
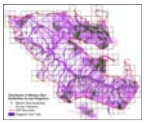


GeoDesign: Coupling GIS Tools with Design Thinking to Identify and Evaluate Alternative Futures


Photographs by Travis Longcore

John Wilson
Symposium on Geocomputation Studies
Wuhan University
19 December 2011

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Outline

- Background
  - Spatial and visual thinking, the design disciplines, and geography
  - GIS technology
  - Role of scale and complexity
- GeoDesign from a Practice Perspective
  - Enabling technology
  - Enabling science
  - Collaboration and multi-disciplinarity
  - Specific goals (livable cities, sustainability)
- Geographic Knowledge Infrastructure
- Final Thoughts

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Design Disciplines

- Design is about imagining what could be and then creating it
  - Designers in professions like landscape architecture, urban design, and planning use spatial and visual thinking to communicate what could be, reducing complex realities into comprehensive alternatives for us to follow and choose among
  - Rely on a series of several enabling technologies – BIM, CAD, etc.

Proposed Anaheim train station & transit hub, 2011

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Spectacular Visuals

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Extraordinary Results

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Design Approaches (Steinitz)

- Anticipatory … with a holistic view of the future, we use deductive logic to see how we get there
- Sequential … uses a directed approach and abductive logic to identify a series of steps that gets us to desired result
- Combinatorial … most valuable when we are not sure what to do. Uses inductive logic. We see the choices that you have to make and we work to choose the best plan. Some things are more important than others, and understanding the combinations helps to identify the best approach
- Constraining … getting people to understand what they want by narrowing their choices. This is a experimental approach that uses sensitivity analysis to narrow the response to defined constraints
- Optimizing … a directed and objective-driven approach in which the designs are as much about what not to do, as they are about what's best

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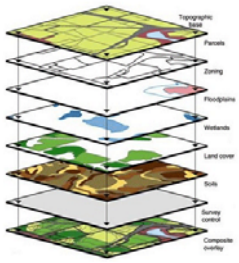
McHarg's Design With Nature



Constraining Design Approach

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Geography (Fisher)

- Focuses on what is or what has been
  - Track interactions and flows to understand how and why things happen up to the present-day
  - Increasingly relies on visual thinking to handle ever-larger amounts of data and to make ever more complex connections between phenomena
  - Geography, with tools such as GIS, had excelled in helping us understand the nature and extent of an exponentially growing human population, using finite resources at unsustainable rates, damaging the natural environment at an ever-increasing rate, and concentrating wealth and power among an increasingly small number of people
- Geography, by itself, cannot show us what to do about these problems going forward

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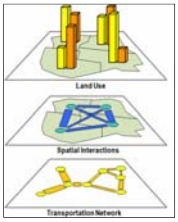
GIS Technology

- Provides tools to solve variety of real world problems
  - Routing – bringing people and assets to locations
  - Location/allocation – site optimization
  - Locating linear facilities – highways, pipelines, corridors, transmission lines
  - Land use models – predicting urban growth, control conditions, public participation
- Two immediate shortcomings
  - Not connected to sketch & record needs of the design disciplines
  - Not aligned with the non-expert user



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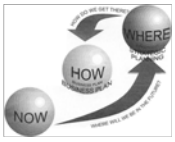
GIS for Planning Support

- GIS has proven less useful for key planning functions of forecasting, evaluation and plan making which involve questions of what the future will and should be
- GIS-based planning systems support traditional models of "planning for the public" which rely on technical expertise of planners to determine what the future should be
- Need new models of "planning with the public" and participatory GeoDesign tools which give stakeholders and the public a more meaningful role in the decisions that shape their lives



USC spatial sciences Richard Klosterman – What If? Planning Support System

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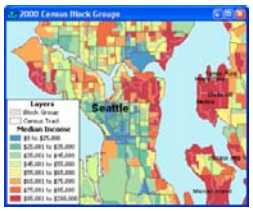
Role of Scale and Complexity

Process of building – site planning, conceptual design, programming and construction drawing



Spatial analysis – land use, census blocks, traffic patterns, air quality tables

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Scale and Complexity (2)

- Additional problems may arise because the strategies, processes, methods and ideas that work at one scale may not work at other scales
- Possible examples …
  - Best Management Practices (to manage runoff and water quality)
  - Green Building Design (support life)
  - Transit Oriented Development (to reduce congestion and vehicle emissions)
  - Smart Growth …

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Scale and Complexity (3)

Global		Cloud cover and CO2 levels control primary energy inputs to climate and weather patterns
Meso		Prevailing weather systems control long-term mean conditions; elevation-driven lapse rates control monthly climate; and geological substrate exerts control on soil chemistry
Topo		Surface morphology controls catchment hydrology; slope, aspect, horizon, and topographic shading control surface insolation
Micro		Vegetation canopy controls light, heat, and water for under-story plants; vegetation structure and plant physiognomy controls nutrient use
Nano		Soil microorganisms control nutrient recycling

(Slide courtesy of Michael Hutchinson)

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Additional GIS Shortcomings

- Focus on terrestrial environments
  - Natural environments – forests, grasslands, etc.
  - Human environments & infrastructure – cities, roads, pipelines, crop and grazing lands
  - Environmental impacts – air & water pollution
- Most of the world has been ignored
  - Oceans – cover 70% of Earth's surface
  - Buildings – people spend 85% of their lives indoors & dense urban areas have much more interior space than land area

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GeoDesign … from a Practice Perspective

- Goal is to identify best and most sustainable design that takes into account livability (people), environmental impact (the planet) and efficiency (profit)
- Relies on an expanding foundation of enabling technology (& science), an emphasis on collaboration, an interest in multi-disciplinary approaches, and a renewed interest in livable cities and sustainability

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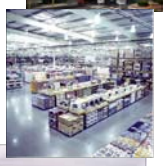
Enabling Technology

- Need to transform design and planning practices to a technology-supported feedback loop that supports the rapid conceptualization, articulation, visualization, modeling and monitoring of transformations in a variety of geographic settings and across multiple scales
- A challenge because the spatial concepts embedded in design practices are fluid, open, imaginative, and even emotional



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Enabling Technology (2)

- Key software requirements
  - Rich 3D visualization
  - Ability to store and search all project data regardless of format
  - Tools to model change through time
  - Inputs from real-time sensors
  - Customizable interfaces for all participants and all workflows
  - Ability for individuals to communicate and design collectively

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ArcSketch Example

- Free ArcGIS product extension
- Provides freedom to design spatially
  - Predicated on observation that designer's sketch when they design
  - Captures the design process, in all its freedom, with spatially-enabled tools for later use
  - Allows users to focus on creation and not technology

Uses out-of-the box or customized symbols to meet your specific needs

Predefine features with respect to the parent feature class, type, and value

Share predefined sets of features with other users to create a common approach to problem solving

Create and maintain a personal geodatabase for each sketch project

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Enabling Science

- A project that explored environmental / economic benefits of green cover …
  - Carbon storage and sequestration
  - Air pollution removal
  - Storm water runoff reduction
  - Energy conservation
  - Wildlife habitat protection
- Utilized the CITYgreen ArcGIS extension distributed by American Forests

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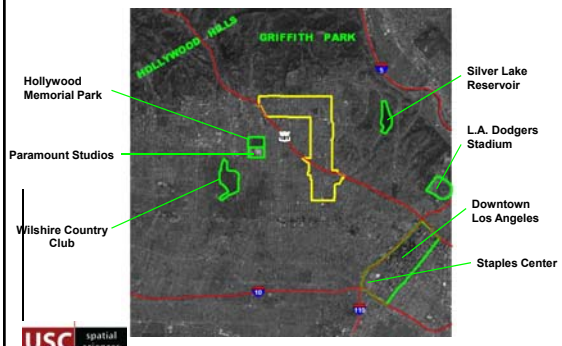
Vermont / Hollywood Study Area



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Study Area Metrics

- 1,380 acres (560 ha)
- 50,000 residents
- 19,500 housing units (50% built before 1959)
- Current land uses
  - Residential (R)
  - Business / Commercial (C)
  - Institutional (I)
- Very little green space

Vermont Avenue (commercial)

Catalina Street (residential)

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Projected Benefits of Green Cover

	Pounds Removed Per Acre Per Year (lb)					Tons carbon stored ($10/t)	Economic Benefits
	O_3 ($3)	SO_2 ($2.45)	NO_2 ($6.90)	PM10 ($5.20)	CO2 ($1.50)		
Current							
Commercial	1.11	0.09	1.02	1.29	0.20	0.013	$17.73
Institutional	5.04	0.42	4.63	5.89	0.91	0.021	$80.31
Residential	4.49	0.37	4.12	5.24	0.81	0.053	$78.81
Scenario 1							
Commercial	3.26	0.27	2.99	3.80	0.59	0.025	$51.97
Institutional	8.26	0.69	7.58	9.64	1.50	0.080	$131.95
Residential	7.21	0.60	6.62	8.42	1.31	0.085	$115.38
Scenario 2							
Commercial	8.85	0.74	8.13	10.34	1.60	0.104	$141.83
Institutional	11.53	0.96	10.59	13.47	2.09	0.116	$184.35
Residential	10.33	0.86	9.48	12.06	1.87	0.122	$165.25

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Several Shortcomings!

- Adopted a multidisciplinary approach
- CO_2 and other pollutants removed by trees and grass equivalent to that produced by 500 automobiles
- Should use valuation models like CITYgreen carefully
  - Incorporates relationships and parameters derived from limited data
  - Works better in suburban vs. established urban areas (like study area) for example
- CITYgreen is not a "peer-reviewed" model
- Project was a purely an academic exercise …

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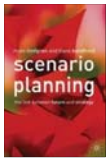
Scenario Planning

- Sketching
  - Sketching and analyzing potential future land use maps
- Spatially informed models
  - Crafting a series of spatially-informed models to measure effects of sketched plans
- Fast feedback
  - Rapidly generating a series of maps, charts and spreadsheets
- Iteration
  - Supporting several rounds of review and revision



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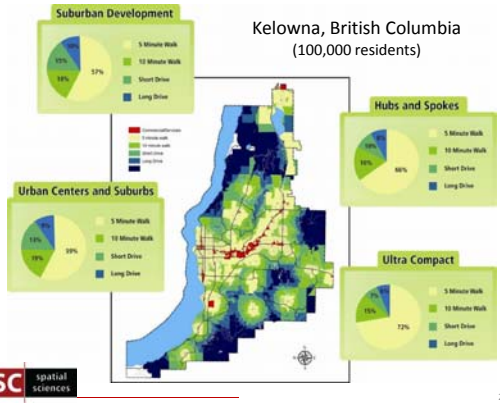
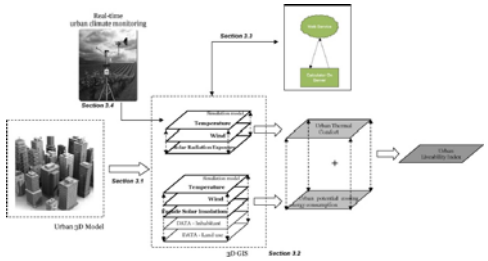


Kelowna, British Columbia
(100,000 residents)

Bridging Scales



Wong et al. (2011) Integrated Urban Microclimate Method as a Sustainable Urban Development and Design Tool

GeoDesign in a Nutshell

- Integrates art (sketching and design) and science (modeling and analysis)
- Enhances collaboration and selection of designs that reflect a community's needs and vision for the future
- Promotes transparency and participation
  - Engages broad audiences who would otherwise lack the means by which to contribute
  - Makes information and trade-offs explicit since everyone can see how each sketch leads to a particular result

Geographic Knowledge Infrastructure

- Contains knowledge describing natural and human environment on Earth
- Multiple components
  - Data
  - Data models that provide structure to the data
  - Models and analytic tools that show predictions or suitability
  - Geospatial workflows
  - Metadata, which describes the aforementioned components, and is key to sharing, discovery and access
- Web environments that make this knowledge more accessible and promote spatially integrated thinking

As we move from an industrial economy to an information economy, our reliance on physical infrastructure is being supplemented by reliance on a new type of infrastructure: geographic knowledge (Dangermond, ArcNews, 2010)

Why is GeoDesign Important?

… has the capacity to shift GIS to a whole new approach, one oriented toward creation, imagination, experimentation, and with a view towards applying knowledge in a forward looking manner

… the GIS itself would fade into background