*Health and Social Care Integration
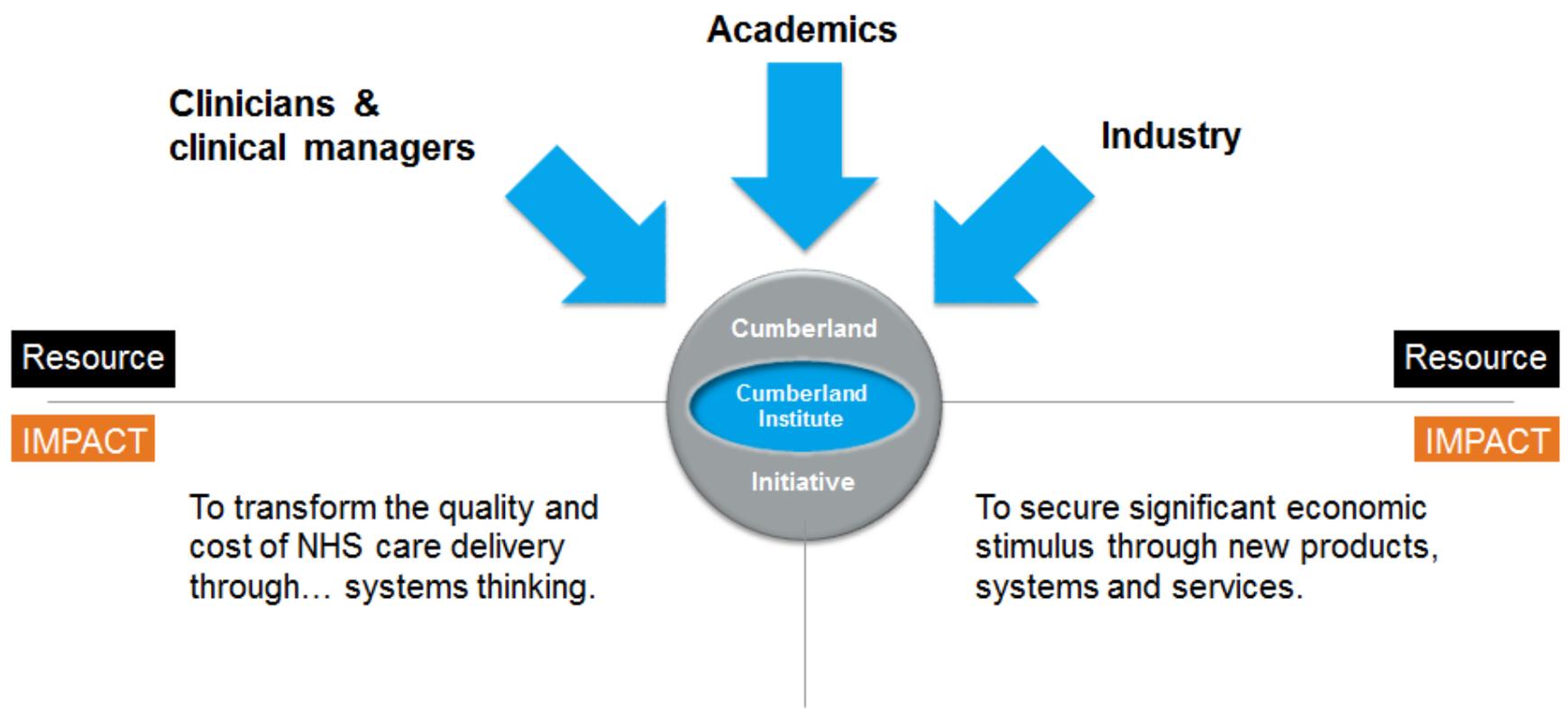with the Cumberland Initiative*

(A System Dynamics Perspective)

Developing Mathematical Models in Healthcare
ABCi, University of Cardiff, 27 January 2016

Douglas McKelvie

What is our vision?

Academics

Clinicians & clinical managers

Industry

Cumberland

Cumberland Institute

Initiative

Resource

IMPACT

To transform the quality and cost of NHS care delivery through… systems thinking.

Resource

IMPACT

To secure significant economic stimulus through new products, systems and services.

- System Dynamics as an approach to simulation

- Two Examples

  - Winter Pressures

  - Predictive Risk Assessment and Integration

- In relation to each

  - One simple "concept" model

  - The actual model

System Dynamics
In Health and
Social Care

http://www.sscr.nihr.ac.uk/PDF/MR14.pdf

"I am often asked by prospective clients, 'What's so great about System Dynamics? What will my organisation get that we can't get from other, more familiar, methods of strategic planning and analysis?' I tell them that System Dynamics is the one method that will allow them to make all of their assumptions explicit and integrate them in a logical and testable way …. will also challenge the assumptions, provide a broader perspective, and put clients in a better position to make decisions that will stand the test of time."

Jack Homer (1996) *Why we iterate…..* System Dynamics Review, 12, 1
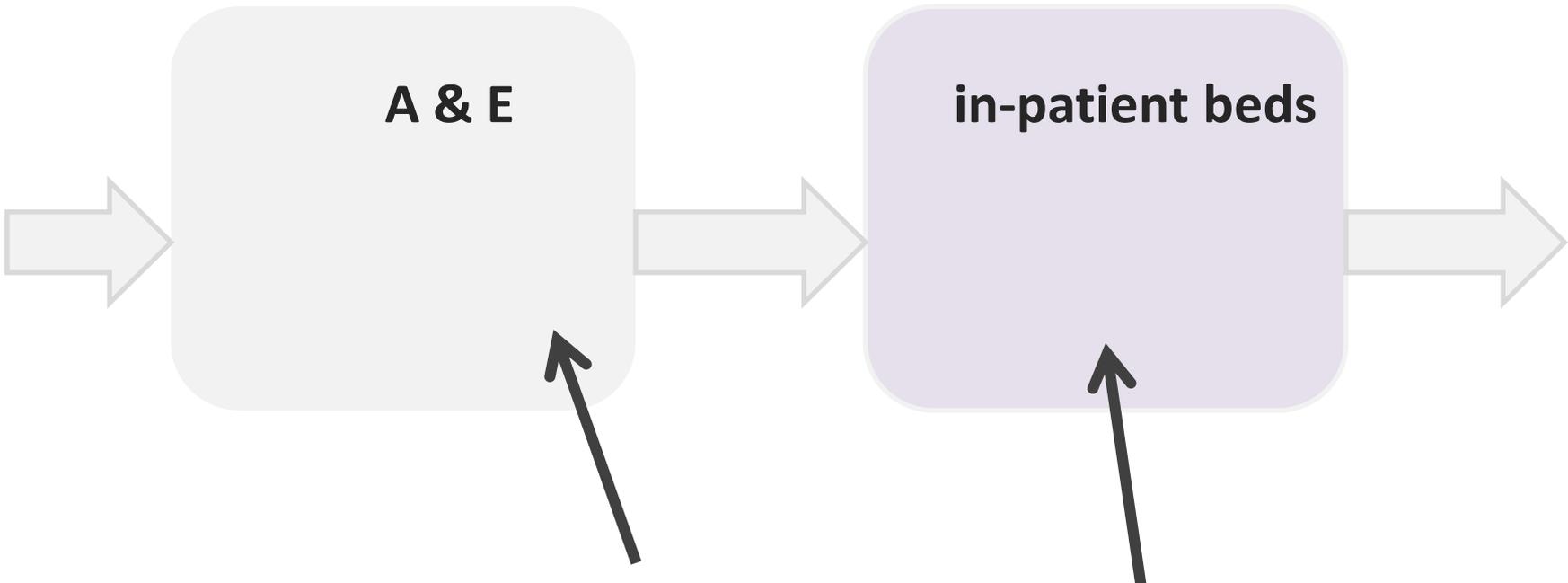
What do we mean by Accumulation and why so interesting?

"Effective decision-making in dynamic systems requires an understanding of the process of **accumulation** through inflows and outflows over time ….. However, research has documented a robust problem in human reasoning: our inability to correctly judge the process by which inflows and outflows **accumulate** over time …… highly educated individuals perform poorly even in extremely simplified Stock Flow tasks"

L. Qi and C. Gonzalez (2015) *Mathematical Knowledge and Understanding Stocks and Flows,* System Dynamics Review, 31, 3

Examples of Accumulations
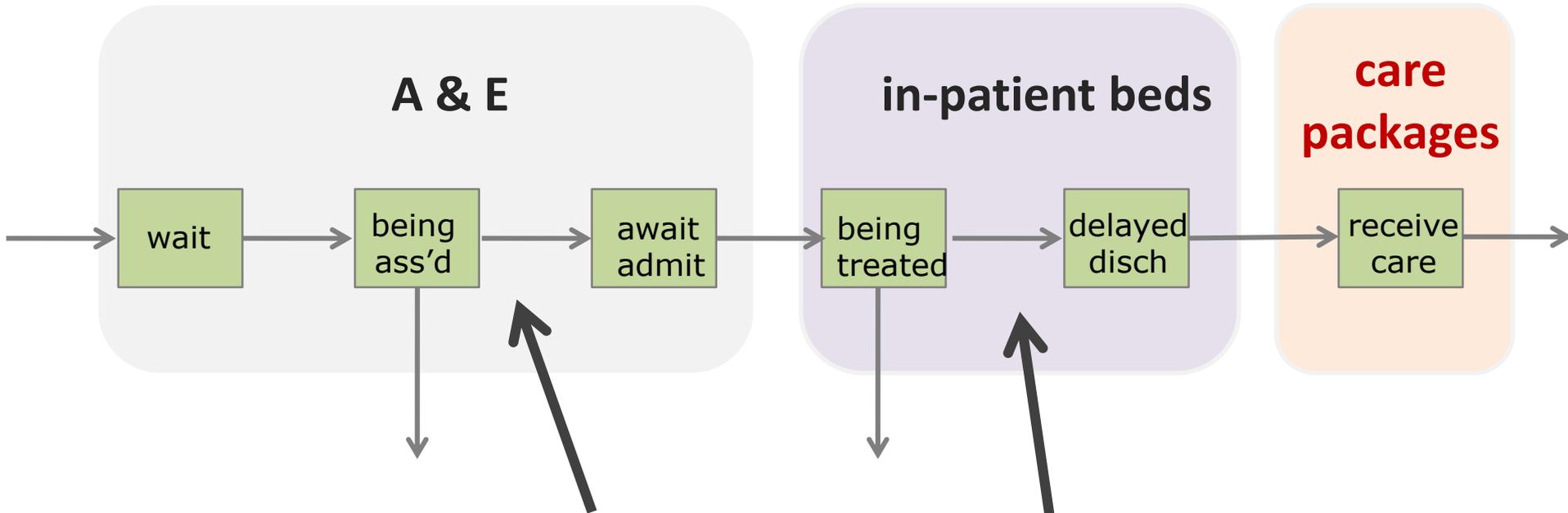
The Process looks something like this:-

A & E
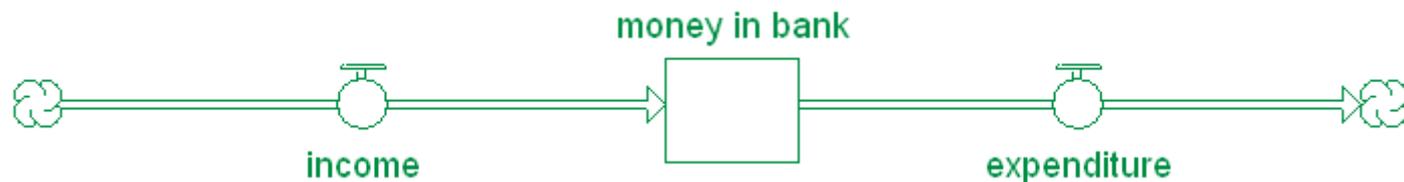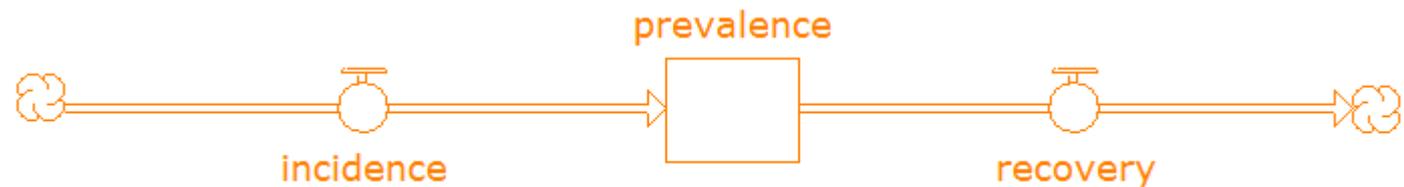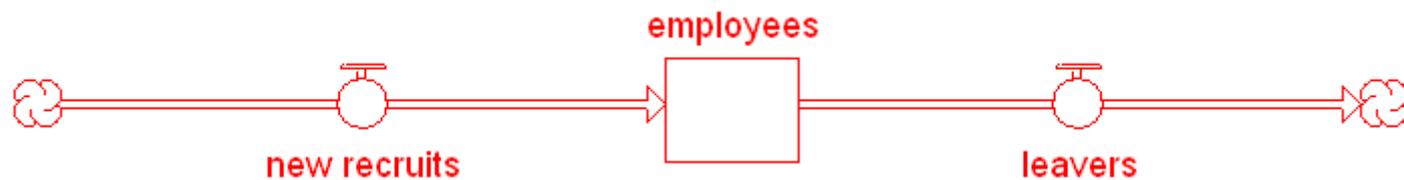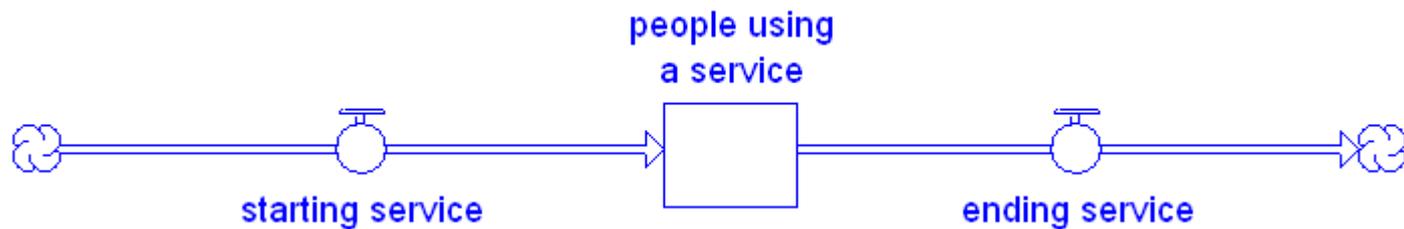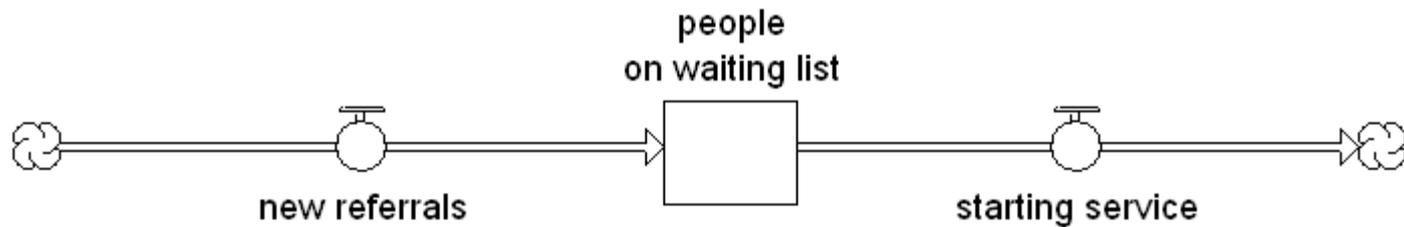
in-patient beds

"People who wait longer in A&E will have a longer los in hospital"

Thinking in terms of Events, which happens first, A&E or inpatient?

The Process looks something like this:-

Some Stocks
- How long it takes
- Is there space?

| A & E | in-patient beds | care packages |

wait → being ass'd → await admit → being treated → delayed disch → receive care
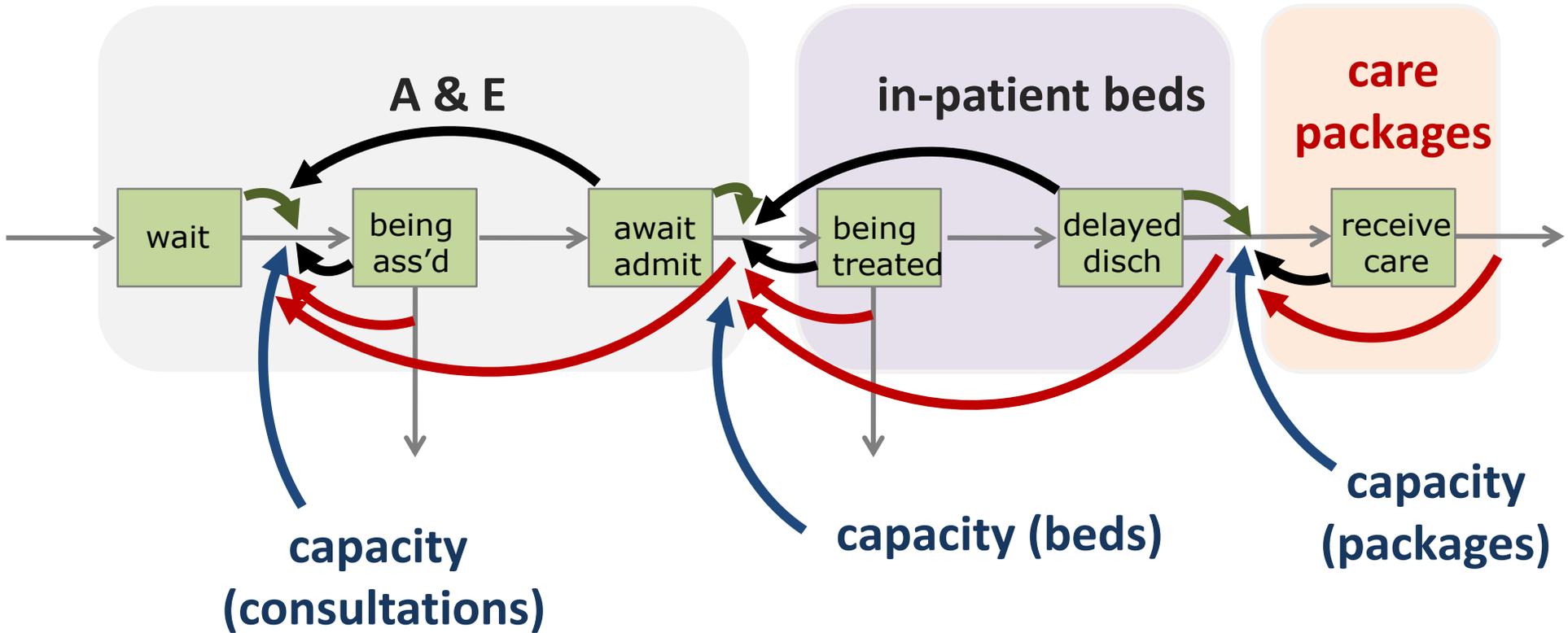
"People who wait longer in A&E will have a longer los in hospital"

Thinking in terms of Events, which happens first, A&E or inpatient?

Thinking in terms of Systems, which processes are CURRENTLY happening?

to consider how the System works, what drives the Flows?

A & E

in-patient beds

care packages

wait

being ass'd

await admit

being treated

delayed disch

receive care

capacity (consultations)

capacity (beds)

capacity (packages)

Thinking in terms of Systems, which processes are CURRENTLY happening?
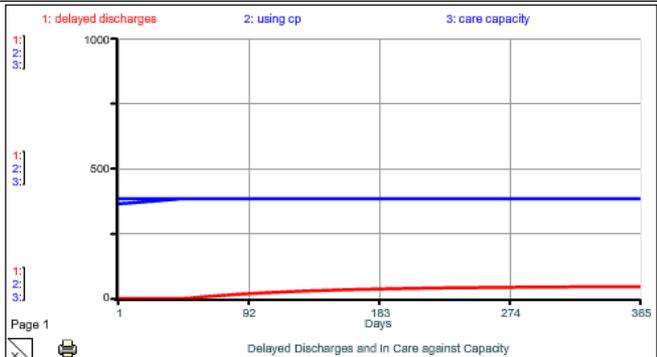
Stereotypical Comparison

Discrete Event Simulation

- Interest in application of maths to processes
- Looks in more detail at distinct functions
- Focus on transition points (events)
- Interest in variation as exogenous input
- More operational?

System Dynamics

- General interest in systems thinking
- Stocks and flows
- Feedback loops
- Non-linear functions
- More strategic?
- Interest in variation as endogenous phenomenon
- Practitioners often interested in specific domains (health, environment)
- Causal metaphor, not correlation

Caveat: the list on the left hand side is highly speculative and probably ill-informed (I hope I made that clear!)

Left chart legend: 1: delayed discharges 2: using cp 3: care capacity

1:]
2:]
3:]

1000

1:
2:
3:

500

1:
2:
3:

Page 1

1   92   183   274   365
Days

Delayed Discharges and In Care against Capacity

Right chart legend: 1: waitlist 2: total in hospital 3: beds 4: delayed discharges

1:]
2:]
3:]
4:]

200

1:
2:
3:
4:

100

1:
2:
3:
4:

Page 1

1   92   183   274   365
Days

Waiting for and In Hospital

advice: if a line disappears

advice: if a line goes off the scale

Run   Pause   Stop   clear   ?

Using only the two yellow sliders, find a model run that keeps 'total person days waited' at 0 ...... FOR LOWEST COST

note

tot person/days waited   138,064   average wait (days)   196   ?

That challenge was also covered in the Methods Review, where '% need care' (green slider on the right) was set to 7%.

0.0 —————— 40.0
         20.0

annual budget

0 —————— 100
        88

allocate % to hospital

Other Model Settings

2 —— 10

?

% of admissions who will need care package

referrals per day   10
average hospital los (d)   9
average care los (m)   24
hosp cost per patient pd   500
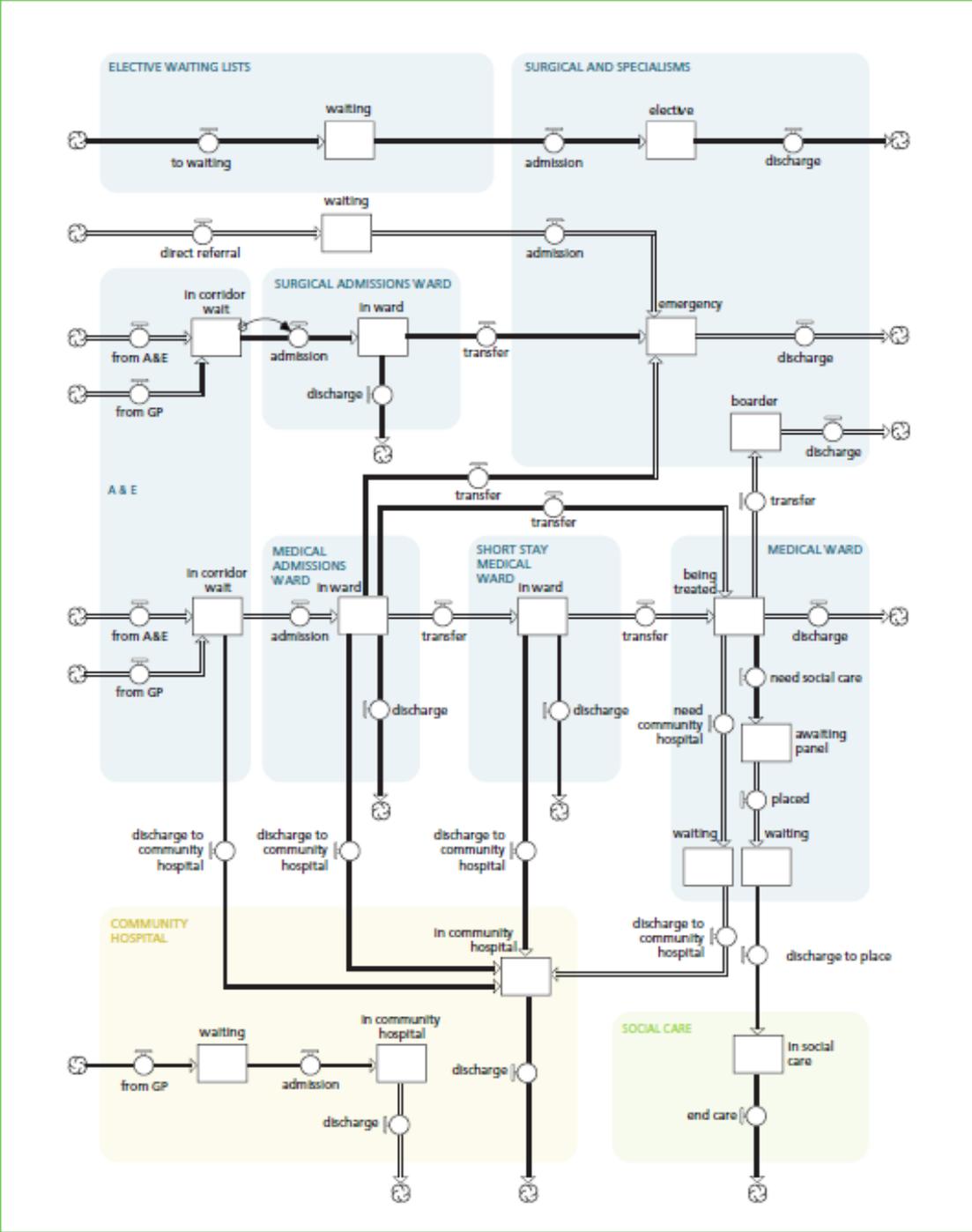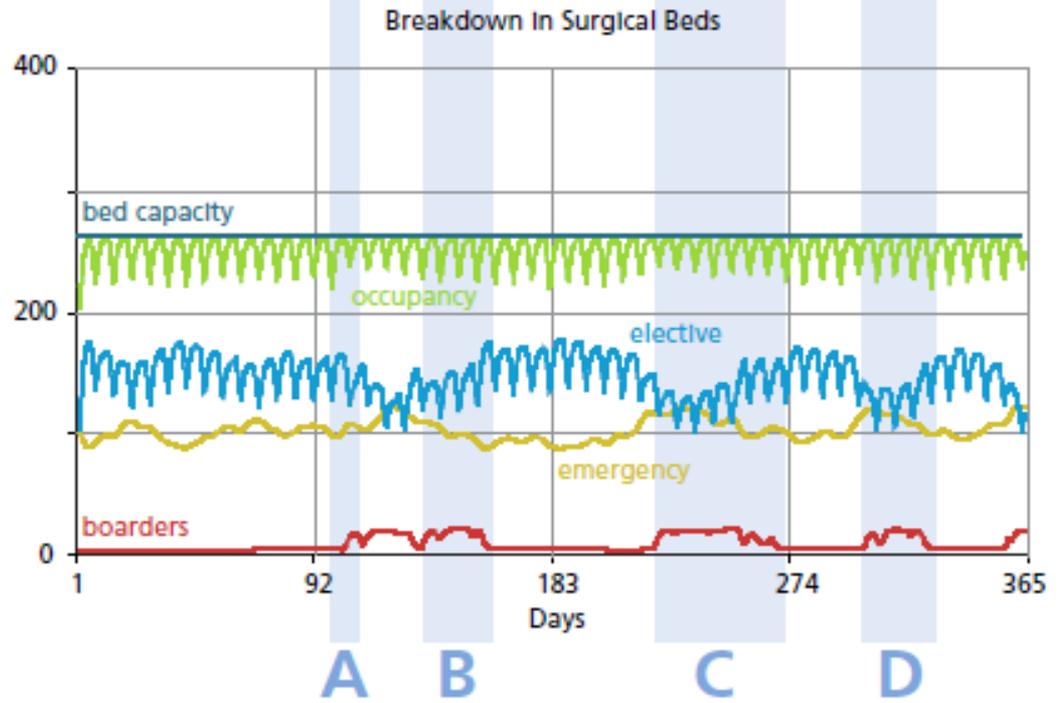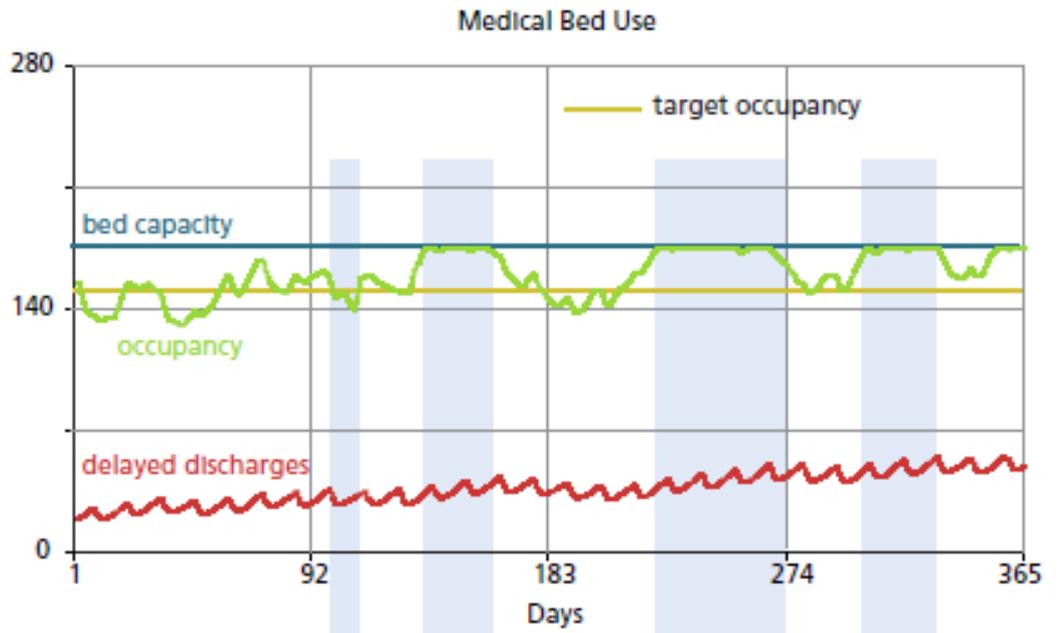care cost pp per week   120

For a version of this model where you can vary more settings CLICK HERE

return   more about modelling

'Winter Pressures Model'

described in the NIHR Methods Review 14

(pages 29 – 32, section on variation)

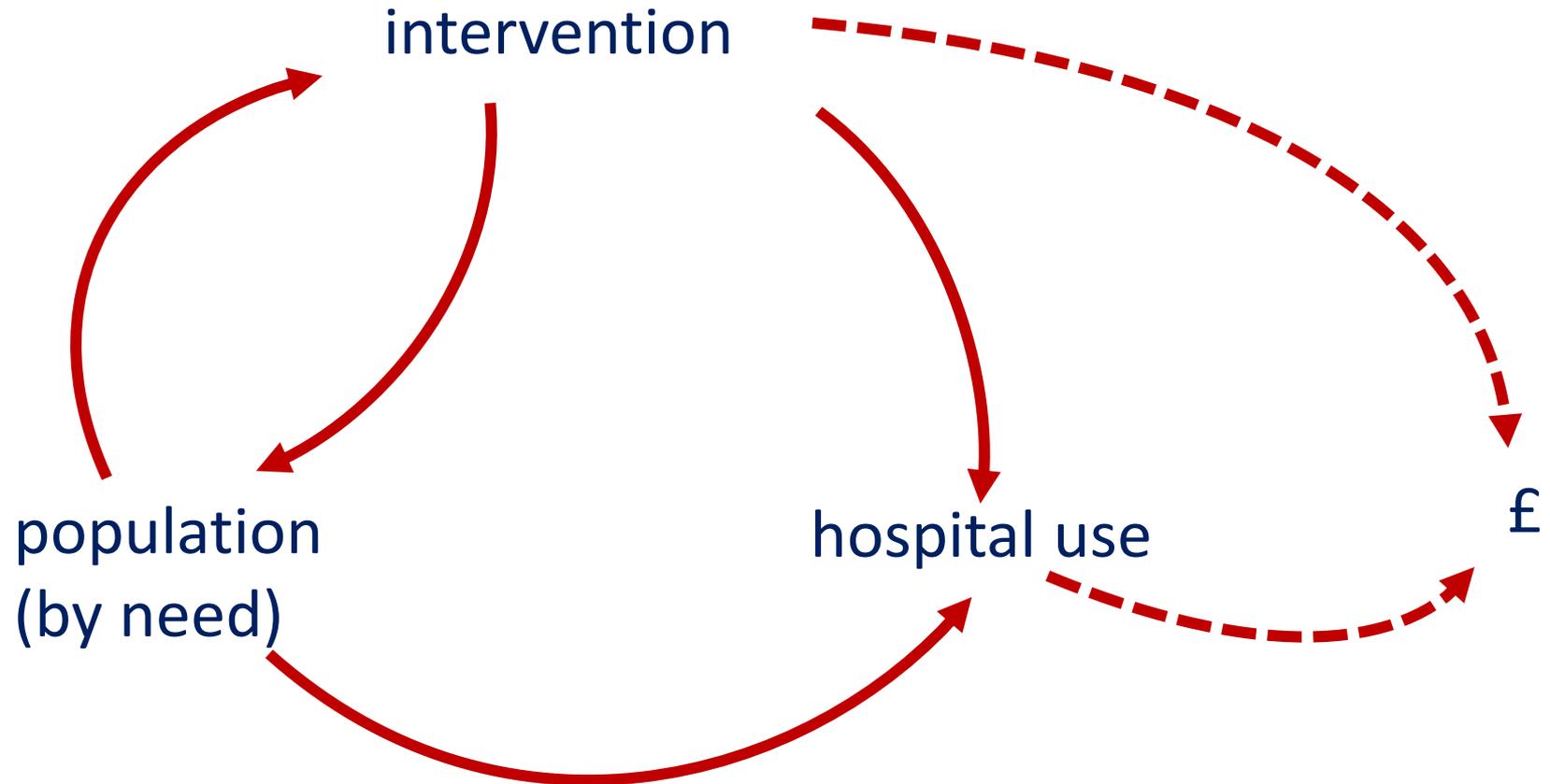Medical Bed Use

Breakdown in Surgical Beds
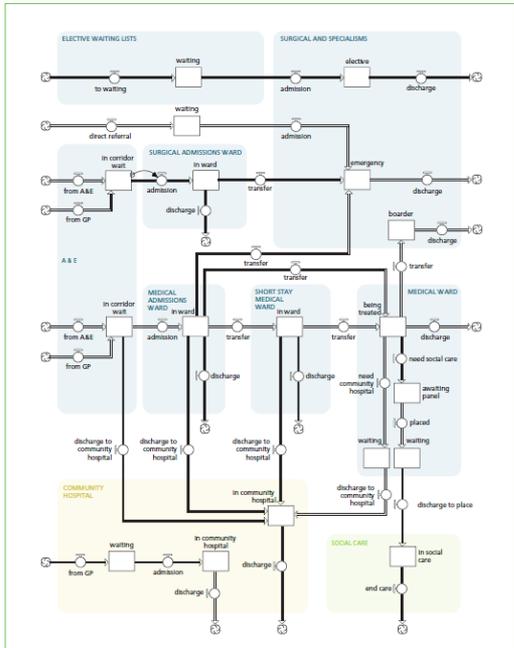
A different type of model

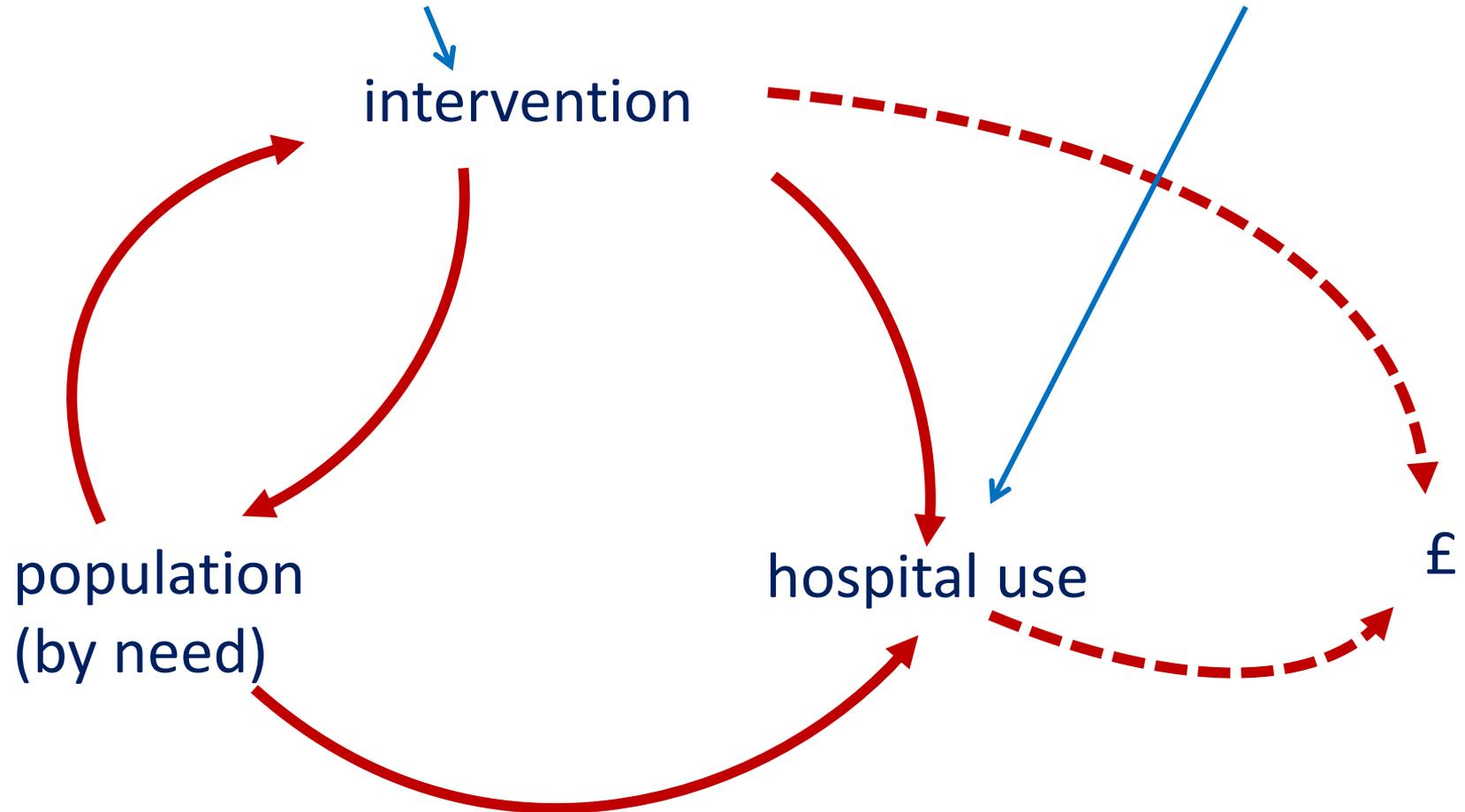Illness (or health) states rather than
Service stages, waiting lists, delays

Modelling Service Integration

Modelling Service Integration

will the cost of **this**.... ....be covered by savings **here**?

intervention

population
(by need)

hospital use

£

And if so, when?

UK Chapter of the System Dynamics Society

Annual Conference

THEME : System dynamics for developing strategy in the real world

VENUE: The Shard, London

DATE: Thursday 14th April – Friday 15th April

http://systemdynamics.org.uk/annual-gathering/

Booking via Eventbrite