Improving the understanding of conceptual modelling

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Outline

- Definition of conceptual modelling
- Literature review on conceptual modelling
- Two preliminary studies on conceptual modelling
- Analysis of the results
- Conclusion and future research

What is conceptual modelling?

- Definition
  - “A software independent description of the model that is to be constructed” *(Brooks and Robinson, 2001)*
- Conceptual modelling is the process of deciding what to include in the model
  - Entities, interactions, rules of behaviour
  - Assumptions and simplifications
- Important stage, but poorly understood

Literature review

- Literature focuses on deciding the level of detail of the model
  - Law (1991) – *"The most difficult aspect of a study is that of determining the appropriate level of model detail"*
  - Robinson (1994) – *Minimum components*
  - Pidd (1996) – *"Model simple, think complicated"*
  - Ward (1989) and Salt (1993) – *Advantages of a simple model*
  - Pritsker (1986) and Davies et al (2003) – *Disadvantage of a simple model*

Literature review

Willemain's(1995) experiment on modelling process

- Invite experts to speak aloud their thought on tackling an artificial O.R. modelling problem for the period of an hour
- Transcripts were analysed by chunks and classified into five different modelling topics:

Topic	Corresponding tasks
Context	Problem structuring
Structure	Conceptual modelling
Realisation	Data collection and analysis, model coding and model experiment
Assessment	Verification and validation
Implementation	Implementation, including model handover to the client

Literature review

- Willemain's(1995) experiment on modelling process
  - Results:
    - Attention to all topics, with emphasis on structure
    - Frequent topic switch between structure and assessment
- Willemain's (1994) survey
  - Modelling style
  - Opinions on the ideal quality of modellers, models, modelling process and clients

Study 1: Project follow through

- **Objective**: Improve the understanding of modelling process and especially conceptual modelling process.
- **Approach**: Follow both **expert** and **novice** modellers through their modelling projects.
- **Projects**
  - Expert project (1):

    Call centre project lasted 10 for weeks
  - Novice projects (6):

    2 Master and 4 Undergraduate student group projects at Lancaster University lasted for 12 weeks

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Study 1: Project follow through

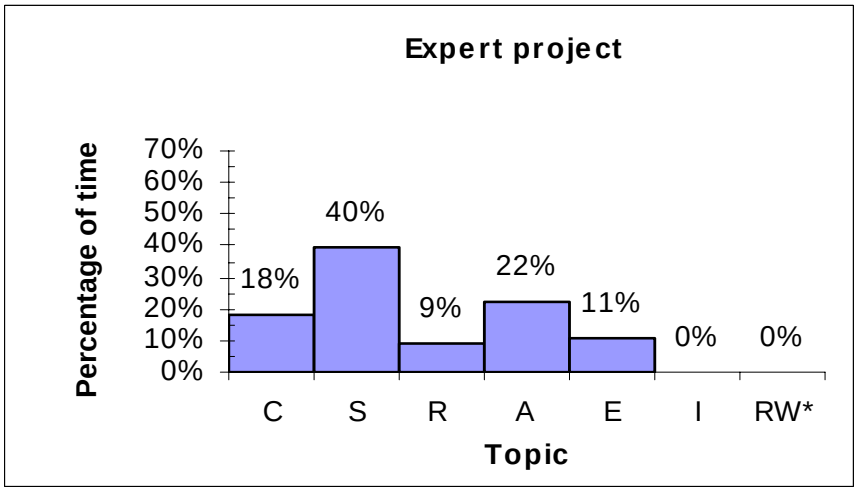
- Differences from Willemain's research:
  1. Real projects
  2. Simulation projects
  3. Novices involved
  4. Data collected for the whole period
- Data needed
  - Time allocation to each topic
  - Changes of the conceptual model over the project life cycle and the reasons
- Method
  - Expert project: informal interviews + filling forms
  - Novice projects: Survey

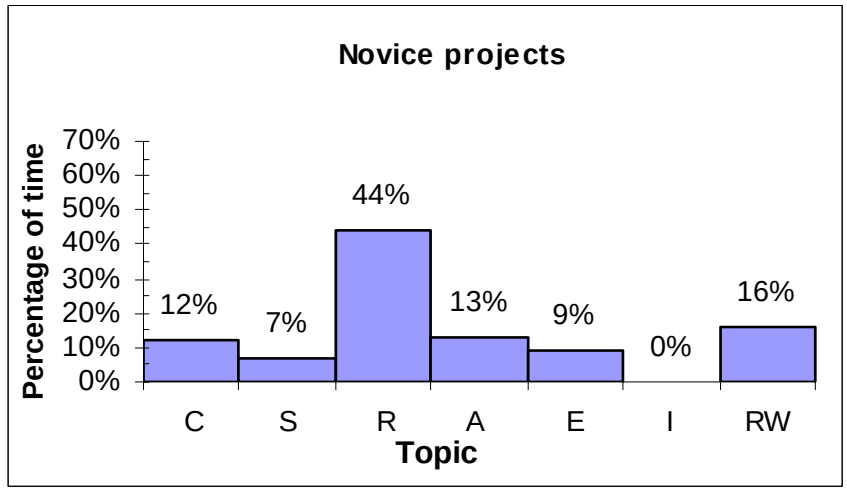
Study 1: Project follow through – results

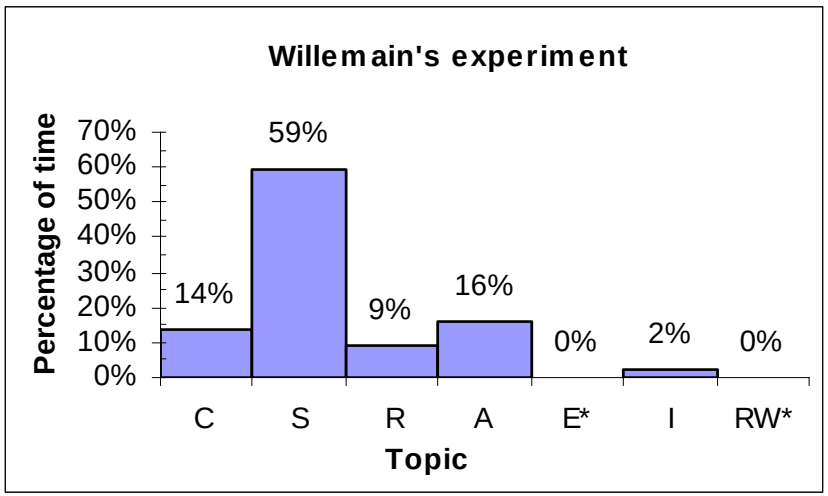
- The Expert project has the similar pattern with Willemain's results:
  - Similar weighting of topics
  - Time spent on each topic spread over most of the project duration

- The Novice project follows a different pattern:
  - Less time spent on conceptual modelling
  - More time on model coding and data collection
  - Follow quite a linear approach to the project stages

Weight break down by topic

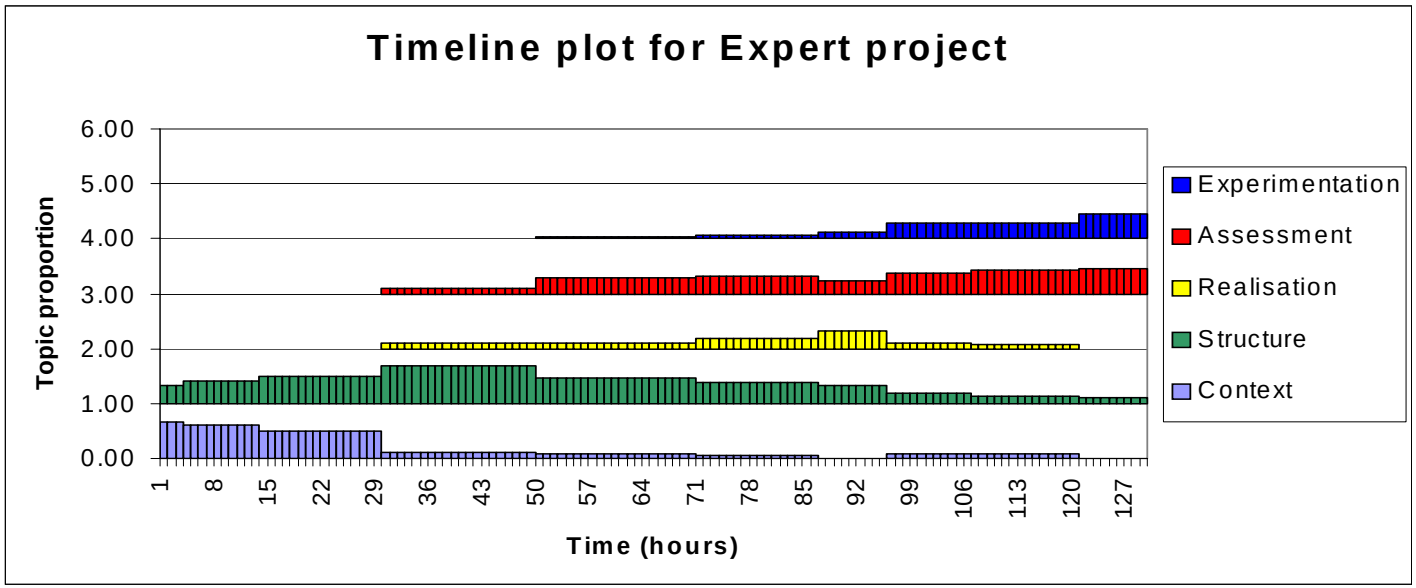


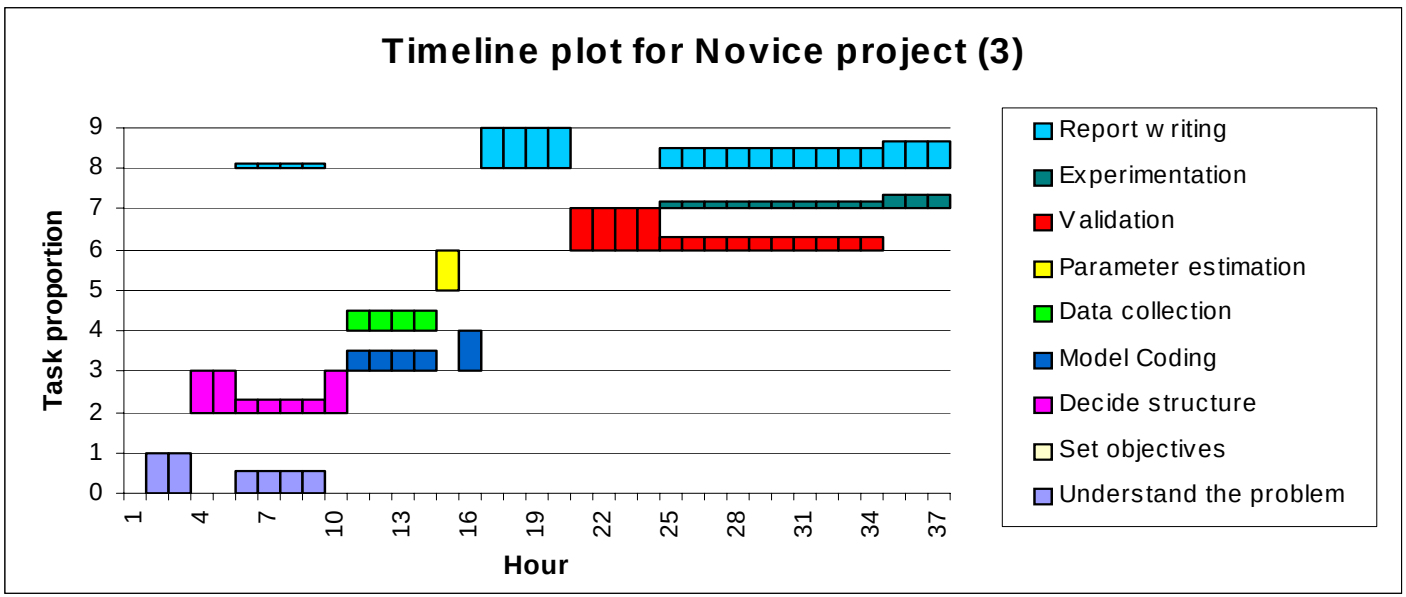




- C=context
- S=structure
- R=realisation
- A=assessment
- E=experimentation
- I=implementation
- RW=report writing
- Asterisk indicates that topic is not recorded separately for that experiment

Timeline plot for Expert project and Novice project (3)





Project follow through – issues raised and future improvement

- Limitations
  - Low feedback rate of students' survey (6/17 = 35%)
  - Confidence issue of self-reporting

- Improvement
  - Focus on small number but more responsible student groups
  - The researcher shadows and observes modellers in person
  - Conduct a complementary survey on modellers' opinions on conceptual modelling

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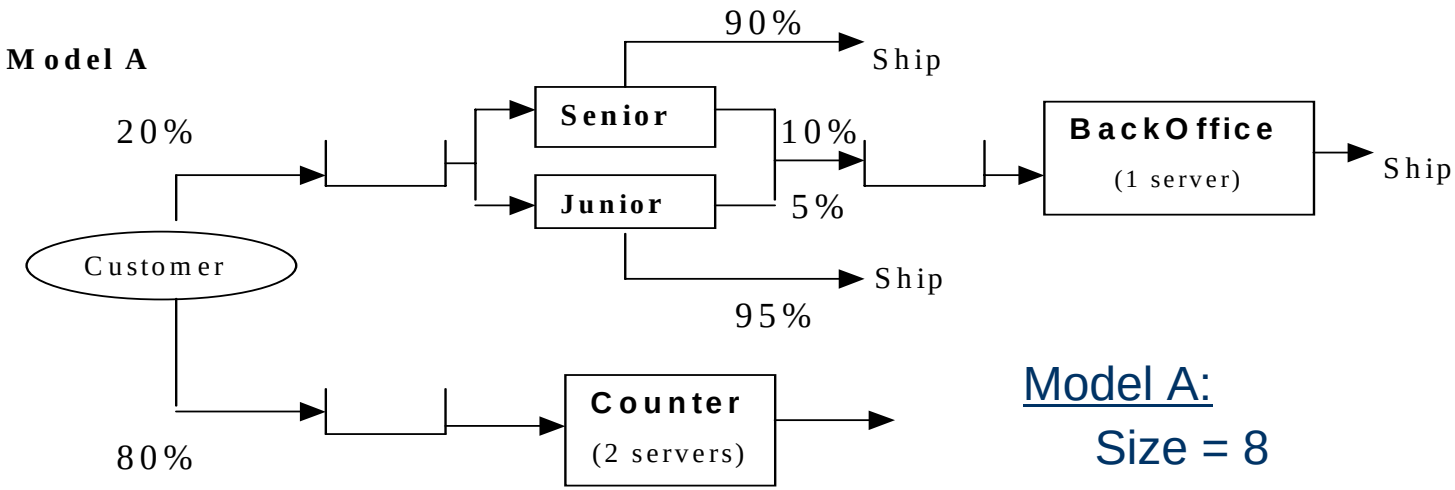
Study 2: investigate relationship between model attribute and model performance

- **Objective**: provide aid to the process of model selection
- **Approach**: experiment on relationship between different facet of model complexity and model performance**.**
- **Definition**
  - Attribute: size, connectedness and calculational complexity
  - Model performance (Brooks, 1996)
    - Results — Future use of the model
    - Verification and validation — Resources required
- **Hypotheses:**
  - ‘size’ and ‘connectedness’ – ‘ease of understanding’
  - ‘Calculational complexity’ – ‘model build time’

Study 2: investigate relationship between model attribute and model performance

- Design of the experiment: four planned bank models
  - Model A: base model
  - Model B: more size
  - Model C: more connectedness
  - Model D: more calculational complexity
- Experiment participants:
  - 16 Master students in simulation course (4 for each model)
- Experiment stages:
  - Answer questions (2 qualitative + 2 quantitative)
  - Construct a computer model

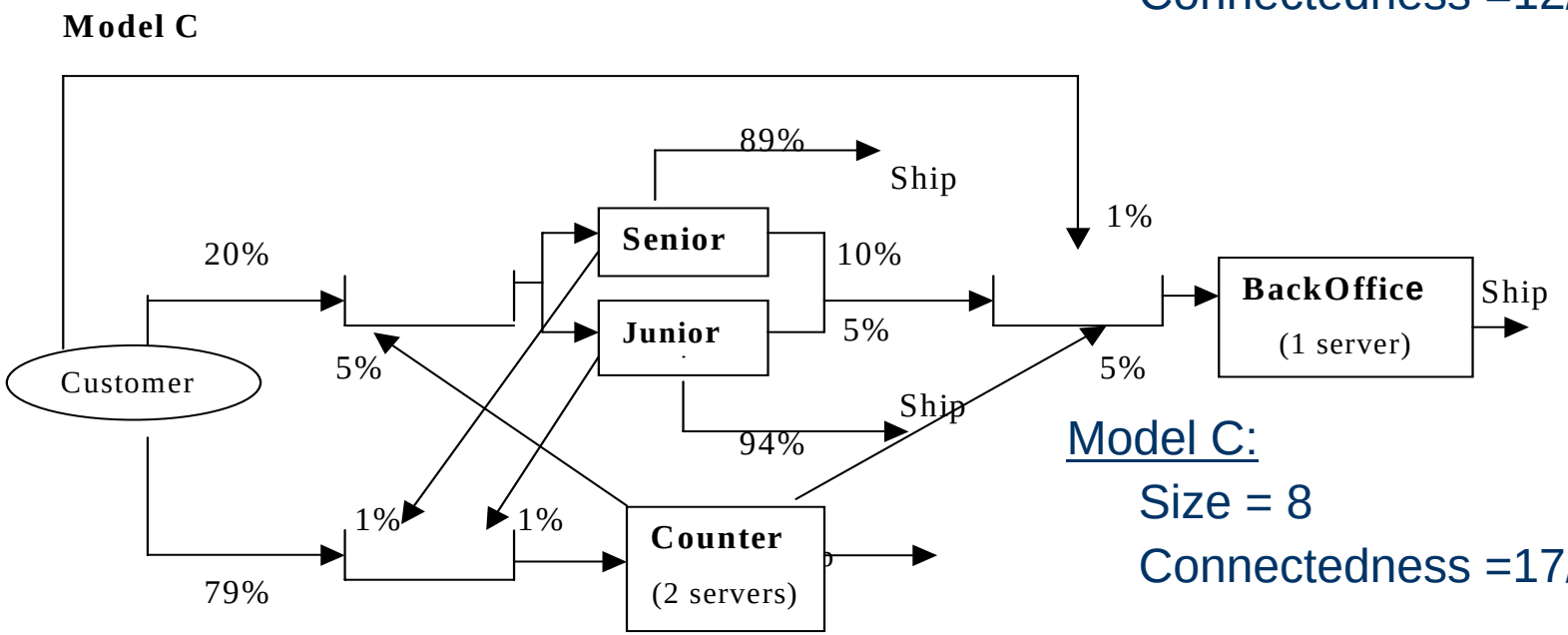
Process diagrams of the bank models



Model A:

Size = 8

Connectedness =12/8=1.5



Model C:

Size = 8

Connectedness =17/8 =2.1

Study 2: investigate relationship between model attribute and model performance

Summary of the **answer-question** stage:

Average % of Mark		Models A	B	C	D	Average
Questions	1	50.00%	37.50%	25.00%	75.00%	46.88%
	2	75.00%	37.50%	62.50%	75.00%	62.50%
	3	62.50%	50.00%	12.50%	50.00%	43.75%
	4	62.50%	37.50%	62.50%	25.00%	46.88%
Average		62.50%	40.63%	40.63%	56.25%	50.00%

Q1: Score = 1.96 – 0.43 Student_type *($R^2 = 0.37$)*

Q2: Score = 2.36 – 0.41 Student_type – 0.60 Model_B *($R^2 = 0.61$)*

Q3: Score = 1.08 - 0.83 Model_C *($R^2 = 0.27$)*

Q4: No relationship found

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Study 2: investigate relationship between model attribute and model performance

- Summary of **model-building** stage:
  - Two-way ANOVA and regression analysis
  - No relationship was found due to difficulties students encountered in modelling
    - Modelling ‘Scrap rule’ – customers will leave the bank if the queue exceeds 15
    - Modelling calculational complexity in model D

Study 2: issues raised and future improvement

- Limitations
  - Small sample size
  - Difficulties students encountered in modelling
- Improvement
  - Focus on ‘size’ and ‘ease of understanding’
  - Design a group of models with more size difference
  - Alter the experiment by asking participants to spot system bottlenecks while observing computer models running to assess their understanding of the models
  - Altered experiment design allow people without simulation background to participate and therefore enlarge the sample size.

Conclusion

- Study 1 (project follow through) shows that the Expert project has similar pattern with Willemain's results, while Novice projects follow a different pattern.
- Study 2 (Experiment) gives some support that 'size' and 'connectedness',but not 'calculational complexity' is related to 'ease of understanding'.
- The two studies are preliminary and the results are tentative.
- Information obtained however is important.
- Further work suggested in each study is work in progress.

Suggestions or Questions?

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