NATIONAL AND ORGANIZATIONAL CULTURES IN GEOGRAPHIC INFORMATION SYSTEM (GIS) DESIGN
A TALE OF TWO COUNTIES

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ABSTRACT

How does culture influence GIS design? How is the cartographic discipline involved in GIS design in different cultures? The research presented in this paper builds on comparative information science work on culturally mediated differences in work values and the comparative analysis of information systems. Research from Hofstede and others identifies four dimensions of culture: power distance, uncertainty avoidance, individualism, and masculinity (Hofstede 1980). Power distance and uncertainty avoidance are most important for information systems. Two county GIS designs are examined based on this framework. The research presented here leads to the identification of culturally influenced differences between the county GIS designs of King County, Washington, USA and Kreis Osnabrück, Germany.

INFLUENCE OF CULTURE ON GIS DESIGN

In GIS research, the information science literature is largely read from a cognitive viewpoint (for example Mark 1989; Frank 1992; Nyerges 1993; Frank 1994). Another body of literature in the information sciences has considered the broader context of information system design and use based on comparative cultural analysis (Hofstede 1980; Eason 1988; Jordan 1994; Tate 1994; Watson, Hua Ho et al. 1994).

Authors in the GIS field recognize larger structures that mediate information system design and practice. De Man (1988) explicitly recognizes the role of culture in influencing the meaning and value of information. Aronoff, writing about implementation, identifies the organizational context of GIS as critical not only to the operation, but for the essential identification of functions that the GIS is to fulfill (Aronoff 1989). Chrisman develops the most complete framework for understanding the influence of culture on GIS to date through custodian institutions and mandates (Chrisman 1987).

Information systems are designed to provide information for enlightened decision making. In a wider social context the meaning and value of information are determined by culture (Weber 1946). In their examinations and ruminations about the use and design of maps, many authors clearly refer to culture's importance. Cartographers, examine this from various perspectives (Turnbull 1989; Freitag 1992; Muehrcke 1992). This literature is very general and does not reflect information system work. Specifically developing the influence of culture on information system design and implementation is not possible from this literature. Recent literature from scholars with a surveying and computer science background examines the issues of culture in spatial comprehension and GIS use (Campari and Frank 1993; Campari 1994).

Work examining the culturally mediated influence of the cartographic discipline on GIS design must elaborate the cultural and institutional framework. One path to study cultural influences would highlight the role of disciplines as the vehicle of cultural expression. Chrisman explicitly discusses the disciplinary and organizational context for the design of GIS and understanding the role of cartography in mediating cultural conceptualizations of spatial 'reality' in his 1987 paper. This extension of the cartographic communication model (Robinson and Petchenik 1975; Morrison 1978) describes the connection between map and reality formed by culturally manifest mandates and institutions. Culture is a framework that contextualizes individual and institutional values, meaning, and consequently the processes through which decisions are made. The study of cultural influences in GIS design and implementation should reflect the social role, situation, and power of disciplines.

The key question examined in this paper is how the cartographic discipline mediates national and organizational cultural values and meaning in GIS design. A discipline can function overtly, as a guild, or indirectly, through a network of relationships developed around professional and personal criteria. This examination limits itself to the role of cartography, a core discipline in the GIS field.

Cultural comparisons are complex. Any cultural characteristics of information conceptualization and exchange must be based upon comparatively validated theoretical approaches.

This paper applies the findings of information science research to a comparison between two county GIS designs in King County, Washington, USA and Kreis (County) Osnabrück, Lower Saxony, Germany. The focus is on overall system design and cultural differences manifest through the distinct involvement of the cartographic discipline. Detailed documents on their respective system designs form the basis of this comparison. Experience working at the communal level on GIS projects in both countries augments this comparison.

The next section of this paper will proceed by giving the reader an overview of each county's GIS design. We will follow this by a section that describes the theoretical framework for the comparison of information systems. The results of the comparison are presented in the third section and a summary of the findings and conclusion follows.

TWO COUNTIES — TWO GIS

King County and Kreis Osnabrück started their GIS design work in 1989. Kreis Osnabrück is the smaller of the two countries, both in size and population.

The essential difference in the GIS design documentation lies in Kreis Osnabrück's reliance on national standards (ATKIS, ALK, MERKIS) for the design of their county GIS, whereas King County is developing their GIS from the ground up. ATKIS - *Automatisierte Topographisch-Kartographische Informationssystem* (Automated topographic and cartographic information system) is the most important. It is the object orientated data model for provision of vectorized topographic data at three scales: 1:25,000, 1:200,000 and 1:1,000,000. ALK - *Automatisierte Liegenshaftskataster* (Automated property cadastre) is the automatization of the Grundbuch (Property Book). The *Maßstaborientierte Einheitliche Raumbezugsbasis für Kommunale Informationssysteme* (Map scale orientated uniform spatial coordination basis for communal information systems)describes GIS at the communal level as a ". . . geographic data base for agency specific, spatial communal information systems based on the national coordinate system, a unified data model for all

topographic and agency specific spatial data, . . ." (Landkreis Osnabrück 1990).

King County's GIS is implemented through a project that involves design issues. Its design starts with a needs assessment (PlanGraphics 1992a) followed by a conceptual design document that describes most data layers along with source, conversion method, and maintenance responsibility (PlanGraphics 1992b). Major features and tabular attributes describe shared data base layers, but without any detailed data modeling (PlanGraphics 1992b). The county council supported a trimmed down version of the unified county GIS and a core project to provide the shared base layers was started. When the project is completed, they will pass on most responsibilities for maintenance to the appropriate agencies. However, a central group is foreseen, whose exact functions are not identified. Beyond the basic lists of features and attributes, the project develops the work on data modeling and agreements with the participating agencies. There is no common understanding of what the county GIS is based on or should provide.

The following table summarizes key design differences between the two counties.

Kreis Osnabrück	**King County**
Organizational	
Information system department of the county government is lead agency. Various working groups are coordinated by a newly created position. GIS data base design is carried out in the responsible agency based on the ATKIS model (Landkreis Osnabrück, Der Oberkreisdirektor 1993b).	Information system department of county transit agency (recently merged into County government) is lead agency. Two committees accompany the project. GIS data base design is coordinated with other agencies, municipalities, and corporations (Municipality of Seattle 1993).
Purpose	
Provision of data and information for more efficient administration and planning at the communal level (Landkreis Osnabrück 1990). Needed improvements are identified by agency and function (Landkreis Osnabrück, Der Oberkreisdirektor 1992; Landkreis Osnabrück, Der Oberkreisdirektor 1993b).	The core project provides capabilities for diverse agencies and purposes that are vaguely defined, ie. "better management of". Project goals are limited to development of the county GIS data base.
Budget overview	
DM 2.89 million (app. USD 1.94 million) (Landkreis Osnabrück, Der Oberkreisdirektor 1993b)	USD 6.8 million (Municipality of Seattle 1993)
Data model (Base layers)	

Provided and defined largely by the national standards ATKIS, ALK, and MERKIS. Extensions are for county purposes and already listed in the object catalog. Agencies can extend the data model when needed in a given scheme.	No explicit data modeling in the conceptual design documents. 72 layers in all Core first five of 14: Survey Control Public Land Survey System Street Network Property Political
Disciplinary involvement	
The use of ATKIS/ALK as basic data base model and requirement that data "fit" this data base (MERKIS) make it necessary to involve cartographers. These standards require other specialists to perform data modeling that fits these standards.	Cartographers and GIS specialists hold key positions in project management. These disciplines and surveyors, environmental scientists, and other specialists (foresters, biologists) are spread throughout other levels of the project.
Information collection, analysis, and display	
Documents describe administrative procedures and source maps in detail, but not how they are performed/used in a GIS-based automatization of procedure (Landkreis Osnabrück, Der Oberkreisdirektor 1992; Landkreis Osnabrück, Der Oberkreisdirektor 1993c).	Documents sometimes identify rough costs are(Municipality of Seattle 1993), but no detailed requirements, sources, procedures of any kind are identified. Only general tasks are described (PlanGraphics 1992b).

THEORETICAL COMPARATIVE FRAMEWORK

In the information science field several works have been published that empirically study the involvement of culture in information system design. This work is generally informed by the sociological work of Max Weber. In his broader system of sociology he establishes the role of culture through its shared set of beliefs that influence what we consider to be meaningful and valuable. Disciplines (professions) and institutions in modern bureaucratic society nurture and transmit these values and meanings (Weber 1946; Weber 1947). Obermeyer (1994) recently discussed the role of professions in GIS in Weber's framework. Chrisman, writing about the involvement of different disciplines and guilds in spatial data handling, also identifies disciplines as carriers and transmitters of cultural values (Chrisman 1987).

To establish the critical role of culture and its effects on GIS design a more explicit, comparative study is on order. Essential to this study is the identification of core cultural values that directly affect GIS design. In the information systems field, unique and key work that empirically establishes these factors was published by Geert Hofstede.

Hofstede published the results of a study of 117,000 questionnaires sent to 84,000 participants in 66 countries examining the role of culture in work-related values (Hofstede 1980). Applying theories of culture and organizational structure from Weber

(Weber 1946) and Parsons (Parsons and Shils 1951; Parsons 1951) to Geertz (1973) and Kluckhohn (Kluckhohn 1951; Kluckhohn 1962) to the research findings, Hofstede (1980) establishes four dimensions of national culture:

- **uncertainty avoidance** — the extent to which future possibilities are defended against or accepted
- **power distance** — the degree of inequality of power between a person at a higher level and a person at a lower level
- **individualism** — the relative importance of individual goals compared with group or collective goals
- **masculinity** — the extent to which the goals of men dominate those of women.

Uncertainty avoidance is the focus of information systems, decision support systems, etc. (Jordan 1994). It is considered together here with power distance because of interaction effects (Hofstede 1980). Due to the similarity in this variable between Germany and the USA it alone is not particularly significant, but important in a wider context with power distance. It is important to note that Hofstede's findings ascribe ideal typical qualities and ideals to each culture in a Weberian sense: they are the strived for forms, not individual characteristics nor implementations.

Organizational Form, Implicit Model of Organization, Problem Solving Approach, and National Culture

	High Uncertainty Avoidance	Low Uncertainty Avoidance
Low Power Distance	Workflow bureaucracy Well-oiled machine Regulations German speaking, Finland, Israel	Implicitly structured Market Negotiations English speaking, Scandinavia, NL
High Power Distance	Full bureaucracy Pyramid Codified hierarchial Latin, Japan, some other Asian	Personnel bureaucracy Family Diffuse hierarchy Southeast Asian

Figure 1 Uncertainty avoidance and power distance. Each box lists the organization type, the ideal model for an organization, the ideal problem solving, approach and national culture associations. (After Hofstede, 1980 p. 319)

Uncertainty avoidance and power distance form critical interactions affecting organizations. In Germany and the USA, where power distance is low, there are two possibilities how to keep organizations together and reduce uncertainty. If there is high uncertainty avoidance (German speaking), "people have an inner need for living up to rules, ... the leading principle which keeps the organizations together can be formal rules" (Hofstede 1980 p. 319). With low uncertainty avoidance (Anglo), ". . . the organization has to be kept together by more ad hoc negotiation, a situation that calls for a larger tolerance for uncertainty from everyone" (Hofstede 1980 p. 319). Figure 1 shows important organizational characteristics based on fourfold division based on uncertainty avoidance and power distance dimensions. Hofstede comments the figure in detail. The "Anglo" cultures "would tend more toward creating 'implicitly structured'

organizations" (Hofstede 1980 p. 319). In contrast, German speaking cultures establish 'workflow' bureaucracies that prescribe the work process in much greater detail (Hofstede 1980 p. 319). Hofstede argues that problem solving strategies and implicit organization forms follow: Germans establish regulations, Anglo-Americans have horizontal negotiations. Germans conceive of the ideal type of well functioning organization as a "well-oiled machine," whereas Anglo-Americans conceive of a "village market" (Hofstede 1980). However insightful cultural factors are, they cannot explain all the differences between organizations.

Even proposing explanatory theories of organizational behavior is a manifestation of the cultural values in which they were written. Comparing Weber's (German), Fayol's (French), and Follett's (American) writing on the exercise of authority in bureaucracies the influence of cultural values is clear, "Weber stresses the office; Fayol, the person; Follet, the situation" (Hofstede 1980 p. 323).

Information transaction cost theory (Willamson 1975) provides additional insight into cultural influence on organizational structure and approaches to problem solving. In this theory, all business activity is transaction between individuals and groups. Information serves as the controlling resource (Jordan 1994). In this form the theory is overly reductionist and simplistic. Boisot extended transaction cost theory to include cultural issues, distinguishing two characteristics of information that affects transactions:

- **codification** the degree of formal representation
- **diffusion** the degree of spread throughout the population (Jordan 1994)

Internalizing the transaction in the organization reduces the diffusion of information (Jordan 1994). Centralized information requires a bureaucracy, whereas diffuse information is distributed in a market. These differences correspond to Hofstede's work (Jordan 1994) and are crucial for comparing and assessing GIS designs. How GIS design codifies or diffuses information will depend on the importance of uncertainty avoidance and ideal organization type. Multi-disciplinary, multiple goal orientations (Radford 1988) will have additional hurdles to face in information system design.

Nominally, highly integrated industries and commerce apply the information transaction approach. GIS design approaches often begin with a similar structured systems approach (Gould 1994). When considering heterogeneous public administrations, a different, highly diversified organizational structure is possible. In county governments the multi-disciplinary interests, missions, goals, and perspectives require consideration of the cultural values that influence the information system.

COMPARISON

The mediation of cultural values through cartography in King Count and Kreis Osnabrück is clear from the respective GIS design documents. In Kreis Osnabrück rules and clearly defined components and procedures are implemented, based on the organizational form of workflow bureaucracy. Effective decison making in Kreis Osnabrück comes after regulations. King County documents leave the coordination and many questions of design open, to be determined through a process of negotiations in an implicit organizational structure.

The following overview, based on the structure as the description of GIS design above, provides a condensed description of differences between the two counties GIS

designs.

Kreis Osnabrück	King County
Organizational	
The EDP group in the county is "lead"; agencies work on "own" data but coordination is maintained through coordinator, working groups, and administrative procedures.	The core project implements conversion according to negotiated data model and quality standards and hands the converted data over to the respective `stakeholder' agencies.
Purpose/Intent	
Development of communal information system: a collection of geographical data and methods and procedures for the systematic collection, updating, processing, transforming, and distribution of all data	Provision of base layers of county GIS to fulfill agency-identified functions in coordination with county agencies.
Disciplinary influence	
Definition of standards and guidelines for organization of data and training of personnel through national groups (ATKIS/ALK and MERKIS)	Implicit through backgrounds and experiences of key personnel. They have been involved with Wisconsion MPLIS projects and local area projects, including the City of Seattle's GIS data base design.
Data organization	
Defined in object catalog based on ATKIS (Landkreis Osnabrück, Der Oberkreisdirektor 1993a)	Developed through negotiations with key agencies
Information structure, analysis, and display	
Defined by standards, agency, legal requirements, and procedure	Described in documents and developed through negotiations with agencies.
Information formalization and control (codification vs. diffusion)	
Centrally codified in an object catalog, with defined ranges for additions through individual agencies.	Ongoing, defined through a pilot project and negotiations with `stakeholders'
Re-engineering or adoption of new techniques and procedures (uncertainty avoidance)	
GIS is used to automate existing procedures. The exact usage of GIS is not clarified for individual procedures and agencies.	Focus is on products. Procedures are open for change. Implementation is developed through negotiations with agencies

Considering the diffusion/codification of information, low/high uncertainty avoidance, and negotiation/regulation approach we can summarize these differences in problem solving strategies. The GIS design of King County foresees the distribution of data and information among participatory agencies after completion of the project (stakeholders with market shares), low uncertainty avoidance (integration will be worked out later), and ongoing negotiations to clarify fundamental and detail questions (including a pilot project to identify key issues). On the contrary, Kreis Osnabrück bases their GIS design on a codification of information (catalog of geographical phenomena based on ATKIS), high uncertainty avoidance (full description not only of data types, but of their use in administrative procedure), and regulations to prescribe form and function of the GIS.

However, in Kreis Osnabrück some administrative regulations may require special data collections. They should be based on ATKIS/ALK, but a mechanism for checking this may not be in place. Thus, the question of the integration of specific data, ie. animal preserves (*Tiergehege*), with ATKIS/ALK remains. If large conceptual differences remain, integration may require substantial interdisciplinary efforts.

Hofstede also identifies characteristics of information system design strategies in terms of implicit models of organization: the "market" for American culture and the "well-oiled machine" for German culture. King County's GIS design makes the concurrent negotiation of critical design issues during implementation necessary. Kreis Osnabrück, on the other hand, designs around standards, the critical issues in implementation are making the technology do what the regulation and procedure require. This is perhaps overly reductionist, but as a pastiche is highly illuminative of the complex fundamental differences between these two cultures' GIS design approaches.

In these two cases, divergent roles of the respective cartographic discipline are evident. In Kreis Osnabrück, cartographers have been key in defining the national standard for geographical databases, ATKIS. These are the basis for the data model designed by the GIS design group. The core project in King County has no such national standards, but the backgrounds of key management personnel in MPLIS work and local GIS work at the local and regional level, ensure the implicit influence of design strategies and approaches from the broader professional context of cartographers and GIS.

SUMMARY AND CONCLUSION

Culture is a broad framework for understanding important contextual factors in GIS design. At the level of national culture, we identify substantial differences in the conceptualization and design of information strategies to aid decision making and the culturally mediated involvement of cartography in GIS design. The role of cartography in directly or implicitly influencing GIS design is evidenced in the role of respective national standards. In the US, the Federal government implements national standards, primarily to regulate transfer, ie SDTS. In contrast, national groups in Germany prepare standards that effect the detailed aspects of GIS design, ie. ATKIS.

Mediation of cultural values in GIS design, implementation, and use are directly or informally manifested. In Kreis Osnabrück, cartographers and surveyors play the key role through the standardization of basic spatial data in ATKIS and ALK. These form

the foundation for much of the county's GIS work. King County's core GIS gets around the issue of standardization by agreeing in committees to develop base layers for the county GIS that best serve the common interest and represent the stakeholders, without predefining the integration of any of the stakeholders' data. Implementation and use of the county GIS in King County hinges on ongoing relationships and negotiations between the stakeholders.

The use of GIS for decision making in both counties will hinge on the success of the county GIS design to implement diverse organizational and cultural conceptualizations of geographical phenomena. The integrative role of GIS hinges on the capability of different disciplines to amalgamate their 'world views'. Over time, will a more predefined topographic model or cartographic representation work more efficiently than a heterogeneous, non-conformal model?

Further research based on case studies (Onsrud et al. 1992) should examine the variance between design and use. Case studies of implementation can provide specific insight into implementation and variance from design, opening important insight into the direct and indirect influence of culture and discipline in GIS.

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