

# Developing your Research: What I Wish I had Known when I was Younger

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## Outline

- ❑ A brief career history
- ❑ How two streams of research developed:
  - ❑ Simulation output analysis
  - ❑ Conceptual modelling for simulation
- ❑ 8 ways to develop your research ... what I wish I had known when I was younger

## Quiz Question

What is my highest cited paper about?

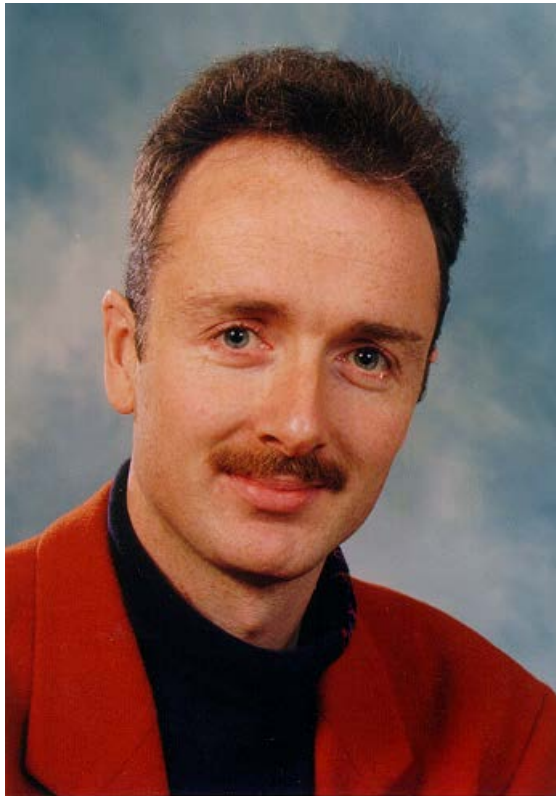
## Practising Simulation (in 1988)



# Practising Simulation



# Becoming an Academic (1992)



Publications 0 – 0 Journals Read

12 INTEGRATED MANUFACTURING SYSTEMS 64

Simulation is primarily a decision-support tool with experiments performed on a trial-and-error basis.

## The Application of Computer Simulation in Manufacturing

Stewart Robinson

Integrated Manufacturing Systems, Vol. 15, 4, 1992, pp. 11-21  
© 1992 Elsevier Science Limited, 0924-6460

### Introduction

To remain competitive there is a continual need for manufacturing organisations to seek improvement. Manufacturing managers are perpetually asked to

the benefits which can be obtained. First there is an overview of computer simulation, followed by a discussion on the applications for which it can be used and the benefits which have been obtained. The article concludes with a case study in which simulation was used to establish human resource requirements and working practices for a manufacturing facility.

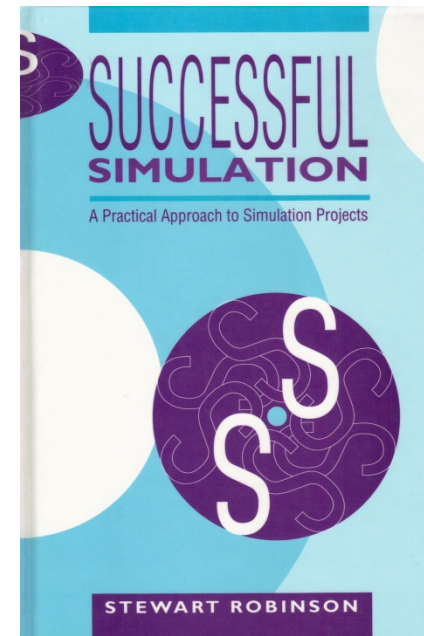
### Computer Simulation

A simulation is a model which imitates reality[1]. For example, a simulation of a manufacturing facility would imitate the operation of machines, the movement of work in progress and the utilisation of labour as they progress through time. A model is built using a software package and then experiments are performed by running the model for a simulated time period. Alternative data and scenarios are tested by changing the inputs to the model, and the outcomes are reported through tabular and graphical results.

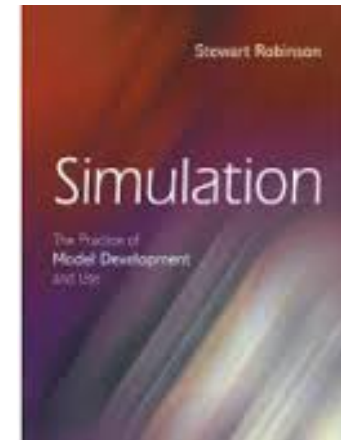
Simulation is primarily a decision-support tool with experiments performed on a trial-and-error basis by asking 'what if?' questions. Examples of the questions which might be asked are:

- What effect will faster cycle times have on throughput?
- Will fewer maintenance teams significantly increase machine stoppages?
- What if buffer storage is increased by 10 per cent?
- What if batch sizes are reduced?
- What effect will changing the layout have on labour efficiency?

Visual interactive simulation (VIS[2]) further enhances the capabilities of computer simulation. A visual display shows carts and labour moving between jobs, while



# Warwick (1998-2011)



## Operational Research Society 5<sup>th</sup> Simulation Workshop (SW10)

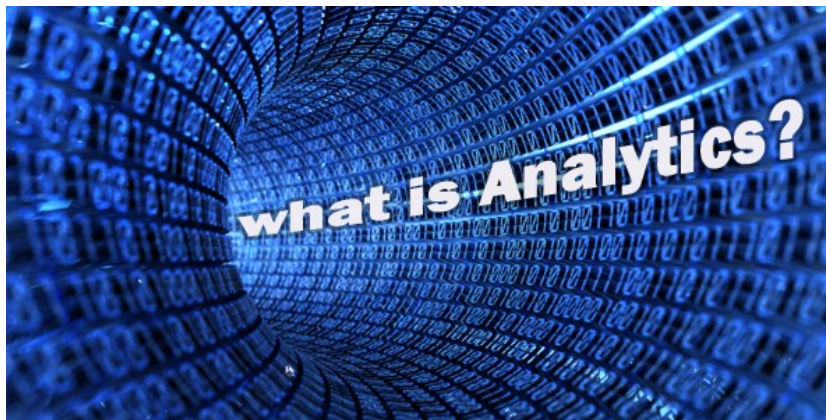
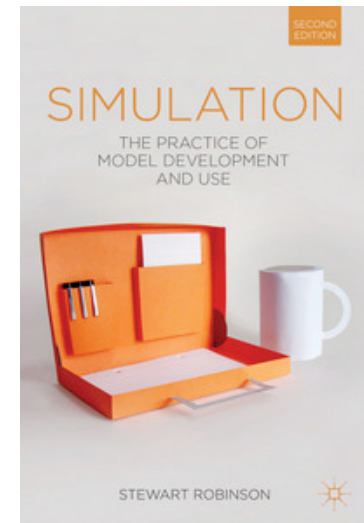
Held in cooperation with:  
The Association for Computing Machinery's Special Interest Group for Simulation (ACM SIGSIM); The INFORMS Simulation Society; The Society for Modeling and Simulation International (SCS)

23-24 March 2010, Worcestershire, United Kingdom

The biennial Operational Research Society Simulation Workshop brings together practitioners and academics working in the field of discrete-event simulation and related

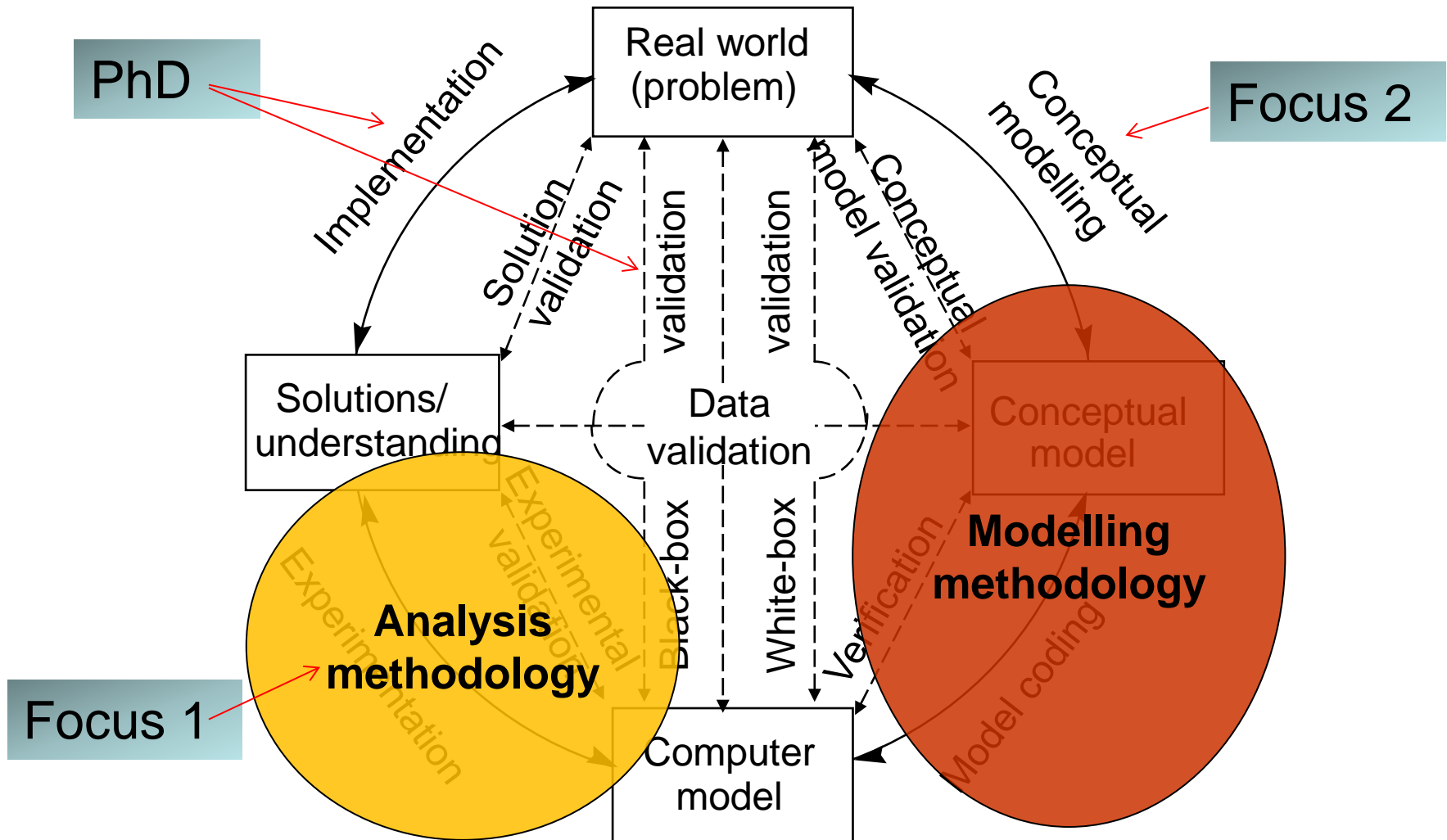


# Loughborough (2011 - )





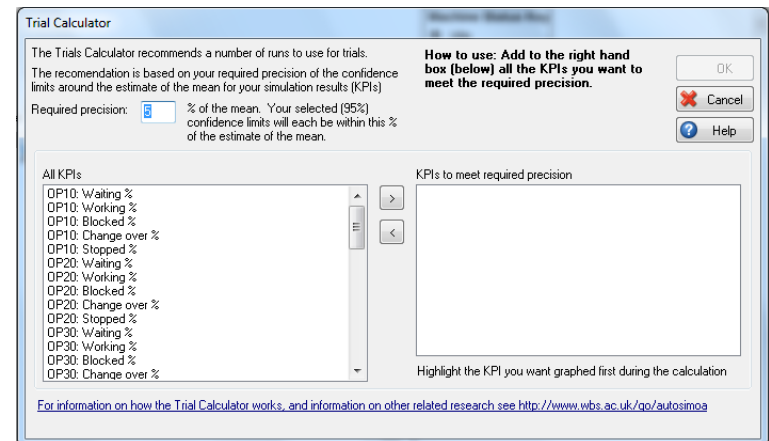
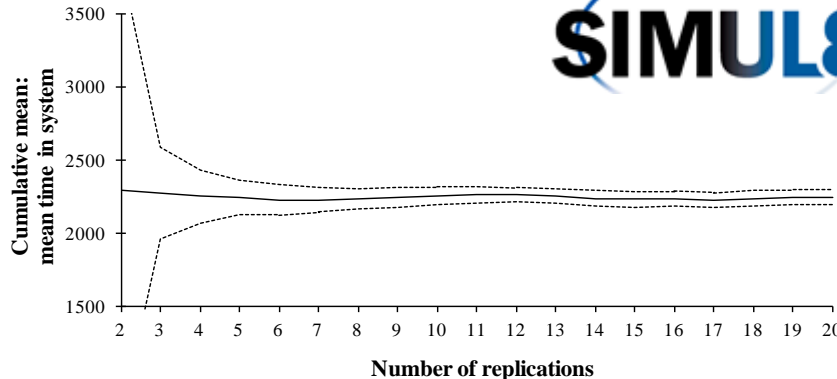
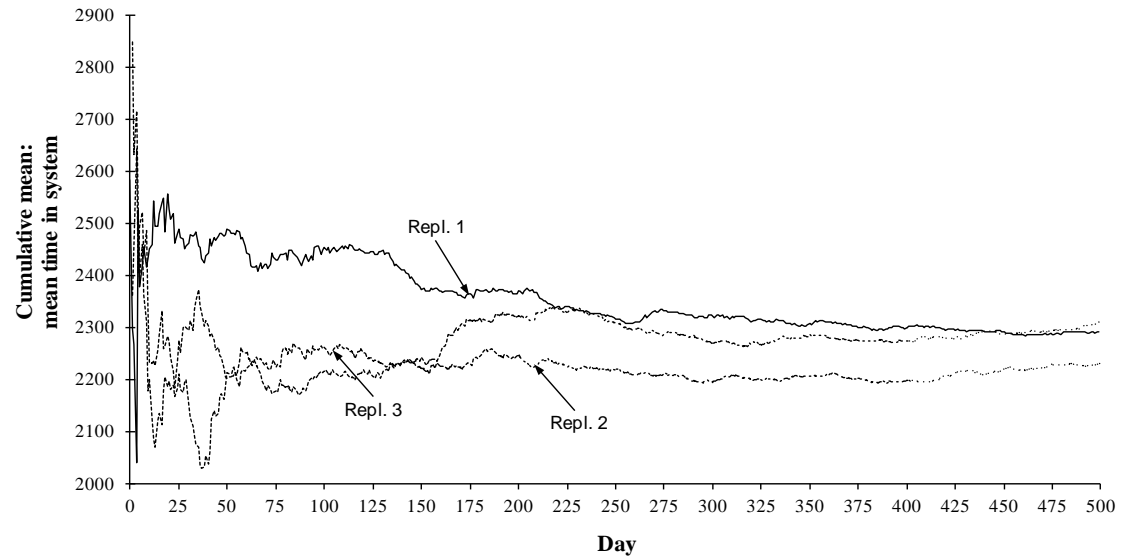
# Research Focus



# Contributing to an Existing Field: Simulation Experimentation

## The Beginnings

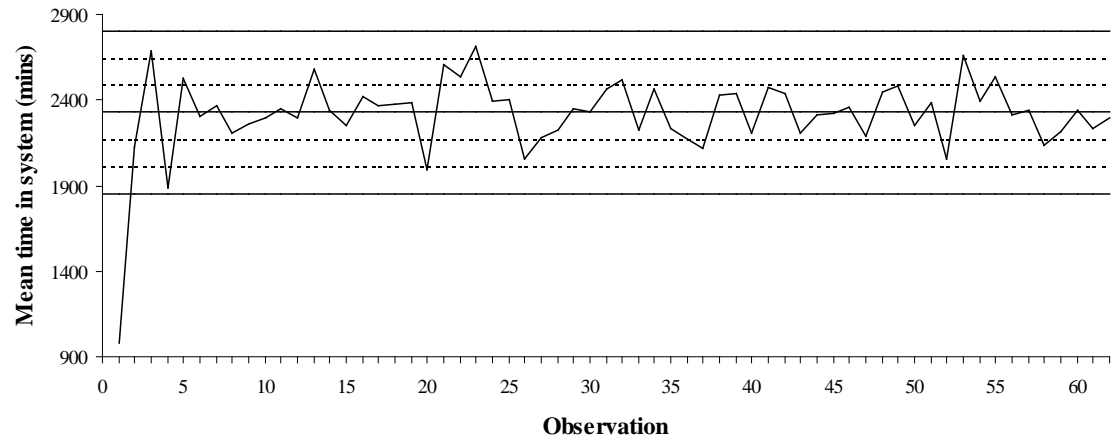
- ❑ We guessed the warm-up period
- ❑ We only ran one replication (and so did our customers)
- ❑ ‘How long is a piece of string?’ (1992)



# Contributing to an Existing Field: Simulation Experimentation

## The Warm-up Period

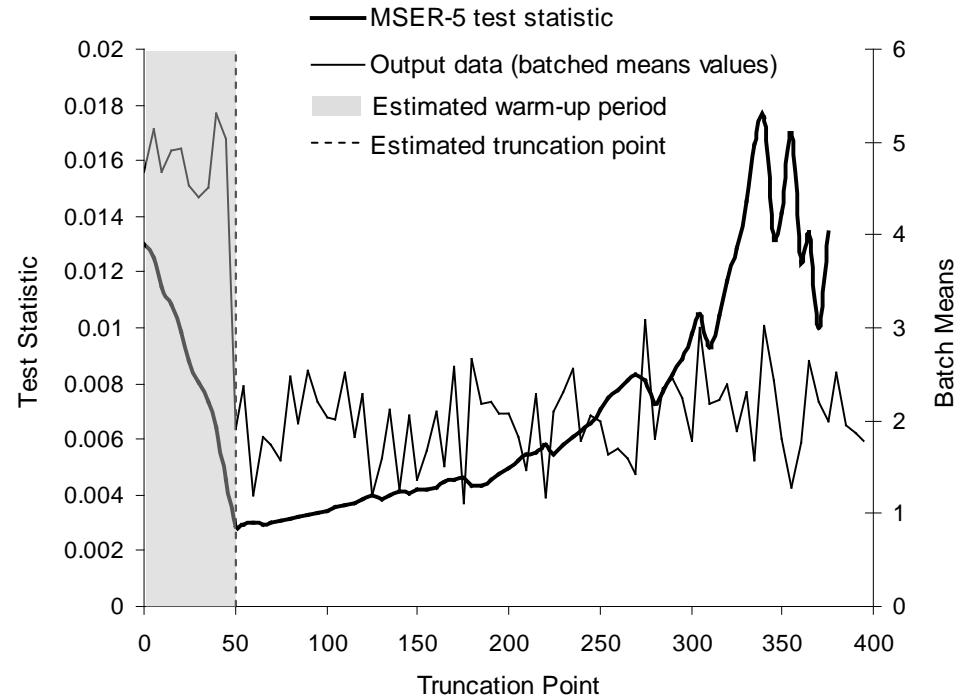
- ❑ Around 50 methods since 1960s
- ❑ Most common approach is to guess
- ❑ Macaroni cheese and statistical process control (2001-2005)



# Contributing to an Existing Field: Simulation Experimentation

## MSER

- ❑ Agis the MSc student (2001)
- ❑ Automated output analysis – final year project (2004)
- ❑ WSC 2005 – Preston White. Visits UK in 2008.

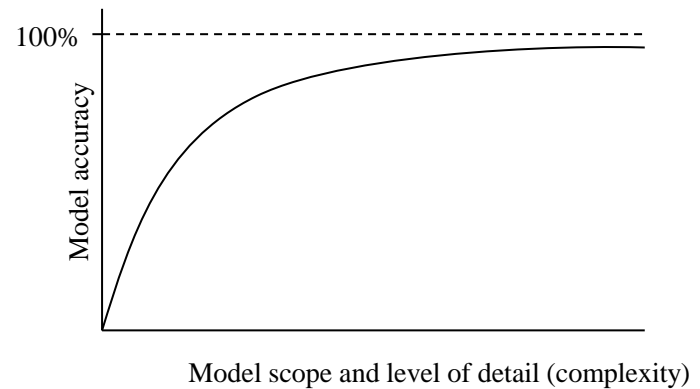


- ❑ EPSRC AutoSimOA project (2006-2009)
- ❑ WSC and INFORMS Simulation Society – getting the Americans to notice!

# Breaking New Ground: Conceptual Modelling for Simulation

## The Beginnings

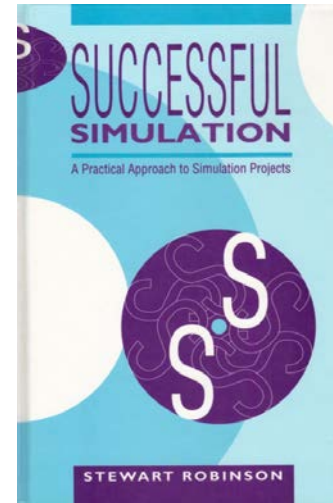
- ❑ The Jaguar engine plant model (1986)
- ❑ Software training courses (1988)



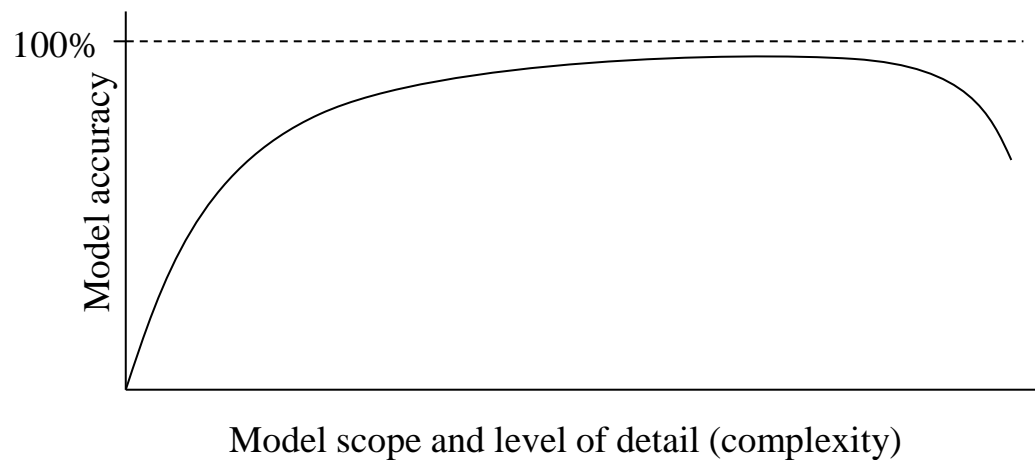
# Breaking New Ground: Conceptual Modelling for Simulation

## Developing the Ideas

- ❑ Book chapter (and article in Industrial Engineering magazine in 1994)



- ❑ The curve got longer



## Breaking New Ground: Conceptual Modelling for Simulation

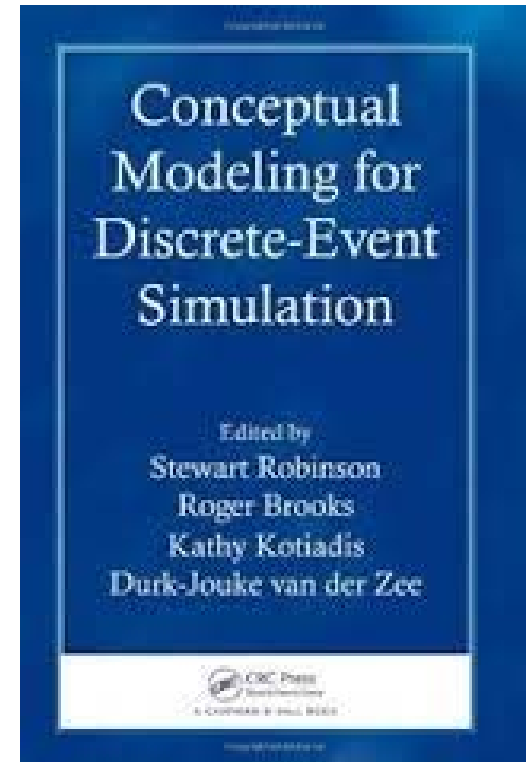
### The Story of the Papers (most dates approximate)

- ❑ 2000 – first draft of journal paper on conceptual modelling
- ❑ 2002 – submission to Interfaces
- ❑ 2003 – *decision*: revise and resubmit as two articles
- ❑ 2005 – resubmitted as two articles
- ❑ 2006 – *decision*: revise and resubmit as one article
- ❑ 2006 – revised and submitted to OMEGA then JORS
- ❑ 2007 – *decision*: revise and resubmit
- ❑ 2007 – *decision*: accepted
- ❑ 2008 – published as two articles

# Breaking New Ground: Conceptual Modelling for Simulation

## Developing the Field and the Network

- ❑ The conceptual modelling group (2006)
- ❑ Special issue in JOS (2008)
- ❑ Conference stream in SW08 and conference session at WSC08
- ❑ Panel discussion at SpringSim (Ottawa 2008)
- ❑ The book (2010)
- ❑ WSC Introductory Tutorial (2011)
- ❑ DoD Handbook (2014)





## ... and then there was Impact

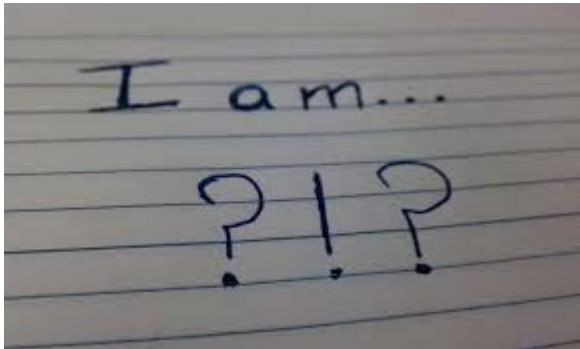
### Summer 2013

“My name is Loren .... I am employed here in the United States as a simulation practitioner. Since August 2012, I have served as one of the technical leads for a major conceptual modeling effort ... At the beginning of this effort, my colleagues and I researched over 30 scientific papers, reports, and briefs composed over the past two decades to determine a process framework for doing our work. In the end, we settled on an approach you authored, as documented in a number of technical papers and most recently in your anthology, *Conceptual Modeling for Discrete-Event Simulation*.

“... it was the socialization benefits of executing the conceptual modeling process framework that were as instrumental to success as the resulting conceptual model itself.

“I am convinced that the practical conceptual modeling process and products have given us a fighting chance for long-term success. For your contributions to that end, I express heartfelt gratitude. “Thank you” is not enough.”

## 8 Ways to Develop your Research



1. Define yourself



2. Work on what interests you and enjoy it



3. Believe in what you are doing and persevere



4. Look for sources of inspiration

## 8 Ways to Develop your Research



5. Network



6. Self promote ... but  
have substance

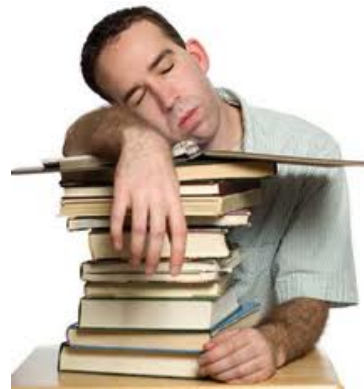
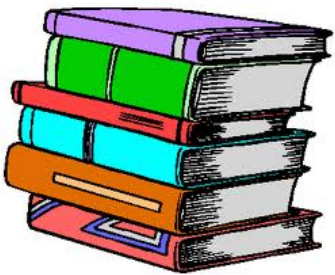


7. Choose carefully who  
you work with



8. Communicate with the  
real world

... and two more!



## Quiz Question

What is my highest cited paper about?

Robinson, S. (1999). Measuring Service Quality: Current Thinking, Future Requirements. *Marketing Intelligence and Planning*, 17 (1), pp. 21-32.