# Chapter 23
# Towards Geodesign: Building New Education Programs and Audiences

**John P. Wilson**

## 23.1 Introduction

Many of the descriptions of geodesign invoked to date have cast it as an iterative design and planning method where emerging designs are shaped using spatial knowledge acquired from geospatial technologies (e.g. Dangermond 2012). This often leads to a relatively elaborate discussion of geodesign workflows (e.g. Steinitz 2012) and how these can be invoked for storytelling, collaboration and public participation, among others (e.g. Niemann et al. 2011). These kinds of descriptions may not serve us very well. An economist, for example, might struggle to think of it differently from one of their own methodologies, such as cost–benefit analysis. Here, I argue that this would be a dangerous outcome and that the aforementioned approaches to defining the field of geodesign pay too little attention to the special place we find ourselves both in the world as a whole and in education in particular. This special "place" can be traced to the precarious state of the world, to the need to invoke spatial thinking to help find solutions to many of our most serious and enduring problems, and to the tremendous opportunities afforded by the Web for learning and collaboration.

Many scholars and commentators have written passionately about the state of the world and the difficult choices we will likely face in the coming decades. Fisher (2012), for example, has written that "the only way we can avoid such a fate is to realign our relationship with the natural world, to reorganize our considerable knowledge about it to reveal the forces that lead to unsustainable practices, and to relearn how to steward what remains of the planet that we have so altered". These observations point to the tremendous gains that our disciplinary-based education systems have yielded during the past few centuries on the one hand and the need for change, given we know much more about ecosystem drivers and outcomes and yet have struggled to put this knowledge to work to create more sustainable ways of living, on the other hand. Fisher (2012) sees GIS as a way to spatialize all of the knowledge about a place and to see the relationships among disciplines and the con-

J. P. Wilson (✉)
Spatial Sciences Institute, University of Southern California, Los Angeles, CA, USA
e-mail: jpwilson@usc.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_23

nections among data. Goodchild (2010), views geodesign as a way for GIS to make good on one of its early objectives (the use of GIS as a tool for creating designs as was popularized by the late Ian McHarg (1969), among others) and thereby promote futuristic collaborations among scientists and designers to help empower efforts to improve and sustain the surface and near-surface environments of the Earth. Finally, Steinitz (2012) in his seminal book summarizing where geodesign is now and where major research and education efforts should be focused in the future, explained how the latter requires the training of "conductors" as well as "soloists" and how this might be accomplished within a master's level curriculum in geodesign.

This chapter explores some of these ideas in more detail and highlights some of the challenges universities are likely to face as they work to create and sustain successful geodesign degree programs in an education setting in which disciplinary silos are still the norm and they are continually challenged to do more with less. The next section describes the importance of spatial thinking and four additional characteristics of geodesign that suggest it represents an important turning point for spatial scientists and practitioners. Section 23.3 uses several examples to show how this "geodesign" concept is not new and highlights some of the challenges that derailed early geodesign projects and lessons learned. Section 23.4 discusses the role of the Web and why this may be an ideal time to accomplish meaningful change with the help of three modern geodesign initiatives. Section 23.5 explores the implications of all of this for geodesign education using the University of Southern California's new B.S. in Geodesign degree as an example and the chapter closes with some conclusions and ideas for future work in the final section.

## 23.2 Five Characteristics of Geodesign

The most popular definitions of geodesign position it as a new field built on top of the spatial sciences, assuming the latter spans all the various ways in which spatial information can be acquired, represented, organized, analyzed, modeled, and visualized (Wilson and Goodchild 2012). The successful pursuit of each of these activities involves spatial thinking at its core and spatial thinking, it turns out, is used in many (most?) occupations and many facets of everyday life to structure problems, organize knowledge, find answers, solve problems, and communicate solutions (Sinton and Lund 2007; Sinton 2012). However, spatial thinking is not explicitly taught in K-12 and college settings in the US and many other parts of the world and a large part of my own interest and fascination with geodesign is the special opportunity it provides to introduce formal training in the spatial sciences to a larger and more diverse audience compared to past years.

Geodesign provides new opportunities to use the spatial sciences to promote and guide design across a variety of spatial scales ranging from specific sites to neighborhoods, watersheds, regions, and the world as a whole. Given this setting, the best geodesign programs will incorporate spatial thinking and teaching that aims to develop student's capacities to conceptualize, visualize, and interpret location, distance, relationships, movement, and change across places and spaces (Goodchild 2010; Sinton 2012). Spatial thinking, viewed in this way, might serve as a kind of "glue" that: (1) provides the means to clarify and understand the role of different perspectives in describing the context for specific problems and/or opportunities; and (2) serves as a platform by which we could engage and use a series of diverse disciplinary backgrounds and perspectives for solving real-world problems. However, geodesign practice itself will need to evolve to encourage and enable the participation of non-spatial thinkers as well, because the growing number and popularity of map-based tools and scorecards threatens to leave these individuals behind on the sidelines.

The second distinguishing feature of geodesign is the use of a variety of geospatial technologies to help gather, organize, analyze, model, and visualize large volumes of both spatial and non-spatial data. These technologies, and the underlying science that they are built on top of, have grown enormously during the past four decades. Their scope and purpose are perhaps best described in the Geographic Information Science & Technology Body of Knowledge (BoK) that was published by the Association of American Geographers and University Consortium for Geographic Information Science in 2006 (DiBiase et al. 2006, 2007) and in the Geospatial Technical Competency Model (GTCM) that was published by the US Department of Labor a few years later (DiBiase et al. 2010). The latest geospatial software platforms provide an increasingly data-rich environment for all with access and endeavor to cover every feature or aspect of interest—including the less tangible attributes that are discussed later in this chapter and contribute to the sense or meaning of place. However, they have traditionally focused on current conditions and how they came to be this way (Fisher 2012). Geodesign then affords new opportunities for utilizing these platforms in ways that encourage spatial thinking and its use in decision making and problem solving.

This last observation brings us to the next two distinguishing characteristics of geodesign: its future orientation and focus on design, which in the most general sense, involves imagining and one hopes, doing something positive, to change conditions on or near the Earth's surface to improve the everyday lives of residents. This pair of characteristics acknowledges that geodesign has emerged at a uniquely important moment in history, given the rapid growth of the human population during the past two centuries, the emergence of cities as home to more than 50% of the human population, the growing numbers of educated people in the world coupled with our steadily expanding capacity to alter conditions at or near the Earth's surface (for better or worse), and the spread of the Web as a platform to share knowledge and aspirations of one kind or another (Worldwatch Institute 2013). The role of the Web is rapidly evolving and it is likely to provide many new opportunities for performing spatial analysis, building spatially explicit models, and visualizing potential solutions to problems across a range of scales in the next few years (Wang et al. 2013). It is perhaps not surprising then that many commentators have written about geodesign as a force for good—for helping individuals and societies to build more sustainable, livable and healthy communities for both current and future generations (e.g. Niemann et al. 2011; Steinitz 2012). For educators, this pair of characteristics points to the need to teach visioning along with systems thinking and analysis.

The fifth and final feature of geodesign is its focus on collaboration. This is manifested in at least two ways. The first is the need for multi-disciplinarity. It takes many workers from multiple fields to build a 20-story residential building for example. However, the size and diversity of this cast would be expanded if we decided to build multiple high-rise residential towers and locate a subway line and station below them. The latter is increasingly likely and may provide new opportunities to build more sustainable and healthy communities. This last scenario also speaks to the increasing complexity of modern life and the growing need for teamwork. The second way in which collaboration is manifested has to do with the need to involve the people who would be affected by these designs and subsequent actions. People vary tremendously in terms of interests, goals and aspirations and the often-cited sentiment that people will come if we build sustainable urban forms (i.e. transit-friendly high density housing for example) may be nothing more than wishful thinking.

This is an especially opportune time because the emergence of the Web and the tremendous opportunities to implement geodesign on top of this increasingly ubiquitous platform provides a multitude of exciting new ways we can engage policy-makers, regulatory agencies, architects, scientists, engineers, and everyday citizens to build more sustainable and healthy communities. The role of the Web and its various manifestations (cloud computing architectures, big data, data analytics, etc.) warrants special emphasis and attention because it dramatically expands the possibilities and the ease of collaboration. However, saying this will be so and making it happen may well constitute two different outcomes unless we proceed carefully, for the reasons articulated in the next two sections. Geodesign educators, of course, will need to use the Web to promote and sustain collaboration in their classroom activities as well for students to grasp the full range of collaboration possibilities moving forward.

## 23.3 Geodesign is Not New!

The five characteristics of geodesign noted above—the focus on spatial thinking, geospatial technologies, the future, design as a force for good and multi-disciplinary collaboration—are not necessarily new and one can find plenty of examples of similar efforts that extend back many decades and even centuries. Three examples from southern California are used below to illustrate these kinds of efforts.

In the first example, the Los Angeles Chamber of Commerce commissioned well-known landscape architects Olmsted and Bartholomew to create a regional plan for "parks, playgrounds, and beaches" in the 1930s. The geospatial technologies of the time consisted of pen and paper and these were used to construct and disseminate a series of maps depicting current and proposed land use conditions—just as modern geospatial software platforms such as ArcGIS and Google Earth are often used today (see, for example, the map books published as a part of the Esri International User Conference each year). Though the plan was never implemented, in the mid-1990s, it resurfaced and became a beacon, simulating new calls for a revitalized city connected by green corridors and major parklands (e.g. Hise and Deverell 2000; Wolch et al. 2012).

This is but one of many plans from Los Angeles that were never implemented and today's land use patterns bear little resemblance to the plan envisaged by Olmsted and Bartholomew. The metropolitan region today stretches 210 km from Oxnard in the west to Redlands in the east and 140 km from Santa Clarita in the north to San Juan Capistrano in the south. Some 18 million residents now call this region home and it is characterized by a series of enduring challenges related to employment, traffic, crime, pollution, fragmented natural resources and environmental goals, among others, that go unmet.

This state-of-affairs provided the backdrop for the second example: the Reality Check Los Angeles event convened by the University of Southern California's Lusk Center for Real Estate and the Greater Los Angeles Area Office of the Urban Land Institute in 2002 (see http://http://www.youtube.com/watch?v=-aHgIh6m3ns for additional details). This event gathered 250 politicians, policy-makers, planners and professionals from various domains. They spent a morning working in small groups to allocate new residents and employment opportunities specified in a future growth forecast on a series of specially prepared maps showing the existing distribution of settlement, economic activity and various kinds of infrastructure. These maps were collected and analyzed by a team of 12 GIS faculty and students in ArcGIS over the lunch break and used throughout the afternoon to delve into what the various groups had tried to accomplish and what would need to happen for their plans to be realized. This effort would not have been possible without modern GIS tools (how else could one have captured and summarized the results from 20 separate tables and compiled the results in map form in 2 h), but in the end it suffered the same fate as Olmsted and Bartholomew's plan given that the designs did not lead (as far as one can tell) to tangible action(s) and there was little engagement with everyday residents.

The third and final example concerns the GreenVisions Plan for twenty-first Century Southern California project that was funded by a consortium of regional conservancies in 2004. This ambitious project, which focused on parks, open space, watershed health, biological conservation and restoration, was organized around the development and deployment of web mapping tools that local residents and citizen groups could use to help prepare funding proposals that would be submitted to one or more of these regional conservancies. The motivation of the funders, led by the San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy, was to provide a platform that could be used by potential grant applicants to identify projects that would provide tangible benefits by adding additional parkland and open space in park-poor areas, improving watershed health, and/or providing new opportunities for the conservation and restoration of important flora and fauna. A web mapping platform was built—see Ghaemi et al. (2009) and Sister et al. (2010) for additional details—and used for one or two rounds of grant funding but ultimately this effort failed because the funding to support the mapping infrastructure disappeared as general economic conditions deteriorated and technology advances rendered the ArcIMS platform on which the application was built more or less obsolete.

The challenges highlighted by these examples point to the need to gather the support of those making decisions as well as experts and those whose everyday lives will be affected on the one hand, and the need to choose the geospatial technologies that are to be deployed carefully on the other hand. Fortunately, the emergence of the Web as a ubiquitous platform for analysis and communication offers new opportunities and ways of meeting the aforementioned needs, as indicated to varying extents by the three recent initiatives described below.

## 23.4 Recent Examples: Getting It Right!

Several authors have spent considerable time clarifying the roles of experts and affected publics in participatory geodesign projects in the past few years. Goodchild (2010), for example, distinguished design and Design in which the former contemplates design as a simple optimization problem and the latter sees the process complicated by varying goals among stakeholders, feedback loops that modify objectives, constraints and data as the process proceeds, and uncertainties about implementation. Spatial optimization models and spatial decision support systems provide just two of many possible approaches for solving geodesign problems given the first view of the world (e.g. Ghosh and Rushton 1987; Malczewski 1999; Jankowski and Nyerges 2001; Faiz and Krichen 2013). Steinitz (2012, pp. 198–201), on the other hand, spent much of the final chapter in his influential book about geodesign describing how future geodesign projects will have greater involvement from the people of the place and will need larger numbers of more technically competent people (i.e. experts) who will be forced to take more active roles, due to changes in political attitudes and information technologies. Figure 23.1 illustrates this particular view graphically and shows how: (1) each of the six stages in a typical “regional” scale geodesign project might be formalized as a model and supported by computational tools; and (2) the ways the people of the place, experts and conductors might be engaged at each stage. Goodchild (2010) offered a similar commentary and noted the need for new sketch and simulation tools to support geodesign as it is conceived here. The beauty of the second approach is that spatial thinking becomes second nature for many of the participants in geodesign.

Three initiatives can be used to show some of the progress that has been made in the past few years. The first example is the Trust for Public Land’s Greenprinting GIS-based service which provides a platform to help communities prioritize their park and conservation goals. The service utilizes GIS in a transparent mapping and modeling process and engages local residents and other stakeholders in a place-based planning exercise. These tools have been employed many times to delineate the lands with the highest conservation value and to meet the diverse goals identi-

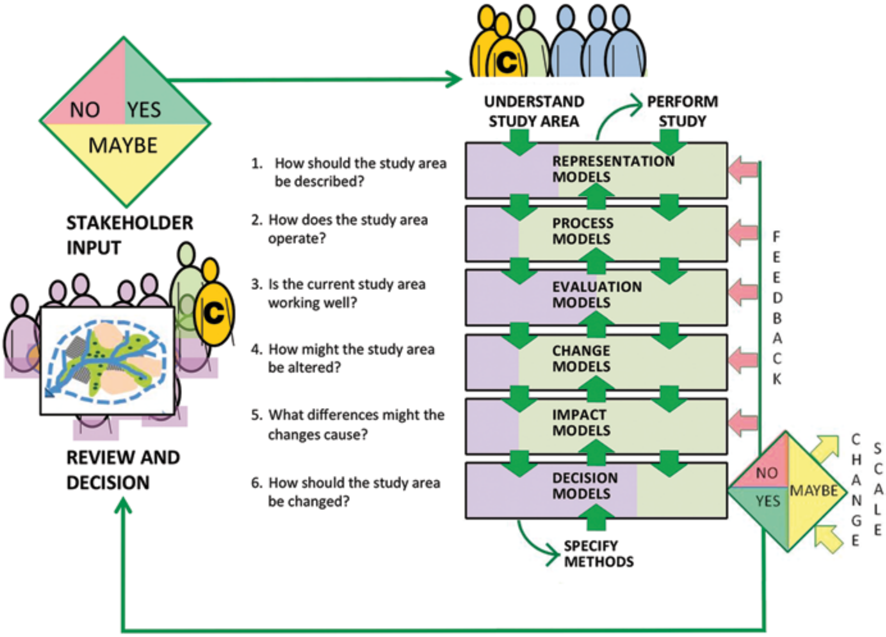


**Fig. 23.1** Schematic showing how future, larger geodesign projects will also have greater involvement from the people of the place and more technically competent people who will have to take a more active role. (Source: Steinitz 2012, p. 200)

fied by stakeholders, such as preserving ranchlands, protecting water sources and creating new parks. These services have been deployed by the Trust for Public Land in a series of collaborative greenprinting projects across the US that have brought more and better geographic information technologies to the task at hand and encouraged some additional public involvement in the planning and design processes.

The second example is SeaSketch (http://www.seasketch.org), a collaborative geodesign software service that is being used for marine spatial planning around the world. Using this service, individuals can: (1) specify their own geographic area(s) of interest; (2) upload existing map services from ArcGIS Online; (3) create and invite users and groups to participate in their project(s); (4) define "sketch" classes for marine management zones; (5) create map-based discussion forums; and (6) create simple surveys to collect data on human uses of the ocean. The goal of marine spatial planning has long been to achieve an optimal balance of marine resource use by reducing conflicts between users and maintaining ecological processes and the ecosystem services they support (Beck et al. 2009). SeaSketch can be thought of as the successor to MarineMap, a web-based platform for collaborative marine protected area planning (Merrifield et al. 2013) that was used to engage a large number and variety of stakeholders and delineate a series of new marine protected areas along the north-central California coast (Gleason et al. 2010). SeaSketch brings similar

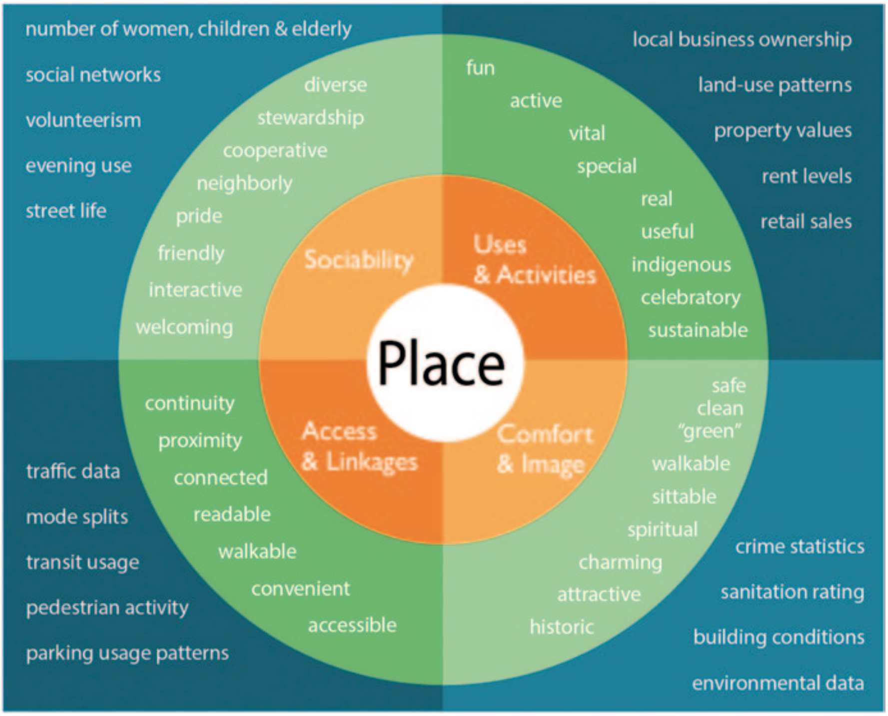


**Fig. 23.2** Schematic showing key attributes, intangible qualities and measurable data included in the Project for Public Space's placemaking concept. (Reprinted with permission of Project for Public Spaces, Inc. © 2014. All rights reserved)

benefits as the first example and is especially noteworthy because it offers greatly expanded opportunities for Web-based stakeholder participation.

The third example is the "placemaking" concept promoted by the Project for Public Spaces (PPS; http://www.pps.org). PPS is a nonprofit planning, design and educational organization dedicated to helping people create and sustain public spaces that build stronger communities. Their pioneering placemaking approach is both an overarching idea and a "hands-on" tool for improving a neighborhood, city or region. It incorporates 11 key elements—(1) the community is the expert; (2) create a place, not a design; (3) look for partners; (4) you can see a lot just by observing; (5) have a vision; (6) start with the petunias: lighter, quicker, cheaper; (7) triangulate; (8) they always say "it can't be done"; (9) form supports function; (10) money is not the issue; and (11) you are never finished—and combines both intangible qualities and measurable data in helping residents imagine new public spaces (Fig. 23.2). Founded in 1975 to expand on the work of William (Holly) White, the author of "The Social Life of Small Urban Places" (Whyte 1980), PPS has completed more than 2,500 community projects in 40 countries and in all 50 US states and trained tens of thousands of people per year so they can transform their own public spaces into vital places that showcase local assets, spur investment and rejuvenation, and better serve local needs. This particular example speaks to the previously noted idea of invoking design as a force for good and the kinds of benefits that would ensue if these approaches could be modified and used with Web-based map services and tools to imagine new places across a range of geographic scales (i.e. extents).

The three initiatives, taken as a whole, are valuable because they indicate the new kinds of collaborations among experts, stakeholders, and everyday residents that are now possible and point to some of the gains that we have made in developing and deploying the kinds of sketch and simulation tools that Michael Goodchild wrote about in his landmark article on geodesign (Goodchild 2010).

## 23.5 Implications for Geodesign Education

The immediate challenge for educators is to plan and build programs that provide the spatial and systems thinking, collaboration, problem solving, experiential learning, and technical skills and experiences that geodesign professionals will need in the years ahead. Responding to this challenge, we have launched a new B.S. in GeoDesign degree at the University of Southern California. Viewed as a multidisciplinary program from the start, the collaboration is led by the Spatial Sciences Institute, housed in the Dana and David Dornsife College of Letters, Arts and Sciences, the planning faculty in the Sol Price School of Public Policy, and the architecture and landscape architecture faculty in the School of Architecture. The development of six learning outcomes supported by this new B.S. degree program follow more or less directly from the commentary and examples offered in the preceding sections:

1. Learn about the myriad ways in which places can be constructed, interpreted and experienced in different ways by different people (e.g. migrants, people of color, the elderly, the poor, teenagers, toddlers and working adults, among others).
2. Learn about the principles of design and how these can be used as a force for good in building healthy, livable and sustainable communities.
3. Learn how urban and regional planning provides a framework for promoting civic engagement and collective action.
4. Learn how geographically referenced data can be gathered and organized to support a large number and variety of collaborative projects.
5. Learn how geospatial data can be analyzed, modeled and visualized to inform design and planning and by doing so, support public participation and urban development.
6. Learn how form and function co-exist and evolve in urban settings and how globalization connects near and faraway places and actions.

Given these learning objectives, the program starts with a series of spatial classes that use geospatial technologies to build spatial thinking competency and then gradually integrates design and planning classes in the mix so our students can focus their time and energy on future challenges and see all that they do as a force for good in the world (Fig. 23.3). Some of the design classes place students in the field

**PRE-MAJOR COURSES (8 UNITS)**

ECON 203 – Principles of Microeconomics
MATH 116 – Mathematics for the Social Sciences

**CORE COURSES (40 UNITS)**

SSCI 301 – Maps and Spatial Reasoning
ARCH 203 – Visualizing and Experiencing the Built Environment
PPD 227 – Urban Planning and Development
SSCI 382 – Principles of Geographic Information Science
ARCH 303 – Principles of Spatial Design I
SOCI 314 – Analyzing Social Statistics
PPD 417 – History of Planning and Development
SSCI 401 – Spatial Science Practicum
ARCH 403 – Principles of Spatial Design II
PPD 425 – Designing Livable Communities

**MAJOR ELECTIVES (20 UNITS FROM GROUPS A & B)**

**GROUP A – BUILT ENVIRONMENT (8-16 UNITS)**

ARCH 361L – Ecological Factors in Design
ARCH 432 – People, Places and Culture: Architecture in the Public Realm
HIST 347 – Urbanization in the American Experience
POSC 363 – Cities and Regions in World Politics
PPD 410 – Comparative Urban Development
PPD 420 – Environmental Impact Assessment
PPD 461 – Sustainability Planning
SOCI 331 – Cities

**GROUP B – DESIGN, ANALYSIS & COMPUTATION (8-16 UNITS)**

ANTH 481 – GIS for Archaeology
ARCH 307 – Digital Tools for Architecture
ARCH 370 – Architectural Studies, Expanding the Field
FADN 102 – Design Fundamentals
HIST 493 – Quantitative Historical Analysis
PPD 306 – Visual Methods in Policy, Management, Planning and Development
PPD 427L – Geographic Information Systems and Planning Applications
SOCI 365 – Visual Sociology of the Urban City and Its Residents

**CAPSTONE (4 UNITS)**

SSCI / ARCH / PPD 412 – GeoDesign Practicum

**Fig. 23.3** Schematic showing the preferred pathways students would follow to complete the University of Southern California's new B.S. in Geodesign degree

so they can learn first-hand how "form" and "function" work together and both the GIS and design classes utilize a mix of labs and studios in specially designed and dedicated learning spaces to promote skill development, teamwork, and collaboration. The planning classes, in turn, provide a series of pathways and protocols for combining collective and individual action to accomplish measureable and lasting change in the world. The capstone studio will be taught by faculty from the three contributing schools and will involve students working with real-world clients to solve one or more real-world problems.

**Table 23.1** List of characteristics that are part of and not part of placemaking as envisaged by the Project for Public Spaces (PPS; http://www.pps.org)

| Placemaking Is … | Placemaking Isn't … |
|---|---|
| Community-driven | Imposed from above |
| Visionary | Reactive |
| Function before form | Design-driven |
| Adaptable | A blanket solution |
| Inclusive | Exclusionary |
| Focused on creating destinations | Monolithic development |
| Flexibleof the car | Overly accommodating |
| Culturally aware | One-size-fits-all |
| Ever changing | Static |
| Multi-disciplinary | Discipline-driven |
| Transformative | Privatized |
| Context-sensitive | One-dimensional |
| Inspiring | Dependent on regulatory controls |
| Collaborative | A cost benefit analysis |
| Sociable | Project-focused |
| | A quick fix |

The overarching focus of this new geodesign degree is on placemaking, as conceived and promoted by the Project for Public Places (Table 23.1). The role of scale is highlighted throughout the program and the need for more sophisticated analytical and modeling approaches is introduced in both the core courses and in a series of electives that introduce and teach new skills and perspectives (Fig. 23.3). We realize that we cannot simultaneously train these new geodesign majors to be experts in architecture, computation, engineering, environmental design, geospatial technology, mathematics, science, and urban planning, and that the new B.S. degree will be a stepping stone for many of our students. With this in mind, we anticipate that some of our graduates will go directly to careers in environmental planning and design firms, in various government departments, and that others will go on to complete master's degrees in environmental science, geographic information science & technology, landscape architecture and planning, among others, before embarking on geodesign careers spread across the public, private and non-profit sectors.

The benefits of studying geodesign at the undergraduate level follow from the broad and deep introduction to design, planning and spatial sciences provided by this path and the opportunity for students to utilize this new knowledge and the accompanying skills to help clarify their future career and educational aspirations and needs. The reverse pathway (i.e. taking one of many undergraduate degrees and then a master's degree program in geodesign) relegates spatial thinking and the accompanying geospatial technologies to the role of Band-Aid in which spatial thinking and the accompanying geospatial technologies are introduced immediately prior to graduation. A much broader and deeper engagement with spatial ways of thinking are enabled by the B.S. degree in Geodesign.

No matter what the path chosen by our graduates, our hope is that some will grow into “conductors” and others will serve as “soloists” (as described in Steinitz 2012) and that all will help us to discover and implement future ways of living that are both rewarding and sustainable following some of the examples published in Yu and Padua (2006), Hou (2010), and McElvaney (2012).

## 23.6 Conclusions

This chapter has painted geodesign as an interdisciplinary field with five important and distinguishing characteristics: a focus on spatial thinking, geospatial technologies, the future, design as a force for good, and multi-disciplinary collaboration. Several examples were introduced to trace the evolution of the geodesign concept and to highlight some of the challenges that derailed early “geodesign” projects. The important role of the Web as a global platform and why this may be an ideal time to accomplish meaningful and lasting change were explained with the help of three recent geodesign initiatives. The Web provides a ubiquitous analysis and communication platform with the potential to transcend scale (i.e. move seamlessly across multiple geographic extents) and incorporate a multitude of voices and viewpoints in planning and decision-making workflows. The ways in which these aforementioned characteristics and a series of both early and recent examples have been utilized to guide the development of a new B.S. in Geodesign degree at the University of Southern California were briefly introduced and used to highlight some the challenges universities are likely to face as they work to create and sustain successful geodesign degree programs in an education setting in which disciplinary silos are still the norm and we are continually challenged to do more with less. My own hope is that this new degree will offer a vehicle to teach how spatial thinking can help to build vibrant and sustainable communities and lifestyles in the years ahead.

## References

Beck, M. W., FerdanÌa, Z., Kachmar, J., et al. (2009). *Best practices for marine spatial planning*. Arlington: The Nature Conservancy.

Dangermond, J. (2012). Foreword. In C. Steinitz (Ed.), *A framework for geodesign: Changing geography by design* (p. vii). Redlands: Esri Press.

DiBiase, D. W., DeMers, M., Johnson, A., et al. (2006). *Geographic information science and technology body of knowledge*. Washington, DC : University Consortium for Geographic Information Science and Association of American Geographers.

DiBiase, D. W., DeMers, M., Johnson, A., et al. (2007). Introducing the first edition of the GIS & T Body of Knowledge. *Cartography and Geographic Information Science, 34,* 113–120.

DiBiase, D. W., Corbin, T., Fox, T., et al. (2010). The new geospatial technology competency model: Bringing workforce needs into focus. *URISA Journal, 22*(2), 57–72.

Faiz, S., & Krichen, S. (2013). *Geographical information systems and spatial optimization*. Boca Raton: CRC Press.

Fisher, T. (2012). Place-based knowledge in the digital age. *ArcNews, 34*(3), 1, 4–6

Ghaemi, P., Swift, J. N., Sister, C. E., et al. (2009). Design and implementation of a web-based platform to support interactive environmental planning. *Computers, Environment and Urban Systems, 33,* 482–491

Ghosh, A., & Rushton, G. (Eds.). (1987). *Spatial analysis and location–allocation models*. New York: Van Nostrand Reinhold.

Gleason, M., McCreary, S., Miller-Henson, M., et al. (2010). Science-based and stakeholder-driven marine protected area network planning: A successful case study from north-central California. *Ocean and Coastal Management, 53*(2), 52–68.

Goodchild, M. F. (2010). Towards Geodesign: Repurposing cartography and GIS. *Cartographic Perspectives, 66,* 7–22.

Hise, G., & Deverell, W. (2000). *Eden by design: The 1930 Olmsted–Bartholomew plan for the Los Angeles region*. Berkeley: University of California Press.

Hou, J. (Ed.). (2010). *Insurgent public space: Guerrilla urbanism and the remaking of contemporary cities*. London: Routledge.

Jankowski, P., & Nyerges, T. L. (2001). *Geographic information systems for group decision making: Towards a participatory geographic information science*. London: Taylor and Francis.

Malczewski, J. (1999). *GIS and multicriteria decision analysis*. New York: Wiley.

McElvaney, S. (Ed.). (2012). *Geodesign: Case studies in regional and urban planning*. Redlands: Esri Press.

McHarg, I. L. (1969). *Design with nature*. Garden City: Natural History Press.

Merrifield, M. S., McClintock, W., Burt, C., et al. (2013). MarineMap: A web-based platform for collaborative marine protected area planning. *Ocean and Coastal Management, 74*(2), 67–76.

Niemann, B. J., Moyer, D. D., Ventura, S. J., et al. (2011). *Citizen planners: Shaping communities with spatial tools*. Redlands: Esri Press.

Sinton, D. S. (2012). Spatial thinking. In J. Stoltman (Ed.), *21st Century Geography: A Reference-Handbook* (p. 733–744). Thousand Oaks: Sage.

Sinton, D. S., & Lund, J. J. (Eds.). (2007). *Understanding place: GIS and mapping across the curriculum*. Redlands: Esri Press.

Sister, C. E., Wolch, J., & Wilson, J. P. (2010). Got green? Addressing environmental injustice in park provision. *GeoJournal, 75,* 229–48.

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

Wang, S., Anselin, L., Bhaduri, B. et al (2013) CyberGIS software: A synthetic review and integration roadmap. *International Journal of Geographical Information Science, 27,* 1–14.

Whyte, W. H. (1980). *The social life of small urban places*. New York: Project for Public Space.

Wilson, J. P., & Goodchild, M. F. (2012). Rethinking spatial sciences education programs. In T. Jekel, A. Car, J. Strobl, & G. Griesebner (Eds.), *Geoinfomatics forum 2012: Geovisualization, society and learning conference proceedings* (pp. 242–245) Berlin: Wichmann.

Wolch, J., Longcore, T., & Wilson, J. P. (2012). Unpaving paradise: The green visions plan for southern California. In D. Sloane (Ed.), *Planning Los Angeles* (p. 230–239) Los Angeles: APA Planners Press.

Worldwatch Institute. (2013). *State of the World 2013: Is sustainability still possible?* Washington, DC: Island Press.

Yu, K., & Padua, M. G. (Eds.). (2006). *The art of survival: Recovering landscape architecture*. Mulgrave: Images Publishing Group.