

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

# **The Integration of Task and Dialogue Modelling in the Early Stages of User Interface Design**

A thesis presented in partial fulfilment of the requirements  
for the degree of  
Doctor of Philosophy in Computer Science  
at Massey University, Palmerston North, New Zealand

**Christopher John Scogings**

**2003**



### CERTIFICATE OF REGULATORY COMPLIANCE

This is to certify that the research carried out in the Doctoral Thesis entitled *The Integration of Task and Dialogue Modelling in the Early Stages of User Interface Design* in the Institute of Information Sciences and Technology, Massey University, Palmerston North, New Zealand:

- (a) is the original work of the candidate, except as indicated by appropriate attribution in the text and/or in the acknowledgements;
- (b) that the text, excluding appendices does not exceed 100,000 words;
- (c) all the ethical requirements applicable to this study have been complied with as required by Massey University, other organisations and/or committees which had a particular association with this study, and relevant legislation.

**Candidate's Name:** CHRIS SCOGINGS

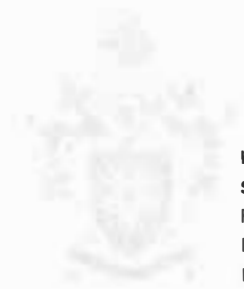
**Signature:** 

**Date:** 17.6.03

**Supervisor's Name:** CHRIS PHILLIPS

**Signature:** 

**Date:** 17.6.03



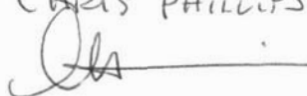
### SUPERVISOR'S DECLARATION

This is to certify that the research carried out for the Doctoral Thesis entitled *The Integration of Task and Dialogue Modelling in the Early Stages of User Interface Design* was done by Christopher John Scogings in the Institute of Information Sciences and Technology, Massey University, Palmerston North, New Zealand. The thesis material has not been used in part or in whole for any other qualification, and I confirm that the candidate has pursued the course of study in accordance with the requirements of the Massey University regulations.

**Supervisor's Name:**

CHRIS PHILLIPS

**Signature:**



**Date:**

17. 6. 03



### CANDIDATE'S DECLARATION

This is to certify that the research carried out for my Doctoral Thesis entitled *The Integration of Task and Dialogue Modelling in the Early Stages of User Interface Design* in the Institute of Information Sciences and Technology, Massey University, Palmerston North, New Zealand is my own work and that the thesis material has not been used in part or in whole for any other qualification.

**Candidate's Name:**

CHRIS SCOGINGS

**Signature:**

**Date:**

17.6.03

## Abstract

In the early stages of the design of graphical user interfaces, models and notations are required for describing user tasks and for describing the structure of the human-computer dialogue to support these tasks. These descriptions should ideally be linked, but in practice *task modelling* and *dialogue modelling* are conducted in isolation with differing notations. The research reported in this thesis reviews both task and dialogue modelling and describes how the divide between the two can be bridged via the Lean Cuisine+ notation.

Lean Cuisine+ was developed as a semi-formal graphical notation for describing the underlying behaviour of direct manipulation user interfaces (Phillips, 1995). The notation has a significant advantage over other dialogue modelling notations in that it can represent task sequences within the context of the dialogue structure and hence bring dialogue modelling and task modelling together. The research describes how Lean Cuisine+ has been analysed and modified in order to simplify it and to make it more suitable for use with a supporting software tool.

There exists a significant gap between user interface design and the design of entire software applications. This is true even for the latest software engineering notation, UML, which has become the *de facto* industry standard. The thesis reviews UML and reveals its shortcomings regarding support for user interface design. The research suggests a solution for the problem by proposing a method for the early stages of user interface design that uses Lean Cuisine+, in order to combine both task and dialogue modelling, and is constructed to form an integral part of the overall software design process advocated by the authors of UML. The method is applied to two case studies.

A prototype Software Environment for Lean Cuisine+ with UML (SELCU) has been developed to enable the construction, storage, editing and printing of Lean Cuisine+ specifications, and to partially support the method. The thesis describes the design, implementation and use of this software support environment.

Finally, preliminary work by the author on the automatic generation of Lean Cuisine+ specifications is reported. This shows promise, and has been further developed recently in associated masters-level research in which extensions to SELCU have been implemented.

## **Acknowledgements**

The completion of this thesis is due, in no small measure, to the unwavering support, guidance and patience of my supervisor Associate Professor Chris Phillips. During the lean years of high workloads and frustration he remained a source of inspiration and dedication to a task that was often pushed into the background. I wish to express my deepest thanks to him.

Thanks also to my second supervisor Dr Peter Kay for proofreading and suggesting corrections to the thesis.

I am grateful also to Professor Ken Milne and members of the Massey University Doctoral Research Committee for recognising that work was progressing, albeit slowly, and for twice adjusting the thesis submission deadline.

Finally, I wish to acknowledge the role played by Associate Professor Gavin Finnie and Mr Rob Dempster who, many years ago, suggested that a PhD thesis was something worth completing.

# Contents

<b>Chapter 1 Introduction</b>	<b>1</b>
1.1 Motivation	1
1.2 Linking task and dialogue modelling	1
1.3 Lean Cuisine+	2
1.4 The Unified Modelling Language (UML)	3
1.5 Objectives of the research	4
1.6 Approach adopted	5
1.7 Research publications	6
1.8 Structure of the thesis	7
<b>Chapter 2 A Review of Task and Dialogue Modelling</b>	<b>9</b>
2.1 Introduction	9
2.2 Task modelling	10
2.3 Dialogue modelling	17
2.4 Dialogue modelling in Lean Cuisine	23
2.5 Towards Lean Cuisine+	24
<b>Chapter 3 The Lean Cuisine+ Notation</b>	<b>25</b>
3.1 Early Lean Cuisine+	25
3.2 Lean Cuisine+ revised	32
3.3 Task modelling with Lean Cuisine+	39
3.4 The revised Lean Cuisine+ notation in action	41
3.5 Review	43
<b>Chapter 4 The Unified Modelling Language (UML) and the Unified Process</b>	<b>45</b>
4.1 Introduction	45
4.2 The UML notation	46
4.3 The Unified Process	54
4.4 UML, the Rational Unified Process (RUP), and user interface design	56
4.5 Uniting UML with user interface design	59
<b>Chapter 5 A Method for the Early Stages of User Interface Design</b>	<b>63</b>
5.1 Introduction	63
5.2 User interface design as part of the Unified Process	64
5.3 The method via a case study	65
5.4 A summary of the method	79

5.5 A further case study	80
5.6 Review	89
<b>Chapter 6 The SELCU Software Support Environment</b>	<b>91</b>
6.1 Introduction	91
6.2 Functional requirements of the system	91
6.3 Design issues	92
6.4 An overview of the current version of SELCU	94
6.5 Format of the data file	98
6.6 Revisions made after initial use	103
6.7 The development history of the system	106
6.8 A case study	108
6.9 Conclusions	110
<b>Chapter 7 The Automatic Generation and Execution of</b>	
<b>Lean Cuisine+ Specifications</b>	<b>111</b>
7.1 Prototyping tools	111
7.2 A HyperCard prototype	112
7.3 A Delphi prototype	117
7.4 Execution of Lean Cuisine+ specifications	119
7.5 Review	121
<b>Chapter 8 Conclusions and Further Work</b>	<b>123</b>
8.1 The Lean Cuisine+ notation	123
8.2 The method for the early stages of user interface design	124
8.3 The SELCU environment	125
8.4 Automatic generation and execution of Lean Cuisine+ specifications	125
8.5 The wider contribution of this thesis	126
8.6 Further work	127
<b>References</b>	<b>129</b>
<b>Appendix 1 The Lean Cuisine+ Notation</b>	<b>139</b>
<b>Appendix 2 The SELCU User Manual</b>	<b>147</b>
<b>Appendix 3 Modelling the SELCU User Interface with Lean Cuisine+</b>	<b>171</b>

## List of Figures

Figure 2.1: An example use case (Constantine & Lockwood, 1999)	14
Figure 2.2: The corresponding essential use case (Constantine & Lockwood, 1999)	14
Figure 2.3: A typical template for description of a use case based on (Jaaksi et al, 1999)	15
Figure 2.4: A tabular representation of the use case described in Figure 2.3	16
Figure 2.5: STD representing the Style menu (Apperley & Spence, 1989)	18
Figure 2.6: Petri net representing the Style menu	19
Figure 2.7: Statechart representing the Style menu	21
Figure 2.8: Lean Cuisine in action (Apperley & Spence, 1989)	23
Figure 3.1: The base diagram for the Finder case study	26
Figure 3.2: The selection trigger layer for the Finder case study	28
Figure 3.3: The option precondition layer for the Finder case study	29
Figure 3.4: The existence dependency layer for the Finder case study	30
Figure 3.5: One of the task sequences for the Finder case study	31
Figure 3.6: Objects and actions in a subdialogue tree	33
Figure 3.7: Conditions have replaced option preconditions	34
Figure 3.8: Different ways of displaying conditions	35
Figure 3.9: Three views of the same dialogue	36
Figure 3.10: Lean Cuisine+ diagram for some commands in a simple word processor	36
Figure 3.1: (repeated in order to easily compare with Figure 3.1.1)	38
Figure 3.11: The same dialogue tree as Figure 3.1 using modified Lean Cuisine+	38
Figure 3.12: An example showing changes to the task sequence notation	39
Figure 3.13: The Lean Cuisine+ tree diagram for the washing machine	41
Figure 3.14: Example conditions in the tree diagram for the washing machine	42
Figure 3.15: Example selection triggers for the washing machine	42
Figure 3.16: An example task sequence for the washing machine	43
Figure 4.1: An example UML use case diagram	47
Figure 4.2: An example UML class diagram	48
Figure 4.3: An example UML object diagram	49
Figure 4.4: An example UML collaboration diagram	50
Figure 4.5: An example UML sequence diagram	51
Figure 4.6: An example UML activity diagram	52
Figure 4.7: UML notation for a class with an interface – a lollipop	57
Figure 4.8: UML activity diagram for opening a folder	61
Figure 4.9: Lean Cuisine+ task sequence for opening a folder	61

Figure 5.1: UML use case diagram for the Library Catalogue	66
Figure 5.2: Textual description for the <i>Search for Book</i> use case	67
Figure 5.3: Textual description for the <i>Request Book</i> use case	67
Figure 5.4: Textual description for the <i>View User Lending Record</i> use case	68
Figure 5.5: Textual description for the <i>Identify Library User</i> use case	68
Figure 5.6: The domain classes for the Library Catalogue	69
Figure 5.7: First draft of the basic Lean Cuisine+ diagram for the Library Catalogue	71
Figure 5.8: First draft of the task sequence for <i>Search for Book</i>	72
Figure 5.9: First draft of the task sequence for <i>Request Book</i>	73
Figure 5.10: First draft of the task sequence for <i>View User Lending Record</i>	73
Figure 5.11: The refined tree structure for the Library Catalogue	75
Figure 5.12: Selection triggers and meneme designators for the Library Catalogue	76
Figure 5.13: Revised task sequence for <i>Search for Book</i>	77
Figure 5.14: Revised task sequence for <i>Request Book</i>	78
Figure 5.15: Revised task sequence for <i>View User Lending Record</i>	78
Figure 5.16: A shortened form of the task sequence for <i>Search for Book</i>	79
Figure 5.17: UML use case diagram for the Timetable Viewer	81
Figure 5.18: Textual description for the <i>Create Student Timetable</i> use case	81
Figure 5.19: Textual description for the <i>Check for Clashes</i> use case	82
Figure 5.20: Textual description for the <i>Create Room Timetable</i> use case	82
Figure 5.21: Textual description for the <i>Check for Double Bookings</i> use case	83
Figure 5.22: Domain classes for the Timetable Viewer	83
Figure 5.23: First draft of the basic Lean Cuisine+ diagram for the Timetable Viewer	84
Figure 5.24: First draft of the task sequence for <i>Create Student Timetable</i>	85
Figure 5.25: First draft of the task sequence for <i>Check for Clashes</i>	85
Figure 5.26: First draft of the task sequence for <i>Create Room Timetable</i>	86
Figure 5.27: First draft of the task sequence for <i>Check for Double Bookings</i>	86
Figure 5.28: The refined tree structure for the Timetable Viewer	87
Figure 5.29: Selection triggers and meneme designators for the Timetable Viewer	87
Figure 5.30: Revised task sequence for <i>Create Student Timetable</i>	88
Figure 5.31: Revised task sequence for <i>Check for Clashes</i>	88
Figure 5.32: Revised task sequence for <i>Create Room Timetable</i>	89
Figure 5.33: Revised task sequence for <i>Check for Double Bookings</i>	89
Figure 6.1: Before (a) and after (b) moving Meneme 3	93
Figure 6.2: SELCU in action	95
Figure 6.3: The SELCU View menu	96

Figure 6.4: Lean Cuisine+ diagram for the SELCU View menu	97
Figure 6.5: A small Lean Cuisine+ example showing conditions and triggers	98
Figure 6.6: The example from Figure 6.5 showing a task sequence	99
Figure 6.7: Before (a) and after (b) constructing a new subdialogue	105
Figure 6.8: Before (a) and after (b) constructing a new task sequence	105
Figure 6.9: The first level of new menemes is created	108
Figure 6.10: Menemes are named and virtual menemes are identified	108
Figure 6.11: The first subdialogue is constructed	109
Figure 6.12: The completed tree structure	109
Figure 6.13: Triggers, conditions and meneme designators	109
Figure 6.14: Revised task sequence for <i>View User Lending Record</i>	110
Figure 7.1: The Search Card in the Property Stack	113
Figure 7.2: User options and system responses for each card type in the Property Stack	114
Figure 7.3: Part of the script information for the Search Card in the Property Stack	115
Figure 7.4: Lean Cuisine+ diagram for the Property Stack	116
Figure 7.5: The Delphi ATM Withdrawal screen	117
Figure 7.6: Lean Cuisine+ diagram for the ATM	118
Figure 7.7: Executing Lean Cuisine+ specifications	120