COMPLEXITY SCIENCE FOR THE REAL WORLD

Models for Real World Policy

A conference for senior policy makers organised by the Complexity Science in the Real World Network, funded by the Engineering and Physical Sciences Research Council

EPSRC
Pioneering research and skills

25 April 2014

Text correct to best knowledge at time and date of print April 2014 -
Alison Cooper, Complexity Science in the Real World Network Coordinator

Introduction
Venue and Programme

Introduction

This conference will consider how policy making can benefit from new tools and thinking emerging from the study of complex social systems.

There will be an opportunity to hear from four major research projects that have been supported by the Engineering and Physical Sciences Research Council to develop and demonstrate the value of the application of complexity science to policy.

As the projects enter their final phase, this conference continues the interaction between academia and policy that has informed the projects since they began in 2010.

On behalf of the the Complexity Science for the Real World Network, I thank all the contributors and wish you an inspiring and thought provoking event.

Professor Nigel Gilbert

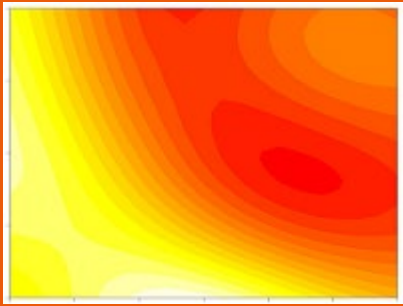
Complexity Science in the Real World Network and projects

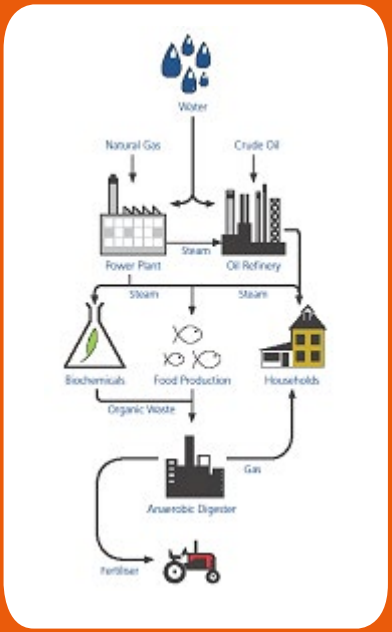
The Complexity Science for the Real World Network brings together four projects at five Universities in four UK locations. It is funded by EPSRC's Complexity Science for the Real World programme, helping Science, Social Science and Engineering to tackle global challenges. The programme started in 2010 and lasts until 2016.

The four projects have a total value of £14 million, involve over 100 researchers and are training 20 doctoral students.

More information about EPSRC can be found at:
www.epsrc.ac.uk

Contents





Images on this page

1. ENFOLDing - modelling global trade flows

2. CLC - example of results obtained via Meta-modelling - advanced statistical models which link inputs and outputs of the underlying computer model

3. ERIE - schematic example of an Industrial Ecosystem

Venue and travel information

The Royal Society
6-9 Carlton House Terrace, London SW1Y 5AG

Travel information - Conference attendees are responsible for their own travel arrangements. The nearest tube stations are Charing Cross and Piccadilly Circus with buses through Trafalgar Square.

Fire and emergency - in such an event please exit and assemble at the top of the Duke of York steps and adhere to information, displayed throughout the building and announcements made by Royal Society staff. If you require first aid contact reception in the first instance.

Signage is displayed throughout the venue. Please refer to the maps available or ask at the reception desk if you require directions.

Storage for coats and luggage is provided throughout the day. While the building is secure you are reminded that valuables are left at your own risk.

Specified requirements
You will have been asked at registration for your dietary and mobility requirements. The information you provided is detailed on your booking confirmation. Please show this to the person on the registration desk if you have any queries. Should you not have a copy for any reason, speak to the reception desk who will be able to retrieve it .

Badges - please wear your badge at all times while attending the event, and hand it in when you leave.

Substitutions - If you are a last minute substitution please provide the booking confirmation for the person you are replacing to reception. We will do our best we cannot guarantee personalised conference packs and special dietary requirements at short notice.

Display materials (by prior arrangement only) - please take them to the reception desk together with your booking confirmation.

Mobile phones - please keep on silent

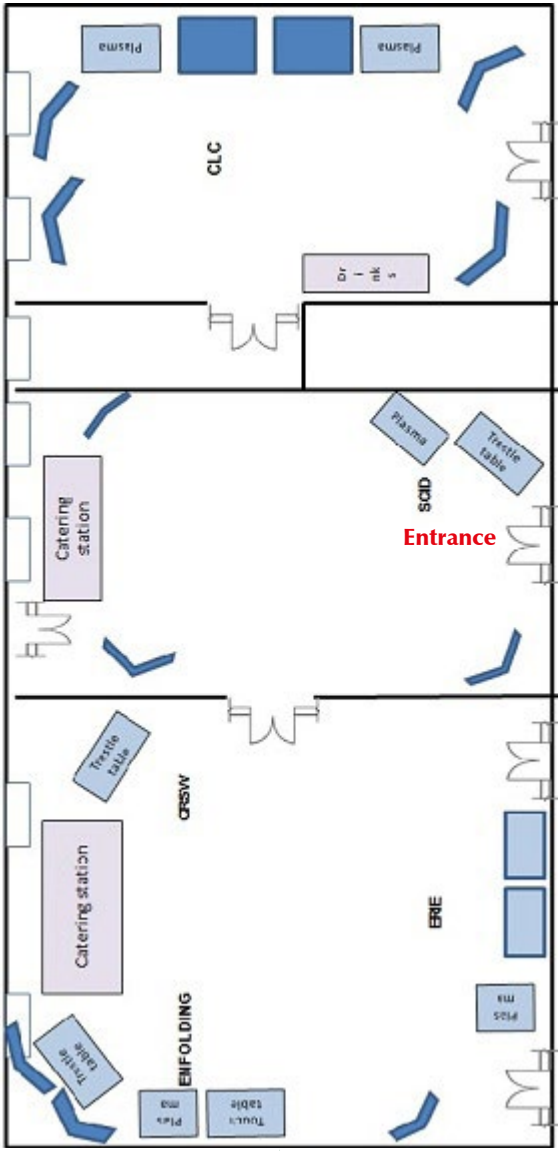
Digital videos and photographs will be made available, so on this occasion other recordings are not permitted. Filming of Q and A will capture audience voices only, not images. Please alert the organisers if you do not wish your recorded image or voice to be used.

WiFi - username **rsnetwork**, password **Newton+apple**

Twitter - Follow @Complexsci and use the hashtag #Complexpolicy

Reception – a selection of alcoholic and non alcoholic drinks and snacks will be provided. Additional or alternative drinks can be purchased with cash.

Floor plan for posters and demos: City of London Rooms



Programme

Time	Item	Lead	Venue
09.30	Registration and Coffee		Reception desk
10.00	Welcome and Introduction to Complexity Science for the Real World – Projects and Network	EPSRC Rep/Prof Nigel Gilbert	Wellcome Trust Lecture Theatre
10.10	Steering Complex Systems for Public Policy	Prof Nigel Gilbert	Wellcome Trust Lecture Theatre
10.30	ENFOLDing - 'Policy Responses to Global Dynamics: Trade, Migration, Security and Development Aid'	Sir Alan Wilson	Wellcome Trust Lecture Theatre
11.00	Break		
11.30	ERIE - 'The Evolution and Resilience of Industrial Ecosystems'	Prof Nigel Gilbert	Wellcome Trust Lecture Theatre
12.00	SCID 'The Social Complexity of Immigration and Diversity: Implications for Policy'	Prof Ed Fieldhouse	Wellcome Trust Lecture Theatre
12.30	CLC 'Modelling Health and Social Care for an Ageing Society'	Prof Jane Falkingham	Wellcome Trust Lecture Theatre
13.00	Lunch, Networking Posters and Demos		City of London Rooms
14.30	'What Does a Good Policy Model Look Like?'	Alec Waterhouse, Department of Energy and Climate Change	Wellcome Trust Lecture Theatre
15.00	Parallel Breakout Sessions	**see page20**	
16.00	Break and reconvene		
16.30	**Closing Talk/Reception Open** 'Policy Challenges in the Context of Global Science'	Prof Bernard Silverman, Chief Scientific Advisor - Home Office	Wellcome Trust Lecture Theatre
17.00	Panel and Audience Discussion of Emerging Issues		Wellcome Trust Lecture Theatre
17.30	Drinks Reception		Bar

Speakers, Projects & Talks

Alec Waterhouse

Alec Waterhouse is the Head of Department for Energy and Climate Change (DECC's) Central Modelling Team. His team are responsible for modelling energy and emissions projections and long term carbon reduction pathways as well as other cross-cutting policies such as Combined Heat and Power. They have recently designed and built a bespoke policy simulation language for household energy modelling. He is also implementing a cross-departmental quality assurance programme for analysis. He started his working life as an engineer before moving into Operational Research and has worked in a variety of organisations ranging from the retail to public sector.

Website:
https://www.gov.uk/government/organisations/department-of-energy-climate-change

The Department for Energy and Climate Change (DECC) is responsible for:

- Energy supply
- Energy pricing
- Climate change mitigation

It works in the UK and internationally and is concerned with fuel standards and energy efficiency.

Prof Bernard Silverman

Bernard Silverman's full-time post since 2010 is Home Office Chief Scientific Adviser. This involves leadership and management of its Science, provision of independent scientific advice to the Home Secretary and Home Office ministers, supporting independent scientific advisory committees, participation in the cross-government network of Chief Scientific Advisers chaired by the Government Chief Scientific Adviser, and international collaboration. His previous work for government included membership of the GM Science Review Panel, a non-executive directorship of the Defence Analytical Services Agency, and Chairmanship of a review panel for the project for the Sustainable Development of Heathrow. He has held senior academic posts at Bath, Bristol and Oxford in computational statistics. He is a Fellow of the Royal Society (FRS) and was recently a member of the Royal Society's Council. He is a Past President of the Royal Statistical Society and of the (US-based) Institute of Mathematical Statistics. He is currently a member of the Arts and Humanities Research Council and of the Technology Strategy Board's Emerging Technologies and Industries Strategy Group.

Website:
https://www.gov.uk/government/organisations/home-office

The Home Office is responsible for:

- Borders and immigration
- Crime and policing
- Law and justice
- Equality, rights and citizenship

It is the lead government department for immigration and passports, drugs policy, crime, counter-terrorism and police.

Sir Alan Wilson, FBA, FRS

is Principal Investigator of the ENFOLDing project and Professor of Urban and Regional Systems at UCL. He is currently Chair of the Lead Expert group for the Government Office for Science Foresight 'Future of Cities' project and is Chair of the Home Office Science Advisory Council. From 2007-2013, he was Chair of the Arts and Humanities Research Council. He was Vice-Chancellor of the University of Leeds from 1991 to 2004, and Director-General for Higher Education in DfES from 2004-2006. He was elected as a Member of Academia Europaea in 1991, a Fellow of the British Academy in 1994, an Academician of the Academy of Social Sciences in 2000, and a Fellow of the Royal Society in 2006. He was knighted for services to higher education in 2001. Setting the agenda for urban and regional modelling in the 1970s, he now works on the evolution of cities and regions. His two most recent books are 'Knowledge Power' (2010, Routledge) and 'The Science of Cities and Regions' (2012, Springer). His five-volume edited 'Urban Modelling' was by published by Routledge in 2013.

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http://alan.blogweb.casa.ucl.ac.uk/

ENFOLDing / University College London

Explaining, Modelling and Forecasting Global Dynamics, links existing data collections to global intelligence systems and geographical mapping, using spatial interaction modelling.

Contact: Helen Griffiths, Helen.griffiths@ucl.ac.uk
Website: enfolding.blogs.casa.ucl.ac.uk

Prof Nigel Gilbert

is Principal Investigator of the ERIE project and Professor of Sociology at the University of Surrey. He has an international reputation as a pioneer in the use of computer simulation in the social sciences and is the author of a textbook in that field and many research papers. He is past President of the European Social Simulation Association and founder-editor of the Journal of Artificial Societies and Social Simulation. He has held a personal Chair at Surrey since 1991. His research interests encompass the sociology of scientific knowledge (understanding how scientists generate reliable knowledge), science policy (strategies for the management of science), innovation networks (the flow of knowledge between high tech. SMEs), industrial ecosystems and privacy in contemporary societies. He has written extensively in these areas and is the editor of one of the textbooks on sociological research methods most widely used in UK universities.

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http://www.surrey.ac.uk/sociology/people/nigel_gilbert/

ERIE / University of Surrey

Evolution and Resilience of Industrial Ecosystems is modelling two real world Case Studies, the 'South Humber Region' and 'Global Food Supply Chains' to develop decision making tools to help policy and industry reduce food shortages and waste.

Contact: Amy Woodward, a.woodward@surrey.ac.uk
Website: http://www.surrey.ac.uk/erie

Professor Ed Fieldhouse

is Professor of Social and Political Science at the Institute for Social Change at the University of Manchester. In 2006 he was appointed as founding director of the Institute for Social Change and executive director of Social Change: a Harvard-Manchester Initiative. He is now Principal Investigator to the Scientific Leadership Team of the 2015 British Election Study and joint editor of the Journal of Elections, Public Opinion and Parties. He has a longstanding interest in research methods and data resources and is Vice Chair of the ESRC's Methods and Infrastructure Committee. He is co-author of over fifty scholarly articles and books on diverse topics including voting behaviour and turnout, social capital, social inequality, unemployment and deprivation. He has extensive experience as a consultant, advisor and contractor for organisations such as the Electoral Commission; Office for National Statistics; Equality and Human Rights Commission; the Department for Work and Pensions; Manchester City Council and Oldham MBC.

Contact: ed.fieldhouse@manchester.ac.uk
Website: http:// http://www.manchester.ac.uk/research/ed.fieldhouse/

MANCHESTER 1824
The University of Manchester

Manchester Metropolitan University

SCID / Manchester

The Social Complexity of Immigration and Diversity project is developing new families of complexity models to aid understanding of communities and effects of immigration, inequalities, social cohesion and trust.

Contact: SCID@manchester.ac.uk
Website: scid-project.org

Professor Jane Falkingham

is Principal Investigator for the Care Life Cycle Project, Professor of Demography & International Social Policy and Dean of the Faculty of Social and Human Sciences at the University of Southampton. She is also Director of the ESRC Centre for Population Change, which examines the drivers and consequences of population change. Jane pursues an active multi-disciplinary research agenda, located at the interface between social policy and population studies, spanning both developed and developing countries. Much of her research over the past twenty years has focused on the social policy implications of population ageing and the well-being of older people, taking a life course approach. She is also part of a team working on an EPSRC project on Rural Electrification in Kenya and an EPSRC research programme developing engineering solutions to help achieve carbon reduction targets within UK cities. Jane has published more than 100 books, journal articles and book chapters.

Contact: j.c.falkingham@soton.ac.uk
Website:
http://www.southampton.ac.uk/demography/about/staff/jcf1.page

UNIVERSITY OF Southampton

CLC / University of Southampton

The Care Life Cycle Project is researching the supply and demand of health and social care within an ageing society, to provide new insights for policymakers in the development of policy.

Contact: Yvonne Richardson, y.richardson@soton.ac.uk
Website: www.southampton.ac.uk/clc

1. Steering complex systems for public policy

2. The evolution and resilience of industrial ecosystems

Prof Nigel Gilbert

1. Steering Complex Systems for Public Policy

In this introduction to the relevance of complexity science to public policy, I shall suggest that society needs to be understood as multi-level, non-linear, emergent and based on social networks. Using examples, I shall explain what each of these terms mean and what the implications are for policy analysis.

2. The Evolution and Resilience of Industrial Ecosystems

The talk will demonstrate how the ERIE project is applying complexity thinking to two issues in industrial and agricultural development. The first concerns the promotion of 'industrial symbiosis' in the bio-energy based economy of the Humber region, North Lincolnshire. I will show how we are working with firms in the region to explore challenges and opportunities in the transition to a low carbon economy, addressing questions of economic development, efficient resource use, environmental impact and job creation at regional and national scales. Metabolic and social interconnections across industrial and governance levels are being investigated to inform stakeholders, increase efficiencies and provide useful tools for economic development for sustainability. A second case study is concerned with modelling the dynamics and resilience of food supply chains.

ERIE is modelling the resilience of these systems, examining the role of information in reducing food waste caused by food scares, worldwide trading of food products and the interacting networks of phosphorous, nitrogen and carbon dioxide. These represent key systems to explore if we are to meet the global challenge of producing secure, nutritious and sustainable food supplies.

I will illustrate the generic methods we are using, including participative modelling, network analysis and agent-based simulation. The two case studies show how it is possible to 'steer' social systems that are complex, multi-level and non-linear.

ERIE
Evolution and Resilience of Industrial Ecosystems

Policy responses to global dynamics: trade, migration, security & development aid

Sir Alan Wilson

Interdependencies and connections modelling for policy

There is a core assumption that one of the main drivers of global dynamics is the system of national economies, internationally connected. A key feature of this project, therefore, is the construction, building on data or through estimation, of 230 national input-output models which are then linked to form a world model. The connections between countries are represented in four workstreams: trade, migration, security and development aid. Each of these relate to particular policy areas. Trade is heavily influenced by the changing patterns of manufacturing and new technologies in shipping and ports, each of which generates policy challenges at both national and international levels. Migration raises policy questions for both exporting (brain drain) and importing (possible demand for resources) nations. Security is modelled in part through the estimation of 'threat' from the disposition of forces around the world and the policy issues are mainly those of defence, occasionally of offence. In the case of development aid, the policy interest relates to the challenge, for any particular donating country (or charity), in maximising the positive impact, whether economic or otherwise. The next step is to understand the interdependencies: economies, in part, drive migration and trade; security concerns affect all of trade, migration and development aid. The aim of this presentation, therefore, is to summarise the policy issues that can in principle be informed by model-based analysis

The social complexity of immigration & diversity: implications for policy

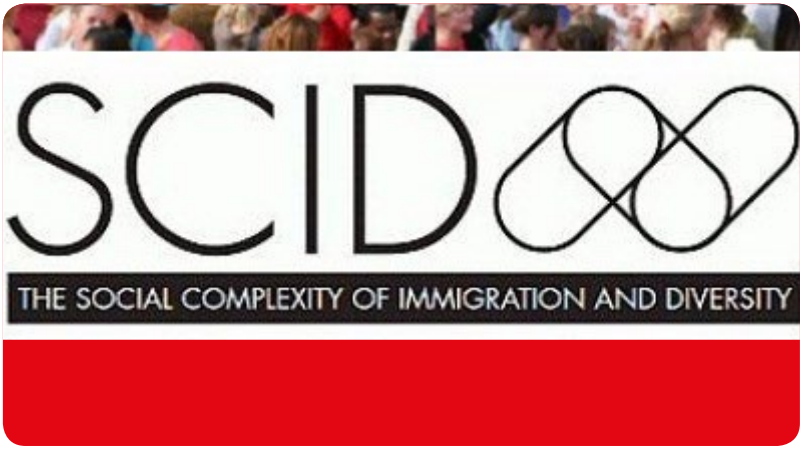
Prof Ed Fieldhouse

Ours has been dubbed the 'age of migration'.

Immigration is a major political issue, with increasing media coverage, rising anti-immigration sentiment and the rise of anti-immigration political parties. The issue of migration sits centrally within the wider debate about ethnic and religious diversity and its effects on social cohesion. We are still, though, a long way from understanding these issues and their potential consequences.

The Social Complexity of Immigration and Diversity (SCID) project integrates two very different disciplines, social science and complexity science, in order to gain new understanding of these complex social issues. It does this by building/making "chains" of related models of these social processes, starting with a complex, 'descriptive' model based on existing evidence and then simplifying in stages, so that each simulation is a model of the one "below" it. The project thus combines the relevance of social science with the rigour of the "hard" sciences.

In this talk, I will present the SCID approach in more detail and give an overview of how the project uses it to look at five issues linked to immigration and diversity: voting behaviour and turnout; trusting behaviours in social interactions; the development of inter-ethnic partnerships in different areas; and the ethnic segmentation of low-skill labour markets.



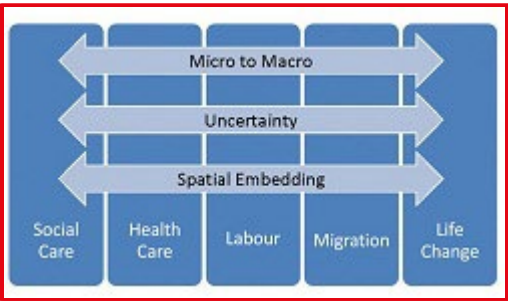
The Care Life Cycle project: modelling health & social care for an ageing society

Prof Jane Falkingham

The University of Southampton is at the forefront of research into the factors affecting the supply and demand of health and social care.

The population of the UK is ageing and as older people are the primary users of health and social care services, this demographic change poses a significant challenge for those planning future service provision. In addition, an ageing workforce will have implications for the supply of health and care professionals. To address these challenges and help policy makers plan effectively for the future, researchers at Southampton in the EPSRC Care Life Cycle project are developing a suite of sophisticated models representing the socio-economic and demographic processes and organisations involved in health and social care provision in the UK. The models allow researchers and policy makers to forecast demand for services and understand the wider implications of potential changes to the way services operate, information that can help them to select the most effective policies.

Three models will be presented: the first model, known as 'linked lives', incorporates the impact of changing living arrangements and family structures on care provision; the second model, working in partnership with Hampshire County Council, examines the demand for local authority social care services; and the final model, working in partnership with the eye clinic at Southampton University Hospital, uses the example of macular degeneration treatment to examine the complex interaction between health and social care.



Developing an integrated suite of models to capture interactions amongst major components of the health and social care systems: a complex systems perspective

‘What does a good policy model look like?’

Alec Waterhouse

The environment for analytical models in government has changed.

The requirement for modelling has if anything increased. However, we have increased the attention we pay to validating and verifying our models. This is of interest to anybody who interacts with government. I will describe the different types of model we use and the steps that could and should be taken to ensure the model is a good one.

‘Policy challenges in the context of complexity science’

Bernard Silverman

Professor Bernard Silverman FRS, Chief Scientific Adviser, Home Office

The provision of scientific advice to Government is itself an example of a complex system, with components above and beyond the normal scope of scientific activity.

I will set out the work of a Departmental Chief Scientific Adviser. Building on the presentations of the day, I will reflect on the ways in which complexity science might be of relevance to the work of Government, both in the kind of scientific advice we need to provide and also to describe the whole system within which we work.

There is a Scientific Advisor in each Government department. 23 in total.

The Chief Scientific Advisor is currently Sir Mark Walport.

Together the advisors form the Chief Scientific Advisors Committee, to advise the government of cross-cutting issues involving Science, Engineering and Technology (SET).

More information is available at: http://www.bis.gov.uk/go-science/science-in-government/chief-scientific-advisers

Parallel Breakout Sessions pm

	Item	Lead	Venue
15.00	How can one manage a policy area that is complex? **see page 22**	Dr Alex Penn, ERIE Project University of Surrey	Wellcome Trust Lecture Theatre
15.00	Guns and roses: the complexity of globalisation, **see page 23**	Rob Levy, ENFOLDing, UCL	Conference Room
15.00	Examples of best practice and challenges for contact and collaboration between policy actors and academics, **see page 24**	Dr Laurence Lessard-Phillips, SCID, University of Manchester, and Prof Bruce Edmonds, SCID, Manchester Metropolitan University	Council Room
15.00	Back to the future: what can we predict and how to do it? **see page 25**	Dr Jakub Bijak and Dr Jason Noble, CLC, University of Southampton	City of London Room 3
16.00	Break		
16.30	Reconvene for final talk and panel	**see main programme page 6**	Wellcome Trust Lecture Theatre

Projects have prepared a set of facilitated breakout sessions to explore some key topics in more depth.

Breakout Session & Facilitator Bios

ERIE: How can one manage a policy area that is complex?

Dr Alex Penn: University of Surrey

Dr Alex Penn FRSA, is a research Fellow on the ERIE Project. She is a complexity scientist with a background in physics, mathematical modelling and evolutionary ecology and a longstanding interest in approaches to managing and designing complex systems.

Within ERIE she manages work on steering complex systems. Her responsibilities range from participatory production of models with system stakeholders to developing methodologies for identifying system leverage points and network modelling of industrial systems. Throughout her career she has worked on connecting novel theoretical approaches with practical applications in domains from ecology to community design. See her **linkedin** profile **http://uk.linkedin.com/pub/alexandra-alex-penn-frsa/11/7b9/915** or e-mail **a.penn@surrey.ac.uk**

As our societies and their goals and challenges increase in scale and become more interconnected, new problems of prediction and management are encountered, requiring new tools for effective policy design.

In this session we will delve more deeply into some key concepts, outlining the particular challenges thrown up by managing complex systems, and the specific tools and overarching approaches which we are developing towards this end. Focussing on areas of policy or systems that are of particular interest to attendees, we will discuss how some novel tools could potentially apply to the issues in question. We will explore the challenges and opportunities for these new tools in real policy making contexts and attempt to make progress on potential solutions and promising application areas. Information and practical ideas will be captured. We aim to finish the session with practical ideas for action on how to take appropriate complexity tools back to your chosen domains and with increased focus on what still needs to be done to render these tools as useful as possible for the real world.

ENFOLDing: Guns & Roses: the complexity of globalisation

Rob Levy: University College London

Rob Levy has an MSc in Quantitative Economics and is working on a global model of trade and the macroeconomy using large datasets and network analyses. He has a background in data consultancy and computer programming and brings these much-needed skills to the study of economics. He blogs about his work at **aidcomplexity.blogs.casa.ucl.ac.uk** and **tweets @aid_complexity**. **Contact: Rob.Levy@ucl.ac.uk**

The growth and export of flowers is one of Kenya's most successful industries, providing around a third of all the EU's demand. But election-related violence has been shown to have seriously affected this vital trade link. In a complex and globalised world, such disruption can have knock-on effects that materialise in unexpected places.

To truly understand the global impact of this and similar events, a new approach to modelling the world economy is needed, which actively acknowledges the strengths and frailties that arise from interconnectedness.

We will explore ways of going beyond traditional trade analysis, diving into countries' economies to see where profit comes from and how internal economic structure, politics, and migration can affect a country's ability to profit from trade.

SCID: Examples of best practice & challenges for contact & collaboration between policy actors & academics

Laurence Lessard-Phillips: University of Manchester

Laurence Lessard-Phillips is a Research Fellow at the Institute for Social Change. Her areas of expertise include the perceptions, measurement, and dimensionality of immigrant adaptation; ethnic inequalities in education and the labour market; transnational behaviour across immigrant generations; and social stratification and mobility. She is currently funded by the ESRC's Future Research Leaders scheme to study immigrant adaptation in academic research, policy, and public opinion. A member of the SCID team since 2010, she is involved in models of voting behaviour and inter-ethnic partnerships.

See http://www.manchester.ac.uk/research/laurence.lessard-phillips/

Bruce Edmonds, Manchester Metropolitain University

Bruce Edmonds is Professor of Social Simulation and Director of the Centre for Policy Modelling (CPM) at the Manchester Metropolitan University Business School. Together with its founder, Scott Moss, he has lead the CPM to become one of the world-leading centres in Policy Modelling. It specialises in developing more detailed and inclusive models along with the methodology adequate to the social/ecological/economic complexities modern society faces. He has just published a handbook on the subject. **See: http://cfpm.org**

Opportunities for contact and collaboration between policy actors and academics have been highlighted as an important barrier to knowledge exchange between the two groups. In this session, we are aiming to draw on the session's participants' experiences in initiating and maintaining this to more clearly identify what 'works' and what does not, as well as what types of tools are appropriate and need developing to overcome the barriers and lead towards increased contact and collaboration.

CLC: Back to the future: what can we predict & how to do it?

Dr Jakub Bijak and Dr Jason Noble:

University of Southampton

Dr Jakub Bijak is a demographer with a particular interest in assessing the sources of uncertainty in models of all forms.

Dr Jason Noble is an agent-based modelling specialist with a corresponding interest in social behaviour.

Contact: j.bijak@soton.ac.uk and jn2@ecs.soton.ac.uk

Sir Francis Bacon famously stated that: "if a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties."

Certainly individuals, policy makers, and businesses make decisions in the face of many unknowns. These decisions can have surprising, and potentially undesired, outcomes. In this session we will explore methods of dealing with uncertainty and complexity in modelling the effects of social policy, as well as better ways of aligning models with existing data.

We will illustrate our arguments with reference to examples from health and social care. We also suggest practical ways in which modelling results – even though complex and uncertain – can still be used by policy makers, businesses and individuals to inform their decisions.

What is Complexity Science?

Complexity science doesn't mean 'complicated'! It is a specific term referring to an approach in mathematical and computational modelling, crossing science and social science disciplines. Techniques from Physics, Mathematics and Computer Science can be used to study many types of system made up of multiple levels and interacting entities, at a range of scales.

Complexity is concerned with what happens when interventions produce unexpected 'emergent' behaviour that cannot be predicted from knowledge of the individual parts. These effects influence behaviour patterns of the system.

Complexity Tools and Methods provide new ways of defining, and visualising complex social systems, the dynamic properties that change with time and implications of change.

Key Technique for Policy Tools:

The projects in the Complexity Science for the Real World Network are multidisciplinary with stakeholder involvement. They use a range of methods from across Science, Engineering, Maths and Social Science. These include:

- Modelling
- Simulation
- Visualising Data
- Qualitative Social Research

Modelling techniques are:

- Agent Based Modelling (ABM)
- Spatial Interaction Modelling
- System Dynamic Modelling
- Multilayer and Multiscale Modelling
- Combined Modelling Approaches

Posters & displays

These are grouped by project in the running order of the programme.

ERIE - Posters and Demos in City of London Room 1

ENFOLDing - Posters and Demos in City of London Room 1

SCID - Posters and Demos in City of London Room 2

CLC - Posters and Demos in City of London Room 3

ERIE:

Steering complex systems: policy strategies for the "Century of Complexity"

ERIE Project

Many of the challenges which now face our societies are complex. They involve coupled socio-economic and ecological systems composed of many interacting elements, which may respond in unexpected ways to our interventions. The behaviour of such systems is not straightforwardly predicable; hence we need novel approaches to their management. In Stephen Hawking's words, the 21st Century will be the "Century of Complexity".

"Steering" is a novel approach to managing complex systems which requires new tools, processes, and perspectives on how problems can be solved. Steering must be an ongoing, circular process of: understanding the system; choosing appropriate interventions given specific structure and dynamics; monitoring and adaption if the system behaves in a way which we do not expect. We present an introduction to both these tools and the process within which they should be applied.

Cascading failure in networked systems

ERIE Project

A network representation can be applied to a wide range of real world systems, such as communications infrastructures, transport links, and financial markets. Elements of such networks are often inter-dependent in their functioning, so that a failure in one part of the network may lead to a failure in other connected components. This can happen recursively, leading to a cascade of failure spreading throughout the whole system. The extent of a cascade is often determined by the structure of the network itself.

Using network analysis to explore international agricultural trade networks, our research has shown that major grain exporters, following mutually reinforcing trade policies, can create a failure cascade effect. The imposition of export restrictions in one country leads to counter restrictions by other exporters in the network. This cascade effect has arguably amplified and lengthened the recent volatility seen in global food prices.

Computational models that inform policy making

ERIE Project

Computational models are increasingly used to inform policy making. A recent UK government review of analytical models suggests that models "influence many billion pounds of government expenditure" and "underpin decisions which affect people's lives".

While there is a significant amount of literature on model development and model use, this literature does not constitute a unified body of knowledge. In addition, little work has been done to investigate the subject empirically. Questions such as "How are policy informing computational models developed?" and "How do computational models relate to other tools in informing policy making?" remain to be explored.

The research is following several policy informing computational models through their development and use in practice. The analysis of these different cases explores the characteristics of the models as well as the development procedures that contribute to the utilisation of models in informing policy making.

Utilising network approaches

ERIE Project

Network science has shown that the structure of interconnections between the components of a network can have a profound influence on how the whole network reacts to internal or external shocks and stresses. Particular structures can produce unexpected indirect effects, transmitting changes, problems or failures far across the network.

The ERIE project is developing network tools that can support policy makers in their interaction with networks, by revealing important actors and connections, uncovering potential indirect effects, designing more resilient systems and finding the most effective points for intervention.

This poster provides an overview of our network projects, including: social and metabolic linkages in the industrial network of the Humber region; UK phosphorus and nitrogen flows; improved information flows for food supply chains and; the effects of collaboration and facilitation on innovation within business networks.

Exploring policy outcomes: an agent-based modelling approach

ERIE Project

Agent-based modelling (ABM) is a powerful scientific technique and tool for decision making. Suitable for studying complex systems and processes consisting of many interdependent and interacting elements, ABM can reveal how simple schemata can lead to complex outcomes. It is used for studying emergent macro-level patterns of processes that involve the interaction of many heterogeneous and adaptive agents, providing a unique insight for industrial and policy stakeholders. For example, ABM simulations allow us to investigate how policies targeting different aspects of the same system interact, often resulting in unintended consequences.

ERIE is utilising ABM to explore several real world issues including: (i) The interaction of policies and the factors that affect the development of a long term, sustainable bio-based economy in the Humber region. This focusses on how waste and energy policy drive the evolution of a market in organic waste (for further details, see the ABM demo).

(ii) How improved information flow along the food supply chain may reduce food wastage caused by food scares. When a food hazard occurs the flow of information along supply chains can be critical in determining whether it escalates into a food scare, leading to unnecessary waste.

Complex systems machine

Interacting with complexity: can you steer the system?

Presented by Alex Penn

Many important problems for society involve the management of interlinked complex adaptive systems. This presents new challenges for policy intervention because their dynamical properties may give rise to behaviours that run counter to our intuition and experience. An added difficulty is that different kinds of stakeholders or "players" are involved, interacting with and influencing the system, with different and potentially contradictory goals. If all system stakeholders, including policy makers, are interacting with the system simultaneously then the outcome of interventions will be difficult to predict and control.

This activity is designed to give an insight by allowing you to attempt to steer policy outcomes in our specially-constructed "complex systems machine". This combines an underlying structure embodying some of the key properties of complex systems and a selection of different players simultaneously trying to manipulate the system. Through trialling "policies" you can gain a better understanding of how the system responds to intervention and modify your strategy accordingly. You can try to adapt your strategy to maintain your desired outcome as other players react to system changes and "change the rules of the game".

Participatory Modelling Activity and Poster: Uncovering the hidden structure of policy making

Presented by David Lloyd

Computational models can help to overcome some of the problems of making policy for complex socio-economic systems by allowing us to explore the potential impacts of policy scenarios "offline". However, models can often lack vital information about stakeholder behaviour or system structure that could be provided by local knowledge. Participatory modelling is a method of working with system stakeholders to build a model collaboratively. Models produced in this way can be quickly transformed into computer simulations that allow for the co-exploration of different scenarios or decisions and points for intervention. These methods not only provide access to difficult-to-obtain or ill-defined information, but increase stakeholder "buy-in" and understanding of their own system.

We will be running a live participatory modelling exercise. In this activity we will tap into your expertise in order to construct a causal map of the key factors that influence the way policy is made. In real-time, this information will be fed into a computational model to attempt to determine which factors are most or least influential and how their connections alter this. Come along to provide your input and perhaps be surprised!

Agent Based Modelling Demo:

Modelling the bio-based economy: how policy can steer industry outcomes

Presented by Anne Skeldon

The Kyoto Protocol sets out internationally binding emission reduction targets for greenhouse gases. The need to meet the specified targets has been a driver for UK waste and energy policies including: increasing landfill charges to reduce the amount of organic material ending in landfill; investment in alternative technologies such as the development of anaerobic digesters, and incentives for producing 'green' energy such as the Renewables Obligation that places a requirement on energy suppliers to derive a certain percentage of their energy from renewable sources.

The expected impact of a given policy is often considered in isolation, but since different policies target different aspects of the same industrial setting they interact. This can lead to unexpected consequences with the timing and order of policy initiatives leading to different outcomes. As part of the ERIE project, we have developed an agent-based model to investigate the interaction of policies and the factors that affect the development of a long term, sustainable market for the recycling of organic waste.

ENFOLDing:

Computer demonstration: interdependencies in global dynamics

Presented by Thomas Oléron Evans and Rob Levy

The policy areas of trade, migration, international security and development aid are fundamentally global in nature, and require a global perspective for analysis and forecasting. The interdependencies between countries, and between these policy areas themselves, is of essential importance.

The Global Dynamics (Enfolding) Demonstration Model is a 'proof of concept' showing how the vast amounts of data published on countries' economies and on trade in commodities and services can be used to build a model of a global system, with which various policy scenarios can be investigated. The model has been designed to communicate with sub-models of migration, security and development aid. This means that policy proposals in one area can be investigated in terms of their effects on the other policy areas covered by the ENFOLDing project. This is an exciting new opportunity to study human systems and explore scenarios at a global level. The model makes explicit the interconnectedness of the global economy and of the various policy areas covered by the sub-models.

A complex analytical approach to understand interrelations across economic and financial markets in the shipping industry

Created by Luca Cocconcelli and Simone Caschili: presenters Simone Caschili and Francesca Medda

The maritime industry is responsible for 90% of world trade volumes and is vital to the functioning of the global economy. Shipping is an inherently international industry, which is subject to complex, non-linear and multi-dimensional dynamics that are characterised by global shocks, like the Japanese Tsunami of 2011. These processes can produce cascading effects to the intertwined shipping industry and international trade. The ENFOLDing Trade work-stream has developed various innovative analytical approaches which aim to understand and highlight the complex interrelation across the trade sector, with particular attention paid to the economic and financial markets in the shipping industry. The analyses are developed to constitute a framework for industry and government organisations to evaluate the impacts of rare events such as commodity trade speculative behaviours, financial and economic developments such as investment decisions in port development, and for the support and promotion of trade growth.

The mathematics of complex systems: Laying the foundations for reliable policy decisions

Created by Thomas Oléron Evans, presented by Steven Bishop

Agent-based modelling is a powerful scientific technique that utilises the speed of modern computers to run complex simulations in which the actions of large numbers of virtual individuals may be predicted and tracked simultaneously. Though a highly popular tool in many different scientific domains, the mathematical basis of agent-based models remains poorly understood when compared with more traditional techniques, which may be underpinned by hundreds of years of theoretical work. This is a serious issue, since it means that where agent-based models are used to inform policy-makers, the reliability of conclusions drawn from them cannot always be guaranteed and the true cause of events observed in simulations cannot always be identified. One of the aims of the mathematics work-stream of the ENFOLDing project is to solve this problem through detailed theoretical analysis of fundamental agent-based models, thus creating a more solid foundation on which to base future research and subsequent policy decisions.

Modelling migration flows for a policy perspective on the effects of economic and labour market inequalities on EU inter-regional migration

Created by Adam Dennett, presented by Alan Wilson

Within the European Union, legislation guaranteeing the free movement of people between countries means that national governments are unable to control immigration in the ways that they would sometimes prefer. Migrants within the EU are primarily influenced by economic factors and so the migration workstream explored the potential for influencing migration through pre-existing systems for wealth redistribution within the EU cohesion policy framework. Using models of inter-regional migration flows within the EU over a 6 year period spanning the accession of the A8 countries in 2004, we were able to show that relatively small changes in regional economic and labour market inequalities can have large effects on migration volumes, but that for flows which are currently causing worry for governments, such as those from Romania and Bulgaria to the UK, the evidence is that present levels of wealth redistribution within the EU are unlikely to alter conditions sufficiently to arrest potential movements.

Modelling threats to global security

Created by Peter Baudains, presented by Peter Baudains

The application of mathematical models to real-world issues surrounding conflict and security has long-attracted considerable interest from a policy perspective. Many problems in the field of security involve the consideration of how some quantity—whether military units, citizens, resources, locations of international boundaries, or the presence of conflict—varies in space and time. In this study, we develop and investigate a spatial dynamic model of conflict between adversaries distributed in space. The key concept in defining this model is to consider the flow of the abstract notion of 'threat' between two adversaries. This generality enables the model to be applied to a variety of different case studies. Analysing the model from a dynamical systems perspective leads to insights that can be considered in the context of such case studies. In particular, we present the outcomes of an application of the model to geopolitical tensions in the Korean peninsula, and present a global model linking subnational instability, military capability and international alliances.

Development aid

Created by Belinda Wu, presented by Belinda Wu

The development aid workstream first focused on the non-trivial problem of definition. Four types of aid have been used: bilateral ODA, multilateral ODA, charities represented by the Bill and Melinda Gates Foundation, and remittances. 'ODA' is an OECD definition of 'official development assistance', subdivided into bilateral, meaning from a country, and multilateral, meaning from an international organisation such as the UN or the IMF. The poster shows the relative magnitudes of these flows – indicating among other things, the significance of remittances. The project then focuses on the effects of aid in recipient regions and the determinants of aid by donors. In the first instance, an input-output modelling framework is explored as the basis for this analysis and some preliminary results are presented. A network analysis of flows from donating countries opens up the second area of research.

SCID:

From computational agent-based models to analytical tractability

Louise Dyson, Luis F. Lafuerza, Bruce Edmonds and Alan J. McKane

Many of the social systems that we have to deal with are highly complex with many inter-dependent sub-systems. This makes them hard to analyse directly using simple models, so one is often left with trying to examine complicated, descriptive models. To aid in understanding these it would be helpful to develop tools for examining how these more complex models relate to simpler models with understandable and analysable mechanisms. We describe a way of analysing the formation of a social network in a complex computational model that represents voting patterns in a population of agents who may live, work and form friendships together. Once the network is formed, we examine the spread of "intention to vote" and compare our findings with those found in the descriptive, agent-based model. Such a multi-stage approach to the analysis of complex social systems might allow for the introduction of scientific rigour whilst retaining its relevance via the descriptive model.

The SCID Modelling Approach

Bruce Edmonds

Much that occurs in the socio-political realm is not directly predictable. However, the broad outline of some of the possible outcomes can sometimes be distinguished beforehand. This "possibilistic" projection lends itself well to a risk analysis of situations and hence can usefully inform policy choices and contingency planning. The SCID project aims to achieve this in a new way. Instead of making bold simplifications of what is being modelled this is done in several stages. This results in a "chain" of increasingly abstract models that allows us to combine some rigour with relevance (at the cost of extra work to check the different levels relate). The result is a "suite" of models from simple to complex, allowing different "kinds" of analysis to be delivered depending on the need. This is illustrated with a model to investigate why people vote.

Turnout in a complex world: Estimating voting cascade effects using an agent based model.

Ed Fieldhouse, Laurence Lessard-Phillips, and Bruce Edmonds

This agent-based simulation of electoral participation examines the cascading effects of campaign mobilisation. Agents have characteristics and interaction rules dictated by existing survey evidence. The interplay between factors important to individual turnout is simulated to gauge direct and indirect effects of campaign mobilisation on voting behaviour of individuals and their social networks. Factors include individual-level (e.g., socio-demographic characteristics), socialisation processes, habit and inertia, 'rational behaviour', political interest, social norms, relational attributes and overlapping social networks (political discussion), mobilisation (interpersonal and party based), and external shocks. Campaign effects are separated into long (socialising and persuading voters) and short (voter mobilisation). Different levels of mobilisation allow us to examine the extent it can spread beyond the primary target across the population and whether it survives over time. The model potentially enables examinination of the impact of policy interventions to mobilise voters or social and political changes on voter turnout (e.g. immigration).

Diversity and inter-ethnic marriage – an agent-based approach

Laurence Lessard-Phillips, Ruth Meyer, and Huw Vasey.

Inter-ethnic marriage, both a cause and a consequence of immigrant integration, is generally used to imply that the social distance between groups is low and, by extension, that community cohesion is high. Using a descriptive agent-based modelling approach, we seek to investigate the processes of partner selection in diverse communities, focussing on individual preferences, opportunities for contact, and group norms to uncover how these may lead to differential rates of inter-ethnic marriage. This provides us with an ability to study 'global' phenomena simultaneously with their causal 'local' processes (and vice-versa) in a dynamic setting and to investigate the development of population-level phenomena from a simulated 'local' social space of norms and values, potentially providing insights into community cohesion and inter-ethnic marriage which would not be available from other sources. Utilising research and evidence from quantitative and qualitative sources from across the social sciences, we thus seek to develop a complex model of emergent processes of differentiation and change in the marriage patterns and social cohesion in various types of local communities.

Emergence of ethnically segmented labour markets using agent-based models

Huw Vasey, Ruth Meyer, and Yaojun Li.

Social scientists and policy makers have long struggled to explain the tendency of low-skill labour markets in advanced economies to segment into niches dominated by certain ethnic groups. Is this a function of demand-side racism or racial queuing – sorting ethnic or racial groups into hierarchies, with the least desirable forced into the least palatable jobs? Or is it a function of homophily – where 'birds of a feather flock together' taking advantage of common ties and backgrounds found in labour market niches dominated by co-ethnics? Or is it some combination of these ideas, alongside a constant back and forth of competing (and differently empowered) performances of everyday life which create a complicated and ever-changing landscape of work in contemporary Britain? The Ethnic Labour Markets (ELMs) model uses agent-based modelling to investigate the emergence and evolution of ethnically-segmented low-skilled labour market niches. It has been designed to engage with these questions by modelling from the 'bottom-up' – exploring how micro processes and interactions can create the kind of macro-level segmentation which is commonplace in low-skilled labour markets.

CLC:

Simulating the cost of social care in an ageing society

E Silverman, J Hilton, J Noble and J Bijak

We present an agent-based model of the ageing UK population. The goal of this model is to integrate statistical demographic projections of the UK population with an agent-based modelling platform. This allows us to capture the basic processes that affect the demand for and supply of social care, including fertility, mortality, health status, and partnership formation and dissolution. By simulating a number of future scenarios, such as changing the age of retirement, we demonstrate the potential impact these changes can have on social care costs.

Forecasting social care demand in Hampshire

J Viana, SC Brailsford and R Dittrich

The UK's population is ageing, and this is a key driver influencing the need for social care. Social care in the UK (unlike healthcare, which is provided free at the point of access) by a range of providers. Social care providers include friends and family (informal care), third sector (charitable organisations), care provided solely by local authorities, care purchased from private providers, or any combination of the above. In order to assess the demand for any provider of social care, a "whole system" approach is required, since the way the system operates will influence the demand for each provider. To this end a System Dynamics simulation model has been developed, which captures some of the complexity of the social care system. The model enables the interventions available to keep people healthier to be assessed, and shows the time it takes for people to develop social care need, the interactions between the provision of social care and hospital admission, and the impact of unmet need (i.e., those people who have a care need but are not receiving any type of social care support).

Age-related macular degeneration in the UK: simulation modelling of links between health and social care

J Viana, S Rossiter, A Channon, A Lotery and SC Brailsford

Age-Related Macular Degeneration (ARMD) is a major cause of sight loss amongst the elderly. There are two types: dry and wet. The latter can be managed by monthly injections into the eye. The frequency of treatment, combined with the UK's ageing population, has increased demand on eye units. There are also links between the health and social care of ARMD sufferers; e.g., treatments affect social care needs, which can affect the likelihood of making regular eye appointments.

We want to explore these complex links, using ARMD as a case study, in a hybrid model using multiple modelling paradigms. At its core, there is a discrete-event simulation (DES) of eye unit operation, where alternative clinic configurations can be evaluated, in terms of indicators such as number of patients treated, waiting times, and appointment durations. The DES is embedded within an agent-based model (ABM) of individual sufferers in their wider social context. Each individual also includes system dynamics (SD) models for the continuous process of sight loss in each eye, where treatment can slow (or even slightly reverse) ARMD-related sight loss.

What determines the receipt of social care from informal, state or private sources?

A Vlachantoni, R Shaw, M Evandrou and J Falkingham

Demographic and policy change can have an adverse effect on the social care support received by older people, whether through informal, formal state or private sources. We have analysed the English Longitudinal Study of Ageing data (wave 4) in order to examine the demographic and socio-economic characteristics associated with the receipt of support by older people from different sources. Three key results have significant implications for the organisation of social care for older persons in the future. Firstly, the number of Instrumental Activities of Daily Living (IADLs), followed by the number of Activities of Daily Living (ADLs) are the strongest determinants of receiving support from any source in later life. Secondly, there are significant gender differences in the factors which are associated with the receipt of support from different sources; for example, physical health is a strong determinant of informal support receipt by men, while mental health status is a strong determinant of informal support receipt by women. Finally, different kinds of needs are associated with the receipt of support from different sources, and this 'link' raises questions about the way future social care should be organised.

Characteristics of informal carers in England and Wales

J Robards, M Evandrou, J Falkingham and A Vlachantoni

Informal caring has become a key social policy issue in relation to population ageing and expenditure cuts in local services for adult social care. The 2011 and 2001 Censuses included a question on the provision of informal (unpaid) care. Results show that informal caring increased between 2001 and 2011, particularly for those providing more than 20 hours per week. Using a 1% sample of England and Wales 2011 Census records matched to the 2001 responses from the same individuals (the Office for National Statistics Longitudinal Study) we investigate the characteristics of informal carers at 2001 and 2011, and for carers at 2001 identify characteristics associated with repetition of caring at 2011. Results suggest that a greater number of people started caring between 2001 and 2011 than stopped. Characteristics of informal caring at 2001 or 2011 show stability. Around a third of those caring at 2001 were also caring ten years later. Multivariate analyses to predict informal caring at 2011 among the carers at 2001 show those providing 50 hours or more care in 2001 were most likely to be caring at 2011, suggesting that past provision of care is crucial in predicting future caring.

Demonstration of age-related macular degeneration model

Stuart Rossiter

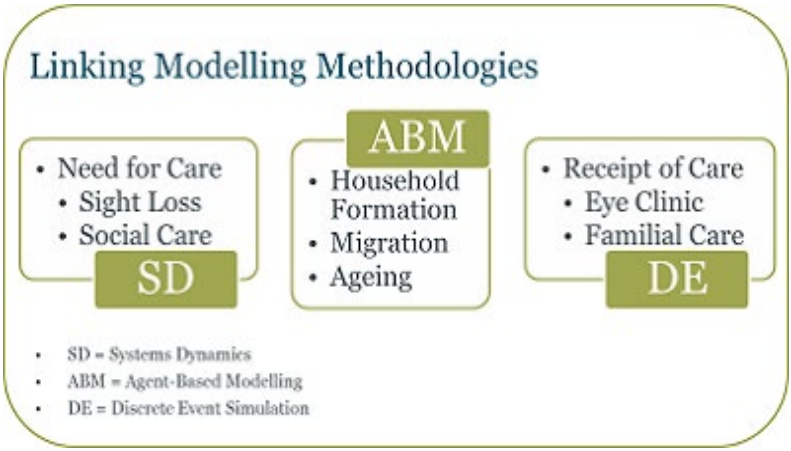
We demonstrate the Care Life Cycle (CLC) project's hybrid (multi-paradigm) simulation model of the eye condition ARMD, as discussed in the related poster. The simulation tries to capture the complex links between health and social care for ARMD sufferers, as well as providing strategic decision-support for the eye unit. It was written using the commercial AnyLogic tool, which allows for rich visualisations of model outcomes and structure, and run-time interaction if desired.

We walk through the different areas of the model via a sample run, pausing the model as needed. We then briefly demonstrate how different scenarios can be simulated, and how the results can differ.

Demonstration of Hampshire social care model

Joe Viana

Social care demands are increasing in the UK driven by demographic change. Current forecasting methods do not take into account the "whole system". The providers of care other than formal council or local authority services, such as: friends, family, and privately purchased care. They assume that current trends will persist and ignore the structure of the system. A holistic Systems Dynamics model of social care need development and supply has been produced to explore how feedback between parts of the system affects future forecasts.



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