Everything you always wanted to know about Dr Siebers (academic details only :)

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Mission Statement

The central theme in my work is the development of human behaviour models which can be used to better represent people and their behaviours in Operational Research (OR) and Social Simulation models. I am a committed advocate of Agent-Based Modelling and Simulation (ABM/S). I am also interested in the application of different types of modelling and simulation to support Risk Analysis and applying ABMS in Systems Biology.

From Archetypes to Multi-Agent Systems (MAS)

My main research interest is to create a framework for developing MAS simulation models that can help to make informed decision about Operational Research and Energy Policy problems. We are working on a holistic development process that encompasses new ways of archetyping the actors within a system, creating reusable ABM design patterns and agent templates. We have built proof-of-concept simulation models to demonstrate how to apply our framework. So far we have considered:

- **Simulation of Retail Staff/Customers:** We looked at the impact of different management practices on customer satisfaction and consequently sales. As a case study system we chose one of the UK's top 10 department stores.
- **Simulation of Energy Users:** We have developed multi-dimensional archetypes of energy users and applied them in the following two cases:
  - Small scale: Simulating an office environment (B-Floor of our CompSci School)
  - Large scale: Simulating energy consumption patterns at city scale (City of Leeds)
- **Simulation of Personnel:** Here we have considered how to represent hospital personnel in a more sophisticated way (beyond the "resource" concept).
- **Simulation of Commuters:** In this project we will look at how we can employ simulation to better understand their impact of interventions for convincing commuters to change from road to rail.

Publications:
- Siebers PO and Aickelin U (2011) 'A First Approach on Modelling Staff Proactiveness in Retail Simulation Models'. Journal of Artificial Societies and Social Simulation, 14(2) 2.
- Zhang T, Siebers PO and Aickelin U (2011) 'Modelling Electricity Consumption in Office Buildings: An Agent Based Approach'. Energy and Buildings, 43(10) pp. 2882-2892.
- Zhang T, Siebers PO and Aickelin U (2012) 'A Three-Dimensional Model of Residential Energy Consumer Archetypes for Local Energy Policy Design in the UK'. Energy Policy, in print.

Creating Multi-Agent Systems of Software Agents and Behavioural Agents

Monitoring the uptake of new equipment in private homes often has ethical issues (intrusion of privacy) and can also be cost intensive. We are interested in exploring the opportunities of using digital occupants for such tests. The digital occupants could be used for testing and calibrating (personalising) newly developed devices (e.g. smart meters) that are part of the house of the future. This way of testing avoids the ethical issues that occur when conducting research with humans.

This project also looks at opportunities to use digital occupants for creating energy efficient buildings. The simulation with the digital occupants could be embedded into the control system and be used to train software agents that reside within the smart devices that control the comfort level (e.g. thermal comfort) for the different occupants (or groups) of the building. For this the software agents will have to find a balance between the comfort of occupants and energy costs.

Introducing Behavioural ABMS to Business Process Modelling

ICT in manufacturing can be seen from two perspectives: a technical one (low level computing) and an organisational one (system level computing). While the technical perspective (e.g. conversion of large data files, efficient information transfer and control across different applications) is always in the forefront, the importance of the organisational perspective (e.g. the process of communication between teams for agile process co-ordination and project management) is often underestimated. In this research we will focus on the organisational perspective. We will develop a novel dynamic decision map (using object oriented analysis and design methods in combination with ABMS) to optimise the communication and timing throughout the entire lifecycle of a project and visualise the different stages in a project so everyone is able to understand where his/her work fits in and how it is linked to other parts of a project. Our focus will be on both, project management and the humans in the loop (e.g. customers, developers, suppliers). We will also take into account concurrencies (developments often happens in parallel and therefore communication needs to be well organise to avoid mistakes through lack of information).

Applications of ABMS: Authoritative Technology Adoption

Evidence shows that there is a difference in the behaviour of people that can freely decide to use a new technology and those that are forced to use it. By using ABMS we want to study the uptake and user learning process of new technology when disseminated in a way that forces people to accept it. A good example is the dissemination of software - while at home people can freely decide if/when they want to use new software; in companies they are often forced to change (e.g. from Windows XP to Windows 7) when the company decides to change. There has been a lot of research and modelling activities on adoption of innovation and new technology but authoritative technology adoption has mostly been neglected. Currently we are interested in the following cases:

- **Energy Users in Council Houses:** Here we are looking at the authoritative technology adoption of smart meters by council house occupants in the city of Leeds.
- **Nursing Home Occupants:** In this project we are planning to look at the authoritative technology adoption of smart meters by elderly people in shared accommodation (where they have a shared responsibility for saving energy). Besides we are interested in how the perceived energy consumption and real energy consumption differs.

Publication:
- Zhang T, Siebers PO and Aickelin U (2012) 'Modelling the Effects of User Learning on Forced Innovation Diffusion'. In: Proceedings of the UK OR Society Simulation Workshop 2012 (SW12), 26-28 March, Worcestershire, UK.

Comparing Different Approaches to ABMS

There is an ongoing debate amongst researchers on how to best represent human behaviour within OR type simulation models. An example of this debate is the way in which to represent a population: Should we use archetyping and randomisation or a fuzzy logic approach for creating a heterogeneous population of actors that reflect the attitudes of the real population they represent? Another example is the way in which we represent knowledge and decision making: Should it be empirical based or theoretical based? Does it make a difference for the simulation output?

We will conduct a comparison study and for this we will build and test some proof-of-concept models of the same system but using different ways of representing human behaviour.

Systems Biology: Translating Mathematical Models into Agent Based Models

Many advances in research regarding immuno-interactions with cancer were developed with the help of mathematical models. These models, however, are not effectively capable of representing problems involving individual localisation, memory and emerging properties, which are common characteristics of cells and molecules of the immune system. ABMS is an alternative paradigm that promises to overcome these limitations. In this research we test if we can build ABMS models that produce the same basic results as established mathematical models and what kind of additional information we can derive from these ABMS models. Our focus is on:

- **Translating Mathematical Models into ABMs:** Here we develop a framework for the translation process but also define which models can easily be translated and which ones need more care when being translated.
- **Making Sense of Outliers:** One of the differences between mathematical models and ABMs is that the former is deterministic and can be solved while the latter is stochastic and needs to be run multiple times - producing multiple results and perhaps outliers. We investigate if these outliers can give us additional information about the probabilities of outcomes in the real system.
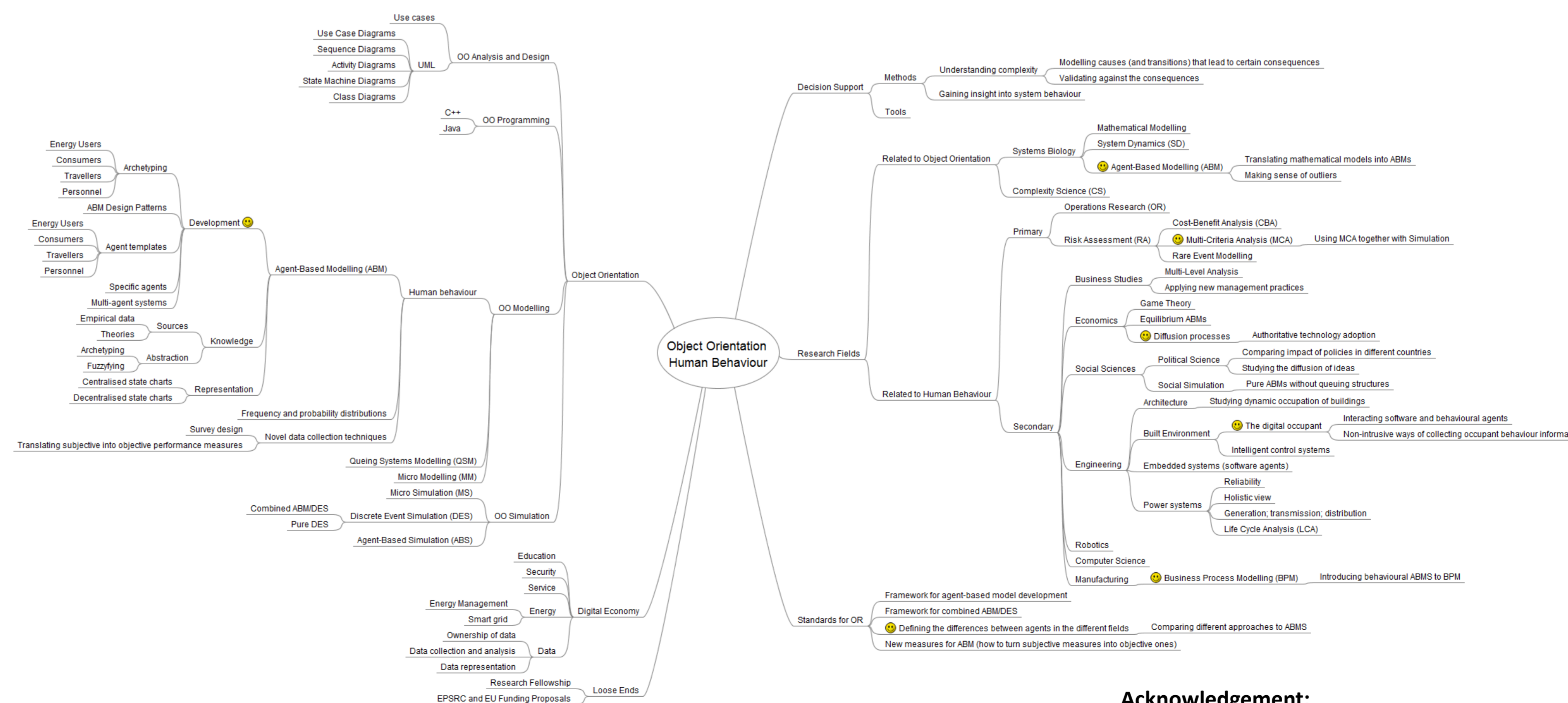
Publication:
- Figueredo GP, Siebers PO, Aickelin U (2012) Investigating Mathematical Models of Immuno-Interactions with Early-Stage Cancer under an Agent-Based Modelling Perspective; BMC Bioinformatics; in print

Using Simulation to Support Multi-Criteria Analysis (MCA) of Service Systems

MCA is a relatively new tool for the appraisal of options that allows taking monetary and non-monetary inputs into account. The latter is particularly useful for assessing service systems as factors such as service quality cannot easily be expressed in monetary terms. With the help of a case study (ferry port operation) we investigate the suitability of using cost benefit analysis for estimating monetary inputs and object oriented simulation for estimating non monetary inputs.

Publication:
- Siebers PO, Sherman G, Aickelin U and Menachof D (2011) 'Comparing Decision Support Tools for Cargo Screening Processes'. In: Proceedings of the 10th International Conference on Modeling and Applied Simulation (MAS), 12–14 September, Rome, Italy