Geodesign 111

Danbi J. Lee
Eduardo Dias
Henk J. Scholten *Editors*

Geodesign by Integrating Design and Geospatial Sciences

Springer

Geodesign by Integrating Design and Geospatial Sciences

More information about this series at http://www.springer.com/series/13477

Danbi J. Lee • Eduardo Dias • Henk J. Scholten
Editors

Geodesign by Integrating Design and Geospatial Sciences

Springer

Editors
Danbi J. Lee
Department of Spatial Economics, SPINlab
VU University Amsterdam
Amsterdam
The Netherlands

Henk J. Scholten
Department of Spatial Economics, SPINlab
VU University Amsterdam
Amsterdam
The Netherlands

Eduardo Dias
Department of Spatial Economics, SPINlab
VU University Amsterdam
Amsterdam
The Netherlands

Series Title ISSN 0924-5499 ISSN 2215-0072 (electronic)
Subseries Title ISSN 2405-4828 ISSN 2405-4836 (electronic)
ISBN 978-3-319-08298-1 ISBN 978-3-319-08299-8 (eBook)
DOI 10.1007/978-3-319-08299-8
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014946298

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

By Henk J. Scholten and Jack Dangermond

The first GIS Summer Institute was held in Amsterdam in August 1989 at the School of Architecture, Town Planning, and Landscape. The Institute's work foresaw the evolution into a digitized world and the adoption of computerized spatial analysis. 22 years later, two of the original participants from that event, Henk Scholten and Jack Dangermond, met again. At that meeting, Jack told Henk about his past professor, Carl Steinitz, who was writing a book about geodesign.

It was an inspiring new concept; a new perspective on an old and familiar problem. In the geodesign framework long-term models are coupled with short-term (impact) models. In its vision, spatial planners should use the outcomes of the long-term models to assess whether the developments occurring in a region necessitate intervention. If true, several solutions to the encountered issues are almost always available. The most promising solutions are worked out in scenarios and the effects are calculated using the impact models. This provides the possibility to test whether the planners' intended goals are attained and what negative effects might occur. If the outcomes are unsatisfactory, go back a step and try again.

In a way, this process is what we are doing today with geodesign. It is a framework for how we can design together to solve complex problems. We step back, using traditional techniques of spatial analysis and modeling, in order to step forth towards innovative technologies and collaboration frameworks.

Our world faces serious challenges, and it's clear that we need to work together to collectively create a better future. We need to leverage our very best brains, our best creative talent, our best design talent, and our best science, and use all of these combined to create a better future. To meet the geographic challenges we face, we need to grow geodesign from a concept understood by a few to a framework used by all. We need to inform the world about the value of geodesign, while at the same time making it easy to implement and use throughout organizations and across society.

Inspired by the successes of Geodesign Summits by Esri in Redlands, California, we organized the first Geodesign Summit in Europe in September of 2013. Designers, planners and geospatial scientists from around the world gathered to share ideas on how to design with spatial information in Europe. This book is testament to the momentum that geodesign is gaining both academically and professionally.

We're confident that through the continued good work of many, geodesign will in due course be widely adopted and recognized as one of the most important ideas to come out of this century.

Acknowledgments

Great thanks are owed to the speakers and participants at the 2013 Geodesign Summit Europe and especially the authors of this book, who graciously agreed to share their geodesign experiences to the world. This book was made possible only through the hard work and support of the VerDuS-programme ('Verbinding Duurzame Steden') of the Netherlands Organization for Scientific Research (NWO), the VU University Amsterdam, Geodan, Esri Europe, Esri Headquarters, and the GeoFort.

Contents

Part I Introduction

1 Introduction to Geodesign Developments in Europe 3
Danbi J. Lee, Eduardo Dias and Henk J. Scholten

2 Which Way of Designing? 11
Carl Steinitz

Part II Resilience and Sustainability

3 Energy Resilient Urban Planning 43
Perry Pei-Ju Yang

4 PICO: A Framework for Sustainable Energy Design 55
Steven Fruijtier, Sanneke van Asselen, Sanne Hettinga and Maarten Krieckaert

5 Holistic Assessment of Spatial Policies for Sustainable Management: Case Study of Wroclaw Larger Urban Zone (Poland) 71
Jan Kazak, Szymon Szewranski and Pawel Decewicz

6 Recent Applications of a Land-use Change Model in Support of Sustainable Urban Development 87
Eric Koomen and Bart C. Rijken

7 Using Geodesign to Develop a Spatial Adaptation Strategy for Friesland 103
Ron Janssen, Tessa Eikelboom, Jos Verhoeven and Karlijn Brouns

8 Geodesign to Support Multi-level Safety Policy for Flood Management 117
Sanneke van Asselen, Henk J. Scholten and Luc Koshiek

9 The Multi-Layer Safety Approach and Geodesign: Exploring Exposure and Vulnerability to Flooding 133
Mark Zandvoort and Maarten J. van der Vlist

10 Interactive Spatial Decision Support for Agroforestry Management 149
André Freitas, Eduardo Dias, Vasco Diogo and Willie Smits

Part III Heritage and Placemaking

11 History Matters: The Temporal and Social Dimension of Geodesign 173
Jan Kolen, Niels van Manen and Maurice de Kleijn

12 Urban Landscape archaeology, geodesign and the city of rome 183
Gert-Jan Burgers, Maurice de Kleijn and Niels van Manen

13 GIS-based Landscape Design Research: Exploring Aspects of Visibility in Landscape Architectonic Compositions 193
Steffen Nijhuis

14 3D LOS Visibility Analysis Model: Incorporating Quantitative/ Qualitative Aspects in Urban Environments 219
Dafna Fisher-Gewirtzman

15 Space Syntax in Theory and Practice 237
Akkelies van Nes

16 A Standard-based Framework for Real-time 3D Large-scale Geospatial Data Generation and Visualisation over the Web 259
Massimo Rumor, Eduard Roccatello and Alessandra Scottà

17 Crowd Sourced Public Participation of City Building 271
Ana Sanchis, Laura Díaz, Michael Gould and Joaquín Huerta

Part IV Adopting Geodesign Thinking

18 Geodesigning ‘From the Inside Out’ 287
Kitty Currier and Helen Couclelis

19 People Centered Geodesign: Results of an Exploration 299
Simeon Nedkov, Eduardo Dias and Marianne Linde

20 Enhancing Stakeholder Engagement: Understanding Organizational Change Principles for Geodesign Professionals 315
Lisa A. McElvaney and Kelleann Foster

21 Geodesign in Practice: What About the Urban Designers? 331
Peter Pelzer, Marco te Brömmelstroet and Stan Geertman

22 Open Geospending: Bridging the Gap Between Policy and the Real World 345
Egbert Jongsma

23 Towards Geodesign: Building New Education Programs and Audiences 357
John P. Wilson

Contributors

Sanneke van Asselen Geodan, Amsterdam, The Netherlands

Karlijn Brouns Ecology and Biodiversity, Utrecht University, Utrecht, The Netherlands

Gert-Jan Burgers Faculty of Arts, VU University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, The Netherlands

Helen Couclelis Department of Geography, Santa Barbara, CA, USA

Kitty Currier Department of Geography, Santa Barbara, CA, USA

Pawel Decewicz Center of Spatial Management, Warszawa, Poland

Eduardo Dias Faculty of Economics and Business Administration, Department of Spatial Economics, SPINlab, VU University Amsterdam, Amsterdam, The Netherlands

Geodan, Amsterdam, The Netherlands

Laura Díaz Institute of New Imaging Technologies, Universitat Jaume I, Castellón, Spain

Vasco Diogo Faculty of Economics and Business Administration, Department of Spatial Economics, SPINlab, VU University Amsterdam, Amsterdam, The Netherlands

Tessa Eikelboom Institute for Environmental Studies, VU University Amsterdam, Amsterdam, The Netherlands

Dafna Fisher-Gewirtzman Faculty of Architecture and Town Planning, Technion - Israel Institute of Technology, Haifa, Israel

Kelleann Foster College of Arts and Architecture, Pennsylvania State University, University Park, PA, USA

André Freitas Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal

Geodan S&R, Amsterdam, The Netherlands

Steven Fruijtier Geodan, Amsterdam, The Netherlands

Stan Geertman Urban and Regional research centre Utrecht (URU), Utrecht University, Utrecht, The Netherlands

Michael Gould Institute of New Imaging Technologies, Universitat Jaume I, Castellón, Spain

Sanne Hettinga Geodan, Amsterdam, The Netherlands

Joaquín Huerta Institute of New Imaging Technologies, Universitat Jaume I, Castellón, Spain

Ron Janssen Institute for Environmental Studies, VU University Amsterdam, Amsterdam, The Netherlands

Egbert Jongsma Netherlands Court of Audit, The Hague, Netherlands

Jan Kazak Wroclaw University of Environmental and Life Sciences, Wroclaw, Poland

Maurice de Kleijn Faculty of Economics and Business Administration, Spatial Economics, SPINlab, VU University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, The Netherlands

Jan Kolen Faculteit Archeologie & Centre for Global Heritage and Development (CGHD), Universiteit Leiden, Leiden, The Netherlands

Eric Koomen Faculty of Economics and Business Administration, Department of Spatial Economics, SPINlab, VU University Amsterdam, Amsterdam, The Netherlands

Luc Koshiek Bevelandseweg 1, Hoogheemraadschap Hollands Noorderkwartier, Heerhugowaard, The Netherlands

Maarten Krieckaert Geodan, Amsterdam, The Netherlands

Danbi J. Lee Department of Spatial Economics, SPINlab, VU University Amsterdam, Amsterdam, The Netherlands

Marianne Linde TNO Built Environment, Delft, The Netherlands

Niels van Manen Faculty of Economics and Business Administration, Spatial Economics, SPINlab, VU University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, The Netherlands

Lisa A. McElvaney Business Transformation Consulting, Redlands, CA, USA

Simeon Nedkov VU University Amsterdam, Amsterdam, The Netherlands

Steffen Nijhuis Faculty of Architecture and the Built Environment, Delft University of Technology, Delft, The Netherlands

Peter Pelzer Urban and Regional research centre Utrecht (URU), Utrecht University, Utrecht, The Netherlands

Bart C. Rijken Faculty of Economics and Business Administration, Department of Spatial Economics, VU University Amsterdam, Amsterdam, The Netherlands

PBL Netherlands Environmental Assessment Agency, The Hague, The Netherlands

Eduard Roccatello 3DGIS, Padua, Italy

Massimo Rumor University of Padua, 3DGIS, Padua, Italy

Ana Sanchis Institute of New Imaging Technologies, Universitat Jaume I, Castellón, Spain

Henk J. Scholten Faculty of Economics and Business Administration, Department of Spatial Economics, SPINlab, VU University Amsterdam, Netherlands

Geodan, Amsterdam, The Netherlands

Alessandra Scottà Geodan, Amsterdam, The Netherlands

Willie Smits Institute of Technology Minaesa (ITM Tomohon), Jl. Stadion Selatan Walian, Tomohon, Sulawesi Utara, Indonesia

Carl Steinitz Harvard Graduate School of Design, Harvard University, Cambridge, MA, USA

Szymon Szewranski Wroclaw University of Environmental and Life Sciences, Wroclaw, Poland

Marco te Brömmelstroet Amsterdam Institute for Social Science Research (AISSR), University of Amsterdam, Amsterdam, The Netherlands

Sanneke van Asselen President Kennedylaan 1, Geodan, Amsterdam, The Netherlands

Maarten J. van der Vlist Wageningen UR Landscape Architecture Group, Rijkswaterstaat, Wageningen, The Netherlands

Akkelies van Nes Faculty of Architecture, Delft University of Technology, Delft, The Netherlands

Jos Verhoeven Ecology and Biodiversity, Utrecht University, Utrecht, The Netherlands

John P. Wilson Spatial Sciences Institute, University of Southern California, Los Angeles, CA, USA

Perry Pei-Ju Yang School of City and Regional Planning and School of Architecture, College of Architecture, Georgia Institute of Technology, Atlanta, USA

Mark Zandvoort Wageningen UR Landscape Architecture Group, Wageningen, The Netherlands

Part I
Introduction

Chapter 1
Introduction to Geodesign Developments in Europe

Danbi J. Lee, Eduardo Dias and Henk J. Scholten

1.1 When Geodesign Crosses over the Atlantic

In 1985 the Dutch National Planning Department was charged with the formidable task of drawing up a new masterplan describing the National Spatial Policy. This resulted in the creation of the Fourth Note on Spatial Planning (Vierde Nota over de Ruimtelijke Ordening). Naturally, the best known and most experienced spatial planners and landscape architects were involved in drafting the document. For the first time in its history a working group was tasked with the preparation of a spatial information system (Scheurwater 1984) which lead to the acquisition and implementation of the first GIS application in Europe, namely Esri's ArcGIS 3.0. Up until that moment the term 'Geographical Information System' was little known in the Dutch language.

Although the Vierde Nota has become a zenith of Dutch spatial planning, and the first use of geographical information for a large scale spatial issue is considered a breakthrough, it presented a number of challenges (Scholten and Meijer 1988). It became apparent, for instance, that the viewpoints and culture represented in scientific models did not match those of planners and designers. It was also an interesting challenge to establish a comprehensive collection of digital geographical data of The Netherlands and its neighbouring countries.

Based on the experiences gained in drafting the Vierde Nota, the decision was made to host the first GIS Summer Institute in Amsterdam in August 1989. It was held in the 'Academie van Bouwkunst', the seventeenth century home of Amsterdam's School of Architecture, Town Planning and Landscape (Scholten and

D. J. Lee (✉) · E. Dias · H. J. Scholten
Faculty of Economics and Business Administration, Department of Spatial Economics, SPINlab, VU University Amsterdam, Amsterdam, The Netherlands
e-mail: danbi.lee@vu.nl

E. Dias
e-mail: ess580@vu.nl

H. J. Scholten
e-mail: h.j.scholten@vu.nl

D. J. Lee et al. (eds.), *Geodesign by Integrating Design and Geospatial Sciences,*
GeoJournal Library 1, DOI 10.1007/978-3-319-08299-8_1

Stillwell 1990). In his concluding remarks at the conference, Peter Nijkamp stated that he thought the term GIS would no longer be in use 20 years hence. He predicted that it would be replaced by so-called CIAs (Computerized Information Analysis) for urban and regional management. In his speech, Nijkamp touched on an issue that we still encounter today—the need for careful evaluation of alternative courses of action due to the high costs of misinformation (Nijkamp et al. 1990). In fact, several contributions from the 1990 proceedings put forward the notion that the differences between planners and analytical scientists and models are reflected by the distinctive systems they use, i.e. CAD versus GIS. Bridging the gap between these systems is seen as the main ambition of geodesign (see for example Wood 1990).

In 2013, the momentum for geodesign in Europe was earmarked by the first Geodesign Summit Europe, hosted by Esri, Geodan and the Vrije Universiteit Amsterdam at the GeoFort in the Netherlands. Researchers and planners from 28 different countries gathered over a few intensive days to discuss the way spatial issues should be approached in light of an extraordinarily digitized and technology-based world. The main difference with a quarter century ago was the growing request to connect scientific models of processes with proposed design solutions in order to understand design impact in a collaborative way between policy makers, scientists, designers, and citizens.

1.2 Geodesign as Concept, Method, and Product

Formal definitions of geodesign appear from around 2010 (e.g. Dangermond 2010; Flaxman 2010; Zwick 2010; Ervin 2011; Steinitz 2012). Brewed from these developments, we define geodesign to be an iterative design and planning method whereby an emerging solution is influenced by (scientific) geospatial knowledge derived from geospatial technologies. Whereas traditional planning and design processes separate context analysis, design, and evaluation into explicit steps, geodesign integrates the exploration of ideas with direct evaluation in the same moment, generating an advanced design solution. In other words, the design impact can be examined through geospatial technology (simulations, modeling, visualization, and communication of design impacts) and be immediately fed back into the evolution of a design. This yields a fitter, more robust and context-sensitive design solution. Geodesign enables systems-thinking, which makes it an attractive approach for today's complex, dynamic, and multi-disciplinary design challenges.

Some argue that geodesign is merely an alluring alias for design methods that have been practiced for many decades already. This is, to a degree, quite true if we dissect the components of our own definition and look at the series of events leading to this point. The academic discourse on spatial and context analysis using overlays began with the first hand drawn overlays documented by landscape designer Warren Henry Manning in the 1913 Billerica Town plan (see Steinitz et al. (1976) for an historical overview of hand drawn overlays) (Manning 1913). In the 1960s, marked by British–Canadian geographer Roger Tomlinson's development of the first geographic information system, the promise of digitized maps sparked a fantastic dream of computerized planning support. All the while, in 1965 American city planner Britton Harris proposed integrating ‘‘sketch planning’’ (as the drawing of alternatives) with state of the art analytical modeling to directly visualize the design implications (Harris 1965).

Scottish landscape architect McHarg’s (1971) seminal book Design with Nature elaborated the idea of an empirical layering of spatial information, and the early integration of scientific and regulatory information in the design phase to filter-out unwanted options. The Harvard Computer Graphics Lab was pioneer in this movement when Fisher (1966) demonstrated SYMAP could perform automated overlays. Steinitz then applied and developed SYMAP into planning applications (Sinton and Steinitz 1969). From there, other mapping and analysis tools emerged as the GIS field matured through the 1970s and 1980s. It strayed, however, from the design realm as designers faced barriers in adopting analytical tools with unfriendly user interfaces, difficulty in collecting spatial data and low computational power. Today, the advent of intuitive user interfaces, increased processing capabilities and wider availability of base datasets allow for the emergence of geodesign as it’s own field (Batty 2013; Dias et al. 2013).

The term ‘geodesign’ as an alias to these past efforts offers two strategic advantages. Firstly, as a moniker for a group of mutually dependent fields of research, it sets a new research agenda aiming to explore symbiotic outcomes between them (data visualization and participatory planning, for example). Geodesign is thus in its infancy relative to traditional sciences. It’s youth incites innovation through debate and dialog on what geodesign really means, which we hope is apparent in this book. More importantly, the journey through which we question and struggle with something apparently ‘new’ allows anyone to participate in the conversation. City planners, designers, architects, hydrologists, traffic engineers, first responders, public health officials, sociologists, biologists, computer scientists, politicians and citizens all have a stake in the future of geodesign for improving the way we plan, manage, develop, protect, and pay for our quality of life.

Secondly, we observe that as a consequence of academic exploration into geodesign, multiple disciplines take ownership of advancing geodesign theory. We hope to see an alignment in the way we work and think through design solutions collaboratively. This is ‘geodesign thinking’, akin to design thinking as explored by many cognitive scientists since the 1960s, except it has a specific geo-spatial requirement to the design problem at hand. By adding the ‘geo’ to ‘design’, barriers into the design world previously encountered by other disciplines are eroded. Design thinking as a problem-solving process becomes accessible, and the lines of communication between technocratic analysts, qualitative scientists, skillful designers, and local citizens become incredibly short.

For our European debut of geodesign (as relatively new concept), Professor Carl Steinitz’s chapter on the Redlands Experiment (Chap. 2) offers a comprehensive syllabus of his seminal work on the geodesign framework, with which many of our authors have aligned their own research. Steinitz’s framework forms the central discourse for exploring all the far corners of the geodesign world. He rightfully points out that all stakeholders should participate in answering the question “What if?”, which is the driver of every geodesign project. He demonstrates, that as an iterative and multi-disciplinary problem-solving method, it is fruitful for the process to result in many designs rather than ‘The Design’ and that by simply combining existing urban design and analysis skills with inventive spatial technologies and local citizens, we can generate a potent mix of problem-solving ability. It is the combination of ingenuity and skill with spatial technology that excites us and gives us a safe space to experiment and play with geodesign. This book offers a strategic glimpse into European geodesign innovations that embody this excitement and is supplemented by interesting case studies from the around the world.

1.3 Benchmarking Geodesign Innovations in Research and Practice

Stemming from a theoretical foundation set by Carl Steinitz, the next chapters showcase a plethora of practical applications (or aspirations) where geodesign thinking is beginning to emerge. In Part 2, the reader will explore ideas on how we measure and evaluate our efforts to build resilient and sustainable cities and regions. Coming from an urban designer’s perspective, Yang (Chap. 3) gives an eye-opening introduction to how we might visualize and evaluate the energy performance of cities, embedding Planning Support System (PSS) theory as a sister of geodesign. By framing urban energy problems as design problems he purports that energy solutions can be explored by altering urban block forms and observing changes in energy fluxes. In doing so, the designer introduces the much needed ‘science’ into their traditional design process. Fruijtier et al. (Chap. 4) discusses energy on a regional level in the Netherlands from a data management perspective, giving a clear overview of the system architecture and digital tools to be utilized in evaluating the feasibility of different regional energy scenarios, towards consensus-driven energy planning.

Regional sustainability can also be measured by evaluating the impact of different urban growth scenarios. In Kazak et al. (Chap. 5), the CommunityViz extension of Esri’s ArcGIS is assessed as a tool for evaluating the impact of spatial policies in Wroclaw, Poland (with and without densification), and found that even without a complex integration of sustainability indicators, policy-makers were better informed. Koomen and Rijken (Chap. 6) draw the same conclusion when undertaking a similar exercise using an interactive touch table with local stakeholders, using Friesland, the Netherlands as a case-study.

Regional resilience can be built by improving adaptability to natural disasters such as overland floods. Janssen et al. (Chap. 7), van Asselen et al. (Chap. 8) and Zandvoort and van der Vlist (Chap. 9) argue that the geodesign framework aligns neatly with a multi-layer safety approach to flood risk assessment and adaptation planning in the Netherlands. Vulnerability assessed by executing 3D flood models with different planning scenarios enables governing bodies to quickly assess new threats and react preemptively. This ability to evaluate and asses across aspects of economics, social and environmental impacts to guide decision-making is the same research agenda adopted by Freitas et al. (Chap. 10) who focus on sustainable agro-forestry (mixed-species) management practices in Borneo, Indonesia. They developed spatial 3D visualizations of the operational trade-offs of different agro-forestry practices, which they suggest will facilitate collaborative decision-making.

In Part 3 of the book, readers will enter the realm of placemaking, where culture, history, and the socio-economic matters of design problems collide. Kolen et al. (Chap. 11) and Burgers et al. (Chap. 12) introduce geodesign from a historian and archaeologist's perspective. They note that landscape history and archaeological heritage have more to contribute to planning and design processes than conventional practices allow. A geodesign framework facilitates the consistent connection of these aspects by first developing Spatial Data Infrastructures (SDIs) that add the much needed quantification and digital documentation of heritage that planners and designers are thirsty for. Heritage digitization becomes the intellectual arena where planners, urban designers, and historians exchange ideas.

Visibility of culturally sacred places (past and present) is of recent interest in geodesign research. It is one of the more obvious and practical measures in evaluating places. Visible landmarks and landscapes that are well composed influence the sense of history (and thus sense of belonging), wayfinding ability and even place satisfaction. Nijhuis (Chap. 13) gives a sharply curated tour of how GIS can be used to explore aspects of visibility in landscape compositions, and comes as a welcome introduction for information technologists and developers to a landscape designer's needs. Visibility is analyzed from the interior in Fisher-Gewirtzman's (Chap. 14) research on visibility impacts on place satisfaction. Here she correlates volume of visible outdoor space (voxel calculations) to a survey of several students from their apartments and notes the influence of individual cultural on place 'level of satisfaction'.

On the other hand, van Nes's (Chap. 15) chapter on the Space Syntax method outlines a very objective and quantifiable tool to analyze street interconnectedness in order to predict economic and cultural hubs in European cities, but notes that the cultural element of where economic centers are placed are not singularly tied to street arrangements. It can be the effort of local associations or concerned stakeholders that generates activity. It is within this public power that Rumor et al. (Chap. 16) and Sanchis et al. (Chap. 17) place their faith to test urban designs. By using 3D geospatial data and (web) visualization tools, they purport that valuable crowd-sourced public opinion can be collected to evaluate and even redesign public spaces.

In Part 4, authors focus on how to adopt geodesign thinking as a common language for exploring design solutions. Currier and Couclelis (Chap. 19) eloquently relate Steinitz's definition of 'people of the place' to the soft aspects of the design problem (what do stakeholders value, establishing sense of place), and argue that before determining a hard outcome (the design interventions), a soft outcome must first be achieved. They propose a methodology called 'perspectives mapping', a process that gives a spatial dimension to 'soft' design criterion that lead to 'hard' design decisions. This builds ownership and understanding of design decisions since stakeholders are empowered with spatial information. The citizens become a source of intelligence, which is a novel notion supported by Nedkov et al. (Chap. 20). By streaming spatial information (relief, air pollution and heat distribution etc.) to citizens during a design exercise, they found that situational awareness was improved and discussions concretized. However they note the lingering organizational challenge of building consensus in large groups, and the scant inclusion of financial information tied to spatial decisions. This is an ongoing challenge for design solutions generally.

McElvaney and Foster (Chap. 21) continue this argument by underscoring the relevance of understanding organizational change principles in the process of dismantling barriers to collaboration among stakeholder groups (and even trained professionals) towards adopting geodesign thinking. This helps the reader in understanding some of the barriers to geospatial technology adoption by urban designers and planners in practice as also discussed by Pelzer et al. (Chap. 22). Both papers distill the challenge down to change resistance due to perceived professional barriers. One of the newer uses of spatial information science is in the field of auditing. Jongsma (Chap. 23) describes the new mandate for the Dutch Court of Auditors to use geo-spatial technology and spatial thinking to improve the way policy is formed, by tracking the impact of government investments.

However, the real challenge, and the backbone, to adopting geodesign thinking is in training and education, as Wilson (Chap. 24) explains, and it is expected that this book will mark a clear starting point for discussion and dissemination of geodesign in Europe in practice as well as the classroom—as a framing concept for collaboration, creative problem solving, and connecting people together through geospatial science and technology. The way in which we collaborate is the most important element that differentiates geodesign from concepts like DSS, PSS, impact assessments and change models, and should be obvious after studying this book. Starting with a concise overview of the history behind geodesign in Europe, to an overview of Steinitz's geodesign framework, we have hand-picked case-studies and technological advancements that represent the most relevant geodesign applications and developments from various disciplines. The book is meant to inspire research, conversation, and analysis into geodesign theory so that we may continue to define it together and in doing so, adopt geodesign thinking.

References

Batty, M. (2013a). Defining geodesign (=GIS+design?). *Environment and Planning B: Planning and Design, 40*(1), 1–2.

Dangermond, J. (2010). GeoDesign and GIS: Designing our future. In: Buhmann E, Pietsch M, Kretzler E (Eds.), Proceedings of Digital Landscape Architecture (pp 502–514.). Wichmann.

Dias, E., Linde, M., Rafiee, A., Koomen, E., Scholten, H. J. (2013). Beauty and brains: Integrating easy spatial design and advanced urban sustainability models. In S. Geertman et al. (Eds.), *Planning support systems for sustainable urban development, Lecture notes in geoinformation and cartography* (vol. 195, pp. 469–484). Berlin: Springer. doi:10.1007/978-3-642-37533-0_27.

Ervin, S. (2011). *A system for geodesign*. Germany: Anhalt University of Applied Science.

Fisher, H. T. (1966). *SYMAP—Selected projects: 1966–1970*. Cambridge: Laboratory for Computer Graphics and Spatial Analysis, Harvard Graduate School of Design.

Flaxman, M. (2010). *Fundamentals of geodesign* (pp. 28–41). Berlin: Anhalt University of Applied Science.

Harris, B. (1965). New tools for planning. *Journal of the American Institute of Planners, 31,* 90–95.

Manning, W. (1913) The Billerica town plan. *Landscape Architecture, 3*(5), 108–118.

McHarg, I. L. (1971). *Design with nature*. New York: Doubleday/American Museum of Natural History.

Nijkamp P., Rietveld, P., & Voogd, H. (1990). *Multicriteria evaluation in physical planning*. Amsterdam: North Holland.

Scheurwater, J (1984). Toward a spatial demographic information system. In Henk ter Heide & Frans J. Willekens (Eds.), *Demographic research and spatial policy: The Dutch experience* (pp. 69–93). Orlando: Academic Press, (Studies in Population).

Scholten, H. J., & Meijer, E. (1988). From GIS to RIA. Paper presented at the URSA-NET conference, Patras, Greece.

Scholten, H. J., & Stillwell J. C. H. (1990). *Geographical information systems for urban and regional planning*. Delft: Kluwer.

Sinton, D. F., & Steinitz, C. F. (1969). *GRID: A user's manual. Laboratory for computer graphics and spatial analysis*. Cambridge: Harvard Graduate School of Design.

Steinitz, C. (2012). *A framework for geodesign: Changing geography by design*. Redlands: Esri Press.

Steinitz, C., Parker, P., & Jordan, L. (1976). Hand-drawn overlays: Their history and prospective uses. *Landscape Architecture, 66*(5), 444–455.

Wood, S. J. (1990). Geographic information system development in Tacoma, geographical information systems for urban and regional planning, *The Geodesign, 17,* 77–92.

Zwick, P. (2010). The world beyond GIS. *Planning, 76,* 20–23.

Chapter 2
Which Way of Designing?

Carl Steinitz

2.1 Introduction

> Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. (Herbert Simon, The Sciences of the Artificial, 1969)

I have organized many collaborative, multidisciplinary studies of major landscape change over more than 40 years at Harvard and in collaboration with other universities. The framework within which I organize most of my work and teaching strategies has been published in my recent book A Framework for Geodesign (Steinitz 2012). In this paper I will focus on one of the most significant decisions which the geodesign team must make when organizing the methods for its study: Which of the change models—which of the many ways of designing—shall we use? The change model which is selected may be the most important part of any professional or academic project because if the methods are unsatisfactory, then the products are also likely to be unsatisfactory.

2.2 The Framework for Geodesign

The framework for geodesign consists of six questions that are asked (explicitly or implicitly) at least three times during the course of any geodesign study. They all have sub-questions that are modified as needed by the geodesign team. The answers to those questions are models, and their content and levels of abstraction are particular to the individual case study. Some modeling approaches can be general, but data and model parameters are local to the people, place, and time of the study.

C. Steinitz (✉)
Harvard Graduate School of Design,
Harvard University, Cambridge, MA, USA
e-mail: csteinitz@gsd.harvard.edu

D. J. Lee et al. (eds.), *Geodesign by Integrating Design and Geospatial Sciences,*
GeoJournal Library 1, DOI 10.1007/978-3-319-08299-8_2

These six key questions are the following:

1. How should the study area be described in content, space, and time? This question is answered by *representation models*, the data upon which the study relies.
2. How does the study area operate? What are the functional and structural relationships among its elements? This question is answered by *process models*, which provide knowledge about the study context.
3. Is the current study area working well? This question is answered by *evaluation models*, which are dependent upon the values of the decision-making stakeholders.
4. How might the study area be altered? By what policies and actions, where and when? This question is answered by *change models*, which will be developed and compared in the geodesign study. These generate data that will be used to represent future conditions.
5. What difference might the changes cause? This question is answered by *impact models*, which are knowledge produced by the process models under changed conditions.
6. How should the study area be changed? This question is answered by *decision models*, which, like the evaluation models, are dependent upon the values of the responsible decision makers.

Questions 1–3 refer mainly to the past and the existing conditions of the study's particular geographic context. They focus on assessment. Questions 4–6 of the framework concern the future rather than the past and present. They focus on intervention.

Over the course of a geodesign study, each of these six primary questions and their subsidiary questions are asked at least three times (Fig. 2.1). In the first iteration the questions are asked beginning with question 1 as we define the context and scope of the work. In this first iteration we treat these as WHY questions for the project. The aim of the second iteration is to choose and clearly define the methods of the study, the HOW questions. In this stage, the framework is used in reverse order, working from question 6 to question 1. This reversal of the regular sequence of conducting a study is crucial to designing a set of potentially useful methods. In this way, geodesign becomes decision-driven rather than data-driven. The third iteration carries out the methodology designed by the geodesign team in the second iteration. During this round we ask the WHAT, WHERE, and WHEN questions as we implement the study and provide results. In this third stage, the framework is again from questions 1–6, through models of representation, process, evaluation, change, impact, and decision. Once a geodesign team has worked its way through the three iterations of the framework questions, there can be three possible decisions as an outcome: "No," "Maybe," or "Yes".

Reaching a "No" implies that the study result does not satisfy the geodesign team and is not likely to meet the requirements of the decision makers. Then any or all of the six steps are subject to feedback and alteration. This makes geodesign particularly nonlinear in its application. If the team's decision is a "Maybe" or perhaps a contingent "Yes" decision, it may also trigger a change in the scale, size, or time frame of the study. Shifting the scale of the project may lead to either larger or

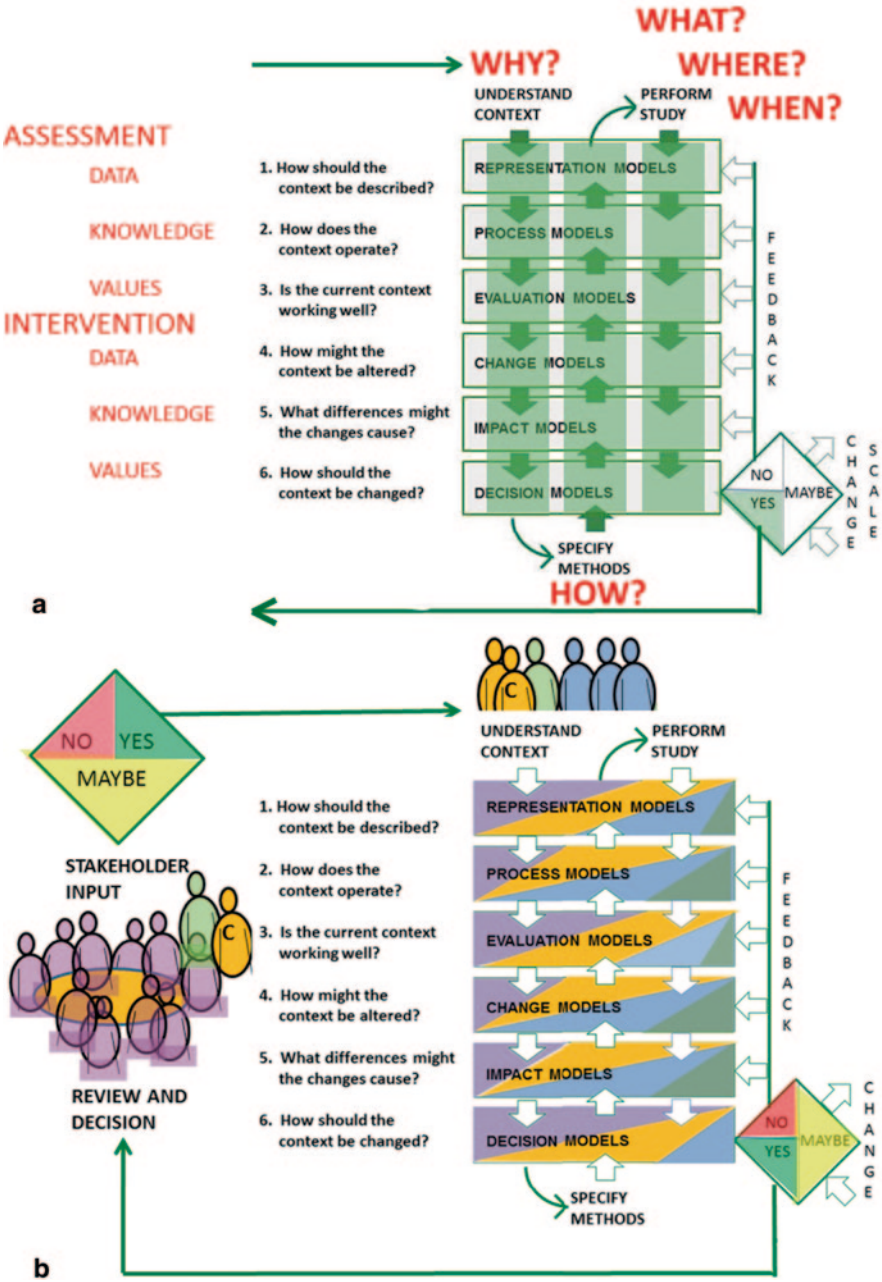

Fig. 2.1 The framework for geodesign

smaller geodesign activities, and the structure and content of several model types may require modifications. Nevertheless, the study will again proceed through the six questions of the framework and continue until the geodesign team achieves a positive ("Yes") decision.

If a "Yes" decision is reached by the geodesign team, the resulting study or proposed project is poised for presentation to the stakeholders for their review towards implementation. The decision makers (and there may be many layers of decision making) also have the choices of "No," "Maybe," or "Yes". A "No" may trigger the end of the study. A "Maybe" will likely be treated like feedback and require changes in the geodesign methods or their results. A "Yes" decision implies implementation and updating for future representation models.

Implementation of agreed-upon designs is not necessarily automatic or immediate, especially for larger and longer-term projects. In whatever ways the geography changes, there will be forward-in-time changes to new representation models. Future generations are likely to seek changes in their geography and see the implemented consequences of the geodesign team's study as part of their data, and so the cycle continues for generations of people of that place. All geography, designed or otherwise, is always in a state of change.

At first glance, the framework may appear to be excessively linear. Yet while the framework's questions and models are purposely presented in an orderly and sequential manner, the framework is normally not linear in its application, and the route through any study is not straight forward. There will always be unanticipated issues, false starts, dead ends, and serendipitous discoveries along the way.

When repeated and linked over scale and time, the questions of the framework may be the organizing basis of a very complex and ongoing study. The result may be a 2-, 3-, or 4-dimensional study, and at a range of scales. Regardless of complexity, the same questions are repeated in any applications of geodesign. However, the answers, models, methods, and results, and the ways by which they were developed and applied will vary according to the case under study.

It is important to emphasize that geodesign (indeed, any design) is not just proposing changes, as question 4 alone might suggest. Whether explicitly or implicitly, all six questions must be satisfied throughout all three iterations of the framework for a geodesign study to be complete.

2.3 Change Models: Ways of Designing

> Many devices which succeed on a small scale do not work on a large scale. (Galileo Galilei, Discorsi e dimostrazioni matematiche, intorno à due nuove scienze, 1638.)

The basic problem of geodesign can be stated as, "How do we get from the present state of this geographical study area to the best possible future?" In the framework we answer the question: "How might the landscape be altered?" with change models, the ways of designing and achieving the products of the geodesign study. The relative influences of the methodological choices made in the second iteration of the framework will not be equal, and change models are a particularly important element within the geodesign framework. There are multiple strategies for approaching change models. In the book I describe eight different ways of designing for change and a ninth mixed example.

All change models combine decisions related to allocation, organization, and expression, and all require visualization and communication (Fig. 2.2). Allocation refers to where changes are located, such as the placement of new housing in the landscape, the conversion of forest to agriculture, or the protection of a rare animal's habitat, and so on. Organization refers to the interrelationships among the elements of the design, such as how the school, the shopping area, the park, the bus system, and both low- and high-density housing all fit together in the design of the new community. Expression refers to the way in which the design is perceived. For example, is it seen as a residential community, or as a friendly place, a beautiful or an expensive one, etc.

These three characteristics of allocation, organization, and expression are rarely applied with equal emphasis in change models. As a general rule, the larger the size of the design study, the more emphasis is placed on allocation. By contrast, the smaller the project, the more emphasis can be placed on expression. This change of emphasis is characteristic of the differences between landscape planning and garden design, or regional planning and architectural design, or demography and being a parent.

I think that the extremes of size and scale are relatively well served. Design professionals such as architects, landscape architects, urban planners and civil engineers are generally capable at serving client needs at the scales which are symbolized in Fig. 2.2 by the house and the urban design. They increasingly work

Fig. 2.2 Influences of size and scale

with the people of the place, and on rare occasion with geographic scientists. Similarly geographically oriented scientists are generally capable of understanding the needs of the environment at the scales symbolized from the globe to the large region. They increasingly work with information technologies, and on rare occasion with design professionals. I believe that collaboration in geodesign can be most significant and effective where the extremes overlap, between the large project and the large region. This requires the participation of all four groups: design professionals, geographic scientists, people of the place and information technologies. This range of geodesign "problems" is where the decisions that can really shape the world's environments (plural) for the better are and should be made.

Regardless of size or scale, every geodesign study has four groups of influences which should be considered: the history of the place and its past designs and proposals, the "facts" of the area which are not likely to be changed during the period of study, the "constants" which should be incorporated into any proposed alternative, and the requirements of the project. Yet, while all change models are different they share the same overarching template (Fig. 2.3). The parallelograms can best be understood as map layers of spatial representations needed for the geodesign study, such as drawn diagrams or data layers within a GIS. The arrows are the links in the cumulative process of making the design.

The first influence is history. Knowing the history of the geographical context within which the geodesign study will occur is essential, particularly the history of any previous designs for that area. In my long experience, I have never worked in a region that didn't already have past designs, and the people who made them were not fools.

Next are facts. Facts are aspects of the geography that are assumed not to change over the life of the design. These can be aspects or results of the study's representation, process or evaluation models. We might be working toward a point in time 20 or 30 years in the future, and such things as subsurface geology or a major river pattern or the evaluation of an historic palace are not likely to change within that time frame.

Then there are constants, the things that are certain to occur in the time-frame of the geodesign study. You must find out about them, because if you don't, none of your alternatives will be implemented. An example of a constant could be a high-

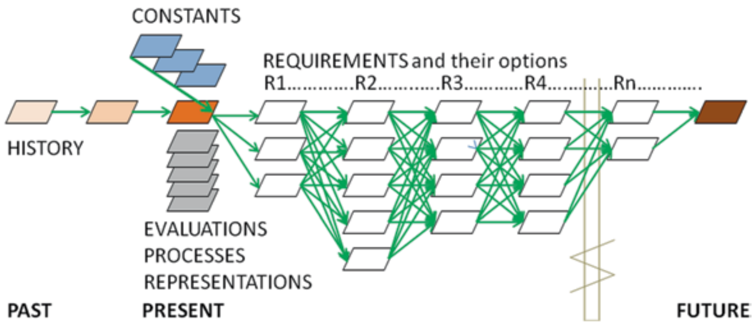

Fig. 2.3 The template for change models

way or sewage treatment system in the study area which has already been proposed, approved, designed, funded, and though not yet constructed, is contracted to begin within the next year or two.

Lastly, there are the requirements and their options, the things that should and could happen. Capturing the major, strategic, and generating requirements and their alternative choices is key here. The most important assumptions must be part of the beginning of the sequence of change-decisions, since if you make the first steps wrongly, you will certainly end up wrong. Then again, if you make the right first steps you still may end up wrong, but you have a better chance of success. Spatial analysis frequently plays its most critical role in the assessment of these initial and strategic alternative choices. You have to be able to say: “either here, here, or here,” or “in one or more of these several ways.”

Each of the eight change models and one mixed example shown in Fig. 2.4 represents a different strategy for approaching and organizing the design and/or simulation of change. (Each is described in Part III of my 2012 book with a case study of major landscape change as applied within the framework for geodesign.) The names of each of these change model strategies reflect their primary approach or characteristic: anticipatory, participatory, sequential, constraining, combinatorial, rule-based, optimized, and agent-based. All eight support the use of scenarios, recognizing that there are an infinite number of future options. At the same time, all of them eventually reduce the possible number of alternatives from the infinite to a manageable number. In the end, the change models must include the most important issues and produce an appropriate range of policy and design choices. Although nearly all designs are the result of combinations of these eight ways, during a given geodesign project one of these eight is likely to dominate. The way that the change model is organized and started is crucial and should be preplanned in the second iteration of the framework for geodesign.

The change models can be considered in three different groups. The anticipatory, participatory and sequential change models assume that the designer or the geodesign team is confident in the ability to directly develop the design for the future state of the study area. The constraining and combinatorial ways assume that the geodesign team is not certain of the crucial initial decisions and must first assess the major requirement-variables before developing the rest of the design. The rule-based, optimized, and agent-based approaches assume that the geodesign team is assumed to understand the rules that guide the processes of change, but also is obligated to test the variability of the main requirements in order to develop the most beneficial design solution.

Well before writing the book I had often argued that there is no such singular thing as “THE Design Method” or “THE Planning Method” (and I consider a plan to be a design). Rather, there are many methods and they must be chosen in the second iteration of the framework and adapted to issues and questions raised by the problem at hand. This raised the important but difficult question: Which way of designing should be chosen? My hypothesis was that the larger and more complex geodesign studies would be best served by the more complex change models (Fig. 2.5).

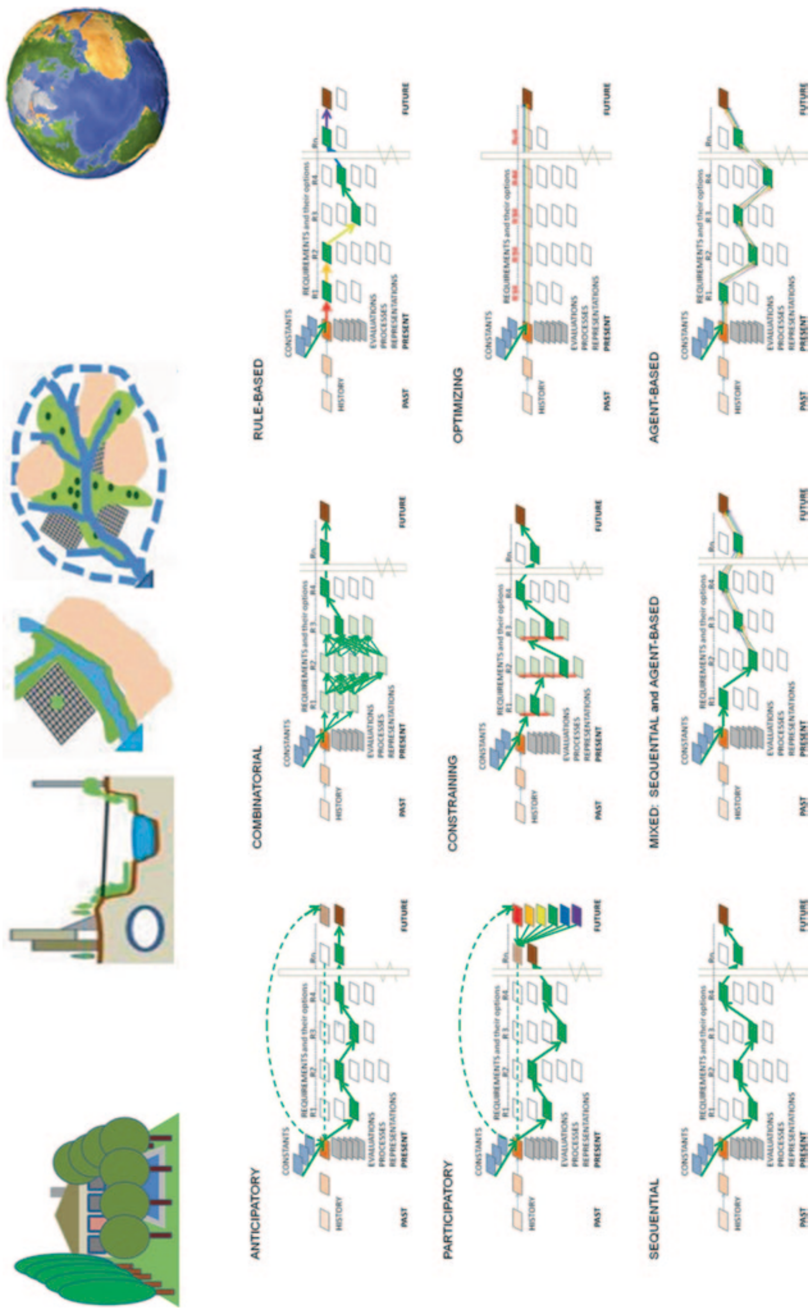

Fig. 2.4 Change models: ways of designing

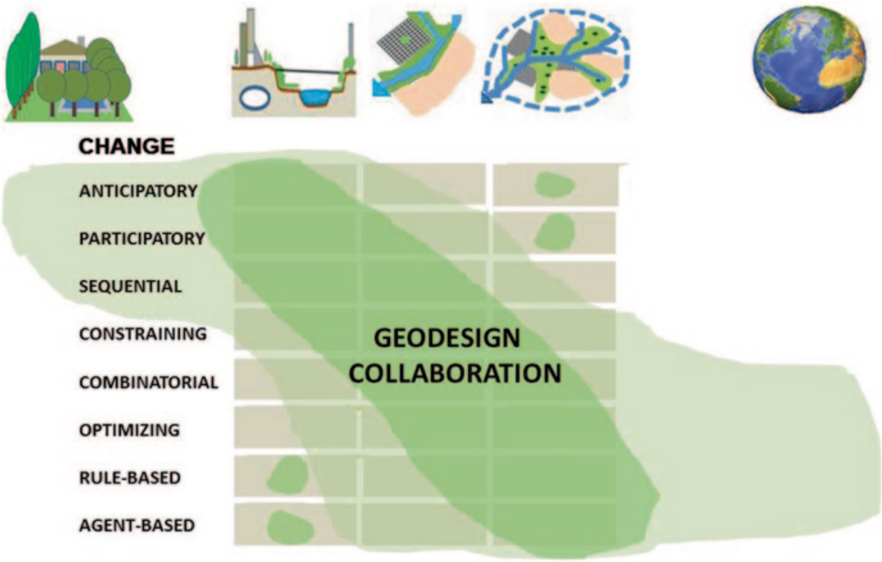

Fig. 2.5 An hypothesis regarding the link between geodesign size and scale, and the efficacy of change models

2.4 The Redlands Experiment

At the first Geodesign Summit in Redlands California in 2010, I proposed an initial experiment to test and compare the efficacy of the nine change models described in my book. This idea was taken up by Jack Dangermond and several other persons, some of whom I had previously worked with. With significant support from Jack and ESRI, an agreement was made with the City of Redlands and the University of Redlands to conduct an experimental workshop that would be of help to the city regarding two prominent issues facing it. The first was the preparation of a landscape plan for the city (which Redlands referred to as an open space plan). This was seen as 2-dimensional design. The other was the 3-dimensional design for a transit-oriented development near ESRI's corporate campus (Fig. 2.6).

In this agreement, the Redlands University and its Redlands Institute would host the workshop and have several faculty and some students as participants, the City of Redlands would organize the data and its representation, process and evaluation models, and establish all the requirements for the two geodesign studies. Its planning staff and several residents who are active in city affairs would be participants. ESRI would contribute several information-technology staff, and allow the workshop to test several geodesign management tools which were in early development. I would help recruit persons who were familiar with the framework and who would organize the work of the geodesign teams, and I would manage the workshop (with a lot of help).

The core team and several persons from Redlands met in October 2010 to plan the workshop and its information flows. There were three significant constraints: the work-