



GeoDesign: Designing Our Future in an Anthropogenic World







John Wilson
Chinese Academy of Sciences
4 July 2011



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 interdisciplinarity
 - Specific goals (livable cities, sustainability)
- Geographic Knowledge Infrastructure
- Final Thoughts

The 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 enabling technologies – BIM, CAD, etc.



Proposed Anaheim
train station &
transit hub, 2011



Spectacular Visuals






Extraordinary Results








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 the 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 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 an experimental approach that uses sensitivity analysis to narrow the response to defined constraints
- **Optimizing** – this is 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



McHarg's Design With Nature







Constraining Design Approach


7

Geography (Fisher)



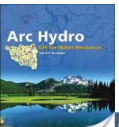
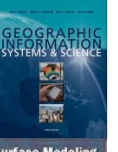




- Focuses on what is or what has been
 - Track interactions and flows to understand how and why things happen in present and in past
 - Increasingly rely on visual thinking to handle ever-larger amounts of data and to make ever more complex connections between phenomena
 - Geography, with tools such 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




8


Extraordinary Results

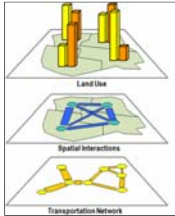










9

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








10

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



Richard Klosterman – What If? Planning Support System

11

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

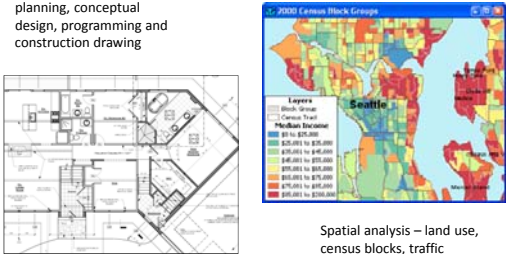





12

Role of Scale and Complexity

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

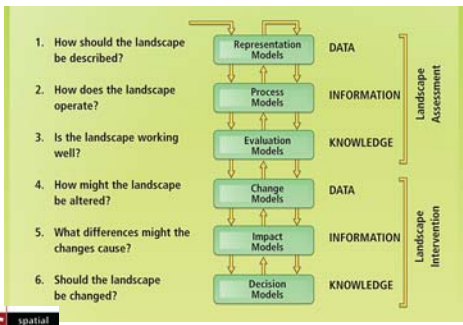



Spatial analysis – land use, census blocks, traffic patterns, air quality tables



13




Steinitz's Model of Landscape Change

14






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 ...






15

Scale and Complexity (3)

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

(Slide courtesy of Michael Hutchinson)



16

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 (and science), an emphasis on collaboration, an interest in interdisciplinary approaches, and a renewed interest in livable cities and sustainability







17

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






18

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

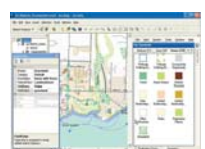



19

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


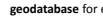


Uses out-of-the box or customized symbols to meet your specific needs

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






20

Enabling Science

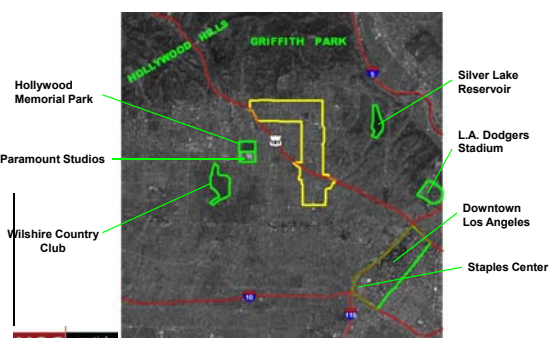
- Will use a small 2006 project to clarify role and value of nature's services in a modern city
- Relies on CITYgreen, an ArcView extension, distributed by American Forests
- Calculates economic benefits of green cover
 - Carbon storage and sequestration
 - Air pollution removal
 - Storm water runoff reduction
 - Energy conservation
 - Wildlife habitat protection






21

Vermont / Hollywood Study Area





22

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)

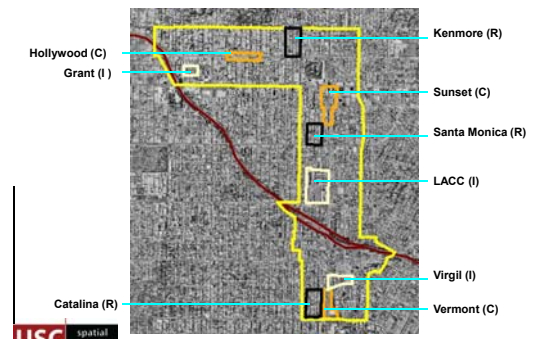




Catalina Street (residential)

23

CITYgreen Sample Sites



24

ArcView Themes

- Acquired digital orthophotography
- Built series of ArcView themes representing trees, shrubs, grass, buildings, etc.
- Verified land cover types in field and collected additional plant attribute data

GRANT SITE

25

CITYgreen Features / Attributes

TREE ID	1
AREA	2.31
PERIMETER	5.39
PUB or PRIV	V
SPECIES	SUC
DIAMETER (inch)	4
DIAMETER CLASS	1
HEIGHT CLASS	1
HEALTH CLASS	4
GROUND COVER: SHRUB, GRASS, PAVED, SOIL, OR MULCH	GRASS

26

Sample Site Land Cover

Site	Area (acres)	Trees	Grass	Shrubs	Buildings	Paved
Commercial	13.6	1.8%	2.7%	0.6%	30.0%	65.9%
Institutional	15.6	8.8%	13.1%	1.1%	26.7%	55.2%
Residential	17.3	7.2%	15.1%	3.4%	33.3%	45.0%
Sacramento						
Commercial		8.0%	11.5%	N/A	20.5%	54.0%
Residential		27.0%	7.0%	N/A	23.5%	33.5%

27

Projected Benefits of Green Cover

	O ₃ (\$3)	SO ₂ (\$2.45)	NO ₂ (\$6.90)	PM10 (\$5.20)	CO2 (\$1.50)	Tons carbon stored (\$10/t)	Economic Benefits
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

28

Several Shortcomings!

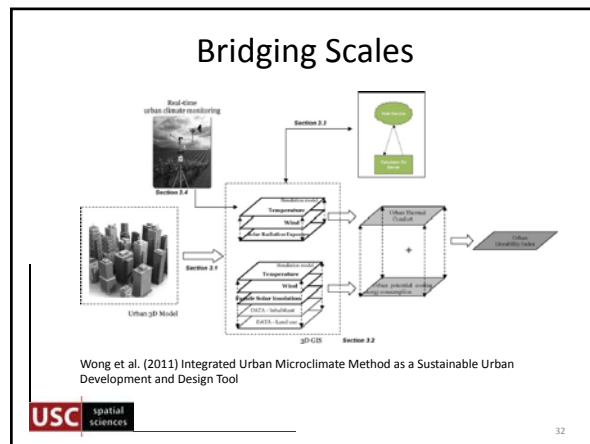
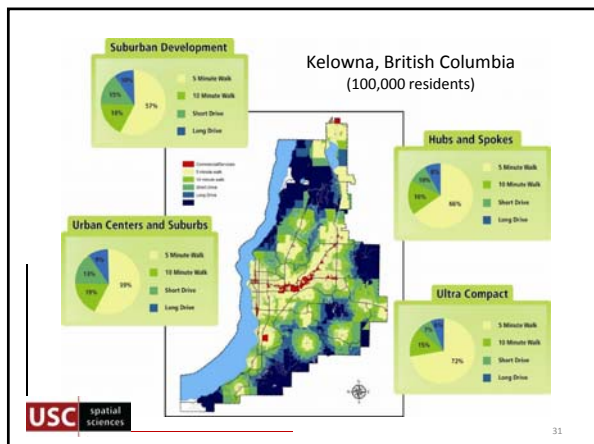
- Adopts a multidisciplinary approach
- CO₂ and other pollutants removed by trees and grass equivalent to that produced by 500 autos
- Should use valuation models like CITYgreen carefully
 - Incorporates relationships and parameters derived from limited data
 - Works better in suburban vs. established urban areas (like study area) for example
- Some have argued that CITYgreen is not a "peer-reviewed" model
- This particular project was purely an academic exercise

29

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

30



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)

USC spatial sciences 34

People / Facilitation

- Most of my comments have focused on the designers, decision-makers and stakeholders
- Need individuals to support and sustain the enabling technology and to push projects to completion
- To succeed, such individuals will need effective communication, facilitation and technology skills

USC spatial sciences 33

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

USC spatial sciences 35

GeoDesign

... 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 facing manner

... the GIS itself would fade into background

USC spatial sciences 36