# Cultural and Linguistic Aspects of Designing Geographic Infoirmation Systems for Spanish Speakers

**Michael D. Gould**
*National Center for Geographic Information and Analysis*
*Department of Geography*
*State University of New York at Buffalo*
*Buffalo, NY 14261*

**ABSTRACT**

Automated cartography and geographic analysis has been available to Latin Americans for more than a decade. Software such as Dana Tomlin's Map Analysis Package (MAP), running first on VAXes and other minicomputers and now on inexpensive personal computers, has reached nearly all areas of the world. Because most of this geographic software is designed and produced in the United States or the United Kingdom, it may be useful to ask how Spanish speakers are utilizing "our" English language software. In this paper I introduce problems often encountered by Spanish speakers (as well as others) when attempting to utilize geographic information systems. Some of these problems are due to the lack of translated documentation but others are due to the lack of natural user interfaces in today's geographic information systems (GISs). I then describe a research project for investigating aspects of spatial cognition in both English and Spanish speakers. These aspects, often linguistically revealed, are to become the foundation for new, uniquely spatial, user interfaces for geographic information systems. Finally, I review preliminary findings of two pilot studies involving native Spaniard subjects and then speculate regarding plans for future testing in Quito, Ecuador. This cognitive testing is aimed at identifying potential cross-cultural differences or commonalities that may be supported in future GISs.

Why would geographers address GIS design from a cognitive standpoint? One reason is that GIS is an area in which geographers can make the most meaningful contributions. During the past decade or so, many but not all of the "tough, technical problems" in GIS have been solved. The remaining technical problems involve such issues as distributed databases, parallel processing and hardware interfacing -- issues that may best be handled by computer scientists or engineers rather than geographers. In the long term, it is expected that identifying the cognitive basis for spatial decision making in a bottom-up manner will foster more effective geographic information systems than will the traditional top-down approach based upon extending current hardware/software capabilities.

## TRADITIONAL GIS DESIGN

Geographic information systems began when the Canada GIS was developed in the early 1960s (see Tomlinson 1984 for a history). The design issues discussed here, however, apply primarily to the GISs available today. It is interesting to note that the world's most popular, general purpose geographic information systems such as Arc/Info, MAP and ERDAS) were designed and built in English (Mark, Gould and Nunes 1989). This is true even of some systems built by non-Anglo Americans such as Microm España (1989). But what is meant by designing "in English?" Simply put, the GIS design procedure reflects the manner in which the designers think about structure and express spatial relations. See Mark's paper in this volume for more on how language structures space. Most GIS designers are native English speakers, and this linguistic/cultural bias often affects the resulting product. This is important considering that GISs are now being utilized worldwide by technicians with limited command of English for mapmaking and spatial data analysis to support environmental planning. This should be

***especially*** important to CLAG members because many of these technicians are Latin American.

## TOOLMAKING AND TRAINING

This section addresses a point made by David Robinson in his chapter in *Geography in America* (Robinson 1989). He lists ten tasks "worthy of study, if necessary by teams of researchers," and in the context of the state of geography in Latin America he relates,

**[end p. 343]**

"Perhaps after centuries of extracting geographic resources, it is time to repay our disciplinary debts, and not in expensive English-language articles and books! Given the recent innovations in microcomputers, in GIS, and other 'hot' technologies (Harnapp 1979), it might be opportune to provide our colleagues south of the border with new tools and training" (Robinson 1989: 498).

The provision of new tools is all well and good, but who is to be responsible for determining the tools' form and function? The Germanic toolmaker, the indigenous tool user or some intermediary? Currently, the toolmaker (GIS designer) is the person for whom the tool (software) is optimized; emphasis is clearly upon facility of programming and software maintenance, rather than upon ease of use. This is a common-sense business practice. The software developer must in essence take out "insurance" against the possibility that the software might malfunction or crash, inflicting damage to the corporate reputation and pocketbook. This insurance most often takes the form of conservative software development methods that sacrifice flexibility for fault tolerance and that concentrate on function rather than form.

Training within the GIS industry currently is a straightforward issue. The client purchases a GIS hardware/software package (the value of which ranges from $5000 to several million dollars) from a North American or British vendor and is provided with dozens of looseleaf binders full of documentation. This was the case recently when the Geographic Information and Analysis Laboratory at Buffalo took possession of a UNIX-based workstation housing one GIS software product. The documentation set consists of at least 70 (I stopped counting) reference books describing in detail the hardware, operating system, compilers, debugging facilities, graphics environments, window managers, device drivers, system administration, networking, and GIS functions and even includes a manual that supports troubleshooting by informing the user which other manual to read next.

Naturally, this documentation is in English only. Surprisingly (or not?), this was the case in Spain as well, when I assisted in the installation of a similar system in a GIS laboratory. Same documentation. The Spaniard instructor installing the software pointed out, in the vendor's defense, that classroom training for one person had also been included in the cost of the GIS software. Unfortunately in many cases *the* classroom is in the United States and the classes in English only.

Although the GIS industry has been slow in responding to the needs of non-English speaking users some progress is being made in the area of training materials. For example, ESRI, maker of Arc/Info, a widely-used GIS, has recently announced a translation effort as part of their new educational products division.

The first educational materials to be translated will be the new self-study workbooks and the new one-week Arc/Info course. After that, the priority will be based on the market demand and the effort required. In determining which foreign languages will be translated, ESRI will consider such factors as the size of the community speaking the language as a major business or technical language, the volume of GIS-related technical literature already available in the language and the importance of the translated materials to the success of existing users and potential users. The languages most likely to be translated include Spanish, French, German, Arabic, Chinese and Portuguese (Henderson 1990: 25).

So, in response to Robinson's plea for an infusion into Latin America of GIS-related tools and training, we should be mindful that these tools are currently no more than costly analogs to the English-only articles and books. A point to be stressed is that while the books may be translated into Spanish with relative ease the same is not necessarily true for the GIS software.

## ASSISTING THE GIS USER

It has been argued by some GIS "experts" that humans are capable of adapting to new environments and, therefore, user interfaces should not support current needs but instead push human capability to ever-higher levels. While this view may appeal to a factory manager interested in maximizing output it begs the question of who will determine the goals. The answer implies a culturally-based norm. For example, is it in the best interest of a native Indian GIS user to learn the 1200+ system commands in English of the Arc/Info GIS so that his/her intellect might be challenged? In fact, just the opposite should happen. The GIS should be made to appear so simple and intuitive as to essentially become invisible to the user. The user should be intellectually challenged to *apply* the system to **[end p. 344]** formulate better theory, solve more complex problems and contribute as much as possible to the field of interest. It is only in the interest of highly-paid GIS consultants to design GISs that are intellectually challenging to use.

But how can a single, general purpose geographic information system be designed so as to allow users, from Australia to Argentina, to operate it more naturally and to provide maximum support of human abilities for geographic analysis? One answer is that we must first learn more about spatial cognition, the ways in which people naturally structure space. Only then can GISs be designed to optimally support the user's conception of space. The alternative has been, and unfortunately may continue to be, teaching the user to cope with an environment designed not for humans but for finite computing machines. Humans do not think in raster cells nor points, lines and polygons.

## A RESEARCH PROJECT

A research project was developed in order to examine human methods for structuring and expressing spatial relations. The project will be carried out during the next year or two. An oral questionnaire/interview will be used to extract both qualitative and quantitative information about English speakers' and Spanish speakers' manipulation and expression of spatial relations, both verbally and otherwise. The research project seeks answers to the following general questions:

1) What are common methods, across English and Spanish speaking cultures, of structuring and manipulating geographic space?
2) How do the methods by which people structure and manipulate geographic space relate to the design of GIS?
3) What new, uniquely spatial user interfaces might be designed to facilitate the effective integration of spatial cognition and GIS?

## HUMAN SUBJECTS

The experimental subjects will include students, teachers and non-academic adults within geographically-oriented disciplines such as geography, planning and forestry and nongeographic areas such as education, architecture and business. To gain cross-cultural and cross-linguistic data the study areas will include both Buffalo, New York and Quito, Ecuador. The experiment described here has been approved by the University at Buffalo Human Subjects Review Board (10/11/89).

Selection of the subject samples in both locations will be based primarily upon opportunity. This is more formally termed "non-probability sampling by accident" (Peil 1982: 28) in the context of social science field research. Given the results of the pretest discussed in the following section attraction of a large number of subjects in desired classes cannot be assumed. But in order to encourage participation each subject will be offered a token payment.

## THE QUESTIONNAIRE/INTERVIEW

The questionnaire in its pretest stage, to be given orally to each subject, consists of 20 questions related to geographic-scale spatial relations and the subject's perception, structuring and manipulation of these relations. Questions will be the same for each subject, and will be read, in the native language of the subject, from a prepared script. The area of interest a "neutral" location, Puerto Rico, will remain constant across North American and Ecuadorian subjects. Most questions are designed to elicit qualitative rather than exact, quantitative responses. Subjects will be allowed (neither encouraged nor discouraged) to sketch on a pad of white paper and to utilize any of several maps of Puerto Rico provided. The oral questioning will be tape recorded and I will take notes as well. A technically-trained interpreter will assist me in administration of the oral questionnaire. The experimenters will answer questions for clarification if necessary but will otherwise remain as unobtrusive as is possible. The oral questionnaire will last 15 minutes per subject, an estimate based on pretest results.

Examples of the questions are as follows. Some are personal, background questions, others

specific spatial problems to be answered using the maps of Puerto Rico.

**[end p. 345]**

Background: Education, English experience, travel experience?

"Describe the relationship between the street network and the University of Puerto Rico campus."

"Given the necessary resources, how would you determine the best location to build a new secondary school in the city (San Juan, PR)?"

"What would be an appropriate route for hazardous waste transportation between point A and point B?"

## ANALYSIS/SYNTHESIS

Data derived from the testing procedures will be analyzed and synthesized using both qualitative and quantitative methods. The transcripts generated from the oral questionnaires, to be open-ended, unconstrained dialogue, will be scrutinized using protocol analysis (Lundberg 1984). This method, often utilized within software engineering/user interface design environments, is similar in many ways to content analysis used in the fields of communication and political science to analyze speeches or unstructured written documents. Essentially, this analysis is a method of classifying verbal statements in an orderly, not ordered, fashion so that emerging knowledge may become more apparent.

Further statistical analysis will be applied as warranted. It is hoped that plausible connections between the nature of a subject's structuring and expression of geographic spatial relationships and their preferred mode of GIS user interface can be realized. Any new insight into these connections will assist in the design of better user interfaces for the next generation of GIS.

## PILOT STUDIES

In this final section of the paper I describe two pilot tests that have served to both direct and constrain the research project just described.

### Pilot Study 1

During the summer of 1989 a simple cognitive experiment was conducted in Valencia, Spain. The experiment replicated earlier testing by David Mark in three North American cities (reported in detail in Mark and Gould, under consideration). The object of the experiment was to approach strangers in a public, urban setting and ask for driving directions from that location to a second, public urban location. The conversations were covertly tape-recorded (as approved by the Human Subjects Review Board) and later analyzed. This covert testing methodology allowed the collection of natural, relatively unbiased spatial language data that is very useful for

studies of spatial cognition. Given the assumptions that language structures space and that cognition can only be studied indirectly through behavior and speech it is possible to learn a great deal by analyzing freeform driving directions.

Twenty-two subjects were tested, roughly half by the author and half by a female native Spanish speaker and former resident of the testing location. The subjects were asked "Perdón. ¿Sabes como ir a Nuevo Centro desde aquí en coche?" where Nuevo Centro was a well known shopping mall. Some interesting results are summarized as follows:

1) No apparent differences in response content or duration due to gender differences between experimenter and subject.

2) No apparent differences in responses due to the native/non-native speaker factor.

3) High variability in the verb forms used to describe "turns" in Spanish (9 different verbs used).

4) No mention of distance or driving times by Spanish speakers, whereas many North Americans did (in Mark's testing).

5) Most Spanish subjects assumed transit by bus, and some could report which bus to take but not how to drive to the destination.

**[end p. 346]**

These results, while not earth-shattering, offer unique insight into how Spanish speakers, at least in Valencia, think about and express spatial relations. Someone designing a geographic information system for city planning or a vehicle navigation system for delivery trucks, as examples, would do well to consider these results in the design process.

**Pilot Study 2**

During the summer of 1990 an experiment was conducted in the Department of Geography at the Universitat Autónoma de Barcelona, Spain. The experiment was similar to the questionnaire portion of the research project described earlier in this paper. Fourteen subjects, 12 students and 2 professors from various disciplines within the social sciences were asked to answer 20 questions regarding their background and then regarding spatial relations using maps of Puerto Rico. The interview sessions were tape recorded with the subjects' permission and the whole process was assisted by a geography graduate student from the department in Barcelona. The questions included those listed earlier in this paper and a summary of the responses follows.

1) When asked to describe, in an open-ended question, the relation between their house and the University, nearly all subjects chose to describe that relation in terms of driving/commuting time.

2) When asked to locate a new secondary school using two maps of the city of San Juan that included the present schools, most subjects chose to locate the schools in areas spatially apart from the present ones regardless of the pattern of streets and any assumptions of urban population density.

3) When asked to locate a summer vacation house for themselves, most subjects chose a location on the immediate outskirts of a major city regardless of land use or physical conditions apparent on the maps, including marshland, mountains or military bases.

Again, while these results are not earth-shattering, they do offer privileged insight into the natural structuring of geographic spatial relations. Without the benefit of pilot studies such as these two GIS designers tend to follow their own instinct, based upon ***assumptions*** about how the rest of the world structures and expresses things. These are often erroneous assumptions.

## CONCLUSION

I have tried, amidst a rough mix of discussion topics and research descriptions, to offer hope that David Robinson's goal of properly guided technology transfer to Latin America is attainable and in progress. I have also mentioned possible contributions being made, and to be made, by geographers in an area that unifies cognitive science and geography. If geographic information systems can in fact assist Latin America in managing economic, environmental and social problems, and we believe that they can, these systems must be designed for more comfortable, natural use by a large proportion of the Latin American community not just the minority that has studied at North American universities. The cognitive approach to designing future GISs has certain advantages over the traditional, "technology-first" approach but it must be informed by knowledge gained through field study not through the assumptions of English speaking GIS designers in California or London.

## Acknowledgements

This paper is part of Research Initiative 13: "User Interfaces for Geographic Information Systems," of the National Center for Geographic Information and Analysis, funded by the National Science Foundation. NSF is also gratefully acknowledged for funding the author's fieldwork under (SES 90-01229). Thanks to Barry Lentnek, Joan Nunes Alonso, and Richard Wilkie for thoughtful comments and suggestions.

## References

Gould, M. D. 1990. Comparing driving directions in English and Spanish-speaking cultures. Presented at the Annual Meeting, Association of American Geographers, Toronto.

Harnapp, V. R. 1979. Landsat as a land evaluation tool in Gulf Coast Mexico, *Revista Geográfica* 90:151-156.

**[end p. 347]** Henderson, J. 1990. Breaking the language barrier, *ARCnews* (Newsletter of Environmental Systems Research Institute, Redlands, CA), 12(3):25.

Lundberg, G. 1984. Protocol analysis and spatial behavior. *Geografiska Annaler* 66B: 91-97.

Mark, D. M. and M. D. Gould, under consideration. Driving directions as discourse: Comparing verbal directions in English and Spanish. Submitted to *Multilingua,* May 1990.

Mark, D. M., M. D. Gould and J. Nunes. 1989. Spatial language and geographic information systems: Cross-linguistic issues, *Proceedings,* II Conferencia Latinoamericana sobre tecnología de los sistemas de información geográfica, 105-130. Mérida, Venezuela.

Microm España. 1989. MICROM image processing system, Barcelona, Spain.

Peil, M., 1982. *Social science research methods: An African handbook*. London: Hodder and Stoughton.

Robinson, D. J., 1989. Latin America. In *Geography in America*. Ed. by G.L. Gaile and C.J. Willmott, 488-505. Columbus: Merrill Publishing Co.

Tomlinson, R. 1984. Geographic information systems: A new frontier. Keynote address, *Proceedings,* 1st International Symposium on Spatial Data Handling, Zurich, 1-14.

**[end p. 348]**