Geog 461 Learning Objective Outline

LOO 21 Linked Analysis for Planning-Level and Programming-Level Decision Situations

21.1 What role does GIS-based modeling play in linking planning to programming?
Nyerges and Jankowski *GISDS* Chapter 9. Linking Analyses across Decision Situation Processes, Section Introduction

After describing integrated analysis among functional themes, we extend the idea of integrated analysis across decision situation processes. More efficient, effective and equitable progress with regard to improvement in community quality of life, must consider how plans, and the budgets to implement those plans, plus the implementation of projects funded by those budgets are connected to each other. **Organizations across the world understand that there are links, but how to implement the links is the real challenge. A start is through database integration that supports the linkage.**

This chapter focuses on links among databases and analyses, highlighting much of the motivation for this book. That motivation stems from a recognized need to answer two of the seven core research questions developed as part of a National Research Council (1999) report titled *Our Common Journey*, summarized by the authors in an article titled *Sustainability Science* (Clark and Dickson 2003, Kates et al. 2001), and posted on the web site for sustainability science and technology forum (Bolin et al. 2000):

6. How can today's operational systems for monitoring and reporting on environmental and social conditions be integrated or extended to provide more useful guidance for efforts to navigate a transition toward sustainability?

7. How can today's relatively independent activities of research planning, monitoring, assessment, and decision support be better integrated into systems for adaptive management and societal learning?

In line with the above motivation, as we mentioned in chapter 1 and from a perspective on integrated watershed management in chapter 8, Heathcote (1998 p. 391) sees a relationship between plans, programs and implementation level management in the following way. She, as do many others, recognize that:

a) plans are developed to guide programs

b) programs are developed to match projects to social, economic, and environmental conditions in the world (i.e., what is needed, what can be done about water resource impairments), and

c) projects are proposed fixes to conditions that are causing those impairments.

Today we focus on planning-level and programming level (GISDS section 9.1), next time it will be the link between programming-level and implementation-level decision processes (GISDS section 9.2).

21.2 What role does GIS-based data integration play in linking planning to programming?
Nyerges and Jankowski *GISDS* Chapter 9. Linking Analyses across Decision Situation Processes
Section 9.1 Linked Analysis for Planning-Level and Programming-Level Situations

Plans are developed to guide growth. Programming is conducted to finance the build-out of a plan. A linkage among planning and programming promotes a sustainable development perspective like that of the Office of Sustainability and Environment at the City of Seattle (See Figure 9.1).

Figure 9.1 City of Seattle - Sustainability Management System Model (draft)

Figure 9.1 provides an overall sense of comprehensive plan linkages to business work (capital improvement) programs at the City. The four step process is based on an approach to total quality management (TQM). As depicted here, the TQM process has been articulated in terms of sustainability decision modeling as the core activity (Brassard 1989).

- Comprehensive plan elements of step 1 depicted at the top of the figure are used to Assess/Revise the goals of a TQM-based sustainability process.
- The business programs are budgeted in step 2 so as to achieve those goals of step 1. A link is established between Comprehensive Plan goals and business program activity to set a Plan of action.
- In step 3 sustainability decision modeling is performed to better understand how work programs can be implemented to carry out those goals. These models can follow the process outlined in Table 9.1.
- In step 4 monitoring and review of the sustainability modeling is used to provide feedback to a new cycle feeding into step 1.
- A multimedia report provides a pleasing visualization presentation of the results more likely understandable to people with diverse backgrounds.
- The triple bottom-line report provides information on the social, economic, and ecological conditions of the community activities under consideration.
- Overall process is iterative in character, moving through steps 1-4 as a cycle, since linear processes seldom ever achieve goals without reasonable feedback.

A TQM approach to decision making is a natural fit to sustainability modeling, because feedback is a very important process in both. Feedback from project outcomes to help steer implementation of plans through programs is a similar approach to business management using TQM.

Generally, the goal of a linked planning and programming decision process is to ensure consistent treatment of options in the long and medium term so that a program implements a plan. Linking comprehensive plans to capital improvement programs is an important challenge facing land, transportation, and water resource oriented organizations. Of the three functional domains…

- Link between land use plans and land use programs is less clear, because the land use programs are a fairly dispersed activity across society.
- Link between transportation plans and transportation CIP is clearer, but major challenges still exist because of the pervasive character of transportation improvement.
- Clearest link within water resources context, in that public agencies have considerable authority over most of what happens for drinking water and wastewater, although there are many external effects.

Within the central Puget Sound region, both the City of Seattle and King County are using “Transportation Strategic Plans” to bridge the gap between Comp Plan transportation elements (a twenty year perspective) and the short-term capital improvement programming (a two year perspective revolving over six years). This intermediate (10-year or there about) perspective provides planners, citizens and elected officials with a more effective temporal transition for decision making.

The first step in the workplan is the database model integration.

- Major challenge in linking planning with programming is that planning projects and programming projects are conceptualized differently, given the spatial and temporal scales.
- Different project conceptualizations mean that from an information perspective, plans and programs are loosely coupled at the current time, but from an information technology perspective, they are even less coupled.
- Working on the information technology coupling would enhance the development of visualizations that foster "shared understanding".
- Clearer conceptualization of the similarities and differences (as in a conceptual database design) would strengthen the link between planning endeavor as well as the programming endeavor. Plans would have to take on grounded direction and programs would obtain a longer-term justification with some flexibility for direction.

Many transportation organizations are actively working on more comprehensive transportation database design projects (including some in this region, e.g., PSRC, KCMetro Transit). Most agencies recognize that the "map graphic" era of GIS is past, and database driven approaches to transportation information is a much sounder perspective to use for the short, medium and long-term. Much of what is driving that perspective is an interest in integrating planning and programming projects.

Representing transportation planning projects and improvement projects in a GIS is actually more challenging than just placing point, line, or polygon geometries in a database, and associated symbols on a map. Planning projects are spatially abstract, whereas improvement projects tend to have multiple temporal dimensions. Planning projects come in many different categories whereby multiple geometries are needed for any single category. In addition, there is a temporal dimension for scoping, design, and building that applies to each of the different spatial geometries for improvement projects. A robust conceptual design would have to take these nuances into consideration.

Because object-based data models are now coming to wide-spread commercial fruition, representing improvement projects in GIS is possible, however, the conceptual database models for such applications are still crude, as no major implementations for multimodal, intermodal transportation planning and programming databases have been published in publicly available literature. The question is only when, not if, both planning projects and the improvement programming projects are expressed in a conceptual design, a linking of plans and programs can be supported through integrating the database designs. Since projects take on so many different dimensions, this integration would be a challenge, but a GIS database integration approach can be used to sort through the differences and the similarities (Nyerges 1989a, b).

As described in chapter 3, a conceptual schema and attendant data dictionary for a database specifies the content of a database in terms of the structure and semantics of metadata rather than data. A structure interpretation involves a description of what data classes exist, specified in terms of entity classes and attributes, and the relationships among them. The dictionary provides their meaning.

Nyerges (1989a) suggests that the conceptual schema integration problem can be carried out as a six-step process, within a broad context of information integration for GIS (Nyerges 1989b). A general process of integration analysis is the same whether it applies to data transfer to develop geographic databases, GIS database design or federated GIS database design as link among agencies. The following overview presents the steps outlined in Elmasri, Larson, and Navathe (1987) except that Steps 2a and 2b in the original sequence are now Steps 2 and 3. These two steps are thought to have such sufficiently significant differences in the activities involved that they are separated herein.

Step 1. Convert into conceptual schemas
Convert from implementation schemas into conceptual schemas using an Entity-Relationship (ER) or Extended Entity-Relationship (EER) data model. The conceptual schema should include all thematic, locational and temporal data description representations. We refer to these resultant schemas as component schemas. In the case of spatial data transfer, the schema of the receiving system is called the **target component schema** and those for sending systems are called **source component schemas**. For component schemas, specify the entity types, attributes and relationships for the target schema as in a normal database design process. Use source schemas to determine if definitions are available to be included in a target conceptual schema. Document new as well as any changed definitions in a target data dictionary to clarify the meaning of the target schema.

Step 2. Component schema analysis and modification
Some constructs may need to be converted from one type to another. An attribute in one schema may be an entity type in another schema. An entity type in one schema may be a relationship in another (Kent 1984). Identifying these similarities and differences is not always easy. A review of data dictionaries can be of significant help.

Step 3. Identification and analysis of equivalence
Correspondences among attributes, entity types, and relationship types are identified. Identify attribute field names that are similar using criteria such as the role of the attribute, whether it is a primary or secondary key, the range of domain values, or data quality etc. Use the attribute similarities to assert equivalences. Use the attribute equivalences to assert entity type equivalences. Assess the results of the comparisons and iterate if needed. Entity types are then grouped. A group, called a cluster, represents a similar or related concept as indicated by the bundle of attributes. A cluster may contain anywhere from one to all entity types depending on the similarity.

Step 4. Integration of entity types
Clusters of entity types are used as a guide for determining which attributes to retain and which to eliminate. Representative entity types from each cluster are chosen to retain selected attributes.

Step 5. Integration of relationship types and entity types created from data abstractions
Relationships are integrated after the entity types have been integrated. Specify attribute equivalences in terms of pairs of entity type names, assert the relationship type equivalences in a type similarity matrix, specify the relationship integration assertions to be used in relationship clusters.

Step 6. Creating the integrated schema
Carry out the integration by selecting the entity type or types from a cluster that 'best represents' the cluster identified in Step 4. The same applies for relationship types in Step 5. Eliminate the redundant descriptions and append the unique descriptions to one another through explicit relationships. The result is the integrated schema.

The above steps are appropriate no matter what the schema integration task. The details with an example for land parcel database integration can be found in (Nyerges 1989a).