NHS
Institute for Innovation and Improvement

Developing competence in modelling and simulation for commissioning and strategic planning

A Guide for Commissioners

Draft for comments

21st August 2009

Your advice and comments about this Guide are welcomed. In particular, we would like to ensure that the Guide covers the right amount of detail, provides comprehensive and helpful advice and is presented in a format suitable to the intended audience, that is to Board members and senior managers within PCTs who are engaged in commissioning.

Please send comments on this Guide to Dr Nick Gaunt at the NHS Institute for Innovation and Improvement

Email: nick.gaunt@institute.nhs.uk

tel. 07775 802736

Revisions

Version	Date	Author	Changes
0.1	10/08/09	N Gaunt	Initial draft
0.2	21/08/09	N Gaunt	Revised and incorporating comments from Pam Smith, SWSHA
0.3	29/10/09	N Gaunt	Reformatted to use Arial (Institute standard)

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This guidance incorporates material prepared by the TORCH project team:

Dr Martin Pitt (project lead)
Senior Research Fellow, Peninsula Technology Assessment Group, Peninsula Medical School, Noy Scott House, Barrack Rd, EXETER EX2 5DW

Professor Ruth Davies,
Professor of Operational Research, Warwick Business School, University of Warwick

Professor Sally Brailsford
Professor of Management Science, School of Management University of Southampton

Professor Thierry Chaussalet
Professor of Healthcare Modelling, School of Informatics, University of Westminster

Professor Paul Harper
WIMCS Research Chair in Operational Research, Sch. of Mathematics Cardiff University

Dr. Dave Worthington
Senior Lecturer, School of Management, University of Lancaster

Professor Mike Pidd
Professor of Management Science, School of Management, University of Lancaster

Mr Giovanni Bucci
AtoZ Consultancy, Kenilworth, Coventry

Introduction

Never before in the history of the NHS has the need to improve productivity been so stark. Even before the current financial crisis the aging population, shrinking workforce, increasing costs of healthcare and rising public expectations were beginning to severely stretch the available resources. It is now recognised that only through innovation and industrial scale transformational change will the NHS be able to maintain quality and at the same time increase productivity. Such large-scale change will require novel approaches to demand management, service delivery, design and implementation of hitherto untested models of care and capacity planning.

Modelling and simulation, long used in science and engineering, are now critical to innovation and operation in many manufacturing and business sectors. Indeed, in many corporations (e.g. in automotive, nuclear, oil sectors) no new process is introduced without first simulating its operation. The same techniques can be used very effectively to model healthcare systems and are set to become key tools to achieving the goals of QIP. Competency in modelling and simulation is already required within the World Class Commissioning Assurance Framework although recent external assessments have confirmed that skills and application of these techniques are poorly developed in the majority of PCTs.

There are several likely reasons for the low level of adoption of modelling and simulation for healthcare planning and commissioning: little awareness of the techniques; perceived complexity of the tools and techniques; a culture of not using information effectively for strategic decision-making; limited skills in the techniques amongst NHS staff; lack of educational courses; and the high cost of external consultancy to develop of models.

Scope

This guidance aims to raise awareness in PCTs of the techniques of modelling and simulation of use in strategic planning, and to support PCTs seeking to develop of their competence in this area by suggesting a ‘curriculum’.

The application of simulation to operations management such as detailed process control, scheduling and logistics is not covered by this guidance. Neither are the methods of descriptive statistics, epidemiological modelling, predictive modelling and risk stratification, which are well served by academic courses.

What can modelling and simulation offer commissioners?

Modelling and simulation have a role in all aspects of commissioning and strategic planning (see the mapping to WCC competencies at the end of this guide). They help you to structure problems, make more informed decisions, predict demand, anticipate change in systems and their capacity to respond, formulate economic cases, locate services and much more. In short they are ‘Tools for Thinking’ (Pidd, 2003). As such, any health services manager should have at least a passing familiarity with these tools and techniques (and commissioning organisations should be able to demonstrate competence against the WCC Assurance Framework).

Developing capability in modelling and simulation

Who in commissioning should have skills?

The techniques of modelling and simulation are widely applicable to strategic planning and commissioning (see Annex for a mapping of techniques to WCC competencies).

Not everyone involved in commissioning needs to be adept at the techniques: clearly there will be a range of capabilities required. Three levels of skill are suggested:

Awareness – members of PCT Boards should be aware of the potential for modelling and simulation to help inform complex decisions and reduce risk in the planning and commissioning of healthcare services. They should know when to expect such techniques to be used and to ensure that they are being applied effectively and appropriately. They do not need to know the technicalities of how they are applied nor whether the work should be undertaken by PCT staff or by external contractors.

Appreciation – senior managers should have a deeper appreciation of the methods available, which are likely to be the most appropriate to their work, what skills might be involved and where such skills can be found. They should be able to determine whether skills in particular techniques should be developed in house or contracted out. They should be able to act as an 'intelligent customer' when dealing with external contractors. They do not necessarily need to understand the technical details of a tool but should know how the technique can help their decision-making and how to make best use of its outputs.

Application – the technical skill in applying modelling and simulation tools and techniques is likely to rest with someone with analytical abilities. This may well be a senior information or public health analyst although there is no reason why anyone with the aptitude, skill and time should not use the methods. Indeed, some of the conceptual modelling skills are relevant to change (and other) management and improvement roles.

Practical skills will of course vary according to technique and need: they will likely be higher for methods used frequently than those used rarely or not at all, and the more advanced techniques are likely to demand a greater degree of skill than simpler ones.

Should expertise be developed in-house or bought in?

Given the potential benefits of using modelling and simulation for strategic planning and commissioning, it is reasonable to plan for some expertise to be developed in-house. However, it may be unrealistic to maintain in-house capability and capacity in the full range of modelling and simulation techniques, so some consideration must be given to the benefits and disadvantages of calling upon external support. Benefits include access to advanced practitioners and techniques; experience from similar projects elsewhere. Disadvantages include: modelling is likely only to be undertaken on specific projects rather than used whenever appropriate; there is unlikely to be significant skills transfer (unless some coaching or mentoring support is procured); the model itself may not be modifiable locally, so the supplier may have to be recalled if a model needs to be revised.

When to develop and maintain in-house expertise

- When the method is used frequently, especially if incorporated into systems and processes

- When you expect to review and adapt models over time

When to consider external support

- If a method is used only infrequently such that it is difficult to maintain sufficient skill in-house.
- When advanced techniques demanding specialist skills are required

What support can be brought in?

- Full project support
- Expertise in specific technique (does assume in-house appreciation of which techniques are appropriate to specific problems)
- Coaching / mentorship to support in-house teams (has the advantage of skills transfer)

How might specialist support be provided within the NHS?

It can be difficult to maintain skills in specialised modelling and simulation techniques in an organisation if these are used only infrequently. Several models have been used to provide these more specialised needs from more centralised units within the NHS.

For example, in the deployment of the Scenario Generator simulation software tool, some communities have chosen not to implement in all local PCTs, but to share expertise, for example through:

- one PCT offering its expertise to others in a consortium arrangement (e.g. North East)
- Commissioning Business Support Services (e.g. West Mids, Greater Manchester)
- a Specialist Decision Support Service (e.g. South Central)
- a Public Health Observatory / Resource Centre (e.g. Oxford)

Other possible approaches include offering the services through:

- Quality Observatories
- NHS / Academic collaboration such as Collaborations for Leadership in Applied Health Research and Care (CLAHRC) or Health Innovation and Education Clusters (HIEC)

There is a balance to be struck between the benefit of scale and centralisation on one hand, and greater distancing of the specialist from the problem and decision making in the commissioning organisation on the other. Success will depend on the specialist analyst being sufficiently skilled in consultancy techniques and able to engage effectively with client teams.

Other sources of expertise

There are many specialist providers of these techniques, both academic and commercial.

A good starting point for academic support is the UK Modelling and Simulation in Healthcare network (MASHnet) – see http://www.mashnet.org.uk

Commercial providers might support products that use particular techniques such as system dynamic or discrete event simulation. They might provide more general analytical and modelling support, or be primarily management consultancies that use a variety of tools as they consider appropriate to their client's needs.

Building in-house capability – a curriculum

The NHS Institute for Innovation and Improvement commissioned the development of a '*Curriculum for the Application of Modelling and Simulation to Commissioning'*. It was developed by a consortium of academic experts through MASHnet (the UK Modelling and Simulation in Healthcare Network) in consultation with a variety of healthcare teams in PCTs and SHAs across England.

The work focussed on the design of a curriculum and modular course because not only is there a need to improve competence in the PCTs but there are currently no suitable academic courses available. It is hoped that the proposed curriculum and course design will serve as a template against which educational providers can offer suitable opportunities for learning.

The overall aim of developing this '*Curriculum for the application of modelling and simulation to commissioning'* is to build capability across commissioning organisations in the NHS by:

- identifying for commissioners which of the many operational research techniques are most applicable to their work
- offering a structured approach to developing competence in those methods
- providing educational providers with suggestions for course content should they wish to provide training in application of modelling and simulation as a part of courses on healthcare strategic planning or commissioning.

The curriculum covers the methods and techniques most applicable to commissioning (a mapping of methods to the WCC competency framework is provided in the Annex).

The pertinent techniques have been compiled into a suite of modules that together comprise an integrated introductory course (table 1).

Table 1: Outline of Course Structure

Module 1	Introduction : Modelling for Commissioning
Module 2	Making Decisions
Module 3	Structuring Problems
Module 4	Understanding Data and Uncertainty
Module 5	Forecasting
Module 6	Service Redesign 1 (Mapping processes)
Module 7	Service Redesign 2 (Using Simulation)
Module 8	Whole Systems Modelling
Module 9	Assessing Cost Effectiveness
Module 10	Service Location and Geographical Models

Ideally the course will be taken in sequence with skills for earlier modules informing the later modules. However, to retain flexibility, modules might also be undertaken as stand-alone units (apart from Module 7) and could be selected from the course a-la-carte.

Three levels of focus

Three different audiences of this curriculum are suggested:

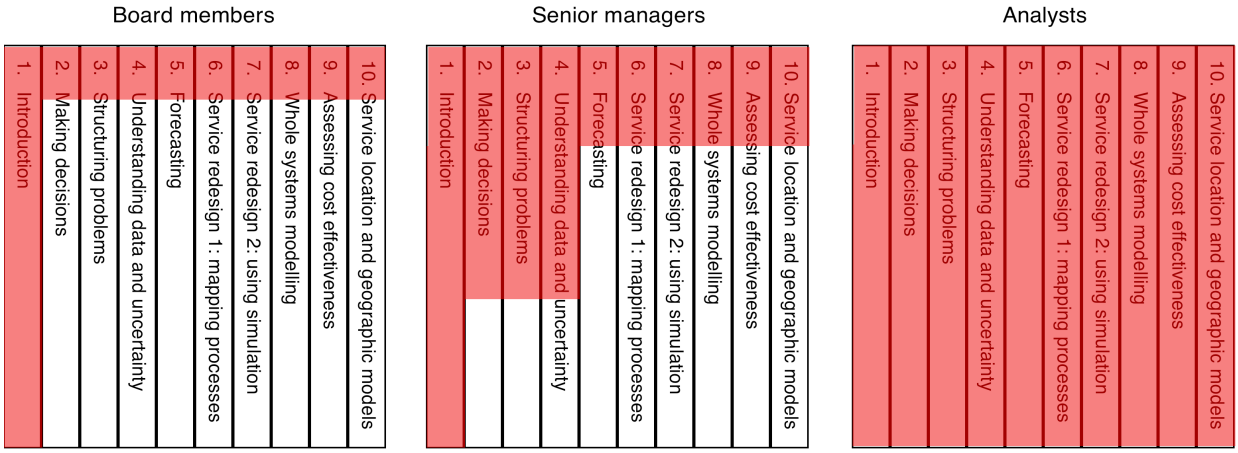
Members of Boards should be aware that effective techniques exist for applying modelling and simulation to strategic challenges that they face. They might benefit from the 'Board Level Overview' and in participation in Module 1.

Senior managers should appreciate the potential benefits that application of particular techniques offer, whether it is appropriate for staff in their organisation to have such skills, how to ensure competence is acquired and, where necessary, to become an intelligent customer of external providers of modelling and simulation methods. They might benefit from participation in Module 1, would find useful the techniques introduced in modules 2 to 4 and should have familiarity with the principles if not the detail in the remaining course content (modules 6-10).

Analysts would most likely be the 'practitioners' of modelling and simulation techniques in their organisation. They will benefit from taking all the modules in the course and might then wish to seek more detailed training in some of the methods to which they have been introduced.

Whilst training for analysts whose role is to apply modelling and simulation techniques would likely be delivered as a full set of modules as outlined, a different format would be more appropriate for Board members and senior managers:

Typical scope of learning needs for three audiences illustrating different breadth and depth



NB. This might be further tailored to individual's needs, for example if a Board member has a particular interest in whole systems modelling

The ten modules of the curriculum

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 1:** **Introduction : Modelling for Commissioning**
Background	Planning is clearly an uncertain business and can be supported and informed by models. The module will engage the group in interactive activities so that they get to know each other. There will be discussion about issues they have to address in their work. The module will provide an overview of the course and will endeavour to motivate the students.
Aims / Learning Objectives	At the end of this module, the students will understand: • The role of models in decision making and strategy in health care • Key distinctions between the different approaches (soft versus hard methodologies) and the limitations associated with these different approaches. • How different techniques might be applied to specific issues in commissioning.
Syllabus	• Introduction – outline of course • Identify PCT problems • Definition and examples of modelling • Example use of modelling in Forecasting • Building a simple model • Good practice in spreadsheet modelling • the use of spreadsheets in a responsible manner.
Case Materials	Provide example of, say, three contrasting models to show variety and problems. These may be presented in the course materials, with DVDs if appropriate. Possible examples are: e.g. renal services (Ruth Davies), out-of-hours provision (Sally Brailsford), location of dental services (Paul Harper).
Assessment	Assessment will be formative to include: identification and understanding of basic methods, simple spreadsheet exercise. Assessed work will be combined with the next module.
Reading	Sanderson C and Gruen R (2006). Analytical Models for Decision Making, Open University Press http://mcgraw-hill.co.uk/html/0335218458.html or £19.79 from Amazon. Pidd M. Tools for Thinking. Wiley (2003). Young T, Brailsford SC, Connell C, Davies R, Harper P and Klein J (2004). Using industrial processes to improve healthcare. *British Medical Journal*, 328:162-4. Harper, PR and Pitt, MA (2004). On the challenges of healthcare modelling and a proposed project life-cycle for successful implementation. *Journal of the Operational Research Society* **55**: 657-661

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 2:** **Making Decisions**
Background	Clearly we all make difficult decisions in our work lives. Models and simulations can help and inform those decisions. For example, we may be looking at choices between investment opportunities in the acute and care sectors.
Aims / Learning Objectives	At the end of this module, the students should be able to: • Understand how modelling can support decision making and the limitations of these approaches • Be able to construct decision trees and assess expected value • To understand how risk might influence decisions • Understand the use of Multi-Criteria Decision Analysis in simple examples.
Syllabus	Discussion of decision making, problems of risk, financial limitations, providing quantitative measures of qualitative outcomes eg health, happiness etc. • Decision trees • Risk • Multi-Criteria Decision Analysis (MCDA)
Case Materials	Case materials in which there are choices between investment opportunities: day hospital for mental versus, immunisation program cervical cancer, screening programme for pregnant mothers re: Downs program. • Develop one of the as an MCDA example and for another use decision trees and include discussion of risk. • A simple team based behavioural simulation exercise to experience different decision roles and their impact.
Assessment	At this stage there would be just formative assessment: Exercises in decision trees and Multi-Criteria Decision Analysis
Reading	Briggs A, Claxton K, Schulpher M (2006). Decision modelling for health economic evaluation. Oxford University Press. Cooper K, Brailsford SC and Davies R (2007). Modelling healthcare interventions. *Journal of the Operational Research Society*, **58**:168-176. Karnon J and Brown J (1998). Selecting a decision model for economic evaluation: a case study and review. *Health Care Management Science* **1**: 133-140. Santos SP, Belton V and Howick, S (2008). Enhanced performance measurement using OR: a case study. *Journal of the Operational Research Society*, **59**:762-775. http://en.wikipedia.org/wiki/MCDA http://en.wikipedia.org/wiki/Decision_tree http://en.wikipedia.org/wiki/Decision_analysis

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 3:** **Structuring Problems**
Background	The decisions that need to be taken are often difficult to assess, especially as there are many stakeholders with different views.
Aims / Learning Objectives	At the end of the module the students should be able understand: • Appreciate the role of problem structuring methods in Commissioning • Be familiar with and able to use an informal approach to problem structuring • Be familiar with and able to use elements of Checkland's Soft Systems Methodology
Syllabus	• Discussion of the problem of combining different points of view from stakeholders • Overview of some different PSM approaches • Learn how to use a SODA (Strategic Options Development and Analysis) • How to draw and interpret a cognitive map • Role play
Case Materials	Case material would be drawn from experts in the field. For example: Case study showing the use of cognitive mapping and SODA for the re-configuring of services within a District General Hospital.
Assessment	Formative assessment: • Interpretation of a cognitive map Assessed work: • Learning diaries and blogs (30%) • Critical analysis of one of the above case studies (70%)
Reading	Rosenhead J and Mingers J (2001). Rational analysis for a problematic world revisited: problem structuring methods for complexity, uncertainty and conflict. Wiley, Chichester. Checkland P.B. (1999) Systems thinking, systems practice: includes a 30-year retrospective. John Wiley & Sons, Ltd, Chichester. Checkland P.B. and J. Poulter (2006) Learning for action: a short definitive account of soft systems methodology, and its use practitioners, teachers and students. John Wiley & Sons Ltd, Chichester. Rittel H.W.J. and M.M. Webber (1973). Dilemmas in a general theory of planning. Policy Sci 4: 155-69. http://en.wikipedia.org/wiki/Soft_systems_methodology http://www.orsoc.org.uk/region/study/problem.htm

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 4:** **Understanding Data and Uncertainty**
Background	Data is crucial for all analysis and modelling exercises and the full potential of data is often not realised. Data is commonly inconsistent, inaccurate and imperfect. Understanding the uncertainty associated with data use in modelling is key. Here the utilisation and proper specification of data in commissioning is explored as well as dimensions of uncertainty and how to deal with it.
Aims / Learning Objectives	At the end of this module the student should understand: • The importance of data • The key sources of data in the Health Service • When and how to collect data for modelling exercises • How to manage when data are imperfect • How to store and analyse data • Sources of uncertainty. Distinguish between underlying statistical uncertainty (e.g. death, illness, travel time), uncertainty in the quality of data, about the future and uncertainty that can be understood and managed (eg variation by time of day, season of year). • different sources of uncertainty and how they may be addressed • simple statistical concepts of uncertainty.
Syllabus	• Discussion about the need for data and sources of data • Overview of IT systems and databases in the Health Service • Primary data and Secondary data • Data collection, interpretation, storage • Introduction to techniques of data mining • Overview of how to deal with uncertainty • Managing uncertainty eg scheduling, forecasting etc. • Review of basic statistics to include confidence limits, prediction limits
Case Materials	Pattern/cluster analysis as means of detecting information in data sets Illustrative use statistical methods to deal with uncertainty
Assessment	Formative assessment • Identification of data sources for particular problems • Tests on course material
Reading	Rowntree D. Statistics Without Tears: an Introduction for Non-Mathematicians. Penguin (1991). Morris C. Quantitative Approaches in Business Studies, Prentice Hall (2003). http://en.wikipedia.org/wiki/Probability_and_statistics

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 5:** **Forecasting**
Background	Planning for the future is a key part of PCT activities. It is important to recognise that forecasting is not the only way of dealing with this problem. There are interactive and game playing approaches and more deterministic methods. Clearly there are dangers in all of these.
Aims / Learning Objectives	At the end of this module the student should be able to understand how to generate some predictive information about the future and how to assess it critically. In particular, they should be able to: • Understand the role and potential benefits of extrapolatory and explanatory forecasting models as tools for thinking in WCC; • Use exponential smoothing and Holt's method to make extrapolatory forecasts in Excel; • Introduce seasonality into extrapolatory forecasts • Understand simple measures of extrapolatory forecast accuracy; • Devise explanatory forecasts to incorporate changes in population, incidence rates, lifestyle factors and alternative service plans. • Appreciate the role of sensitivity analysis in the context of forecasting, and links to scenario planning and risk assessment.
Syllabus	• Introduction to time series concepts, time series, seasonality, discontinuities, noise and residual variations, • Introduction to methods for trend forecasting, outlining regression, moving averages, exponential smoothing etc. • Practical session – Forecasting annual PCT birth numbers. • Practical session – Forecasting age-specific birth rates. • Practical – Incorporating commissioning decision and social factors into forecasts • Discussion : uses of forecasting, reservations and challenges, links to planning and risk assessment.
Case Materials	Two contrasting case studies presented in background material. Projection of Birth Rates in PCT area showing seasonal changes. Developed using simple forecasting techniques (eg smoothing etc).. Development of new treatments in, say, areas of cancer. Use scenario planning. This can be done as a team exercise.
Assessment	Formative Assessment: • To develop, report on and critique a forecasting exercise relevant to WCC with the participants organisation.
Reading	Unfortunately most textbooks on time series forecasting, even those aimed at business students, tend to be too mathematical for our purposes. O'Brien F and Dyson R. Supporting Strategy: Frameworks, Methods and Models. Wiley (2007). http://www.solver.com/simulation/monte-carlo-simulation/ http://en.wikipedia.org/wiki/Forecasting http://www.uoguelph.ca/~dsparlin/forecast.htm

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 6:** **Service Re-design 1 (Mapping Processes)**
Background	There may be many ways of providing services to meet the needs of patients with particular conditions. Commissioning can be designed around 'patient pathways' to ensure effective and integrated care delivery, although other models of care might be considered that achieve defined quality and outcome. This module examines ways to map processes that can be used to support commissioning.
Aims / Learning Objectives	At the end of this module the students should be able to understand: • What is meant by a patient's pathway • The different pathways that can be assessed • The type of data needed • The use of process mapping techniques to construct pathway diagrams • Understand the difficulties in comparing and assessing them.
Syllabus	• Discussion of what is meant by a patient pathway. How important are they to PCTs? How much control do they have? • Pathway analysis using workshops and post-its
Case Materials	• Case studies of pathway modelling and process mapping of care pathways. • Look at alternatives eg home care v. residential care.
Assessment	Formative Assessment • Development of simple process maps Assessed work: • Learning diaries and blogs (30%) • Critical analysis of one of the above case studies (70%)
Reading	Hunt VD. Process mapping: how to re-engineer your business processes. Wiley (1996). Audit Scotland (2000). The map to success: using process mapping to improve performance. Accounts Commission, Edinburgh, UK. Lane DC, Mondefeldt C, Husemann E (2003) Client involvement in simulation model building: hints and insights from a case study in a London hospital. *Health Care Management Science* **6**:105–116. http://www.audit-scotland.gov.uk/docs/local/2000/nr_010201_process_mapping.pdf http://en.wikipedia.org/wiki/Flowchart

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 7:** **Service Re-design 2 (Using Simulation)**
Background	Simulation takes the analysis of treatment pathways and service re-design a stage further encompassing uncertainty and what-if scenario modelling within a visually interactive format. Here these principles are explored using Discrete Event Simulation.
Aims / Learning Objectives	At the end of this module the students should be able to understand: • Use pathway diagrams and process maps to create a simulation. • The use of simulation techniques, particularly Discrete Event Simulation • Adjust the parameters of simulation to explore a range of 'what-if' scenarios. • Understand the difficulties in comparing and assessing different service designs.
Syllabus	Discussion of what is meant by a patient pathway. How important are they to PCTs? How much control do they have? • Pathway analysis using workshops and post-its • Introduction to DES • Practical exercise using DES
Case Materials	Case studies from Scenario generator and Focussed-on For example: • Look at care alternatives eg home care v. residential care. • Goodhope Hospital – example of re-design for Vascular Surgery.
Assessment	Formative Assessment • Development of simple simulations Assessed work: • Project work based on a simulation model and its use to test a range of specified scenarios.
Reading	Pidd M. Computer simulation in management science. John Wiley & Sons Ltd (2004). Oakshott L. Business Modelling and Simulation. Pitman Publishing (1997). Robinson S. Simulation: The practice of model development and use. Wiley (2003). http://en.wikipedia.org/wiki/Simulation Griffiths JD, Price-Lloyd N, Smithies M and Williams JD (2005). Modelling the requirement for supplementary nurses in an intensive care unit. J*ournal of the Operational Research Society*, **56**:126-133. Fletcher, A, Halsall, D, Huxham, S, et al. (2007). The DH Accident and Emergency Department model: a national generic model used locally. J*ournal of the Operational Research Society*, **58**:1554-1562. Bowers J and Mould, G (2004). Managing uncertainty in orthopaedic trauma theatres. *European Journal Of Operational Research* **154:** 599-608

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 8:** **Whole Systems Modelling**
Background	This part of the course looks at strategic models using compartmental approaches and System Dynamics. These approaches are linked to a range of strategic issues in policy making, including public health and the health needs assessment. The module will examine how modelling approaches can capture the overall dynamics and interactions from a Whole System modelling perspective.
Aims / Learning Objectives	At the end of the module, the student will be able to: • Understand how System Dynamics can be used in a Whole systems approach to modelling • Understand the role of compartmental models • Develop a simple System Dynamics model • Interpret other modelling approaches
Syllabus	• Introduction and presentation of selected participant case studies. • Introduction to System Dynamics • Case study investigation : The Nottingham Project • Practical session – mapping your own case study, developing influence diagrams • Introduction to System dynamics in Compartmental models. (eg agent based modelling) • Hands-on modelling session using System Dynamic software.
Case Materials	Case studies using System Dynamics to explore the impact of strategic options for health care • The Nottingham Project – Using System Dynamics to model emergency health services • Chlamydia Screening Case Study
Assessment	Formative Assessment • A case based influence diagram • Development of simple SD simulation (eg using STELLA software) • Spreadsheet compartmental models
Reading	Sterman JD. Business Dynamics: Systems Thinking and Modelling for a Complex World. Irwin/ McGraw-Hill (2000). Brailsford SC, Lattimer VA, Tarnaras P and Turnbull JA. (2004), Emergency and On-Demand Health Care: Modelling a Large Complex System, *Journal of the Operational Research Society*, **55**:34-42. Lane DC, Monefeldt C and Rosenhead JV (2000). Looking in the wrong place for healthcare improvements: A system dynamics study of an accident and emergency department. *Journal of the Operational Research Society* **51**: 518-531. Royston G, Dost A, Townshend J and Turner H (1999). Using system dynamics to help develop and implement policies and programmes in health care in England, *System Dynamics Review* **15:**293-313. Evenden D, Harper P, Brailsford SC and Harindra V (2005). System Dynamics modelling of Chlamydia infection for screening intervention planning and cost benefit estimation. *IMA Journal of Management Mathematics*, **16**:265-279. http://en.wikipedia.org/wiki/System_dynamics

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 9:** **Assessing Cost Effectiveness**
Background	The cost effectiveness models developed for NICE affect what treatments are funded, what treatments are given and what new technologies are adopted. It is important to be able to understand these and to be able to challenge them.
Aims / Learning Objectives	At the end of the module the students should be able to: • Understand generic metrics for outcome (QALYs, DALYs etc) • To use cost, utility and effectiveness data to drive the assessment of cost effectiveness • Run deterministic Markov models • Assess the output from NICE in the light of their own population demands
Syllabus	• What is Health Economics and how does it contribute to decision making? • How are health costs and utilities derived? • What is a QALY and where did they come from? Look at the history and the current derivation of the indices. • Use of deterministic Markov models to determine future states • Discussion of uncertainty in the context of module 2 • Assessment of some NICE models
Case Materials	• Alzheimer's models • Markov models (eg screening models)
Assessment	Formative Evaluation: • Calculation of Quality indices • Exercise in deterministic Markov model with QALY outcomes • Add uncertainty to models Assessed work: • Learning diaries and blogs (30%) • Critical analysis of one of the above case studies (70%)
Reading	Cooper K, Brailsford SC and Davies R (2007) Modelling healthcare interventions. *Journal of the Operational Research Society*, **58:**168-176 Barton P, Bryan S and Robinson S (2004). Modelling in the economic evaluation of health care: selecting the appropriate approach. *Journal of Health Services Research Policy* **9**: 110-118. Sonnenberg FA and Beck JR (1993). Markov models in medical decision making: a practical guide. *Medical Decision Making* **13**: 322-338 http://en.wikipedia.org/wiki/Cost_effectiveness_analysis

TORCH Teaching Operational Research for Commissioning in Health	**MODULE 10:** **Locating Services and Geographical Models**
Background	Decisions are needed about where to locate facilities such as community hospitals, dialysis units and dental practices. There is usually a desire to provide good access whilst constraining costs.
Aims / Learning Objectives	At the end of this module the students should be able to: • Interpret Geographic Information System (GIS) models • Understand 'gravity' models • Formulate and solve simple transportation problems • They should understand the strengths and weaknesses of these approaches.
Syllabus	• Discussion of various location problems faced by PCTs • Understand how GIS software works • Interpret GIS output eg look at catchment areas of Emergency departments • Gravity models • How to calculate travelling distance • Linear Programming use in transportation problems
Case Materials	• GIS analysis of A&E department catchments in the Midlands. • Hospital location change. • Mobile screening units.
Assessment	Formative Assessment • Interpretation of gravity models • Simple transportation problems
Reading	http://en.wikipedia.org/wiki/GIS Harper PR, Phillips S and Gallagher JE (2005). Geographical simulation modelling for the regional planning of oral and maxillofacial surgery across London. *Journal of the Operational Research Society,* **56**:134-143. Evenden D, Harper P, Brailsford SC and Harindra V (2005). System Dynamics modelling of Chlamydia infection for screening intervention planning and cost benefit estimation. *IMA Journal of Management Mathematics*, **16**:265-279.

General Bibliography

"Analytical Models for Decision Making" (Understanding Public Health) by Colin Sanderson and Reinhold Gruen, Open Univeristy Press. (2006)

This book describes the quantitative and qualitative methods that can help decision-makers to structure and clarify difficult problems and to explore the implications of pursuing different options. The accompanying CD ROM provides the opportunity to try out some of the proposed solutions. The book examines:

- Models and decision-making in health care
- Methods for clarifying complex decisions
- Models for service planning and resource allocation
- Modelling for evaluating changes in systems

"Tools for Thinking" by Michael Pidd, Wiley (2nd edition, 2003)

A very readable introduction to the principles of modelling. Also contains an introduction to many of the modelling approaches used in the course.

"Business Modelling and Simulation" by Les Oakshott, Pitman Publishing (1997).

Although this is mainly about simulation, the first 4 chapters (on models and modelling) are useful and one chapter is based on a healthcare setting. Chapter 3 contains a very readable introduction to basic probability and statistics.

"Statistics Without Tears: an Introduction for Non-Mathematicians" by Derek Rowntree, Penguin (1991).

This is a gentle, detailed introduction to practical applications of probability and statistics for people who do not have a mathematics background.

Mapping to World Class Commissioning competencies

The following table is a summary of the mapping of techniques to the World Class Commissioning competencies. A more detailed mapping to sub-categories of competencies is available in the final TORCH report.

	Problem Structuring				Conceptual Modelling				Quantitative Modelling								Simulation			
	Drama Theory & Confrontation Analysis	Soft Systems Methodology	Strategic Choice Approach	Strategic Options Development and Analysis	Activity Diagrams & State Transition Diagrams	Swim Lane Activity Diagrams	MapsCommunication and Data Flow Diagrams & Information	Influence Diagrams & Issue Maps	Decision Trees & Multi-Criteria Decision Analysis	Project Management / PERT	Univariate and Multivariate Analysis	Forecasting	Queueing Theory	Optimisation	Data Envelopment Analysis	Markov Modelling	Agent Based Simulation	Discrete Event Simulation	Monte Carlo Simulation	System Dynamics
1. Locally lead the NHS	○	○	○	●	○	○	○	●			○	○								
2. Work with community partners	●	●	●	●	●	●	●	●	●	●	○	○		○					○	○
3. Engage with public & patients	●	●	●	●	○	●	○	●												
4. Collaborate with clinicians	○	○	○	●	●	●	●	●	●	●	○			○			○	●	○	●
5. Manage knowledge and assess needs	●	●	●	●	●	●	●	●	●		●	○					○	○	●	○
6. Prioritising Investment	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
7. Stimulate the market	●	○	○	●	○	○	○	●	●	●	○	○	○	○	○	○	●	●	●	●
8. Promote improvement and innovation	●	●	●	●	●	●	●	●		●										
9. Secure procurement skills	●	●	●	●	●	●	●	●			●				●				○	
10. Manage the Local Health System	●	●	●	●	●	●	●	●							●					
11. Make sound financial investments	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

● Relevant
○ Potentially relevant