

Table of contents

List of Figures	vi
List of tables	viii
Preface	ix
Acknowledgements	x
1 Introduction	1
1.1 Research motivation	1
1.2 Research objectives	2
1.3 Scope of research	3
1.4 Methodology	4
1.4.1 Conceptual level	5
1.4.2 Operational level	5
1.4.3 Implementation level	5
1.5 Structure of the book	5
2 Three-dimensional GIS and Excavation	7
2.1 3D GIS modelling of complex environments and processes: the state of the art	8
2.1.1 Geological modelling and the petroleum industry	8
2.1.2 Environmental modelling	8
2.1.3 Urban planning	10
2.1.4 Advantages and potentials of using 3D GIS for modelling complex phenomena	10
2.2 3D GIS: a working definition	11
2.3 Modelling and three-dimensional GIS for archaeological excavation	12
2.3.1 Models and modelling: a terminological clarification	13
2.3.2 Abstraction processes: from the field to the computer	13
2.3.3 Modelling archaeological subsurface data with 3D GIS: terms of reference	14
2.3.4 The construction and meaning of the archaeological data model	14
2.3.5 Multiple representations as a solution to model complex data	15
2.4 The state of art in the development of three-dimensional intra-site GIS: archaeological challenges and technical solutions	15
2.4.1 Early case studies of three-dimensional modelling for archaeological excavation	16
2.4.2 Two-and-a-half-dimensional modelling	19
2.4.3 Three-dimensional GIS for excavation: two procedures for reconstructing stratigraphy	22
2.4.4 From explorative visualisation to spatial patterning 3D GIS with a view	27
2.4.5 Towards dedicated 3D GIS architectures	30
2.4.6 Conclusion	31
2.5 Summary	32
3 Fundamentals of 3D Modelling and Visualisation within a GIS Environment	33
3.1 GIS models	33
3.1.1 What do GIS model? The representation of spatial data	33
3.1.2 Data structures: raster and vector. A debate or reconciliation?	34
3.1.3 Spatial and non-spatial attributes	36
3.1.4 GIS functions	36

3.2	Three-dimensional modelling in GIS	40
3.2.1	Review of representations and data models for 3D GIS	40
3.2.2	The construction and structuring of three-dimensional spatial models	42
3.2.3	Three-dimensional spatial models and their semantics – from geometry to topology	43
3.2.4	Three-dimensional GIS: analytical functionality requirements in a three-dimensional model	47
3.2.5	Summary	50
3.3	Three-dimensional visualisation	50
3.3.1	The role of visualisation in a 3D GIS environment	50
3.3.2	Visualisation and archaeological excavation	51
3.3.3	Visualisation requirements and technical issues	53
3.3.4	Summary and remarks	53
3.4	Conclusion	54
4	Making Visible: Archaeological Excavation in Three Dimensions	55
4.1	What is left to say?	55
4.1.1	Geometry and the space of excavation	55
4.1.2	Material and immaterial	56
4.1.3	Many places, many spaces	59
4.2	The production of archaeological space	59
4.3	Space in archaeological GIS	61
4.4	Critique and reassessment of some concepts used in excavation practice	61
4.4.1	On stratigraphy	62
4.4.2	On surface and depth	62
4.4.3	On lines, grids and objects	64
4.4.4	On mapping	64
4.4.5	On mimics	65
4.5	Reasoning about 3D archaeological space in a GIS framework	66
4.6	Concluding thoughts	68
5	Conceptual Design and Operational Framework	69
5.1	Designing and implementing data models in GIS: concepts and terminology	69
5.1.1	Design phases in modelling	69
5.1.2	The design process of the project	72
5.2	The conceptual framework	72
5.2.1	Conceptual framework: rationale of the system	73
5.2.2	The 3D spatio-temporal framework: underlying principles	74
5.2.3	The framework illustrated	75
5.3	The data model schema: design principles	77
5.3.1	Design concept 1. Use of a three-dimensional GIS	77
5.3.2	Design concept 2. Matters of scale: modelling sitescapes through time	77
5.3.3	Design concept 3. Information integration	80
5.3.4	Design concept 4. Representation of field-based and object-base excavation	81
5.3.5	Design concept 5. Expressing and extracting different information	82
5.3.6	Design concept 6. Connecting GIS and process/simulation models	83
5.4	Data model workflow and system architecture	83
5.4.1	Notes on the chosen system architecture	83
5.4.2	Primary observations database and data pre-processing	84
5.4.3	Creating three-dimensional primary and derived models	86
5.4.4	Model visualisation and assessment	96
5.5	Conclusions	96

6	Making Practical: Examples of Intra-site 3D GIS	99
6.1	The Kouphovouno project	99
6.1.1	Background	99
6.1.2	Excavation procedures	101
6.1.3	Data collection: procedures for recording three-dimensional shapes and relationships	101
6.2	The building of the excavation three-dimensional base model	106
6.2.1	Geometric model of contexts	106
6.2.2	Geometric modelling of post-holes	108
6.3	Analytical potential and limitations of context-based excavation in 3D	111
6.4	Considerations on three-dimensional GIS and stratigraphic excavations	113
6.5	The rescue excavation at Hoge Vaart	114
6.5.1	Background	114
6.5.2	Data collection	115
6.5.3	Palaeo-geological setting and chronology	119
6.5.4	Spatial processes examined at Hoge Vaart	119
6.6	Taking Hoge Vaart into the third dimension: the approach	121
6.6.1	Reassessing Hoge Vaart within a three-dimensional framework: data retrieval and preliminary evaluation	121
6.6.2	Formation processes and GIS modelling at macro-scale	123
6.6.3	Three-dimensional GIS analysis and visualisation at meso- and micro-level	131
6.7	Summary of the Hoge Vaart case study	149
6.8	Summary	150
7	Conclusions and Further Research	151
7.1	Summary	151
7.2	Conclusions	152
7.3	Further research	154
	Glossary	155
	References	161