Whole Systems Partnership

System Dynamics in healthcare

SCiO Open Meeting – London, Monday 16th July 2018

Giving people a new perspective

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Simple tools & concepts….

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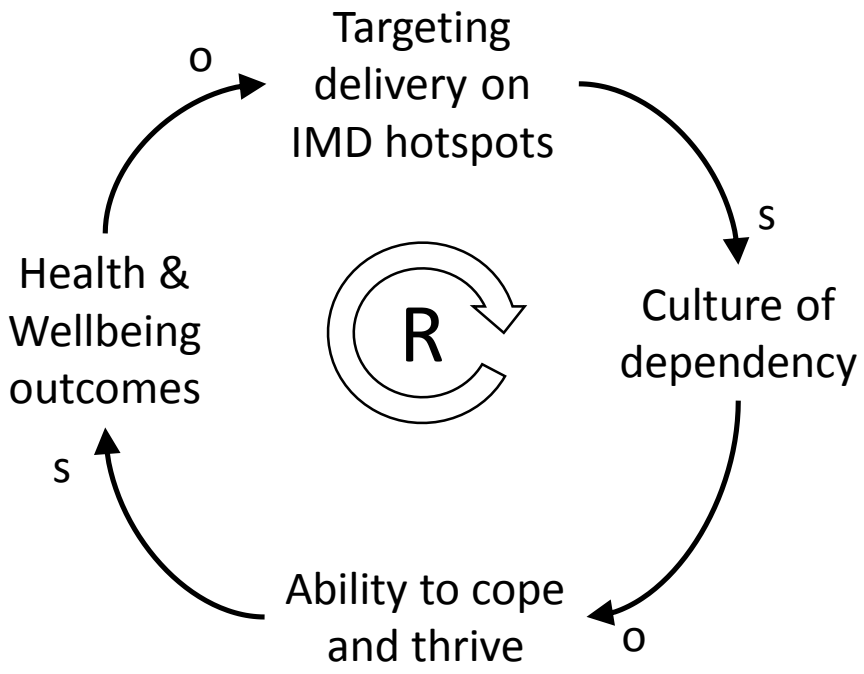
1. Influence diagrams.
2. Stock and flow modelling.

An influence diagram



1. When we target traditional delivery models of care on areas of high need we encourage a culture of dependency.
2. A greater sense of dependency reduces a communities ability to cope and thrive.
3. When a community's ability to cope reduces, outcomes become worse.
4. When outcomes get worse the tendency to do more of the same is reinforced.

This is a classic re-enforcing loop that will spiral ever downward. It requires a different point of intervention, namely at the point of 'dependency'. Interventions or ways of work that reduce levels of dependency will feed through the system and have the potential to reverse the downward spiral into a positive one, i.e. reduced dependency increases the ability to cope and outcomes resulting in the need for less targeting. It may be counter-intuitive, but our current paradigm actually increases inequalities whilst a focus on a strength based approach will, over time, reduce them.

Stock & flow...

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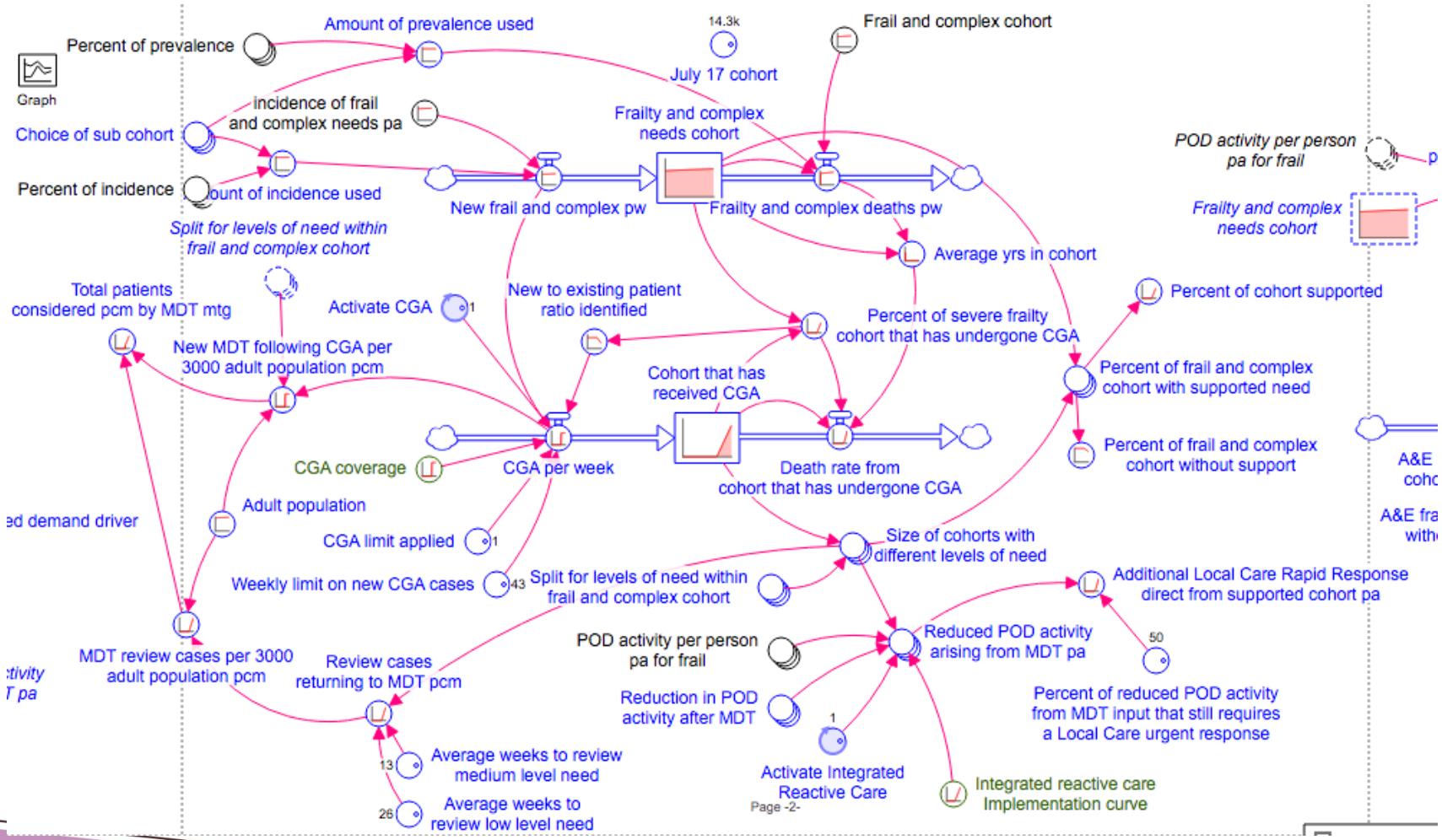

Method selection

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- Clients have lots of questions they want answering – but choosing the right solution is a challenge!
- We are facilitating a Community of Practice in Kent, funded by the Health Foundation to 'Advance Applied Analytics' with a focus on System Dynamics – and they face this challenge daily;
- We have therefore developed a 'critical appraisal framework' to help them choose the right approach…

The questions we ask

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The questions we ask are framed by what is, in general, an imperfect understanding of the issues we face. We therefore suggest two sets of considerations in framing the questions we ask before proceeding to identifying the most appropriate modelling and simulation approaches:

The **context** for the question:

1. When do we need an answer by?
2. What is the nature and quality of the data?
3. What level and type of skills are required to answer the question?

The **purpose** of the question:

1. To visualize and understand what's happening and stimulate new insights.
2. To (re-)design a (new) service & to understand impact within a system.
3. To test our assumptions about expected impact and establish a monitoring framework for change.

And, are any of these negotiable…..?

Defining the question

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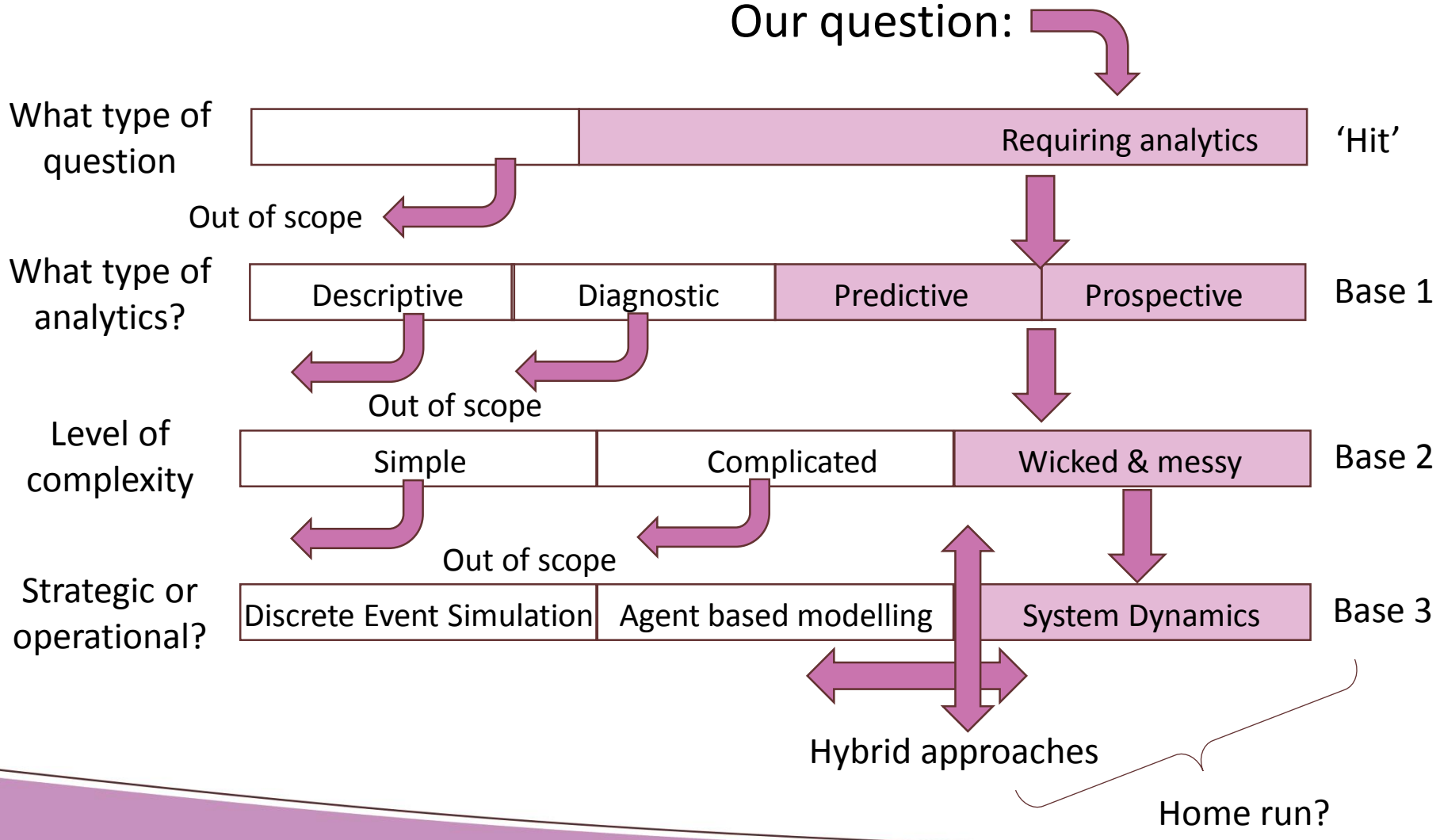
- Frame the question you think the modelling needs to answer;
- Identify a 'high level' list of model design specification, i.e.:
  - Over what timescale should we model?
  - What are the boundaries of the system we should look to model at?
  - What level of 'granularity' or detail should be included?
  - What supplementary questions would it be useful for the model to answer?

The framework



Suitability of SD

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- System Dynamics modelling is the 'tool of choice' when:
  - ✓ The scope of an issue is '***strategic***' rather than operational or tactical;
  - ✓ The importance of variability or tracking individuals within a system is low;
  - ✓ The number of entities is ***large***;
  - ✓ When control over the system is exerted through ***rates*** rather than queues;
  - ✓ When timescales are ***relatively long***;
  - ✓ When the purpose is ***to inform policy making*** and to gain understanding about a system.

Ref: Brailsford et al, *Discrete-Event Simulation and System Dynamics for Management Decision making,* (2014), Wiley

Combined or hybrid approaches

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1. Integrated: two approaches used in one model, for example conceptualisation of falls model the infection model (both AB & SD);
2. Parallel: building two models in parallel that 'speak' to each other, e.g. Hillington unplanned care (DES & SD)
3. Sequential: a sequence of modelling approaches – do 'x' before you do 'y', for example needing a quick understanding of the big picture before developing the detail e.g. Leeds (SD then DES)
4. Nested: certain descriptive or diagnostic analytics is required, and often specified by the needs of a simulation model e.g. the emerging frailty model (SD informed by KID.

What does successful look like?

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Evidence about what makes a successful simulation project (including but not exclusively System Dynamics) has identified the following 5 elements:

1. High levels of communication and interaction between the client and the modeler throughout the project.
2. Modeler skills, competence and understanding of the client context.
3. Responsiveness and flexibility in delivering on the project.
4. Involvement and engagement with the client and relevant stakeholders.
5. The customer of client organisation should be committed, supportive and engaged in the modelling work throughout.

Ref: Key Performance indicators fir successful simulation projects. JOR (2017) 68, 747-765

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Using System Dynamics – some case studies

A choice of case studies…

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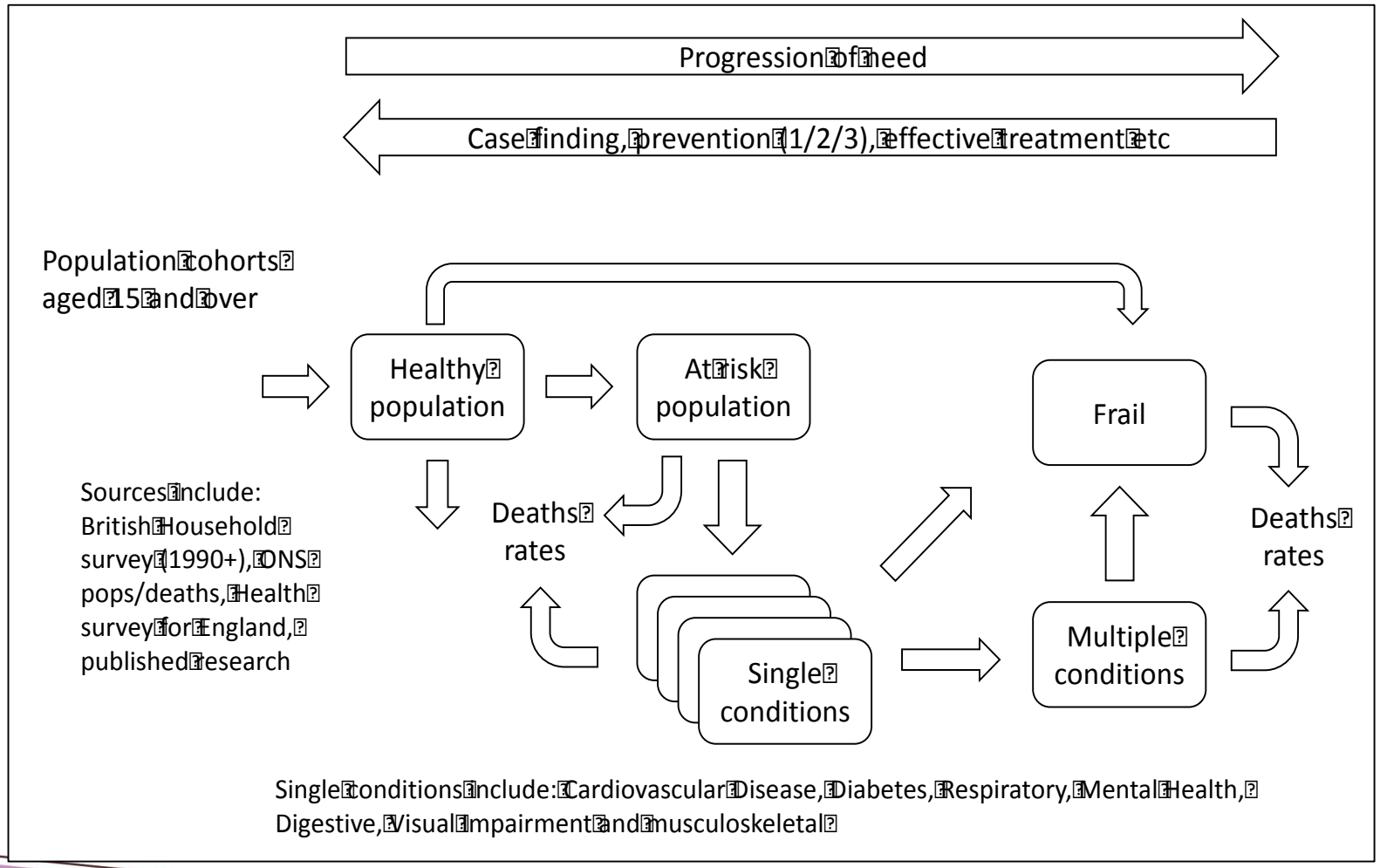
1. Population health needs – the Kent whole population cohort model & the impact of preventative measures over time.
2. Service transformation – cardiovascular services in Leicestershire and future workforce requirements.
3. Putting Trust in your model – the behavioural side of systems.

Population health needs

- We need to understand future levels of need within a population, e.g. for acute hospital admissions or social care at home – a key question underpinning current STP planning across England;
- Use of an 'actuarial' approach to 'predict' future levels of need, including identifying high cost groups through regression analysis and applying age related population projections to 'see' the future;
- However, the nature of ageing, and therefore of health and care needs, for a given population changes over time (healthy life expectancy) and varies significantly between geographies (inequalities).

Conceptualising the system



Asking the right questions of the data

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1. What population segmentation approach is appropriate so that people/cohorts progress through levels of need?
2. What evidence is there for cohort specific risk factors:
   a. For movement between cohorts;
   b. For access services.
3. What interventions, trends or preventive measures impact on 2a?
4. What are the potential service transformation initiatives that would impact on 2b?

[Supported in this case by the Kent Integrated Dataset]

A dynamic approach to population segmentation

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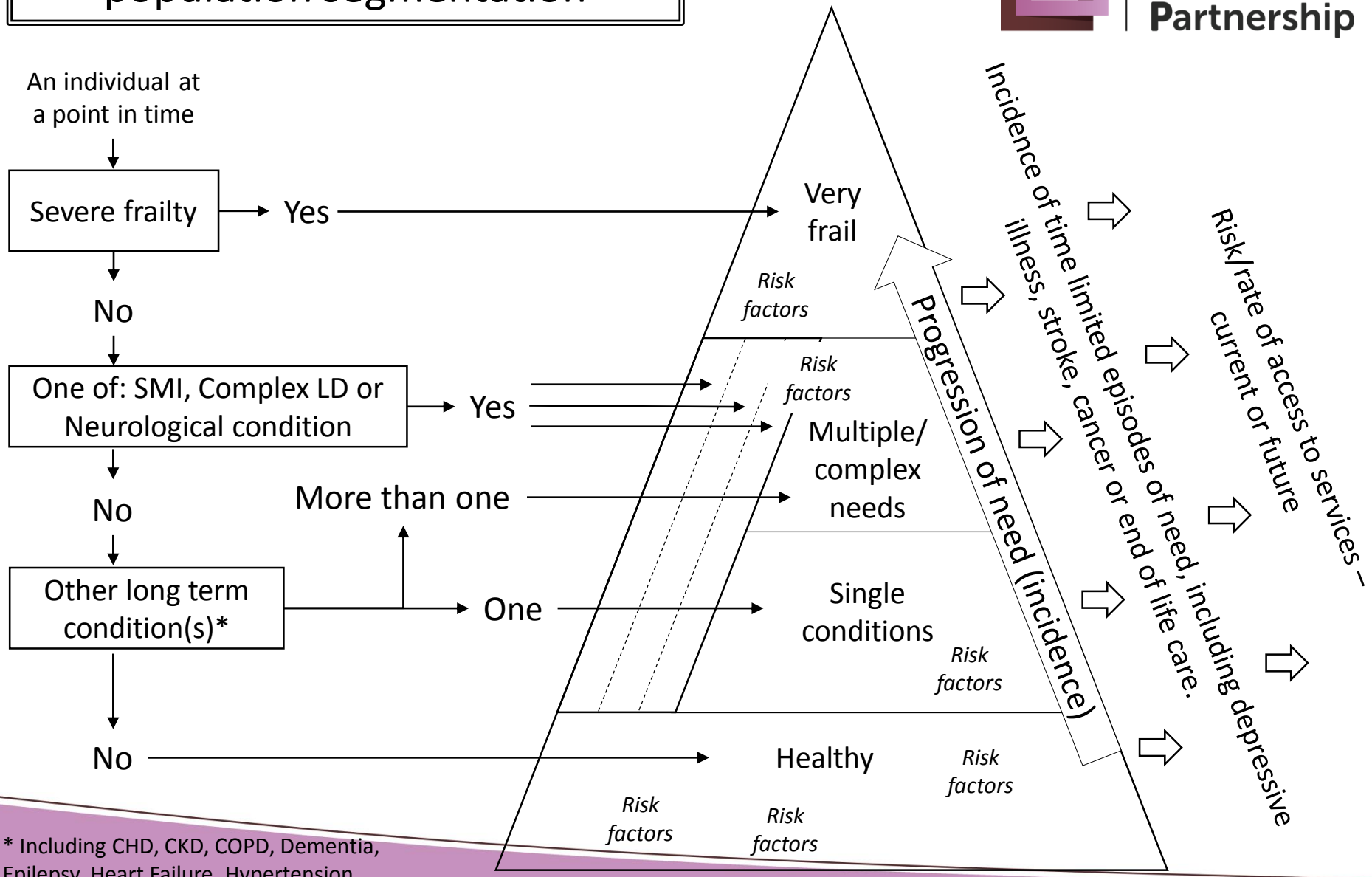

* Including CHD, CKD, COPD, Dementia, Epilepsy, Heart Failure, Hypertension.

The model interface and scenario generator

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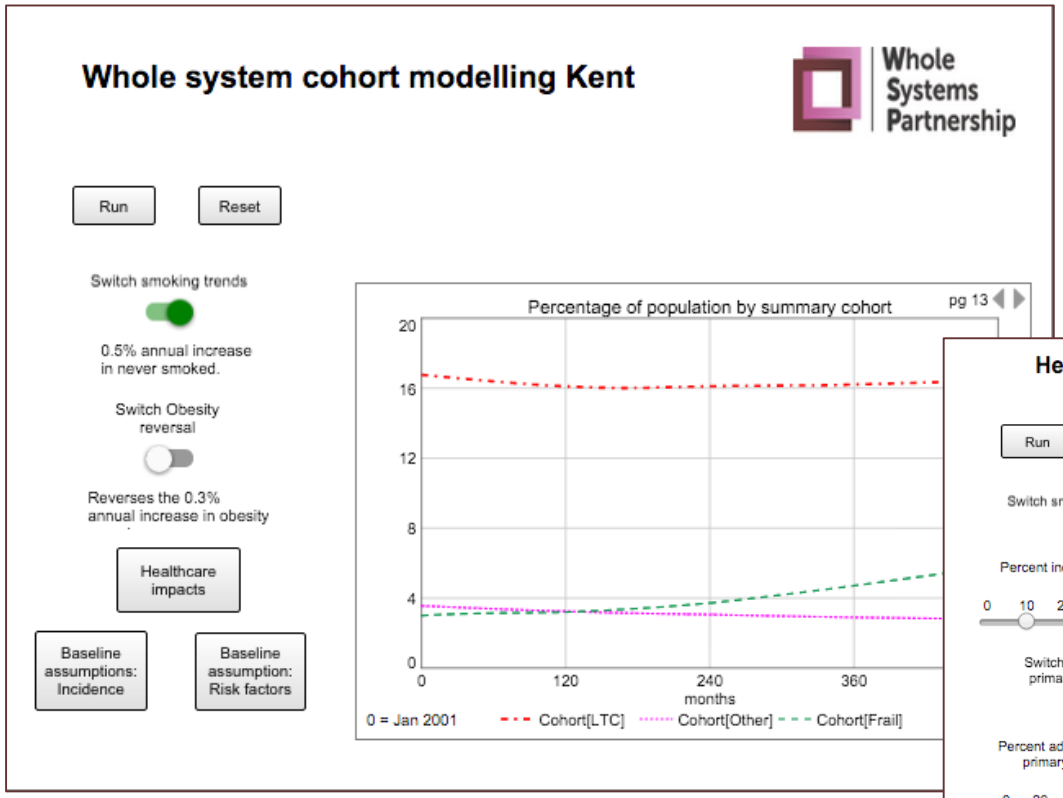
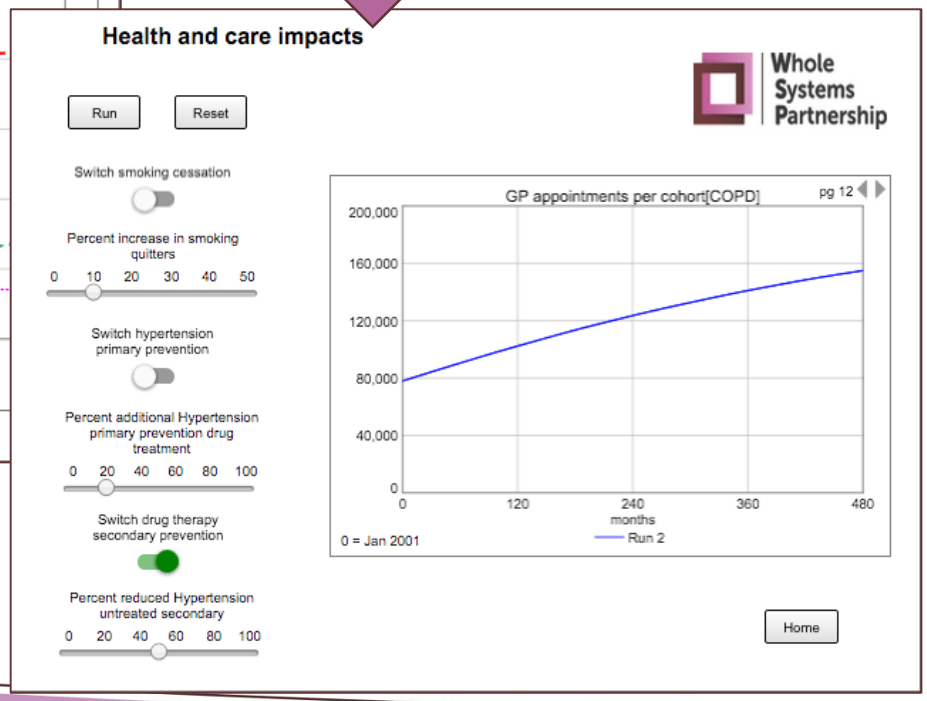
Changes in population health needs in response to prevention strategies → impact on service utilization rates





The art of the possible….

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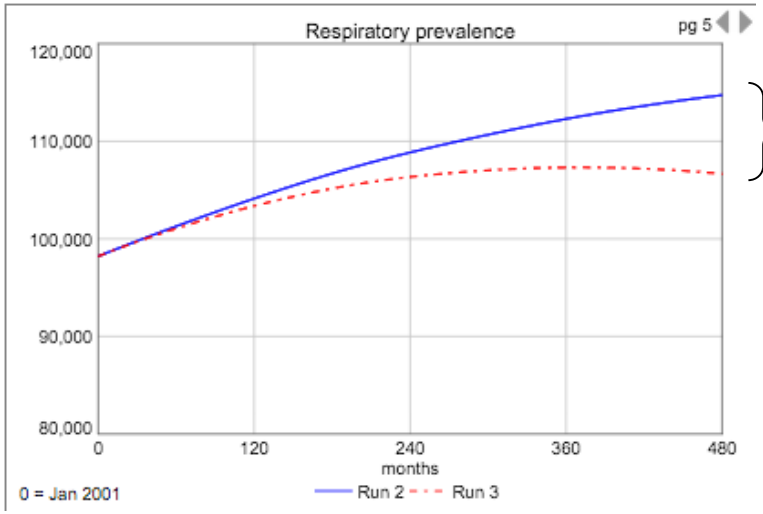
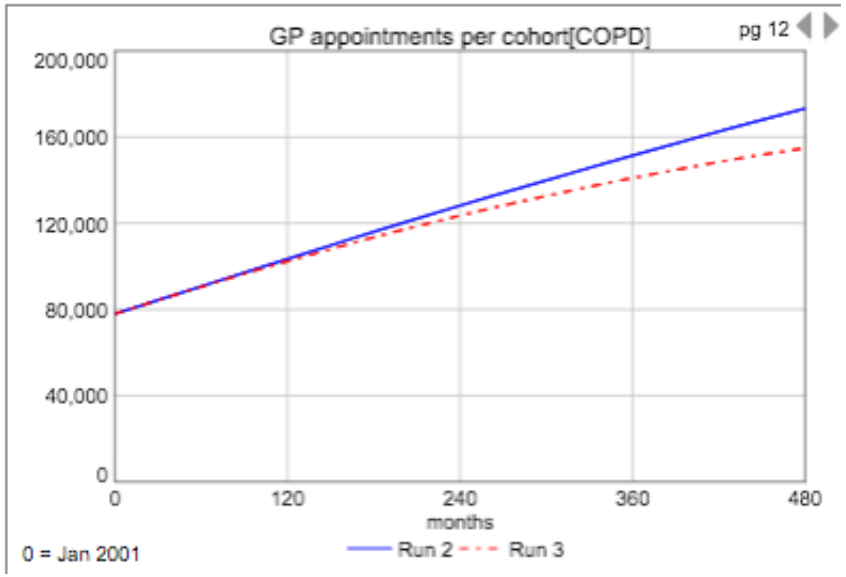
- Smoking levels are falling, but what if we were to accelerate that reduction…..
- Obesity levels are rising, but action is being taken and there is a growing public awareness of the risks, so what if these trends were reversed…..
- Hypertension can be managed effectively with appropriate, low cost drugs, so what if this were extended across the population……

The smoking example

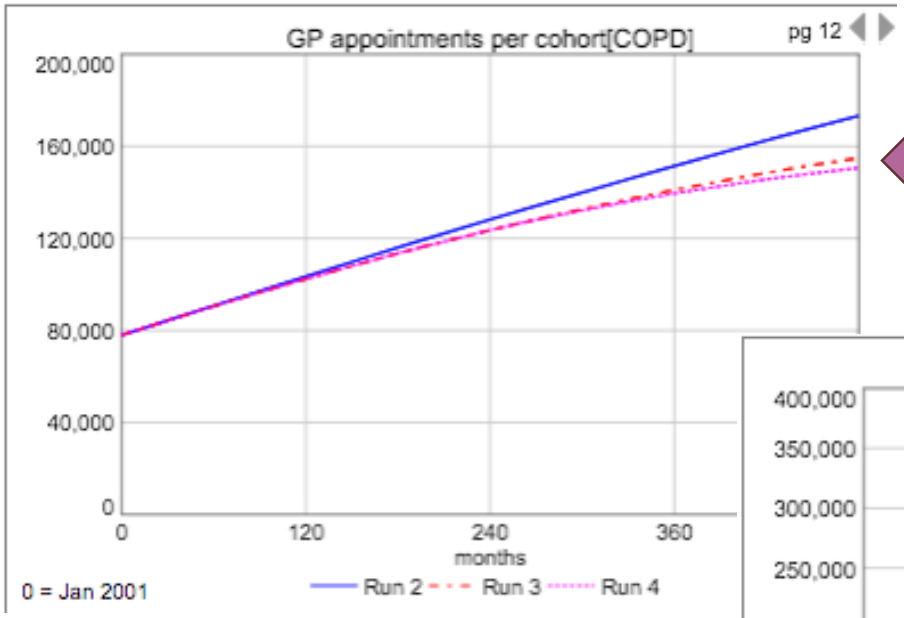


Benefits from reduced levels of smoking since 2001 on the prevalence of respiratory disease

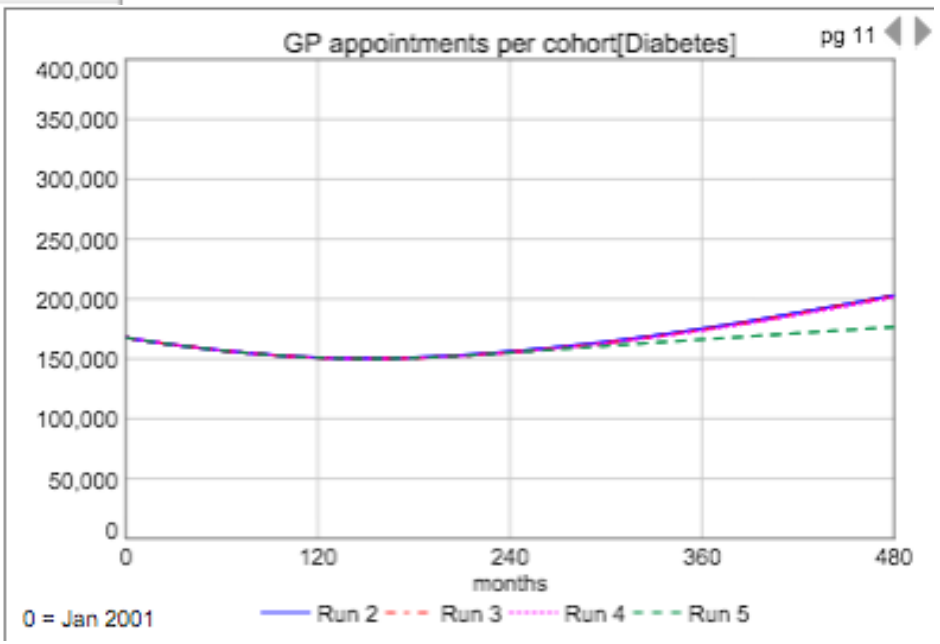
Translates into a moderation of the number of GP appointments for COPD



Further efforts at smoking cessation



The marginal benefit of accelerated efforts at smoking cessation from 2016



An equivalent impact on GP appointments for diabetes following a reversal of levels of obesity……

Challenges for commissioning in the here and now

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- Are we tackling needs at the right time → reducing risk factors for medium to long term benefit;
- The rising tide → 'baby boomers' are healthier than previous generations, but there are a lot of them so healthy aging will be critical to medium to longer term sustainability;
- Are we commissioning for frailty → different ways of understanding quality of life, reducing isolation, better ways to support the dying;
- Drivers for integration → health conditions will increasingly have associated challenges associated with frailty that if left unaddressed will simply recur and re-present;
- Wider determinants & inequality → are we commissioning with all available intelligence from the KID and other cohort modelling approaches.

A service transformation example

- The development of an integrated Community Cardiorespiratory service is designed to have an impact on patient pathways across the primary, community and hospital sectors;
- This strategic workforce plan is designed to reflect these changes, as well as the underlying population health needs, and identify future workforce capacity and capability to deliver the key care functions within the new service;
- It is rooted in local plans for the service, has used the best available activity and workforce baseline data and has been the product of two engagement events with senior stakeholders;
- The modelling outputs are an answer to this challenge which needs to be understood in the context of both our modelling assumptions and the uncertainty expected as the service is put in place – but the model allows us to refine these assumptions to test implementation.

A service transformation example

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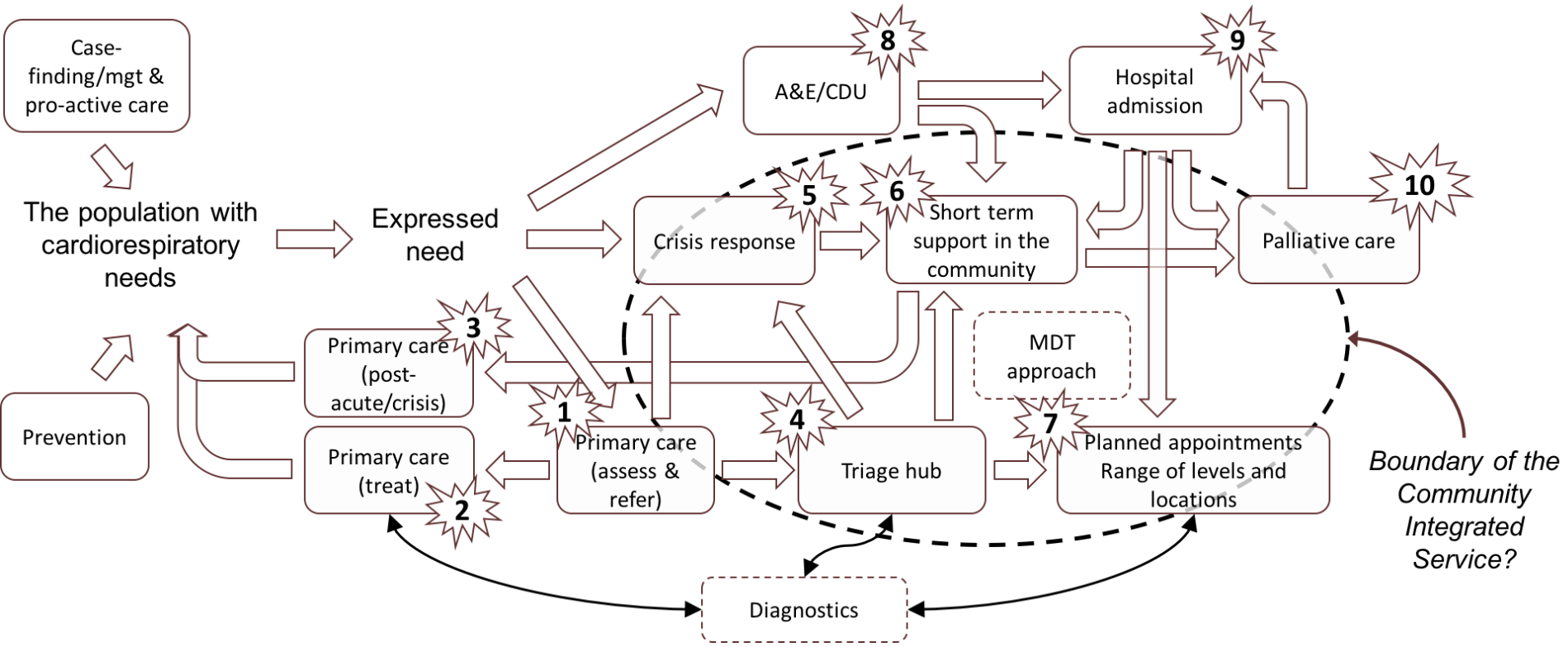

Scope of modelling

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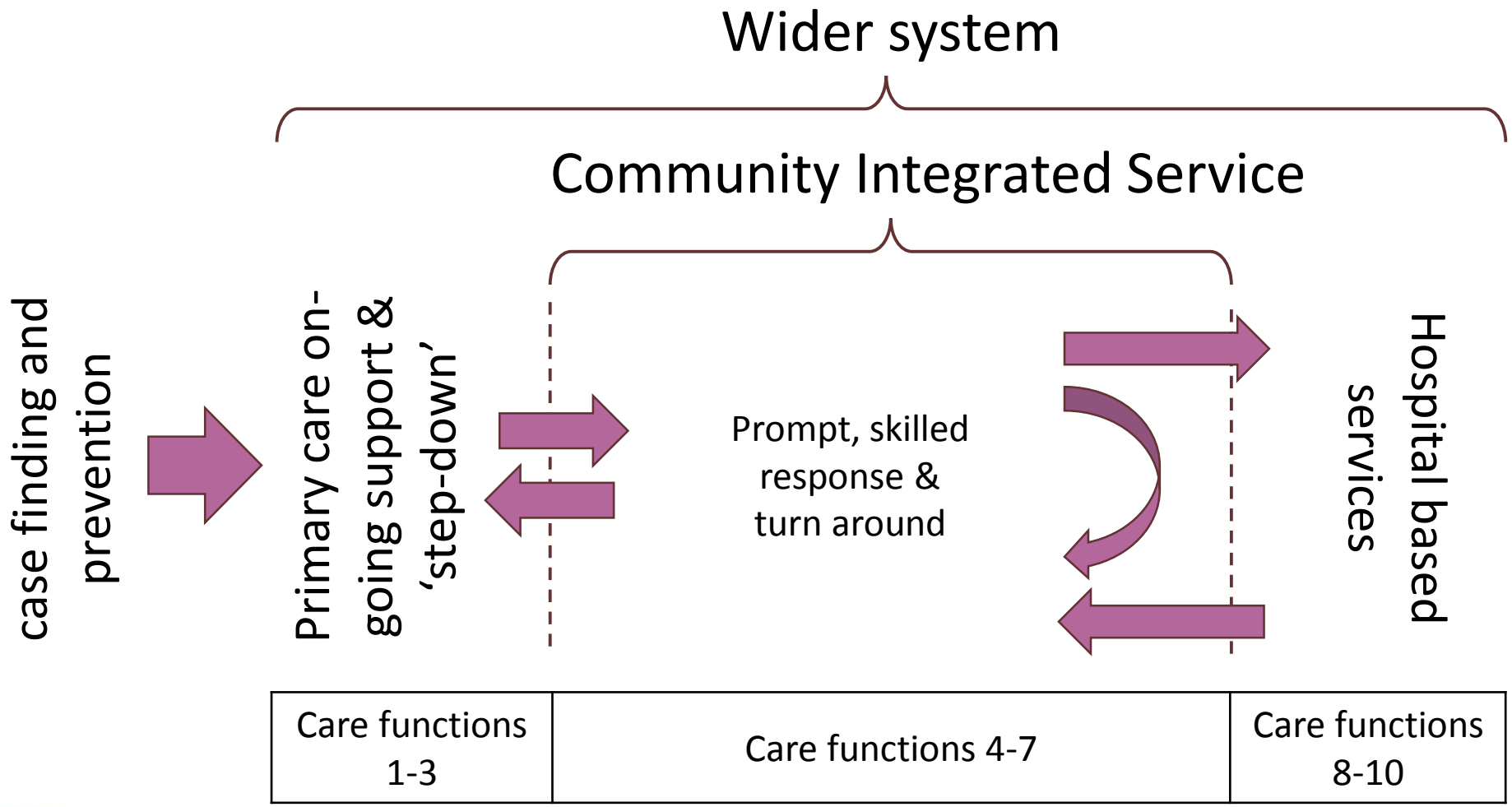

Leverage points for service transformation

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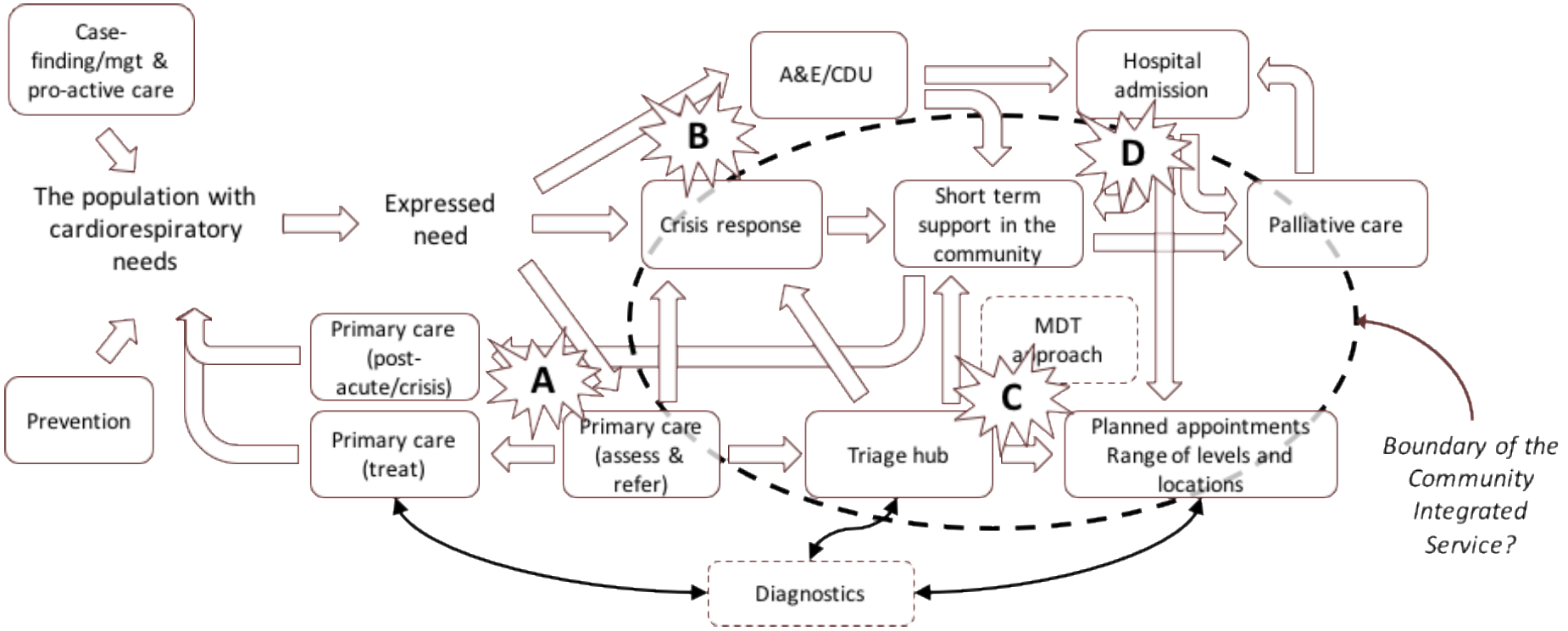

Transformation assumptions linked to care functions (CF)

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A. That the skills, capacity and support to primary care will enable a higher proportion of needs to be addressed in primary care (CF1-3);

B. That a proportion of needs currently presenting at A&E (CF8), and potentially progressing to an admission (CF9), will be supported by a Crisis Response care function and/or short term support in the community (care functions 5 & 6);

C. That the referral hub (CF4) will effect a shift in the location of planned appointments (CF7) to community settings;

D. That more effective discharge planning will result in greater use of short term support in the community (CF6) and timely referral to palliative care (CF10).

Overview of the model

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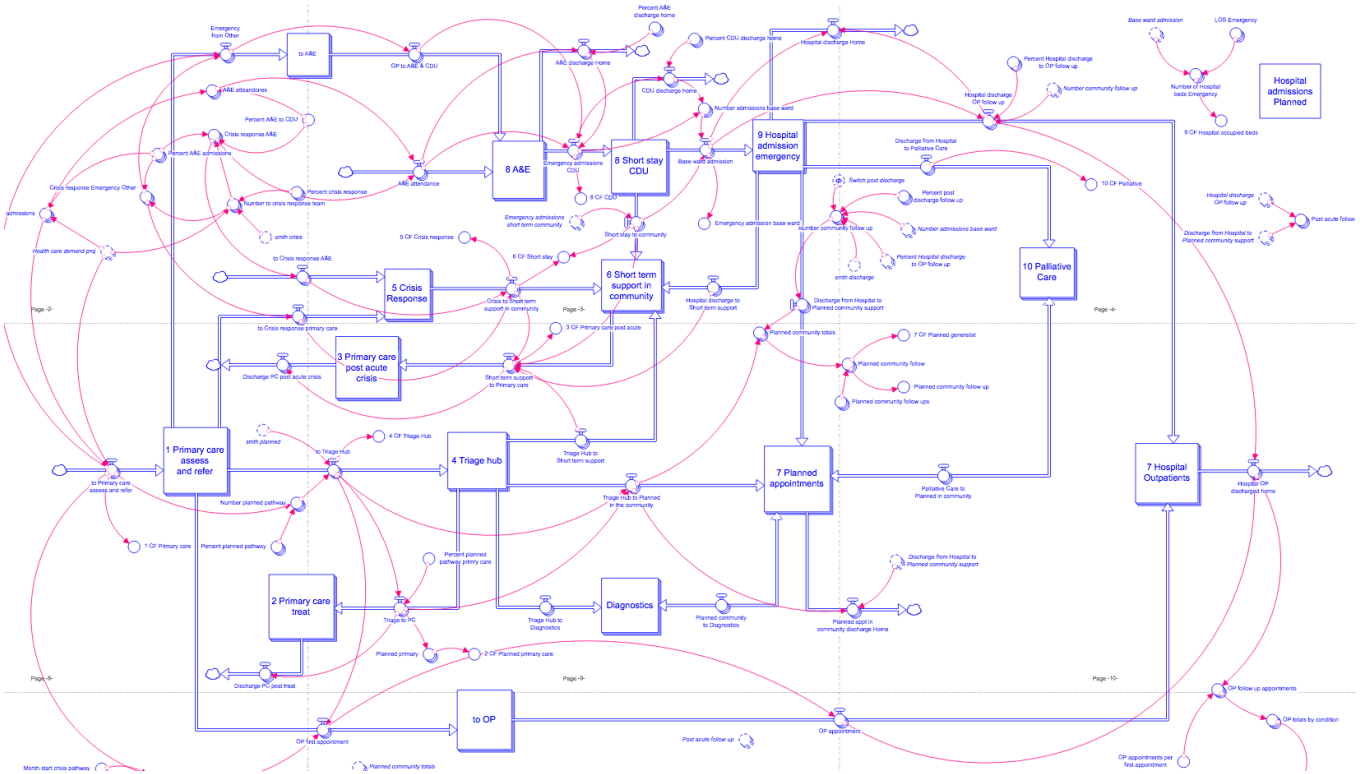
- The modelling tool reflects the care function map……



With knobs on.....

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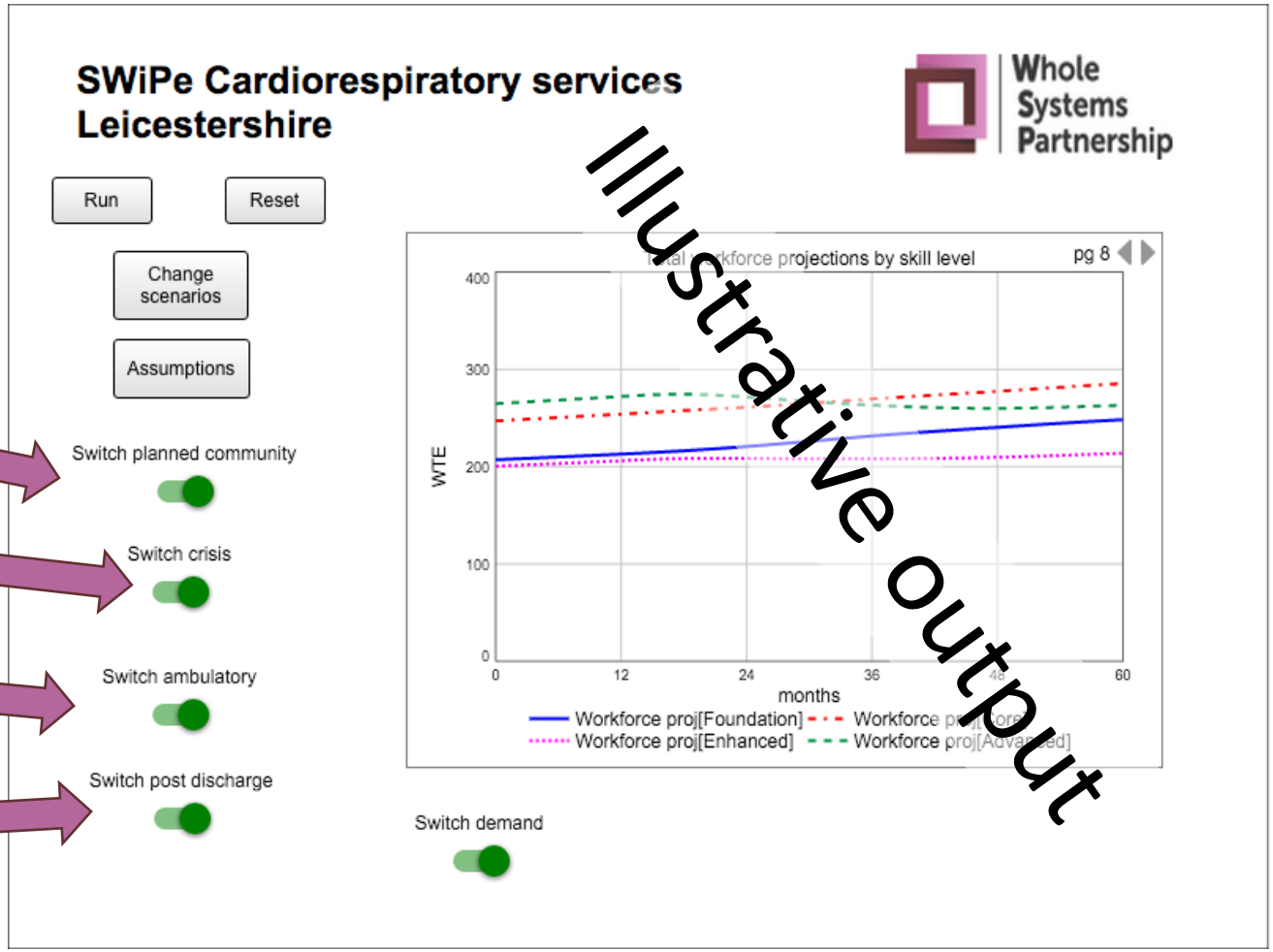

A

B

C

D

The scale of ambition

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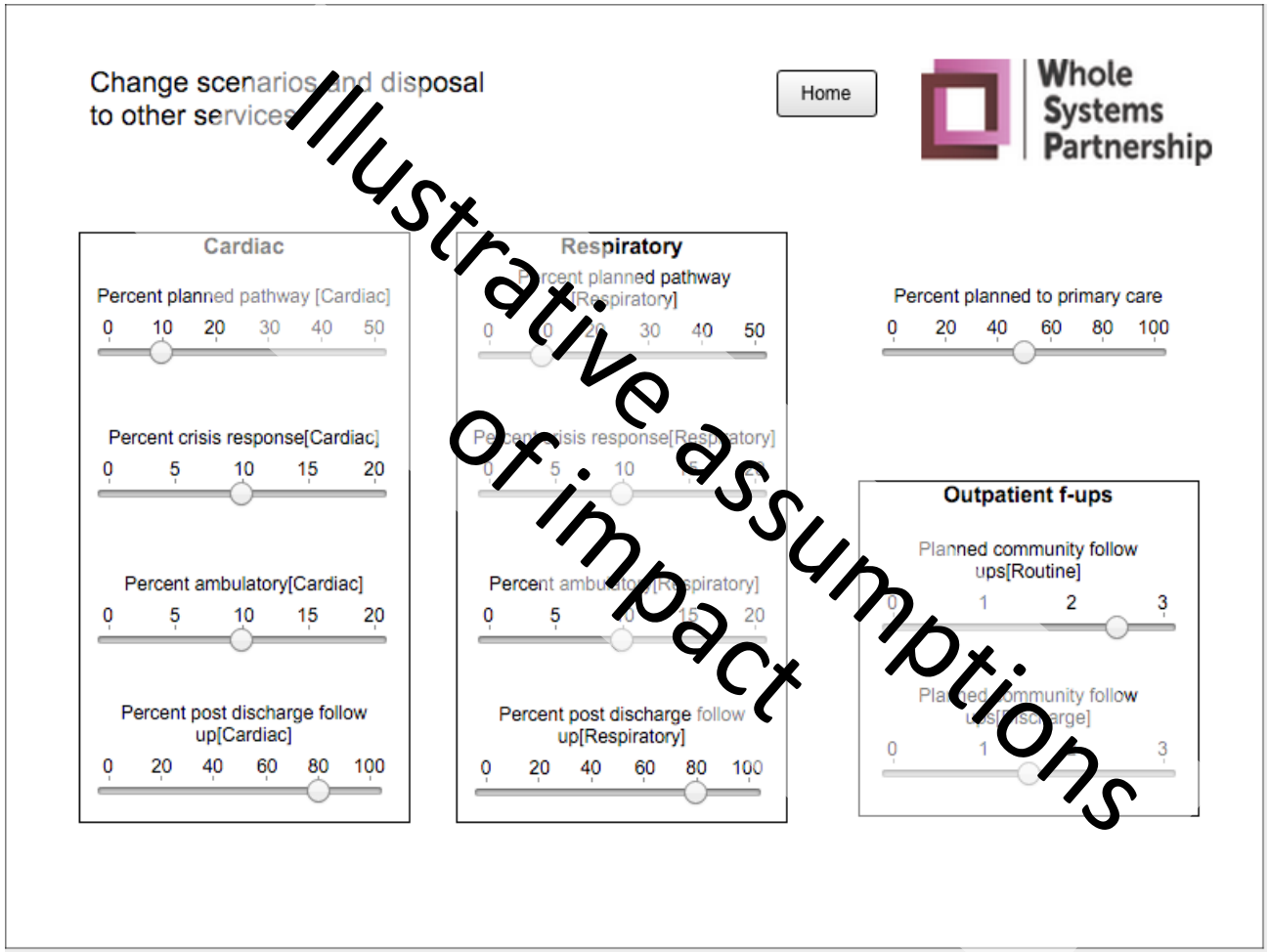

Illustrative assumptions of impact

The changing shape of the workforce

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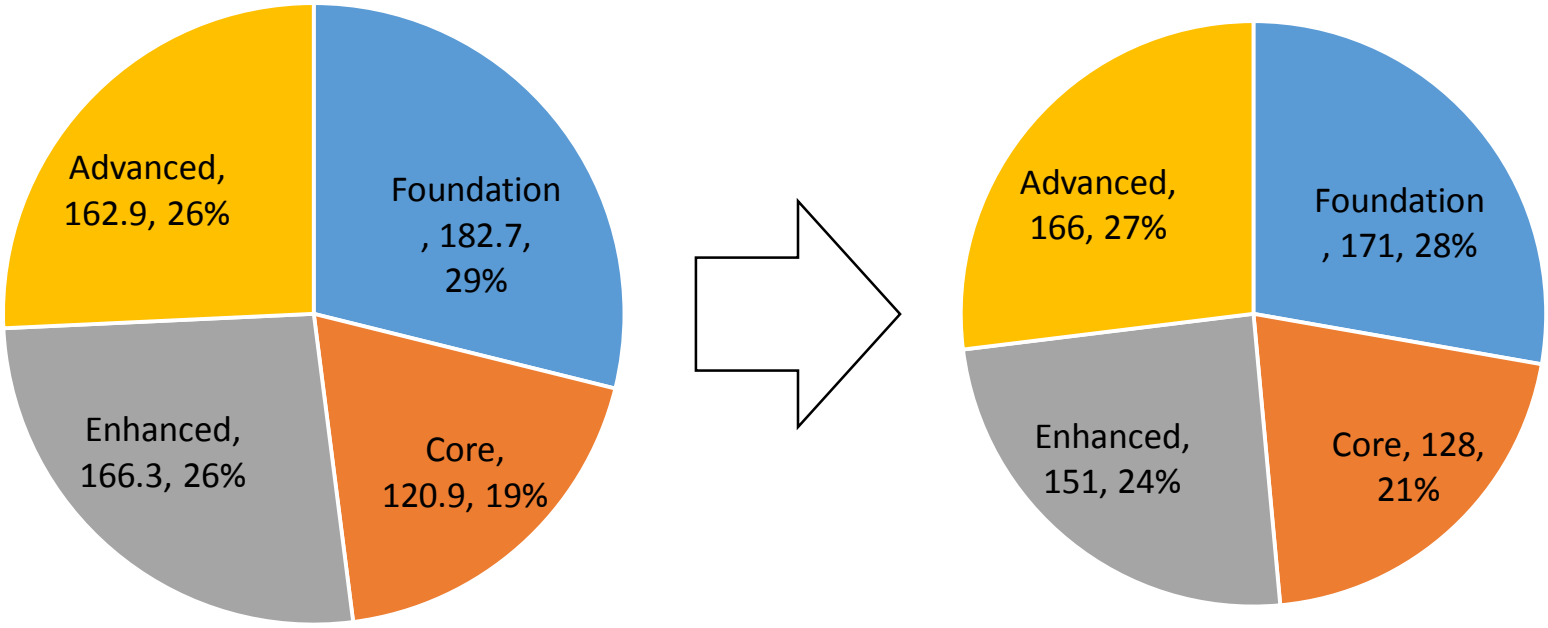

Total wte = 632.8

Total wte = 616.0

Headline outputs - workforce

- The new integrated Community Cardiorespiratory service would need c.52wte staff to deliver the care functions necessary to achieve the service transformation envisaged, with c.9wte at foundation skill level, c.20wte at core skill level, c.14wte at enhanced and c.8wte at advanced skill levels;
- c.29wte of this increase would need to work either in or closely aligned to primary care;
- c.27wte fewer staff would be required to support inpatient care and 54wte hospital based outpatient care;
- In total the workforce could reduce from 633wte to 613wte and achieve the improved outcomes.

Headline outputs – capacity and finances

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- Bed numbers, based on a reduction in occupancy levels from 95% to 90%, for the patients whose needs can be addressed by the new service could reduce from 139to 117, which includes the impact of growing underlying need – i.e. a reduction of 22 beds;
- Unscheduled admissions for the same group of patients would fall from c.515 to 474pcm;
- Estimated tariff savings of c.£4M pa could be achieved when the service is fully rolled out;
- The direct costs of the new workforce is estimated at £2.1M.

The 'soft' stuff that's really hard!

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"Most operational research and management science courses focus on the 'physics' of factories and other systems and teach how to find optimal policies; people play little role in these models, and where they appear they are usually assumed to be the perfectly rational, self-interested maximisers central to economics."

Prof John Sterman, MIT (2016)

Within and without…

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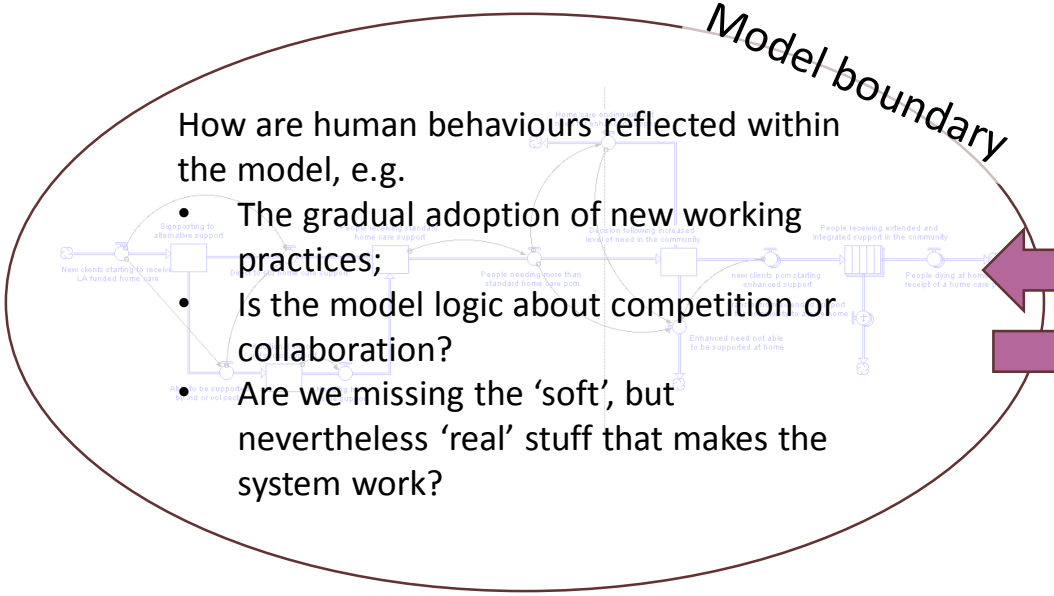

What behaviours are present when we 'engage' with a model?

- Do we trust the data;
- The '*not invented here*' syndrome;
- '*I don't do physics*'!
- '*Just tell me the answer*'!

Failure here will mean our models lose validity because they don't properly reflect the real world.

Failure here will mean our models don't influence our decisions and therefore fail to make a difference.

After Kunc et al, *Behavioral operational research,* (2016), Palgrave Macmillan.

An example – putting Trust in your models

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- Our hypothesis:
  - ✓That taking measures to improve the level of trust between patients and staff during recovery from treatment will speed up recovery – and have wider system benefits....

The system – an overview

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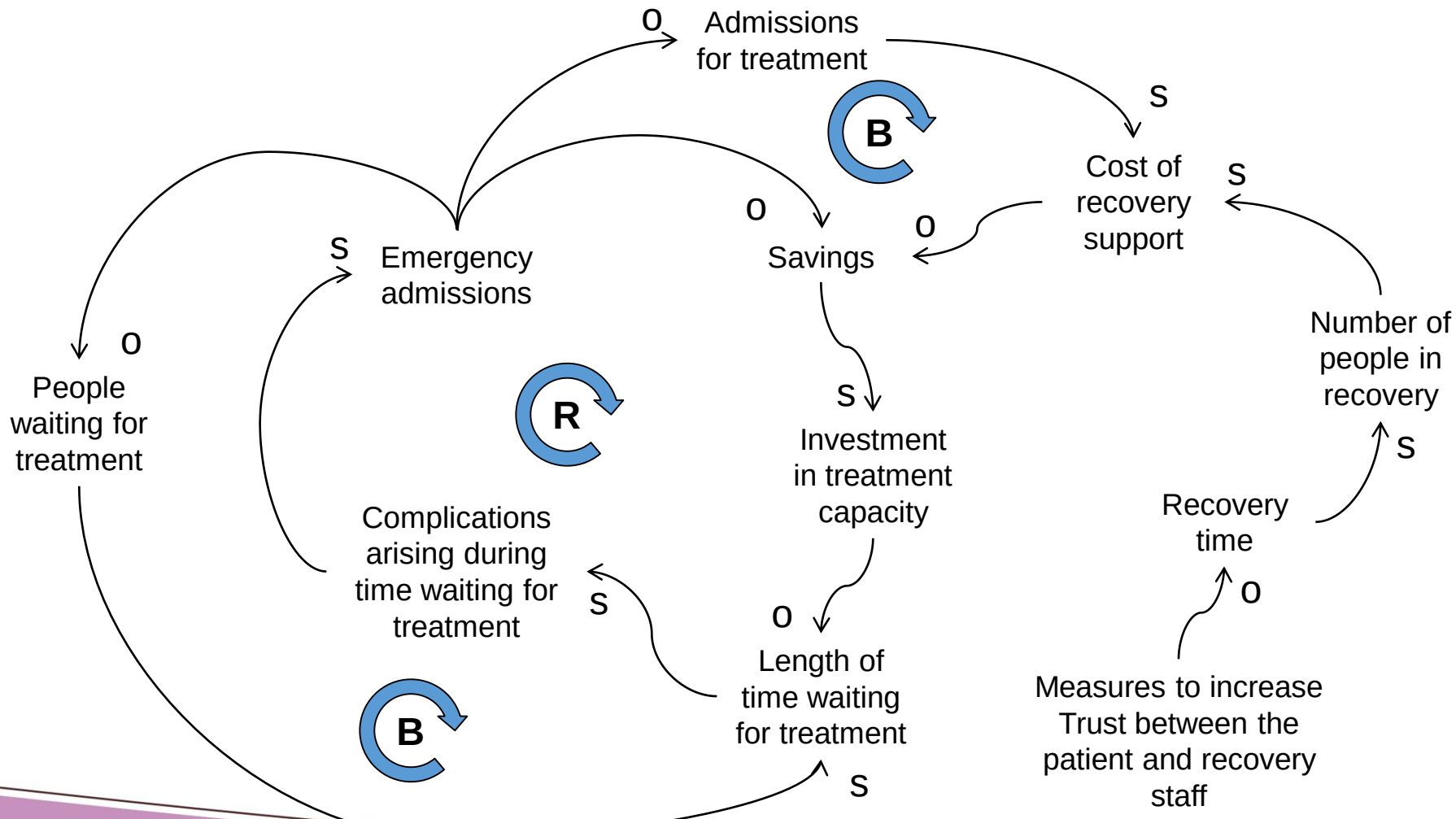

Modelling the impact of Trust on the wider system

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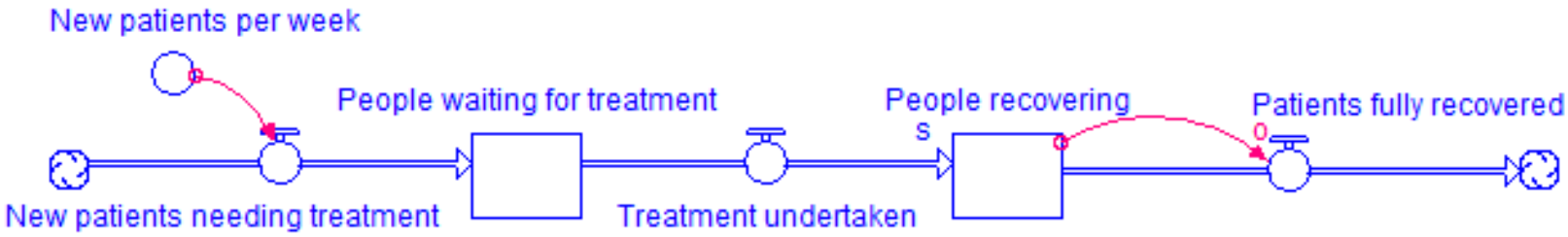
- Let's assume that:
  - There is a simple treatment pathway with people waiting, being treated and then recovering from their treatment:



Modelling the impact of Trust on the wider system

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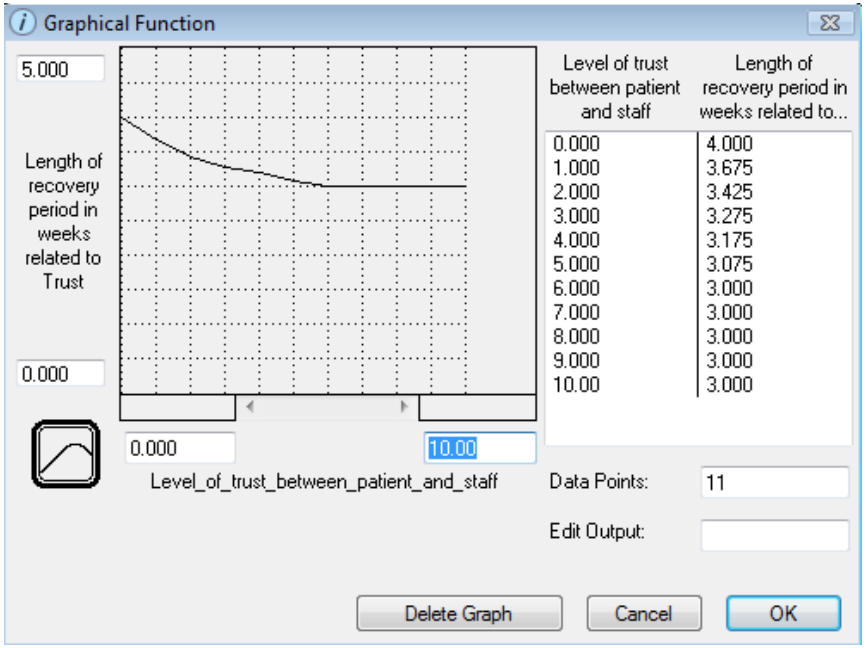
- And further that:
  - The level of trust between the patient and recovery staff will affect time to recovery in the following way:



Modelling the impact of Trust on the wider system

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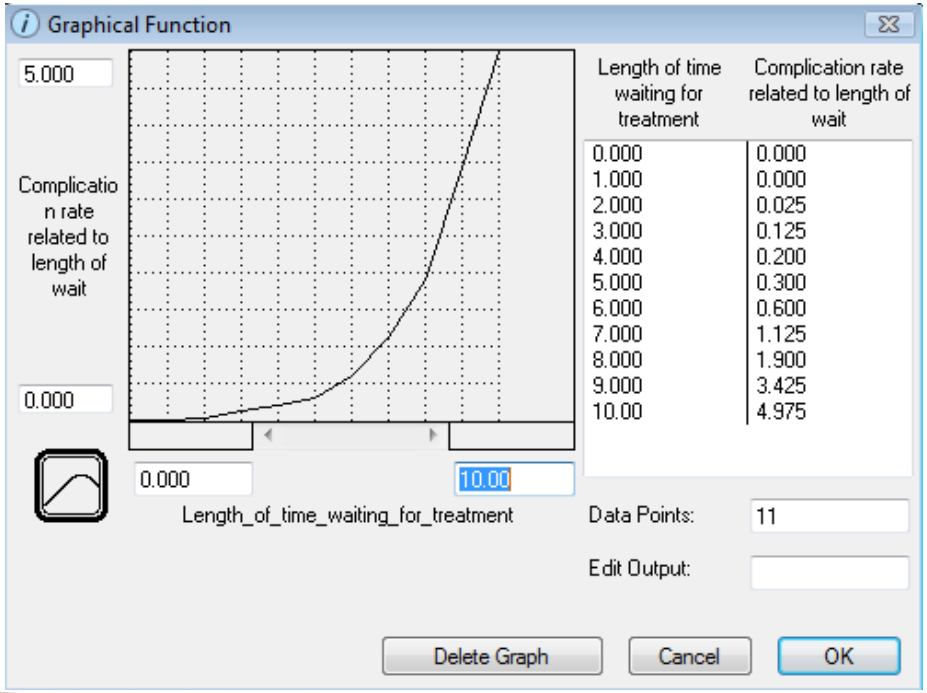
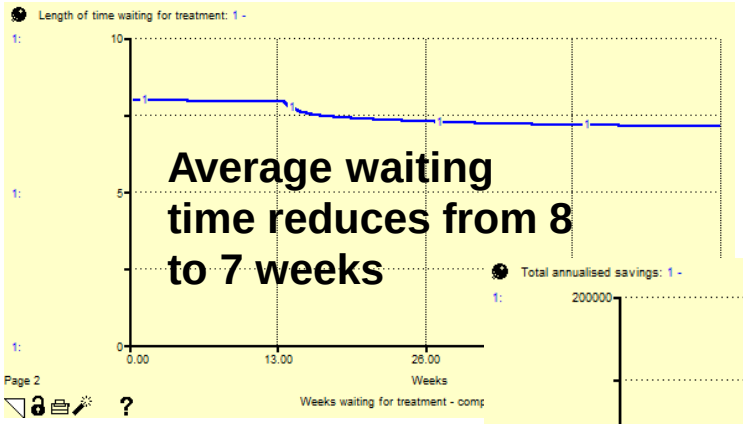
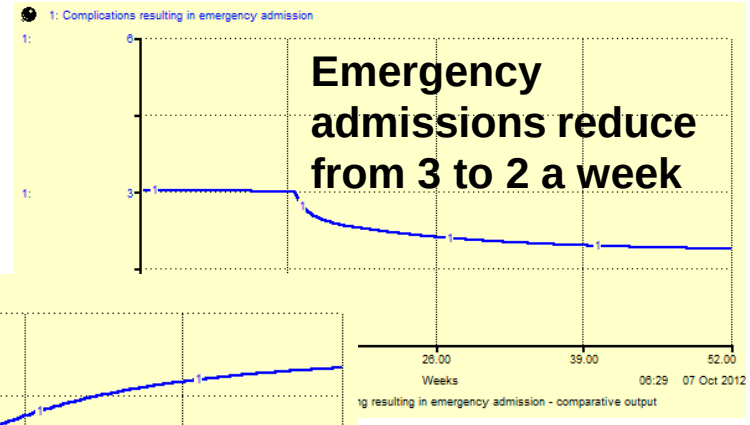
- And further that:
  - The cost of supporting a person during recovery is £200pw;
  - That there is a decision to re-invest half of this in treatment capacity through retraining of staff;
    - That this reduces the waiting time to treatment, which has a relationship with the % of people who require an emergency admission during the time to wait in the following way;
    - And that each saved emergency admission would have cost £2,400.

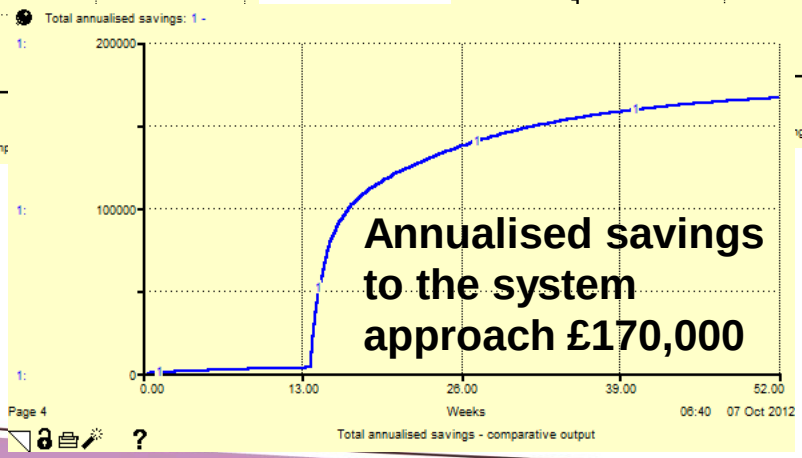


System benefits

- If the treatment pathway has 23 people entering each week and sufficient staff to maintain the system in equilibrium at the outset, with an initial waiting time to treatment of 8 weeks and normal recovery taking 4 weeks then....







Measuring trust and other relational elements

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- WSP has recently completed a two-year research project with Leeds University to identify *behaviours that reflect the nature of relationships between people in a particular system;*
- *These behaviours reflect the attributes of:*
  - ✓*Integrity, respect, fairness, empathy and trust;*
  - ✓*Together these build into 'relational value' – something that contributes to the overall system behaviour;*
  - ✓*Just as in quantum physics, the 'stuff in-between' has an important role to play.*

Further information at www.thewholesystem.co.uk/relational-thinking/research/

Thank you

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Find our more at:

www.thewholesystem.co.uk/workforce-modelling

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Bonus material

A brief summary of theory and practice for System Dynamics…….

What are the distinctives of systems thinking?

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- Dynamic thinking: positioning your issue as part of a pattern of behaviour that has developed over time;
- ‘System-as-cause’: constructing a model (qualitative or quantitative) to explain how the problem behaviour arises;
- ‘Forest’ thinking: seeing the ‘big picture’ and taking a more ‘on average’ view of the system;
- ‘Operational’ thinking: analysing how things actually work, the cause and effect relationships, and how performance is actually being generated.

The distinctives of systems thinking (contd)

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- ‘Closed-loop’ thinking: moving away from laundry lists of exacerbating factors and describing the ‘feedback loops’ that interact to create the performance of the system;
- ‘Quantitative’ thinking: quantifying not just the hard data but also the soft variables that are operating in the system;
- ‘Scientific’ thinking: using models to discard falsehoods not just to ascertain ‘the truth’.

Characteristics – refined in the 'heat' of consultancy

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- Engagement – combining mental models and aligning language;
- Modelling the issue not the data – but an agent for improved data capture and quality;
- Understanding delays and feedback as fundamental contributors to system dynamics;
- A learning process – iterative and 'experimental', embedded in a strategic approach that reflects an improvement cycle and 'action research'……

When is System Dynamics the 'tool of choice'?

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- An effective & appropriate tool when:
  - The scope of an issue is ***strategic*** rather than operational;
  - The importance of statistical variability or noise is low;
  - The importance of tracking individuals is low;
  - The ***number of entities is large***;
  - When 'control' of the system is through ***managing flows*** rather than queues;
  - When ***timescales are long***; and
  - When the purpose is ***policy*** making rather than optimisation or prediction.

[After Brailsford et al, '*Discrete-event simulation and system dynamics for management decision making*', Wiley (2014)]

System dynamics as part of a learning approach

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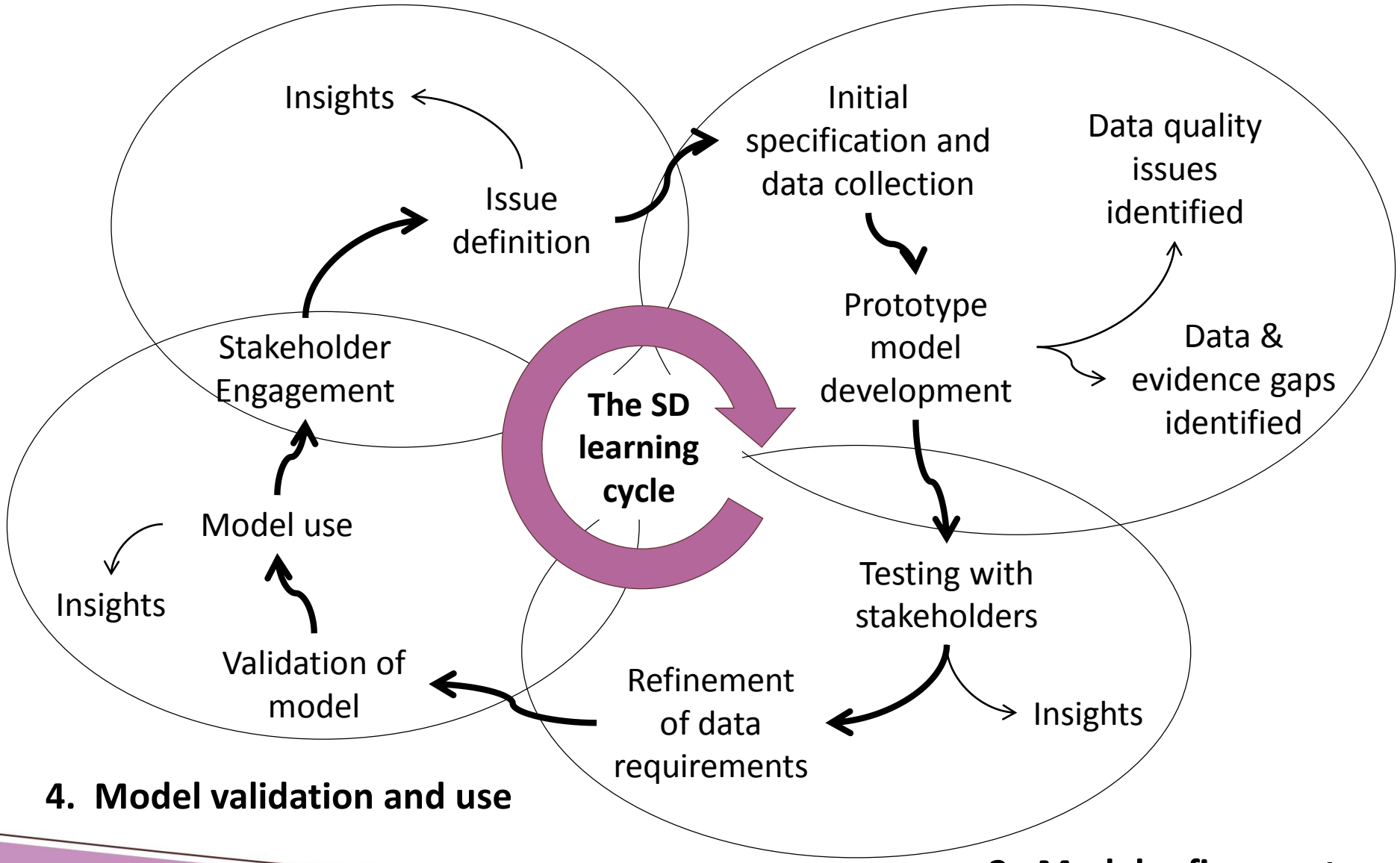
- System dynamics models are developed to reflect stakeholders understanding of a how a particular system 'works' – it's connections and inter-relationships;
- Engagement, learning, feedback and therefore iteration between stakeholders and the model is critical;
- Models provide insight into system behaviour over time under a range of 'what if' scenarios generated by the underlying assumptions and input from the model user;
- The model building process is as important as the final output because it helps to develop a consistent way of understanding the system and a common language to explore policy options.


1. Model conceptualisation
2. Model development
Insights
Issue definition
Initial specification and data collection
Data quality issues identified
Prototype model development
Data & evidence gaps identified
Stakeholder Engagement
The SD learning cycle
Model use
Insights
Validation of model
Testing with stakeholders
Refinement of data requirements
Insights
4. Model validation and use
3. Model refinement

Typical process for developing an SD model

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1. Issue definition through engagement, consensus forming and boundary setting.
2. Development of a prototype model to reflect the issue, boundaries and suggested system behaviour developed by the stakeholder group – scaled to the local system.
3. Confirm and challenge with key stakeholders before developing the data specification to populate the model.
4. Using the model to explore what-if scenarios and to generate policy options for implementation.
5. Using the model to inform key monitoring data.
6. Reviewing the model periodically through implementation to test progress, generate further learning, and potentially to develop the model to reflect that learning and adjust implementation.

A few books and contexts that have influenced me……..

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The list is long, but those that you might say have 'shaped' my thinking have been:

- *Thinking in Systems*, D H Meadows, (2008) – Chelsea Green;
- *Systems thinking*, M C Jackson, (2003) – Wiley;
- *The Fifth Discipline*, P Senge, (1990) – Century Business.

Along with:

- 15 years of being part of the International System Dynamics community, including making contributions to conferences through papers and talks;
- An MBA at Durham in the mid-90's and an MA in Applied Professional Ethics from Leeds in 2014/15.