Conceptualizing Space

Mapping Schemas as Meaningful Representations

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Introduction

The development of Geographic Information Systems (GIS) has transformed the fields of cartography and geography. The integration of database technology with visual mapping technology has provided an advantage over traditional mapping techniques. GIS enables the building of maps that can be dynamically reconfigured to portray various types of data over the same geographic space.

Maps, including those produced by GIS, are considered to be models of the real world. Cartographers and geographers are trained in a cultural tradition that lends primacy to the scientific method. One assumption built in to the method is that hypotheses must be falsifiable. In order for them to be falsifiable, they must be testable. In order to be testable, they must be measurable. The scientific method restricts itself to testing phenomena in the material world. Because of the advantages conferred by the increasingly sophisticated measuring techniques in cartography and geography, maps have become powerful tools. They have facilitated the control of territory, the exploitation of resources and the consolidation of power. The power that has come through the usage of maps has reinforced the idea that maps represent reality.

Maps are not representations of reality, per se, rather they are representations of space and the objects and entities therein. What we identify as objects and entities in space is dependent upon the cultural schemas we employ. Schemas about space are deeply embedded in our cognition. Spatial schemas regulate boundaries for social interaction, the flow of information, and navigation. They are integral to our lives and our cultural interactions.

Our conceptualizations of space, being culturally regulated, must diverge in some ways from that of other cultures. Does it then make sense that taking the same geographic region that an indigenous mapmaker would produce a different map than a mapmaker from the culture with a scientific tradition? How do we account for these differences, i.e., the development of different schemas? Are we able to use a tool such as GIS, based on a scientific paradigm, to create the representations of space that are derived from different cultural schemas? This thesis proposes to explore these questions.

Chapter One will begin by building a broad understanding of the conceptualization of space and the metaphors we use to structure it. It will delineate the categories of spatial knowledge we employ, how we transform knowledge from one form to another, and the sources from which we derive them. This chapter will introduce the concept of space and how it is transformed into place through the use of cultural practices.

Chapter Two will focus on schemas and their relationship to culture. We explore schemas and the internalization of lived experience in terms of navigation. Questions of innate knowledge arise during our examination of spatial schemas and the ways in which navigators from two very different cultures embody space. We find a better explanation of the embodiment of space offered by the emergentist paradigm as we illustrate the difficulties that would be faced by the navigators if they were to use their spatial schemas in different cultural contexts.

Chapter Three focuses on the use of schemas in creating and regulating cultural boundaries on space. The chapter explores how boundaries on a landscape can be (re)conceptualized to conform to culturally-different schemas. It examines the use of schemas to delineate cultural and geophysical boundaries on space.

Chapter Four examines first the historical evolution of mapmaking and the epistemology of cartography. It then lays out the basic functionality and capabilities of GIS to establish a foundation for the incorporating indigenous narrative into a GIS.

Chapter Five offers three examples of indigenous narrative and the discusses the contexts from which the narratives were derived.

Chapter Six examines the ways in which indigenous narrative may be incorporated into GIS. It explores the unique challenges posed by each of the narratives and the possible thematic layers that can be created.

The Conclusion will offer thoughts regarding the conceptualizations of space and using GIS as a tool for meaningfully representing cultural schemas. It will also offer a bit of speculation on the integration of GIS with other software.

1 Conceptualizing space

Place is the first of all beings, since everything that exists is in a place and cannot exist without a place.
--Archytas, as cited by Simplicius, Commentary on Aristotle's Categories

Space that has become meaningful to us has been transformed into *place*. Place is defined as "any portion of space regarded as measured off or distinct from all other space, or appropriated to some definite object to use; position; ground; site; spot; rarely, unbounded space."[1] Place is distinguished from unbounded space insofar as the spatial metaphor has meaning to us. We imbue defined spaces with meaning, project our schemas onto them thereby making them places.

Places are intimately connected to culture—we invest our thoughts, values and collective sensibilities in places as a way of asserting our identities and the identities of others. Place—the way we conceptualize it, the way we organize it, the way we temporalize it—forms a core part of our understanding of the world around us.

Before the advent of literacy, places served as durable symbols of historical events and as aids in recalling those events. Places became a means of constructing the collective past and social traditions, as well as personal and social identities. They served as reinforcement for behavioral patterns and social expectations as delineated through myths and moral tales. Places, serving as anchors within indigenous mythtelling, also provided an explanation of the local ecology and assisted mythtellers in reinforcing social behavior as it related to ecological conservation and sustainability.

1 Webster's Revised Unabridged Dictionary, © 1996, 1998 MICRA, Inc.

1.1 Using Metaphor

Our speech is laden with spatial metaphor. “Map it out for me.” “Give me the lay of the land.” “Stay on the straight-and-narrow path.” “Don't make a mountain out of a mole hill.” “He also *dwelt* at *length* on the growing problems in China's countryside, where incomes are *falling* and unrest is growing.” None of these statements need refer to geographic objects or spaces at all, rather to ideas, philosophies, plans, and storylines. Understanding any of these statements requires contextualizing them in culture.[2]

Spatial metaphors are rooted in our bodily experience. Understanding our experience in terms of objects and substances, as Lakoff and Johnson assert, allows us to treat our experience as discrete entities by picking out parts of them.[3] Identifying parts of experience as entities enables us to categorize them, group them in ways that make them useful. Human purposes—locating mountains, meeting on a neighborhood street corner, weeding gardens—require us to impose artificial boundaries on space in order to make it discrete, just as our own bodies are discretely bounded by the surface of our skin.

We create metaphors of these experiential entities and substances. We structure them internally and relative to one another. Structuring permits us to reason, comprehend, acquire knowledge, and communicate, but it does not create meaningful metaphors.[4] The meaningfulness of metaphors arise from our preconceptual bodily experiences, which can be understood as being structured “by the convergence of our gestalt perception, our capacity for bodily movement, and our ability to form rich mental images” in addition to the constantly recurring image schemas in our everyday bodily experience.[5]

In developing our understanding of spatial cognition below, we need to acknowledge the use of metaphor. The use of metaphor is unavoidable, as language is composed of metaphor. We are required to use language to communicate simply because we cannot share the neural networks of our brains. We need to be clear that our use of metaphorical categories is not an indication that we are using a symbolic processing model of cognition. The types of knowledge and the sources of knowledge we will discuss should not be inferred to be symbolic units of knowledge filed into the metaphorical database of our brains. The categories we are using to discuss space are metaphors that simply facilitate communication.

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2 The literature regarding the use of metaphor is quite extensive. Those interested in other aspects of metaphor might want to begin with Fabrikant (2000) in discussing metaphor in relation to user interfaces, Kuhn (1993, 1995, 1996) on metaphor specifically related to GIS user interfaces, McPherson (1998) in relation to the cultural aspects of metaphor, and Howitt (2001) regarding metaphors related to indigenous mapping.

3 Lakoff, G. and Johnson, M. (1980) Metaphors We Live By, Chicago: University of Chicago Press, p. 25

4 Lakoff, G. and Johnson, M. (1987) Women, Fire, and Dangerous Things: What Categories Reveal About the Mind, Chicago: University of Chicago Press, p. 267.

5 Lakoff and Johnson, (1987), p. 267.

1.2 Spatial Cognition

Spatial cognition is “the knowledge and internal or cognitive representation of the structure, entities, and relations of space; in other words, the internalized reflection and reconstruction of space in thought.”[6] We can describe spatial cognition as the use of schemas to understand the relations of space and the objects contained therein. Spatial cognition allows us to construct representations of space in our minds and transform our knowledge of space using different scales and perspectives.

Spatial cognition is linked to and influences, but differs from, perception. Perception is the stimulation of sensory nerves and the associated impulses that are transferred to our brains. Much of our understanding of space develops from our ability to visually perceive space.[7] With vision, perception consists of the reception of light on our retinas. Our retinas are two-dimensional spaces upon which varying wavelengths of light land. Because our eyes are set apart, we have stereoscopic vision which results in slightly different images landing on our retinas. The two slightly different images from our retina are transferred via neurons to the brain, and cognition allows it to be reconstructed as a unified three-dimensional image.

Our sensorimotor capabilities develop in three-dimensional space, through our ability to perceive and cognize space. Our cognition and the schemas we employ in understanding what we perceive in turn affect what we are able to perceive. We have particular ways of looking at space, particular boundaries that we recognize, which are shaped by culture. Spatial cognition is the functional process by which we perceive our physical space and the layers of cultural meaning we create for understanding it. Spatial cognition is fundamental to our lives, allowing us to move around, to deal with a wide range of concepts, features and hazards.

There are a variety of models that address the cognition of space. There are models developed for use in artificial intelligence research.[8] There are models that address issues of *naïve* geography,[9] which is often referred to as *common sense* geography. Naïve geographic models are concerned with how people put together mentally the multiple views of space they experience. There are also

6 Hart, R. A. and Moore, G. T. (1973) “The development of spatial cognition: A Review.” In Downs, R. M., and Stea, D., (eds.), Image and Environment: Cognitive Mapping and Spatial Behavior. Chicago, Aldine Publishing Company, p. 246.

7 We focus on vision as it is the dominant sense involved in our cognition of space, but that does not mean other senses are any less significant, i.e., touch to a blind person.

8 Kuipers, B. (1994) *Qualitative Reasoning: Modeling and Simulation with Incomplete Knowledge*. The MIT Press, Cambridge, MA. Kuiper’s model, which describes a spatial semantic hierarchy that can be represented on four different levels: control, causal, topological, and metric. The first two being symbolic, egocentric representations; the latter being continuous representations of external real space).

9 Egenhofer, M. J. and Mark, D. M., (1995) Naive geography. Santa Barbara, CA: National Center for Geographic Information and Analysis, Report 95-8. Naïve geography is defined as the body of knowledge that people have about their surrounding geographic world. Naïve geography assumes common sense reasoning about space and makes a number of general claims about how people transform their understandings of space in a variety of ways.

models that speak to notions of mereology,[10] which concerns the theory of wholes and their parts.

Mereological proponents such as Smith (1995, 1996, 1997) suggest that it is erroneous to study beliefs, concepts and representations without also studying their context. The idea that people have maps in their heads, he says, is misleading. "Contextual linkages that make our concepts mean what they mean derive not so much from interconnections between concepts inside the head as from interconnections between the cognitive agent and the common-sense world in which he finds himself."[11] This thesis argues that while it is true that the interconnections between the cognitive agent and the external world are crucial in how space is cognitively represented, it is also true that the "interconnections inside the head" are just as important. For it is through these interconnections that meaning is made, allowing space to become place.

1.3 Nature of Spatial Knowledge

Our understanding of space is multifaceted.[12] We have categories of knowledge about space, obtained in a variety of ways and from a variety of sources. Mark's taxonomy[13] responds to a variety of frames about cognizing space offered over the previous forty years. We adopt his framework here because of its simplicity and the ease in applying it to the notion of schema acquisition and the examples of indigenous narratives throughout this thesis.

There are three broad categories of spatial knowledge identified by Mark: declarative, procedural, and configurational. These forms of knowledge are informed by three different sources of spatial knowledge—haptic, pictorial, and transperceptual spaces. This section will outline the categories of spatial knowledge, their sources, and then discuss how they are integrated within cognition.

1.3.1 Categories of Knowledge

1.3.1.1 Declarative

Declarative knowledge is that abstracted knowledge of geographic facts—Paris is the capital of France; Canada is part of the North American continent, etc. The most direct way to obtain declarative knowledge is through schooling. We are

10 Smith, B. (1995) "Formal Ontology, Common Sense, and Cognitive Science." *International Journal of Human-Computer Studies* 43: 641-557. Mereological Realism can be applied to explain how the same extended entity can be partitioned in different ways but still be considered one entity (e.g., "France is the totality of its 90 departments." vs. "France is the totality of its 311 arrondissements.")
11 Egenhofer and Mark, section 5.3.
12 There are a variety of sources that categorize the different facets of space in different ways. Those interested could begin with Piaget and Inhelder (1956), Kuipers (1975), Couclelis et al. (1987), Haber and Wilkinson (1982), and Zubin [in Mark et al. (1989a)].
13 Mark, D. M. (1993) "Human spatial cognition." In Medyckyj-Scott, D., and Hearnshaw, H. M. (eds.), *Human Factors in Geographical Information Systems*, Belhaven Press, p. 51-60.

taught the names of countries and capitals; of rivers, lakes, and oceans; of deserts and mountains. Though we may never have been to Asia, we know the highest mountain range on the planet is the Himalayas. We don't require direct experience of space to obtain declarative knowledge of it. Indeed, declarative knowledge of space may well be completely cultural and be impossible to discern from physical space alone.

1.3.1.2 Procedural

Procedural knowledge is the knowledge that allows people to perform navigation tasks. It may not be necessarily conscious knowledge, especially if one has repeated experience with the path navigated. Procedural knowledge consists of the recognition of markers and direction as a way of guiding one's travel from one point to another. The procedural path may be as simple as Point A to Point B, or it may consist of multiple legs—Point A to Point B, to C, D, E, and so on, until the final destination is reached.

1.3.1.3 Configurational

Configurational knowledge is 'map-like' and akin to Euclidean geometry. Maps are, in fact, representations of configurational knowledge and may represent political configurations, topological configurations, ecosystem configurations, highway configurations, or any configuration useful to have on a map. Configurational knowledge is distinguished from procedural knowledge in that it is not simply a path, but rather it is knowledge of the contiguous parts constituting a whole. How that whole is defined depends on the specific purpose of the representation. What configurational knowledge does is give us a "birds-eye" view of a particular space.

1.3.2 Transforming Knowledge

Humans are able to transform geographic knowledge from one form to another. Configurational knowledge comprises the larger context in which other spatial knowledge is integrated. Configurational knowledge is derived mostly from maps, which then provide a reference frame for other information acquired experientially.

Procedural knowledge can be derived from configurational knowledge, as when we read a map to plan a route. Declarative knowledge can be derived from procedural knowledge as when one remembers particular facts even though one has forgotten the route.

Declarative knowledge can be developed from configurational knowledge, as when one forgets the configuration of a map, but remembers the capital of a particular country. Declarative knowledge can be integrated into procedural knowledge by the identification of additional markers along a journey.

Our knowledge of space—declarative, procedural, and configurational—is often transformed from one form to another without conscious effort. Our cognition, as our body, is embedded in space and embedded with spatial knowledge. We are continually engaging space and the cultural meanings we have created for it.

1.3.3 Sources of Knowledge

We derive our spatial knowledge, categorized above, from three sources—haptic, pictorial, and transperceptual spaces.[14] Haptic, pictorial and transperceptual spaces are categories we impose based on scale and point of reference.

1.3.3.1 Haptic

Haptic space is our experiential space. It is constrained by the horizons of our sensory perception—sight, sound, smell, taste, touch (temperature, airflow, pressure, etc.). Haptic space consists of overlapping "fields" of sensory input, of which we may or may not be conscious. Haptic spaces are the most important early form of spatial information that humans perceive. Haptic spatial information is fundamental to cognition; without it we have no means of acquiring knowledge of the world around us.

1.3.3.2 Pictorial

Pictorial space is the experiential space that we would be aware of by making a 360° turn. It is the proximate, interactive space in the awareness of individuals, where events unfold. Pictorial spaces are based primarily on visual perception, sometimes augmented by auditory and olfactory perception.

1.3.3.3 Transperceptual

Transperceptual spaces are composed in the mind from a number of independent haptic or pictorial spaces. Transperceptual spaces are not perceived all at once, and cannot be observed from a single viewpoint. They must be experienced over a longer period of time in order to be understood, and our understanding of them is aided by procedural and configurational knowledge.

Geographic space, of primary concern to this thesis, is often considered to be transperceptual space. The entirety of space within a large building such as the Sears Tower in Chicago would be considered an example of transperceptual space, though not necessarily geographic. The geographic space encompassing an area such as the Yellowstone National Park, or the island of Bali, would be also considered examples of transperceptual space.

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14 Mark, D. M. (1993) p. 51-60

Unlike the categorizations of (declarative, procedural, configurational) knowledge, the sources of knowledge form a hierarchy. Pictorial spaces are understood through the metaphorical extensions of haptic concepts; and transperceptual spaces are understood through the metaphorical extension of pictorial concepts (and to a lesser extent, haptic spaces).

1.3.4 Cultural Integration

Spatial cognition is fundamentally tied to haptic space. Indeed, haptic space is the primary source of our lived experiences, and where we first develop our sensorimotor capabilities and understanding of space.

Haptic and pictorial spaces are closely linked. Haptic spaces are limited by our sensory perception, but encompass much of pictorial spaces. Pictorial spaces are, in one sense, haptic spaces just beyond our field of perception (e.g., the space that exists just around the corner, just outside of our visual perception). They are the spaces in which our neural networks are embedded and where we interact with others. It is within these spaces that we experience the patterns of interaction that contribute to our development of schemas regarding space.

Our cognitive representations of space are influenced by the cultural context in which we form our understanding of space, our spatial schemas. These representations can be modified or refined based upon formal and informal learning contexts and cultural interactions. In indigenous cultures, the procedural and configurational knowledge is often transmitted in the form of narrative tales. Indigenous representations of geographic space often include the concept of relationships—to the surrounding geography as well as to the social expectations and behavior of a people.

In his study of Inuit mapmaking, Rundstrom says that the Inuit likely acquire their extensive environmental knowledge through travel. But travel, itself a form of procedural knowledge according to Mark, is unlikely to confer fully developed mapping skill within a culture.

> *The Inuit were good mappers not simply because they traveled, any more than wilderness backpackers or long-distance truckers are naturally accurate mappers. It is the specific actions that one takes during travel and how one mentally organizes, memorizes, and recalls what is encountered that are important. All of that is shaped by the categories of reference influenced by the broad cultural context and by the characteristics of the environment.*[15]

The characteristics of the environment—what is important for us to notice—are influenced by the schema we hold regarding our spatial context. The categories we develop in our cultural contexts help us transmit this knowledge between

15 Rundstrom, R. A. (1990) "A Cultural Interpretation of Inuit Map Accuracy," Geographical Review, Apr90, Vol. 80 Issue 2, p. 154.

persons. But the categories we employ may or may not be the same ones employed by other cultures.

Rundstrom tells us of how European explorers relied upon and praised highly the mapmaking abilities of the Inuit. The maps were extremely accurate, according to the Europeans, which suggests that quite a bit of geographic information was exchanged between the two cultural groups. While we know that the Europeans considered Inuit maps to be extremely accurate, we don't necessarily know the cognitive categories employed by the Inuit in their creation of maps. But because the Europeans readily used the Inuit maps, it suggests that there were overlapping spatial schemas at work in the creation and use of the maps by the different cultures.We acquire our spatial knowledge in many ways--we explore, read maps, travel, give and receive directions, and so on. Our cognition allows us to use our haptic experience and combine it with procedural and configurational knowledge to create coherent representations of pictorial and transperceptual spaces. Our conceptualizations of space are tied to our bodies, based in experience, and influenced by the schemas we derive from our cultural context.

1.4 Space Becomes Place

As stated at the beginning of this chapter, space that has become meaningful to us has been transformed into *place*. Place is distinguished from unbounded space insofar as the spatial metaphor has meaning to us. We imbue defined spaces with meaning, project our schemas onto them thereby making them places.

Heidegger's concept of *dwelling* reinforces our understanding of the distinction between place and space. The concept of dwelling focuses on the forms of consciousness in which individuals perceive and apprehend geographical space.[16] It is more than that. It consists in the multiple *lived relationships* people have with places, and by virtue of these relationships spaces acquire meaning. As Heidegger puts it: "Spaces receive their essential being from particular localities and not from 'space' itself."[17]

Place can be a powerful metaphor for enforcing cultural patterns. Places not only demarcate boundaries of space, but of behavior. The Western Apache use *place-making* to link specific geographic spaces to social and moral imperatives.[18] The Australian Aboriginal peoples use The Dreaming as a complex oral mapping of their geographic spaces, again linked to cultural

16 Basso, K. H. (1996) Wisdom Sits in Places, University of New Mexico Press, p. 106.
17 Heidegger, M. (1977) "Building Dwelling Thinking," in Martin Heidegger: Basic Writings, D. Krell, (ed.), New York: Harper and Row, p. 332.
18 Basso, p. 34.

norms.[19] The Haida culture of the Pacific Northwest also link particular geographic spaces with historical and moral narratives.[20]

In Apache narratives, for example, the spatial anchor is a required feature of the story. There is no real chronological anchor, allowing the storyteller to bridge the time between past and present. Removing the spatial anchor, however, sets the story adrift, resulting in a loss of resonance and subjective connection to the tribal past, to culture. The spatial anchor helps to reinforce their connection to their land and offers a “permanent” manifestation of the cultural and moral norms of the community. The chronological variability allows for adapting narratives for greater impact on the listener, further reinforcing connection to community.

Place-making among the Apache can be described as a *lived relationship* with their land:

> *“For Indian men and women, the past lies embedded in the features of the earth—in canyons and lakes, mountains and arroyos, rocks and vacant fields---which together endow their lands with multiple forms of significance that reach into their lives and shake the ways they think. Knowledge of place is therefore closely linked to knowledge of the self, to grasping one’s position in the larger scheme of things, including one’s own community, and to securing a confident sense of who one is as a person.”*[21]

1.5 Summary

Conceptualizing space is an essential part of human cultural experience. We create metaphors regarding space that arise out of our bodily experience. We structure those metaphors in order to be able to reason, comprehend, and communicate about space. We can categorize types of knowledge as declarative, procedural, and configurational, and transform these types of knowledge from one form to another. We derive this knowledge of space from haptic, pictorial and transperceptual sources.

Our cognitive representations of space are influenced by the cultural context in which we form our understanding of space. What is important for us to notice about space and spatial relationships is determined by what is useful to us culturally and what enables us to interact successfully with others. We transform space that is meaningful into *place*, which can be a powerful metaphor for enforcing cultural patterns and behavior.

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19 Kane, S. (1994) *Wisdom of the Mythtellers*, Broadview Press, pp. 64-5.
20 Kane, pp. 46-51, pp. 68-9, pp. 104-5.
21 Basso, p. 34.

2 Schema Acquisition

Schemas have become a central organizing concept in the cognitive sciences, but they are often misunderstood. In developing our understanding of schemas, we need to discuss several facets. First we want to define them and explore them generally as cognitive entities. Second, we want to examine their relationship to culture and how they come to be shared among members of a group.

We are specifically interested in schemas about space and how we acquire them. We will examine the skill of navigation—the task of locating oneself in space—in different cultural contexts and explore the schemas that navigators develop regarding space. Schemas regarding space seem to be such a fundamental component of cognition that it leads us to question to what extent some schemas, especially those related to space, can be innate.

2.1 What are schemas?

Strauss and Quinn define schemas as “networks of strongly connected cognitive elements that represent the generic concepts stored in memory.”[22] D’Andrade expands on this concept and describes schemas as “flexible configurations, mirroring the regularities of experience, providing automatic completion of missing components, automatically generalizing from the past, but also continually in modification, continually adapting to reflect the current state of affairs.”[23] Describing them as ‘flexible, mirrored configurations’ implies that schemas are representational entities within cognition that are comprised of several elements. Schemas are not the individual elements rather strongly connected clusters of elements of experience within cognition. Elements of experience are clustered in cognition, in our neural networks, because they are

22 Strauss, C. and Quinn, N. (1997) *A cognitive theory of cultural meaning*, Cambridge University Press, p. 6.
23 D’Andrade, p. 140.

clustered in our lived experiences. Clustering cognitive elements makes them more efficient.

Because of the strong connections of elements and their clustering, we are able to fill in information that may be missing from our experience. Schooling, for example, has a number of associated elements—teachers, peers, desks, books, reading, writing, lecturing, and so on. When someone mentions ‘school’ or ‘schooling’, there are a variety of schemas evoked in cognition based upon our lived experience with the same. Simply mentioning the name of something is often enough to activate schemas associated with it.[24] D’Andrade offers us an example:

> *“John wanted to do well on the exam, but his pen ran out of ink and his pencil broke. He tried to find a pencil sharpener, but there wasn’t one in the room. Finally, he borrowed a pen from another student. By then he was so far behind he had to rush, and the teacher took off points for poor penmanship.”*[25]

D’Andrade’s example requires knowledge of a number of schemas: school, exam-taking, as well as sub-schemas for pencils and pens. In this example, the schemas are integrated in a hierarchy. The simple schemas for the function and use of pencils and pens are embedded within more complex schemas related to school and exam-taking. Our cognition automatically completes the pattern—that John was writing, that he was in school, that he was in a classroom sitting next to a writing surface (i.e., desk or table), and so on. Schemas help to fill in the ambiguous or missing information because the associated neurons are more likely to be activated by the initial stimuli.

Schemas, these strongly connected cognitive elements, are powerful processors of experience, help with pattern completion, and promote cognitive efficiency. They serve to both inform and constrain our understanding of experience. People recall schematically embedded information more quickly and more accurately.[26] In fact, schemas hold such sway in our cognition that people may falsely recall schematically embedded events that did not occur.[27] They are more likely to recognize information embedded in existing schemas because of repeated activation of the schemas. This repeated activation evokes expectations within cognition, and the easy recognition of contradictory or challenging information that do not conform to those expectations formed as part of the existing schemas. Information that is orthogonal to existing schematic structures, that doesn’t acquire salience through the repeated activation of schemas and the creation of associated expectations, is much less likely to be noticed or recalled.[28] Because of their functionality in pattern completion,

24 We will return to this notion in Chapter Four as part of our discussion of Apache place-making.
25 D’Andrade, p. 125-6.
26 DiMaggio, [from InfoTrac Web]
27 DiMaggio, [from InfoTrac Web]
28 DiMaggio, [from InfoTrac Web]

schemas function, in some sense, as flexible filters of experience, enabling us to attend to its salient features while filtering out the non-salient.

2.2 Schemas' relationship to culture

Schemas are cognitive entities. They help us to process information. But they are also cognitive representations of entities in the external world. It would be inaccurate to say that schemas are separable from culture, for that would imply that culture consists solely of the external world structures outside the individual. Cognitive anthropological models reject this line of thinking. This thesis adopts a cognitive anthropological perspective in its understanding of culture. The discussion of schemas marks a shift away from the focus on deliberative and explicit cognitive processes, which mirror the ways we deal with language in cognition, to thinking and cognition as automatic and implicit as described by Strauss and Quinn.[29]

Strauss and Quinn, in their framework, refer to schemas as *intrapersonal* structures. The objects or events that are manifest outside individual cognition, the entities in the external world, are *extrapersonal* structures.[30] According to Strauss and Quinn's model, culture consists of the interplay between the intrapersonal cognitive structures and extrapersonal structures such as systems of signs, infrastructure, environment, social interaction, and so on. The intrapersonal and the extrapersonal are different and distinct, but closely interconnected. They are not isolated from one another, rather separated by a permeable boundary. Culture encompasses both intrapersonal and extrapersonal structures and emerges from the interplay between them. It is through this interplay that we can see that some of the intrapersonal cognitive structures called schemas are shared.

2.2.1 Shared schemas as cultural schemas

The sharing of schemas does not require people to have the same experiences at the exact same time and place, rather that they experience the same general patterns. As agents in the world, we organize our experiences[31] in ways that ensure ease of interaction, coordination of activities, and collaborative interaction. Because we organize our experiences in particular ways, people in the same social environment will indeed experience many of the same typical patterns. In experiencing the same general patterns, people will come to share the same common understandings and exhibit similar emotional and motivational responses and behaviors.[32] However, because we are also individuals, there can be differences in the feelings and motivations evoked by the schemas we

29 The debate between symbolic processing and connectionist models of cognition is beyond the scope of this thesis.
30 Strauss and Quinn, p. 6.
31 We organize our experiences in two ways: by organizing the external world structures and by interpreting/organizing their meaning with our cognitive structures.
32 Strauss and Quinn, p. 122-3.

hold.[33] "The learner's emotions and consequent motivations can affect how strongly the features of those events become associated in memory."[34] Individuals will engage the external world structures and experience the same general patterns. Similar stimuli and experiences will activate similar schemas. It is in that sense we considered them *shared* schemas. It's their quality of sharedness that makes them a dimension of the cultural.

Schemas also have other qualities. Some schemas are durable. Repeated exposure to patterns of behavior strengthens the networks of connections among the cognitive elements. Some schemas show historical durability. They are passed along from one generation to the next. Some schemas show applicability across contexts. We draw upon them to help us make sense of new and unfamiliar experiences. Some schemas exhibit motivational force. Such motivation is imparted through learning, explicitly and implicitly, strengthening the emotional connections among the cognitive elements. Schemas are strongly connected networks of cognitive elements, having a bias in activation through repeated exposure to the same or similar stimulus, but they are not rigid and inflexible. They are adaptable, sometimes resulting in the strengthening of existing schemas, sometimes in their weakening in the face of new experience.

We share the intrapersonal dimensions of culture when we interact with others. In sharing these intrapersonal dimensions, schemas are activated. Activation evokes meanings, interpretations, thoughts, and feelings. We make meaning of our experience. The cultural meaning of a thing, which is distinct from the personal cognitive meaning, is the typical interpretation evoked through life experience, with the acknowledgement that a different interpretation could be evoked in people with different characteristic life experiences.[35] In some cases our experience is *intra*cultural, where we share a similar cultural frame. In other cases our experience is *inter*cultural, where we are sharing different cultural frames. The meanings evoked by one person in relation to a particular extrapersonal structure may not be the same as those evoked in another. In fact, the meanings evoked may not be the same within the same person at different times, for they may experience schema-altering encounters in the interim. The ways in which we share these intrapersonal dimensions of culture makes each person a junction point for an infinite number of partially overlapping cultures.[36]

2.3 Spatial schemas

What happens when we extend our notion of schemas to spatial cognition and development of spatial schemas? In Chapter One, we described spatial cognition as fundamental to our lives, allowing us to move about and deal with a wide range of concepts, features, and hazards. Our schemas regarding space

33 Strauss and Quinn, p. 132.
34 Strauss and Quinn, p. 133.
35 Strauss and Quinn, p. 6.
36 Strauss and Quinn, p. 7.

(i.e., spatial schemas) are acquired the same way all schemas are—by internalizing the external world structures through experience, forming networks of strongly connected cognitive elements of experience in cognition. These spatial schemas do not stand in isolation and are linked and connected to other schemas derived from our lived experience. We constantly mediate space when interacting with the extrapersonal world. In mediating space, spatial schemas will be activated, evoking interpretations and meanings regarding the space and the spatial relationships of the extrapersonal world structures.

2.3.1 Navigation

Navigation is a collection of techniques for answering the question, "Where am I?" The question concerns the correspondences between the surrounding world and some representation of that world (i.e., mental representations or charts). In *Cognition in the Wild,*[37] we see the confluence of several facets of culture with the internalization of experience in producing an 'embodiment' of space in cognition in order to answer the question, "Where am I?" Hutchins' research shows us just as much about the acquisition of spatial schemas as it does about the context from which it is derived. Indeed, Hutchins comes to the conclusion that in order to be able to understand cognition and the schemas developed by individuals, one must also study the cultural context in which they exist.[38] This thesis will contrast the navigation techniques of Hutchins' naval team with those of Micronesian[39] navigators, in particular those of the Marshall Islands.[40]

Hutchins focuses on the complementary functioning of a team of naval personnel to fix the position of their ship as part of the activity of navigation. The naval team are part of the bridge crew of a helicopter carrier, *U.S.S. Palau*, a single propeller vessel driven by a 22,000-horsepower steam turbine engine. The *Palau's* flight deck is just over 592 feet long, with a four-story structure jutting up about half way between the bow and stern. The navigation bridge is situated two levels above the flight deck. The navigation team consists of a pelorus operator, a bearing recorder, a plotter, a quartermaster, and a navigator. They do most of their work at the chart table, on the port and starboard wings, and in the

37 Hutchins, E. (1995) *Cognition in the Wild*, Cambridge, MA: The MIT Press.
38 Hutchins, p. 292. "The proper unit of analysis...includes the socio-material environment of the person, and the boundaries of the system may shift during the course of activity…In the present context, many things remain inexplicable until we consider the history of the person in the task environment. This seems especially pertinent to the nature of learning, since learning must be a consequence of interaction with an environment through time."
39 The islands of Micronesia include Kiribati (formerly the Gilbert Islands), Guam, Nauru, the Commonwealth of the Northern Marianas, the Federated States of Micronesia (Yap, Phonpei [Ponape], Chuuk [Truk], and Kosrae of the Caroline Islands), the Republic of the Marshall Islands, and the Republic of Palau.
40 The Marshall Islands are situated in the eastern part of Micronesia, and I will use "Micronesian" and "Marshallese" interchangeably in this thesis. Most of the knowledge regarding Micronesian culture stems from my intracultural and intercultural experiences in the Marshall Islands over the span of eight years. I became intimately familiar with the customs, culture, and language, first as a Peace Corps Volunteer and later as a liaison between Marshallese and American workers on a military base. As a Peace Corps Volunteer, I owned my own outrigger sailing canoe and learned Marshallese sailing techniques, though not the traditional wave navigation used for ocean travel.

charthouse. And although their functions are coordinated, and they are able to communicate with one another, they are dispersed spatially. No one team member is able to see every other member of the team from their assigned vantage point. The team attempts to establish a coherent set of correspondences between what is visible in the (surrounding) world and what is depicted on a chart (a representation of that world).

The methods, tools and practices of the navigation team contrast starkly with the Micronesian system of navigation. The Micronesians traditionally used outrigger canoes to sail between islands and islets, which are spread over vast distances. The design of the Marshallese outrigger canoe is considered to be the most advanced among the indigenous Pacific Island cultures, having an independently floating outrigger that provides for extraordinary stability while sailing. The outrigger canoes they historically used to sail between atolls could exceed 50 feet in length.[41,42] Like the navigators of the *U.S.S Palau,* the Marshall Islands navigators also establish a coherent set of correspondences between what is visible in the world and what is depicted on their mental representation of a "chart." However, there are no "universal units of direction, position, distance, or rate, no analog-to-digital conversions, and no digital computations."[43] Micronesian navigators have an elegant way of "'seeing' the world in which internal structure is superimposed on external structure to compose a computational image device."[44] In other words, the navigator calculates and fixes his position in his mind's eye.

2.3.2 Identity

People are products of history. To every action they bring their personal history and experience, which includes the particular identities and roles they adopted in different situations. The members of the navigation team studied by Hutchins have adopted identities for themselves and in relation to one another. The overall context for their identity is that of the military. They learn what it means to be a seaman in a clearly stratified hierarchy. They adopt constraints on their behavior that signify their status within the hierarchy, which is drilled into them from the time of basic training. In order to be able to function as a senior team member of the military navigation team, and develop an intuitive sense of location and direction, each team member progresses through a series of functional positions. One begins as a pelorus operator who provides information about visual landmarks and water depth in the space being navigated. One then progresses to the job of bearing recorder whose job it is to keep the deck log, as

41 There are five different outrigger designs in the Marshall Islands. Ocean-going outriggers, known as *walap*, are rarely built anymore as most inter-atoll traffic is done by air or cargo ship. However, the smaller *korkor*, averaging 10-12 feet in length is a common sight outside the urban centers and is used for intra-atoll travel.
42 For photographic examples of Marshallese outriggers, see Spennemann (2000), and for an example of a *walap*, see McCurdy (1997).
43 Hutchins, p. 93.
44 Hutchins, p. 93.

well as timing and recording bearings. The plotter then plots fixes and projects the dead reckoned track. The quartermaster on watch has the responsibility for the overall supervision of the team in addition to maintaining several other logs and references in case of emergency. The quartermaster has progressed through the bearing taking, bearing recording and plotting functions in the same way information flows through them. The navigator is the actual leader of the team and is also responsible for directing the steering and engine functions of the navigation task.

It is important to understand the environment of the Marshall Islands in order to understand its culture and how one's identity is derived from it. The Marshall Islands consists of approximately 70 sq. miles of land mass spread over approximately 500,000 sq. miles of ocean—the equivalent to having the city of Boston's land area spread over the eastern third of the United States. The islands are actually 34 atolls and islets. An atoll is formed by the upward growth of a coral reef from the sides of an extinct and submerging volcano.[45] The reef typically forms an irregular ring, the inside of which is called a lagoon. Tiny islands, sometimes miles long but typically no wider than a couple hundred yards, often form atop the reef. The land is divided into tracts, called *wato*, that stretch from the lagoon-side to the ocean-side of the island. And all of the land is owned by women.[46] There is a scarcity of land, but the reef supports an abundance of life that enables survival. The environment is harsh and acquiring resources for survival is necessarily a cooperative effort. Cooperation is so vital that the culture has developed mechanisms to avoid conflict—even the hint of conflict is avoided at all costs. Primary among the mechanisms is a strict adherence to rank and seniority. The younger always defer to the older, even if the difference in age is only a few days. There is also a caste system of *irooj* (chiefs), *alab* (clan leaders), and *ri-jerbal* (commoners/workers). This strict stratification by caste and age is similar to that of the military navigation team in that those of lower rank (or age) always defer to those of higher rank (or age).

In order to survive, the islanders must be able to exploit the reef and be able to move from island to island when the scarce resources on a *wato* are deplenished. Outrigger canoes are an essential tool for such activities. Experience sailing from the time they are children provides the basic knowledge of outrigger functioning and the ability to sail within the lagoon. Ocean navigation, however, navigation requires apprenticeship with an experienced navigator to develop the additional skills of using celestial and wave navigation. A Marshallese navigation team is somewhat less complex in terms of the instruments and measurements they need to handle, but the captain directs the

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45 The theory of atoll formation was originally proposed by Charles Darwin. For a more detailed explanation, see Darwin, C. (1909). To see islands in various stages of atoll formation, see TERC (No Date).
46 Use of the word, "owned," is a poor characterization of the concept as it exists in Marshallese culture. It would be more appropriate to say that "the people belong to the land," as land is not so much "owned" by any single person as it is held in trust for future generations of the family and clan. What determines one's rights to live and use the tract of land is one's matrilineage. One typically has more than one tract of land upon which one may live and extract resources.

team who will take on the tasks of steering, tacking,[47] sail adjustment, visual sighting of reef hazards, bailing, and so on. The captain has a special status while navigating the sailing outrigger and outranks everybody regardless of caste or age.[48] LaBedbedin describes the Marshallese custom:

> *You know in Majal custom you're forbidden to say one word if you're not in charge. Our old word for captain is ri-jela or one who know. He is only one to say kabbe or bwabwe or point out which wave to follow.*[49]

2.3.3 Situatedness

The military navigation team navigates by fixing the position of their vessel on charts, which corresponds to where they are in space. Fixing position is more than establishing correspondences, however. In learning how to fix the position of their vessel, Hutchins' navigators learn how to "feel bearings as directions in the local space defined by bodily orientation" as a way of "think[ing] like a compass."[50] As indicated above, the navigation team members have specific roles and expectations of performance in relation to the task of navigation, to each other and to themselves. They share an understanding of their own roles and those of the others. They may not share, however, the same understanding of the information being passed among each other. For example, within the military navigation team, if a bearing of "059" degrees is reported the novice may consider it to be simply a string of numbers to be written down in a book. The experienced navigator, upon hearing this same bearing, "may know which direction he is currently facing and may actually feel the direction indicated by the bearing as a physical sensation."[51] The schemas he has developed through learned experience are more complex than those of the novice. His schemas are embedded at a conceptual-affective level where he can coordinate his cardinal direction schema with his bodily frame of reference.

The Micronesian navigator does something similar.[52] Micronesian navigation techniques rely on celestial navigation, but if ever blown off course the navigators would be lost. Because the islands are low-lying coral atolls and islets, there are no significant visual references that rise vertically from the horizon when sailing between atolls in the outriggers. The navigators had to rely upon the wave formations in order to navigate. So they also learn wave navigation, learn to feel

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47 Tacking with most Micronesian sailing outriggers is accomplished by moving the pivot of the sail from one end of the outrigger to the other as a non-stationary mast located in the center of the vessel supports it.
48 The notion of "There is only one captain" was repeatedly drilled into me throughout my experiences sailing in the islands.
49 Knight, G. (1980) *Man This Reef*, Majuro: Micronitor News and Printing, p. 71. Marshallese words in italics. *Majal* is the local derivation of Marshall. *Kabbe* is tacking toward the outrigger. *Bwabwe* is tacking away from the outrigger.
50 Hutchins, p. 141.
51 Hutchins, p. 141.
52 For a more thorough discussion of the contrasts between Western and Micronesian concepts and calculations regarding navigation, see Hutchins, pp. 65-93.

the differences in wave patterns, as depicted in the story of Taramalu and La Enjin:

> *They put her in jape, (large wooden bowl our ancestor used to pound breadfruit,) and float her upon reef. You know that huge rock on Namorik reef called Daij, well they blindfold her and swim her around rock at high tide on and on till she can point to rock no matter where she is. From rock of jape and roll of wave she know she is east of rock or south or north, or west. They teach her about four wave. Not these little wave that wind blow. But wave (swell) of this world. One come from West. One from North. And then that big one that is always strongest, one we call buntokrear (fall from East).*[53]

The navigator doesn't imagine the area to navigate from a bird's eye view. His central point of reference is himself. With celestial navigation, he models the progress of the voyage "as the movement of an unseen [reference island] that starts out under a star bearing ahead of and to the side of the course and ends up under a star bearing behind and to the same side of the course."[54] The navigators have, for centuries, used stick charts—known generically as *medo*—to map the wave formations they would encounter while sailing between atolls and islets.[55] With wave navigation, teaching a novice how to read the waves in order to navigate includes having him lie inside the hull of the outrigger canoe in order to experience the different waves, similar to Taramalu sitting in a wooden bowl to do the same. He feels the relationship between the main waves driven by the winds and secondary waves (or the lack of them) resulting from the presence of an island. The interference pattern created by these two types of waves allows the navigator to direct the canoe along the waves of greater amplitude—which was the indicator of the presence of land—toward the island. The navigators also rely on other indicators such bird sightings to indicate his proximity to land even when it is beyond the horizon and out of sight. The Micronesian navigators use their bodily sense and their bodily frame of reference just as the experienced naval navigator does, by making himself the central point of reference, by thinking like a compass.

Our spatial schemas seem to be so deeply embedded that it seems as if there is an innate quality to them, as though at least some of the knowledge we have about space is genetically programmed into our psyche and not acquired through experience. For example, the navigators' bodily sense and bodily frame of reference seems to be some form of innate knowledge standing in contrast to the particular schemas employed for calculating position and direction. Is there a genetic capability or genetic constraints that influence the development of the navigators' spatial schemas? What do we really know about innateness in terms of spatial cognition? Is the navigators' bodily frame of reference an innate type of

53 Knight, p. 69.
54 Hutchins, p. 89.
55 Thrower, N. Maps and Man: An Examination of Cartography in Relation to Culture and Civilization, New Jersey: Prentice-Hall, Inc., 1972, p. 5.

knowledge? Before answering these questions, we need to diverge a little to discuss exactly what we mean by innate knowledge.

2.3.3.1 Innateness

One of the difficulties faced by cognitive approaches to culture is the question of innate knowledge. How is it that children who have physical impairments such as blindness or deafness acquire the same cognitive schemas at generally the same rate as their non-impaired peers? The impairment of cognitive functioning would suggest that the lack of a significant modality of sensory perception would significantly affect the acquisition of schemas, but such doesn't seem to be the case. Humans tend to acquire cognitive schemas at the same rate regardless of impairment of some sensory modalities. This suggests that there is an innate component to at least some types of knowledge—that is, the pump seems to be already primed.

The notion that there is an innate structure to knowledge stems from Descartes' nativist perspective that concludes that much of our knowledge is innate and results from the character and structure of our minds moreso than any particular event we might experience.[56] The human mind, according to this perspective, is built to interpret the world by categorizing it in particular ways. In her chapter, "Innate Knowledge", Landau reveals how the nativist perspective holds validity when examining three domains—language, space and number. What Landau concludes is that despite very different environmental conditions humans are "born with predispositions to create skeletal knowledge systems particular to specific domains", and that "these skeletal systems are nourished by information from the environment, but their character is not *caused* by it."[57]

We can see the validity of the nativist perspective when we consider the case of Kelli, a blind child studied by Landau and Gleitman (1985). Kelli, being congenitally blind, was able to extrapolate metaphors for *look* and *see* to her sensory modality of touch. Kelli used the words *look* and *see* in her speech when she wanted to touch and explore an object, just as a seeing child would when they wanted to explore visually an object. Further Kelli was able to distinguish between the notions of *look* and *touch*. When asked to *look* at a book, for example, Kelli explored it with her hands. But when asked to *touch* a book, she did just that, without tactile exploration of the object itself. The example of Kelli indicates that a blind person is able to develop a vocabulary that includes visual metaphors without ever having experienced them.

56 Landau, B. (1998) "Innate Knowledge", A Companion to Cognition Science, W. Bechtel and G. Graham (eds.), Blackwell, p. 576.
57 Landau, p. 576.

Similarly, Landau, Spelke and Gleitman[58] studied the spatial knowledge in a blind child and concluded that Descartes' perspective was valid. In the experiment, a two-and-a-half year old child, blind since birth, was tested for her ability to navigate competently in an unfamiliar environment. The child was walked from a particular starting point to another point in the room and then back again. The same process was repeated with two more points in the room. The child was then given a set of spatial inference problems, in which she was asked to move between the landmarks on her own. She was moved from the starting point to a second point and then asked to find a third point and given the freedom to move about on her own. When she reached the third point, she was then asked to find the second point. She was subsequently asked to find points from different starting points. The child moved along roughly straight-line paths between pairs of landmarks along paths previously not experienced, which suggested to Landau that "the blind child possesses spatial knowledge that is apparently quite similar to that of the sighted child."[59] Landau and her colleagues concluded that "such a system of knowledge arises whether the child has experienced the rich spatial environment afforded by vision or the less rich information about the larger environment that is afforded by the other senses, making plausible Descartes' proposal that certain properties of space are innate."[60]

In the spatial domain, blind children form a representation of space similar to that of sighted children, including information about angles and distance.[61] Even lacking the sensory modality of sight, they are able to develop cognitive representations of space. Their lack of sight does not inhibit their ability to internalize their lived experience. Nor does it prevent them from understanding the meanings related to a particular place even if the metaphorical constructs that communicate them are beyond their experience. From the examples looked at by Landau, she concludes that "learners come to the task of learning prepared with some initial biases, schemas, and structures which will be used to filter, analyze, and reorganize data provided by the environment."[62]

So, according to Landau, there seems to be at least some innate structures and schemas that allow for the creation of meaning within cognition. But how do these innate structures and schemas integrate with our notion of culture as the interplay of the intrapersonal and extrapersonal? When we talk of interplay, we are talking about *emergent phenomena*. The variation in responses to the same stimulus indicates that culture is an emergent phenomenon and that innate structures don't always predict the same response in reaction to the same stimulus.

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58 Landau, B., Spelke, E., and Gleitman, H. (1984) "Spatial knowledge in a young blind child", *Cognition*, 16(3), pp. 225-60.
59 Landau et al., p. 582.
60 Landau et al., p. 582.
61 Landau, p. 580-2
62 Landau, p. 589.

2.3.3.2 Emergentism

Whatever innate structures exist seems to help in our creating meaning and schemas, but they are inadequate as sole explanations of how meaning or schemas are created. If we consider that innate structures are closely aligned with brain architecture, as is implied by nativist theory, we run into the problem of how the brain architecture works. Further, we have difficulty explaining, "how 10^{14} synaptic connections in the human brain could be controlled by a genome with approximately 10^{6} genes."[63] We would also have difficulty explaining how brain damage in infants often does not result in the same impairments of cognitive functioning, as would the same damage done to an adult brain.

Even so, both nativists and emergentists recognize that brain architecture and the neurochemical processes that occur are necessary for cognition to occur. While the nativists claim that there must be some innate schemas prior to experience, the emergentists refute that claim by demonstrating that the phenomena claimed to be innate is confused for domain specificity, species specificity, localization or learnability. Emergentists such as Bates define *"innateness* as a claim about the amount of information in a complex outcome that was contributed by the genes."[64]

Bates, Elman, Johnson, Karmiloff-Smith, Parisi, and Plunkett[65] offer us a classificatory schema for better understanding the way in which meaning creation and brain architecture work in terms of innateness. There are three levels of classification—representational constraints, architectural constraints, and chronotopic constraints. Representational constraints refer to "direct innate structuring of the mental/neural representations that underlie and constitute *knowledge*."[66] Architectural constraints refer to "the innate structuring of the information-processing system that must acquire and/or contain these representations."[67] Chronotopic constraints refer to "innate constraints on the timing of developmental events…[such as] the number of cell divisions, spatiotemporal waves of synaptic growth and pruning, and relative differences in timing between subsystems."[68]

Representational constraints can be understood as the limits of synaptic connectivity. What detailed knowledge we have is dependent upon the way in which the neurons fire to embed that knowledge neurochemically. The representations we generate within cognition are in turn highly dependent upon

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63 Bates, E., Elman, J., Johnson, M.H., Karmiloff-Smith, A., Parisi, D., Plunkett, K. (1998) "Innateness and Emergentism", A Companion to Cognition Science, W. Bechtel and G. Graham (eds.), Blackwell, p. 593.
64 Bates, et.al. p. 591.
65 Bates, et.al. pp. 590-601.
66 Bates, et.al. p. 591.
67 Bates, et.al. p. 592. Architectural constraints are further broken down into sub-levels: base computing units, local architecture, and global architecture. Base computing units refer to the neurotransmitters; local architecture to the number and thickness of layers of a given region; and, global architecture includes the characteristic sources of input and patterns of output that connect the brain to the outside world.
68 Bates, et.al. p. 592.

the architectural constraints. Some forms of knowledge can only be acquired as long as the right architecture is in place.[69]

Chronotopic constraints appear to be a significant factor in the development of architectural constraints and subsequently representational constraints. Early in life, from fetal stages through childhood, the growth of neural pathways can overcome the same impairments that would have significant effects in an adult brain. For example, damage to the left temporal lobe, where much of language processing occurs, in infants does not result in the same aphasia that would affect an adult with similar damage. The chronotopic constraints allow for the development of language processing ability by other regions of the brain as more neural pathways are created throughout childhood. Other regions of the brain take on the language processing ability in a child, where they have been "solidified" in an adult.

When nativists claim that there are innate structures and schemas, they are making claims to innate representational knowledge. Using the emergentist notions of constraints, we can see that there is an underlying structure to cognition that allows for the development of schemas and the creation of meaning—which isn't the same thing as having innate knowledge. Having a system in place that allows for cognition doesn't mean that the system is necessarily primed with knowledge. Further, what nativists claim as innate can also be explained by domain-specificity, species specificity, localization and learnability.[70] The categorizations by Bates et al., provide us with the basis to understand knowledge as not something that is innate, rather something that is emergent—subject to chronotopic, architectural, and represetational constraints and emerging from the interplay of intrapersonal and extrapersonal structures.

2.3.4 Embodiment

Spatial schemas are established at an unconscious level, below the level of calculation, beneath discourse and representation. Or at a preconceptual level as Lakoff and Johnson might say.[71] There may be some *innate constraints* that support the cognition of space and the task of navigation for both the seaman and the islander, but it doesn't result in the same cognition of space. The schemas that are embodied are very different. If it were innate representational knowledge, we would expect the military navigator and the outrigger navigator to conceptualize space in the same way.

The quartermaster of the military navigation team, just as his Micronesian counterpart, formulated his understanding of where he was using his bodily frame of reference. His ability to cognize space is the result of using his bodily frame of reference in conjunction with the schemas he developed in establishing

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69 Bates, et.al. p. 592.
70 Bates, et.al. p. 595-600.
71 Lakoff and Johnson, (1987), p. 267.

a *lived relationship* with his environment. The process by which each navigator locates himself in space occurs in very different contexts, however. Each navigator's learning facilitates the development of very different schemas and ways of navigating. The military navigator progresses through a series of functional roles and tools for computation designed to progressively build his knowledge in fixing his vessel's position. He internalizes his experience and develops the ability to think like a compass. The Marshallese navigator learns how to utilize celestial navigation techniques and how to read wave patterns. He also internalizes his experience using himself as the central point of reference in determining his position and direction. Both have very different ways of learning and understanding their location in space, different stimuli they respond to while navigating, yet both ultimately use their bodily orientation as part of determining their position and direction.[72]

The embodiment of their navigation skills is different from one another. The military navigator is internalizing a series of measures that are recorded on a chart. By the time the navigator has assumed the lead role, he has learned about the variety of measurements and how they were gathered. His repeated exposure to the measurements on the charts activates schemas that evoke interpretations of position and direction. He uses those measurements in relation to his bodily orientation in local space to determine the vessel's position and direction. We could say that he is matching the patterns of his haptic experience with the patterns of his configurational knowledge. The Marshallese navigator has internalized his experience with wave patterns and celestial navigation. His repeated exposure to wave patterns and the Marshallese constellations activates schemas that evoke interpretations of position and direction. He uses his bodily orientation directly in analyzing the wave patterns in order to determine his position and direction, in order to match patterns of haptic experience with his configurational knowledge.

The embodiment of chart measurements as opposed to wave patterns represents two very different ways of engaging space. It's important to note that there is an issue of scale when comparing the navigation techniques of the military team studied by Hutchins and the Micronesian navigators. The military team handles a helicopter carrier, while the Micronesian navigator handles an outrigger canoe. All of the canoe and its crew are visible to the Micronesian navigator, whereas the members of the military team are not always visible to each other much less the entire ship. The elements of scale have an impact on the communication and coordinatrion of schemas that must occur for successful navigation. Each navigator has different ways of engaging space and have

72 There is also an interesting interview of Bourdieu by Wacquant regarding the notion of *habitus*. *Habitus* is a relational construct set within and specific to a field, another relational construct. The functioning of *habitus* is similar, but not directly related, to the functionality of cognitive schemas. It is described as "durable and transposable system of schemata of perception, appreciation, and action that results from the institution of the social in the body," by Bourdieu, and is what integrates our explicit and implicit cognitive processes. See Bourdieu, P. and Wacquant, L (1992), *An Invitation to Reflexive Sociology*, Chicago: The University of Chicago Press.

developed different schemas for navigating it within a specific cultural context. Each uses different tools, which are integral to their understanding of space. Yet both navigators have a level of competence with their respective contexts and artifacts and can navigate successfully across long distances.

If the navigators in our examples were to switch vessels, they would be lost. The military vessel, a helicopter carrier, is a large vessel not subject to the same sensitivity to wave patterns as is the smaller sailing outrigger. The outrigger does not have the capacity for holding charts with which to make measurements—the size and layout of the outrigger doesn't allow for chart tables, and the proximity to water doesn't allow for the use of paper-based or electronic tools. They would not be able to access their familiar tools or utilize their spatial schemas to navigate. They would need to rely upon a completely different team composition and set of tasks to facilitate their navigation. The navigators' haptic experiences would be mismatched with their schemas and their configurational knowledge. They would not be able to use their existing schemas as filters to attend to the salient features of the environment. Their bodily orientation, their sense of situatedness, would fail them.

We see that the context in which one learns navigation techniques imparts very different cognitive associations. The embodiment of spatial schemas, though deeply embedded in our psyches, is an emergent process and doesn't represent innate knowledge. Extrapersonal worlds come to be internalized as part of the practice of navigation and the types of knowledge that inform the practice. The embodiment of space is an embodiment of the cultural schemas and is specific to each culture.

2.4 Summary

Schemas are networks of strongly connected cognitive elements. They are intrapersonal cognitive structures that are the internalizations of extrapersonal world structures. They are flexible and adaptive even though they exhibit a bias in activation, which allows them to function in terms of pattern completion. Schemas that result from similar stimuli and experiences are considered to be shared schemas, and as such they evoke comparable meanings, thoughts and feelings. This quality of sharedness makes them a dimension of the cultural.

We develop schemas regarding space in the same way we develop all schemas—through the internalization of lived experience. Spatial schemas are not formed in isolation, rather they're formed in a cultural context where we are constantly mediating space. Our spatial schemas, which are cultural schemas, are embodied at an unconscious level, beneath the level of calculation, discourse and representation. Because they are embedded at such a deep level, they seem to be innate.

We see, however, that nativist claims to innate knowledge can be better explained with an emergentist perspective. In examining the ways in which our navigators engage space, the emergentist frame allows us to see that while there may be some innate constraints that support the cognition of space, it doesn't result in the same cognition of space. Having a system in place that allows for cognition doesn't mean that the system is already primed with knowledge. The bodily orientation of the navigators is not some form of innate knowledge, for if we switched their vessels and cultural contexts, they would not be able to match their haptic experience with their configurational knowledge. Their bodily sense would fail them.

In this chapter we focused on how schemas were acquired, in particular how spatial schemas are acquired as part of the task of navigation. In our next chapter we are going to delve deeper into spatial schemas. We are going to examine the ways in which we create boundaries on space and the schemas we employ in making space meaningful. Boundaries allow us to constrain movement and behavior, regulate power and identity. We will find that just as the schemas involved in the navigation of space are culturally informed, so too are the schemas involved in recognizing boundaries in haptic, pictorial and transperceptual spaces. In fact, they have more to do with our recognition of boundaries on geographic (transperceptual) spaces than may have been previously assumed.

3 Boundary Recognition

We divide up space in many ways. In Chapter One, we outlined categories that divided space by scale (haptic, pictorial, transperceptual). In Chapter Two, we saw a division of space based on the specific roles of the military navigation team. We have linguistic divisions imposed on space, such as when an English speaker uses *here* or *there*, and *come* or *go*, and when a Marshallese speaker uses *tok, woj,* or *lok* (to the speaker, to the listener, or away from both, respectively).[73] Marshall Islanders divide their islands into tracts called *wato*, which are not "owned" by persons. Rather the people belong to the land, have rights to live there and have the responsibility to ensure its productiveness for future generations. Aboriginal groups in Australia have a similar "the people belong to the land" conception of their land.[74] In delineating the concept of boundaries and how they are culturally constructed, this thesis will adopt the framework composed by Rapoport (1994) because it offers us a concise analysis of the ways in which our cognitive schemas regulate boundaries on space.

All groups mark specific locales and organize space, using it differentially, establishing certain rights over portions of it. As such, humans form a mosaic of groups in space, congregating in particular spots on the earth's surface.[75] These congregations may eventually become permanent centers of settlement, or even cities. The geographic space becomes, in effect, a socio-cultural space. With the complexity of the social comes a complexity of the cultural schemas formed to deal with an ever-diversifying context. And we can study that space in a variety of ways: in terms of status, power, group membership, social networks, myth, ritual, symbolism,[76] and so on. Space becomes meaningful through

73 For an extended discussion of the linguistic construction of space, see Levinson (1996).
74 Davis, S. and Prescott, J.R.V. (1992) *Aboriginal Frontiers and Boundaries in Australia*, Melbourne: Melbourne University Press.
75 Rapoport, A. (1994) "Spatial Organization and the Built Environment," in Companion Encyclopedia of Anthropology, Tim Ingold, ed., New York: Routledge, p. 469.
76 Rapoport's notions of latent (symbolic) aspects of organized space emphasize meaning. He distinguishes three levels of meaning for spatial organization: High-level meanings related to cosmology, cultural schemata, worldviews, philosophical systems, the sacred, and so on; Middle-level meanings

cultural classification. Cultural schemas influence the regulation of boundaries and help determine the rules and functions for domains of privacy, patterns of access, and degrees of penetration. Boundaries may be manipulated by individuals or groups to regulate information flows or interaction. They frequently involve systems or sequences of boundaries which can become fairly complex, and which structure and articulate the cultural landscape.[77] Though there are cerrtainly many discussions in the literature regarding the divisions and boundaries we impose on space,[78]

3.1 Cultural boundaries and space

Every time we divide space to foster organization, we impose a boundary—metaphorical or otherwise. We organize space for many reasons—to facilitate or inhibit communication, to confer competitive advantage or collaborative solution-seeking, to reinforce social hierarchies or to foster connections among peers, and so on. Spatial organization is an integral component of cultural interaction, and we can look at that organization from several perspectives—space, time, meaning, and communication.[79]

The same space can become different *settings*,[80] can be used differently and mean different things at different times. Settings are at least partly independent of the "hardware" located there—the plans of settlements, buildings, or rooms as defined by walls, etc. The same spatial unit can comprise different settings at one time, or can become different settings at different times. For example, a vacant piece of land may become a market, a political rally or a theatrical performance (as examples of multiple settings), or it can also be a soccer field, a playground, etc. Studying these settings are problematic because they are temporary, and they do no persist and cannot be identified when people or objects are no longer there.[81]

To further illustrate the complexity of the organization of spaces over time, we can imagine an urban setting in the United States where people create mental maps of particular areas, by recalling procedural knowledge and configuring transperceptual space. Different groups may occupy a particular area at different times. Perception of relative safety can lead to large areas of cities being used or avoided at certain times. Rapoport asserts that such notions of safety are "encoded in urban images, cognitive schemata or mental maps for given towns

communicating identity, status, wealth, power, and so on; and, Lower-level instrumental meanings providing material cues for identifying uses for settings, social situations, expected behaviors, privacy, and so on. The meanings of these different levels vary cross-culturally and over time.

77 Rapoport, p. 471-2.

78 See also Turk (2000), Bala (1999), Benko and Strohmayer (1997), Gupta and Ferguson (1997), Sutton (1995), and Turnbull (1989).

79 Rapoport, p. 465.

80 Rapoport, p. 465.

81 Rapoport, p. 462.

or cities."[82] Or as Heidegger says, "Spaces receive their essential being from particular localities and not from 'space' itself."[83]

Cognitive schemas about particular spaces place constraints on movement. Constraints on movement may be established to ensure a measure of privacy, rather than for safety concerns. They can be organized by avoidance or by scheduling. Avoidance can be achieved by rigid regulation of behavior or by separation in space. Separation can be achieved by putting up markers, some of which can be very subtle—a change in ground surface in an Australian Aboriginal camp to indicate private space, the placing of an ash heap in a Bedouin camp to indicate a public area, or the placement of a roof beam in a Norwegian farmhouse to distinguish semi-public from private space. Making markers stronger increases the clarity of cues and reinforces the organization of meaning.[84]

In discussing the cultural boundaries on space, the focus thus far has been on the human-scale spaces as opposed to transperceptual- and geographic-scale spaces. We haven't considered yet how different schemas regarding spatial relationships interact on these scales. The next sections will explore two examples of how spatial boundaries are constructed in contexts that illustrate the immediate experience of community as constituted by a wider set of social and spatial relations. In the first example, we will consider the regulation of power through the establishment, dissolution and use of boundaries, both physical and social. In the second example, we will consider identity and its power to sculpt new meaning for geographic space. From there the discussion will progress to an analysis of the unique qualities of geographic space and the ways in which we impose boundaries upon it.

3.1.1 Power

In Rofel's examination of space and factory discipline in China,[85] she explores how the memory of spatial relationships from earlier times, including the 1950's and the Cultural Revolution (1966-76), contributed to the creation of "spaces of subversion" during a reorganization of production methods in a silk factory in Hangzhou, China.

Rofel explains that space is a "contested domain of relations of production because of its recognized connections to power."[86] The configuration of spaces of an urban factory greatly affects the contrasting schemas of managers and workers. Managers try to adopt modern methods of production based on the

82 Rapoport, p. 465.
83 Heidegger, p. 332.
84 Rapoport, p. 467.
85 Rofel, L. (1997) "Rethinking Modernity: Space and Factory Discipline in China," in *Culture, Power, Place: Explorations in Critical Anthropology*, Gupta, A. and Ferguson, J. (eds.), London and Durham: Duke University Press. pp. 155-78
86 Rofel, p. 159.

concepts of scientific management and efficiency. And though seemingly a global enterprise geared towards export, the workers are still steeped in the schemas of pre- and post-liberation eras as well as those of the Cultural Revolution.

The architectural design of the factory studied by Rofel was based on pre-liberation (1949) design, which imitated the layout of the Forbidden City, the center of Imperial power. The main factory office, housing the highest level of management, sits in the center of the grounds apart from where the manual labor occurs. The Party cadres occupy the second floor of this main office, setting them apart from the shop supervisors and workers. The shop buildings radiate out in four directions from the main office. Thick concrete walls separate the managerial offices from the shop floors.

The symbolism displayed in the architectural design mirrored that of imperial power, where “inner” and “upper” represented the center of power. The display of hierarchy based on the architectural layout was presumed to be sufficient in and of itself for managerial control of the workers. Yet, this display of power did not produce more efficient production among the workers, nor the discipline necessary for improved production.

As part of the Cultural Revolution, workers challenged the hierarchic relationships of managers and workers and stormed the offices, pulling managers out of them, reading and burning personnel dossiers.[87] Afterwards, the toppling of the hierarchical relationships lived on in memory, where the workers resisted the imposition of hierarchy and worked to subvert the new spatial relationships that were imposed on them by the rearrangement of machinery and production flow.

One example of such subversion is the creation of a rest space by several workers, on the shop floor (though off to the side), in full view of the shift leader’s desk and the entrance to the shop. Rofel notes, “It was the only place to sit down.”[88] The workers flaunted their presence there and often complained about the new measures of production. When the shift leader would yell at them, they would respond in kind. They retained the schema developed during the revolution that resisted the attempts to separate the “economics” of the factory from the “politics” of power.

A second example of spatial subversion concerned the density of the spinning, twisting and combining machines. Workers were not readily visible, forcing managers to walk every row—something they rarely did. The most senior workers would gather to chat and to rest amid the density of machines. They crafted their identities around the memories of work just after liberation, when silk work was a skill valued by others and displayed with pride. They resisted the

87 Rofel, p. 172.
88 Rofel, p. 167.

efforts to increase productivity through new spatial arrangements and insisted on recognition for hard work already done.

A final example of spatial subversion is that of the youngest generation, newly arrived from the countryside. They refused to remain spatially rooted in one place or move in the prescribed ways. They would constantly visit one another, did not work quickly or with pride, nor did they find it terribly important to ensure the quality of their work.

We can see that in the case of the silk factory, identity and social relations exerts a strong influence on how people are constantly struggling to define and redefine their spatial relationships.

3.1.2 Identity

In our next example, we want to examine the notion of identity as tied to geographic space. The anthology edited by Gupta and Ferguson, *Culture, Power, Place: Explorations in Critical Anthropology*, works in some ways to dispel the notion that cultural identity is connected to a particular geographic location or territory on the planet—something that we want to keep in mind as we examine examples of indigenous narrative later in this section. Their premise is that it is a fundamental mistake "to conceptualize different kinds of non- or supralocal identities (diasporic, refugee, migrant, national, and so forth) as spatial and temporal extensions of a prior, natural identity rooted in locality and community…where 'the local' is understood as the original, the center, the natural, the authentic, and opposed to 'the global,' understood as new, external, artificially imposed, and inauthentic."[89]

In her examination of the Punjabi community in California, Leonard describes how the Punjabi immigrants reconceptualized their geographic space in terms of their ancestral homeland.[90] Many of the Punjabi immigrants were from landowning and martial castes. In the first half of the 20th century, immigration and segregation laws put Asian immigrants at a political disadvantage by disallowing interracial marriage, allowing and then rescinding citizenship, and by restricting land ownership. Even so, the Punjabi immigrants who settled in the northern Sacramento Valley—a transperceptual/geographic space—were reminded of Punjab, where "fertile fields stretched across the flat valley to the foothills lying far in the distance."[91] Punjabi immigrants who settled in the Imperial Valley and the San Joaquin Valley made similar claims —the fields, the crops, and the early farming methods were "just like the Punjab."[92]

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89 Gupta, A. and Ferguson, J., eds. (1997) *Culture, Power , Place : Explorations In Critical Anthropology*, Duke University Press, p. 7.
90 Leonard, K. (1997) "Finding One's Own Place: Asian Landscapes Re-visioned in California," in *Culture, Power, Place: Explorations in Critical Anthropology*, Gupta, A. and Ferguson, J. (eds.), London and Durham: Duke University Press., pp. 118-36.
91 Leonard, p. 125.
92 Leonard, p. 125.

Leonard recounts the story[93] written by Hari Singh Everest submitted to a northern California Sikh journal. In the story Everest relocates Punjabi regional sacred landmarks, both Sikh and Hindu, in California. He bestows the name of his homeland on the new environment. This envisioning of the Yuba City area as so similar to the Punjab stands in stark contrast to the social realities of the lives of the immigrants. Many married outside their caste, marrying "brown" Mexican women who spoke Spanish and practiced Catholicism, and created cross-religious bonds such as having a Muslim godparent to a Sikh child. The experience of the various communities in the different valleys was similar in both social reality and how they "visualized their new locality in terms of the old, using familiar landmarks to ground their new identity."[94]

Leonard notes the significance of the accounts in incorporating Asian men as part of the landscape—countrymen taking physical possession of the land and making their livelihoods from it. Just as significant is that though they were agricultural laborers, deprived of citizenship and political power, their accounts include no other actors in the land. The white men who blocked them from power "magically disappeared from the scene."[95] The immigrants pictured themselves as alone, in charge of the physical landscape.

In envisioning their social reality, the Punjabis considered themselves superior to the Mexicans who occupied the same social space, and to whom many of them were married. However, they emphasized the commonalities between the Punjabi men and Mexican women. They argued that there were similarities of appearance and of language. They viewed both groups as having similar material culture—making roti (tortillas), sitting on the floor, sometimes eating from plates on tables with benches.[96] They even emphasized the commonalities in religion, claiming that all religions are the same; Sikhism is a composite of Islam, Hinduism and Christianity; all gods are the same, but called different things because of the different languages; Sikhism has ten "crosses" which are the ten gurus; Sikhs have all the same commandments as Catholics; and so on.[97]

The Punjabi immigrants saw themselves as landowners in their new locale. They viewed their new space in terms of the familiar landscape of the Punjab, which helped to create a collective identity in their new land even in the face of externally imposed identities of subordination by white men who, interestingly, played no part in their newly envisioned landscape. The blending of Punjabi Sikh and Mexican Catholic identities (along with the Muslim and Hindu) was part of the process of place-making, enabling the immigrants to reshape their identities and enable their resistance to the political powerlessness of the times. Their descendants "spoke Spanish and English, practice Catholicism, and refer to

93 Leonard, p. 126.
94 Leonard, p. 127.
95 Leonard, p. 127.
96 Leonard, p. 132.
97 Leonard, p. 132.

themselves as Hindu; whose ashes, if Sikh, were scattered into either the 'holy waters' of the Salton Sea or the Pacific Ocean and who, if Muslim, lie buried in 'Hindu plots' in rural California cemeteries; who looked out over the Sacramento Valley and saw landscapes identical to their beloved Punjabi homeland."[98]

3.2 Geophysical boundaries

In discussing cultural boundaries above, we are discussing spaces on the human scale, the haptic and pictorial spaces. Geographic spaces are set apart from the other categories of space because they "derive primarily from the fact that geographic objects are not merely located in space, but are tied intrinsically to it in a manner that implies that they inherit from space many of its structural properties."[99] For example, the lake cannot exist independently of its location.

Table-top examples reinforce the view that nature can be cut at is joints—the view that there is a true, God-given structure, which science attempts to make precise. Geographic categorization involves a degree of arbitrariness on a number of different levels, and is generally marked by differences in the ways culture structures or slices their worlds.

The identification of geographic entities, though inheriting their structural properties from the space they inhabit, may not be always clear-cut. The boundaries of a bay, for example, may be clearly determinate on the sides where it borders land. The portion where it opens to the ocean, however, is a fuzzy boundary. It is indeterminate and any demarcation of it would be arbitrary and likely to vary from person to person and culture to culture. The identification of what a thing is may influence the location and structure of the boundary; for example, if the bay were identified as a sea, it may have a larger water boundary than if it were identified as a bay or a cove. If a geographic entity is identified as a marsh, then its boundary may be located farther up the slope than would be the boundary of the same feature if it had been identified as a lake.[100]

What geographic entities are identified will depend on the schemas one has developed. Foresters may see a forest as stands, with definite boundaries. An ecologist may see the same forest as plant communities and ecotones with no sharp boundaries. The ecologist may have additional schemas regarding the aesthetic and spiritual value of the forest. The logger may hold schemas that view the forest as a source of income for his family.[101] We can see that the identification of and boundaries of geographic entities can vary and are not always as clear-cut as they may seem.

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98 Gupta and Ferguson, p. 11.
99 Smith, B. and Mark D. (1998) "Ontology of Geographic Kinds," from *Proceedings, International Symposium on Spatial Data Handling*, Vancouver, Canada, 12-15 July 1998. [Online] Available: http://www.geog.buffalo.edu/ncgia/i21/SDH98.html [2001, August 17], Section 1.2
100 Smith and Mark, Section 1.2
101 Mark, Section: Disciplinary and experiential differences.

What we recognize as a boundary is dependent on what we recognize as an entity or object in the space, because geographic entities are tied intrinsically to the space and have boundaries contiguous to the entities surrounding it. We recognize objects “of a straightforwardly physical sort—such as rivers, forests, bridges…[that] have different sorts of properties.”[102] We endow these objects with qualitative rather than quantitative features and with social and cultural significance. There are other objects we recognize as part of the world (e.g., bays) but which exist only because we impose a boundary in demarcating it. There are other (geopolitical) objects such as nations and neighborhoods that exist both physically and through human cognition and action.

As we will come to see in using Geographic Information Systems (GIS), it is important to understand the distinction between *bona fide* and *fiat* boundaries. The former are boundaries that correspond to genuine discontinuities in the world, the latter are projected onto geographic space in ways that are somewhat independent of such discontinuities.[103] Examples of bona fide boundaries include shorelines and water courses (Martha’s Vineyard, Merrimack River, Dead Sea), as well as the surfaces of objects such as planets. Fiat boundaries are those imposed solely by human cognition and include many state/provincial boundaries, property lines, postal districts, etc. Fiat boundaries generally lie skew to any pre-existing qualitative discontinuities (e.g., the boundaries of Colorado and Alberta, Tropic of Cancer, Prime Meridian). Many of the boundaries we recognize in geographic space are at least partially fiat boundaries—the outer boundary of a bay, the boundaries of a wetland, the boundaries delineating the area of a specific soil type. These partial fiats rely more upon the cognition of space than political processes, but are still imposed on geographic space. In some cases, the opposite is true, such as the island of Hispañola—a bona fide shoreline boundary—with its fiat boundaries demarcating Haiti and Dominican Republic.

Fiat boundaries exist only by virtue of the demarcations made by human cognition and behavior. Because they are products of human cognition, they will more likely vary from culture to culture. Fiat boundaries have implications for the ways in which people and cultures interact, where people establish the boundaries of their territory and how they regulate crossing of those boundaries, for example. In our interactions with others, we impose fiat boundaries on our pictorial space—the cultural boundaries we discussed at the beginning of this chapter. Our most clearly recognized fiat boundaries exist as representations on maps. And through maps the notion of bona fide boundaries as existing independent of human cognition, much like the boundaries of table-top entities, is reinforced.

102 Smith and Mark, Section 3.3
103 Smith and Mark, Section 5

3.3 Summary

Cultural schemas influence the regulation of boundaries. We divide up space in many ways and establish constraints on movement by marking space. Constraints on space place constraints on movement and the exercise of power. In other ways, marking space can be a means of establishing and reinforcing identity.

Objects at the table-top scale reinforce the notion that there is a true and obvious structure to space, which science attempts to make precise. Entities at the geographic scale inherit their structure from the space they inhabit. The boundaries for geographic entities may conform to genuine discontinuities (bona fide) or be imposed solely by human cognition (fiat), and is often a combination of the two. Boundary recognition depends on the schemas one has developed, the cultural context in which one is immersed.

4 Mapping Space

4.1 A Brief History of Mapmaking

4.1.1 Pre-modern Mapmaking

It is likely that prehistoric mapmaking served basic purposes such as indicating hunting or gathering sites. We can't know for certain since we don't have much physical evidence to study besides a few carved bones and petroglyphs. These ancient maps are what most cartographers now call *route maps.*[104] They illustrate a detailed, linear path from one point to another—whether that point was a fishing site, a well or spring, a hunting site, or another village. Marshallese stick charts are an example of a route map,[105] though not a very detailed one. They are constructed to indicate patterns of waves and swells generated upon the ocean surface by the winds—though for a long time, Western navigators and scholars thought them to represent ocean currents—and are an example of cartography in its most basic form. Maps of our modern roadways are another example of route maps, which are more accurately scaled than ancient route maps.

In ancient Egypt, however, humans developed a *theoretical map*.[106] The Egyptian map portrays the route to Paradise. Theoretical maps differ from route maps in that they are represent a model, which doesn't necessarily comply with 'reality.' Attributing it to ecclesiastical zeal, Wilford offers several examples of these types of maps created during the Middle Ages by Europeans.[107] These Christian mapmakers, says Wilford, "could not be bothered with the latitude of the next city when Paradise was out there waiting to be mapped in all its glory."[108] Wilford explains that these mapmakers had moved away from the

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104 This is a broad description of route map, which generally refers to a more detailed, linear depiction of a particular route between specific places.
105 Thrower, p. 5.
106 Thrower, p. 10.
107 Wilford, J.N. The Mapmakers, New York: Alfred E. Knopf, 2000, pp. 40-65.
108 Wilford, p. 40.

scientific cartography started in Ancient Greece by Ptolemy in favor of mapping that reflected Christian doctrine more than observed fact. Their techniques were nonquantificational and nongeometrical.

After the Ancient Egyptians and before the European Middle Ages, the Greek scholar, Eratosthenes (276-196 BC) was likely the first to consolidate all previous information regarding maps and the earth into a logical framework. Eratosthenes is considered to have accurately calculated the circumference of the earth to within 200 miles. His measurements of the length of the Mediterranean were the best for 1300 years. He also attempted to divide the earth in a meaningful way, into northern and southern parts and into eastern and western sections, providing the first rudimentary grade and measurements of latitude and longitude.[109] Other scholars attempted to refine Eratosthenes' work and add to it, including Ptolemy.

4.1.2 Emergence of Scientific Cartography

Ptolemy, in his volume, *Geographia*, contributed much to the science of modern cartography. The Greeks, primarily because of the work of Eratosthenes, already accepted the idea of a spherical earth but Ptolemy's work codified it into written form. Ptolemy's work also included measurements of the circumference of the earth; irregular and regular divisions of this sphere (coordinate systems); map projections; maps of different scales; and a world map that embraced large parts of Europe, Africa and Asia—though it was less accurate as distance from the Mediterranean increased.[110]

The Romans were heirs to Ptolemy's and other Greek cartographic works. The Romans appear to have been eminently practical in their own cartographic work, developing maps to assist the military, administrative and other concerns of the empire. The geometric techniques employed by the Greeks along with the *cadastral maps* (property maps)—first developed in Ancient Egypt as a response to Nile flooding which erased boundary markers—allowed the Romans to exercise considerable control over the empire.

The Chinese, too, created cartographic representations of their territory—at least as early as the sixth century BC—as evidenced by the *Yu Kung* (Survey of China). The Han Dynasty (207 BC-AD 220) rulers and generals seemed to have a high regard for maps, using them for military and administrative purposes. The application of grids (coordinate systems) to Chinese maps is attributed to Chang Heng, a contemporary of Ptolemy.[111.]

109 Thrower, pp. 16-21.
110 Thrower, pp. 19-21.
111 Thrower, pp. 22-25. The influence of Chinese cartography upon Western thought (and vice versa) regarding maps is unclear and not the thrust of this examination of cartography. I include it only to show that scientific cartography is not unique to Western cultural paradigms.

From the time of the Renaissance, western[112] cartographers have adhered to a scientific bias. Slowly, as new instruments were developed and more information was gathered, the cartography of the earth has expanded. European exploration of the world in the 17th, 18th, and 19th centuries produced a great deal of information that, sooner or later, was added to maps. The emphasis on quantification and measurement 'advanced' the discipline of cartography. With the gathering of more detailed and quantified information, different types of maps were also created—thematic maps, topographic maps, isothermal maps, block diagrams—and mapping techniques refined. Maps became an essential tool to the conducting of warfare and statecraft. Printing and lithography enabled greater production and dissemination of maps. Aerial photography and satellite imagery added still more detail to maps.

Scientific cartography has culminated in the use of computers to generate dynamic maps and become embedded into GIS. The assumption in GIS is that all geographic features represented as vectors (as opposed to rasters) can be characterized and defined as one of three basic feature types: point, lines, and/or areas. It is the same assumption built into paper-based mapmaking as illustrated in the following figure[113]:

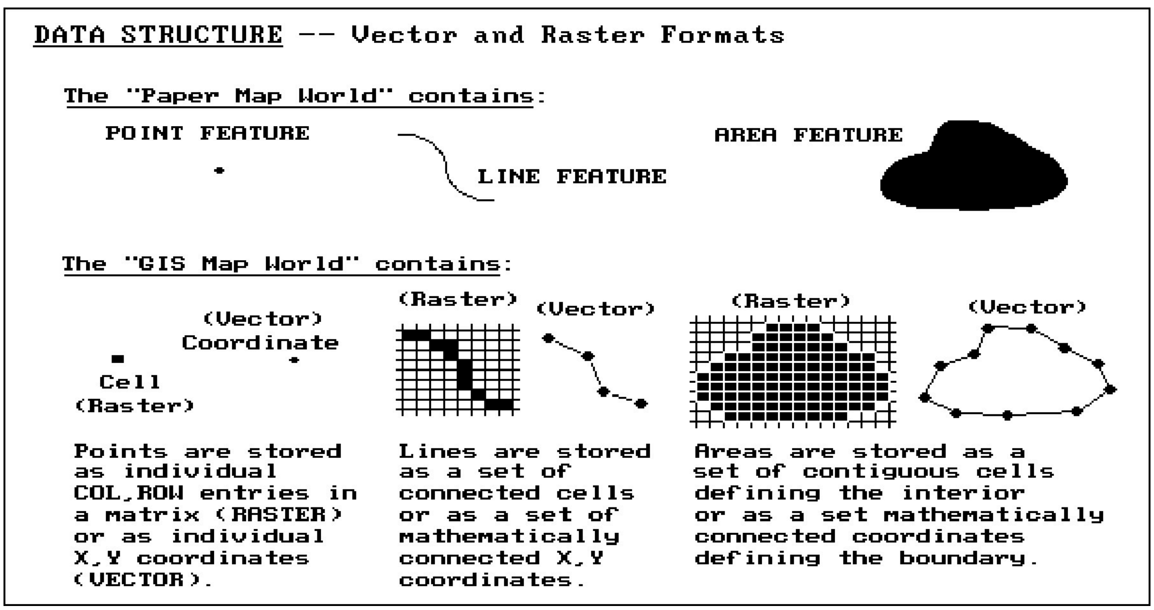

Figure 1. Comparison of the data structures of maps and the data structures used by GIS.

112 The cartography that informs GIS has a history with its roots in Europe. It is in this sense that it has "western" roots. Subsequent usage of "western" should be inferred to mean having a lineage based in European traditions.

113 Buckley, D.J., (No Date). The GIS Primer, [Online]. Available: http://www.innovativegis.com/education/primer/nature.html [2001, August 17].,

4.1.3 Epistemological Power of Cartography

Cartography as a representation of ‘reality’ seems to have been embedded in Western thought as far back as Ancient Greece.[114] Socrates is supposed to have employed a world map to deflate the ballooning ego of his pupil Alcibiades. As told by Aelian in *Various Histories*, written in the 3rd century AD, Alcibiades boasted of his wealth and land holdings so much that Socrates finally took him to a place in Athens where there was a plaque showing the circuit of the world. He asked Alcibiades to point out Attica, which the young man did, and then to show him his property in Attica, which the young man could not do. “These then make you boast,” said Socrates, “though they are not even part of the earth.”[115]

The notion that cartography was a representation of reality seems to have been reinforced by the utility of maps as a means of exerting control over territory. Route maps allowed people to travel more efficiently as more information about their environments became known. And, cadastral maps allowed for the mapping of property, and, hence, the levying of taxes by governments. The practical nature of maps persists, and has become embedded in Western thought as representations of reality. Wilford’s characterization of the European cartography of the Middle Ages, as “close-minded ignorance” and “the slough of intellectual stagnation,”[116] is representative of the contemporary scientific bias inherent in cartography.

Maps have become a fundamental epistemological framework for understanding our world. An example of this was illustrated in Chapter Two, with the use of charts as an integral tool for the military navigation team to navigate and develop their ability to “think like a compass.” The creation and use of maps has been in the throes of revolution for the last two decades. Computer technology has enhanced the science of mapmaking in profound ways. It used to be that the printed map functioned as its own database, the primary storage medium for spatial information. Printed maps had to do two things (simultaneously): store information and be a visualization of how an area looks. With the advent of GIS, the map-as-visualization is freed from the map-as-multipurpose-database. Maps can now be customized in size, scale and perspective.

It seems quite obvious that cartographic methods, with their quantification bias, have embedded themselves thoroughly into Western notions of reality. They are certainly firmly embedded within GIS, as described by a GIS practitioner who characterized maps as graphic representations

114 In this section, we are concerned with the epistemological dimensions of cartography and the power maps, as artefacts of history, have in shaping our knowledge and understanding of our world. The ontological questions regarding what is chosen for representation in maps is carried in various ways throughout this thesis and discussed explicitly in Chapter Six. Those interested in more in-depth ontological perspectives would benefit from the various readings of Smith and Mark (1999), and Turk (2000).
115 Wilford, p. 12.
116 Wilford, p. 40.

> *"…of where features are, explicitly and relative to one another. A map is composed of different geographic features represented as either points, lines and/or areas. Each feature is defined by its location in space (with reference to a coordinate system), and by its characteristics (typically referred to as attributes). Quite simply, a map is a model of the real world."*[117]

This epistemological paradigm contrasts sharply with Kane's descriptions of geographic epistemological frames employed by indigenous cultures[118,] which embed the notion of invisible or sacred worlds, which exist simultaneously or in parallel with our 'real,' geographic world. It would be a mistake to consider the mapping of such epistemological frames as the mapping of doctrine, for they speak as much to cultural identity and observed ecology as to the physical features of the landscape, unlike the theoretical maps of ancient Egypt and Middle Ages Europe. Whether the epistemological frames of indigenous geography and GIS can be reconciled will be discussed in Chapter Six, but certainly it behooves us to acknowledge at this point that cartography has firmly embedded the notion of maps as representational of reality within Western culture, and that maps are used to control territory and maintain power.

Kane characterizes the effects of this scientific epistemological frame quite well:

> *Long after encounters with other cultures ought to have dissolved in Europeans their pride in being alone at the center of the world, maps hold that pride in place. Controlling the world through visual maps is a long tradition. For the Romans, the Mediterranean was* Mare Nostrum*; beyond was* Terra Incognita *with its cherubic zephyrs and other decadent traces of myth haunting the margins of the maps. Following such maps as these, the explorers came, then the traders, then the settlers; capital cities flourished at the intersections of the trade routes, and soon politics linked up all the centers of power with which we are familiar: Rome, Paris, London, Washington, Tokyo.* [119]

4.2 GIS

Geographic Information Systems (GIS) is a computer-based tool for mapping and analyzing geographic phenomena that exist, and events that occur, on Earth. The technology integrates database operations such as query and statistical analysis with the visualization and geographic analysis benefits offered by maps. This integration with maps distinguishes GIS from other information systems and allows for data capture, data management, data manipulation and analysis, and the presentation of results emphasizing the inherent characteristics of spatial data. GIS can consist of a variety of hardware and software tools, and the level of integration of these tools dictates the quality of the geographic data processing environment.[120]

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117 Buckley, D.J., (No Date). The GIS Primer, [Online]. Available: http://www.innovativegis.com/education/primer/nature.html [2001, August 17].
118 Kane, S. (1994) Wisdom of the Mythtellers, Broadview Press.
119 Kane, p. 61.
120 Buckley, http://www.innovativegis.com/education/primer/concepts.html

GIS systems have four main functional subsystems:

1. A data input subsystem
   - ➔ Allows the user to capture, collect, and transform spatial and thematic data into digital form; data is usually derived from a combination of hard copy maps, aerial photographs, remotely sensed images, reports, surveys, etc.
2. A data storage and retrieval subsystem
   - ➔ Essentially, the database component (and its corresponding interface) of GIS; organizes the spatial and attribute data for easy retrieval and analysis; permits rapid and accurate updating of the database.
3. A data manipulation and analysis subsystem
   - ➔ Allows the user to define and execute spatial and attribute procedures to generate derived information; generally considered the heart of a GIS, and distinguishes it from other database information systems and CAD (computer-aided drafting) systems.
4. A data output and display subsystem
   - ➔ Allows the user to generate graphic displays, maps, and tabular reports of the information contained in the database.

We will not discuss each subsystem in depth, rather touch on the salient points of each to help in our understanding the issues involved in incorporating indigenous concepts of place into GIS.

GIS as a technology has a context, which includes hardware, software, data, people and methods. These five components, and their proper planning and functioning, are critical to a successful GIS. Planning includes many factors, among them which data models to employ, what types of spatial and attribute data to incorporate, practitioner training, and data gathering methods, though we will not discuss all of them here.

4.2.1 Data Models

The data models employed by GIS are of particular concern to this thesis. Thematic maps, such as maps of political boundaries of countries, apply a layer of information to the mapping of geographic space. GIS allows for the storage of multiple thematic layers and allows for their dynamic retrieval on a selective basis. Buckley offers the following graphic to illustrate this layering:

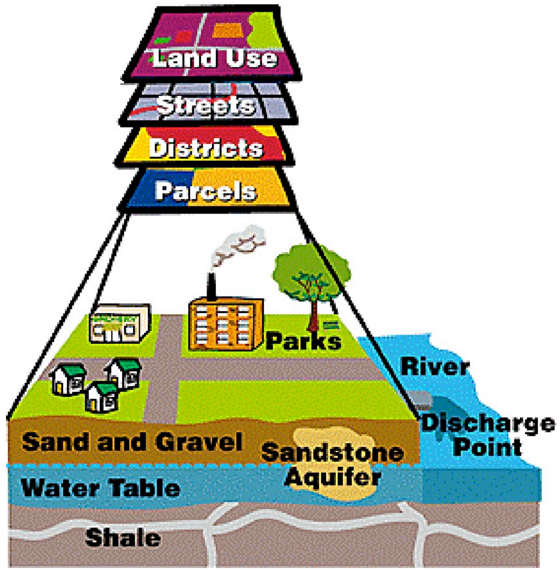

Figure 2. Graphic illustration of the thematic layering concept embedded in GIS.[121]

The layer concept enables the organization of the complexity of the real world into a simple representation so as to facilitate our understanding of various natural relationships. It has been used to solve problems related to tracking delivery vehicles to modeling global atmospheric circulation. It seems feasible that layers regarding indigenous concepts of place may also be built for representation in GIS. What concerns us here is the data and data types involved.

The data types incorporated into GIS are those traditionally found in maps: spatial data and attribute data. Spatial data describes the absolute and relative location of geographic features; attribute data describes the characteristics of the spatial features and can be quantitative and/or qualitative in nature. An example would be spatial data providing the coordinate location of a forestry stand, while the attribute data provides information regarding the characteristics of the forestry stand—cover group, dominant species, height, etc.[122]

4.2.1.1 Spatial Data

Spatial data has traditionally been stored and presented in three ways—as vector, as raster, or as image. Vectors are the most common type of spatial data used in making maps. Vectors are directional lines that are used to represent a geographic feature. Sequential points (a series of X and Y coordinates) are used to define a linear segment. These segments compose polygon shapes that define the boundaries of a particular feature. It is through the use of vectors, i.e.,

121 All figures (graphics) in this chapter were taken from: Buckley, http://www.innovativegis.com/education/primer/concepts.html

122 Buckley, http://www.innovativegis.com/education/primer/concepts.html. Image data is one form of data that can be considered as spatial (photographs, animation, movies, etc.) and/or attribute (sounds, descriptions, narrations, etc.).

directional lines, that we can represent a geographic feature. Vector data creates visual areas on the map, as illustrated below.

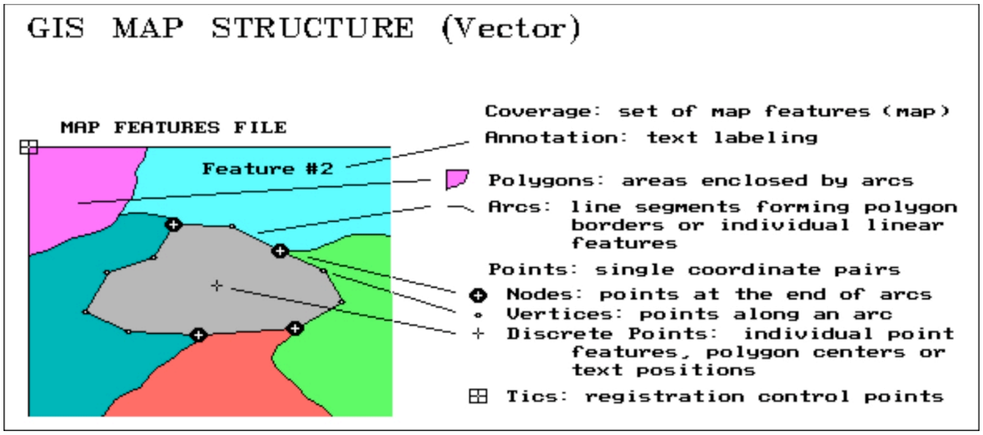

Figure 3. GIS Map Structure (Vector)

Raster models incorporate the use of grid-cell data where the geographic area is divided into cells identified by row and column. Raster data includes such information as elevation, species type, density, etc. Since geographic data are rarely comprised by regularly spaced shapes, cells must be classified according to the most common attribute. Accuracy is a concern for raster model data such that selecting too big a cell will yield overly generalized data, too small will yield too much data and lengthen processing times.

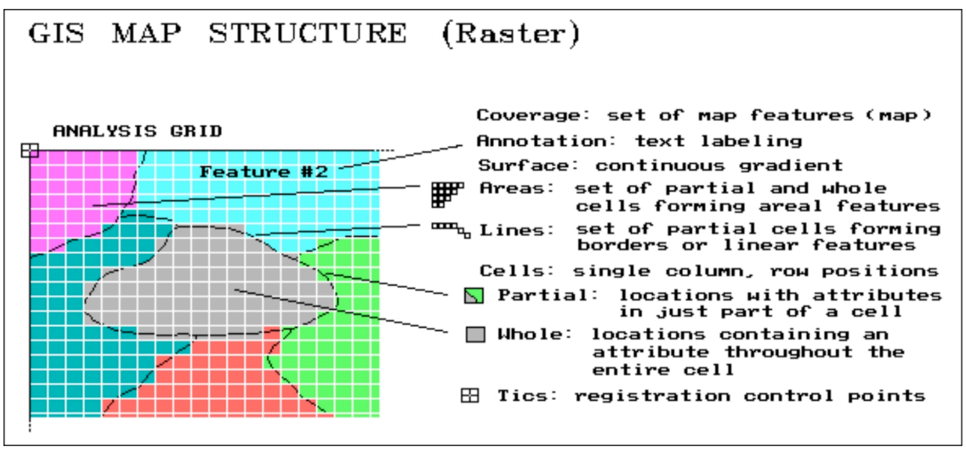

Figure 4. GIS Map Structure (Raster)

GIS software will often use a combination of data models to represent the 'real world.' A combination of both data types can provide a better representation as illustrated in the figure below.

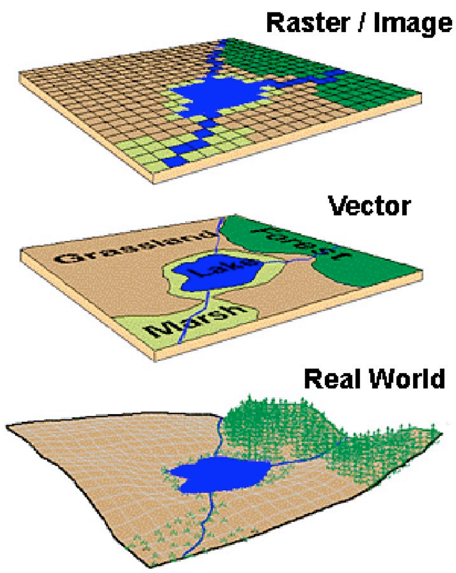

Figure 5. Raster and Vector data types as representative of 'real world' geographic space.

Most raster-based GIS software requires that the raster cell contain only a single discrete value. Hence, a data layer (e.g., a forest stand) may be broken down into a series of raster maps, each representing a single attribute—species, height, density, etc. Each attribute can be mapped to its own layer and later combined for visualization. Vector models maintain data through multiple attributes—e.g., forest inventory polygons *linked* to a database table containing each attribute as a column of data.

Vector data does not handle continuous data (e.g., elevation) very well, though raster data does. Conversely, raster data does not handle linear data (i.e., shortest path) very well while vector systems do. Raster data provides the foundation for quantitative analysis techniques and allows for sophisticated mathematical modeling, whereas vector data are constrained by the capabilities and language of the relational databases in which they reside.

Image data is most typically used in GIS systems as background display data. Image data, usually photographs, must be converted to raster or vector data in order to be useful in any type of analysis.

How does GIS organize and portray spatial data? GIS uses *spatial indexing* to store and retrieve data, which involves the portioning of the geographic area into manageable subsets or *tiles.* These tiles (not to be confused with rasters; see Figures 4 and 5) are then indexed mathematically to allow for quick searching and retrieval. Spatial indexing is analogous to the definition of map sheets.

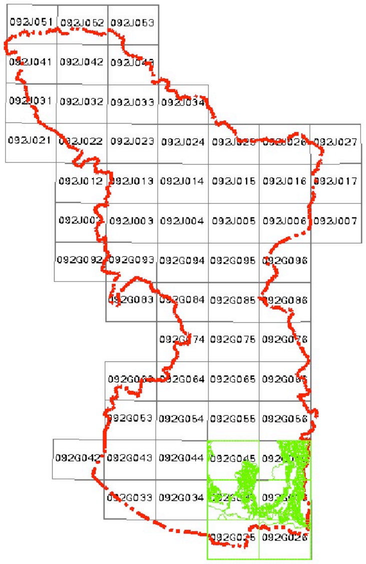

Figure 6. Diagram illustrating a typical map library that is compiled for an area of interest.

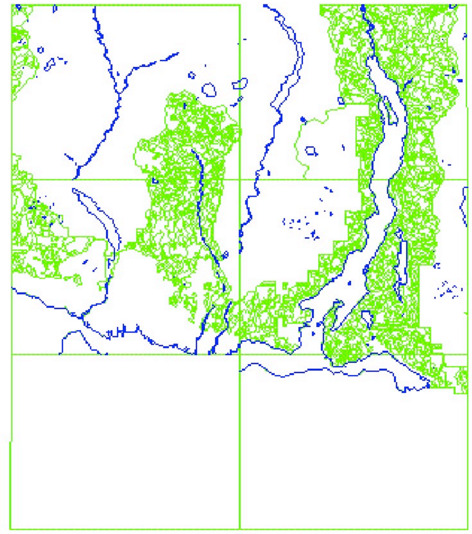

Figure 7. Detailed tiles from the lower right portion of the map in Figure 6.

4.2.1.2 Attribute Data

Attribute data describes the characteristics of spatial features and can be stored and managed with a variety of data models: Tabular, Hierarchical, Network, Relational, Object Oriented.

Tabular models store attributes as sequential data files with fixed formats, typically comma-delimited values in plain ASCII text. While simple, it lacks predefined record structure, any means for checking data integrity and is an inefficient method of data storage with no indexing capabilities.

Hierarchical and Network models use the tree metaphor, much like a genealogical family tree, for storing data. They are useful for data that changes only infrequently. Hierarchical models are limited to 'child' tables having only one 'parent' table to which they are related. Network models eliminate that limitation, allowing the child to have more than one parent, but become very complex and unmanageable very easily.

Relational models use a database organized into tables—each identified by a unique table name and organized into rows and columns. Columns store values for specific attributes, and each row represents a unique record. Data is often stored in several tables, which can be joined to each other by common columns (usually a unique identification number). These unique identifiers are commonly known as *primary keys* in relational databases and can be used to join tables on an ad hoc basis for the purposes of querying the database and retrieving information. Relational databases, by far, are the most common and useful way of storing and retrieving attribute data.

The following figure illustrates their basic functioning:

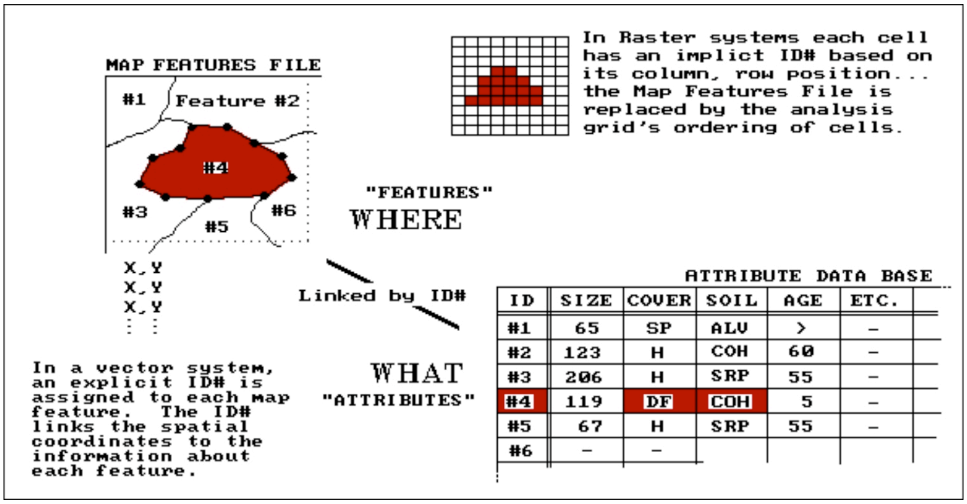

Figure 8. The basic linkage between a vector spatial data and attributes maintained in a relational database file.

Object Oriented models are relatively new, and they manage data through *objects* as their name suggests. An object is a collection of data elements and operations that together are considered a single entity. Because of this bundling of attributes, querying the system seems more natural to the end-user, unlike the relational model where one has to have some knowledge of the table structures and relationships in order to construct an effective query. Even with the potential promise of utility of the Object Oriented model, the relational model currently remains the most widely used within GIS software.

4.2.1.3 Metadata

In addition to the above models for incorporating attribute data, an important form of data to include is *metadata*. Metadata is information that provides the who, what, when, where, why, and how regarding the GIS.[123] Appropriate metadata will describe what the dataset is, who created it, why it was created, and how it was created. It will also indicate how reliable the data is, what problems were encountered in collecting the data, and what problems remain with the dataset. It should also include information as to how to get a copy of the dataset.

Metadata is important to include, especially if the GIS is constructed over longer periods of time by more than one individual. It serves as a concise reference for the variety of information contained in the database. By accessing the metadata, one can find what data there is to conduct analyses with the GIS. One can also

123 Schweitzer, P. (No Date) Putting Metadata in Plain Language, [Online] Available http://www.geoplace.com/gw/1998/0998/998abc.asp [2003, May 1].

determine what data may not be incorporated and what further research and information gathering can be or needs to be done.

4.2.2 Portraying Spatial and Attribute Data

As mentioned above, most GIS software organizes spatial data using a thematic approach that categorizes data into layers. The intended purpose for and the users of the GIS dictate what defines a layer. If the purpose was for natural resource management, it might include layers for forest cover, soil classification, elevation, road networks and access, ecological area, hydrology, and so on. Good GIS practice will include proper needs analysis, planned data collection, and identified layer themes so the database can be constructed properly.

Data input for GIS involves two types of data, spatial and attribute. Both types of data are required if the GIS is to be useful. For GIS developers and practitioners, the accepted theoretical solution is to *topologically structure* spatial data—shown above in Figure 5 as the 'Real World.' Topology is a mathematical method used to define spatial relationships. Topological methods allows us to structure data based on the principles of feature adjacency and feature connectivity. It provides the best reflection of the geography of the 'real world' and provides an effective mathematical foundation for encoding spatial relationships, providing a data model for manipulating and analyzing vector based data. By linking together spatial and attribute data, GIS is able to generate topological structures (in their own tables or records) that represent geographic space and portray attribute information (e.g., names, elevations, usage, etc.). This type of GIS-generated information typically contains information regarding user labels, areas, perimeters, etc. based on how the mathematical model defines such entities as arcs, nodes, polygons and the rules for properly depicting them (i.e., no duplicate lines, no gaps in arcs that define polygon features, etc.).

The capability of topologically structuring spatial data in GIS is important to indigenous communities. Topologically structuring data allows one to distort distance, angles, and shape, while conserving the connectivity between the parts. Indigenous maps contrast starkly with European maps, which are based in Euclidean geometry and have a projective geometry based on a coordinate system of latitude and longitude.[124] A similar suggestion has been made of Australian Aboriginal conceptions of territory mapping, that they did "not imagine territory as a block of land hemmed in by frontiers but rather as an interlocking network of 'lines' or 'ways through.'"[125] Knowledge of the 'lines' was essential for survival in the arid landscape, where the irregular rains meant dramatic changes as to the location of water and vegetation from year to year. Having data structured through projective geometry would be of limited use to indigenous communities.

124 Staple, G.C. (1995) "Notes on Mapping the Net: From Tribal Space to Corporate Space", *TeleGeography 1995*, October, pp. 66-73.
125 Chatwin, B. (1988) *The Songlines*, Penguin USA, as quoted in Staple (1995).

GIS technology, being computer-based, requires that data about geographic place be broken down into smaller, discrete units. Relational databases help structure these discrete units of data in a flexible way—the smaller the units of data are, the more flexible the database becomes. Indigenous concepts of place don't always lend themselves easily to such reduction, however. They are more likely to focus on holistic patterns and relationships, or whole ecologies or morality, than discrete slices of time or measurement. Whether or not these concepts can be incorporated into a database will be explored in more detail in Chapter Six.

4.2.3 Mapping Relationships

Computers are complex tools, but they cannot think; they are just machines. So, in a sense, GIS doesn't "handle" the portrayal of relationships within geographic space. Humans do. It is the human capacity for recognizing patterns and assigning meaning to them that makes GIS a useful tool in mapping various relationships we might find in our environments. How, then, does GIS handle the portrayal of relationships within geographic space?

The advantage of using a relational database is that one can continue to add tables of data that can be linked to previous data. For example, we may decide to map an area of within a wilderness area. We could create layers for the watershed, the various types of flora and fauna, and so on. Suppose that a fire devastates the area, eliminating much of the trees, grasses, etc. We could then create additional layers to record the effects of the fire, mapping the burned and unaffected areas. We could add more data at particular intervals to record the re-growth in the burned areas. Because the data would be representative of geographic space and portrayed visually, the changes we observe as we progress through the layers might reveal patterns.

GIS is capable of calculating and portraying many types of relationships. It can be helpful to public health agencies in tracking the spread of communicable diseases and locating nodes of origin. It can be helpful to wildlife biologists in determining the effects of loss of habitat of particular species because of human expansion into those areas. It can be useful to land resource management in tracking the exploitation and reforestation efforts of logging companies. GIS also has the capability of providing visual representations of predictive biophysical models that track the environmental (atmospheric, soil, hydrologic, etc) changes of a particular area through mathematical formulation and visual representation. Using GIS as a tool in conjunction with biophysical modeling can provide the means to quantify, measure, and represent landcover change spatially, for example, "and link these changes to other spatially-referenced datasets to determine the causal factors behind deforestation and forest cover regrowth."[126] We can create more predictive biophysical models by adding data for variations in temperature and precipitation and species migration from surrounding areas.

126 Evans, T. (No Date) *GIS at CIPEC: Land Use and Land Cover*, [Online] Available: http://www.cipec.org/research/gis/gislulc.html [2003, May 1].

We could interpolate the data to portray the re-growth of various species in six months, a year, and so on.[127]

Though the primary output of GIS is maps, many GIS have multimedia capabilities. Not only can the database include text of various indigenous narratives, for example, but also sound and video data. So long as the multimedia data is linked in the database to the particular geographic space, it can be retrieved through a link on the map (as portrayed in Figure 8 above) or through contextual menus that allow access to the data. We could, for example, include a series of video clips that depicts the geographic space.

GIS is literally transforming the way in which we see the world. Through the accumulation of detail and the creation of layers, GIS is allowing us to see the data in the database portrayed visually, in map form, revealing patterns. These patterns may be expressed in quantitative terms—the percentages of growth of particular types of flora, for example. Or, if we were to have incorporated narratives of indigenous concepts of place, we could express them qualitatively—the impact of a particular spirit being on the re-growth of the forest, for example.

4.2.4 GIS Limitations

We have limitations with GIS, however. GIS is a **geographic** information system and, as such, is geared towards representing visually entities on the geographic scale. It is not limited to such representations, however, and is capable of representing entities at the pictorial scale such as a building. What is more often used to model buildings is Computer Assisted Drawing[128] (CAD) systems. The differences in usage for GIS and CAD technologies are differences of scale. It seems clear that GIS is more appropriate for representing transperceptual spaces and geographic scales, while CAD is more appropriate for haptic spaces and microscopic scales. Pictorial spaces, however, vary in scale and as such may be fairly accurately represented by either technology, depending on what the representation is designed to do. Pictorial spaces represented by CAD can contain a fairly high level of detail, assuming that is important. Pictorial spaces represented by GIS usually will be less granular and might lack much of the fine detail of particular human-scale objects, but can be configured with a series of pictorial spaces to represent transperceptual spaces at the geographic scale. We will return to this notion of configuring multiple pictorial spaces into transperceptual spaces in Chapter Six.

4.3 Indigenous Use of GIS

GIS has embedded within it an ontological and epistemological bias derived from a western cartographic tradition. Indigenous peoples, however, have begun to use GIS as a means of asserting their rightful occupancy and use of their

127 For those interested in examples of biophysical modeling use with GIS, see a list of projects by Zimmermann (No date) and Reich et al. (1995).
128 Also sometimes referred to as Computer-Aided Drafting.

traditional lands. Using GIS to map the land means adopting its embedded biases of measurement. However, such measurement is usually accompanied by the extensive knowledge of land use and local ecology when conducted by local peoples. The Darién region of Panama, for example, was mapped by the indigenous communities.[129] The completed maps revealed the intimate relationship between remaining natural vegetation patterns and indigenous settlement and subsistence patterns. Government and university participants in the mapping project estimated "that the maps...are far more accurate and detailed than anything that has ever been done in the Darién."[130] The cooperative effort of several communities in building the maps provided for a broader understanding of the effects of loggers, cattle ranchers and peasant farmers in the region. It raised their "awareness to the numerous threats to their well-being and motivated them to seek collective strategies to curb the invasion of their lands."[131] For the peoples of the Darién, GIS became a tool of empowerment.

The Darién example is not unique. The Miskito of the Central American Caribbean coast are mapping their reefs and ocean resources.[132] The Ye'kuana of southern Venezuela have created a series of ethnocultural maps in asserting their legal claim on ancestral lands.[133,134] The Nepalese communities of the Makalu-Barun region, in the northeast of the country, are participating in the mapping of their lands, parts of which are slated to become the Makalu-Barun National Park and Conservation Project.[135]

The First Nations communities of Canada are very active in the use of GIS to map their traditional lands.[136] The Assembly of First Nations in Canada has engaged in a project involving 61 indigenous communities in the Great Lakes Drainage Basin of central Ontario, where they have tried to integrate their traditional knowledge with conventional scientific methodologies in mapping the region from an indigenous perspective.[137] Some are using the technology to create maps in support of their land claims against the federal and provincial

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129 Gonzalez, N., Herrera, F., and Chapin, M (1995) "Ethnocartography in the Darién", *Cultural Survival Quarterly*, Winter, Vol 18, No 4.
130 Gonzalez, N., Herrera, F. and Chapin, M (1995) p. 32.
131 Gonzalez, N., Herrera, F. and Chapin, M (1995) p. 33.
132 Nietschmann, B. (1995) "Defending the Miskito Reefs with Maps and GIS: Mapping with Sail, Scuba and Satellite", *Cultural Survival Quarterly*, Winter, Vol 18, No 4., pp. 34-37.
133 Arvelo-Jiménez, N. and Conn, K. (1995) "The Ye'kuana Self-Demarcation Process", *Cultural Survival Quarterly*, Winter, Vol 18, No 4., pp. 40-42.
134 Interestingly, the Ye'kuana began their project with an ethnocultural history narrated by one of the elders, and which was assented to by a major gathering of the Ye'kuanas.
135 Forbes, A.A. (1995) "Heirs to the Land: Mapping the Future of the Makalu-Barun", *Cultural Survival Quarterly*, Winter, Vol 18, No 4., pp. 69-71.
136 The Aboriginal Mapping Network maintains an online resource website with many examples of maps, research, and other information. Available: http://www.nativemaps.org/index.html [2003, May 1].
137 Bird, B. (1995) "The EAGLE Project: Re-mapping Canada from an Indigenous Perspective", *Cultural Survival Quarterly*, Winter, Vol 18, No 4., pp. 24-24.

governments, such as the Squamish Nation of British Columbia.[138] The Ahousaht First Nation has gone a step further and replaced many of the English place names with traditional Ahousaht place names:

> *"Through oral histories, Roman [manager of the Ahousaht GIS office] has begun documenting stories associated with geographic locations on maps. From his work, a rich history of land use is taking shape. For approximately 10km of shoreline, for example, Roman has mapped the location of over 200 traditional place names. What emerges is not a map of "white spaces", often interpreted as "unused lands", but instead a more comprehensive picture indicating a strong historical presence and relationship with the land."*[139]

In the next two chapters this thesis will focus on indigenous narratives. We will examine the contexts of three particular narratives and analyze the spatial information contained in each. We are most interested in how the meaning of such narratives can be represented in GIS, for the physical location and boundaries of a place sometimes embody meanings other than those related to occupancy and resource use.

4.4 Summary

Mapmaking has emerged as the process of creating boundaries that represent 'reality.' The history of mapmaking and cartography has resulted in the dominance of a scientific paradigm in so-called Western cultures, primarily because of the power of maps to facilitate travel, control territory, and the consolidation of political power. The usefulness of maps has reinforced the belief of maps as models of the real world. The use of GIS by indigenous communities has allowed them to assert their rightful claims to land often classified as useless or unoccupied by non-indigenous mapmakers.

GIS is the latest evolution in mapmaking. It uses thematic layers to organize the information for visualization of geographic spaces. The technology enables the building of dynamic maps, which can visually portray a variety of spatial and attribute data for analysis.

138 Calla, J. and Koett, R. (1997) "GIS Implementation at the Squamish Nation", *GIS'97 Natural Resource Symposium, Vancouver, B.C., Canada, February 1997*, [Online] Available: http://www.innovativegis.com/papers/sngis97/sngis97.html [2003, May 1].
139 Olive, C. and Carruthers, D. (No Date) *Putting TEK into Action: Mapping the Transition*, Draft paper from the Ecotrust Canada Mapping Office, [Online] Available: http://www.nativemaps.org/abstracts/tek.html [2003, May 1].

5 Indigenous Narratives of Place

5.1 Narrative Practice

The notion of place-making among the Punjabi immigrants mentioned by Leonard in Chapter Three is examined in more detail by Basso with respect to the Western Apache. To Basso[140], *place-making* is a cultural expression of retelling history and reinforces moral behavior within the Western Apache community. Apache place-names strengthen cultural identity and instruct community members on proper moral behavior. To Kane,[141] from whom we will draw examples of Haida and Australian narratives, *mythtelling* is a means of understanding local ecology, cultural identity, and serves as reinforcement of particular behavior patterns. While Basso emphasizes the social over the ecological, Kane emphasizes the ecological over the social. Both, however, provide us with examples of indigenous narrative through which we can examine schemas that are tied to space.

5.2 Narrative Contexts

Each of the narratives below has a different focus. The ethnographic accounts[142] from which they originated were constructed with different contextual themes, with different explanatory purposes. Each of the narrative examples exists within a larger context, of both narrative and culture. They are but single examples in a myriad of tales that are shared among members of the respective cultures. Using connectionist metaphor, we could say each example is like the firing of a network of neurons that produces a gestalt—a complex of associated thoughts and feelings. This gestalt embodies an array of interconnected thoughts and feelings that are further interconnected and intermingled with a variety of other

140 Basso, K. (1996) Wisdom Sits in Places, University of New Mexico Press.
141 Kane, S. (1994) Wisdom of the Mythtellers, Broadview Press.
142 Kane's *Wisdom of the Mythtellers* is classified as a work of comparative literature rather than comparative ethnography, even though some of the examples he uses are derived directly from ethnographic literature.

thoughts and feelings. They form a density of connections that are difficult to extricate from one another and, if linked together with other gestalts, form a complete network, a complete worldview of the culture.

Similarly, mapping the geographic space in which these narratives occur produces contiguous entities, interconnected with each other and forming a complex map of indigenous space. The purpose of the map will determine what information is gathered. The purpose of the Geographic Information System (GIS) will determine not only what information is gathered, but also how the database is constructed. The thematic layers of the GIS are analogous to the themes identified in the ethnography. In order to determine the thematic layers in which to incorporate the information contained within the narrative examples above, it behooves us to understand the contextual constraints in which the narrative examples exist so we can understand the constraints we face incorporating the narratives into GIS.

5.3 Narrative Examples

5.3.1 The Apache

The Apache are an indigenous Amerindian group located in the Southwestern United States. They are part of the larger Athabascan cultural group, which had its roots in the north. The center of Apache culture "is self-importance,"[143] in which raiding was not only encouraged but also enjoyed. They typically had traveled in small bands and had been historically known as fierce fighters and great hunters in their desert environment. Each band was lead by a headman who employed reason, prestige, and good example in leading the band. His counterpart was a headwoman who counseled in the ways of living and organized gathering parties among the women. The introduction of the horse by the Spanish colonizers increased their ability to roam for food and to engage in battles with the invaders of their lands. They signed a treaty with the U.S. Government in 1872 that confined them to a reservation in Arizona. The Apache nation is comprised of ten sub-tribes. The sub-tribe from which this narrative is taken is the Cibecue Apache.

5.3.1.1 Cottonwood Trees Stand Here and There

The narratives of Apache *place-making* are framed with an opening and closing line that distinguishes them from other categories of tales. Such opening and closing lines could be considered metaphorical boundaries, separating the morality tale from the general conversation. Oftentimes, simply expressing the opening line is sufficient to share the entire schema with others. The narratives evoke a particular physical setting in which the listeners can imaginatively situate for everything that happens—i.e., create a pictorial space in their mind.

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143 Hamond, J. (No Date) *Apache* [Online] Available: http://emuseum.mnsu.edu/cultural/northamerica/apache.html [2003, May 1].

> *It happened at Big Cottonwood Trees Stand Here and There.*
>
> *Long ago, the Pimas and Apaches were fighting. The Pimas were carrying long clubs made from mesquite wood; they were also heavy and hard. Before dawn the Pimas arrived at Cibecue and attacked the Apaches there. The Pimas attacked while the Apaches were asleep. The Pimas killed the Apaches with their clubs. An old woman woke up. She heard the Apaches crying out. The old woman thought it was her son-in-law because he often picked on her daughter. The old woman cried out: "You pick on my child a lot. You should act pleasantly toward her." Because the old woman cried out, the Pimas learned where she was. The Pimas came running to the old woman's camp and killed her with their clubs. A young girl ran away from there and hid beneath some bushes. She alone survived.*
>
> *It happened at Big Cottonwood Trees Stand Here and There.*[144]

On the surface, this narrative seems to be about an ancient battle between two cultural groups. But it is not used to evoke memories of history, per se. Rather, it is about proper behavior and the harmful consequences that may come to persons who overstep traditional role boundaries. Apache couples live in the camp of the bride's parents during the first year of marriage. During this year, the bride's mother may request that her son-in-law perform various tasks and she may also instruct and criticize him. He accepts this role and the instruction without question. Once a couple establishes a separate residence, however, the mother-in-law may properly interfere in her son-in-law's affairs only at the request of her daughter. Women who do not abide by this arrangement and continue to criticize their sons-in-law imply that they are immature and irresponsible, which is a source of acute embarrassment for the young men and their wives. This tale, then, serves as a metaphor for appropriate social behavior: Even when meddling might seem to serve a useful purpose, it should be scrupulously avoided. The woman on whom this story centers failed to remember this and was instantly killed.[145]

Apache are reminded of the tale every time they encounter the Big Cottonwood Trees. Non-Apache, who have never heard the tale, would simply have no idea as to the cultural significance of the grove of trees. They would have no reference for making meaning of this particular grove of cottonwood trees. For the Apache, however, the encounter or mention of the Big Cottonwood Trees evokes cultural schemas, in particular the social boundaries that prevent interference by family members.

We see that schemas associated with familial relationships, marriage, privacy, restraint, and so on, are conveyed through this tale. Among the Western Apache, morality tales are conceptualized as *arrows* piercing the mind of the recipient, sometimes striking with great precision and causing immediate, intensive reflection about his immoral behavior. Not only is the tale itself

144 Basso, p. 52.
145 Basso, pp. 52-3.

conceived of as a metaphorical event within haptic space (arrow flying across the distance to pierce the target), but also such tales among the Western Apache are tied to specific geographic locations. The association of these *arrows* to physical sites in the geographic landscape is significant because the places serve as a permanent reminder of proper conduct and the consequences of improper conduct. Building on the hunting metaphor, the Apache say that these places *stalk* them:

> *Even if we go far away from here to some big city, places around here keep stalking us. If you did wrong, you will hear the names and see the places in the mind. They keep on stalking you, even if you go across oceans. The names of all these places are good. They make you remember how to live right, so you want to replace yourself again.*
>
> --*Nick Thompson, in* Wisdom Sits in Places[146]

5.3.1.2 The Apache Context

The worldview from which the narrative of Big Cottonwood Trees is drawn explicitly associates the physical geography to the members of the culture. The narrative may be flexible in terms of time, but requires a spatial anchor to be understood. The focus of the Basso's ethnography is the activity of *place-making* of the Apache. The purpose of the ethnography is to portray the strong connections the Apache community has with their lands and how places of historical significance exert influence on the behavior of individuals and reinforce their identity as Apache.

There are four types of Apache narrative[147]—*myths*, which concern the time of creation and are used to instruct on the complex processes by which the world came into existence; *historical tales*, whose main purpose is to provoke the conscience and correct improper behavior; *sagas*, which are tales of recent history whose main purpose is to entertain; and *gossip*, which is storytelling of current or recent events. The Apache narrative above is an *historical tale*, distinguished by an introductory and closing line that set them apart from other categories of tales. These Apache narratives are tied directly to places and specifically intended to evoke schemas of appropriate behavior, to reinforce cultural identity and connection to Apache land and its community's history.

Simply mentioning the name of the particular place is sufficient to evoke the schemas related to appropriate behavior. But the mention of the place name evokes more than schemas related to behavior. Apache narratives require a spatial anchor, without which the story loses resonance. The spatial anchors are built into the name of the places. Apache place-names rarely form complete sentences, but the Apache language is rich with prefixes and suffixes that carry an extraordinary density of information. Basso offers a few examples[148]:

146 Basso, p. 59.
147 Basso, pp. 49-50.
148 Basso, p. 46.

Water Flows Down On A Succession Of Flat Rocks

Tséé Biká' Tú Yaahilíné: Tséé (rock, stone) + Biká' (on top of it; a flattish object) + Tú (water) + Yaa- (downward) + -hi- (linear succession of regularly repeated movements) + -lí- (it flows) + -né (the one).

Water Flows Inward Under A Cottonwood Tree

T'iis Bitl'áh Tú 'Olíné: T'iis (cottonwood tree) + Bitl'áh (below it, underneath it) + Tú (water) + 'O- (inward) + -lí (it flows) + -né (the one).

Line Of White Rocks Extends Up And Out

Tséé Hadigaiyé: Tséé (rock, stone) + Ha- (up and out) + -di- (extends in a line) + -gai- (white, whiteness) + -yé (the one).

These examples illustrate how thoroughly descriptive Apache place-names are. But they also enable Apache listeners to imagine in great detail how they appear, locating the narrated events in the physical settings where the events occurred. Place-names embed a particular spatial relationship between the individual and the geographic space. They provide situatedness to the individual's cognition—providing the specific visual perspective of where the individual must be located in order to see the named place. Simply including these place-names as labels for particular geographic spaces provides a richness of information, enabling all individuals to imaginatively situate themselves in the exact same geographic position in recalling the associated schemas for appropriate behavior.

5.3.2 The Haida

The Haida are an indigenous First Nation in the Queen Charlotte islands, located off the northern British Columbia coast along the border of the archipelago of Alaska. They are known as the "Children of Eagle and Raven", who play significant roles in Haida mythology and formed the basis of their lineage and social structure. Each lineage provided its members with entitlements to economic resources as well as to myths and legends, dances, songs, and music. Each "household" (about 10 nuclear families of a lineage, sometimes including slaves) was headed by a chief. Chiefly rank was inherited through the matrilineal line. Haida mythology suggests that they have continually occupied their territory since the last ice age. Their economy was based around hunting, fishing, and harvesting shellfish. Food was the foundation of the "potlatch"—the Haida ceremony marking important life changes and rites of passage. The abundance of resources allowed for the development of craftsmen who devoted their time to art and elaborate canoes.[149]

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149 MacDonald, G.F. (2001) *The Haida: Children of Eagle and Raven*, [Online] Available: http://www.civilization.ca/aborig/haida/haindexe.html [2003, May 1].

5.3.2.1 *Qaasghajiina*

This myth tells the story of the *Qaasghajiina*, the Creek Woman[150], who dwells at the headwaters of the major streams, and her lover, *Sghaana*, the Killer Whale who cruises out to sea near the reef, watching the river mouth. *Sghaana*, who has knowledge of the weather, sends the fair-weather clouds to indicate the salmon are coming to the headwaters, where *Qaasghajiina* will guard them. A complex set of schemas surrounds this myth, including mystery in relation to the sexual relationship between the goddess of the river and the powerful whale. The details of the stories may vary according to who is recounting the myth, but the basic plot involves a gang of boys who paddled out one day to the creek. Typical teenagers, they carried on as if they owned the creek and fished many salmon. As they were roasting the salmon over a fire, a copper-colored frog leaped into the clearing and stared at the leader. The mischievous boy put the frog into the fire and piled firewood on top of it. He should have remembered that the frog—who is a talisman of wealth and who is called “my child” by the goddess—is the totemic familiar of the Creek Woman.

> *On top of it they piled up the fire and laughed at it. After some time had passed, the frog exploded. The hot coals were scattered all about, but it sat in its place just as before. It was not burnt. Again they heaped hot coals upon it, and built the heap up large. Again they put it in. After some time had passed, it exploded, and sat in its place as before. Now they heaped the fire up high, and they put it into it. Again it exploded, but, as before, it sat in the same place. Then they went to sleep. When it was day, they went down along the creek. They came out and launched the canoe. Then they got in and picked up their paddles. But when they had paddled a while, and were off some distance, some one called after them from Singgil Point, “Ho, there! Stop until I have given you directions!” They stopped at once in surprise, and looked at him … ”The foremost one in the canoe on the right side will die at Point Ttsii. The one on the other side will die at Point Laaghanaus. The next one will die a Point Sqaughaus. The next one will die at Point Qqaaighanttiis. Only the one in the stern will be saved; and when he gets home, and has finished talking about himself, he too will die.” As this person stood at Singgil Point, they could see the ground through his body.*
>
> *They died as he had foretold. One died first at Point Ttsii. One died at Point Laaghanaus. One died after that at Point Sqaughaus. After that, one died at Point Qqaaighanttiis. It happened as he had foretold. When the survivor came home around Point Sqqaaxunans, the people felt strange about it, and the people of Jigwa moved at once. They came down to meet him, and, as they stood beside his canoe on shore, he gave a rough account of what had happened. He related everything from the beginning. When he had finished telling it, he acted like people who fall asleep.*[151]

The myth reinforces the notion of sanctity of place. It teaches us to be respectful of places, not for what humans can make of them or take from them, but for their own sake. Its narration reminds the listener that there is something sacred about

150 Actually, there is more than one manifestation of the Creek Woman. Each of the creeks is guarded by a Creek Woman, who are collectively regarded as multiple manifestations of the one spirit being.
151 Kane, pp. 48-9.

the reefs and headwaters of the Queen Charlotte Islands, and woe to those who forget.[152] There are schemas related to fertility, weather patterns, the permeable boundaries between the rivers and ocean, the permeable boundaries between the rivers and the surrounding land. The narrative also illustrates the incorporation of procedural knowledge and the configuration of transperceptual spaces that are important to the Haida. Traveling from the headwaters to the village requires that the traveler pass a series of points, which mark the journey and convey information about a traveler's progress.

5.3.2.2 The Haida Context

The focus of Kane's ethnographic accounts is the comparative examination of indigenous cosmologies as they relate to their environments. His primary purpose is to reveal the complexity of indigenous worldviews and portray them as systems of understanding as valid as the scientific basis of understanding inherent in so-called Western cultures. Understanding the interplay of ecological processes is the primary focus of each account.

The *Qaasghajiina* narrative is part of the ecological worldview of the Haida. The Haida have a mythic cosmology that speaks of three worlds—the world beneath the sea, the world above the clouds, and the world in-between. The boundaries between the worlds are permeable, and the worlds are capable of influencing each other. To the Sky Beings, the top of the sky ebbs and flows like an ocean. To human beings, the surface of the sea is a boundary that is mysterious, for one never knows what one may find underneath. The headwaters where the *Qaasghajiina* live exist at the boundary of where the world beneath the sea meets the world in between. The goddess is inseparable from the locale—she is the mystery of the headwater. Since every salmon stream in the islands of the Haida has a woman guarding it, a presence of female fertility and renewal, each myth remembers a particular part of the land as story. This myth is typical of powers which intersect with our world at various points yet prefer to remain invisible.[153]

In Haida cosmology some characters, like Raven, a wise being who takes the form of a bird, are able to permeate the boundaries between worlds. Humans, especially mythtellers, are also capable of permeating the boundaries between worlds, but they must be mindful of the principle involved in any exchange between the worlds: balance. For indigenous mythtellers boundaries can be crossed invisibly—by words, thoughts, and spirits. Just as an inappropriate exchange at one of the orifices of the body may cause injury or death, the inappropriate use of words can cause insult, or death. Mythtellers act as guides, transporting the listener through language to the invisible world. Words, conveying the thought of the spirits, can affect this exchange across the

152 Kane, pp. 46-51, pp. 68-9, pp. 104-5.
153 Kane, pp. 46-51, pp. 68-9, pp. 104-5.

boundary to the Otherworld.[154] The mythic world and the experiential world overlap in geographic space, yet remain necessarily distinct from one another in order to maintain the balance of exchange.

Because the worlds sometimes intersect, mapping the *Qaasghajiina* narrative would entail mapping a part of the mythic world, considered to be separate from the experiential geographic space where humans exist.

5.3.3 The Krantji Kangaroo Clan

The Krantji Kangaroo Clan are Northern Arrernte people who come from the desert plain and scrub mulga around the northern end of Central Australia's MacDonnell Ranges. They were hunter-gatherers who lived in small bands of 15-30 people. Bands were the basic economic unit, and several bands were grouped into tribes. The links between groups were based on kinship and marriage ties, common ceremonial affiliation and shared ownership of, or responsibility for, sacred sites and objects.[155] They have view their existence as intimately linked with the survival of their homeland's ecosystem and have enshrined that belief into their spiritual life. They share their land with the Red Kangaroo, whom they hunt for food, but only on the desert plains.[156]

5.3.3.1 Krantjirinja

One myth of the Krantji Kangaroo clan holds a small spring as a sacred place.[157] In the myth, the god takes his animal form by day and his human form by night. He emerged into the world from this small spring, called Krantji, and is said to still be there. He exists, in part, in the slabs of rock below the spring, sending out reproductive energy. His human descendants, who always approach the spring with their eyes closed and their weapons left some distance away, indicating they have not come to this place to hunt, worship *Krantjirinja*. It is forbidden to kill the red kangaroos at this place of *Krantjirinja*.

From this sacred site radiates the energy of life, fanning out in mythlines that travel outward from the spring. The red kangaroo follows the trails as they seek out the particular grasses eaten by kangaroos. During rainy times, they expand their range into the foothills of the Macdonnell ranges. During dry times, they fall back in groups to riverbeds where the grasses can be found. Because the springs and rivers are the sources of sacred energy, the kangaroo cannot be hunted in what is, in fact, its prime habitat. The mythlines, in effect an oral map of the grazing patterns of the red kangaroo, are also the means by which the

154 Kane, p. 104.
155 Aboriginal Art and Culture Centre (No Date) *Arrernte Tribal Group*, [Online] Available: http://www.aboriginalart.com.au/culture/arrernte2.html#tribal [2003, May 1].
156 McGhee, K. (No Date) *The Krantji Kangaroo Clan of Central Australia*, [Online[Available: http://www.amonline.net.au/factsheets/krantji_kangaroo.htm [2003, May 9].
157 Although we don't have the precise narrative of Krantjirinja , we do have a description of it offered by Kane, which we will utilize here in lieu of the actual narrative.

species is allowed to build up its local population at particular sanctuaries where the ancestor is worshipped.[158]

There are several schemas associated with the narrative of *Krantjirinja* —hunting schemas, water cycle schemas, conservation of resources, the connection between humans and kangaroos, and so on. The narrative also sits in a larger context of narratives of the various places of significance to the Aboriginal cultures of Australia. The places are connected one to another via mythlines—paths that one may travel in navigating across the continent. The narrative of *Krantjirinja* is but one node in a complex web of mythlines that traverse the continent and traverse different cultural groups.

5.3.3.2 The Krantji Context

The myth of *Krantjirinja* also derives from Kane's ethnographic account. The Krantji clan form their understanding of *Krantjirinja* within the context of *The Dreaming*. Aboriginal *Dreaming* poses the existence of a metaphysical universe, which is primary and is translated into physical form. *The Dreaming* of the ancestors created all of the animals, plants, springs, rocks, mountains…everything in our physical universe. Then, exhausted, the ancestors disappeared into the earth and the sky, where they continue to dream. Their nourishing dream energy is felt around the places where the ancestors fought and made love and checked each other during the days of creation.

The Dreaming also left a vibrational residue in every member of every species that exists. Some Aboriginal shamans describe their perception of the *Dreaming* as acoustic signatures of each of the animals.[159] They see the life of the landscape interwoven in a web of threads. This perception is commonly visualized in Aboriginal art as tiny dots, representing the vibrating, acoustic energy.[160] Below is an example of Aboriginal art that depicts the acoustic patterns of the *Bush Tucker Dreaming* painted by Maggie Willliams:[161]

158 Kane, pp. 66-7.
159 The representation of *The Dreaming* as acoustical signatures is not true for all Aboriginal cultures. Neither should the reader infer that all Aboriginal art and painting depicts the landscape or is composed as dot-paintings as depicted in Figure 9. For those interested in other expressions of Aboriginal art, see *Aboriginal Art Online*, Available: http://www.aboriginalartonline.com/index.html [2003, May 1].
160 A vivid image of Aboriginal art by Maureen Turner Nampijinpa, Fire Dreaming, was captured by One World Magazine and can be found online at http://www.oneworldmagazine.org/gallery/abo/pix2.html.
161 Williams, M. (2001). *Bush Tucker Dreaming,* [Online]. Available: http://www.aboriginalartpaintings.com/store/prod529.htm [2001, August 9].

Figure 9. Bush Tucker Dreaming.

The Dreaming is conceptualized as acoustic vibrations. These vibrations still exist throughout the landscape. *The Dreaming* isn't an event has concluded, rather an emergent process that continues indefinitely:

> *"The Dreamtime is the period in which creative acts were performed by the first ancestors of men -- spirits, heroes, and heroines who established the pattern of nature and life, and created man's environment. The Dreamtime is a process as well as a period: it had its beginning when the world was young and unformed, but it has never ceased. The ancestor who established law and patterns of behavior is as alive today as when he performed his original creative acts. The sacred past, the Dreamtime, is for Aborigines also the sacred present, the Eternal Dreamtime."*[162]

For the individual, *The Dreaming* is something invisible yet making its presence felt in visible forms, behaving as if it had properties of mentality, yet occupies no time and space. What the individual observes are the matter-and-energy processes, which are the bearers of the acoustical patterns. Individuals exist within *The Dreaming*, and are an integral part of the emergent process and the emergent patterns that give form to the world both physically and culturally.

> *"The individual mind is imminent but not only in the body. It is imminent also in pathways and messages outside the body, and there is a larger mind of which the individual mind is only a subsystem. This larger mind is comparable to God and is perhaps what some people mean by God, but it is still imminent in the total interconnected social systems and planetary ecology."*
>
> --Gregory Bateson in Mind and Nature[163]

Mapping the narrative of *Krantjirinja* necessarily entails the mapping of "feelings, desires, projections, activities, and images of consciousness"[164] of the human

162 Carrick, J. (ca. 1980) (An exhibit catalog of aboriginal artifacts), as found in Fiedler, L. (No date). *"The Australian Aboriginal Origins and Art: A Very Brief Orientation,"* One World Magazine, [Online] Available at http://www.oneworldmagazine.org/gallery/abo/intro.html [2001, August 9].

163 Bateson, G. (1980). *Mind and Nature - A Necessary Unity*. Bantam Books, as found in Sheldrake, R. (1990) *The Rebirth of Nature*, London: Century Books, p. 117.

conceptualization of the space, for external spaces cannot exist separate from the internal.

5.4 Summary

Place-making and *mythtelling* are practices by which tales are narrated. They serve a variety of purposes, from expressing concern about and reinforcement for moral behavior and cultural identity, to offering a coherent gestalt view of a particular cosmology. They can be narrated in different ways, with emphasis on different aspects of the narrative in order to offer up different messages.

The examples we use are derived from ethnographies that have different purposes. These purposes determine what data is collected and the form in which it is presented. The Apache tales focus on the moral imperatives to the culture, and describe how embedding such imperatives into the physical geography serve to reinforce cultural identity. The Haida and Krantji tales focus on the ecology and the indigenous cosmology that supports how the culture understands its environment. These narratives constitute legitimate forms of meaning with respect to space. The primary purpose of this thesis is to present the notion that indigenous understandings of environment are as meaningful to those communities as scientific paradigms are to others.

164 Lawlor, R. (1991) *Voices of the First Day: Awakening in the Aboriginal Dreamtime*, Rochester, Vermont: Inner Traditions, p. 42.

6 Indigenous Narrative and GIS Integration

Maps are representations of 'reality' as determined by the creator of the map. More precisely, maps represent *our schemas regarding spatial reality*. Our modern maps have a variety of ways in which they represent spaces—color, labels, symbols, geo-coordinates (latitude and longitude), etc. Maps also portray relationships within a spatial context. GIS is a tool that facilitates the analysis of these spatial relationships. The advantage of GIS is in producing dynamic maps, creating varied associations of qualitative data of the same space and identifying and analyzing the patterns created.

In mapping space, we are actually mapping schemas. The meaning that transforms a space into a place—the schemas derived from our cultural context—is the qualitative data that needs to be incorporated into the GIS database along with the quantitative data. In this chapter, we will examine some of the challenges in portraying the 'reality' of space—the qualitative and quantitative data—as illustrated in the examples of indigenous narrative in the previous chapter.

Mythtelling often conveys information about ecological complexities and the patterns humans find in their environment.[165] Incorporating the spatial data of indigenous narratives may or may not be feasible, depending upon the particular culture or narrative. Some indigenous concepts of place, e.g., the Dreaming of Australian Aborigines, are very amenable to geographic representation. Even Apache concepts of place, with their primacy of moral teaching, may not be problematic because Apache place-names are quite descriptive in terms of geographic space (e.g., "Water Flows Down On A Succession Of Flat Rocks"). Others, e.g., the Haida, may be less amenable because of the 'separateness' required between the physical and sacred worlds—though the production of

165 Kane, p. 41.

different layers to accommodate this separateness is a possible solution to this problem.

Would the GIS practitioner, immersed in a cultural context where the scientific method is a dominant paradigm, produce the same map of the same indigenous geographic space as an indigenous mapmaker, immersed in a different cultural context? The answer seems obvious: "No." Each is coming to the task with different histories and, more importantly, different schemas regarding space. As we discussed in Chapter Three, what the mapmakers recognize as an entity in geographic space will determine the boundaries they impose on that space It is possible they would identify the same entities—e.g., a particular grove of trees—but that these entities would carry entirely different meanings, requiring different thematic layers to be incorporated into the GIS database. To the GIS practitioner the grove might simply be a grove, an identifiable feature of the landscape with no particular significance. But to the indigenous mapmaker the grove might also represent a significant historical space, *a place* that has a variety of association, i.e., a place of conflict, a moral imperative to refrain from interfering in another's relationship, and so on.

Since attribute data can consist of almost anything, it seems that oral narrative information about place would most likely fit into this category of data. Can we construct a database that includes indigenous concepts of place?[166] How might we categorize such data and portray it? Attribute data for indigenous concepts of place may include categories unique to the culture—particular deities associated, categories of moral tales, local environmental or ecological knowledge, and so on. We will examine these questions in more detail below.

If the incorporation of oral narrative of indigenous concepts of place is successful, GIS may become more meaningful to indigenous communities. However, being computer-based, it raises a question regarding the variability inherent in indigenous narratives and the ways in which that variability might be handled.

6.1 Variability

We know that accessibility of information by individuals results in different representations.[167] Individuals will often interpret the same data differently, such as when hearing the bearing "059 degrees" means different things to different

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166 Although there is a transparency in our discussion regarding the knowledge and types of information contained in indigenous narrative, the call for transparency is not always inherent in other cultures. There are often restrictions on the dissemination of information based on a variety of criteria (e.g., sacred knowledge, gender-specific knowledge, cross-generational constraints, issues of trust and power). Any investigation or gathering of information must take this into consideration as part of its ethical framework. For further discussion on the ethical considerations, see: van Maanen (1988, 1995), Denzin (1985), Rosaldo (1993), Alvarado (1987), Stringer (1996). For a discussion of ethics related directly to geography or GIS, see Rundstrom (1995), Turk and Trees (1998a), and Duncan and Duncan (2001).
167 Hutchins, p. 266.

members of Hutchins' navigation team. Within the factory at Hangzhou, China studied by Rofel, the meaning of work took on different meanings that were evoked by the contrasting schemas—the pre-liberation focus on quality, the Cultural Revolution focus on political consciousness, the post-Revolution focus on independence and socializing, and the managerial focus on efficiency. Punjabi immigrants reconceptualized the same geographic space in terms of the familiar landscape of their homeland. Exposure to the same patterns and stimuli in the environment may result in the formation of shared schemas and evoke meanings that are largely shared by members of a culture, but there always exists slight variations in how individuals interpret and consequently communicate the meaning of them. There will be individual variation in the communication of the shared schemas.

Ethnographers are confronted with this individual variation when involved in ethnographic research and they must be able to sift through the information and construct larger frames. "What the ethnographer sees and hears at different times and places are little bits of this and that, all of which must be put together into a coherent framework."[168] The ethnographer is contextually situated to observe the schemas manifest through interactivity as he works to configure the boundaries of the many pictorial spaces recalled by the storyteller.[169] Basso, for example, constructed the larger frame of *place-making*, within which the Apache narratives sit. He took the structure that was provided by the Apache in their own understanding of their land and constructed a single frame through which to view and facilitate analysis of Apache *place-making*. While a single narrative told by a member of an indigenous culture may be limited to that individual's schemas, gathering multiple instances of the same narrative begins to reveal where the schemas overlap and can be considered as representative of the shared, cultural schemas. The responsibility of the ethnographer is to organize the structured information offered by the people being studied.

In all narrative, there will be an inherent variability we need to be cognizant of in understanding the primary point of reference when creating the visual representation of areas in GIS. The variability of the narratives among individuals should not be problematic since GIS practitioners recognize this same kind of variability when they map pH levels in soil, for example. Since they cannot measure every square centimeter of soil within a given area, they estimate the pH levels of the soil in the intervening areas between the points where they have measured. The use of GIS in conjunction with biophysical modeling, discussed in Chapter Four, illustrates another way in which GIS can handle variability over time. In approaching the development of a GIS that incorporates indigenous narrative, an ethnographic approach assumes variability and the ethnographer being able to construct a larger framework into which each narrative's variability fits. Variability is a recognized part of GIS, as it is with ethnography.

168 D'Andrade, p. 157.
169 This is the approach used by Hutchins, and described in *Cognition in the Wild*, p. 262.

6.2 Big Cottonwood Trees Stand Here and There

The example of Big Cottonwood Trees provides us with limited spatial information. The only direct information we have is a declarative knowledge that derives from the place-name: Big Cottonwood Trees Stand Here and There. There is some implicit procedural knowledge incorporated in the narrative: "Pima arrived at Cibecue…," "The Pimas came running to the old woman's camp…" and the "young girl ran…and hid beneath some bushes." But none of this knowledge is explicit or designed to transmit an explicit understanding of the paths traveled in the geographic space.

The information provided, however, does allow us to create a limited configurational understanding of the space. We know that there is a grove of Cottonwood Trees, which seems to not be a dense grove because the "Stand Here and There." We also know that the Apache had dwellings in the space, though we don't know of what type, size, or their precise location. We can assume with some confidence that the space of the Big Cottonwood Trees lies somewhere close to Pima territory, for it doesn't make sense that a Pima attack party would travel to the far side of Apache territory to conduct an attack.[170] Based on the above information, the geographic space is likely close to a territorial border, includes a non-dense grove of cottonwood trees, and includes several dwellings.

None of the information contained in the narrative provides any understanding of the source or scale at which the space is identified—haptic, pictorial or transperceptual. Based on our contextual understanding of Apache *place-making* we know that the activity of *place-making* enables the individual to imaginatively situate himself in the geographic space where the story unfolds. The name of the place is based on a pictorial scale of space. The question arises as to whether the pictorial scale refers only to the grove of cottonwood trees, or to the grove and the dwellings. If it includes the dwellings, then it is possible that the space is a transperceptual space. The only way to know for certain is to rely upon someone with knowledge of the space.

The extent of the space will obviously depend on how the space is identified, how much area beyond the actual grove is considered to be part of that *place*. In this case the boundaries defining the space are likely to be a combination of bona fide and fiat boundaries. Incorporating the geo-coordinates of the boundaries as quantitative data within the GIS database is a relatively simple matter once the entities comprising the space have been identified. Depending on the level of detail required, the individual trees in the grove and the individual dwellings could also be mapped.

170 An assumption such as this incorporates other schemas related to conflict and war strategies, and territorial boundaries.

While we may lack a complete understanding of the space known as Big Cottonwood Trees Stand Here and There, it is likely that an Apache would have an experiential understanding to accompany the narrative. The spatial knowledge, spatial source (scale), etc. he holds would make the mapping of the space and the relevant boundaries a relatively easy undertaking.

Having identified the physical space and determined the extent of its area and the level of detail required, we could begin incorporating thematic layers for the cultural schemas related to the space. Creating a thematic layer imposes a categorical boundary on the qualitative data to be incorporated into the database. The categories to incorporate would depend on the purpose of the GIS.[171]

For this particular narrative, we identified the dominant cultural schema as the prohibition against interfering in a relationship. There are several ways in which we could represent the space on this thematic layer. The area defined on the map could be represented by a solid color, similar to Figure 3 in Chapter Four. Other thematic layers could be defined and represented in a similar way; layers for: housing, plants, paths of travel, marriage, privacy, conflict, etc.

We could construct thematic categories for every place named by the Apache within their territory. There may be several places that are related to the same themes. If we were to portray that layer for the entire Apache territory we would likely see a patchwork of colored areas representing the theme. How meaningful would this layer be? It's unlikely that it would be very meaningful unless it was compared to other thematic layers. For example, portraying layers for refraining from interfering could be compared to layers related to conflict and war. If there was much overlap between the two themes, we could determine how closely linked are such schemas within the Apache culture.

We could supplement the map we generate with links to other types of multimedia data. Links could be represented by text, by icons, or through contextual menus. The multimedia data, related to the space, could take various forms—text, audio, video, graphic illustrations, photo images, etc. For example, it might contain photo images of the space, the text of the narrative, an audio narration of the text, or even a video reenactment of the narrative.

6.3 Qaasghajiina

The Haida narrative of the *Qaasghajiina*, the Creek Woman, provides us with extensive spatial knowledge. We can derive declarative knowledge from the Points mentioned—Singgil, Tsii, Laaghanaus, Sgaughaus, and Qqaaighantiis—

171 The categories of qualitative data ideally should be determined before the database is constructed. Although it is not impossible for categories of data to be added later, the need to go back and collect the data related to those categories adds time and cost to the GIS project. And until the data is collected for all places or entities within the database, blank or indeterminate areas will exist on the map, limiting the usefulness and validity of analyses based on the information contained in the GIS.

and the village of Jigwa. The procedural knowledge of the narrative is quite explicit. The boys traveled "along the creek" to launch the canoe. They traveled from Point to Point (as listed above) in order to arrive at the village.

The configurational spatial knowledge of the Haida narrative defines several spaces. There are the headwaters of the creeks where the *Qaasghajiina* reside and which are not necessarily contiguous. There is the waterway traveled by the boys from the village to the creek and back again. There are the five areas of the Points. And there is the village of Jigwa. Taken together the spaces are directly related to the narrative of the *Qaasghajiina.* The *Qaasghajiina* is connected with several other beings of other narratives—*Sghaana*, the salmon people, and the copper-colored frog—that expand our configurational knowledge of the area into the sea and further inland.

In this narrative, it is quite clear that we are talking about transperceptual space of the headwaters of the creeks where the *Qaasghajiina* reside. Several non-contiguous, pictorial spaces have been configured into an identifiable transperceptual space protected by the *Qaasghajiina*. Though we may not have the extensive detail of each pictorial space, mapping the transperceptual space would be a fairly straightforward task. The boundaries that we would impose would, again, be a combination of bona fide and fiat. Exactly how much of the headwaters, how much of the creeks, and how much of the adjacent land to include in the mapped space would depend on how the Haida define the "headwaters" where the Creek Women live.

The dominant cultural schema in this narrative concerns the sanctity of place. The narrative is also connected to schemas related to fertility, weather, ecological relationships between the land and the sea. Just like with the Apache narrative, we could create thematic layers for each of the related schemas and represent the space as a solid color. And as we map the surrounding landscape, we would likely see a patchwork of color representing the various schemas connected with the identified places.

With this narrative, however, we have an additional dimension. We have the intersection of worlds, where the power of the mythworld beings intersects our real world and is defined by boundaries we can't see. In mapping the headwaters of the creeks as defined places, we are also mapping the power of the *Qaasghajiina* over these spaces. Their power likely becomes diminished the further one travels from the headwaters and ceases to be influential at all at a certain point. If our purpose were to map the power or the influence of the *Qaasghajiina*, then we might use a gradient of color that diminishes in opacity the further one moves from the center of power.

As we continued to map the entire territory of the Haida in this manner, representing the areas of influence by the other mythworld beings, we would be able to see the areas where the power of different beings intersect and overlap.

The ecology of the Haida territory could then be understood in terms of Haida cosmology, making it more meaningful to the Haida. Alternatively, the scientific measurements could also be incorporated into the GIS and the thematic layers compared to the ones created for the power of the mythworld beings. We could visually compare the indigenous and scientific schemas imposed upon the environment and determine the extent of their overlap.

Multimedia data could be incorporated in the same way described for the Apache narrative. Links to text, audio, video, etc. could be incorporated into the map through text links, icons or contextual menus. Linking supplemental information in this way would provide additional context for any analysis that may be undertaken using the mapping capabilities of GIS.

6.4 Krantjirinja

The narrative of *Krantjirinja* provides us with only one piece of declarative knowledge—the name of the spring, Krantji, from which the Aboriginal clan derives its name. The procedural knowledge we can garner is limited and nonspecific, mentioning only that the human descendents of *Krantjirinja* approach the spring with eyes closed and without weapons. *Krantjirinja* is but one narrative in a web of narratives that recall *The Dreaming*. Recitation of the narratives forms the procedural knowledge of a journey that can traverse the continent.

The configurational knowledge we find is also nonspecific to a large extent, mentioning the trails followed by the kangaroos along riverbeds away from the spring and into the foothills of the Macdonnell ranges. But as with our other examples, the identification of the spaces that are configured to represent the extent of *Krantjirinja's* influence would be more easily identified by someone from the clan with experiential knowledge of the area and would likely be a combination of bona fide and fiat boundaries. We also know from the context of *The Dreaming* that the spring of *Krantjirinja* is but one place in a web that spans the continent.

It seems a fair assumption that place of *Krantjirinja* is a space that fluctuates between a smaller pictorial space and a larger transperceptual space, depending on the water cycle of the region. This fluctuation will influence the boundaries we draw at any particular time, but establishing minimum and maximum boundaries dependent on the water cycle is simply a matter of pairing in the database the area coordinates with the amount of water that falls with the rains in the area of the Krantji spring.

This area defined by the minimum and maximum boundaries can be represented with solid colors in the GIS. The defined area would be time- and water cycle-dependent. For example, with heavy rains the streams will carry more water to grasslands and be depicted as the maximum area on the map, while dry seasons will result in a reduction in the flow of water into the streams and limit the extent of the kangaroos grazing range and be depicted as closer to the minimum area on the map. In this particular case, we could also use a color gradient to define the maximum area of *Krantjirinja's* influence. The opacity of the areas furthest from the spring could fluctuate depending on the amount of water discharged from the spring.

The dominant cultural schema is the same as for the *Qaasghajiina*—sanctity of place. Connected to this schema are other schemas related to hunting, water cycles, resource conservation, human-kangaroo relationships, etc. We could create thematic layers for each of them and map them as we described above for the other narratives and which doesn't need to be reiterated here a third time.

There are a couple of other facets to this narrative and the narrative context of *The Dreaming*, which might affect the way we choose to represent this place in GIS. The first concerns the identification of *Krantjirinja*. *Krantjirinja* is a sub-geographic entity that represents a geographic space. Mapping the schemas related to *Krantjirinja*, e.g., the water cycle, is not the same thing as mapping *Krantjirinja* himself. However, including a portrayal of *Krantjirinja* doesn't necessarily mean incorporating an image of a kangaroo into the map. The Aboriginal conceptualization of this space is not dependent upon precise images of a kangaroo:

> *"With your vision you see me sitting on a rock, but I am sitting on the body of my ancestor. The earth, his body, and my body are identical."*[172]

There are no sharp, distinguishing boundaries between the features of the landscape, the continued existence and *dreaming* of the ancestors, and the consciousness of the people who have a lived relationship to the space. In the Aboriginal worldview, the logic of space is the logic of *Dreaming*.

Because *The Dreaming* is such a pervasive concept in the Aboriginal conceptualization of space, it might be useful to consider incorporating the visual representations of *Dreaming* into GIS. Aboriginal art, as depicted in Figure 9 in Chapter Five, is a visual representation of *The Dreaming* and the spaces in which the ancestors reside. We could incorporate these representations as linked multimedia files in the GIS. However, there is another possible way to incorporate such representations—as background images.

We only briefly mentioned image data as one form of spatial data in Chapter Four. Image data is most typically used in GIS as background display data. Satellite photos of geographic space can be incorporated as a layer of data, over which lay the other thematic layers of the particular space. Aboriginal art regarding *The Dreaming* can be incorporated in the same way as satellite photos—as images on a layer. The GIS practitioner needs to ensure the proper

172 Lawlor, p. 42.

orientation and scale of the art image as a layer, but the result would be a close visual representation of the places identified by the Aboriginal peoples in geographic space.

6.5 Summary

There are several factors to consider in trying to incorporate the concepts of space found in indigenous narrative into GIS. The identification of geographic entities and the inclusion of their geo-coordinates into the database is no more difficult than it would be for entities identified by scientific paradigms. Identification amounts to a delineation of bona fide and fiat boundaries.

Representing such entities on a map is slightly more complex and dependent upon the purposes of the map. The use of solid or gradient color may be appropriate in different cases, depending on whether or not the map is designed to represent physical-world or the power of mythworld entities. The multiple schemas associated with a particular geographic space can be represented on individual thematic layers. It may also be possible to compare different thematic layers to determine the amount of overlap and, presumably, how closely linked they may be within the culture.

We can supplement our maps with additional, multimedia data such as text, audio, video, etc., which may provide much of the contextual information related to particular geographic entities and which may be useful in analysis of geographic spaces. Just as photo images may be used as background, so may some forms of Aboriginal art of *The Dreaming* be used as background images for Aboriginal GIS.

Conclusion

In looking at examples of indigenous narratives that have a significant spatial component, we find indigenous conceptualizations of space are not merely primitive understandings of space that are better explained by a scientific paradigm. They are ontologically different conceptualizations of 'reality.' Each culture creates its own legitimate forms of meaning.[173] Individual cognition will focus on the features of space that are culturally meaningful. Conceptualizing space is so fundamental a phenomenon within our cognition, embedded at a preconceptual level, that we believe our personal conceptualizations of space to represent 'reality' as it truly is.

This thesis has attempted to bring the same standard of meaningfulness regarding space to indigenous and non-indigenous paradigms. It presents the notion that indigenous understandings of their environment are as meaningful to those communities as scientific paradigms are to others. We asked, "Would mapmakers from indigenous cultures and those from cultures with an embedded scientific paradigm produce the same maps of the same geographic space?" We concluded that because of the schemas they use to engage space they would produce different maps. Their personal histories and the entities in space that they recognize as meaningful for mapping would differ. They would, in effect, produce different representations of 'reality.'

Mapping space is the mapping of schemas. Representations of space are representations of cultural schemas. Indeed, any map generated is a representation of a particular set of cultural schemas. Using a tool based in one set of spatial schemas to map those of another culture can be a complex, but not impossible, task. All cultures have some way of recognizing and imposing boundaries upon space. Incorporating indigenous boundaries into GIS consists of the same process for incorporating non-indigenous boundaries—creating bona fide and fiat boundaries to delineate entities within geographic space. This practice is already in effect among many indigenous communities, a few examples of which were outlined in Chapter Four.[174] Many, such as the Ahousaht of British Columbia, are incorporating traditional names and boundaries into the GIS along with the resource management information typically used by scientific and government agencies. GIS has the potential to represent the spatial realities of indigenous peoples in ways that can be more

173 The assumption embedded in our discussion is that the worldviews, epistemologies, and ontologies of indigenous peoples have their own axioms of logic, internal consistency, and forms of legitimacy. Further discussion on this topic can be seen in Rosaldo (1993), Watson-Verran and Turnbull (1995), and Wilson (1998).

174 Many indigenous communities are incorporating indigenous and non-indigenous understandings of their space into GIS. They are incorporating their own names for places as well as mapping for resource management based on non-indigenous paradigms. For a sampling of GIS projects conducted by indigenous communities, see *Cultural Survival Quarterly*, Winter 1995. See also the many examples linked via the Aboriginal Mapping Network [Online] Available: http://www.nativemaps.org/map_gallery.html#MoreMaps [2003, April 24].

easily understood by, and which are more meaningful to, both indigenous and non-indigenous cultures.

What of the cultural mapping suggested by this thesis? The narratives examples of the Apache, Haida, and Krantji Kangaroo clan have significant spatial components and represent another form of information that can be captured for spatial representation. Spatial components aren't the only reason to do cultural mapping, howevver. Mapping the geographic entities in these and other narratives may just be the first step in the way we map culture onto space. Much of what we've discussed in this thesis concerns the schematic associations that are evoked by interacting with or recalling a particular place. The meaningfulness of the place is an important component in understanding the cultural significance of it, or even being able to identify it at all. To that end, GIS may serve as a tool for cultural analysis. For example, an ethnographer researching a culture may incorporate information gleaned from individual interviews onto different layers. He could determine where the boundaries of the schemas match up and where they differ, pointing to the potential *intracultural* and *intercultural* interactions that might arise within a community. Later, he can easily retrieve the layered information drawn from various and variable sources and begin to construct thematic layers, imposing an organizational structure based on categories of interest. Subsequent ethnographers can add to or refine the information already collected and incorporated into the GIS. As more data is accumulated about particular spaces and their related schemas, GIS can begin to serve as a respository of cultural data that can be shared among many people, which makes the creation and integration of metadata so important. Ultimately, we could end up with an extensive cultural mapping, with the inclusion of narrative, text, multimedia and other data that can be used in many ways—for teaching, for research, for planning, for legal claims, and more.

With respect to research, we could also map the same geographic area based on different cultural schemas, as suggested above in comparing the manifestations of the mythworld with the understandings developed by scientific methodology. Such a comparison need not be limited to two cultural paradigms and could create a robust arena for examining intercultural interactions. Each cultural understanding of the particular space could be grouped into a set of layers and compared to one another. Each set of layers would likely include information not specifically spatial in nature and inclusive of related schemas, making each entity identified in geographic space a beginning point for the examination of an entire gestalt of networked connections. By linking the related schemas to places, we could begin to construct a visual representation that parallels Strauss and Quinn's assertion that each person becomes the junction point for an infinite number of overlapping cultural schemas. Using GIS, each place becomes the junction point.

Using GIS as a tool for cultural analysis as described here may seem an awkward application of a technology designed to map geographic space.

However, if we consider that all cultural phenomena happens *someplace* the idea of using a spatial mapping technology seems less strange. Space is a universal entity that every culture has some way of understanding, though such understandings are often based on very different cultural frames. GIS technology has the advantage of having a consistent interface through which one can access the data by visualizing spatial representations. The difficult part is devising a standard format for including the qualitative data. A system of categorization would have to be agreed upon by those concerned—ethnographers, GIS practitioners, indigenous communities, students of culture, governments, etc.—that would enable the consistency of format for qualitative data, thereby facilitating its analysis.

The awkwardness of GIS as a cultural mapping tool becomes apparent, however, when we consider that the visual geographic representations of dominant cultural schemas—e.g., refraining from interference, sanctity of place—is not a readily intuitive means by which to understand cultural schemas. For example, generating a layer of representation of the space related to the schema of non-interference might be compared with a layer for the schema related to conflict. Representing such schemas as geometric areas on a map might result in overlapping areas and could be indicator of how closely related these schemas are. Comparing the relative sizes of areas designated as connected with the same schemas does not necessarily tell us that one area is more strongly associated with or more frequently activates a particular schema. Making these analysis would require more than just visual representations of geographic space. Drawing conclusions about the complexity of cultural phenomena would require much more contextual information such as the information provided through the multimedia links. Viewing a cultural schema as a geometric area of solid color on a map is not a readily intuitive way of grasping their meaning and more research is needed into this way of representing cultural knowledge and meaning related to space.

There are new technologies and representation methods, (not necessarily part of GIS, though capable of being integrated with it) being developed that may facilitate understanding of the associated meanings of a particular place. Three-dimensional visualization techniques, often used in considering the visual and aesthetic impact of natural resource management,[175] may provide a useful interface that allows the indigenous users of GIS to more easily grasp the space being portrayed and its associated meanings. This type of visualization creates a virtual reality or virtual environment[176] where objects have a sense of spatial presence independent of both user and technology. This form of representation could be interactive, allowing the user to feel the effects of being present in that particular space or environment by being able to manipulate aspects of it.

175 Buckley, D.J. and Berry, J.K. (1997) *Integrating Advanced Visualization Techniques withh ARC/INFO for Forest Research and Management*, Paper presented at the 1997 ESRI User Conference, San Diego, CA, [Online] Available: http://www.innovativegis.com/papers/vis/p347.htm [2003, May 1].
176 Bryson, S. (No Date) *Virtual Reality: A Definition History*, [Online] Available: http://www.fourthwavegroup.com/fwg/lexicon/1725w1.htm [2003, May 1].

The space could also be represented with a digital elevation model,[177] which contains spatial elevation data in a regularly gridded pattern in raster format. Modeling data in this way would transform a flat geometric area on a map to something similar to Figure 10 below, which is more topographically representative by illustrating the contours of the landscape:

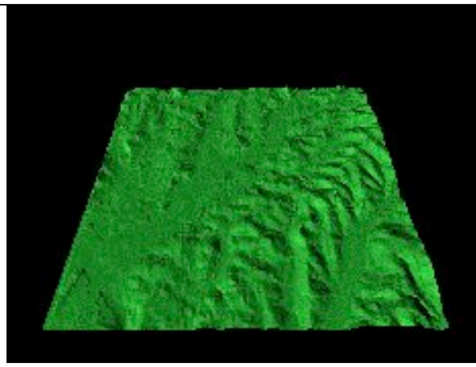

Figure 10. Example of Digital Elevation Modelling technique.[178]

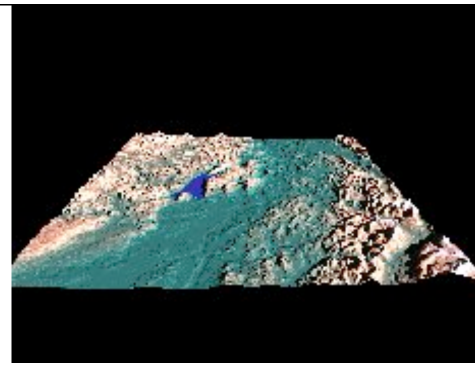

Figure 11. Example of Height Dependent Coloration applied to Figure 10.[179]

By adding coloration to the ranges of elevation, the area could be further transformed into something similar to Figure 11. This technique could be extrapolated for use with cultural divisions of space. The sacred spring of the *Krantjirinja* and the extent of his life-giving power could be mapped in this way, for example. In fact, any of our narrative examples could be represented this way. It would provide a more meaningful representation to the indigenous culture, as it would incorporate many of the spatial schemas of the particular places. However, representing the associated schematic meanings (i.e., the imperative of non-interference by relatives) as colored geographic areas would still be problematic for those not possessing those cultural schemas. It would still be necessary to draw from the contextual information associated with that particular place, even with the inclusion of highly detailed metadata in the database.

Another potential area of integration parallels the biophysical modeling discussed in Chapter Four. Software for modeling neural networks and social phenomena makes it possible to explore the connection between the micro-level behavior of individuals and the macro-level patterns that emerge from the interaction of many individuals. How an integration of such software with GIS might occur is beyond the scope of this thesis, but the schemas that are captured for representation in GIS could serve as the basis for writing the rules needed for such modeling

177 Childs, J. (2000) *Digital Terrain Modeling Techniques*, [Online] Available: http://www.terrainmap.com/rm3.html#dem [2003, May 1].
178 Taken from Childs (2000), [Online] Available: http://www.terrainmap.com/rm3.html#dem [2003, May 1].
179 Taken from Childs (2000), [Online] Available: http://www.terrainmap.com/rm10.html#height [2003, May 1].

software to work. If such integration is successful, GIS could provide a simulation environment in which students, teachers, business people, government agents, academic researchers, indigenous communities, and many others could model the intercultural and intracultural experiences in a particular population. The simulations might provide the foundation for making predictions regarding the introduction of a particular technology with a particular community, or making an effective plan for resolving inter-ethnic conflicts, for example. The possibilities are infinite.

GIS is capable of representing the geographic realities, which are expressions of cultural schemas, of indigenous communities in meaningful ways. And as the processing power of computers increases, along with storage capacities and networking capabilities, the visualizationand modeling techniques and sharing of information among indigenous communities, social scientists and technologists will be facilitated. How much traditional knowledge or narrative is included into the database depends on the purpose of the GIS and the constraints imposed on its usage, e.g., restrictions in making certain traditional knowledge public, restrictions on using recordings of people who have died, or the limited skills in using the tool effectively. GIS technology is inclusive insofar as it is able to represent boundaries in space and situate emergent cultural phenomena in relation to those boundaries. Any set of spatial schemas that include delineation of boundaries can be incorporated and represented visually. The technology doesn't care what boundaries are incorporated. Ultimately it is just another tool, albeit a complex and expensive one. And while its potential for integration with social and network modeling software is still unclear, its use for biophysical modeling and use in indigenous and non-indigenous communities as a means of capturing cultural schemas is an issue of intent and resources, not capability.

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