Geog 464 Learning Objective Outline

LOO 05 Geodesign and Synthesized Workflows for GIS

5.1 What is a geodesign workflow method using assessment and intervention?
5.2 What is a synthesized GIS-based workflow method?

5.1 What is a geodesign workflow method using assessment and intervention?
RUGIS Chapter 3. Section 3.2.2

Some times decision problems are somewhat complex. Carl Steinitz (40 years of GIS at Harvard) developed a landscape modeling workflow process to address complex, regional planning decision problems, we called it *nuanced workflow*, but it has become to be known as *geodesign workflow*. The workflow can be used for planning, improvement programming and project implementation decision situations, as well as many others. The content, structure, process, and context of decision problems are different since the information needs are different in each of those situations. (see Chapter 8).

Geodesign is composed of two main components, assessment and intervention, each with three modeling steps. The *six-step workflow method* has been applied in practice in several GIS-related projects that address urban-regional landscape issues over the past twenty-five years or so around the world (See the bibliographic references to Steinitz in the textbook). See example about sustainable urban watershed development.

Modeling steps are informed by a collection of critical thinking questions that drive information gain throughout the workflow process.

Assessment Modeling about Geoscape Conditions
1) Representation Modeling
The following questions drive information gain when conducting representation modeling.
- How should the state of the urban-regional community with regard to the particular issue at hand be described in terms of a database design that uses value structures?
- What data categories are to be represented by measurements of attributes, space, and time?
- Whose concerns about these design questions should we consider? Are there other groups that should be consulted to make sure we have incorporated all the relevant data into the representation model?

Representation models provide the content and structure for characterizing problems. Complex decision problems are fraught with various interpretations of concerns about urban-regional communities. Stakeholder perspectives from diverse groups, even if these are groups within a single organization tend to align with various concerns, often these are called stakeholder interests. It can be said that those differences of interest are the basis of stakeholder groups. Working with a variety of stakeholder groups on an oil leasing decision problem in the Santa Barbara Channel, Edwards and vonWinterfielt (1987) organized stakeholder interests into *value trees (values, criteria, objectives and goals) to show the similarities and differences among environmental, social and economic objectives and criteria* according to different stakeholder groups. We will look at values structures when we look deeper into database design.

2) Process Modeling
The following questions drive information gain when conducting process modeling.

- If a representation model forms a categorical content and structure foundation for a process model, then how might we examine relationships among land use, transportation, and environmental elements over time as a basis for articulating process dynamics?
- What are the relationships among the spatio-temporal elements, such as land use and transportation, that provide us insight and better understanding of urban-regional process?
- What land use, transportation, and or water resource processes do we need to consider?
- How does the land use, transportation, and or environmental transformation process work?

Urban-regional process modeling adds information about change and process to the content and structure (representation) information to better understand how community conditions are transformed across space and over time. **Without process model information we rely upon the representation model content and structure information to feed an evaluation model.** Landscape change is commonly a land use change issue (Steinitz et al. 2004). Land use change is supported by access to transportation, as it is very difficult to get to places without transportation infrastructure, e.g. like highways or bikeways. The land use and transportation theme connection is fundamental in growth management. The Puget Sound Watershed Characterization project developed a GIS-based structural approach to dynamics using multiple spatial-temporal scales. This is a major reason why we are using the data from this project.

3) Evaluation Modeling
The following questions drive information gain when conducting evaluation modeling.
- How does one judge whether the current state of the urban-regional environment is working well?
- What are the metrics of judgment, e.g., esthetic beauty, habitat diversity, cost, nutrient flow, public health, public safety, and/or user satisfaction, in order to evaluate the nature of change?
- Which of these do we want to consider in various scenarios? A scenario is a collection of assumptions about (baseline, best case, worst case) conditions defined as part of a representation model, carried forward in process modeling, and addressed in evaluation modeling.

The value structure values, criteria, objectives, and goals are used in this model. Scenarios for evaluation models develop out of *tweaking* assumptions about processes, as we can change the input to a process. Given a different set of assumptions about how change might occur, we can generate a variety of scenarios. Sometimes people refer to scenarios as “worst case” or “best case”. Those references must be explicit about what “worst” means and what “best” means. This comes back to understanding values, goals, objectives and criteria that are part of scenario descriptions.

Intervention Modeling about Geoscape Decision Options
4) (Design) Change Modeling
The following questions drive information gain when conducting (design) change modeling.
- By what design options might the current urban-regional landscape be changed, whether conserving or changing the landscape in regards to what, who, where, when, how much, how many, etc.?
- How might a community be changed by implementing design option(s)?
- Again, how many variables can we consider in these models before being overwhelmed?

Many people say that the only constant in the world is *change*. A change model forms the basis of what differences in landscape conditions human beings might bring to action. Scenario models provide a foundation for change models as we take the “before conditions” and contrast them with “after conditions” for a particular collection of conditions. The result of social, economic

and environmental conditions that differ in a major way (or not) is the outcome of a scenario-based change model.

5) Impact Modeling
The following questions drive information gain when conducting impact modeling.
- A change model forms the basis of "what content, structure, process" change are important enough to consider as impacts, i.e. what major landscape condition changes occur in the change model that matter to enough to people to account for costs and benefits of the change?
- What impacts are significant enough to compute that we would want to trade-off certain of these when feeding information to a decision model?
- What are the predictable impacts, i.e., the outcomes of changes that we might expect e.g., the impacts of land use development on water resource conditions?
- What impacts are less predictable because changes and processes are not well understood?
- From where does this uncertainty come…perhaps from absence or underdevelopment of a process model?

Impact models are perhaps more difficult to construct than the previous models, because impact models rely upon good information output from all of the preceding models. Impacts due to urban-regional growth - whether land use impacts, transportation impacts, water resource impacts - are difficult to estimate. The difficulty arises from what is not known about processes. Although considerable data exist, when it comes to modeling impacts, we never seem to have enough of the *right (aka appropriate) data*.

6) Decision Modeling
The following questions drive information gain when conducting decision modeling.
- How is a decision to change, conserve, and/or improve the "landscape" to be made in regards to urban-regional impacts?
- How can a comparative evaluation be undertaken based on a sensitivity of impact change among alternative courses of action?
- How are we to treat impacts in an equitable manner?

Note that step six of the geodesign workflow is about decision modeling. When we trade-off one impact against another we can set priorities for what we value. Chapter 7 of RUGIS text looks at decision modeling issues. What if we do not have the time, resources, insight, and/or data to undertake all of the six steps of modeling? **If not, then we introduce information uncertainty into a GIS workflow process.** Consider the nature of that uncertainty by asking if one step were eliminated, how would you handle information gain. Is it better to know by intention than by ignorance?

The three models of each of assessment and intervention are twins of one another. See Figure 1 data, knowledge, and values

05.2 What is a synthesized GIS-based workflow method? *RUGIS* Chapter 2. Section 3.2.3

Comparing the basic workflow and the geodesign workflow methods, we see similarities and differences in the phases.

Combining them articulates a synthesized method (**Table 3.5**). *Removing the process modeling phase and combining the change and impact modeling phases makes the nuanced workflow look similar to the Basic workflow method. Every time we eliminate one of the six phases we*

introduce additional information uncertainty into the resulting information in our GIS project. Eliminating the process modeling phase means that we do not have insight into the details of process change that underlie evaluation modeling. Eliminating change modeling leaves the impact models in a naïve state – no information about change makes the impact information somewhat uncertain. What is a GIS Analyst to do? How do you/we/organization/community live with information uncertainty? Throughout lab assignments, consider where information uncertainty is inherent in the workflow process. Make a note for later treatment.

Table 3.5 Comparing Basic and Geodesign Methods to Derive a Synthesized Workflow Method

Simplified (Basic) Workflow	**Nuanced Workflow**	**Synthesized Workflow**
1) Identify project objectives - selection of criteria	1) Representation Modeling; Identify objectives in terms of all steps in workflow	1. Representation Modeling 1.1 Problem description based on information needs expressed in terms of goals, objectives, targets (thresholds to reach), and criteria (data categories and measurements). Consider human resources for implementation in particular context. What is left unknown?
2) Create Project Database	1) Representation modeling, database development	1. Representation Modeling 1.2 Database Development – Specification and Design of Schema and Implementation of Database. Consider human resources for implementation in particular context. What is left unknown?
None	2) Process Modeling	2. Process Modeling - Identify critical relationships among features about how they interact. Consider availability of resources for implementation in particular context. What is left unknown?
3) Data analysis – single scenario based on inclusionary and exclusionary constraints	3) **Evaluation** Modeling	3. Evaluation Modeling – Select the characteristics relevant to various scenarios for a new waste treatment plant. Based on human resources available consider number of scenarios to compute. What is left unknown?
None	4) Change Modeling	4. Change modeling - compute the changes in the primary feature under consideration, e.g., number of people served by treatment plant at a given site. What is left unknown?
3) Data analysis – Combined data layers	5) Impact Modeling	5. Impact Modeling – given the change model, compute the external affects of siting a plant at the particular locations. Site and situation impacts. What is left unknown?
3) Data Analysis - Single combination of impacts	6) Decision Modeling	6. Decision Modeling - Perform trade-off analysis using the impacts generated from the impact model. What is left unknown?
4) Report	None	7. Final Report - Create the final report as a model of the information from all other steps. Use the interim reports from all other steps to synthesize a final report.