Knowledge Area: Domain Applications

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1. Topic Title: Geodesign and GIS&T

2. Summary Abstract:
Geodesign leverages GIS&T to allow collaborations that result in geographically specific, adaptive and resilient solutions to complex problems across scales of the built and natural environment. Geodesign is rooted in decades of research and practice. Building on that history, is a contemporary approach that embraces the latest in GIS&T, visualization, and social science, all of which is organized around a unique framework process involving six models. More than just technology or GIS, Geodesign is a way of thinking when faced with complicated spatial issues that need systematic, creative, and integrative solutions. Geodesign holds great promise for addressing the complexity of interrelated issues associated with growth and landscape change. Geodesign empowers through design combined with data and analytics to shape our environments and create desired futures.

3. Keywords:
Geodesign; Design; GIS; Collaboration; Planning; Landscape Architecture

4. Definitions

- Geodesign: geodesign is a method which tightly couples the creation of design proposals with impacts simulations informed by geographic contexts and systems thinking and supported by digital technology. (Flaxman 2010).
- Collaborative: geodesign is a mode of creative problem solving, which is rarely the domain of a lone thinker – most of the world's important innovations emerged out of team work. Bringing together diverse ideas, from multiple perspectives, results in richer, more inspired solutions.

Collaboration occurs when more than one person or organization work together to achieve a goal.

- Systems thinking: A holistic approach to set of elements or parts that is coherently organized and interconnected in a pattern or structure that produces a characteristic set of behaviors.
- Stakeholder engagement: Various individuals, groups, officials and/or organizations who have an interest in the geodesign process outcome comprise the stakeholders. Effective engagement ensures the voices and needs of all stakeholders are accounted for and enables stakeholders to be better able to evaluate how proposed changes will impact their interests or circumstances.

5. Description/Body

5.1 Introduction to Geodesign

The term geodesign has been associated with GIS&T and in increasing use since it was coined in 2005 by Jack Dangermond, President and Co-founder of Esri (Miller 2012). Though the term itself is relatively new, the intellectual concepts and techniques associated with geodesign are rooted in decades of research and practice beginning in the 1960s. Ian McHarg, at Penn, and Phil Lewis, at Wisconsin, were landscape architecture professors and practitioners at the forefront of using land information for planning and design. Harvard's Computer Graphics Laboratory provided early implementation of these concepts into digital tools (Foster 2016a, Wilson 2015). These pioneers were early adopters of integrating environmental science, both analog and digital, as key aspects of the landscape design process (Tulloch 2013).

Geodesign is a contemporary application of creative problem solving for land-based design and planning challenges that now includes dynamic, digital GIS&T and interactive collaboration. Bill Miller, former Director of Geodesign at Esri, a leading GIS software company, asserts that geodesign is the third stage in how Geographic Information Systems have evolved.

> "There are three major segments of GIS evolution and technologies …. (The first) is data, with maps that bind, secure and use data. Esri started out developing geodatabases, and the big question was, "where's the data?" As that mission was fulfilled, it migrated to the second segment, (which is)… analysis and feature processing -- you analyze geography for various purposes and reasons. The third segment is design, and that's the most recent segment. Once you have data and you analyze it for a purpose, then you do creative work with that analysis." (Ball, 2012)

There are many ways that geodesign has been defined. Flaxman (2010) and McElvaney (2013) are often cited as they provide explanations that cover four central tenets of geodesign, namely: it is a design process, it incorporates geospatial data and science, the process engages stakeholders, and dynamic digital technology aids in bringing all of this together (Foster 2016):

> "Geodesign is a method which tightly couples the creation of design proposals with impacts simulations informed by geographic contexts and systems thinking and supported by digital technology." Michael Flaxman (2010)

> "Geodesign is an iterative design method that uses stakeholder input, geospatial modeling, impact simulations, and real-time feedback to facilitate holistic designs and smart decisions." Shannon McElvaney (2013)

5.2 The Geodesign Framework

To permit these four central tenets to easily coexist a structured framework is needed that enables fluidity without sacrificing organization (Foster 2016). This is what the Framework for Geodesign outlined by Steintiz provides (2012). The Geodesign Framework is rooted in six fundamental questions. Three are questions about a place's past and the present, and three questions about the future.

The fundamental questions about the past and present are:

- How should the state of the place be described?
- How does the place work/ operate?
- Is the place currently working/ operating well?

The fundamental questions about the future are:

- How might the place be altered or changed?
- What differences might the change cause?
- How should the place be changed?

The method for addressing these questions are called "models." Steinitz outlines six models that form his Framework. The framework process requires cycling through these questions (models) three times, with a slightly different perspective in each iteration (Steinitz 2012). All answers relate to each other and build upon the previous question – therefore each answer contributes to the next question (model). See Figure 1. The models are also "paired" based on their "root" – for example both the Evaluation and Decision models require knowledge of stakeholders or professional team members. The Representation and Change models are rooted in data, and the Process and Impact models work with that data to provide information (which can then be "acted" on via the Evaluation and Decision models).

Steinitz's geodesign process enables the framing of culture, place, and problems into understandable models. Each model is essentially attempting to communicate an important idea about suitability. Whether it is the soil, pedestrian safety, or future land uses - each bit of information is a clue to understanding what creative change may be best for that place. Thus, the geodesign framework is a tool that establishes a process to think critically about places and cultures, and how to promote resilient, sustainable, and equitable living environments.

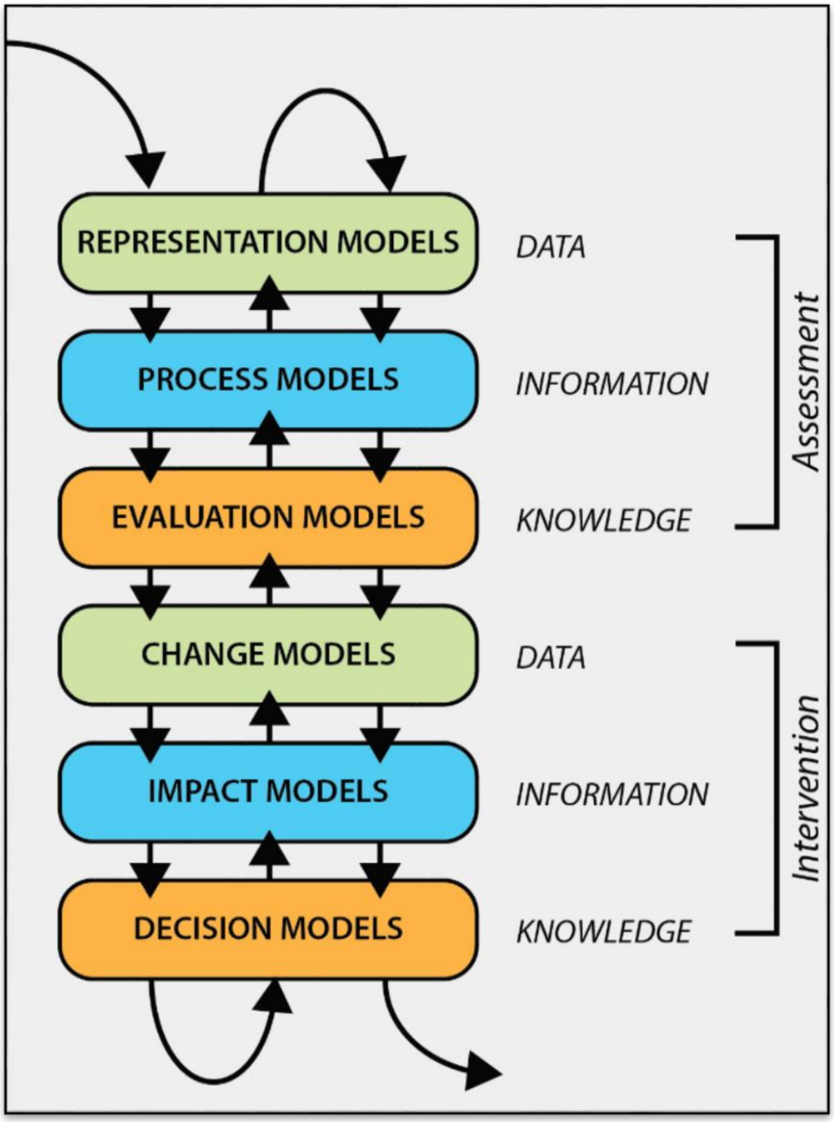

Figure 1: Geodesign Framework. Goldberg, D. (2017) *Adapted from Steinitz (2012)*

The first pass through the six models is the "Why" iteration: Why are you worried about the place or the issue? Why should this project be done? Gaining a thorough understanding of the problem is key to the future success of the process. For the second pass through the framework, the questions (and models) are taken in reverse order. Steinitz refers to this as the "How" iteration of the Framework: How will the project be organized and run? This pass through the framework is focused on setting up detailed guidance on how to approach the creation of design solutions. This "How iteration" establishes the methodology for doing this particular geodesign application – which is then implemented during the third pass through the models.

As these are often complex challenges, the process recognizes that there may not be a final accepted design solution the first time through the framework – sometimes things need to be re-examined at a different scale, or new people or information require circling back to an earlier point in the process.

This framework assists in devising solutions befitting the place and the community's values which are rooted in a decision-driven, data-informed design process. Though not labelled specifically as "geodesign," there are other, similar frameworks for land use design and planning that include most of the four central tenets that characterize geodesign for this paper. Two prominent examples are Carr and Zwick's LUIS: Land-Use Conflict Identification Strategy (2007), and the Sustainable Systems Integration Model (SSIM™) by the multi-national design and engineering firm AECOM (Sofian et al 2015).

5.3 Value of Geodesign for design and conserved environments

Steinitz portrayed geodesign as a Venn Diagram on the cover of his book (2012). [Figure 2] Essential to this portrayal is that geodesign is a multidisciplinary, collaborative process. It is process that fills the gap between science and design -- both the GIS&T and the design perspectives are crucial to moving towards more sustainable solutions for the land and for communities.

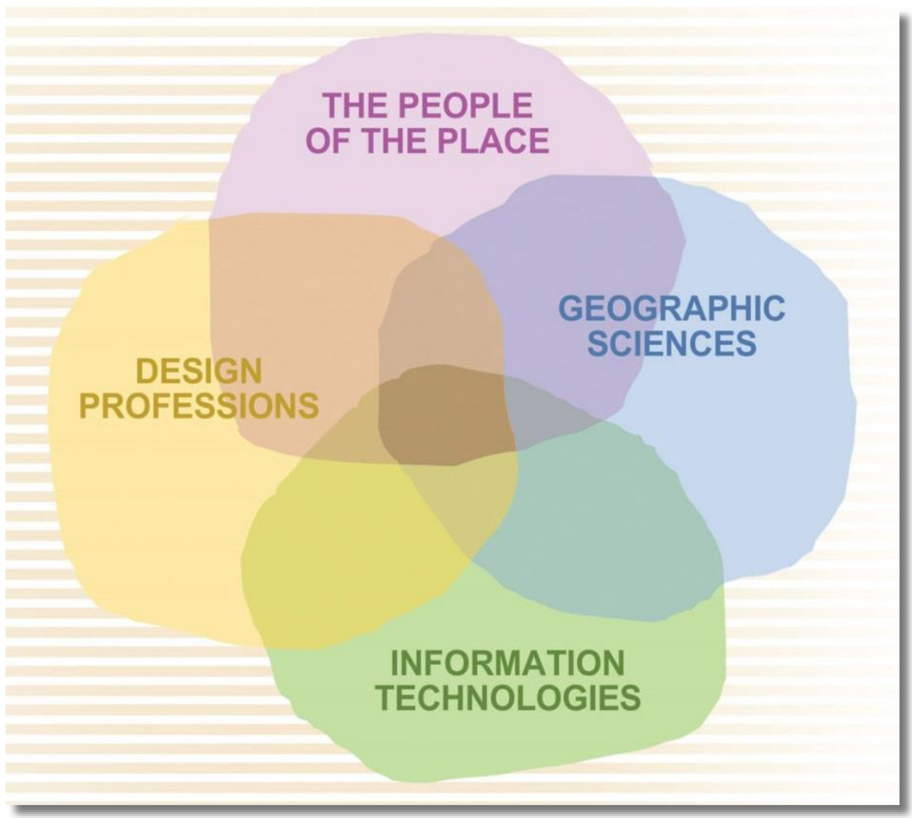

Figure 2: *"A Framework for Geodesign: Changing Geography by Design" (Steinitz 2012)*

Steinitz advocates that effective collaboration throughout the geodesign process must involve these groups: "(a) the people-of-the-place, (b) design professionals, (c) geographic scientists, and (d) information technologists" (McElvaney 2014). Innovation nearly always comes from collaboration—bringing diverse ideas together can illuminate creative solutions to tough challenges.

Along with the important role collaborative input plays in geodesign, equally valuable is how the geodesign framework assists in managing complexity. Often a land-based design and planning challenge can seem overwhelming. Part of this is due to the possibility of multiple "drivers of change" impacting an area (Arup 2009). The global engineering firm Arup has categorized these drivers as mainly falling into five categories -- "STEEP": Social, Technological, Economic, Environmental, and Political. The genius of the geodesign process is that by following the models and asking questions in a proper sequence, the team can filter out the "noise" and get to the key issues impacting the place. Further, the use of technology continues to evolve in ways that make dealing with complexity more manageable. The power of GIS&T benefits the process in three important ways:

1) analyze and manage information
2) measure performance to illuminate and reveal consequences
3) dynamically visualize alternatives

As part of the geodesign framework models, decision-makers establish metrics for the desired performance of the design. Computation, such as comparing factors, is used to reveal the consequences of various actions. This "measuring performance" computation step is one of the unique and distinguishing features of geodesign. And in particular, the ability to calculate and compare feedback on various intervention strategies in real-time is extremely valuable for engaging stakeholders in recognizing that different choices can have different impacts on their desired goals.

Once the basic geodesign framework process is understood, including what questions to ask when, it can be seen to be applicable at many scales and for a variety of issues. Geodesign can effectively address complex environmental design problems for situations ranging from resilient urban design at neighborhood scales to conservation planning at national and international scales.

5.4 Common Application Areas

There are vast application areas and existing case studies to help illustrate the concepts, suite of tools, stakeholder participants, and workflow of the geodesign framework. Steinitz (2012) and McElvaney (2012), for example, outline a series of case studies in diverse contexts and settings that offer unique perspectives and lessons on the ways in which the geodesign framework has been applied. A review of previous application areas and case studies reveal six categories of observations on geodesign projects, which include:

- <u>Theme/Topic of investigation</u>: varies widely from urban design challenges, rural development scenarios, to ecological conservation areas;
- <u>Sponsor</u>: ranges from government, foundation, university, or private stakeholder;
- <u>Budget</u>: ranges from no budget, minimal, very large;
- <u>Duration</u>: one-day, one-week, up to multiple years;
- <u>Scale of analysis</u>: includes neighborhood, region, state, nation, or transnational;
- <u>Methodology</u>: low to high technology solutions.

The following case study from Los Angeles, California illustrates a collaborative and on-going engagement effort that uses the geodesign framework.

5.5 Case Study: The Taylor Yard River Park Geodesign Project

<u>Project Overview</u>

Located just north of downtown Los Angeles, the Taylor Yard River Park (G2 Parcel) was purchased by the City of Los Angeles in March 2017 as part of a larger effort to restore and revitalize the Los Angeles

River. The Taylor Yard site covers nearly 250 acres of land along the Los Angeles River which was historically used for rail maintenance and fueling by the Union Pacific Railroad Company. The Taylor Yard River Park Geodesign Project took place in January 2018 as a joint effort between the City of Los Angeles, the University of Southern California, and Geodesignhub (Geodesignhub.com) to organize and deliver a geodesign workshop to explore alternative design scenarios to promote human and ecological health of the Los Angeles River and Taylor Yard site in Los Angeles. Created by Hrishi Ballal in 2014, Geodesignhub is an online tool that leverages the geodesign framework while facilitating discussions and negotiations on the future of a place.

Workshop Objectives

The objectives of the workshop were to:

- Create a design strategy developed by community residents in partnership with city planners and design professionals that can be shared with local residents and be used to inform a site specific regeneration plan;
- Help train students and aspiring design professionals to engage in problems-based learning and hands-on experience in urban revitalization efforts; and
- Demonstrate the power of geodesign methods and tools to address real world problems.

Geodesign Workshop

The Taylor Yard River Park Geodesign Workshop assembled 18 individuals – comprised of students, professionals, and stakeholders – to participate in a one-day workshop to create alternative design scenarios by discussing and identifying priorities and restrictions of the site. The workshop featured interactive break-out groups and concluded with a negotiation among participants to create a single collaborative design plan for the site. Workshop participants included: community representatives from Cypress Park, representatives from the City of Los Angeles, representatives of LA River Revitalization, environmental conservationists, landscape architects, urban planners, USC Geodesign students, and ESRI technicians.

Outcomes and Next Steps

The Taylor Yard site provided an ideal study context to demonstrate the value of contemporary digital geodesign tools to help the City of Los Angeles achieve valuable outreach and citizen engagement goals in the restoration and revitalization of the Los Angeles River. The workshop brought together diverse stakeholder groups and utilized spatially explicit negotiation tools available in the Geodesignhub software platform to facilitate discussions and produce viable design alternatives for the Taylor Yard River Park site. The project necessitated that design solutions consider complex urban and environmental challenges.

The workshop was successful in achieving the three stated objectives. Workshop facilitators and participants used the geodesign framework to gain unique and valuable insight into land-use planning that leveraged design professionals, local stakeholders, and spatially-informed computing systems to create, vet, and discuss viable alternative design scenarios in a collaborative planning process. The study area was organized into ten critical evaluation systems, which included: 1) green infrastructure [GINF]; 2) blue infrastructure [BINF]; 3) low density housing [LDH]; 4) mixed use development [MIX]; 5) parks [PARK], 6) public services]PS]; 7) recreation [REC]; 8) parking [P]; 9) active transport [ATRA]; and 10) public transport [PTRA]. Evaluation maps were created for each system to use in Geodesignhub and rankings were applied to each system (e.g., existing, not appropriate, capable, suitable, feasible). The final collaborative design (Figure 3) reflects the four central tenets of geodesign, that is: the design process, incorporating geospatial data, stakeholder engagement, and synthesis using dynamic digital technology. After the workshop, the final negotiated design for the Taylor Yard River Park was then rendered into a dynamic 3D simulation model using Esri's ArcGIS Urban software program (Figure 4). This next phase of the project is to present the digital renderings of the design alternative to local stakeholders and city officials and engage in an advanced discussion on the future of the Taylor Yard site.

Figure 3: Final Negotiated Design from the Taylor Yard River Park Geodesign Workshop Using Geodesignhub Software Platform.

Figure 4: 3D Rendering of the Final Negotiated Design of the Taylor Yard River Park Using ArcGIS Urban.

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7. Learning Objectives

- Define geodesign and describe how it contributes to GIS&T.
- Describe the four essential groups of people that are needed for a collaborative geodesign project.
- Recognize the opportunities that might be possible in land planning and design practices through deploying the geodesign process.

8. Instructional Assessment Questions

- What are two advantages and two disadvantages of using the geodesign framework?
- How does size and scale of a given project impact the geodesign workflow?
- How ow does geodesign provide value in taking on complex land-based challenges and finding geographically specific, adaptive and resilient solutions?

9. Additional Resources

- Geodesign Wiki: http://geodesignwiki.com/tiki-index.php
- Geodesignhub: https://www.geodesignhub.com/
- Esri Geodesign: http://www.esri.com/products/arcgis-capabilities/geodesign
- Geodan Phoenix Touch Table: https://www.geodan.com/solutions/phoenix/
- Geodesign Special issue, Landscape and Urban Planning: https://www.sciencedirect.com/journal/landscape-and-urban-planning/vol/156?sdc=1
- Jack Dangermond: Geodesign and the Emerging GIS Platform (ASLA 2014) https://www.youtube.com/watch?v=jo87NHlXyjQ&list=PLARIwn93fYrouAFwYWCAlTVvsUoPasnFY
- PSU Geodesign Case Studies: http://geodzmooc.vmhost.psu.edu/

10. An Associated Image

See images in text.

11. Acknowledgements

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