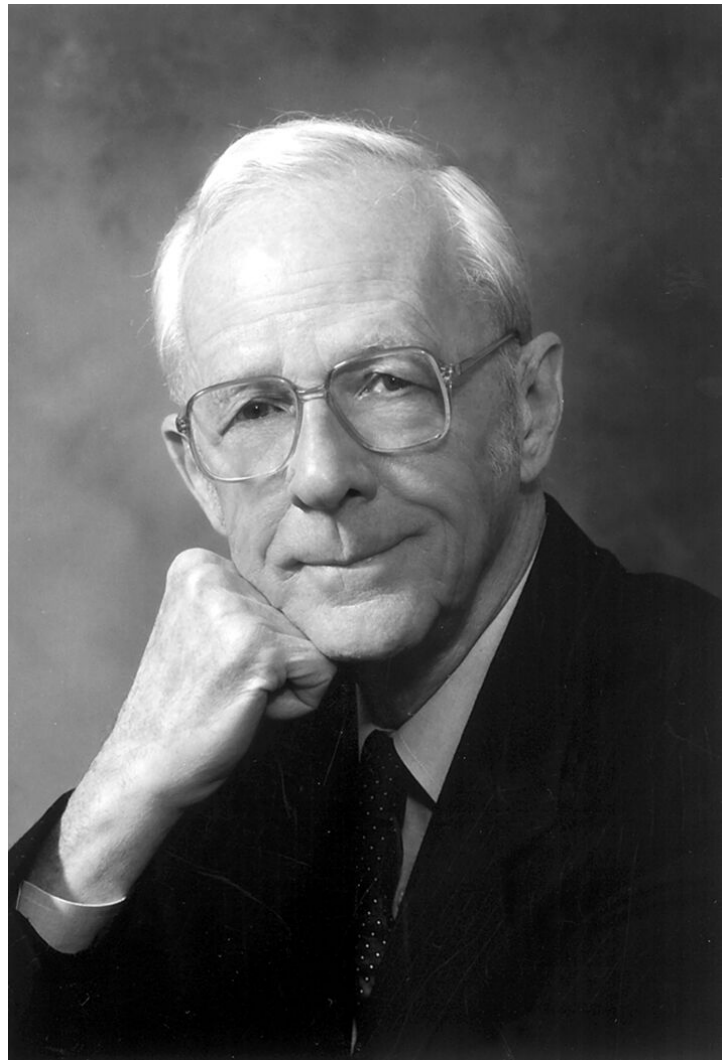
Background

- Founded by Jay Forrester, System Dynamics (SD) is grounded in concepts of accumulation and feedback and one thread in a complex field collectively known as the 'systems sciences'
- The systems field, in all its various interpretations, is concerned with concepts of;
  - Wholeness
  - Boundary Judgements
  - Interdependence
  - Feedback
  - Structure
  - Emergence
  - Meaning-making
  - Dynamics Over Time
- Systems Dynamics utilises computer simulation to help gain insight into these system characteristics



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Development

- SD has its origins in the work of Jay Forrester who published 'Industrial Dynamics in 1961
- During the 1970's a number of people began to broaden the focus of the field to issues of social interest
- Anne Ackerman and Eric Wolstenholme have applied SD to health issues in the UK
- Jack Homer, Bobby Milstein and Gary Hirsch have done the same in the US
- I have been using modelling within the NZ health sector since the mid-90's

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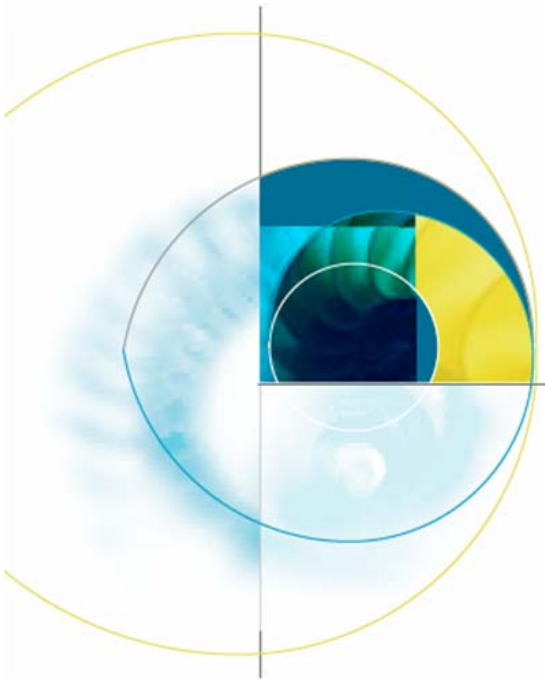
Jay Forrester – Founder of System Dynamics



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Why Was it Used in LBD?

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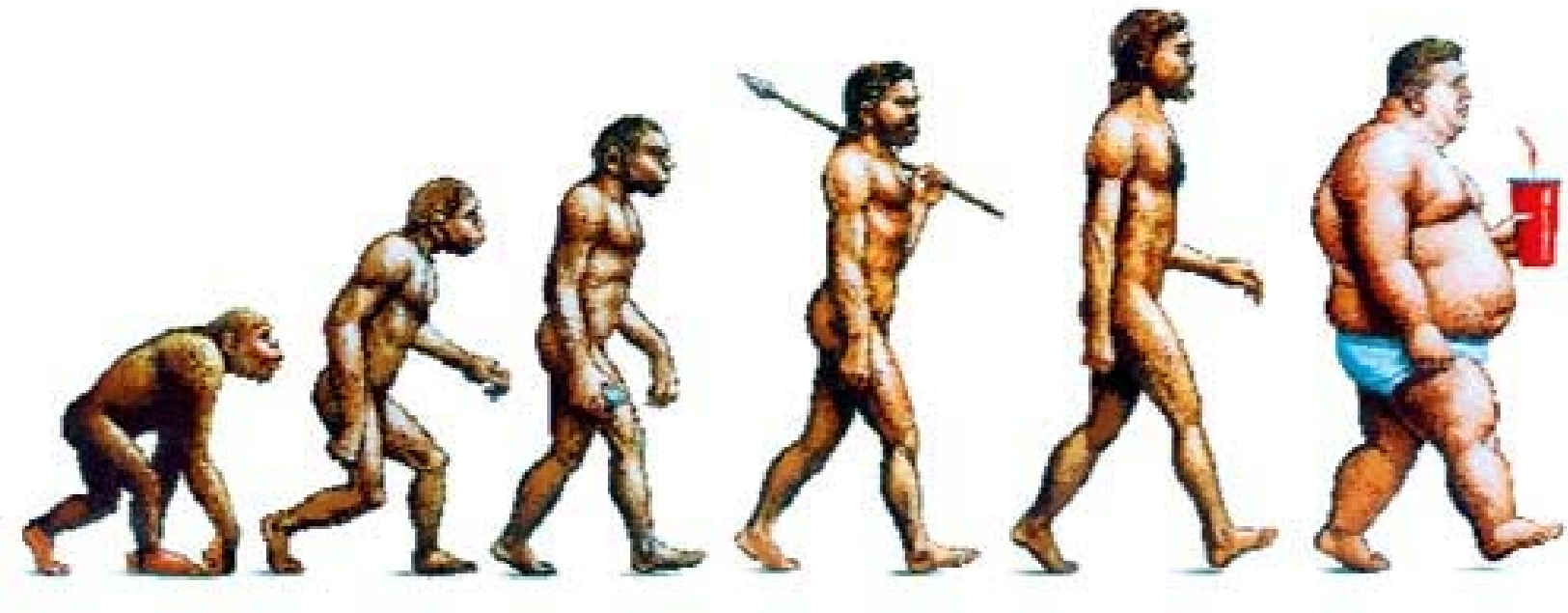
The LBD Challenge



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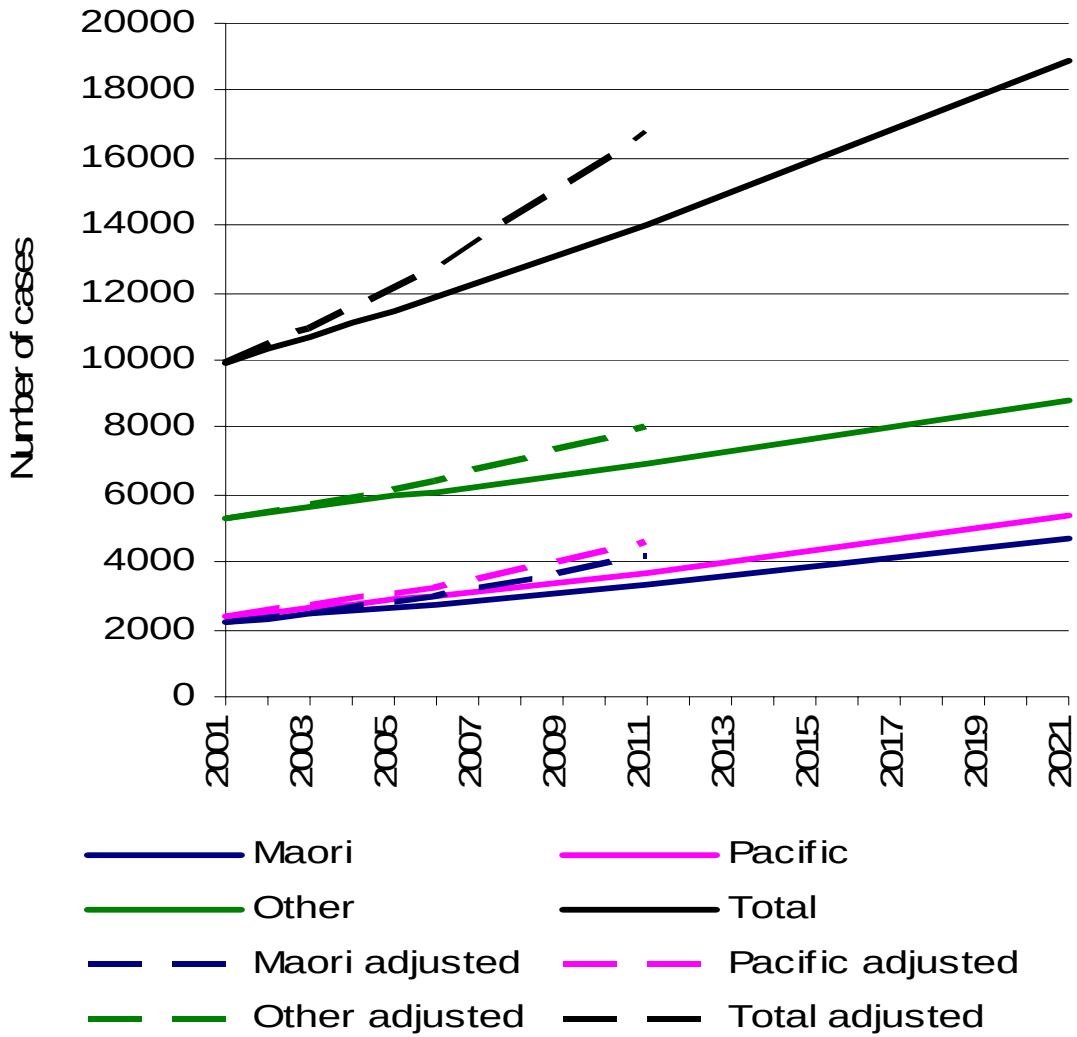
Prevalence of diagnosed type 2 diabetes (assuming no change in risk factor prevalence) for 25 - 89 year of age by ethnicity



A Lindsay 2003

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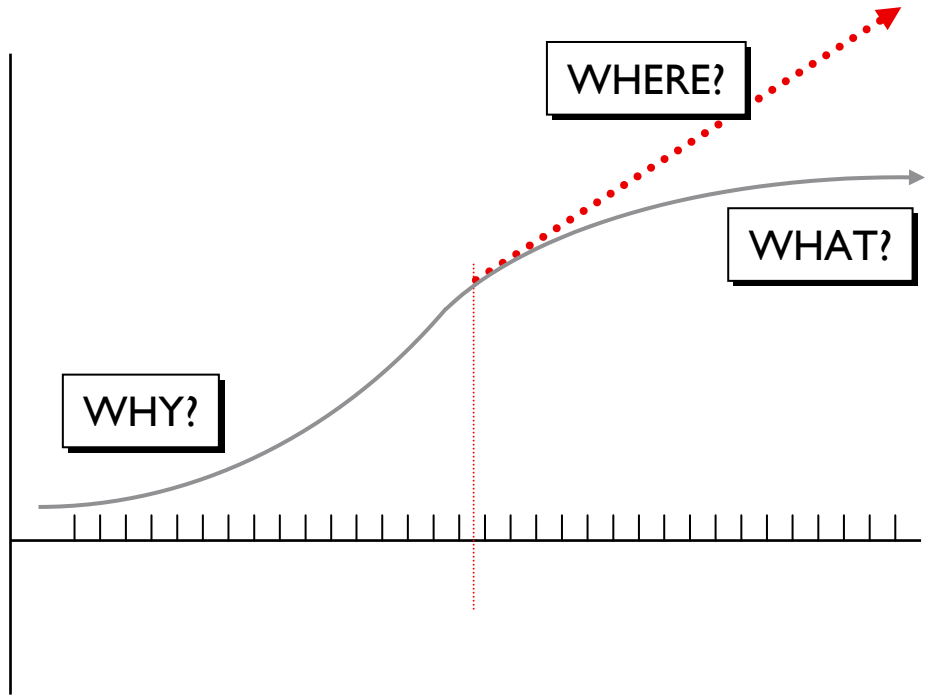
WHY is has the historical pattern followed the current path?

WHERE will it lead if we carry on with current practices and policies?

WHAT can we do to improve the trend in the future



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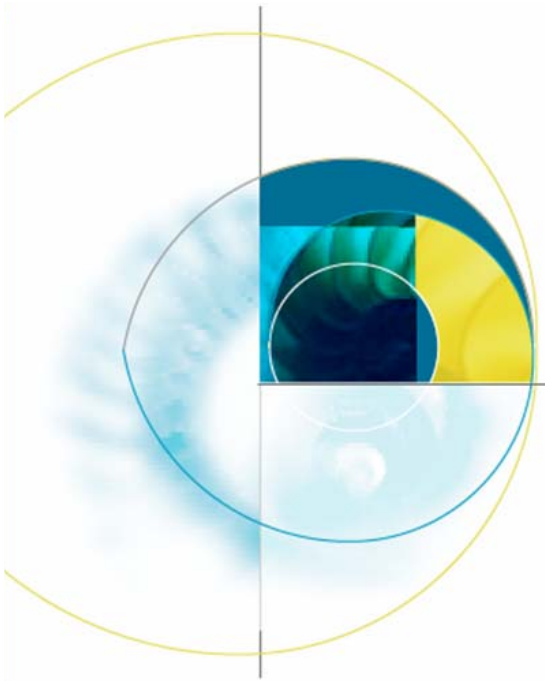
LET'S BEAT DIABETES



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The Process of Building the Model

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The Process of Participative Modelling

Step 1: Initial scoping and consensus building

- bridge the gap between evidence, policy and stakeholder engagement
- build mutual understanding
- solicit input from a wide group of stakeholders
- maintain dialogue between the groups

One of the major strengths of dynamic modelling is that it enables clinicians, managers, policy makers and the broader public to focus and clarify the mental model they have of a particular issue, to test it, to elaborate it and then to do something that they cannot do in day-to-day life: run their model and let it yield the consequences hidden in their assumptions and understandings.

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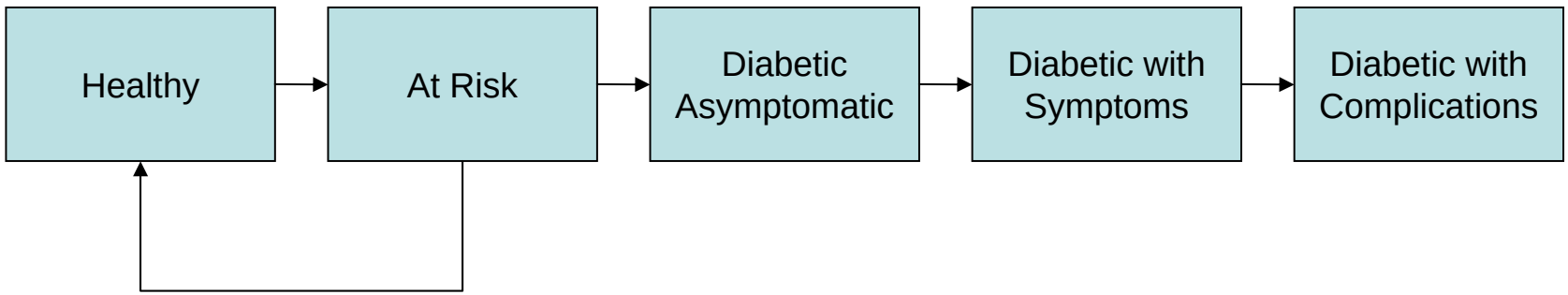
October 2003



- Beginning to look at the broader system
- Understanding the need to impact on the rates of flow through the system
- Like it or not wherever you focus you affect the whole system

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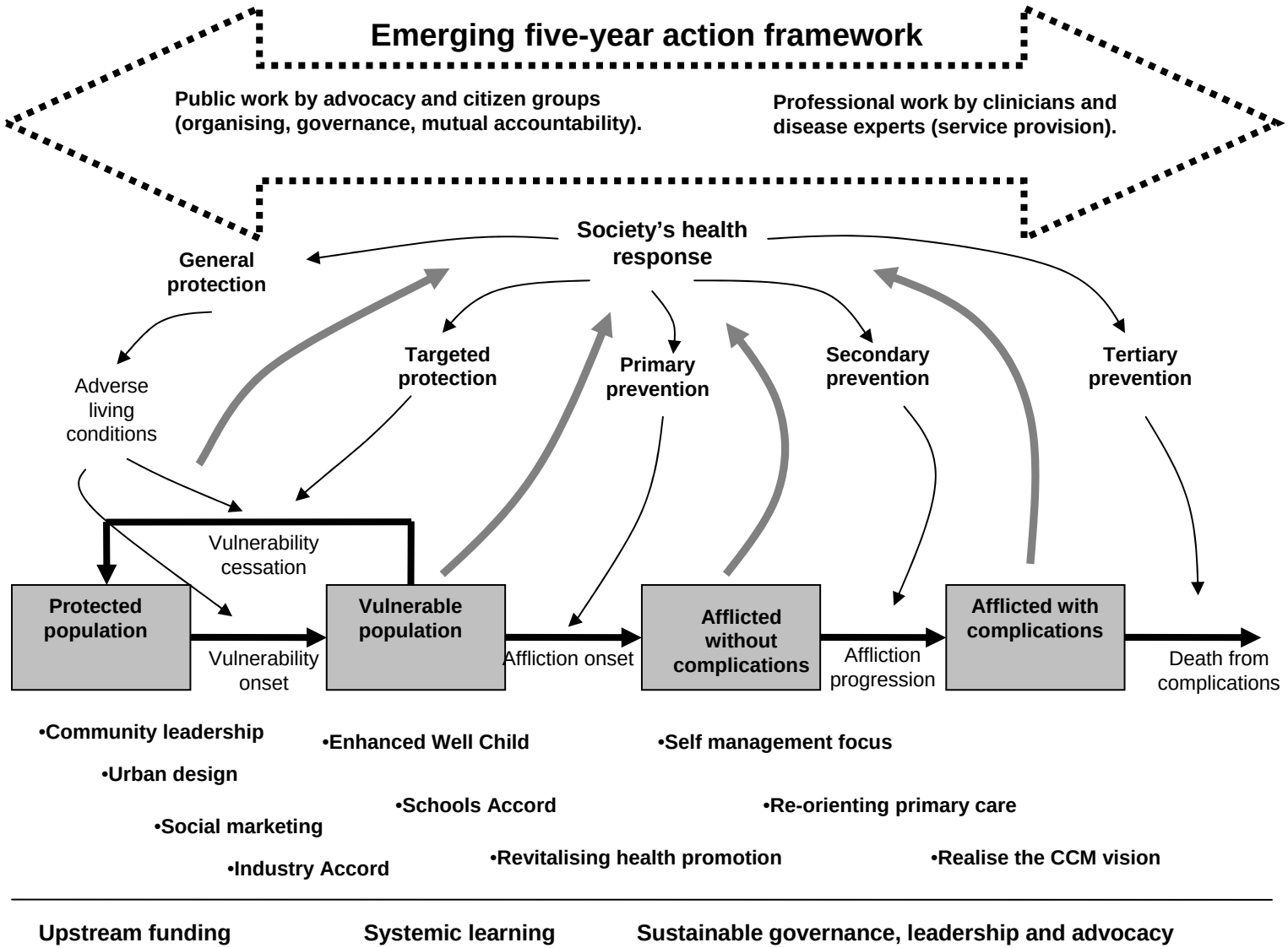
July - 2004


Emerging five-year action framework
Public work by advocacy and citizen groups (organising, governance, mutual accountability).
Professional work by clinicians and disease experts (service provision).
Society's health response
General protection
Adverse living conditions
Targeted protection
Primary prevention
Secondary prevention
Tertiary prevention
Vulnerability cessation
Protected population
Vulnerability onset
Vulnerable population
Affliction onset
Afflicted without complications
Affliction progression
Afflicted with complications
Death from complications
•Community leadership
•Urban design
•Social marketing
•Industry Accord
•Enhanced Well Child
•Schools Accord
•Revitalising health promotion
•Self management focus
•Re-orienting primary care
•Realise the CCM vision
Upstream funding
Systemic learning
Sustainable governance, leadership and advocacy

The Process of Participative Modelling

Step 2: Detailed modelling and validation

- collect detailed historical data for calibration and testing
- analyse areas of uncertainty
- more focus on realism and precision
- replicate the dynamics of the system of interest

Step 3: Exploration of Scenarios and Policy Options

- aim for more informed decisions
- a better understanding of how the system works and the consequences of different policy options
- close the gap between decisions, actions and results.

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Modelling Team

- Dr Brandon Orr Walker - Whitiora
- Dr Lester Read - CCREP
- Dr Arun Gagakhedkar – Kidz First
- Dr John Wellingham - DHB
- Dr Kirsten Lindberg - DHB
- Dr Andrew Lindsay - DHB
- Dr Sharad Ratanjee – Middlemore Dialysis
- Dr Robert Scragg – School of Population Health
- Paul Stephenson - Synergia

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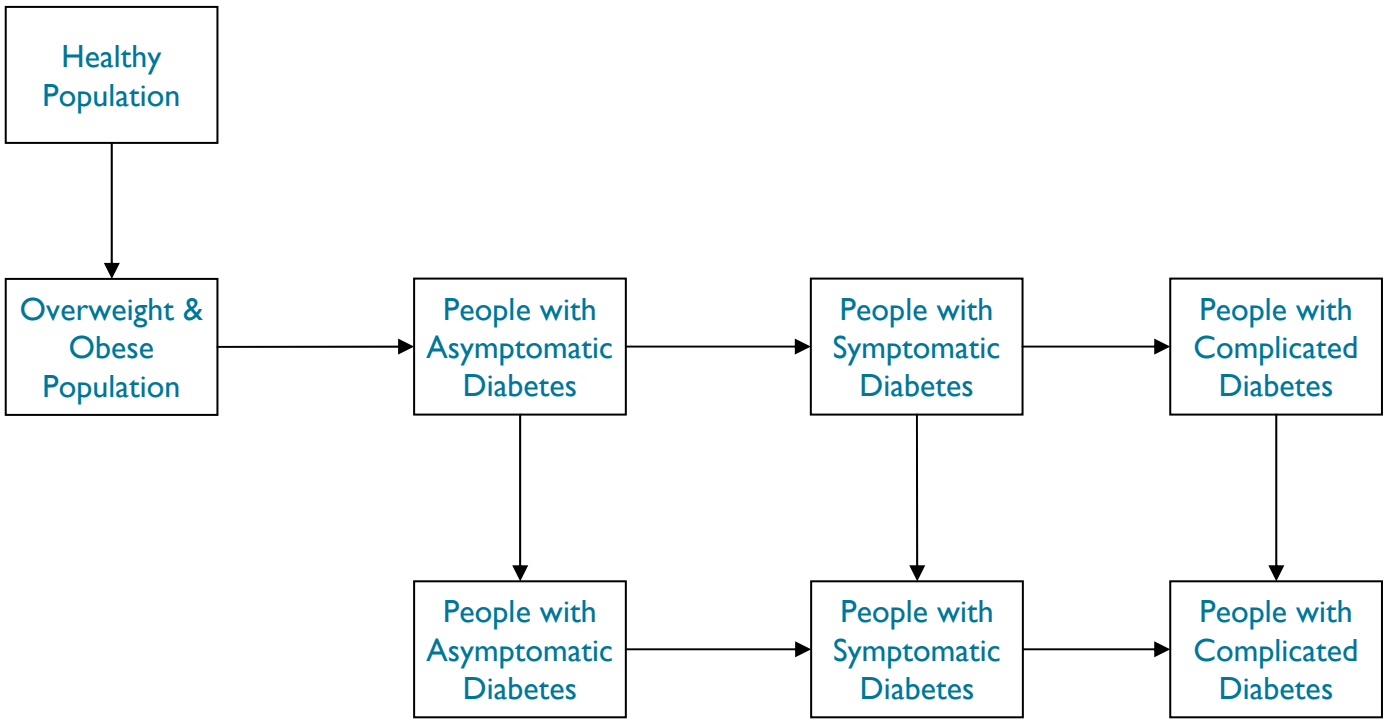
Basic Model Structure



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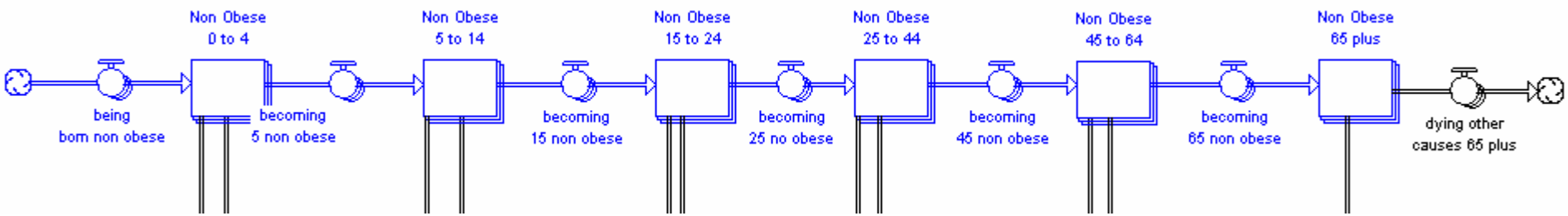
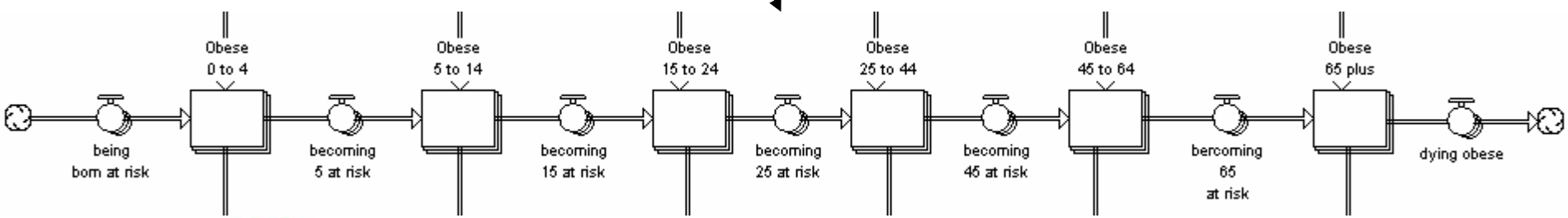
Healthy Population



Overweight & Obese Population



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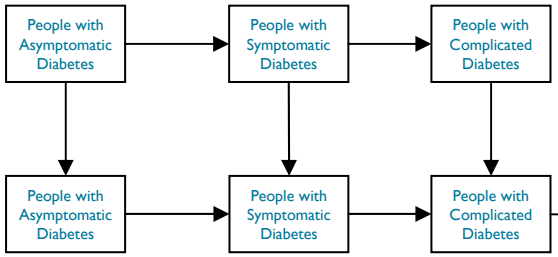
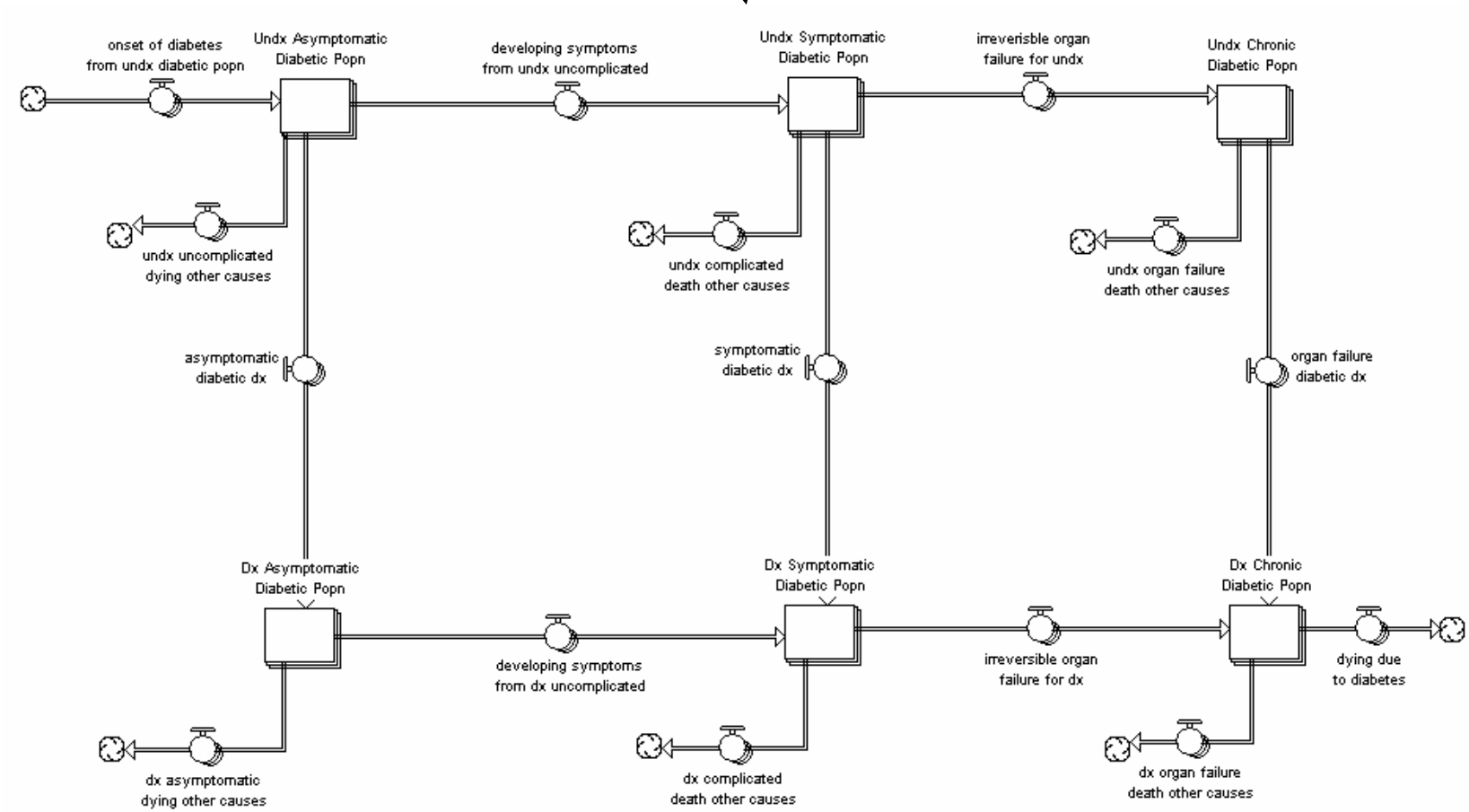
LET'S BEAT DIABETES





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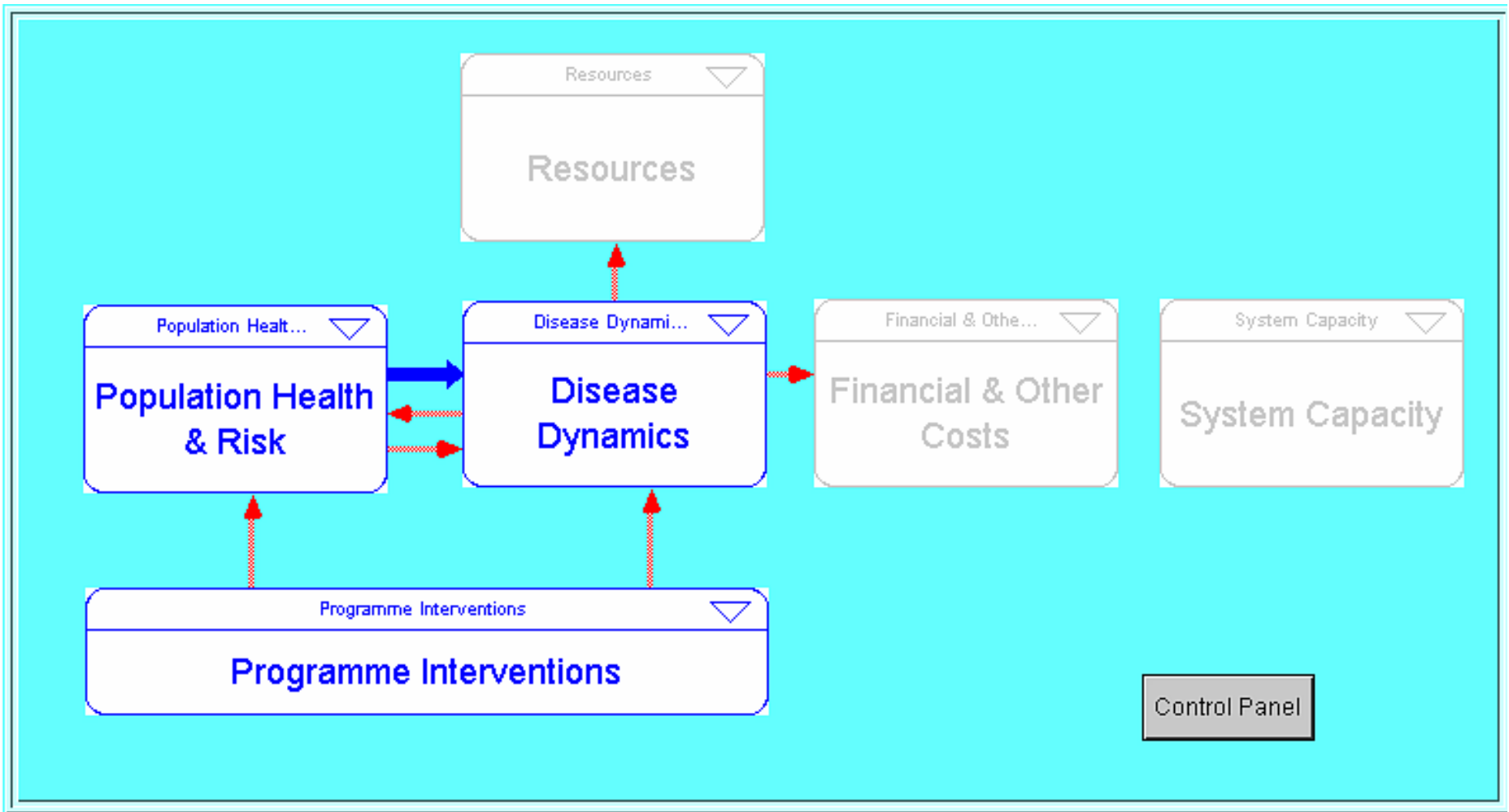
December 2004



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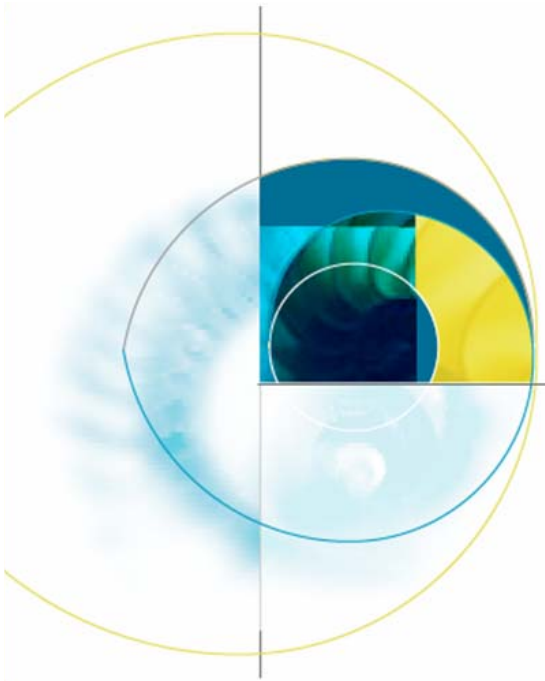
LET'S BEAT DIABETES



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Model Outputs

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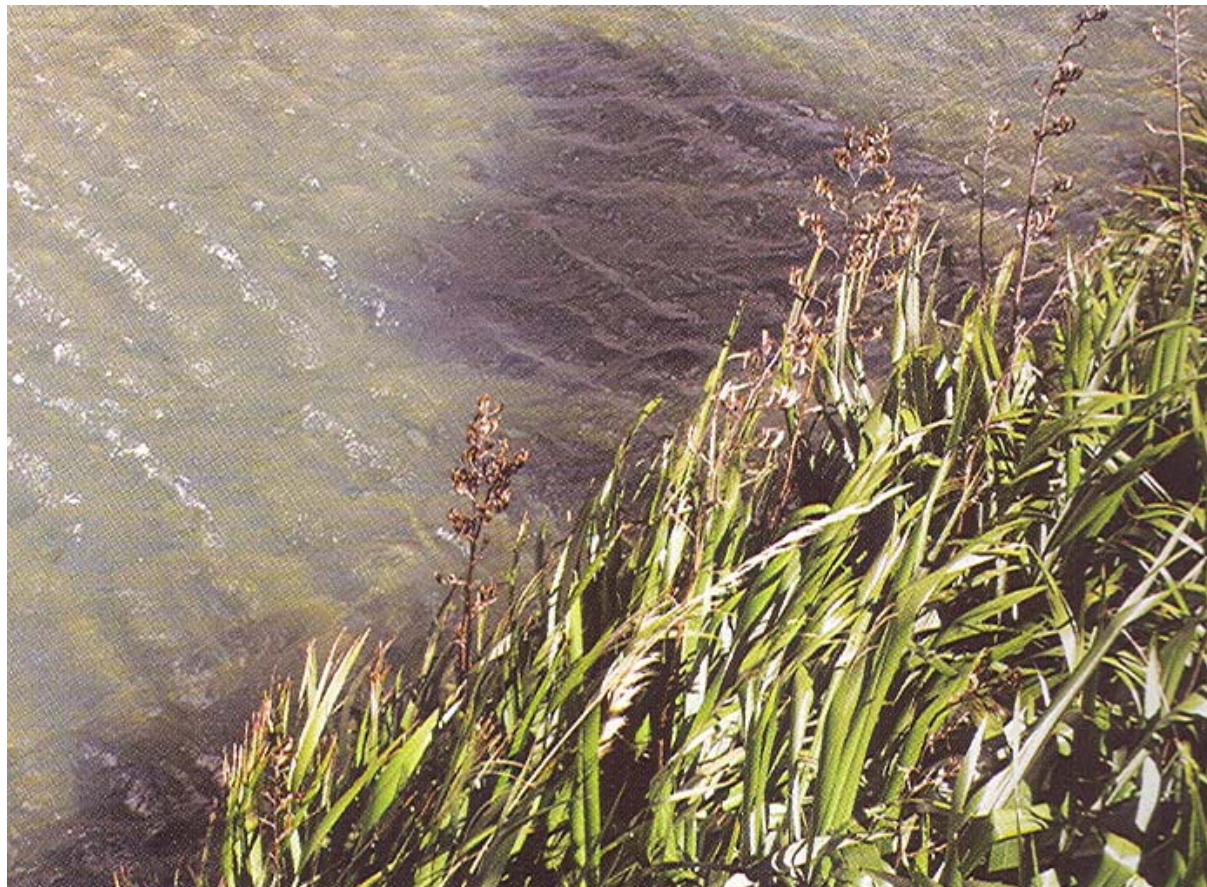
Some Caveats

…computer models faithfully demonstrate the implications of our assumptions and information. They force us to see the implications, true or false, wise or foolish, of the assumptions we have made. It is not so much that we want to believe everything that the computer tells us, but that we want a tool to confront us with the implications of what we think we know.



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LET'S BEAT DIABETES

Let's Beat Diabetes Model

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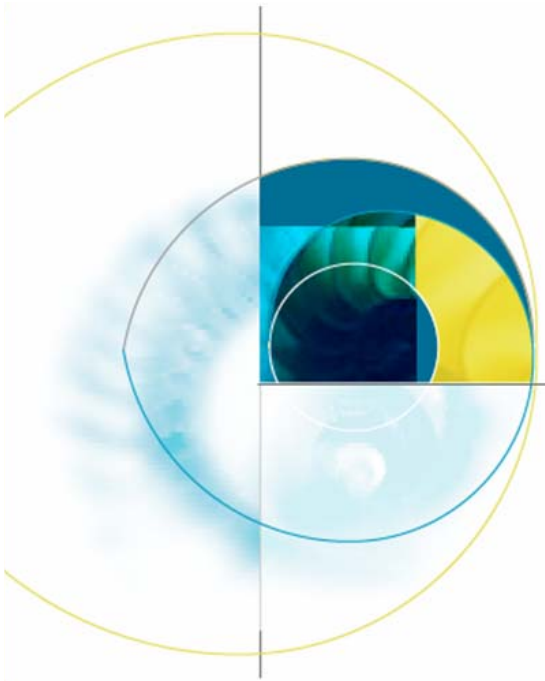

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What Counties Learnt

Counties Manukau District Health Board
6th November 2007

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What Have We Learnt

- "I now look at my work differently. It has given me a better perspective of diabetes in its broader context"
- We now have a good framework that captures our best knowledge. It provides a good research agenda. We can continue to build and refine it as our knowledge base improves.
- We have a more concrete and specific understanding of the consequences of various policy options.
- We are much clearer about the sensitive variables
- We have better questions to ask

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What Have We Got

- A tool that:
  - enables us to explore options
  - can help communicate the complexities of what we are trying to deal with
  - can help build collaboration amongst the various people involved
  - we have a database of knowledge that can be built on
- People who can use the same set of processes and skills to explore more specific aspects such as ESRF or specific programmes such as CCM or Well Child or focus on specific areas of concern such as Maori and Pacific Islanders.

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The Underlying Maths

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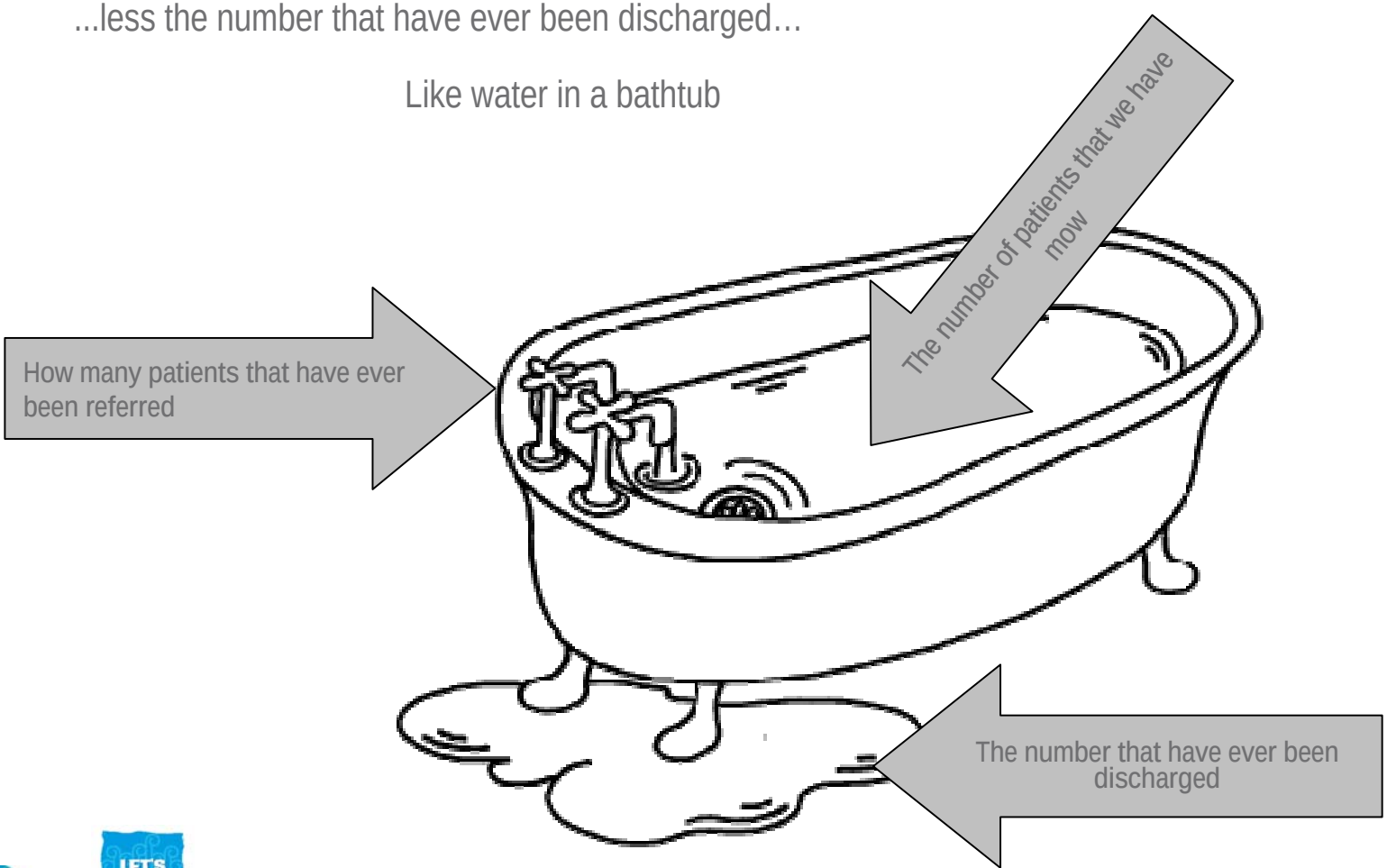
The number of patients you have right now is equal to…

…the number that have ever been referred….

...less the number that have ever been discharged…

Like water in a bathtub



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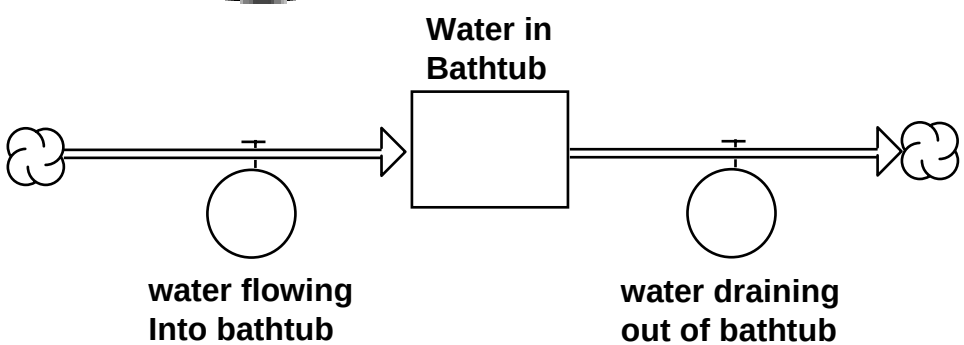
Bathtub Dynamics



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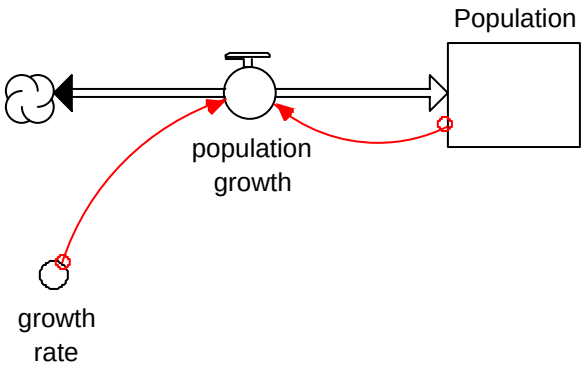
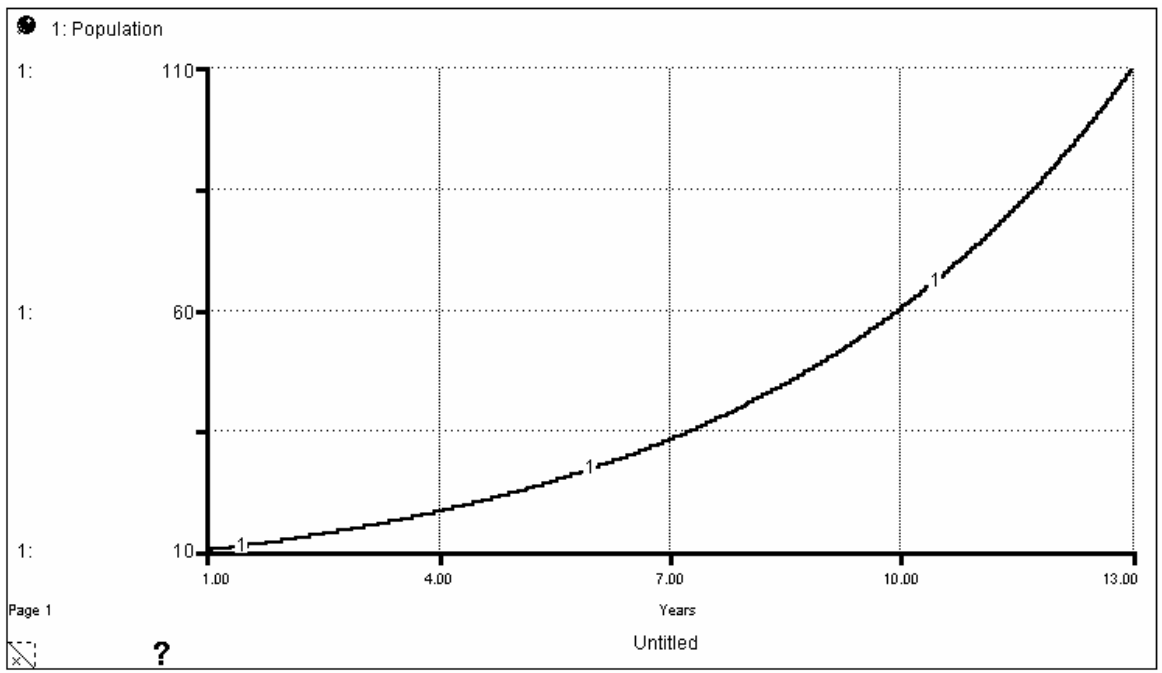
Model Example



Initial population = 10
Growth rate = .2
Population Growth = Population*Growth Rate



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Under The Hood

frac. growth rate = .2
dt = .01

$stock_t = stock_{t-dt} + dt * flow_{t-dt \to t}$

$flow_{t \to t+dt} = stock_t * growth\ rate$

Population

10 (initial) people
10+.01*2 = 10.02
10.02+.01*2.004 = 10.024
10.024+.01*2.0048 = ……

Growth Rate

10*.2 = 2 people/year
10.02*.2 = 2.004 people/year
10.024*.2 = 2.0048 people/year

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