

A Community-Based Information Technology Services Determination of GIS User Information Needs

Barrett S. Caldwell

Associate Professor, School of Industrial Engineering / School of Aeronautics and Astronautics, Director, Indiana Space Grant Consortium

ABSTRACT

As remote sensing and geographical information systems (GIS) technologies become more commonplace in society, there are increasing calls for the use of such technologies to benefit local communities. However, a gap continues to exist between the priorities of GIS research specialists, commercial technology providers, and the public (including civic and county agencies and others implementing local public policies). This paper describes origins and processes for a method of technology planning for community-based information technology services (CoBITS). The CoBITS effort emphasizes the development and evaluation of information technology design priorities to serve members of a local physical community. In the United States, the public library/public broadcasting model of shared resources serves as a basis for CoBITS technology planning. Drawing on the author's prior work in this area, this paper summarizes how the CoBITS process can be applied to prioritizing community-based geospatial information technology needs. The specific user needs identified in this paper can be seen as dynamic due to the local community priorities (and experiences). However, the methodology presented here can be applied broadly to link research and public policy priorities for GIS and remote sensing applications.

KEYWORDS

IT, GIS, User Information Needs

INTRODUCTION

Tremendous growth in personal computer use and access to the Internet has spawned much speculation about the context of information and communication technology (ICT) support of real versus “virtual” communities (Kiesler, 1997; Negroponte, 1995; Perry, 1992; Weiser, 1991). While opportunities for electronic interaction can help expand ranges of experience, connection, and social sharing, they do not replace communities of place—the towns and neighborhoods where users continue to reside. In addition, the increase in storage and processing capabilities of ICT systems has led to new considerations of the complexity and amount of information that can be available to members of the local community. New information availability and use options create new demands for infrastructure bases to maintain and improve quality of life in local communities of place.

Several strategies have been developed for the technology planning and implementation of community-based computing networks (Aldred et al., 1994; Hronicek, 1994; Lowenberg, 1994; Morino, 1994; Verschuren, 1994; Williams, 1994). These strategies include addressing issues of hardware and software design, technology and market penetration, and relative allocation of technical, personnel, and financial resources. However, there can be a concern leveled that such strategies fail to address a critical, and essentially prior, question. This question is one of identifying the goals, orientation, and community model of the community network (Craig & Elwood, 1998; Morino, 1994; Rheingold, 1993; Weiner et al., (2002). This becomes a political question of not only (or even primarily) of *how* technology is implemented, but *who* does the implementation and *why* technology priorities are chosen.

Although specific technologies can be used for particular aspects of community networks, broader discussions address the orientation and use of the technology in a community context. Several basic orientations have been identified, including:

- Debate Society: political exchange, debate, and social activism
- Main Street: online shopping and economic activity
- Town Common: community information and social interaction
- Town Hall / Public Library: government functions and local services (police, fire, health)

While these options are not strictly exclusive, many technology designers often focus on a single model. The failure of the “dot com” sector in the early 2000s highlights the shortcomings of a strict and exclusive focus on the economic aspects of the Main Street model of virtual communities. Affiliative communities for social interaction, as well as activism networks for political interaction, can both thrive in the peer-to-peer ICT environment. However, neither model addresses the logistical needs for maintaining local community infrastructures or needs for improved resource allocation at the town and county levels of analysis.

Geographic information systems (GIS), remote sensing, and other geo-spatial data and tools have come into play as a significant potential contributor

to improved public services, policy and planning activities, and community development / community participation (Elwood & Leitner, 2003; Ghose, 2003; Weiner et al., 2002). Authors in the area of community participation address very strong issues regarding political activism and social engagement demands for appropriate technology use. While these issues are often ignored by technologists focusing on the tools and data of GIS, they are essential to how communities address, envision, share, and utilize such tools and data. Thus, the implementations of GIS research findings and technology developments can be seen as a component of the social, political, and policy processes that support and sustain communities of place.

A legitimate alternative model describing the goals and orientations of GIS implementations can be based on the town hall and public library models of community development common in the US. An approach based on local participation and involvement, rather than *a priori* theoretical perspectives, has been described as “action” (Rivlin et al., 1986), “grounded theory” (Crano & Brewer, 1986) or “community-active” (Foxall, 1986) research. Any of these approaches can be considered a “community-centered” or “community-based” approach to technology design and planning.

The remainder of this paper is organized as follows. A summary of a community-based approach to information technology needs is provided as a process model for determining priorities of GIS user needs. This process model was applied to identify public perceptions and priorities for implementing GIS tools and services in local communities. Results of a survey of local GIS practitioners are used as an example of how public policy and technology implementation may be influenced by local needs, understandings, and experiences. The discussion of the survey results address both the specific issues limiting GIS implementations and priorities in a specific community, as well as how the general model can be used to improve acceptance and utilization of GIS and remote sensing capabilities to achieve local community goals.

DEVELOPMENT OF THE COBITS PROCESS

The author’s involvement with a community-based technology planning approach to information technology systems began with the Community Information Partnership Program (CIPP). This partnership was begun in 1993 by a group of interested community leaders from libraries, schools, universities, and public broadcasting media from two counties of a Midwestern US state. The two counties included a range of local community needs, including the state capitol of nearly 200,000, and a small rural area with no town of over 10,000. The initial CIPP steering committee focused the development of a Community-Based Information Technology Services (CoBITS) model on an extension of the public access and information exchange history of public libraries, public schools, and town hall functions in the US. The author of this paper was invited to assist in identifying priorities for information needs and technology design guidelines for resulting community information technology offerings. Details of the original CoBITS effort are summarized in a prior paper (Caldwell & Robertson, 1996). In summary, however, the results of the effort identified public perceptions of critical dimensions of how information technologies could be expected to serve public policy and community development needs.

Community-Based System Design Considerations

A list of potential information technology services was developed using a modified nominal group / Delphi technique (Delbecq et al., 1975). This list addressed four distinct levels / types of “information transactions” which could be used to classify many potential services. Transaction levels were defined as:

Static Information Access: Looking up information from published records, databases, and directories; do not require significant or frequent human interaction or updating.

Dynamic Query Access: Identifying local experts who can respond to immediate needs and direct responses, either generally or specifically to the person making the request.

Conversations and Discussion Groups: Ongoing and evolving interactions emerge among a fluid and unpredictable group of participants with shared interests.

Portal / Gateway Nodes: Local community resources can serve as portals to larger network opportunities (such as a local bus or train station, telephone cooperative, or community-based Internet service provider).

The list of information services, grouped into transaction levels, also help to specify technology implementation constraints affecting the use of community-based information technologies. These transaction constraints address characteristics of the flow of information in a social or organizational context (Caldwell et al., 1995; Eason, 1988; Sproull & Kiesler, 1991; Taha & Caldwell, 1993). The issues addressed include the following:

Static vs. dynamic information sources: Published bus schedules, telephone numbers of local government offices, and land ownership records change, but usually not very frequently. Current bus locations are more dynamic sources. Information updating may occur on a regular or event-based schedule, but depends on the update rate of the associated information source.

Public vs. private information: Many elements of community resources (hours of operation, activities, locations) are generally and publicly available. Other resources and more personal records may be held private, except for emergency services (reverse telephone number – address lookup for emergency response).

Two-point vs. multi-point information paths: Looking up a library record or accessing local land records represents direct interactions between the user and the (pre-identified) information provider. If a user (or a local community office) provides new information or a list of helpful links, the

expansion of communication paths can begin to grow beyond the original CoBITS system, and in unexpected ways.

Synchronous vs. asynchronous interactions: Depending on the user's need for information and prior experience, an expectation may develop for communications and information technologies to support either synchronous (real-time conversational interactions, such as face-to-face or telephone exchanges), or asynchronous (sequential communications such as exchanging letters) information flow. The success of many transactions may depend on whether these user expectations of information exchange can be reliably met with existing technology implementations.

This general approach to identifying CoBITS priorities can be used as a strategy for identifying and prioritizing public uses of GIS technologies, services, and data. Although some aspects of the CoBITS project described above focused on providing improved software interfaces to access researcher-relevant GIS data, the growing availability of consumer-grade devices and tools requires an additional focus on priorities for the use of GIS to support public policy and community development initiatives.

ISSUES AND NEEDS OF GISTECHNOLOGY USERS

The author was invited to participate in a second CoBITS project, in a different Midwestern US State, to help bridge the gap between the research community's perspectives on appropriate uses of GIS, and local community perspectives (as understood by county GIS extension practitioners) on public services to be supported by GIS. The state geographic information council published, in 2002 (IGIC, 2002), a list of potential GIS technology areas of application, include:

1. Emergency planning and response (for homeland security purposes)
 - 1.1 Security
 - 1.2 Disaster mitigation (business recovery and continuity of government)
 - 1.3 Preventing loss of communication
 - 1.4 Assuring access to and interoperability with systems in neighboring counties
2. Public safety mutual aid (information about road networks, addresses, and civil boundaries; aerial photography, parcel information)
3. Disaster planning, mitigation, and response (evacuation route and wind plume information, locating chemical spills and contamination sources in hydrography and sewers)
4. Drainage management (water flow courses across counties)
5. Land and water resources

6. Water quality and service (watershed and wetlands data, locating contamination)
7. Highway planning (road information)
8. Public health (epidemiology, mosquito control)
9. Utility coordination (locations of utility infrastructure, shared information about infrastructure of each utility company)
10. Community studies (provide access to unified data)
11. Improved citizen-centric services (educate the public so they may participate in decision-making)
12. Economic development (interdependency of metropolitan areas necessitates regional planning)

One question, however, was which of the above list of application areas, or other potential areas, should be the initial emphasis of the state efforts, and what would be the justification for their selection. The GIS project served as an opportunity to demonstrate the application of CoBITS public policy and planning efforts to improve understanding and align priorities between researchers, practitioners, and community leaders.

The GIS information needs study follows conceptually from the prior CoBITS study addressing local web-based information services. Several university and state government agencies with interests in GIS applications have become involved in a new GIS-related information services initiative. Various collaborations began in 2002 to develop an integrated, statewide resource repository for public access to geospatial information at the county level of analysis. With an eye toward participating in a national project, several efforts were consolidated under an umbrella project description (IndianaView) in 2003. As a part of the IndianaView development effort, the author's research team conducted a research project on the different needs and challenges that current and future users could face when beginning to implement GIS for county services. This research was considered critical to ensure that limited state funds would be effectively and appropriately spent on GIS capabilities (data acquisition tools, data processing systems, and available data layers) that would be seen as valuable to the cities and counties that would be paying for and using those GIS capabilities. The remainder of this paper describes the initial stages of the methodology for this particular research, the data collection process, and the list of most important issues for GIS users.

Applying the CoBITS Process to Identify GIS User Needs

This research focused on data related with user needs collected from users of GIS at the community, professional, and technical level. In particular, the primary interest of the government agency has been on studying three representative areas of the state: northern watershed regions near Lake Michigan; southern rural counties; and areas of fast growth surrounding Indianapolis. These regions were identified based on perceived differences in public policy needs and which GIS capabilities would be seen as relevant at the county or town level. For example, rural regions can be concerned with data collection

that permits daily indications of soil moisture or crop distress among relatively fixed property types. Conversely, a rapidly growing suburban county may be more interested in changes in land use over a period of months or years, with relatively little concern for differences between daily observations.

The research project emphasized the county as the unit of analysis, corresponding to the use of county-level extension educators as the primary practitioner liaisons between research-based developers and users of GIS systems, and public decision makers at the town or county level. For this user needs study, approximately twenty counties were sampled (out of a total of 92 in the state) in a two-phase study of GIS user needs and priorities. The approach used to collect data was a Quality Function Deployment methodology (QFD), based on methodologies made popular in industrial engineering and quality management fields. QFD was developed and promoted as a tool for improving supplier responsiveness to customer demands in a continuous improvement / production systems / customer satisfaction context. QFD takes customer requirements and translates them into technical components and enhancements at any of the production stages (Akao, 1990; Sullivan, 1986), which can then be evaluated in terms of the technical challenges and costs required to meet those customer requirements. Through QFD, the functions of a given product or service that are deficient, missing, or improperly enacted are highlighted by focus groups of users at various levels of the product or service use. Next, users rank these needs by assigning point values to each need such that a greater number of points indicates a more important or relevant need in comparison to other needs. (In a final stage, not described in this paper, these rankings are entered into a QFD matrix allowing an overall ranking of all users' needs against technology feasibility and dependency evaluations).

The state GIS implementation process had already recognized the following barriers between research perspectives and public policy needs when highlighting the following GIS technology application challenges (IGIC, 2002).

- An interoperable framework is needed to support geospatial information at local and state levels
- There are multiple GIS software platforms
- There are multiple coordinate systems
- There are multiple measurement systems
- There are multiple database schemas for GIS layers and for attribute tables
- There are few formal data-sharing agreements

The research described in the next sections included a two-phase survey methodology designed to systematically address classes and types of user needs, GIS implementation priorities, and barriers to effective GIS implementation in urban, suburban, and rural counties. The goal of the research was to ensure that state efforts to obtain and utilize resources for GIS would receive maximum support from local public groups and counties.

RESEARCH METHODOLOGY

Phase I: Initial Questionnaire

The purpose of Phase I was to get a general overview of GIS users characteristics and needs from a county implementation and use perspective. Following that rationale, a preliminary questionnaire was developed based on the previously collected interview data. In later phases and steps, a final assessment instrument would be constructed based on this first questionnaire, so a systematic and comprehensive needs assessment strategy was required.

A prior GIS implementation research team had attempted to develop a method for identifying and prioritizing GIS tools to be used in county government and public offices. Some user needs data had been collected from county representatives, but there was a lack of consistency in interpretation of the term “user information needs”. Pre-existing data sets (i.e., public data, base layers of GIS, and other forms of archival data) were the primary source of information for the prior implementation research team. However, a variety of county representatives (auditors, planners, assessors, surveyors, GIS commissioners, engineers, planning directors, and public works employees) were all interviewed as “users” without a systematic set of definitions or data collection methods.

The Phase I initial questionnaire helped to resolve many of these prior problems in data collection and interpretation from GIS “users”. The Phase I questionnaire systematically asked respondents to list as many needs or anticipated needs as possible, independent of their prior experience with GIS. This questionnaire was also intended to assess the amount of time respondents have used GIS technology (if at all), if they currently use GIS, and/or if they intend to use GIS in the future. Other items were included for determining GIS expertise and interest. Demographic information regarding the name of the county of employment, occupation/job title, and highest level of completed education was requested, as well as the following items:

- Willingness to work with technical information;
- Willingness to accommodate new technology in the workplace;
- Perception of the level of technological readiness of the county.

This questionnaire was distributed to the attendees at a *GIS for Economic Development* seminar, once the seminar had ended. It is important to note that the seminar was designed for attendees with little or no prior experience with GIS, and was intended as an introduction to the technology and its capabilities.

Phase I: Results and Discussion

Eleven respondents completed the preliminary questionnaire after attending the full-day GIS seminar. Of the eleven respondents, seven had prior experience using GIS technology ranging from one to eight years. Additionally,

only six of the eleven respondents suggested one or more user needs that were asked in the questionnaire. Among the respondents, two indicated to have ‘Some College’ as the highest level of education reached; six indicated ‘Bachelors Degree’; three indicated ‘Master’s Degree’.

Thirteen separate user needs were indicated by the eleven respondents. The five needs listed by those with no prior experience with GIS (presumably areas in which they are interested in applying GIS) were:

- Utilities
- Ownership of Property
- Business Locations
- Population and Growth Projections
- Transportation systems

The eight needs and problem areas of GIS listed by those with prior experience with GIS were:

- Accessing readily available technical assistance for ArcView users
- Maintaining up-to-date parcel maps
- Obtaining the appropriate level of quality information relating to GIS
- Getting high resolution of ortho[graphic] maps
- There is a lack of standardization in addressing which prevents the merging of address databases
- It is difficult working in Indiana counties on the state border because not all of the same data is available in the counties of neighboring states
- Demystify GIS so it can be adopted more quickly
- Minimize duplication of work by improving coordination

This second list clearly differs from the first in that it focuses both on more technical research and applications emphases (technical assistance for ArcView, maintaining data layers) rather than basic use elements (accessing ownership records as a standalone data layer).

Results from the Phase I questionnaire GIS-focused state government materials were reviewed to include additional information needs that might be considered as relevant but not cited by the respondents. All potential needs were reviewed and validated by the state government GIS implementation chair as relevant GIS issues. The final assessment instrument design and results will be explained in Phase II.

Phase II: Final Assessment Instrument

The second phase of the GIS user needs project involved the construction of a final assessment instrument from the results of the Phase I user needs identification. Results obtained from the initial questionnaire and the information collected from the IndianaMap Prospectus (IGIC, 2002) were used to construct a list of 21 issues and needs related with GIS technology. Respondents were asked to indicate their amount (if any) experience with GIS technology, current and anticipated use of GIS technology, their education level, current occupation title and county where they worked. Respondents were also asked to rate their willingness to work with technical information as well as to adopt technology at the workplace on a 7-point scale (0- not at all willing; 7- extremely willing), and to rate the technological readiness of county of work on a 7-point scale (0-not at all technological ready; 7- extremely technological ready).

In order to identify priorities for GIS user needs, participants were also asked to allocate a total of one hundred points among a series of issues and needs related with GIS technology from a list of twenty-one issues identified in Phase I. In addition, blank space was provided for respondents to extend the list by suggesting additional needs and issues. Respondents were to allocate between zero and one hundred points for each issue in the list, including any issue they suggested, restricted by the condition that the total points allocated were to sum one hundred. This point allocation scheme (known as an “ipsative” measurement technique) allows the respondent to establish the importance of a particular issue compared to others, especially if one doubles or triples the score obtained by another issue. Finally, if an issue received a score of zero points or no score, it was considered as not relevant for the respondent. This technique has been used in prior research to determine user priorities for improving classroom design features and information technology medium features (Caldwell, 1993; Caldwell et al., 1995) and in the original CoBITS research to prioritize services in a community information network (Caldwell & Robertson, 1996).

A total of twenty-eight surveys were sent out by mail. The chair of the GIS initiative and a local agricultural extension project coordinator provided the project team with a list of county network contacts to whom the survey could be sent. The surveys were sent to all individuals for whom contact information could be confirmed.

Phase II: Results and Discussion

A total of twenty-two responses were received from the population surveyed, for a 79% response rate. Respondents were distributed among the counties as follows: eight respondents from the watershed region (including two responses from the same county), five respondents from the southern rural counties, and nine respondents from the central urban growth areas. Occupations of respondents included a number of direct GIS technology specialists and high level users, including:

- CAD System Operator
- City Planner

- County Surveyor
- GIS Administrator / Controller / Coordinator / Director / Manager
- IMAGIS Program Manager
- IT Administrator
- Plan Director
- Senior GIS Specialist
- Deputy Surveyor

Of the respondents, two did not have previous experience with GIS technology and twenty had, with an average length of GIS use of 7.2 years (sd 5.5 years). The average scale of willingness to work with technological information was 6.2 points (sd 0.9) and of willingness to adopt new technology in the workplace was 6.3 points (sd 0.9). The perceived technological readiness within the workplace average rate was 4.8 points (sd 1.5). All responded affirmative on currently using GIS technology, and in their intention to use GIS technology in the future. Point allocation for all the given issues and needs are as shown in Table 1.

Seven of the twenty-two respondents of the final assessment instrument also suggested additional unlisted issues, with a total of thirteen additional issues. None of the issues was listed more than once. A list of the additional issues is as shown in Table 2. Interestingly, one of the respondents allocated more than half of the points to the issue “funding sources for GIS development other than local taxes”.

The null hypothesis for ipsative measurement would generate an expected average point allocation of 4.5 points ($100/22=4.5$) per issue or need. (The total of twenty-two comes from the twenty-one given plus approximately one additional issue – actually, 0.6— suggested.) The first eight issues listed in Table 1 exceed 4.5, and are thus considered as relevant priorities for initial implementation efforts. Strict statistical analyses would focus more attention on the actual distribution of point allocations; traditional Pareto or scree test analyses would examine the breakpoint of mean scores for the point allocations to use as an appropriate number of items for selection (Box et al., 1978).

When presented with these issues, the GIS project recipients indicated that this additional statistical evaluation was unnecessary for their purposes; they were simply happy to have a short and defensible list of priorities for GIS implementation based on a statewide sample of user needs. As a result, the eight items were analyzed as the final priority list (from a functional and practical, rather than statistical, perspective) for additional analysis. In accordance with established QFD methods (Akao, 1990; Sullivan, 1986), four GIS technology experts examined this list of eight issues (user “whats”) against current technology capabilities (provider “hows”) to determine relative costs and effectiveness for implementing different levels of the GIS services and applications described by the top eight user needs.

Table 1. Average, standard deviation and median of points allocated for each issue and need, ordered by mean points allocated.

	Issue/Need (Original Presentation Order to Left)	MEAN	STD DEV	MEDIAN
7	Maintaining up-to-date parcel maps	9.19	6.60	10.00
12	Public safety mutual aid (e.g., information about road networks, addresses, and civil boundaries; aerial photography, parcel information)	8.05	5.34	8.00
1	Utility coordination (e.g., locate utility infrastructure, share information about utility company infrastructure)	7.67	10.57	5.00
2	Ownership of property	7.14	6.05	5.00
11	Emergency planning and response (for homeland security purposes; security, disaster mitigation, business recovery, continuity of government, preventing loss of communication, assuring access to and inter-operation with systems in neighboring counties, etc.)	5.71	4.30	5.00
8	Obtaining high resolution of ortho maps	5.19	4.92	4.00
5	Transportation systems	5.00	6.30	4.00
13	Disaster planning, mitigation, and response (e.g., evacuation route and wind plume information, locating chemical spills and contamination sources in hydrography and sewers)	4.67	4.61	5.00
17	Highway planning (road information)	4.48	3.84	4.00
14	Drainage management (water flow courses across counties)	4.33	3.86	4.00
16	Water quality and service (watershed and wetlands data, locating contamination)	4.19	2.86	4.00
6	Accessing readily available technical assistance for GIS software users	3.86	4.66	2.00
9	Sharing GIS data and structures across counties (e.g., interoperable platforms, coordinate systems, addresses, GIS layers)	3.75	3.42	3.50
18	Public health (e.g., epidemiology, mosquito control)	3.38	3.01	4.00
15	Land and water resources	2.81	2.34	2.00
21	Economic development (e.g., interdependent metropolitan areas necessitate regional planning)	2.81	2.77	2.00
10	Demystification of GIS so it can be adopted more quickly	2.76	3.67	2.00
20	Improved citizen-centric services (educate the public so they may participate in decision-making)	2.14	2.37	2.00
3	Business locations	2.10	2.26	2.00
4	Population and growth projections	1.86	1.93	2.00
19	Community studies	1.76	2.10	1.00

Table 2. Additional issues and needs suggested by respondents of the final assessment instrument. Three was the maximum number of issues suggested by a single individual.

Additional Needs/Issues Suggested by Final Assessment Instrument Respondents

- Funding sources for GIS development other than local taxes
- Get our system up-and-running and improve government operation through access to information, then expand to other areas
- Merge with our manatron/software
- Privacy and data accessibility issues
- Easy to use, interactive maps for public use
- Quick, accurate delivery of data to government workers' desktops via intranets
- Removal of redundant data creation and maintenance efforts by different entities through better coordination, cooperation, communication, and data sharing
- Property tax assessment
- Infrastructure management-roads, bridges, culverts, signs
- Rectification of census boundaries to our maps
- Integration of GIS data creation, maintenance, and use into the existing workflows of those users who best know the data, who currently maintain the data in non-GIS environments, and who can best utilize it in the performance of their duties
- Use of GIS data as a part of the decision-making process in the day-to-day business of government and in public meetings
- Maintenance and verification of physical location address data

Due to rapid changes in consumer and research capabilities for achieving specific technological functionalities, the specific matrix of linking “whats” to “hows” will not be a consistent result. In addition, the specific user needs identified by this two phase survey are highly affected by local community priorities and experiences. (Incidentally, both an outbreak of tornadoes, and one hundred-year floods, affected several of the counties sampled in the GIS project within a few months after the survey was completed. Anecdotal reports indicated that several county respondents would have drastically revised their point allocations to emergency and disaster planning had those events occurred before the survey had been sent out.) Nonetheless, the GIS implementation team, county respondents, and technology experts were all satisfied with the use of the methodology described above as a systematic way of linking the technology capabilities identified by GIS professionals with the public policy and local service needs identified by county respondents.

GENERAL DISCUSSION

The study described in this paper defines a method that allows for user participation in defining the needs and priorities for GIS technology implementations at the county or other local level. A primary assumption guiding this work is that local governments are unable to support all possible user needs or address all potentially interesting research issues with their limited technical sophis-

tication, financial resources, and time requirements. The attempt to cover all needs proposed and or suggested is an almost impossible task, potentially leading to an expensive and improper allocation of resources, and backlash against what may be seen as a waste of community effort on applications that do not primarily benefit them.

The community-based focus on customer needs that was completed for a state GIS project is a demonstration of the principles of pairing GIS technical capabilities to local community needs. The methods described in this paper, previously demonstrated in other CoBITS contexts (Caldwell & Robertson, 1996; Caldwell et al., 1995), highlight the general principles of gathering broad user data that can be used to create a defensible policy for initial technology implementation efforts. The customer-focused data collection strategies have a history of use in industrial engineering contexts of improving product designs to meet consumer priorities.

The specific list of GIS technical applications selected in this study for further development reflect the local priorities, experiences, and expertise of the users surveyed. Overall, the process for determining priorities resulted in a stronger level of acceptance and agreement on the meanings, contexts, and elements of "GIS user needs". More importantly, participants and respondents described their support for acknowledgement of social concerns, and making those concerns a more explicit part of the process. This type of engagement process can result in higher public support and collaboration for technology implementation phases of this and other future GIS implementations to benefit local government and support public policy initiatives.

CONCLUSIONS

GIS professionals and researchers have many reasons to be excited about the growing interest in public policy and services uses of GIS technologies. However, despite the number of critical research questions associated with environmental quality concerns, instrumentation capabilities, and data analysis methods, these issues can be seen as esoteric, or even unnecessary, by less sophisticated local government or community organizations. Since these organizations may be asked to substantially support the costs of GIS technology implementations and applications, it is essential that GIS research and technical applications professionals maintain awareness of local priorities and align their research needs with the policy and operations needs of those local communities. The community-based information technology services (CoBITS) process model described in this paper serves as a useful methodology for accomplishing this important objective.

ACKNOWLEDGMENTS

The author expresses his gratitude to Michelle Banner and M. Cecilia Gonzalez for analysis and contributions to prior versions of this paper, to anonymous reviewers for improving the clarity and flow, and to Haydee Cuevas, Ph. D., for invaluable editorial support. Portions of this work were supported by the State of Wisconsin, State of Indiana, and Indiana Space Grant Consortium (NASA). However, the opinions and presentations are those of the author, and not of these or any other government organization.

REFERENCES

- Akao, Y. (Ed.). 1990. *Quality Function Deployment: Integrating Customer Requirements into Product Design* (English ed.). Cambridge, MA: Productivity Press, 387.
- Aldred, B., Lambert, H., & Mitchell, D. 1994. *Community Networking - a Lakes Approach*. Paper presented at the Proceedings of the 1st International Workshop on Community Networking: Integrated Multimedia Services to the Home, Piscataway, NJ.
- Box, G. E. P., Hunter, W. G., & Hunter, J. S. 1978. *Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building*. New York: John Wiley and Sons, 653.
- Caldwell, B. S. 1993. *A Systems Approach to Instructional Quality*. 1993 ASEE Annual Conference Proceedings: Shaping Our World Century II (pp 1406-1413). Urbana, IL, American Society for Engineering Education.
- Caldwell, B. S., & Robertson, J. W. 1996. Community-Based Information Technology Services 1: What (Some) Users Want. *IPCT-J: Interpersonal Computing and Technology Electronic Journal*, 4(1), 20-33.
- Caldwell, B. S., Ung, S.-T., & Taha, L. H. 1995. Appropriateness of communications media use in organizations: Situation requirements and media characteristics. *Behaviour and Information Technology*, 14(4), 199-207.
- Craig, W. J., & Elwood, S. A. 1998. How and Why Community Groups Use Maps and Geographic Information. Retrieved August 29, 2007, from http://www.iapad.org/publications/ppgis/How_and_why_community_groups_use_maps.pdf.
- Crano, W. D., & Brewer, M. B. 1986. *Principles and Methods of Social Research*. Newton, MA: Allyn and Bacon, 386.
- Delbecq, A. L., Van de Ven, A. H., & Gustafson, D. H. 1975. *Group Techniques for Program Planning*. Glenview, IL: Scott, Foresman, & Co, 174.
- Eason, K. (1988). *Information Technology and Organizational Change*. London: Taylor & Francis, 247.
- Elwood, S. A., & Leitner, H. 2003. GIS and Spatial Knowledge for Neighborhood Revitalization: Negotiating State Priorities and Neighborhood Visions. *Journal of Urban Affairs*, 25(2), 139-157.
- Foxall, G. 1986. A Conceptual Extension of the Customer-Active Paradigm. *Technovation*, 4, 17-27.
- Ghose, R. 2003. Community Participation, Spatial Knowledge Production, and GIS Use in Inner-City Revitalization. *Journal of Urban Technology*, 10(1), 39-60.
- Hronicek, R. A. 1994. *California Research and Education Network*. Paper presented at the Proceedings of the 1st International Workshop on Community Networking: Integrated Multimedia Services to the Home, Piscataway, NJ, 255-256.

- IGIC. 2002. *IndianaMap Prospectus*. Indianapolis: Indiana Geographic Information Council.
- Kiesler, S. (Ed.). 1997. *Culture of the Internet*. Mahwah, NJ: Lawrence Erlbaum Associates, 480.
- Lowenberg, R. 1994. *Telluride InfoZone: A Program of the Telluride Institute*. Paper presented at the Proceedings of the 1st International Workshop on Community Networking: Integrated Multimedia Services to the Home, Piscataway, NJ.
- Morino, M. 1994. *Assessment and Evolution of Community Networking*. Paper presented at the Apple Conference on Building Community Computing Networks, Cupertino, CA.
- Negroponte, N. 1995. *Being Digital*. New York: Vintage Books, 287.
- Perry, T. S. 1992. Forces for Social Change. *IEEE Spectrum*, 29, 30-32.
- Rheingold, H. 1993. *The Virtual Community*. New York: HarperCollins, 447
- Rivlin, et al., 1986. Environmental Psychology and Action Research: Lewin's Legacy. In E. H. Stivers & S. A. Wheelan (Eds.), *The Lewin Legacy: Field Theory in Current Practice* (pp. 194-200). Berlin: Springer-Verlag.
- Sproull, L., & Kiesler, S. 1991. *Connections: New Ways of Working in the Networked Organization*. Cambridge, MA: MIT Press, 212. Retrieved February 5, 2009, from http://morino.org/under_sp_asse.asp.
- Sullivan, L. P. 1986. Quality Function Deployment. *Quality Progress*, 19(6), 39-50.
- Taha, L. H., & Caldwell, B. S. 1993. Social Isolation and Integration in Electronic Environments. *Behaviour and Information Technology*, 12(5), 276-283.
- Verschuren, T. 1994. *First steps towards integrating multimedia services to the home: Experiences in the Netherlands*. Paper presented at the Proceedings of the 1st International Workshop on Community Networking: Integrated Multimedia Services to the Home, Piscataway, NJ, 241-247.
- Weiner, D., Harris, T. M., & Craig, W. J. 2002. Community Participation and Geographic Information Systems. Retrieved August 29, 2007, from <http://www.iapad.org/publications/ppgis/Community%20Participation%20and%20Geographic%20Information%20Systems.pdf>.
- Weiser, M. 1991. The Computer for the 21st Century. *Scientific American*, 265(3), 94-104.
- Williams, G. A. 1994. *The WELL: On Being in The Community Business*. Paper presented at the Proceedings of the 1st International Workshop on Community Networking: Integrated Multimedia Services to the Home, Piscataway, NJ, 249-254.