

Issues in Conceptual Modelling for Simulation

Setting a Research Agenda

Stewart Robinson

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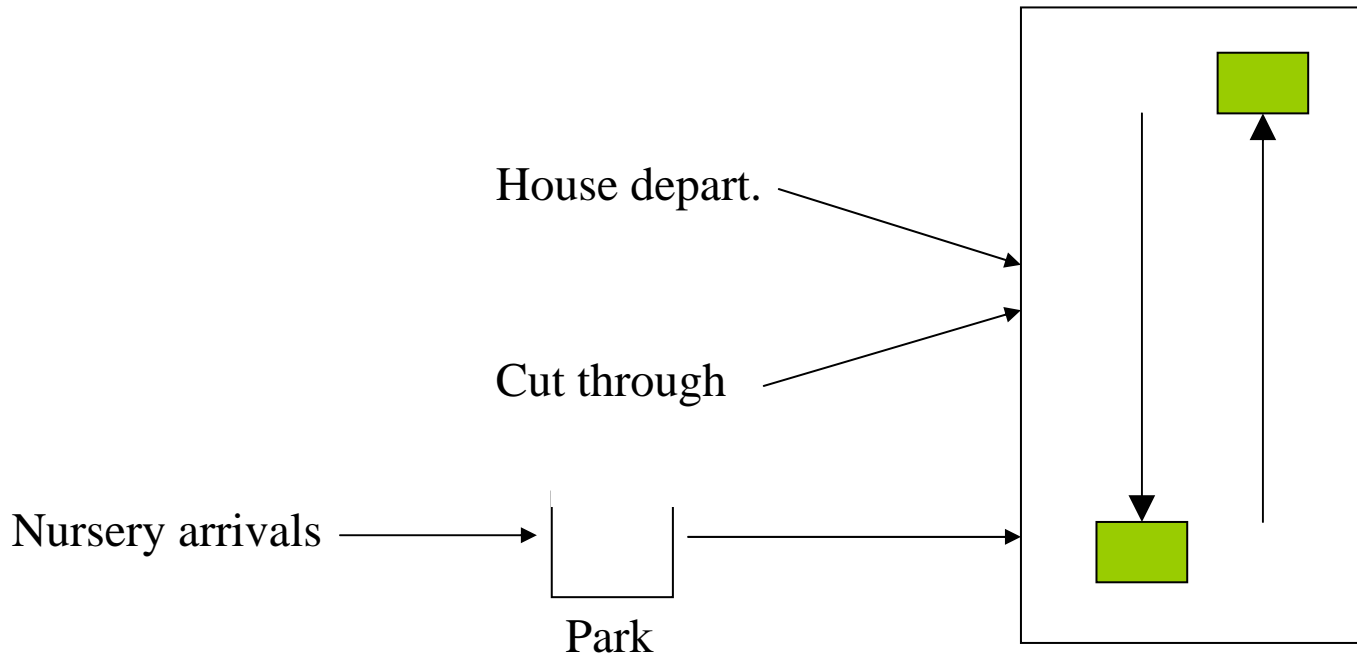
WARWICK
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Background

Could we open a day care nursery here?



Background



How did I come-up with this model?



Background

Conceptual modelling is the abstraction of a model from a real or proposed system.

It involves deriving an appropriate simplification.

Conceptual modelling is important because it impacts all aspects of a simulation study, e.g.:

- Data requirements
- Speed of model development
- Model validity
- Model run-speed
- Confidence in the model



Background

Conceptual modelling is important, but difficult and little understood.

- Few books devote many pages to the subject.
- There are very few research papers.
- Major discrete-event simulation conferences rarely include papers on conceptual modelling.

This is very different to other fields e.g. software engineering (requirements engineering) and databases (the Journal of Conceptual Modeling).



Background

Aim: to identify the key issues in conceptual modelling and thereby to identify potential issues for research.

- Definition of conceptual model(ling)
- Conceptual model requirements
- How to develop a conceptual model
- Conceptual model representation and communication
- Conceptual model validation
- Other issues in conceptual modelling

Definition of Conceptual Model(ling)

Authors: Balci, Fishwick, Nance, Robinson, Zeigler + military group (Pace et al)

Key facets of a conceptual model:

- Conceptual modelling is about moving from a problem situation, through model requirements to a definition of what is going to be modelled and how.
- Conceptual modelling is iterative and repetitive, with the model being continually revised throughout a modelling study.

Definition of Conceptual Model(ling)

More key facets:

- The conceptual model is a simplified representation of the real system.
- The conceptual model is independent of the model code or software, while model design includes both the conceptual model and the design of the code.
- The perspective of the client and the modeller are both important in conceptual modelling.

Definition of Conceptual Model(ling)

Robinson (2004) - amended:

'The conceptual model is a non-software specific description of the computer simulation model (that will be, is or has been developed), describing the objectives, inputs, outputs, content, assumptions and simplifications of the model.'

Conceptual Model Requirements

Clear requirements would provide a guide for conceptual model design.

Overarching requirement is for simplicity, in order to gain benefits of faster development, faster run-speed, lower data requirements, greater understanding.

- Occams Razor: *'plurality should not be posited without necessity.'*
- Antoine de Saint-Exupery: *'Perfection is achieved, not when there is nothing more to add, but when there is nothing left to take away.'*

Conceptual Model Requirements

More detailed requirements given by various authors: Pritsker (1986), Henriksen (1988), Nance (1994), Willemain (1994), Brooks and Tobias (1996), Robinson (2004), van der Zee (2005).

For example Willemain:

- Validity
- Aptness for problem
- Value to client
- Usability
- Feasibility

How to Develop Conceptual Models

1. Principles of Modelling

e.g. Pidd (1999):

- Model simple think complicated
- Divide and conquer
- Do not fall in love with data ...

Useful rules of thumb

But lack of specific guidance on how to get from
a problem to a model

How to Develop Conceptual Models

2. Methods of Simplification

e.g. Ward (1989), Courtois (1985), Zeigler (1976), Innis and Rexstad (1983).

Simplify an existing model

But do not help determine what to model in the first place

How to Develop Conceptual Models

3. Modelling Frameworks

A set of steps to guide a modeller through conceptual modelling.

Examples:

- Nance (1994) : conical methodology
- Pace (1999): 4 stage approach
- Guru and Savory (2004): framework in a specific context

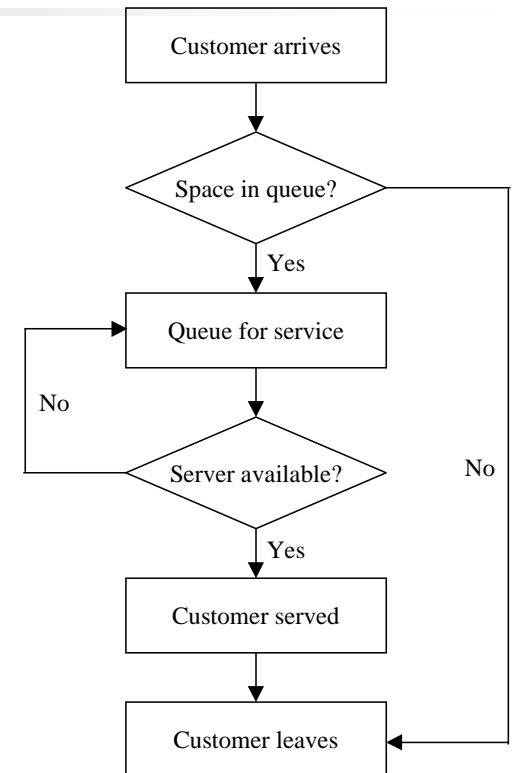
But there is only limited work in developing and testing frameworks.

Representing Conceptual Models

No agreed method.

Examples:

- Process flow diagrams
- Activity cycle diagrams
- Petri nets
- Event graphs
- UML (the unified modelling language)
- Tables describing the model rationale and content





Conceptual Model Validation

Is the model going to be sufficiently accurate?

But how can we validate?

Problem: statistical methods cannot be used.
Therefore reliant on qualitative approaches.

e.g. Balci and Nance (1985): formulated problem verification.



Other Issues

- Teaching conceptual modelling
- Enhancing creativity in modelling
- Rapid prototyping for model development
- Group model building and facilitation
- Iterative development of the conceptual model throughout the lifecycle of a simulation project
- The role of data in conceptual modelling



A Research Agenda?

- Developing consensus over the definition of a conceptual model/conceptual modelling.
- Identifying the requirements for a conceptual model.
- Development of methods for designing conceptual models including modelling principles, methods of simplification and modelling frameworks.
- Moving towards standard methods for representing and communicating a conceptual model.
- Developing validation procedures.
- Investigating effective means for teaching the art of conceptual modelling.

The Field of Conceptual Modelling

How can we move this field forward?