

SEMIOTICS IN INFORMATION SYSTEMS ENGINEERING

KECHENG LIU holds a chair of Computing Science at the School of Computing, Staffordshire University. He leads a research group on semiotics for information systems. He has created the research (specialist) award of Information Systems with Semiotics, the first of this type in the United Kingdom.

Dr Liu first worked in the Commission for Integrated Survey, China State Planning Committee and Chinese Academy of Sciences. As a programmer and later systems analyst designer, he was involved in and led a number of projects of developing information systems for regional planning and development purposes. Originally trained as a computer scientist in his university education in China, his postgraduate and doctorate education has been shifted towards management and business systems; both of them were received in the Netherlands. He is one of the main contributors to an information systems methodology, MEASUR (Methods for Eliciting, Analysis and Specifying Users' Requirements).

Dr Liu's work is found in various computing areas, such as information systems methodologies, requirements studies, information systems engineering, human-computer communication and collaborative work.

Cambridge University Press
0521593352 - Semiotics in Information Systems Engineering
Kecheng Liu
Frontmatter
[More information](#)

SEMIOTICS IN INFORMATION SYSTEMS ENGINEERING

KECHENG LIU
Staffordshire University



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press
0521593352 - Semiotics in Information Systems Engineering
Kecheng Liu
Frontmatter
[More information](#)

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge, CB2 2RU, UK <http://www.cup.cam.ac.uk>
40 West 20th Street, New York, NY 10011-4211, USA <http://www.cup.org>
10 Stamford Road, Oakleigh, Melbourne 3166, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain

© Cambridge University Press 2000

This book is in copyright. Subject to statutory exception
and to the provisions of relevant collective licensing agreements,
no reproduction of any part may take place without
the written permission of Cambridge University Press.

First published 2000

Printed in the United Kingdom at the University Press, Cambridge

Typeface Times NR MT 10/13pt. *System* QuarkXPress™ [SE]

A catalogue record for this book is available from the British Library

ISBN 0 521 59335 2 hardback

Cambridge University Press
0521593352 - Semiotics in Information Systems Engineering
Kecheng Liu
Frontmatter
[More information](#)

To Lily and Jimmy
Their love is my drive

Contents

<i>Preface</i>	<i>page xi</i>
1 Introduction	1
1.1 Information and information systems	1
1.2 Problems and challenges in information systems	2
1.3 Approaches and methods for information systems development	5
1.4 MEASUR: a semiotic approach to information systems	7
1.5 About this book	8
Part one Semiotic framework and methods	11
2 Understanding semiotics	13
2.1 Signs and their functions	13
2.2 Semiosis and learning	15
2.3 Semiotics in computing	17
2.4 Semiotics in organisations and information systems	19
3 A semiotic framework for information systems	21
3.1 Philosophical stance	21
3.1.1 Objectivist paradigm	21
3.1.2 Subjectivist paradigm	24
3.1.3 Radical subjectivist paradigm	26
3.2 The semiotic framework	26
3.2.1 Physics	27
3.2.2 Empirics	28
3.2.3 Syntactics	29
3.2.4 Semantics	30
3.2.5 Pragmatics	31
3.2.6 The social level	33
3.3 An example of semiotic analysis	35
4 A semiotic approach to information systems development	37

viii	<i>Contents</i>	
	4.1 MEASUR	37
	4.2 How MEASUR can help in information systems development	39
	4.2.1 Infrastructure analysis	40
	4.2.2 Systems analysis, design and implementation	46
	4.3 Summary	47
5	Knowledge representation and information analysis	49
	5.1 Some basic considerations in knowledge representation	50
	5.1.1 Expressive adequacy and notional efficiency	50
	5.1.2 Semantic primitives	50
	5.1.3 Types of knowledge	51
	5.2 Representation approaches	52
	5.2.1 Typical examples	52
	5.2.2 Conceptual graphs	54
	5.3 Some fundamental issues of information analysis	56
	5.4 The role of information analysis	58
6	Semantic Analysis	61
	6.1 Theoretical aspects of Semantic Analysis	61
	6.1.1 Affordances	61
	6.1.2 Ontology and some other fundamental notions	63
	6.2 NORMA	64
	6.2.1 Well-formed formula	65
	6.2.2 Affordance and ontological dependency	65
	6.2.3 Semiotic behaviour	67
	6.2.4 Time	67
	6.2.5 Determiner and identity	68
	6.2.6 Generic-specific relationship	68
	6.2.7 Defining authority and responsibility	69
	6.2.8 Graphic representation – ontology chart	69
	6.3 Using LEGOL to specify Norms	71
	6.4 Conducting a Semantic Analysis	73
	6.4.1 Understand the problem domain	74
	6.4.2 Generating candidate affordances	75
	6.4.3 Candidate grouping	76
	6.4.4 Ontology charting	78
	6.4.5 Norm Analysis	79
	6.5 Commentary on Semantic Analysis	80
7	Pragmatics and communication	82
	7.1 Human communication	82

<i>Contents</i>	ix
7.2 Other approaches to communication	83
7.2.1 Speech Act Theory	83
7.2.2 Functional approach	86
7.2.3 Deontic logic for communication	89
7.3 Pragmatic aspect of human communication	94
7.4 The Norm Analysis method	98
7.4.1 The concept of norms	98
7.4.2 Norms in business organisations	100
7.4.3 Norm Analysis	102
7.4.4 Norms in computer systems	106
8 The social layer: modelling organisations as information systems	108
8.1 Organisations as information systems	109
8.2 The notion of responsibility	111
8.3 An organisational morphology	112
8.4 Modelling the organisation	113
8.5 Summary: requirements for an effective information modelling method	114
Part two Applications	117
9 From semiotic analysis to systems design	119
9.1 The semantic aspect of databases	119
9.2 Capturing the semantic aspect	120
9.3 Capturing the time aspect	121
9.4 Ontological modelling for conceptualisation	123
9.5 Intentions, propositional attitudes and consequent operations	124
9.6 Other aspects of databases: facts, beliefs, and knowledge	125
10 Semantic temporal databases	133
10.1 Databases	133
10.1.1 Developments in database management systems	133
10.1.2 Semantic temporal databases	136
10.2 The semantic templates	138
10.2.1 Defining a semantic template	138
10.2.2 ST for database design	139
10.3 Systems construction	142
10.4 LEGOL	143
10.4.1 Basic syntactic structure	143
10.4.2 Some important operations	145

11	Normbase: a new approach to information management	150
11.1	The Normbase concept	150
11.2	The Normbase system	152
11.2.1	The Normbase engine	152
11.2.2	The semantic temporal database	154
11.2.3	The norm store	155
11.3	Information management with the Normbase system	156
11.4	Using semiotic methods with other approaches	157
11.4.1	Relational database for implementation	158
11.4.2	Object-oriented methods for design and implementation	159
12	Case study: development of a land resources information system	164
12.1	Background	164
12.2	Semantic Analysis for requirements modelling	165
12.3	Norm Analysis	171
12.4	System design and implementation in the Normbase approach	174
12.5	Discussions and conclusions	179
13	Case study: development of a test construction system	180
13.1	Background	180
13.1.1	CONTEST project	180
13.1.2	User requirements	181
13.1.3	Why choose Semantic Analysis?	184
13.2	System analysis	186
13.3	System design	190
13.4	System construction	194
13.5	Discussion and conclusions	194
	Appendix A Semantic templates and surrogate specification	196
A.1	Definition of ST	196
A.2	Examples of using ST in discourse modelling	197
A.3	Examples of surrogates	199
	Appendix B LEGOL applications in the CRIS case	201
B.1	Questions and LEGOL statements	201
B.2	Output from the Normbase	203
	<i>Bibliography</i>	208
	<i>Index</i>	217

Preface

Information systems are a multi-disciplinary subject, whose objects of study are information and its functions, information technology and its use in organisational contexts. For nearly three decades, scholars and practitioners have been pursuing effective paradigms, approaches, methods and techniques for developing and engineering information systems. The book is intended to contribute to this direction.

The research work on which the book is based began in 1989 in Twente University, the Netherlands, where I joined a team led by Professor Ronald Stamper. The team has been preoccupied by a series of philosophical and methodological investigations into information systems for a long time. My work at that time, with a focus on information modelling, was just a part of the large programme entitled MEASUR.

The research programme began in 1973, marked by Stamper's book on information. It was first called LEGOL, which aimed to deliver a set of legally oriented techniques for requirements specification. It soon extended into a research effort into Methods for Eliciting, Analysing and Specifying Users' Requirements (hence MEASUR). In the last ten years, the programme has further expanded into a set of methods to deal with all aspects of information systems. The theory of organisational semiotics is a key foundation for the methods and techniques developed within MEASUR. These methods and techniques enable one to understand and articulate the business problem and its context under the study, to capture semantics and intentions of users in requirement models, and also to implement technical information systems that are flexible and adaptable to the organisational change.

This book focuses on the requirements engineering and development of IT-based systems. After introducing basic principles of semiotics and the relevance to information systems, the book presents the methods for

requirements analysis and modelling, and techniques for implementing technical systems. Finally, the last part of the book demonstrates the application of these methods and techniques through a number of case studies.

I am deeply indebted to Ronald Stamper, my mentor and a true hero, who has introduced me to this fascinating semiotic perspective of information systems. Thanks are also due to Peter Andersen and Rodney Clarke, with whom I have had inspiring discussions in the last few years on a number of occasions.

Since I joined Staffordshire University in 1993, I have been working with a team of colleagues in a number of projects, including knowledge sharing, information infrastructure, collaborative and software agent-based information systems and electronic commerce. One particular project is on requirements recovery in legacy systems re-engineering. I am grateful to my colleagues in this team with whom I have had many opportunities to discuss the ideas and apply these methods to various research problems: Albert Alderson, Alan Dix, Hanifa Shah, Bernadette Sharp, Dave Brunskill, Sue Blakey and Geoff Crum.

A research-based master's course of Information Systems and Semiotics, the first of this kind, was launched two years ago at Stafford. I must acknowledge the students on this course and my other PhD students for their enthusiasm in their exploring the relevance and power of semiotic methods to their research work. Their feedback has been highly valued.

I would like to thank David Tranah of CUP, and Peter Jackson, my copy editor, for making this book possible; particularly for Peter's thorough and rigorous editing, which has made this book a smooth and pleasant read!

KL
Stafford