Exploring frameworks for mixing DES and SD in theory and in practice

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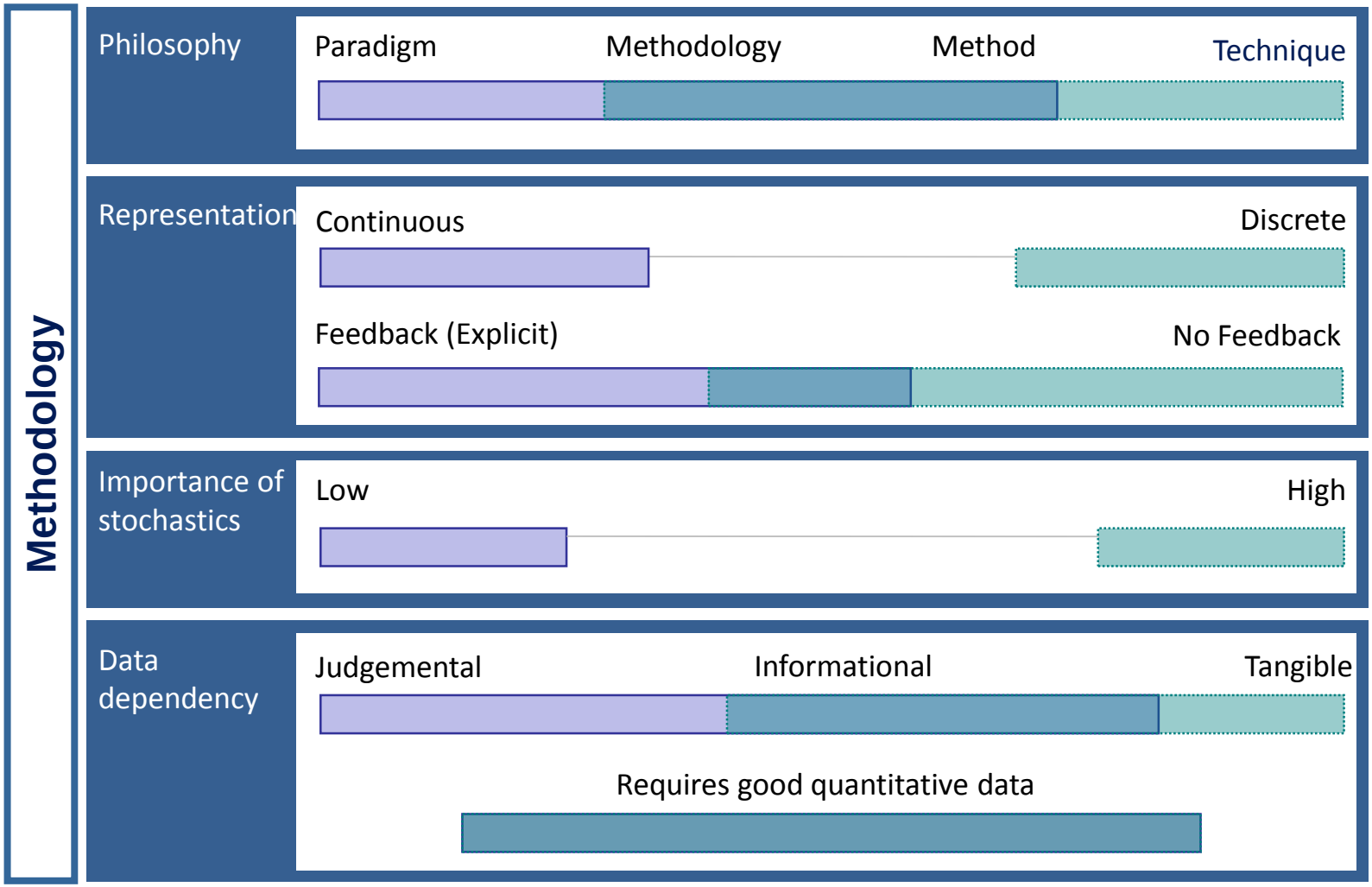
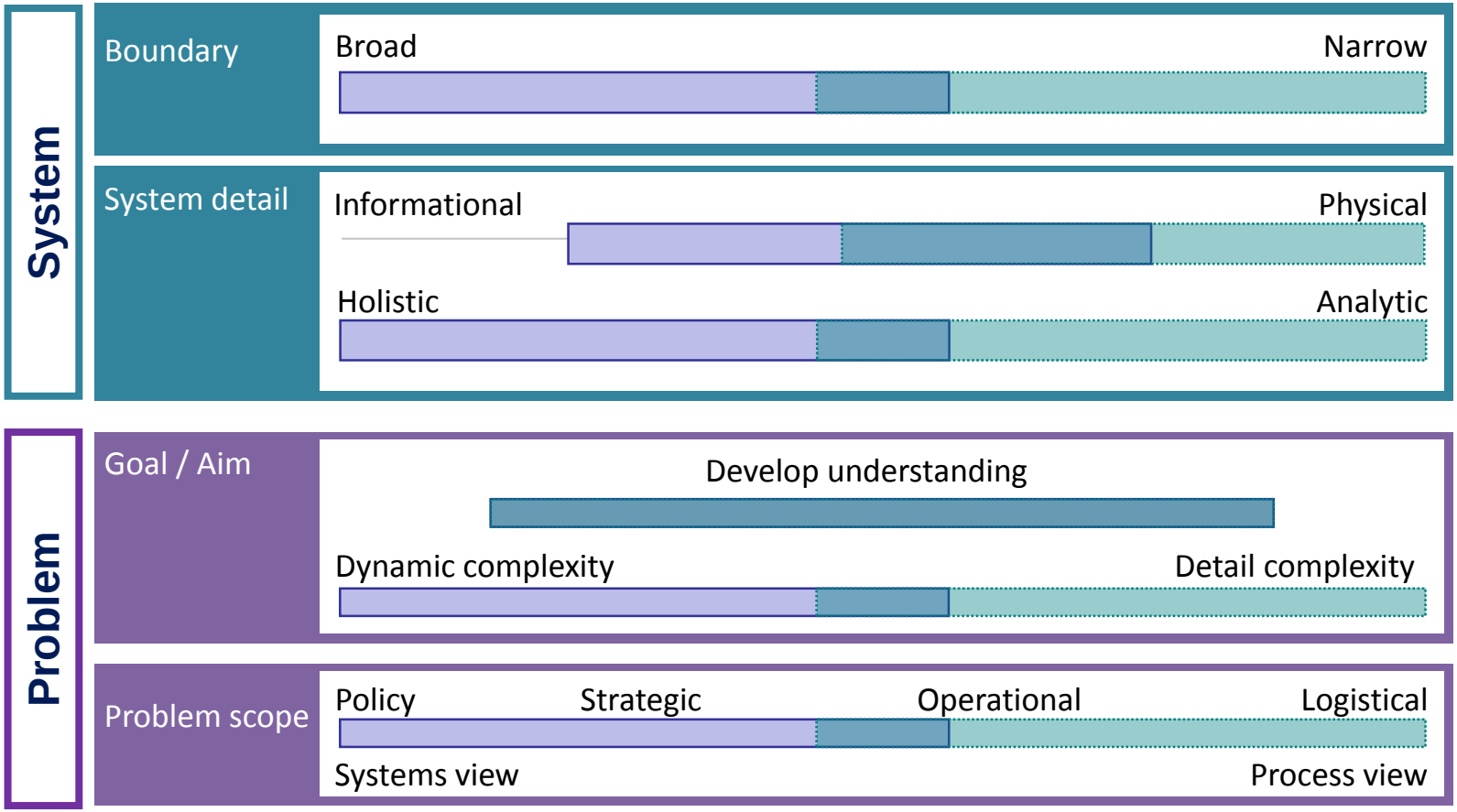
Executive summary

1. Commonality/overlap of the methods
2. Framework of mixed method designs: categorising mixed methods projects
3. Mixing in practice
4. Practical challenges and value of mixing methods

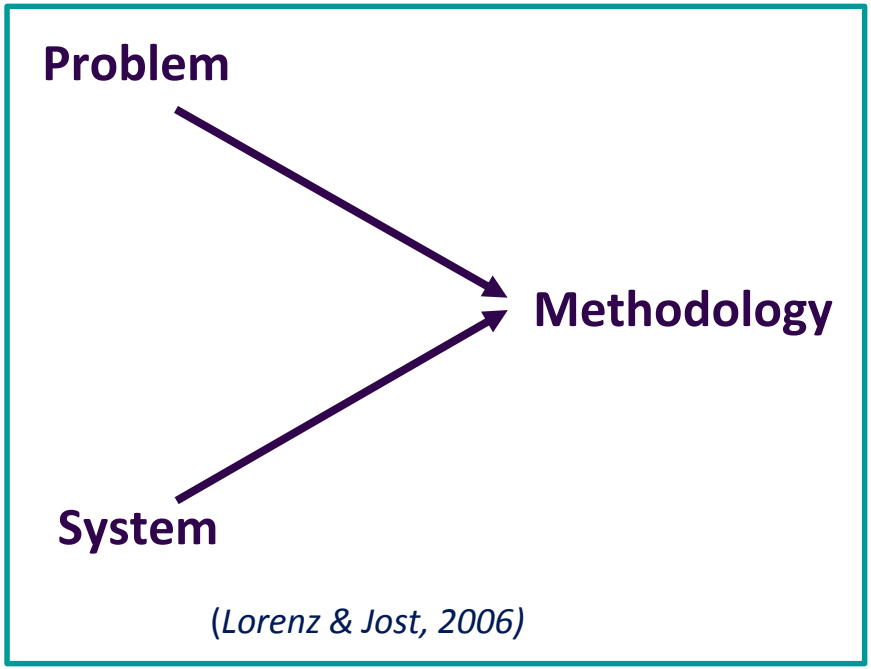
Comparison of DES & SD (1)



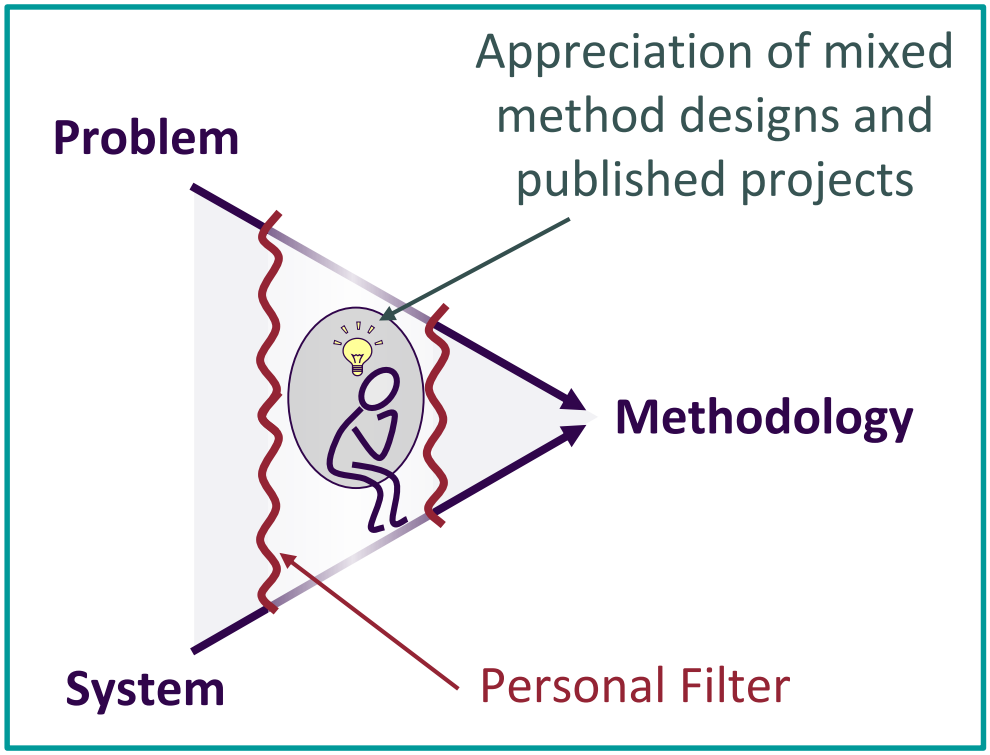
Comparison of DES & SD (2)



Selection of a project methodology



Adapted to become…



Terminology

- Ambiguous terminology can muddy the approach taken

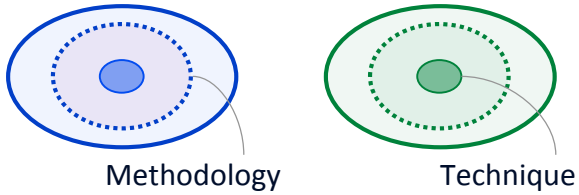
- ‘Hybrid’ may overemphasise the links drawn between the models
- ‘both methods’ may underemphasise

Terminology

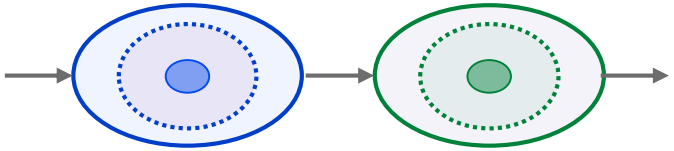
Description of mix	Paper
Both	Dierks, Dulac & Leveson (2008), Martin & Raffo (2000)
Combined	Chatha & Weston (2006), Lee, Cho & Kim (2002)
Comparing or versus	Morecroft & Robinson (2006, 2008), Ozgun (2009)
Composite	Brailsford, Desai & Viana (2010), Viana et al. (2014)
Hierarchical	Kouskouras & Georgiou (2007), Chahal & Eldabi (2008)
Hybrid	Alvanchi, Lee & AbouRizk (2011), Barton (2000), Borshchev, Karpov & Kharitonov (2002), Donzelli & Iazeolla (2001), Han et al. (2006), Jacob, Suchan & Ferstl (2010), Lee, Han & Pena-Mora (2007), Mazaeda et al. (2012), Pena-Mora et al. (2008), Rabelo et al. (2007)
Hybrid & Integrated	Venkateswaran, Son & Jones (2004)
Integrate & Synchronise	Helal et al. (2007)
Integrated	Brailsford, Churilov & Liew (2003), Reiner (2005)
Inclusion / addition	Phelps, Parsons & Siprelle (2002) – referred to by brand name: Simulation Dynamics
Discrete events in SD	Wolstenholme (1980), Howick & Eden (2004)
Unclear – DES then SD	Brailsford et al. (2004)
Unclear – SD for DES	An & Jeng (2005)
Unclear – SD in DES	Fioroni et al. (2007)
Unclear	Su & Jin (2008)

Mixed method designs

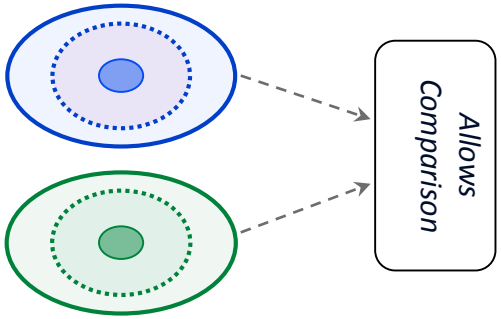
Isolationism



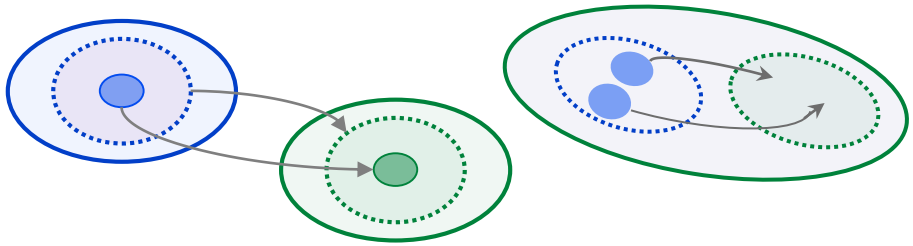
Sequential



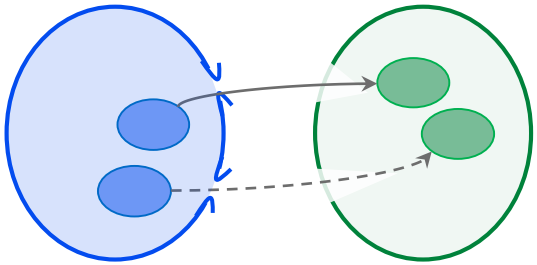
Parallel



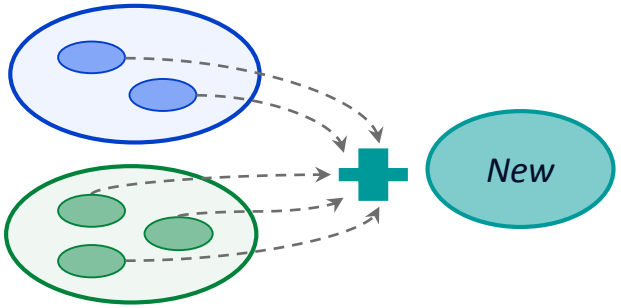
Enrichment



Interaction

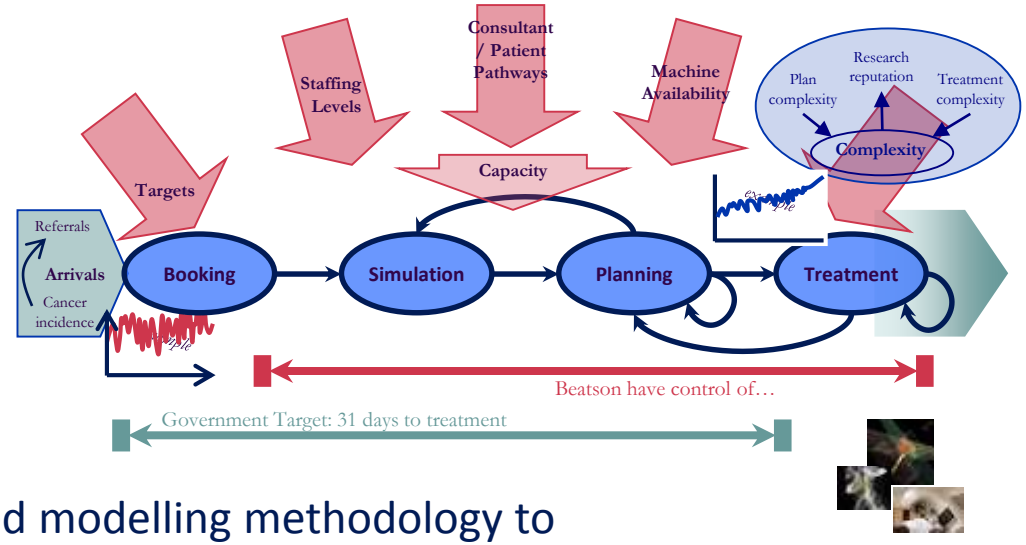


Integration

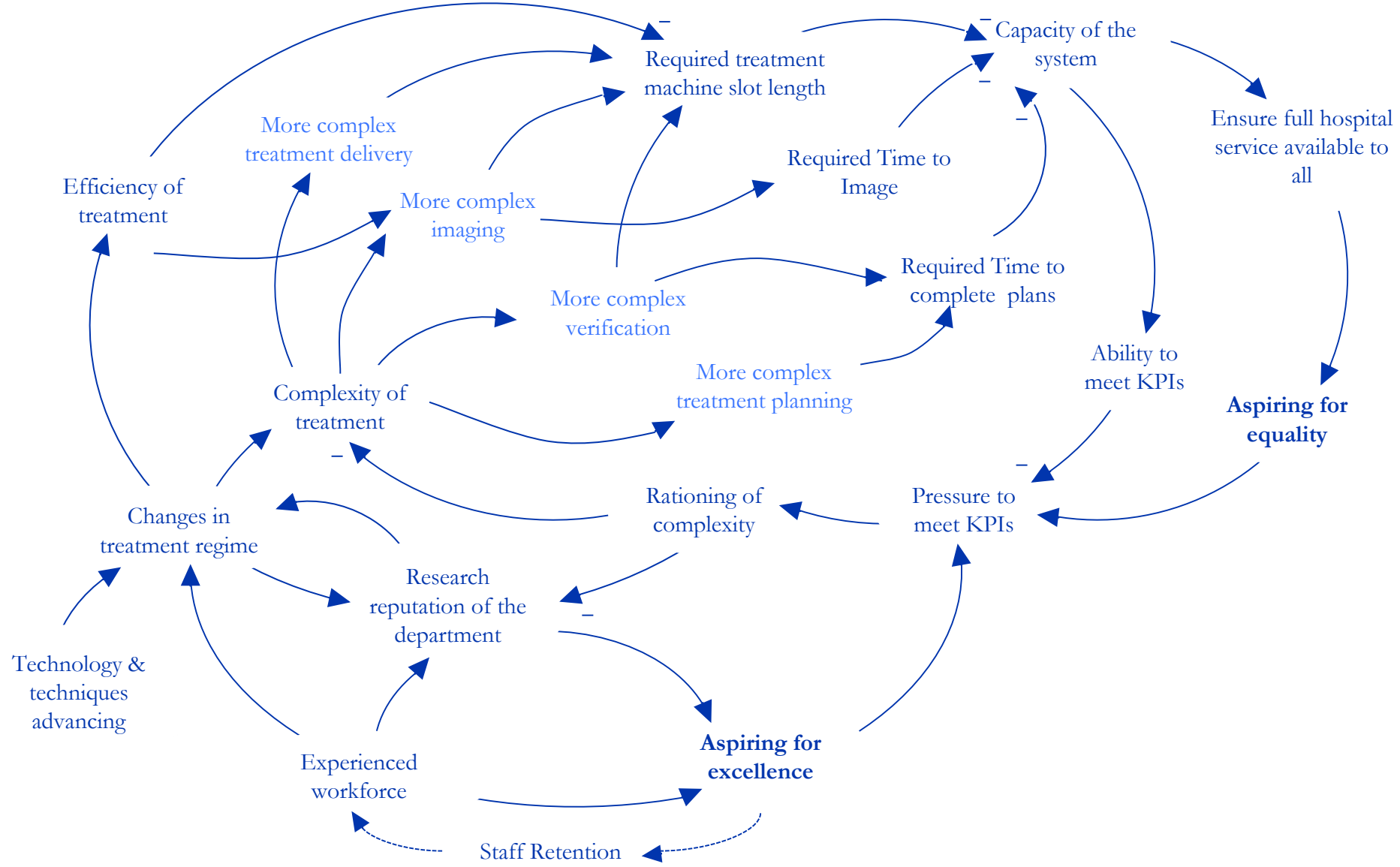


The Beatson Project: Introduction

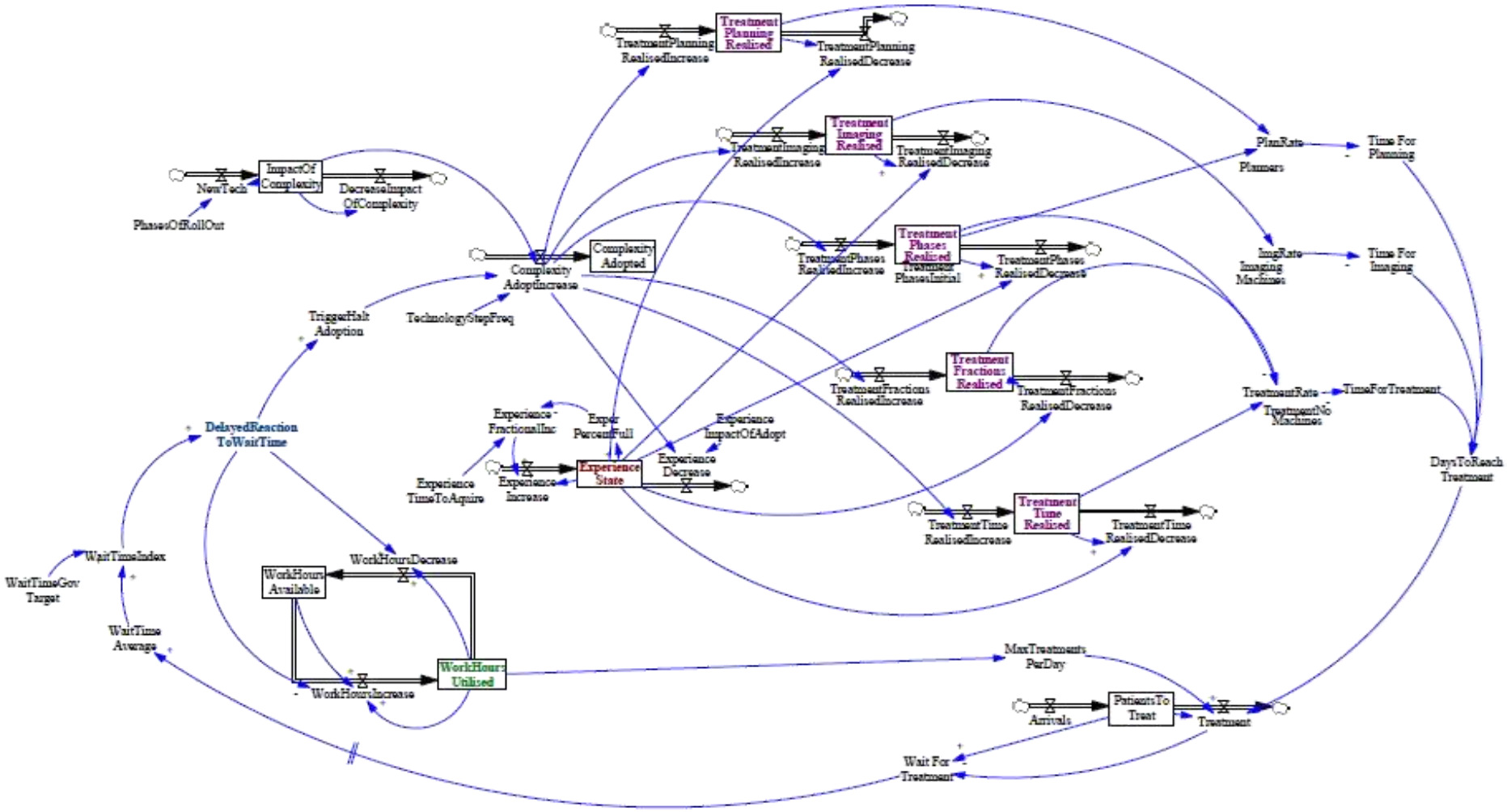
- Working with the Beatson
- Why Radiotherapy?
  - Complex, multistage process
  - Interrelated stages with feedback
- Overview
  - The aim was to apply the developed modelling methodology to pertinent issues within the radiotherapy centre
  - Issues are explored at both the strategic and the operational level ...
  - …to shed light on the balance to be struck between what is hoped to be achieved, and what can realistically be implemented



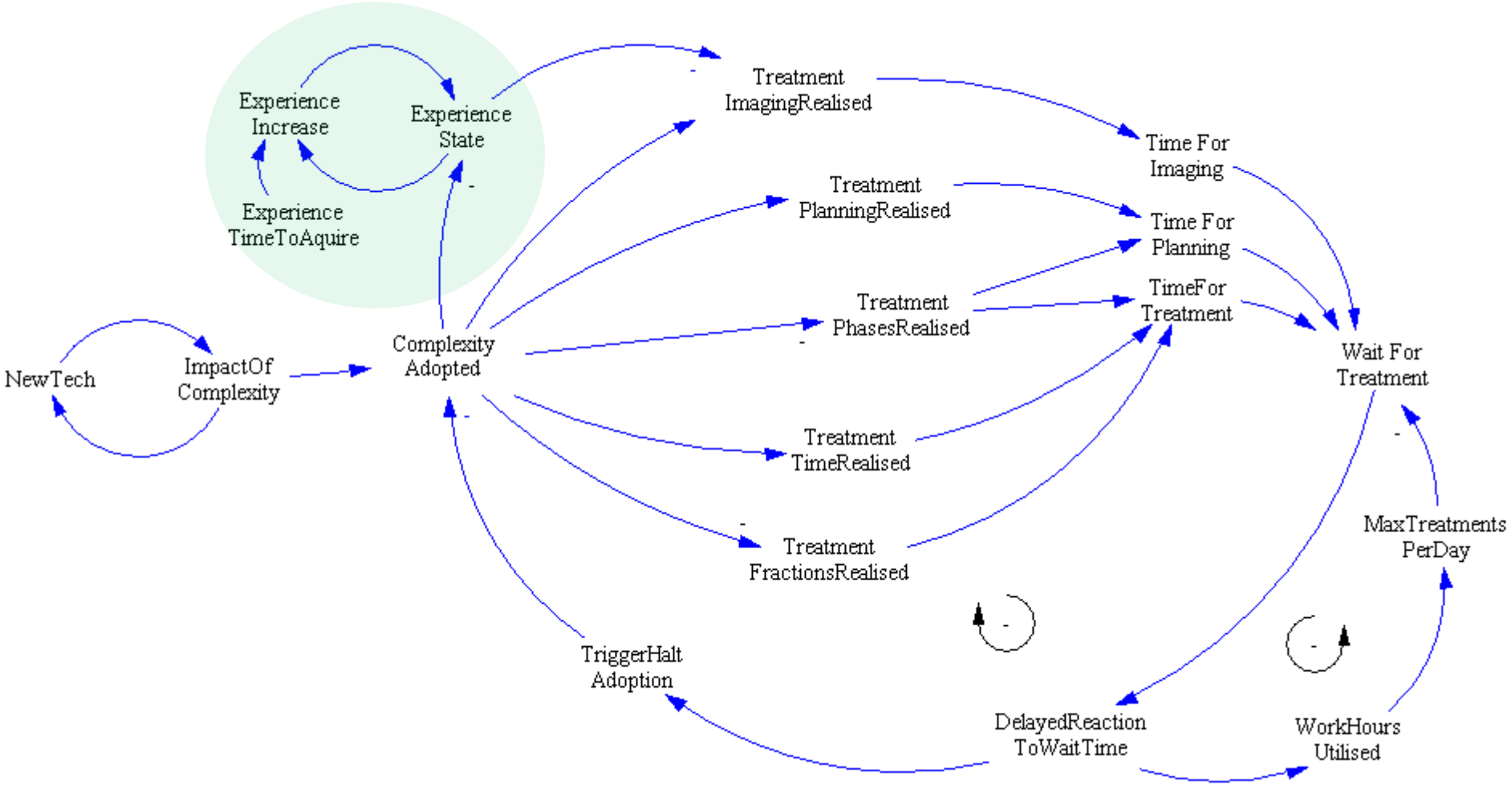
Problem Definition



SD Model: Stock & Flow Diagram

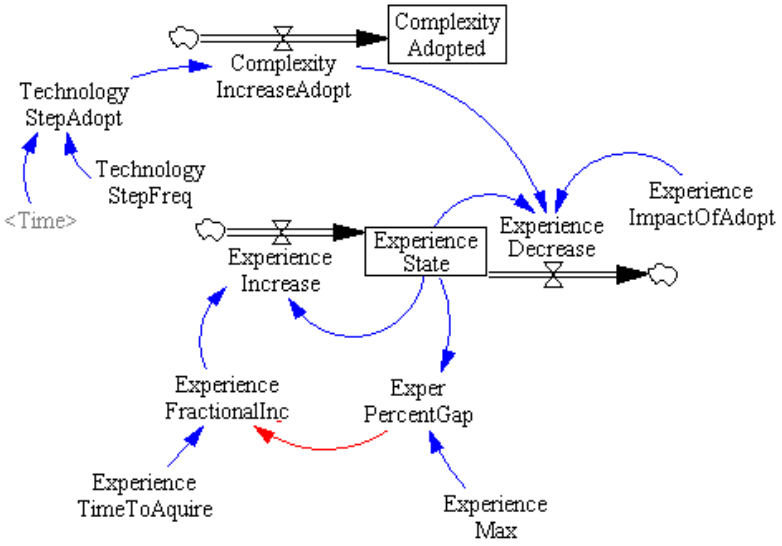


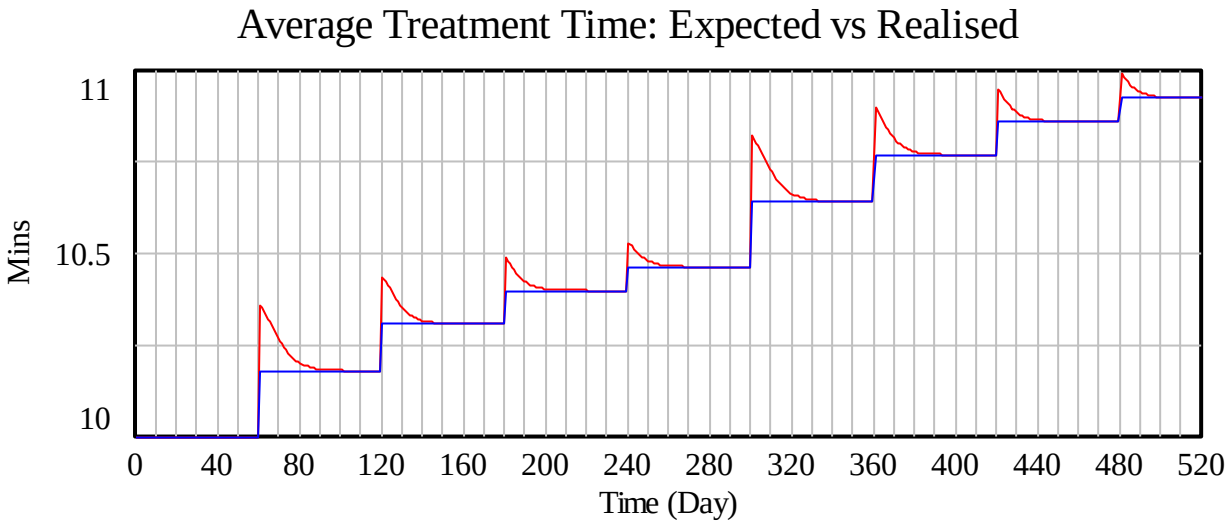
SD Modelling



SD Modelling - Capturing Staff Learning

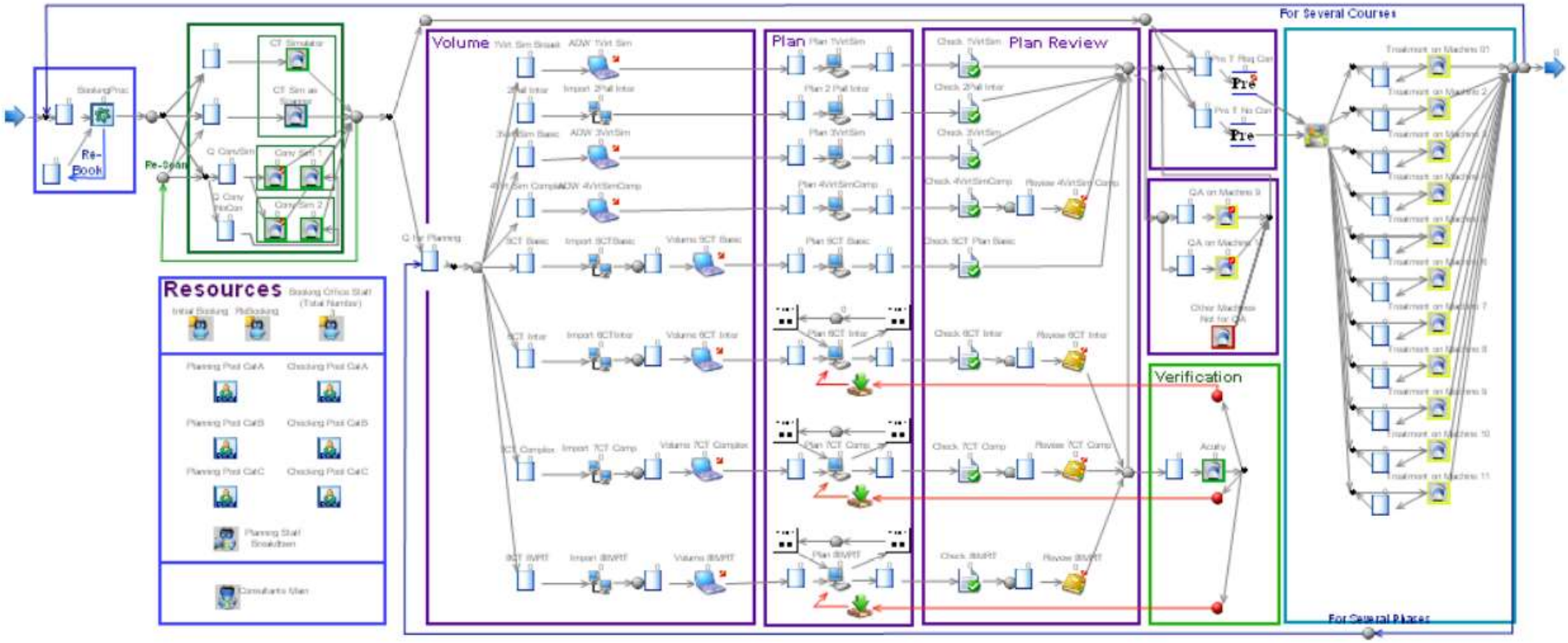
- Using SD to capture the drop in experience when a new radiotherapy regime is adopted.
- This translates to a larger impact than expected on the treatment time of patients



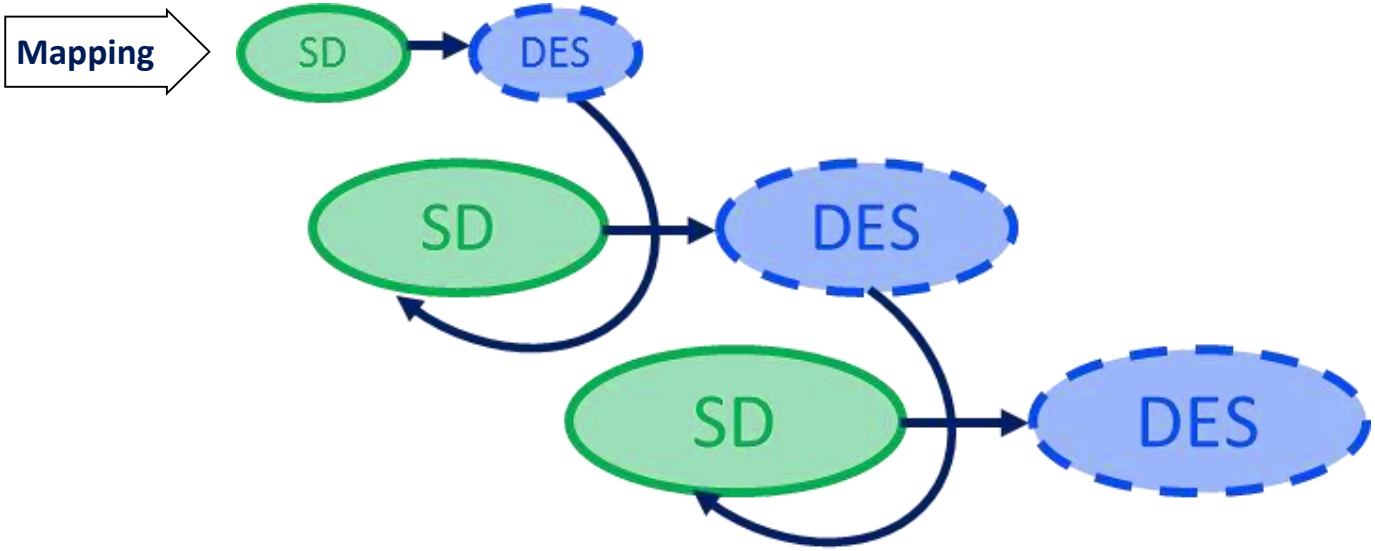


DES Modelling

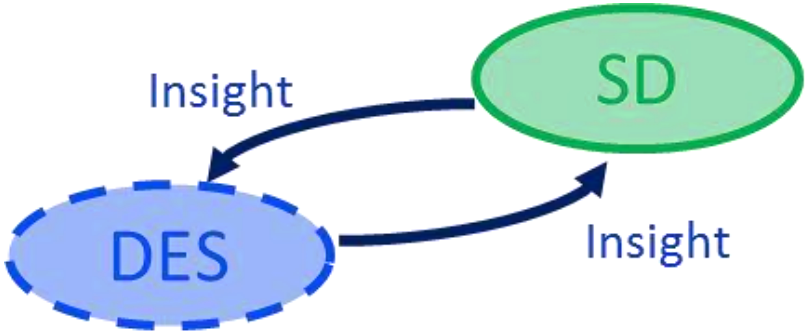
	Average Arrived	Average Leaving	Av. Completed Patients	Average Total Imaging Sims	Average Treatments Delivered	Total IMRT patients	Time to first treatment (Days)
D	6,462	6,301	97.57%	8,260	108,840	29.2%	26.22 [sd: 16.59]
BASE	6,462	6,149	94.83%	8,262	106,189	20.7%	28.52 [sd: 20.56]



Mixed Method Design



Identified points of interaction between the models



Mixed Modelling Insight: SD focus

- Enabled exploration of the value of changing to more complex treatment regimes
  - Time realised for activities peaks then returns to an expected level (the target level for that regime)
  - Overall progressive decrease in the number of phases required per patient
  - Progressive increase in time required on treatment machine per session per patient
  - Net effect of decrease in the contact time on treatment machines.
  - Staggered technology implementation needed to cope with the learning process involved with changing treatment regime.

… whilst accounting for the constraints and issues to be encountered in practice.

Mixed Method Design	Isolationism	Parallel Design	Sequential Design	Enrichment Design	Interaction Design	Integration Design
Number of possible methods under consideration	1 only	more than 1	1 or more	more than 1	more than 1	more than 1
View of the system	Single view of the system	Two possible representations of the same system	Need to capture different parts/behaviours of the same system			
Number of separable roles of each method under consideration	All issues fit a single method	Single theme requiring complementary insight	Single theme with separable issues	Single role of the methods		
Interaction likely	-	No	Yes	Yes	Yes	Yes
Direction of interaction	-	-	One direction	One OR Both directions	One OR Both – if only one then sequential design	Both directions
Form of interaction	-	-	Model insight and hard data	Hard data only	Model insight and hard data	Hard data only
Frequency of interaction over time window	-	-	Once – single pass	Low to High (Likely high)	Low to High (Likely low)	Low to High (Likely high)
Number of points of interaction	-	-	Single to multiple	Single to multiple	Single to multiple	Single or Multiple (Likely multiple)
Triggered or regular interactions	-	-	-	Triggered by the state of the system AND / OR Regular, every X timesteps		
Number of models created	1 only	more than 1	more than 1	1 only	more than 1	1 only

Realised value of the modelling process

- Problem structuring … Open to capturing a broad range of issues
- Both SD and DES have explicit roles to play
  - SD … Enabled exploration of the value of changing to more complex treatment regimes
  - DES … Identified process restrictions and limitations
- Used to develop understanding of the system
  - ... whilst building a case for/against policy changes
  - Overall benefit to equity of care

Realised value of mixing DES & SD

- From the client's perspective …
  - Challenged beliefs about behaviour of the system
  - … leading to a change in understanding by stakeholders
  - … effect on the culture of the centre

- From the modeller's perspective …
  - Challenged personal perceptions of the system
  - Requisite modelling …. Cycling between methods encouraged explicit consideration of what is really needed in the models

Discussion

- Mixing methods is valuable to capture complex problems
- Concerns
  - A desire to model everything
  - Possible to obtain the value from both methods … but at what price?
- Value
  - Encouraged an open view of the issues … different method world views
  - Client acceptance & buy-in

Key learning points

1. Commonality/overlap of the methods
2. Set of mixed method designs to categorise mixed methods projects
3. A general mixed method model development process
4. Practical challenges and value of mixing methods
   - Distinct roles of methods within the action research project
   - It need not be technically challenging, and needs conceptual support