Table of Contents

1 Introduction 1

1.1 Motivation 1

1.2 Creativity in Education 3

1.3 IT in the Educational Context and its Suitability for Creative Learning 5

1.4 Creation of Games, Creative Learning and Tangible User Interfaces 10

1.5 Problem Statement 13

1.6 Overall Aim and Objectives 15

1.7 Research Methodology 16

1.8 Research Hypothesis 17

1.9 Outline of the Thesis 18

2 State of the Art 21

2.1 Introduction 21

2.2 Related Work 22

2.2.1 Supporting Programming and Performing in a Pre-established World 22

2.2.2 Creating Characters for an Ecosystem World 27

2.2.3 Advanced Platforms to Create Game based Ecosystems by Programmers 30

2.3 Feature Based Comparison 33

3 A Model Supporting Physically-Based 2D Ecosystems to Foster Creativity 39

3.1 Introduction 39

3.2 Model Requirements: Editing and Simulating 42

3.3 Ecosystem Model 43

3.4 Entity Model 44
3.5 Physically-based Entities 46
3.6 Exploring Creativity in Collaborative Construction Tasks 55
3.6.1 Creativity Assessment Model 55
3.6.2 Creativity Tangible Simulator Component 60
3.6.3 Experimental Evaluation 63
3.6.4 Overall Discussion 83
3.7 Conclusions 86
4 A Model of Reactive Entities Based on DataFlow Enhanced Rules 87
4.1 Introduction 87
4.2 Rule-based Behavior 89
4.3 A Generic DataFlow Model 93
4.4 User based Study on DataFlow Comprehension 98
4.4.1 Participants 98
4.4.2 Materials 100
4.4.3 Method and Procedure 103
4.4.4 Task 103
4.4.5 Results and Discussion 103
4.5 A Tabletop Based Rule Editor 110
4.5.1 Tabletop Design 110
4.5.2 Implementation 112
4.6 Conclusions 113
5 Surface Interaction Toolkit Support 115
5.1 Tangible Surface Interfaces 115
5.2 Touch Technologies 118
5.2.1 Microsoft Surface 122
5.3 User Interface Controls 124

5.3.1 Basic controls 125
5.3.2 Input Management 129
5.3.3 Complex controls 131
5.4 TangiWheel: A Hybrid Design for Collection Exploration 134
5.4.1 A Survey on Widgets for Collection Manipulation 135
5.4.2 Design Discussion 141
5.5 Experimental Evaluation of TangiWheel 149
5.5.1 Participants 151
5.5.2 Equipment 151
5.5.3 Method 151
5.5.4 Experiment 1: Acquisition and Basic Manipulation 154
5.5.5 Experiment 2: Match to Sample (MTS) 156
5.5.6 Experiment 3: Series Edition 160
5.5.7 Questionnaire Results 166
5.6 Conclusions 171
6 Simulation Middleware 175
6.1 Introduction 175
6.2 Meta-Object Instantiation 176
6.2.1 Type System 176
6.2.2 Event System 179
6.2.3 Property Definitions 179
6.2.4 Actions Library 181
6.2.5 Data Processors 182
6.3 Ecosystem Enactment 183
6.4 Meta-Model Performance Verification 188
6.5 Physics Simulation Stress Test 192
6.6 Case Studies 193
6.6.1 A Pong-like Ecosystem 193

6.6.2 An Asteroids Ecosystem....201
6.7 Conclusion....207
7 Conclusions....209
7.1 Summary....209
7.2 Results of the Thesis....213
7.3 Acknowledgements....214
7.4 Further Research....215
Appendix A. Experiments on Creativity....217
Appendix B. DataFlow Comprehension....227
Appendix C. Pong AGORAS Specification....253
Appendix D. Asteroids AGORAS Specification....263
8 References....281