



SYNERGIA

Decision Making in Complex Systems

Practical Application of
Systems Thinking and
Dynamic Modelling

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1st November 2022

Synergia



Synergia Learning Series

1. Implementation Science
 - No link
2. Creating a Data Commons – better decision making through integrated data
 - <https://synergia.consulting/news/creating-a-data-commons/>
3. Mātauranga Māori and Systems Thinking
 - <https://synergia.consulting/news/matauranga-maori-and-systems-thinking/>
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 - <https://synergia.consulting/uncategorized/systemic-approaches-to-obesity-prevention>
5. Maximising the value from evaluation
 - <https://synergia.consulting/news/maximising-the-value-from-evaluation/>
6. System Thinking basics – approaches, tools and techniques
 - <https://synergia.consulting/news/system-thinking-basics-approaches-tools-and-techniques/>
7. Introduction to System Dynamics Simulation Modelling
 - <https://synergia.consulting/news/introduction-to-system-dynamics-simulation-modelling/>

Tonight

- What does Systems Thinking have to offer?
- Qualitative tools for understanding systems
- Quantitative tools for understanding systems
- Discussion / questions



What Does Systems Thinking Have to Offer?

Population Health

- Population Health, as a discipline, has a strong focus on identifying individual “risk factors” or “determinants” of disease in populations.
 - This approach focuses on developing population health interventions that target these determinants individually, ultimately decreasing the risk of poor health outcomes they determine. We assume these interventions have direct, linear effects and are consistent across different places in different times.
 - This has led to some great successes e.g. - victories: germ theory, the health hazards of smoking, and a more nuanced understanding of the etiology of cardiovascular disease—all of which have vastly improved human health.
-

BUT:

“Hunger, poverty, environmental degradation, economic instability, unemployment, chronic disease, drug addiction, and war, for example, persist in spite of the analytical ability and technical brilliance that have been directed toward eradicating them. No one deliberately creates those problems, no one wants them to persist, but they persist nonetheless. That is because they are intrinsically systems problems—undesirable behaviors characteristic of the system structures that produce them. They will yield only as we reclaim our intuition, stop casting blame, see the system as the source of its own problems, and find the courage and wisdom to restructure it.”

Meadows, D. (2008). *Thinking in Systems: A Primer*. Vermont: Chelsea Green Publishing.

System Thinkers are always asking what are the *system conditions* that are creating the behaviours we see and how can we redesign the system to deliver different behaviours

A System is...

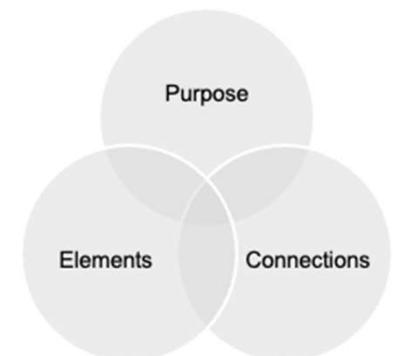
"A system is an interconnected set of elements that is coherently organized in a way that achieves something."

Meadows, D. (2008).
Thinking in Systems: A Primer.
Vermont: Chelsea Green Publishing.

A system must, therefore consist of three kinds of things:

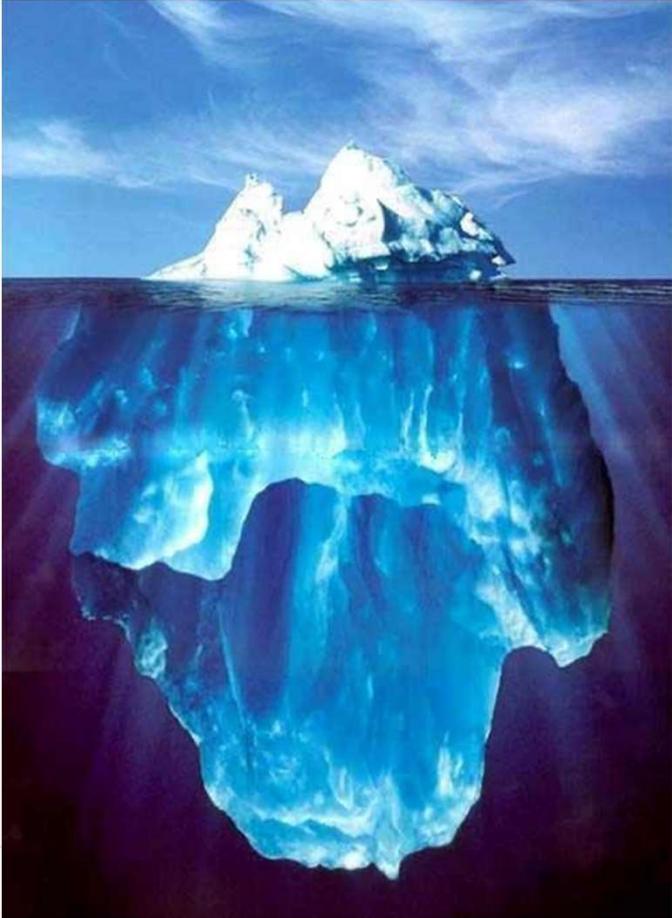
- Elements,
- Connections, and
- A function or purpose

]= Structure



Seeing Systems Through Structure

Increasing Leverage



EVENTS

React

PATTERNS

Prepare

STRUCTURE

MENTAL MODELS

Design

VALUES

Changing Systems = Changing Structure

Changing systems requires an understanding of the conditions that are creating the behaviour of interest. Systems change aims to bring about lasting change by altering underlying structures and supporting mechanisms which make the system operate in a particular way. These structures and supporting mechanisms can include policies, routines, relationships, resources, power structures, values, mental models.

As a result systems thinking focuses on highlighting these structures and supporting mechanisms, aiming to improve our understanding of the complex interplay among people, place, and time

Different Responses to the Same Data

One of the features of complex human systems, is that people in it often have completely plausible, yet conflicting interpretations of the same events and data – they have different ‘mental models’.

Visual mapping and modelling tools are powerful ways of surfacing these differing perspectives and finding ways to test them and potentially accommodate them into one ‘meta’ perspective

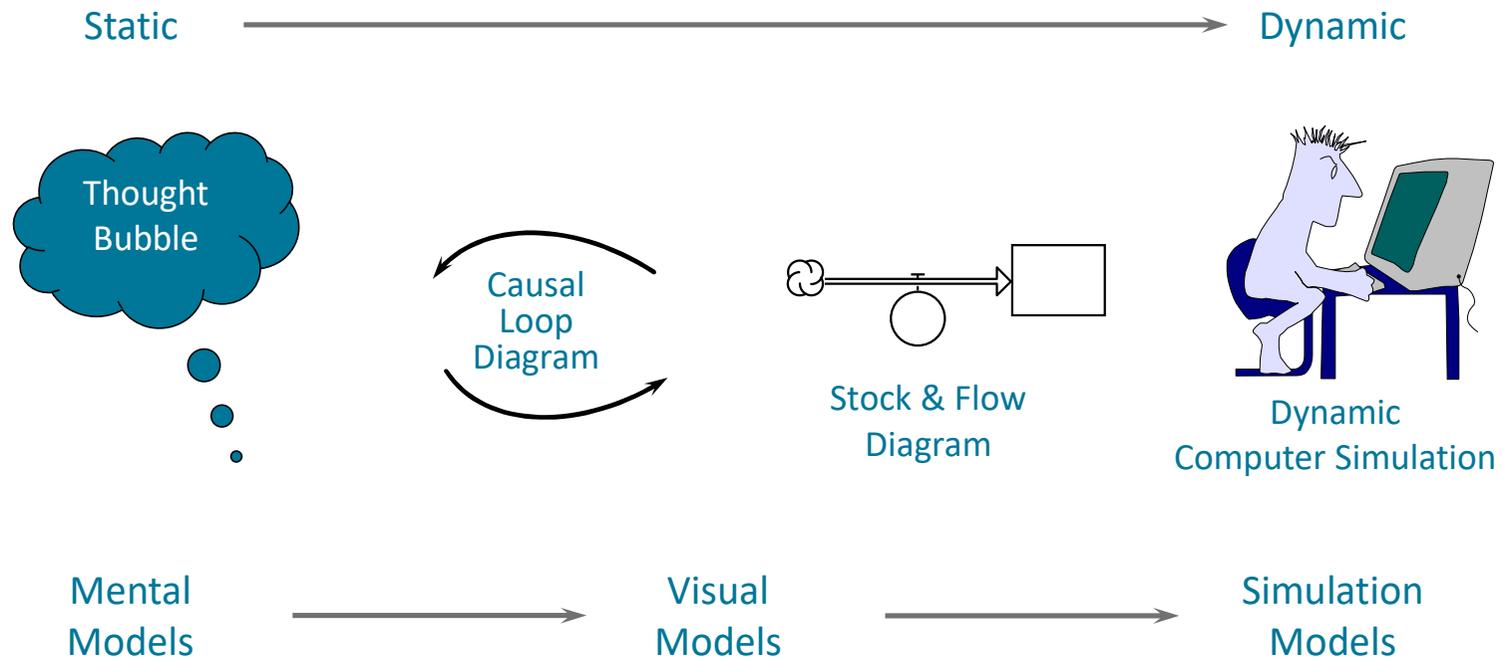
Another But;

It is very difficult to discuss systems with words only. Words, by their nature come one at a time, in a linear, logical order. Systems happen all at once. They move, not in straight lines but multiple directions, all at the same time.

To discuss systems we need a language that has some of the properties of the systems we are trying to understand. System Dynamics is one of the system disciplines that has a language, a pictorial language that helps to build up system pictures.

It is this language we want to share with you this afternoon

We All Use Models



All Models Are Wrong and Most Research is False

“All models are wrong, but some models are useful”

George Box & Norman Draper (1987)
Empirical Modelling and Response Surfaces
New York. Wiley

“The best model of a cat is a cat”

Norbert Wiener(1945)
https://en.wikiquote.org/wiki/Norbert_Wiener

The Contribution of System Thinking

We certainly do not believe that Systems Thinking is better than a reductionist way of seeing. It is complementary and therefore can be revealing.

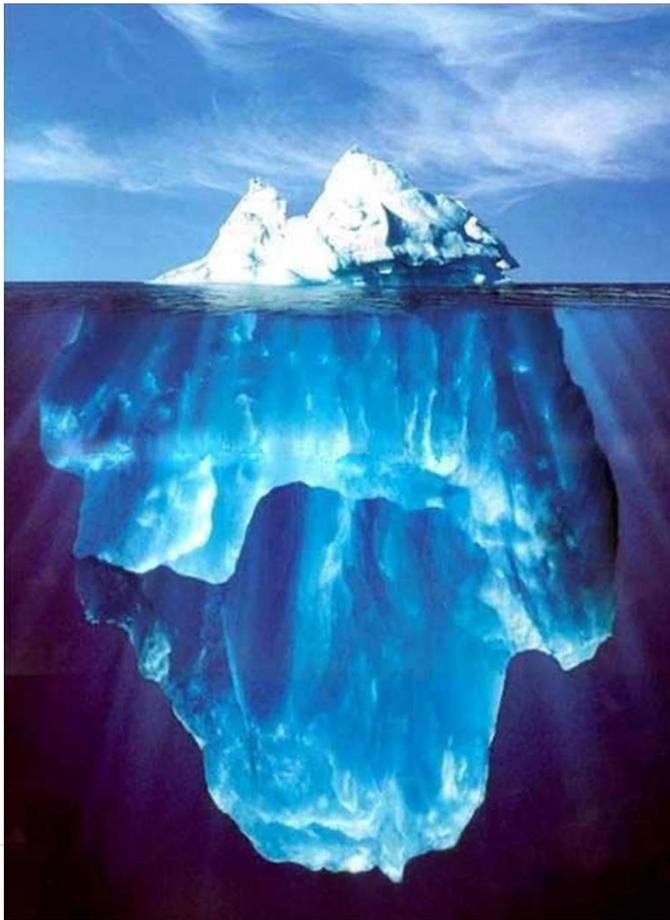
There are multiple ways of seeing the world, and each can contribute to increasing our knowledge of the amazing and complex world within which we live.



Qualitative Tools

Seeing Systems Through Structure – a reminder

Increasing Leverage



EVENTS

React

PATTERNS

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MENTAL MODELS

Design

VALUES

WINTER PAIN

WINTER PAIN

- A 62-year-old woman punched a healthcare worker after waiting **21 hours** in Auckland Hospital's ED.
- She waited a total of **27 hours** before being admitted to its mental health unit.
- Security were called to the ED **260 times** over winter last year.
- On June 30, security staff were called **9 times** in 24 hours.
- At Christchurch Hospital, security staff were called **85 times** over winter.

Emergency dep
around the cou
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over the past 9
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A health
punch
62-year-old woman who
had spent 21 hours in
Auckland City Hospital's emergency
department because there were no
beds in the mental health unit.
Another "extremely verbally

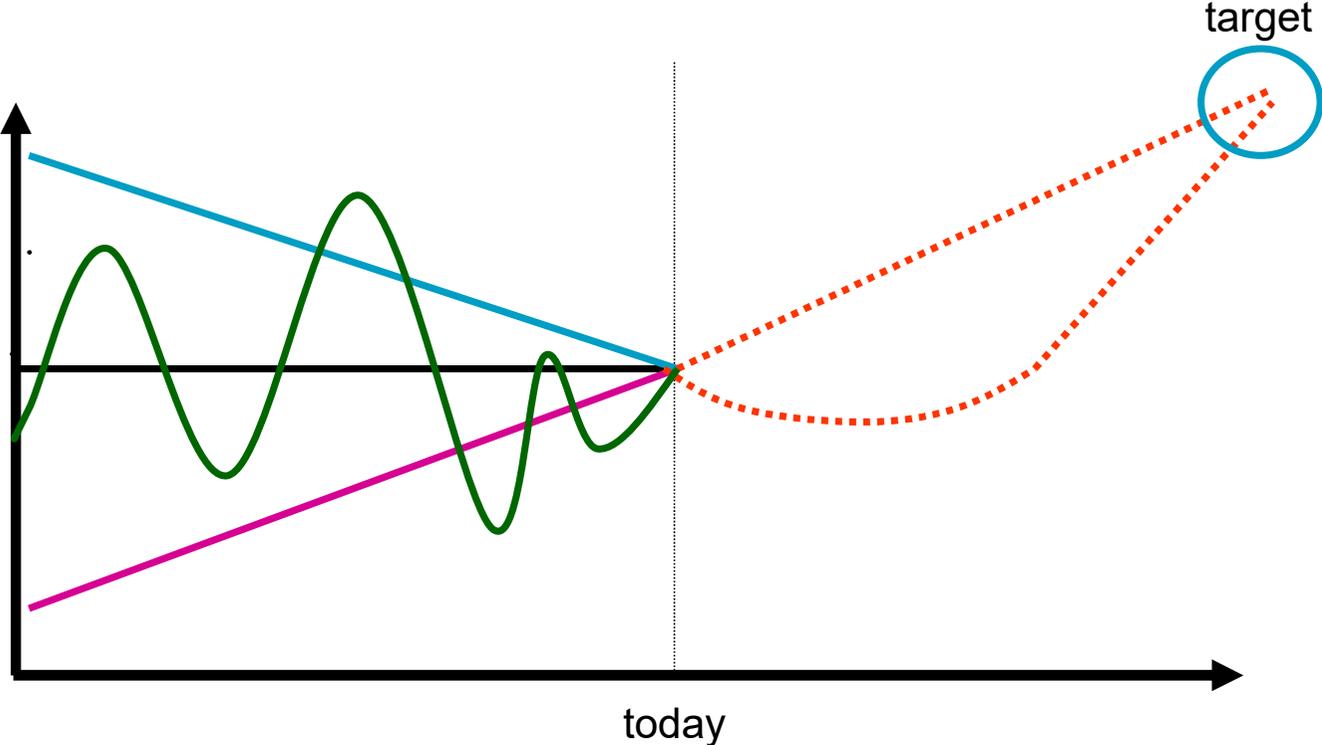
winter, documents reveal workers at Auckland City Hospital's busy emergency department regularly face abusive behaviour and threats from mentally unwell patients, writes **Sophie Trigger**

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Hospital's ED,
before being
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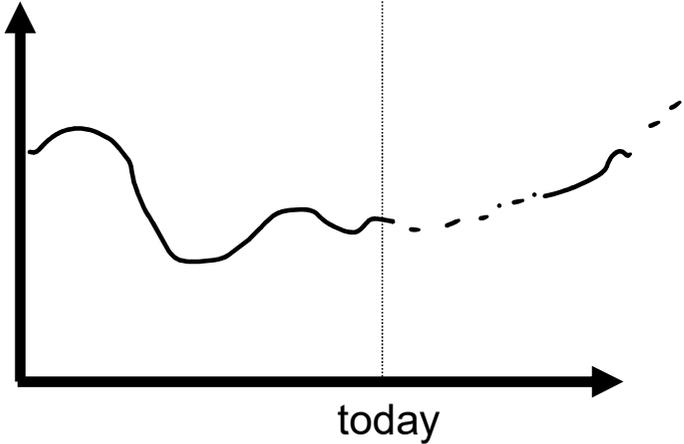
otence and
staff were not
employed in the New
Zealand Medical Journal, the report
found verbal abuse and threats
toward staff accounted for 69 per
cent of all reports. Incidents involving
physical threats or assault made up

Have a history and future

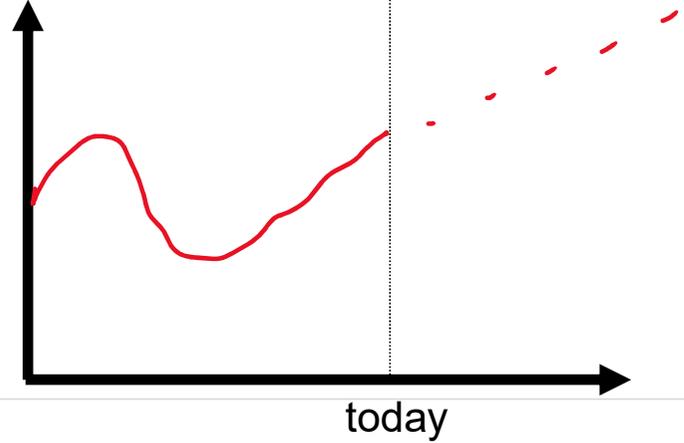


Moving from static lists to list with patterns

- Waiting times in ED are really high



- We are experiencing nursing workforce shortages

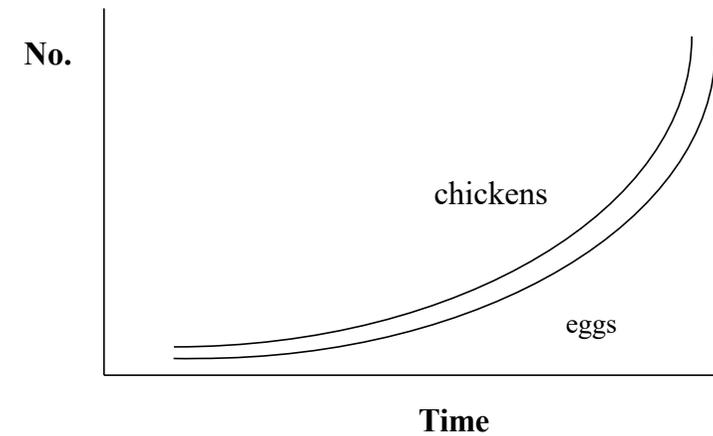
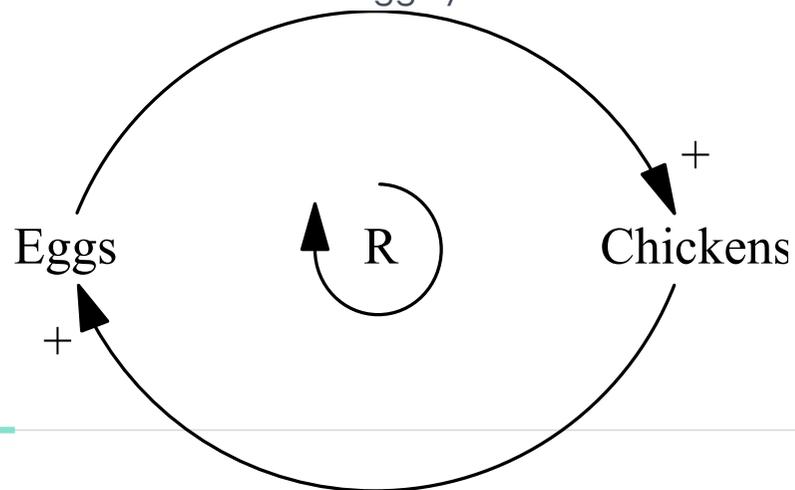


Causal Loop Diagrams

Help to understand what is causing the behaviour we see. Helps us start to dig into the 'structure' of the system and understand the 'mental models'

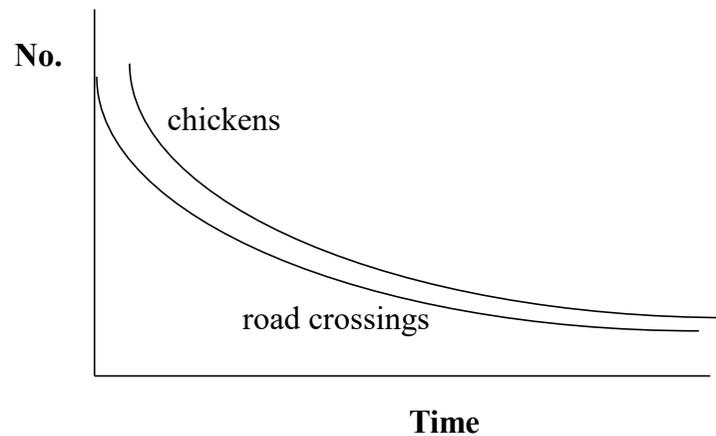
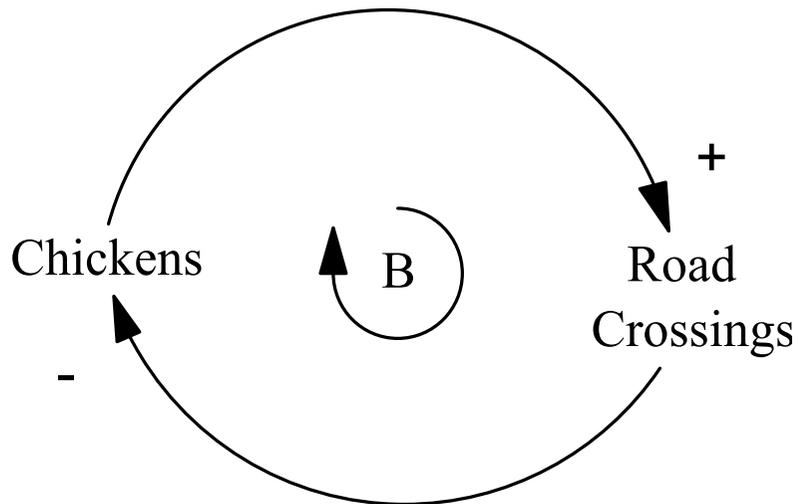
The complex system for today is:

- The chicken and egg system



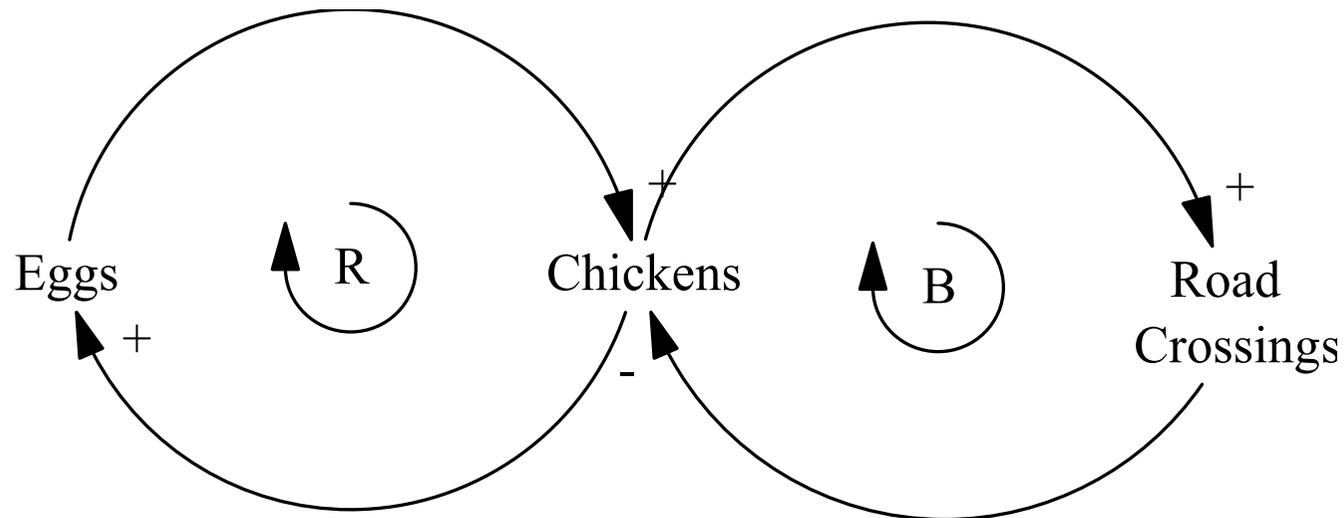
Reinforcing feedback loops generate “runaway” behaviour (they reinforce in the same direction of change).

Be careful crossing the road



Counteracting or balancing feedback loops generate “homing in” behaviour
(they resist change; push them one way, they push back the other).

A complex system in action



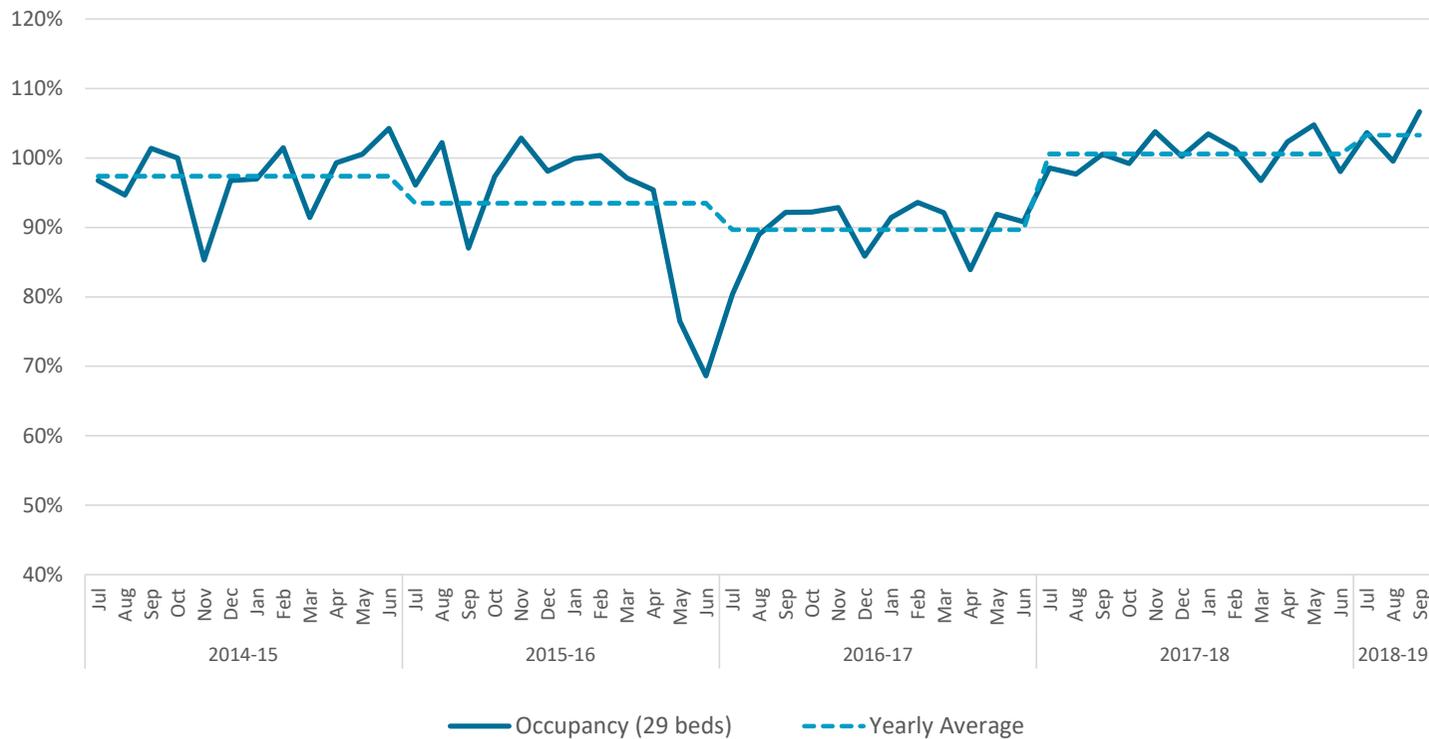
What are the dynamics of the chicken population when both loops are active simultaneously?

Sketch a behaviour over time graph showing the behaviour of the chicken population over time. Assume the initial population is 10 chickens - but includes at least one rooster.

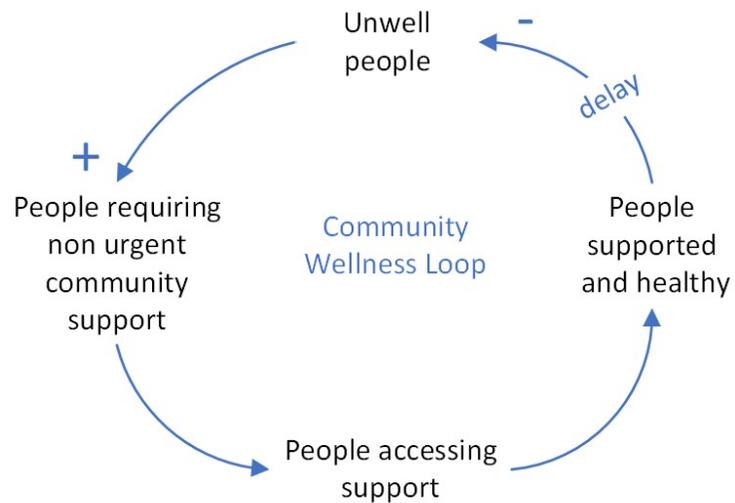


**An example –
demand for
acute mental
health services
increasing**

In patient occupancy has been consistently at 100% or more since July 2017



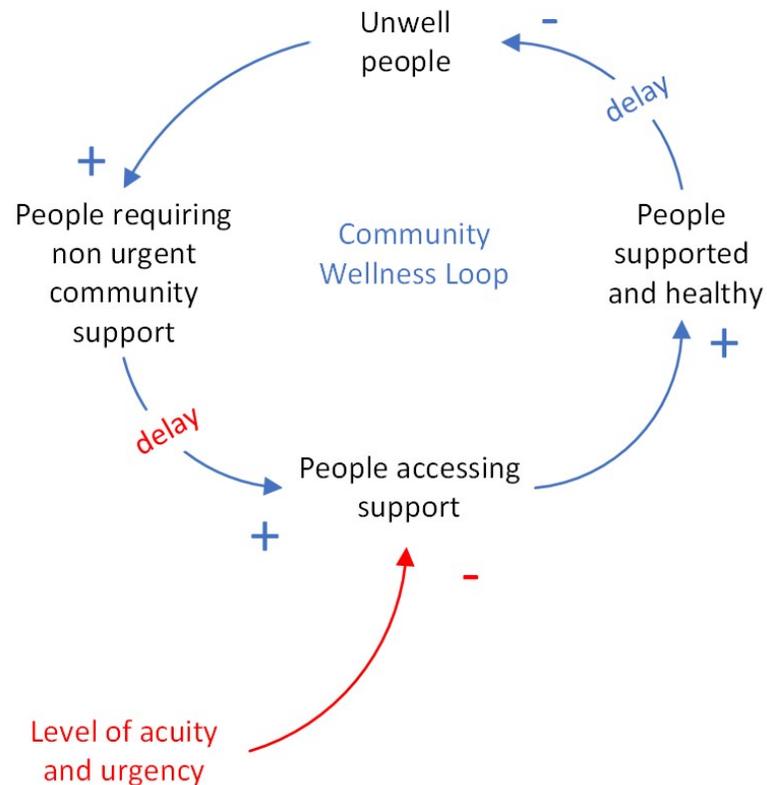
Exploring the dynamics that may be driving the data story



Most people are healthy. Over time some people become unwell and require non urgent support from a community team.

People access this support and recover, regaining a level of health and wellbeing.

Exploring the dynamics that may be driving the data story

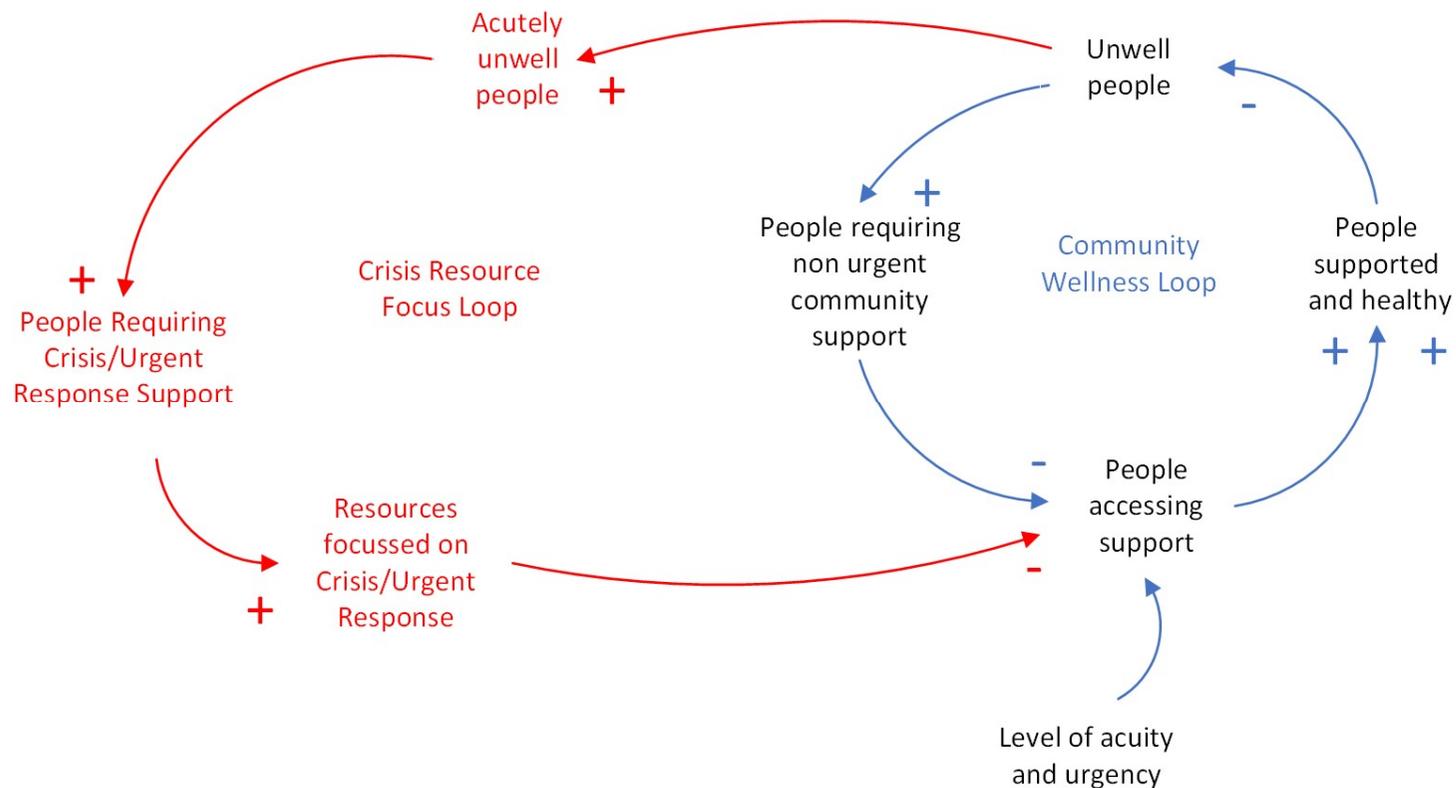


For some people however there are delays in accessing community support.

Some people do not get access when they should, or there are gaps in care due to overall system demand and a focus on higher acuity.

This is reducing the ability of community teams to support people with planned, proactive care, leading to the build up of pressure and demand in the community system.

Exploring the dynamics that may be driving the data story

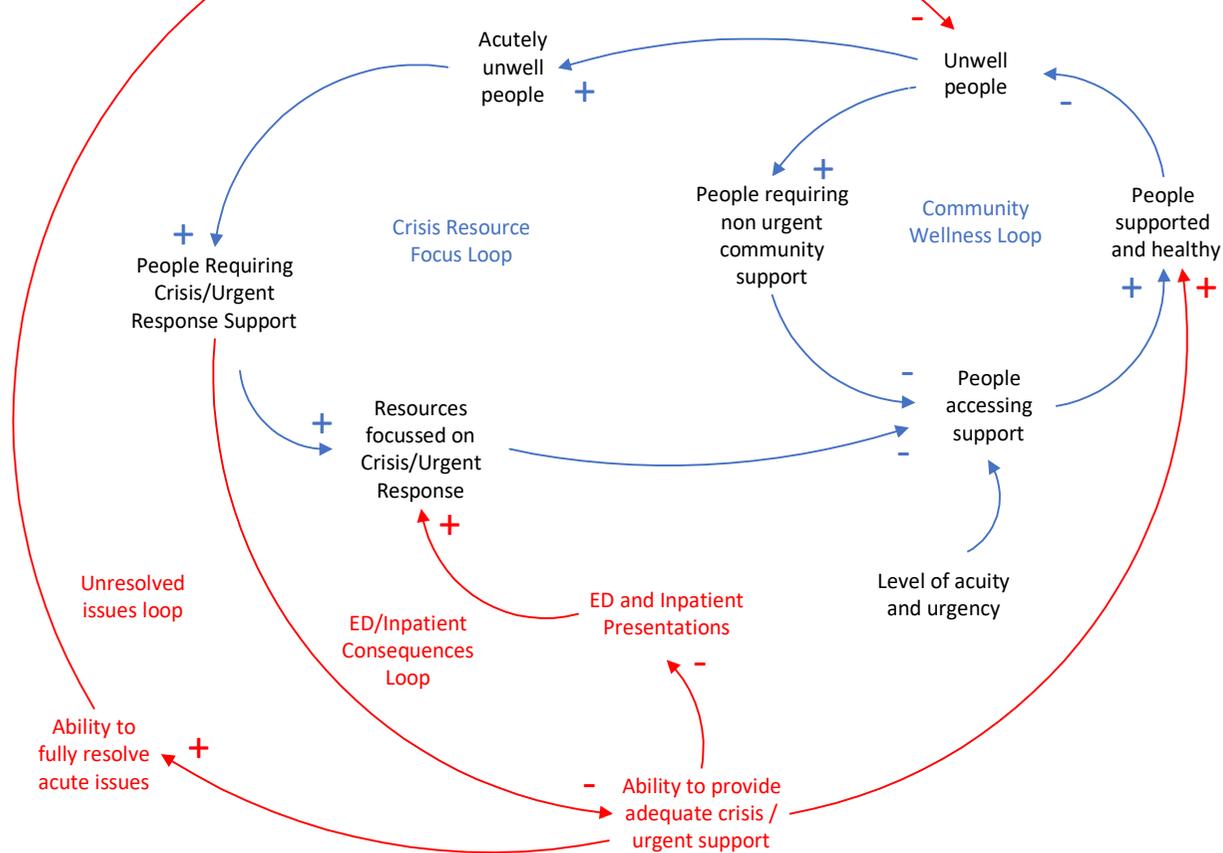


As the level of unresolved mental illness rises, the level of acutely unwell people increases.

This is placing pressure of crisis and community mental health teams whose focus becomes increasingly on people with urgent/acute needs.

This further reduces the capacity of community team to provide proactive support.

Exploring the dynamics that may be driving the data story

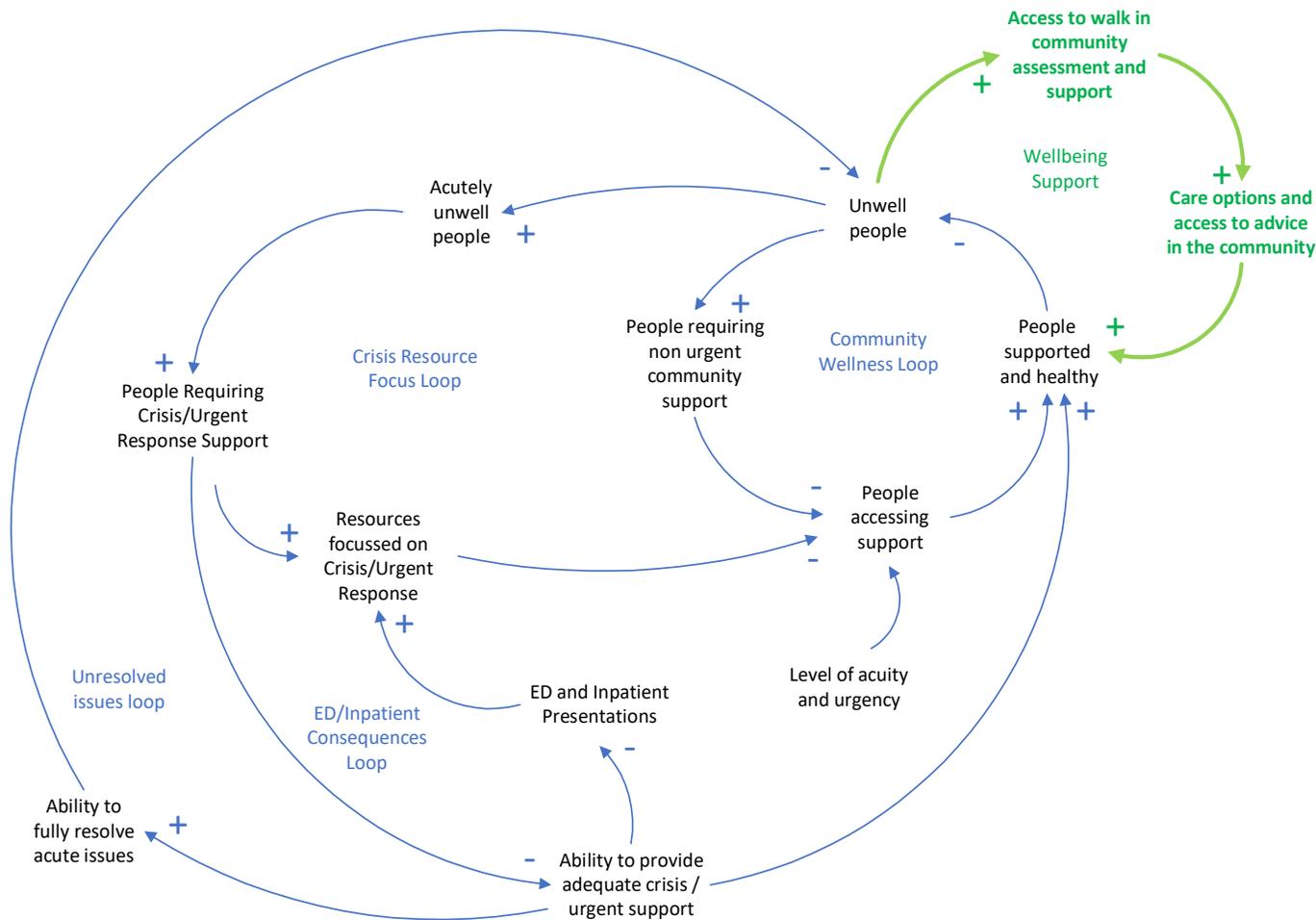


As acuity rises more people start presenting at ED. This means that crisis/urgent resources become more focussed on provide acute/urgent support.

By focussing on acute issues, the longer term recovery support is not provided, further reinforcing the inability to fully resolve issues in a proactive and supportive way.

This means that whilst people are having their acute needs met their underlying needs are not being met meaning that they are remaining unwell.

Exploring the dynamics that may be driving the data story



To break this cycle we are proposing a walk-in community assessment and support service.

This will provide rapid access (no delay) for those who are unwell to access care and support options in the community – supporting them to stay well and return to state of wellness.

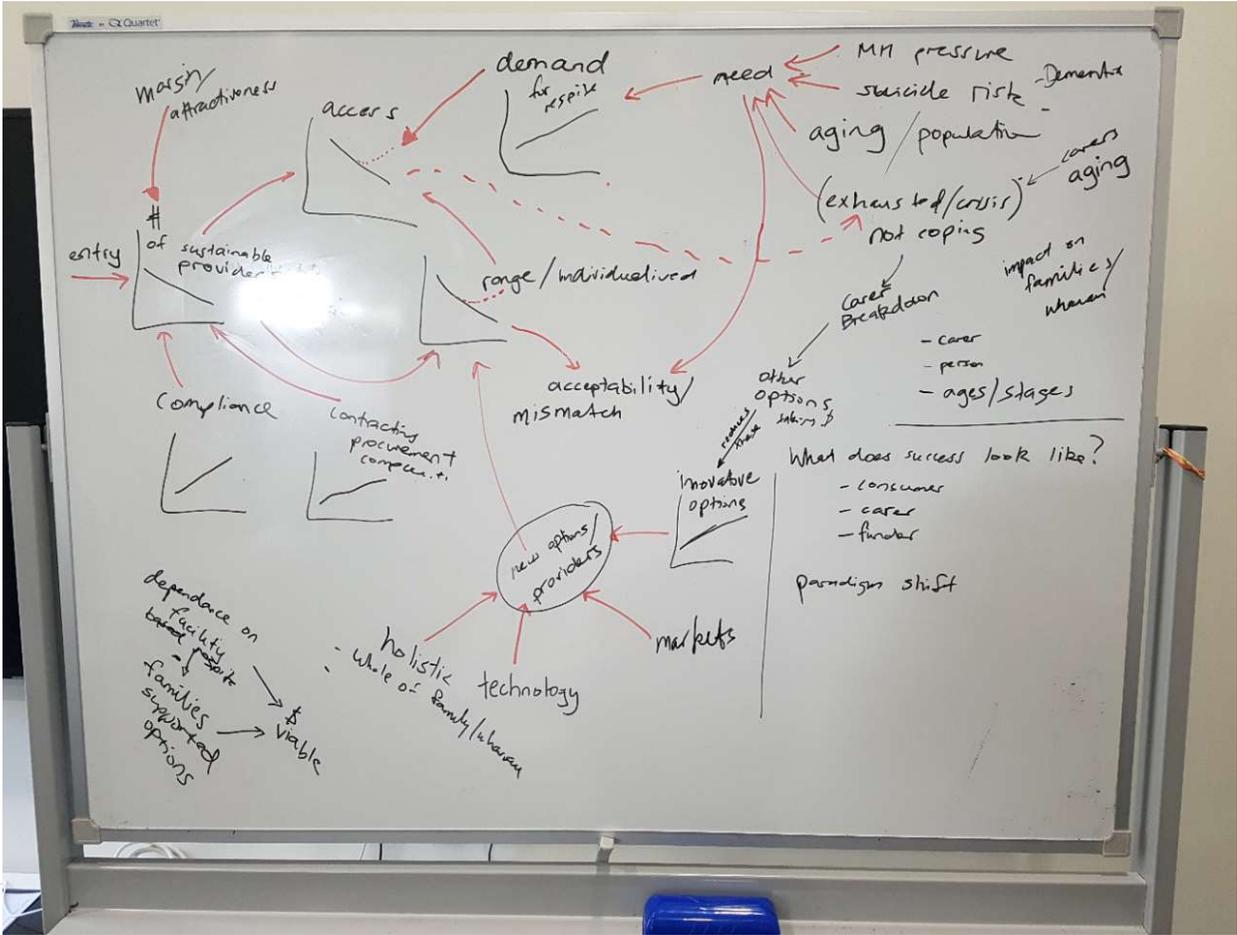


An example – BOT and CLD

Case for investment respite services

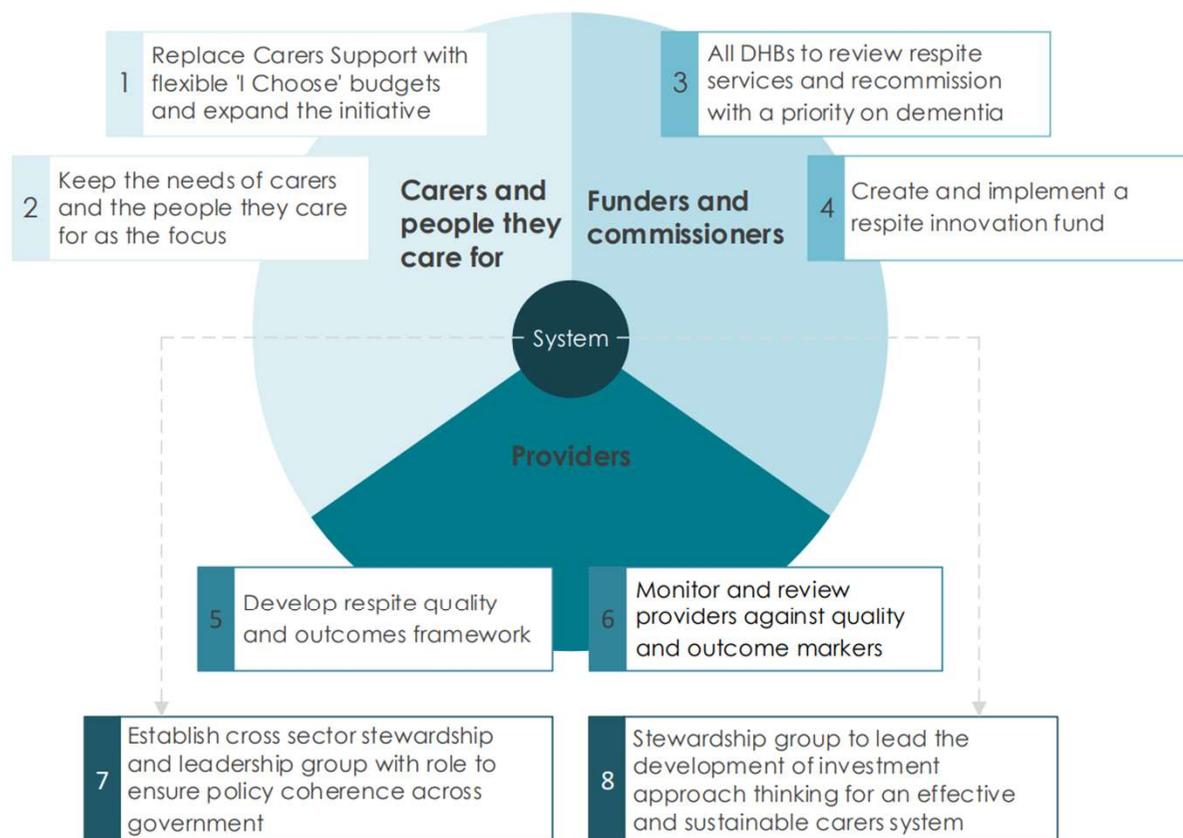
List of factors

- Aging population
- Lack of services
- Need increasing
- Compliance costs for providers
- Viability of providers
- Carers aging
- Lack of investment

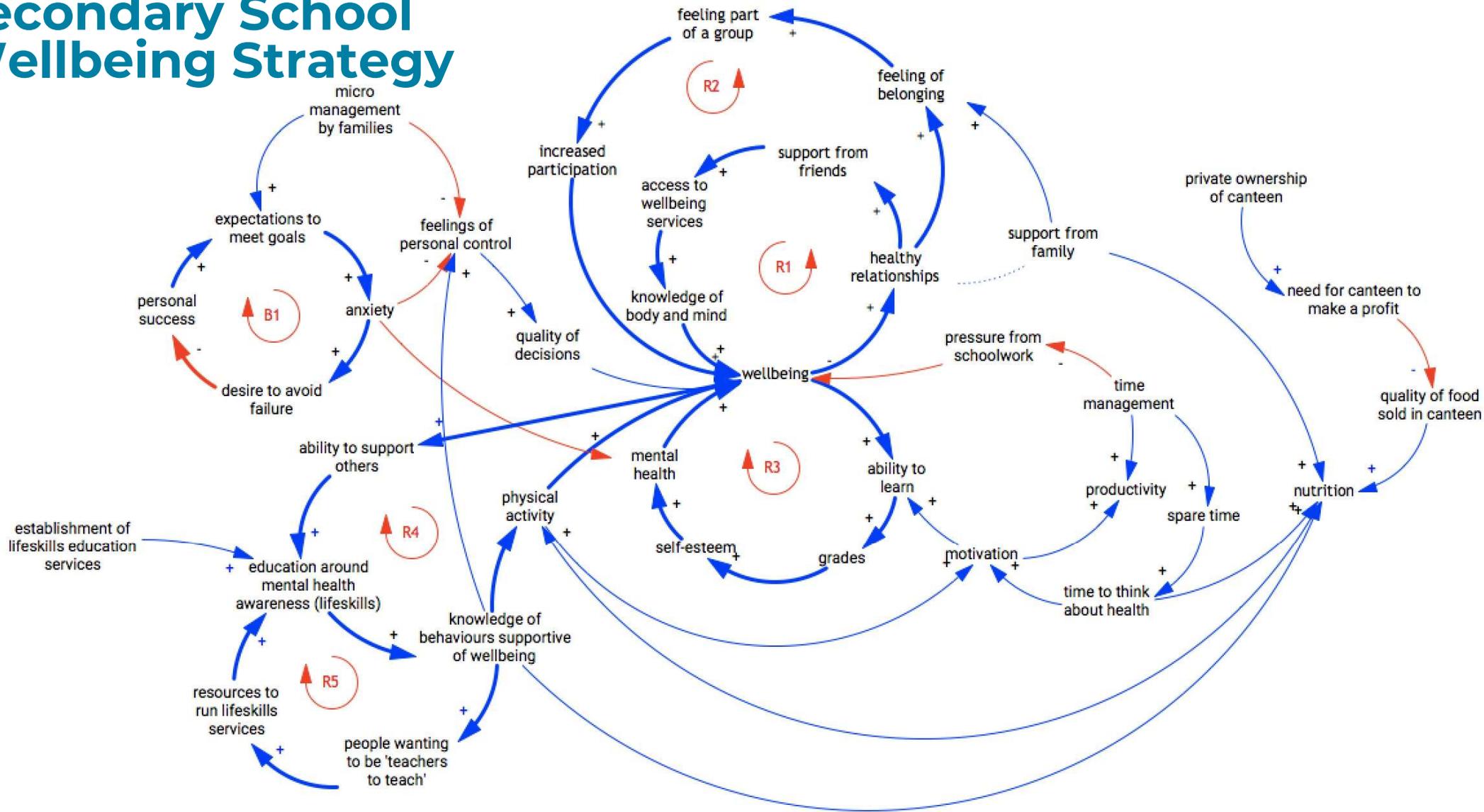


RESPIRE IN NEW ZEALAND

WE MUST DO BETTER

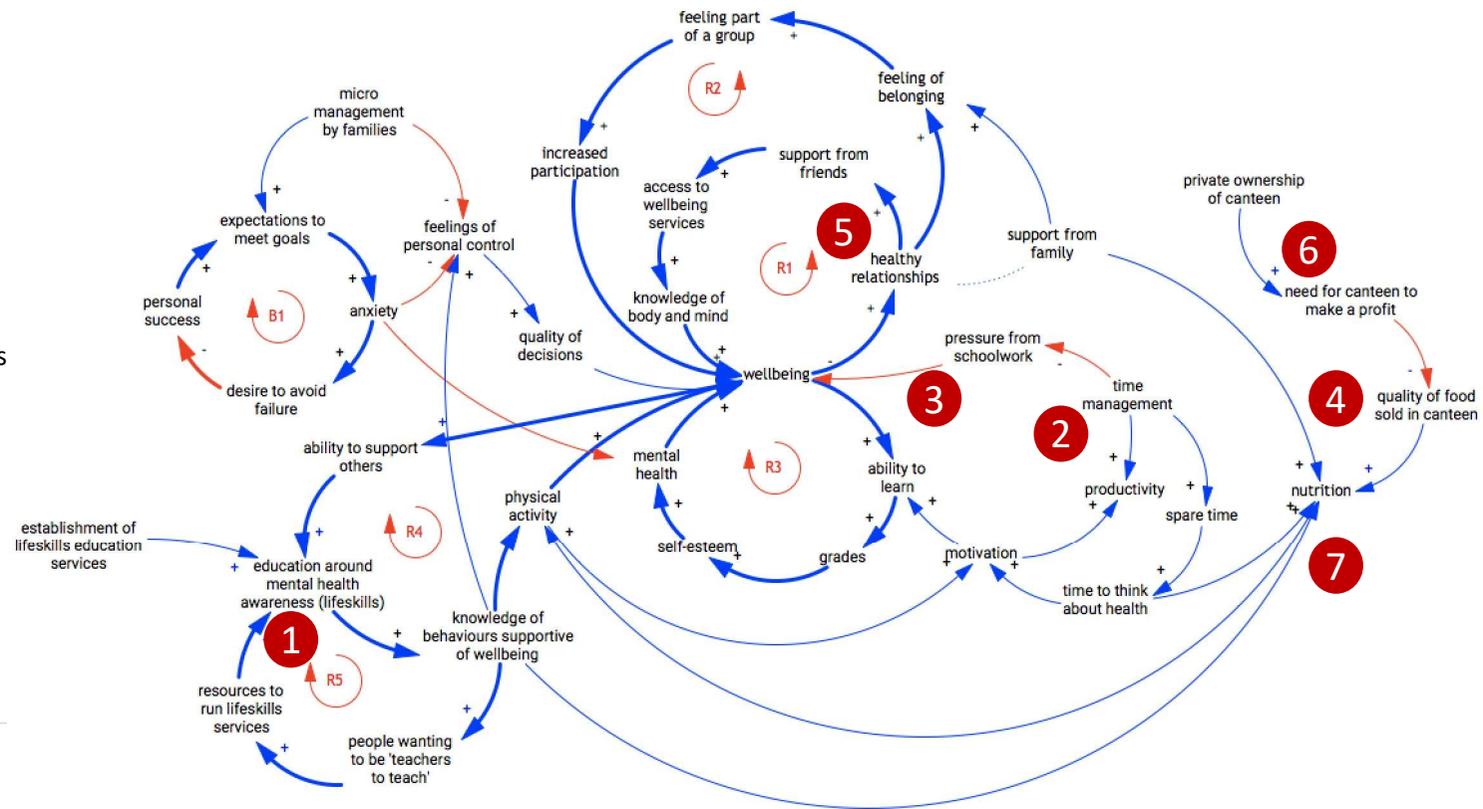


Secondary School Wellbeing Strategy



Mapping Potential Actions

- 1 Create a new life-skill class/seminar series
- 2 Provide a course to help Improve peoples' time management
- 3 Build a nurturing school environment
- 4 Change the canteen menu
- 5 Develop activities to support positive relationships
- 6 Change canteen business model
- 7 Change nutrition guidelines for school events





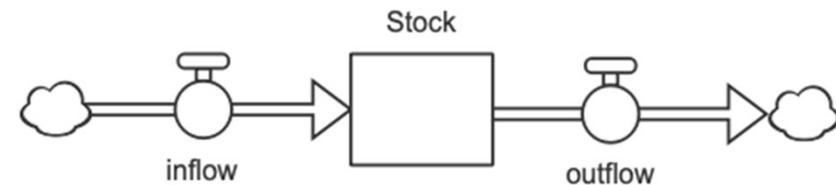
Simulation Modelling



1. Understanding Structure

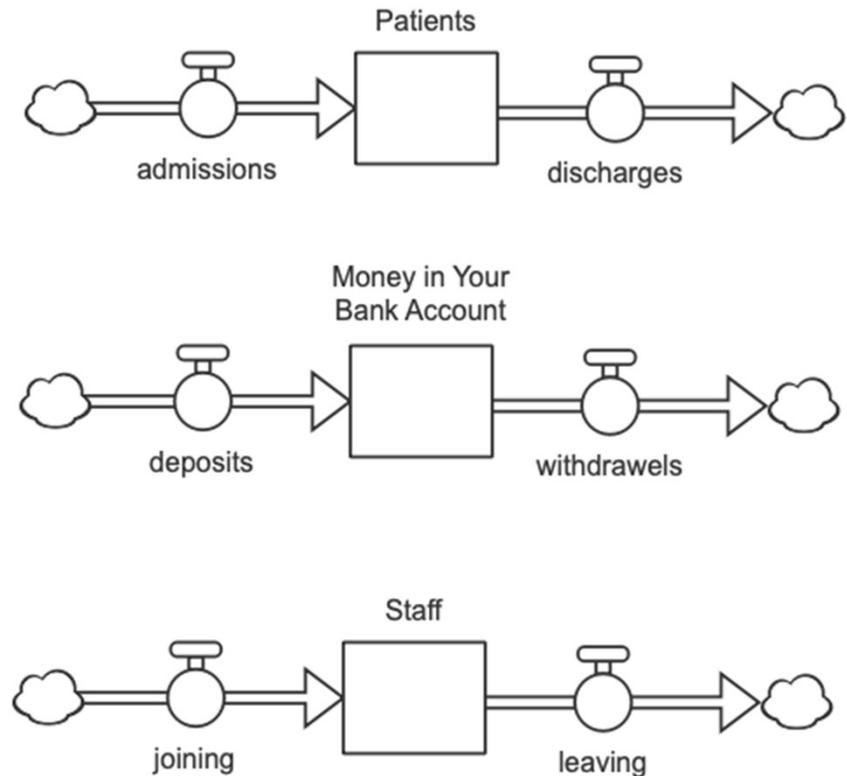
Stocks & Flows

- Stocks are just what they sound like – system elements that you can see, feel, touch, measure. Patients in a hospital, staff running a service, quality of care....
- A stock does not have to be physical – quality, power, capability are all stocks
- Stocks change over time through changes in the flows. A stock is the current sum of all the inflows and all the outflows that have occurred throughout the system's history.

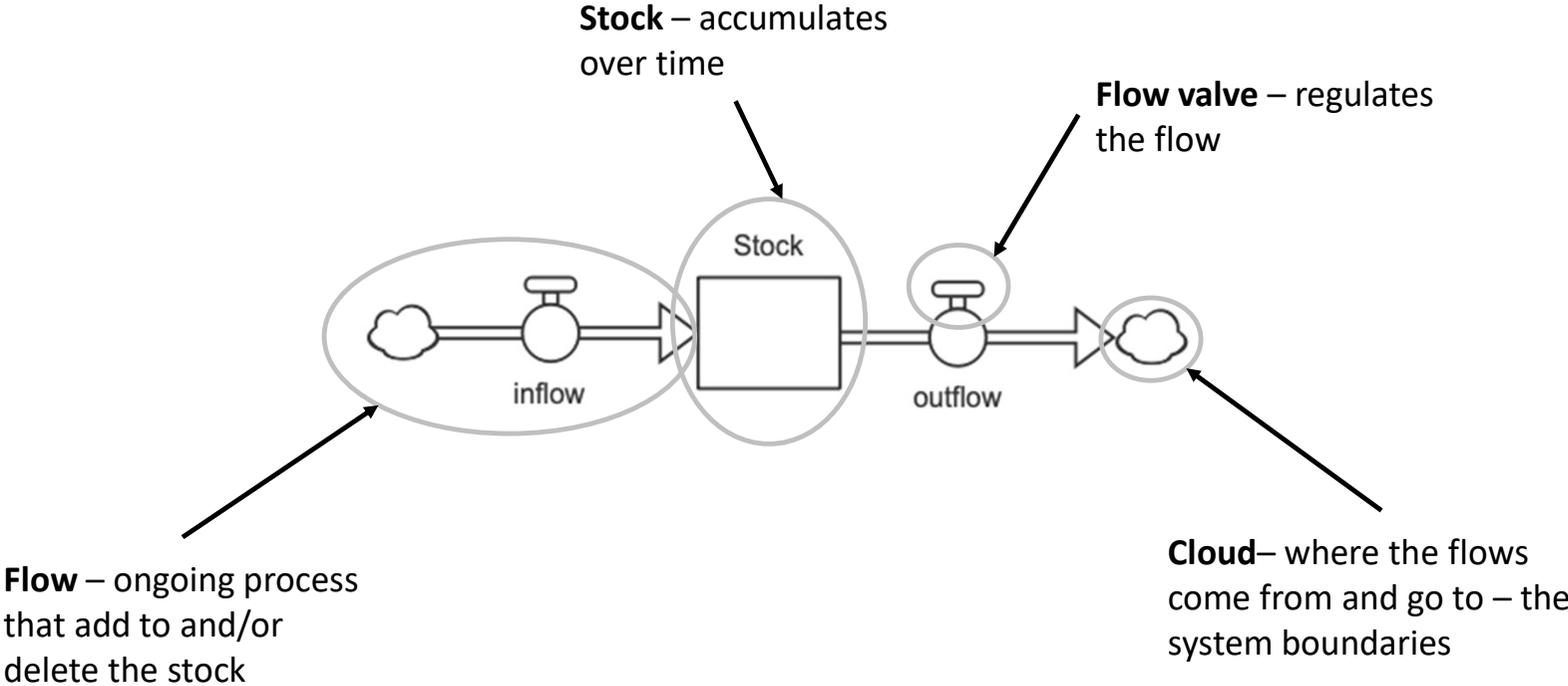


Stocks & Flows

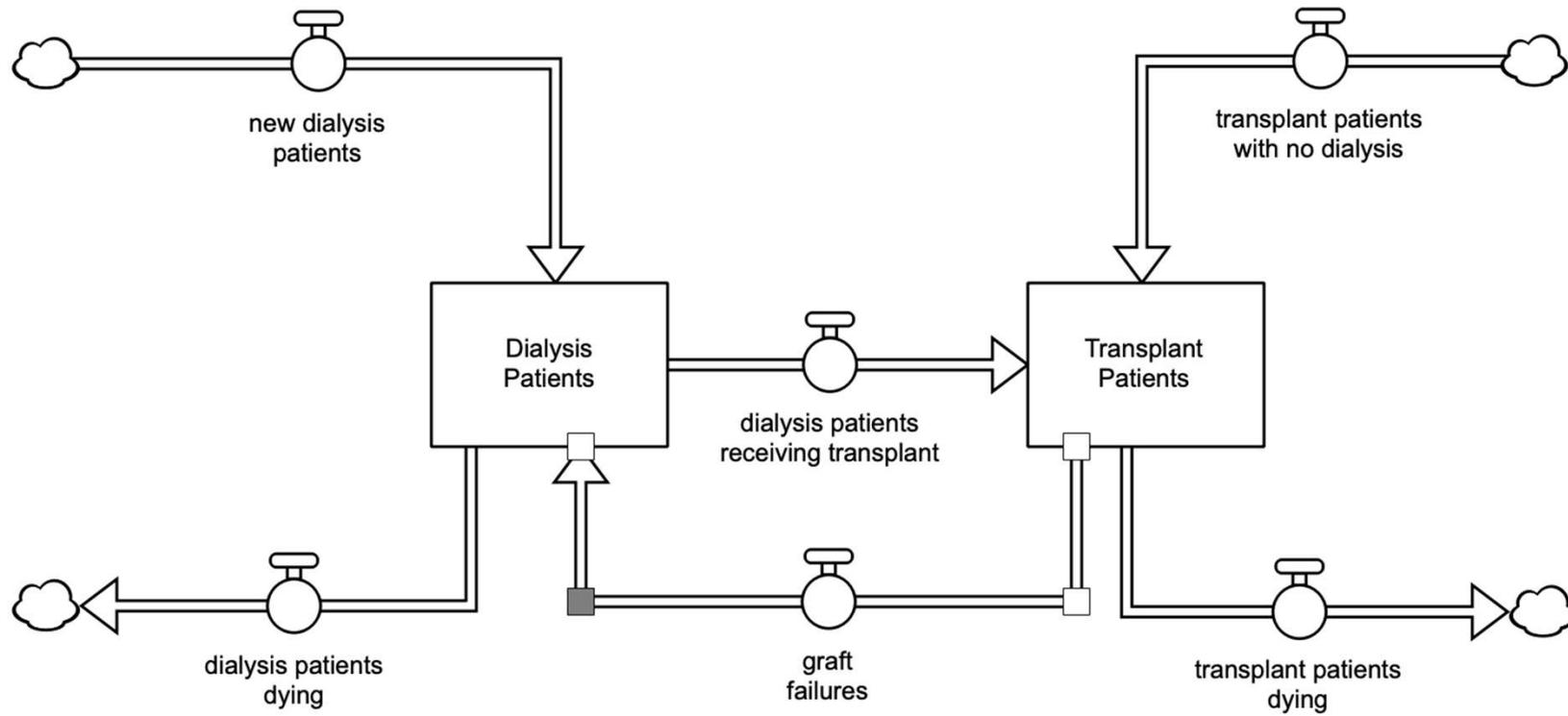
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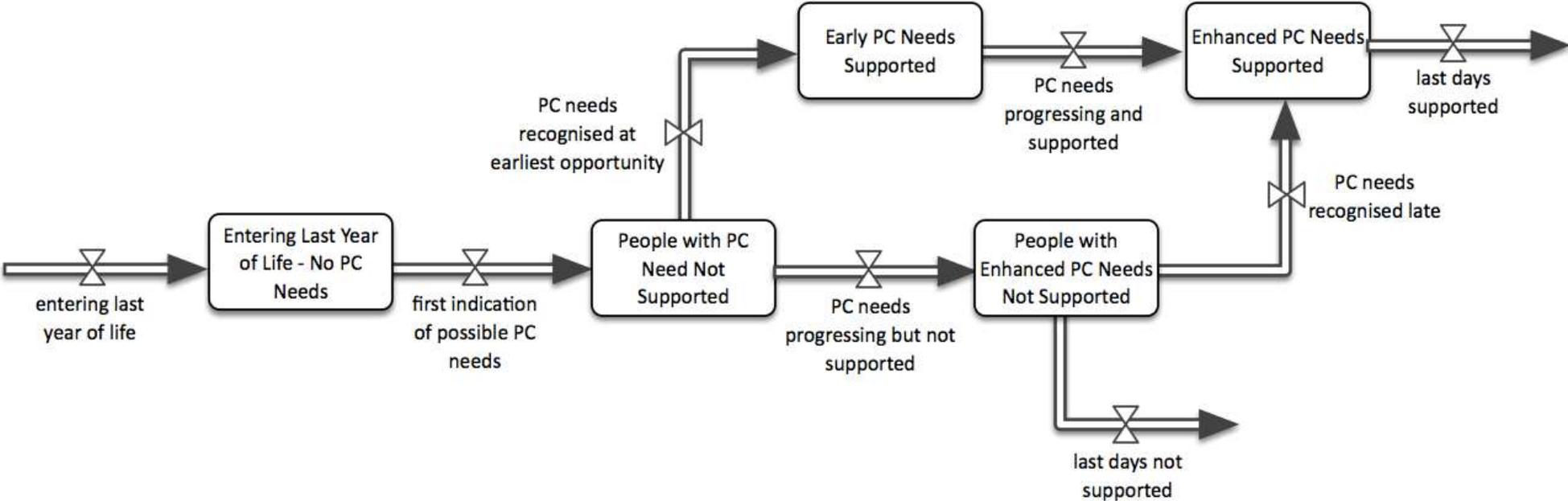
Stocks & Flows



Renal Patients



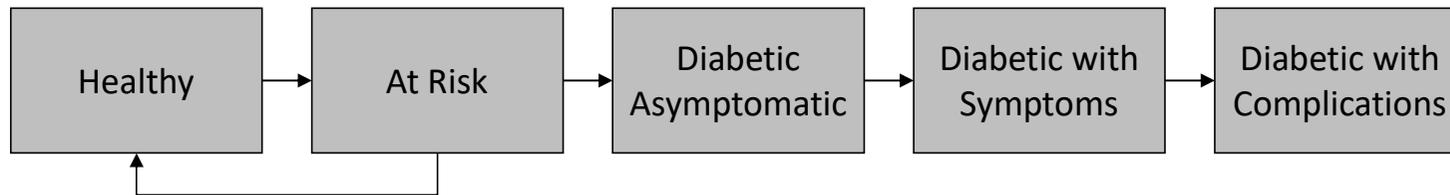
Palliative and End-of-Life Care





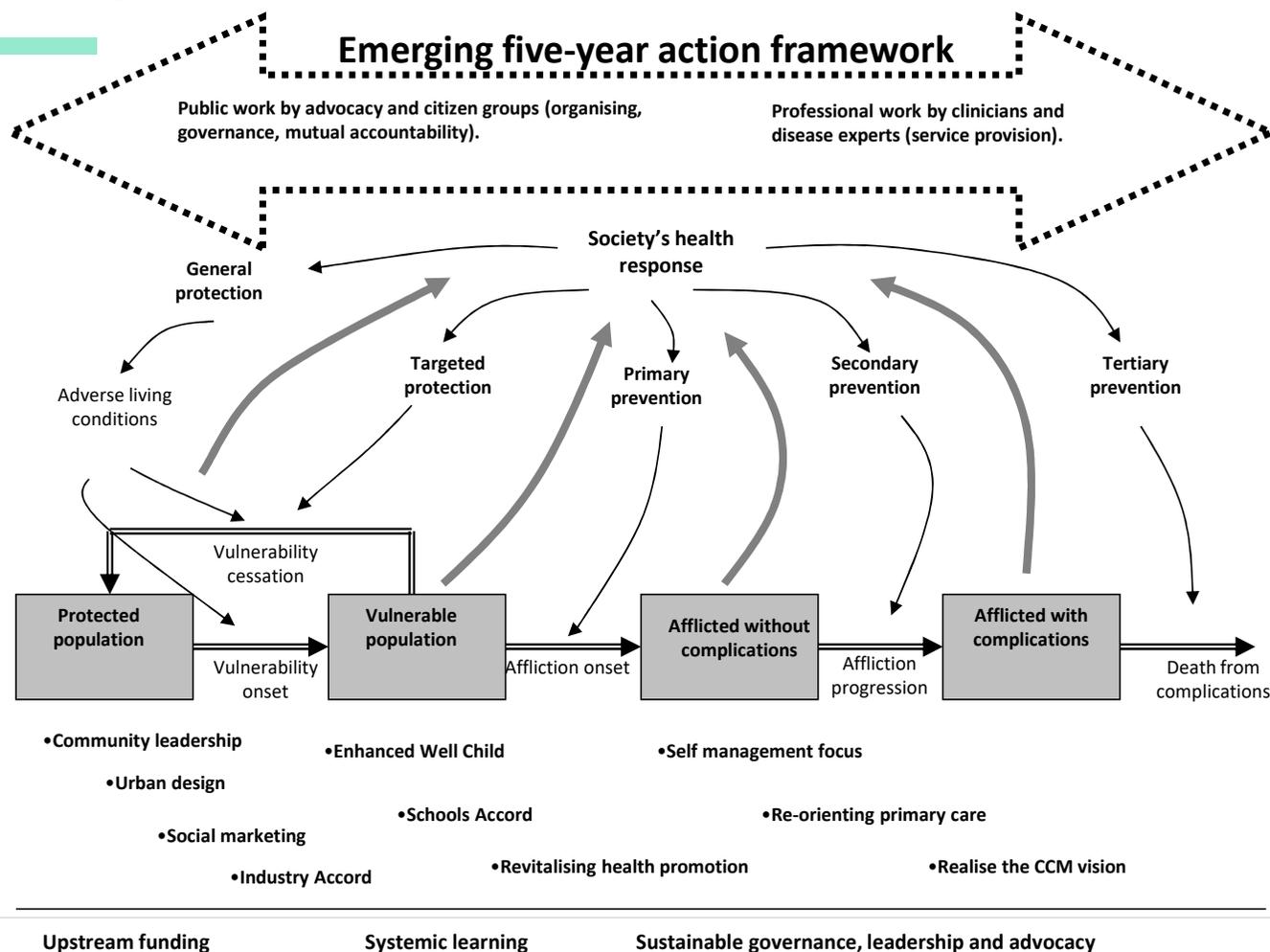
Same Condition Different Structure: Examples from Diabetes

October 2003

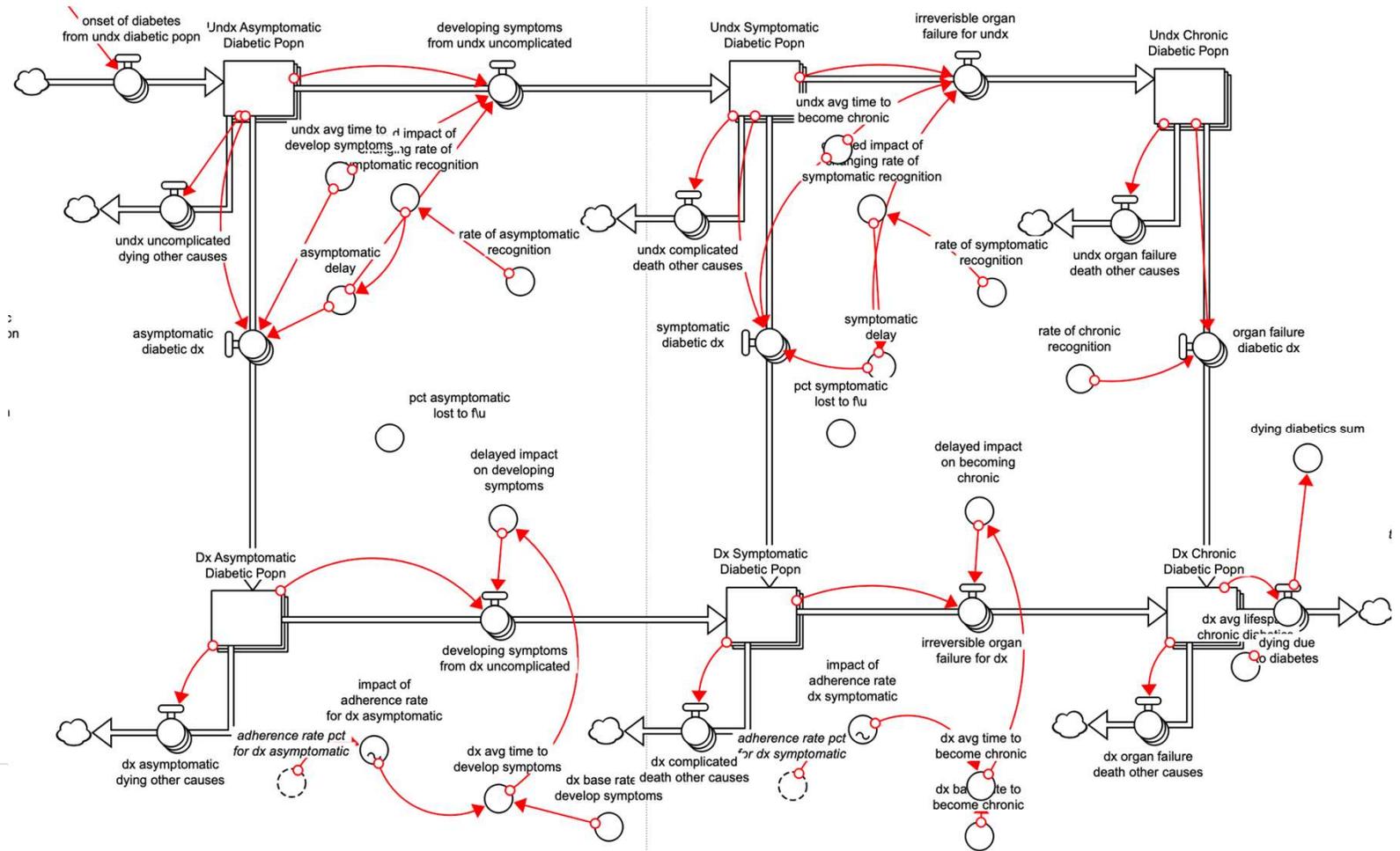


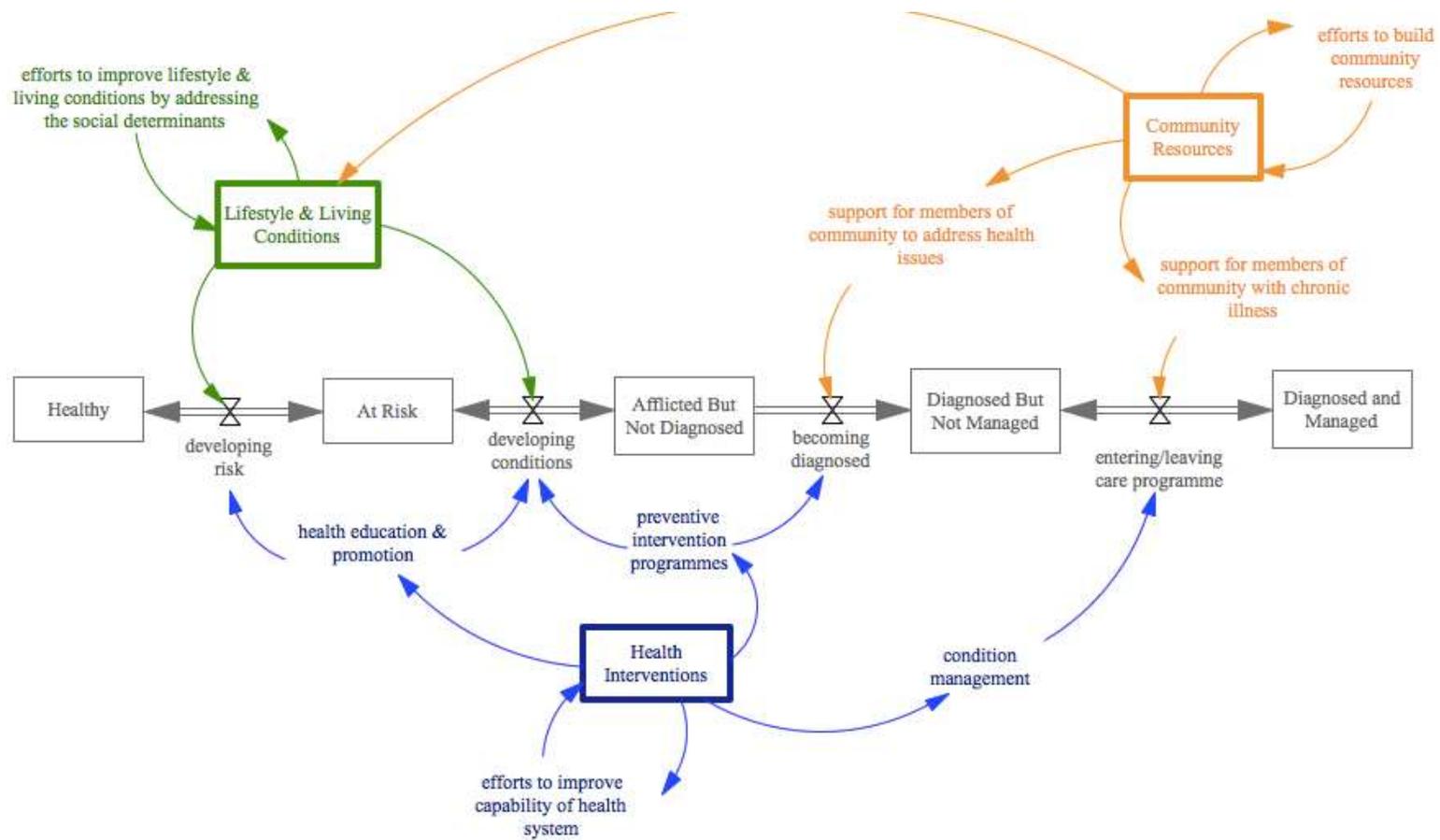
- Beginning to look at the broader system
- Understanding the need to impact on the rates of flow through the system
- Like it or not wherever you focus you affect the whole system

July - 2004

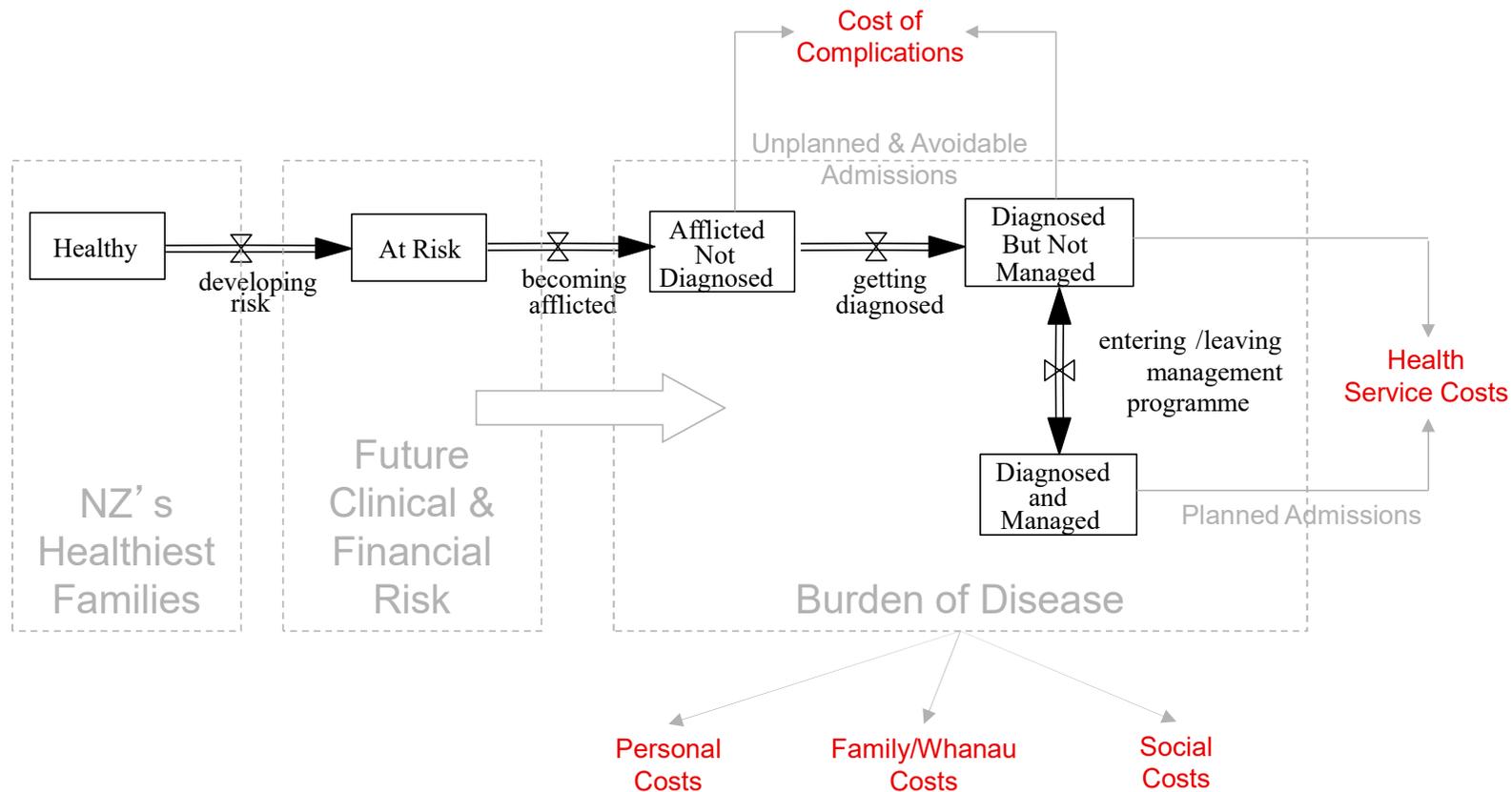


December 2004





"We need to understand what is driving the finances and not leap to quick-fix solutions that can end up compounding the situation." *Sir John Anderson*





2. Data

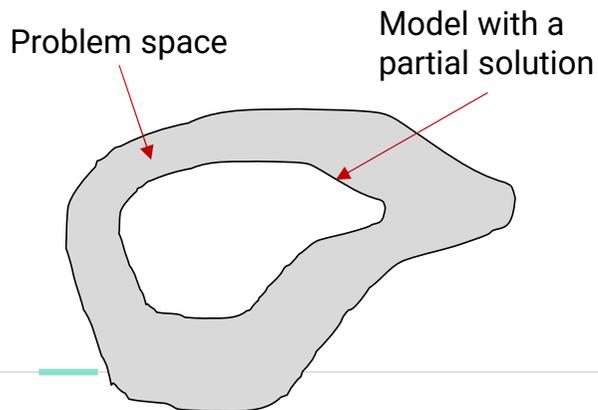
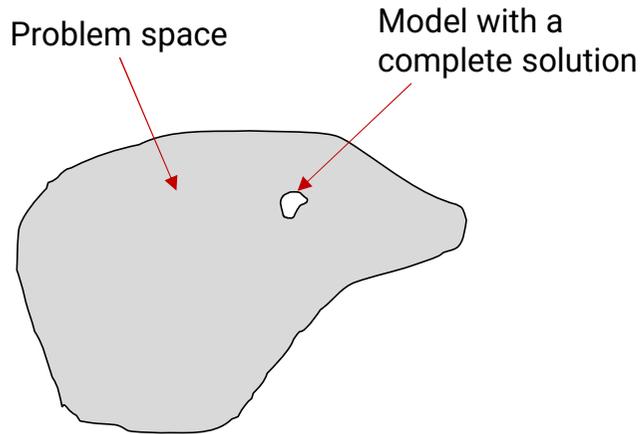
Data, On Its Own, Is Not Enough

“It would be nice if you could just plug the data into a statistical model, crunch the numbers, and take for granted that it was a good representation of the real world...predictions are potentially much stronger when backed up by a sound understanding of the root causes behind a phenomenon”

Nate Silver (2012)
The Signal and the Noise: the art and science of prediction.
Penguin. London

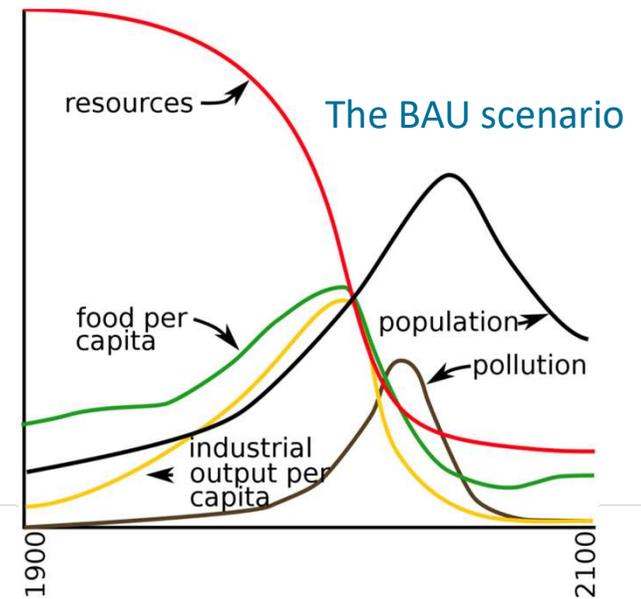
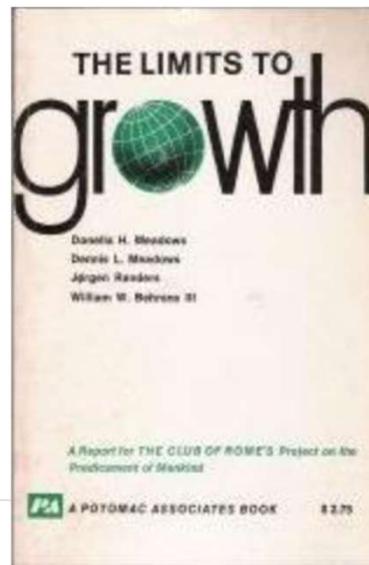
Systems Modelling is an attempt to develop that understanding

Data ≠ Precise Numbers

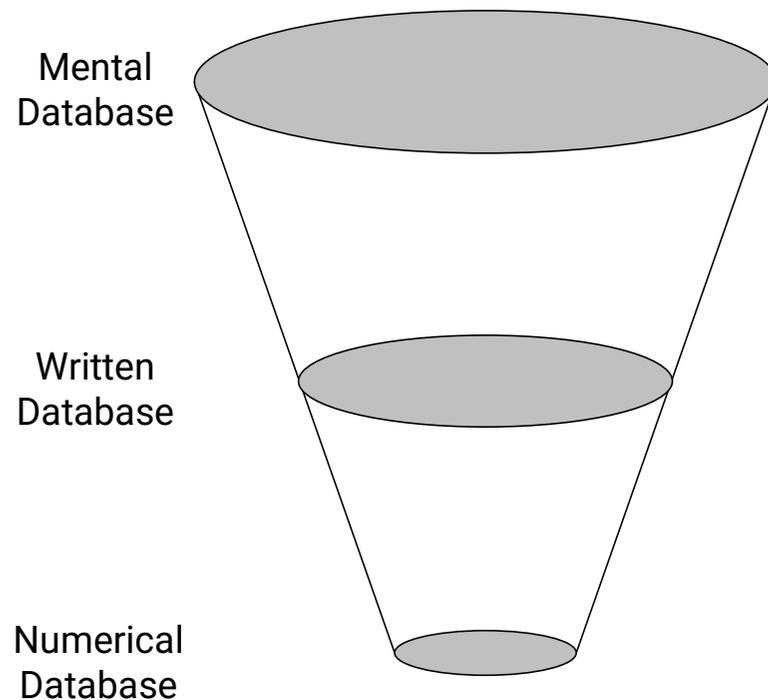


“A solution outlining cause and effect relationships might be able to provide a clue to the design of corrective actions... without carrying out any precise measurements.”

Saaed, K. (1992).
"Slicing a complex problem for system dynamics modeling."
[Systems Dynamics Review 8\(3\): 251-261.](#)



Data ≠ Numbers



"[SD modellers]... would regard a series of conversations with mothers about their children to be as useful a source of information as a twenty-year time series on fertility data."

Meadows, D., *The Unavoidable A Priori*
In Randers, J., Ed. (1980). *Elements of the System Dynamics Method*
Cambridge, Productivity Press.



3. Simulation Examples

[Palliative Care \[AU\]](#)

[Palliative Care DEMO](#)

[Photo Voltaics](#)

[Suicide Prevention](#)

[Infectious Disease](#)

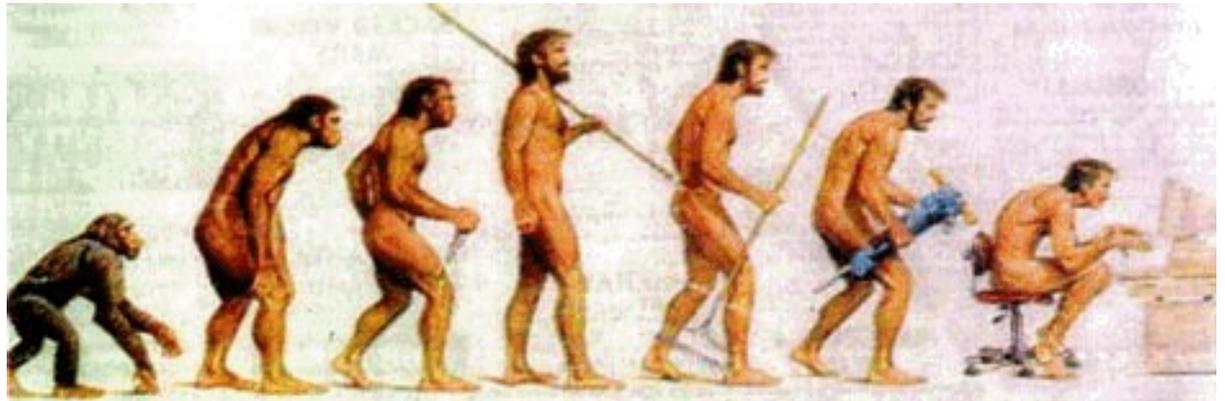
[Diabetes/Renal Model of Care](#)



4. Final Thoughts

Computer Models: (Tools to Challenge our Thinking)

...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.



Pagels, Heinz, R. (1988).
The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity.

THANK YOU