Collaborative GIS And Its Effect On Common Ground:

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ABSTRACT

Many technical papers have been published regarding collaborative geographic information systems (GIS). These papers analyze the structure, features, and design rationale behind geocollaborative software, but do not closely examine the dynamics which occur among the users as a result of using the software. Our study simulates an emergency planning scenario and uses a software prototype to facilitate group decision making. The study, which is still underway, focuses on how collaborative GIS currently facilitate communication among users. It also examines how relationships among users grow and are affected by a collaborative GIS. One question is how does current software affect the common ground that develops naturally during group collaboration? Another is, how can we take our understanding about the common ground process and apply it to the design and development of future collaborative GIS? This paper examines both these questions, as well as relevant prior research in this area.

Introduction

Collaborative geographic information systems are generally defined as processes which integrate people and technology in order to manage, transform and analyze spatial data (Balram and Dragicevik 2006), in order to solve instances of what Horst Rittel coined as "wicked" problems. A "wicked" problem is, by definition, ill-defined and ambiguous. The term is applicable to many of the problems that we attempt to solve which involve spatial data. There are no right solutions – only better and worse ones. (Rittel et al 1973) In particular, situations that require the use of geospatial data often have unclear goals and no "correct" answer. The diversity of stakeholders can also contributes to the wickedness of a problem.

The challenges of stakeholder diversity are especially apparent when we consider a multi-faceted group of people – for instance, a local community group that is planning where to put a dam. Some stakeholders may be environmentally conscious, others only concerned about how it may affect local business, etc. Another factor is the "not in my backyard" syndrome – stakeholders may be in favor of building the dam, but do not wish it to affect their lives directly. This is only one of the many factors which have to be taken into account. No matter where you put the dam, someone will be unhappy with the decision. Participatory GIS are one attempt to solve this particular wicked problem by facilitating community involvement and making the relevant information widely available. It also allows information which may only be held by a few local residents to be leveraged during the decision making process.

When group members are able to leverage information that is not immediately available to all members of their group, they are taking advantage of common ground. . *Common ground* has been defined as the joint knowledge people have – not just of the facts involved, but about one another, the roles they play, and communication protocol. (Clark 1996) As common ground increases among participants, their knowledge of "who knows what" can contribute to their success in decision making. The "wickedness" of a problem is also partially due to the diversity among the stakeholders, but as common ground increases among participants, understanding among them may increase as well, also leading to greater success in decision making.

Method

Our study simulates an emergency planning scenario where a number of rescuees need to be taken to a nearby shelter. There are three collaborators, all the same gender, and each one has knowledge specific to their role. The Public Works collaborator has information about roads, construction, downed power lines, etc. The Environmental Expert knows about inclement weather and areas where flooding or mudslides could occur. The Mass Care collaborator has health specific knowledge – things like information about the shelters, injuries to the rescuees, and supplies. There are four possible shelters – but only one is the optimal choice. The concept of a hidden profile is utilized – each participant only has a portion of the information. (Stasser & Titus, 1985) To discover the best option, the participants must pool their knowledge together. Each member gets role-specific information and is asked to decide individually which shelter is the best, and give their rationale for that decision. They then have 20 minutes, working as a group, to make a group decision, and to explain their rationale for this choice.

For the first part of this study, the experiments were conducted with paper maps – each member had a role-specific map which no one else could see. A group map is provided so that the participants can share information and collaborate to choose the best shelter. A software prototype was developed based on requirements gathered from observing what participants did while using the paper maps. The second part of the study utilizes this software prototype. Several pilot sessions were run to discover and fix any major faults in the software prototype, and then the experiments were conducted using the software prototype. Currently a version with additional features aimed at better supporting collaboration is being developed, and upon completion of the improved prototype, a third set of experiments will be conducted.

The software prototype is written in Java and is built using a previously developed piece of software– BRIDGE. BRIDGE stands for Basic Resources for Integrated Distributed Group Environments, and its goal is to support user collaboration on the internet. For more information about the structure and usage of BRIDGE, see papers by Ganoe et al. (2004), Rosson et al (2007), and Convertino et al. (2007). The usage of BRIDGE allows for synchronous viewing and editing of shared maps. It also uses Geotools, which is an open source Java code library that provides methods for the manipulation of geospatial data. (http://geotools.codehaus.org/)

The structure of the software prototype mimics that of the paper materials used in the earlier study – there are two main panes, one to display a role specific map and the other to display a shared team map. It offers users functionality they would expect from tools like Google Maps– the ability to zoom in and out and pan across the map. The software also has functionality which was designed specifically for the study – the ability to create annotations, to draw on the map, to copy annotations from the role-specific map to the team map, and to sort through a list of annotations. It also features a radar view: when one team member moves a pointer over the map, the others can see it. User pointers are also labeled with the name of their role. This allows participants to be aware of one another's movements – not just of what is happening, but who is doing it.

Common Ground

Many of the software prototype's features, such as the radar view just mentioned, support activity awareness between participants. The concept of activity awareness is something which has been discussed by J.M. Carroll and his colleagues. Activity awareness encompasses knowing what your team members know, their attitudes, their goals, and how the view of the shared plan evolves over time. (Carroll et al. 2005) This type of awareness becomes extremely important when members have role-specific information. If other members know that a member holds certain types of information, they are more likely to query for it. For example, in our study, someone might ask the Public Works collaborator what they know about the roads in an area around a shelter. Knowledge of other's knowledge encourages elicitation of facts that might not otherwise emerge in the discussion. Common ground is an essential part of maintaining activity awareness among participants.

The question of how common ground is affected by computer supported collaboration has not been fully answered. The studies described here are still under way, and so any theories or findings at this stage are extremely tentative, and cannot be backed up with hard evidence and analysis. To understand the possible implications of computer supported collaboration on common ground, we must first take into account the previous research on computer-supported cooperative work.

Computer-Supported Cooperative Work

The research area of computer-supported cooperative work (CSCW) has its roots in questions about office automation. (Bunn 2007) Office users began to use software such as processors and spreadsheets on an every day basis – automating the flow of information within an organization, and the way users collaborated seemed the logical next step. Most of these early attempts failed (Lyytinen and Hirschheim 1987), due to developers underestimating how socially complex even the most routine tasks are. CSCW was begun as an attempt to integrate software development with our understanding of how people work in groups. Lyytenin (1998) cites unclear requirements, inadequate understanding of users' work, and misunderstanding of uncertainties that the system would have to deal with, as three of the main reasons for the failure of information systems. All of these causes have to do with the way people work together.

Informal interactions that take place between users are often overlooked when developing collaborative software. These interactions, while seemingly unnecessary, are in fact vital to the development of common ground between individuals who work together. Because these interactions are informal, users themselves are often unaware of how integral they are to the work process. So when developers try to elicit requirements, they often get only the formal part of the process. As Bannon and and Schmidt note (1989), if individuals in an office were to truly follow only formal procedures, work would become extremely inefficient. This indicates a requirement that collaborative software not to force users to adhere to rigid procedures – more often than not such procedures will be counter-intuitive and hinder, rather than support collaboration.

Not only does collaborative software need to support informal interaction, but it also needs to support decision making within a contextual framework. Making decisions involves pulling information from both commonly shared and individual knowledge. Software should facilitate both the sharing of knowledge and the representation of the problem domain. This is especially true of collaborative GIS. Dealing with geospatial information requires that the user not only be able to see the data, but share their insights on said data with other participants.

Implications

Analysis of the data gathered from the paper prototype study we conducted shows a marked difference between first and last runs within a group. Members come to share information more readily, and spend less time managing how they share the information. This pattern is consistent with the development of common ground among the participants. Analysis of the data from the software prototype study is still underway, but similar results are expected. The question is, does common ground increase faster when it is being supported by technology?

If it does not, is it possible to improve the software to better support the development of common ground between users? One possible modification to the software prototype could involve support for sorting through user made annotations and tagging them with relevant labels. There are, however, possibilities beyond what can be done to our prototype. The majority of collaborative GIS merely provide a way to display data. Providing users with the ability to link pieces of data together, as well as combine them to form metadata would surely support the collaborative process.

Linking data together is not altogether a new idea – in fact, Rinner (2006) touches on this in his paper concerning argumentation mapping. The concept of linking geographical locations to information and arguments about it is certainly not new. However, the concept of using a software agent to collect data and combine it to form meta-data is a relatively novel one. The argument that most users will not bother to create meta-data themselves is a valid one. Even asking the user to tag a specific piece of information is a hassle, and it is debatable whether the user would take advantage of the feature. But if, for instance, a software agent could "learn" which pieces of information were relevant to a certain shelter, it could categorize that information together. Users would then be able to pull up all the information on that one shelter, better enabling them to make a decision.

Software which could categorize information could be very helpful. For example, many groups in our study rarely, if ever, compared one shelter against another. Instead, they went through the shelters, one by one, discarding them based on shelter-specific arguments, such as when a shelter had too many cons, or even just a few life threatening ones. This is an area where the human mind seems insufficient – when overwhelmed with data, people only focus on small portions of it, and are unable to "see the big picture". Providing users with a way to manage this data could increase their ability to make the optimal decision.

Looking to the Future

The practical potential of our study and the software developed for it is fairly straightforward. Many local experts meet together once or twice a year to plan for emergency situations. The infrequency of these meetings can be attributed not only to time constraints and other obligations, but the inconvenience of requiring that everyone be in the same place to participate in these meetings. Development of a piece of software similar to ours would allow them to have these meetings no matter where the participants were.

Another use would be to deconstruct previous emergency plans and analyze them for their effectiveness. Having digital copies of maps and user made annotations and descriptions of rationale for previous emergency situations could prove to be invaluable. Viewed in hindsight, this information could allow users to see flaws in their rationale, or where more information might have been useful.

Outside of our simple software prototype and study, the field of collaborative GIS has a lot of potential. The technology being developed and researched today can be leveraged to enhance community participation, integrate both expert and common knowledge about spatial tasks, emergency planning scenarios, and to support mobile GIS devices.

As pointed out by Gillavry (2006), geographic information and maps are becoming increasingly accessible to people – not just businesses and government. With the advent of technologies such as Google Map, Geotools, location aware devices, and widespread access to geospatial data, it is becoming easier to develop and utilize geocollaborative software.

Most collaborative GIS merely offer a way to present information. As technology moves forward, and the field of AI advances, the possibilities for even greater support of collaborative work will increase. Taking user input and combining it to form meta data is just one of those. With sufficiently advanced AI, the system itself could learn along with the users, learning to work with them and understand their actions. Then, cooperative work truly would become computer supported.

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References

Ballram, S. Dragicevik, S. Collaborative Geographic Information Systems: Origins, Boundaries, and Structures. 2006. *Collaborative Geographic Information Systems.*

Bannon, Liam J. and Schmidt, Kjeld. 1989. CSCW: Four Characters in Search of a Context. *ECSCW '89. Proceedings of the First European Conference on Computer Suupported Cooperative Work, Gatwick, London, 13-15 September 1989,* PP. 358-372.

Bunn, Julian J. (2007) Collaborative Computing Environments for HEP.

Carroll, J.M., Rosson, M.B, Convertino, G., Ganoe, C.H.. 2005. Awareness and teamwork in computer-supported collaborations. *Interacting With Computers 18.* 2006. (21-46)

Clark, H. H. (1996) *Using Language*. (Cambridge, UK: Cambridge University Press)

Convertino, G., Zhao, D., Ganoe, G., Carroll, J.M. & Rosson, M.B. 2007. A role-based multiple view approach to distributed geo-collaboration. In J. Jacko (Ed.), *Proceedings of Human-Computer Interaction International—Part IV* (pp. 561-670). Berlin: Springer-Verlag.

Ganoe, C.H., Somervell, J.P., Neale, D.C., Isenhour, P.L., Carroll, J.M., Rosson, M.B., & McCrickard, D.S. 2004. Classroom BRIDGE: Using collaborative public and desktop timelines to support activity awareness. *Proceedings of User Interfact Software and Technology, UIST 2004* (pp. 21-30). New York: ACM.

Gillavry, E. M. Collaborative Mapping and GIS: An Alternative Geographic Information Framework. 2006. *Collaborative Geographic Information Systems.* Ed: Shivanand, B., Dragiæeviæ, S.

Lyytinen, K. and Hirschheim, R. 1987. "Information System Failures: A Survey and Classification of Empirical Literature", *Oxford Surveys in Information Technology,* vol. 4, 1987, pp. 257-309.

Lyytinen, K. 1988. Expectation Failure Concept and Systems Analysts' View of Information System Failures: Results of an Exploratory Study. *Information and Management* Vol. 14 1988, pp. 45-56.

Rinner, Claus, 2006. Argumentation Mapping in Collaborative Spatial Decision Making.

Rosson, M.B., Dunlap, D., Isenhour, P.L., & Carroll, J.M. 2007. Teacher Bridge: Building a community of teacher developers. *Proceedings of the 40tt Hawaii*

International Conference on System Sciences (Abstracts p. 5a). IEEE Computer Society Digital Library.