

Contents

Introduction	ix
 The Specification Statement	
<i>Carroll Morgan</i>	1
1 Introduction	1
2 Specification statements	3
3 The implementation ordering	7
4 Suitability of the definitions	8
5 Using specification statements	10
6 Miracles	12
7 Guarded commands are miracles	14
8 Positive applications of miracles	16
9 Conclusion	19
10 Acknowledgements	20
 Specification Statements and Refinement	
<i>Carroll Morgan and Ken Robinson</i>	23
1 Introduction	23
2 The refinement theorems	31
3 The refinement calculus	32
4 An example: square root	37
5 Derivation of laws	41
6 Conclusion	44
7 Acknowledgements	45
 Procedures, Parameters, and Abstraction:	
Separate Concerns	
<i>Carroll Morgan</i>	47
1 Introduction	47
2 Procedure call	48
3 Procedural abstraction	49
4 Parameters	51
5 Conclusion	58
6 Acknowledgements	58

Data Refinement by Miracles

<i>Carroll Morgan</i>	59
1 Introduction	59
2 An abstract program	60
3 A difficult data refinement	61
4 Miraculous programs	61
5 Eliminating miracles	62
6 Conclusion	63
7 Acknowledgements	64

Auxiliary Variables in Data Refinement

<i>Carroll Morgan</i>	65
1 Introduction	65
2 The direct technique	66
3 The auxiliary variable technique	66
4 The correspondence	67
5 Conclusion	69
6 Acknowledgements	70

Data Refinement of Predicate Transformers

<i>Paul Gardiner and Carroll Morgan</i>	71
1 Introduction	71
2 Predicate transformers	72
3 Algorithmic refinement of predicate transformers	74
4 Data refinement of predicate transformers	74
5 The programming language	76
6 Distribution of data refinement	79
7 Data refinement of specifications	81
8 Data refinement in practice	82
9 Conclusions	83
10 Acknowledgements	84

Data Refinement by Calculation

<i>Carroll Morgan and Paul Gardiner</i>	85
1 Introduction	85
2 Refinement	86
3 Language extensions	90
4 Data refinement calculators	92
5 Example of refinement: the “mean” module	96
6 Specialized techniques	101
7 Conclusions	107
8 Acknowledgements	108
9 Appendix: refinement laws	108

A Single Complete Rule for Data Refinement	
<i>Paul Gardiner and Carroll Morgan</i>	111
1 Introduction	111
2 Data refinement	112
3 Predicate transformers	115
4 Completeness	116
5 Soundness	118
6 Partial programs	120
7 An example	123
8 Conclusion	125
9 Acknowledgements	126
 Types and Invariants in the Refinement Calculus	
<i>Carroll Morgan and Trevor Vickers</i>	127
1 Introduction	127
2 Invariant semantics	128
3 The refinement calculus	129
4 A development method	133
5 Laws for local invariants	135
6 Eliminating local invariants	137
7 Type-checking	139
8 Recursion	141
9 Examples	143
10 A discussion of motives	150
11 Related work	151
12 Conclusions	152
Acknowledgements	153
A Additional refinement laws	153
 References	155
 Authors' Addresses	159