DESIGN AND IMPLEMENTATION OF A GIS-ENABLED ONLINE DISCUSSION FORUM FOR PARTICIPATORY PLANNING

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DESIGN AND IMPLEMENTATION OF A GIS-ENABLED ONLINE DISCUSSION FORUM FOR PARTICIPATORY PLANNING

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PREFACE

This technical report is a reproduction of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Engineering in the Department of Geodesy and Geomatics Engineering, September 2006. The research was co-supervised by Dr. Y. C. Lee and Dr. David Coleman, and support was provided by the Natural Sciences and Engineering Research Council of Canada.

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ABSTRACT

Public participation is a process whose ultimate goal is to facilitate consensus building. To achieve this goal, there must be intensive communication and discussion among the participants who must have access to information about the matters being addressed.

Recent efforts in Public Participation Geographic Information Systems (PPGIS), however, concentrate mainly on making GIS and other spatial decision-making tools available and accessible to the general public. Relatively little effort to date has been put into addressing the communication and discussion needs of participatory planning, such as facilitating the transparent exchange of ideas among the participants. Simply making such tools available and accessible cannot satisfy the communication needs during participation.

In this thesis, a prototype has been designed and implemented to demonstrate that web-based GIS can be integrated with an online discussion forum to enhance communication during spatially-related discussions in participatory planning. Based on the evaluation criteria developed in this thesis, the prototype confirmed its ability to enhance communication as compared with selected major online PPGIS applications.

DEDICATION

This thesis is dedicated to the memory of my mother Mrs. Lai Kiu Tang, and my supervisor Dr. Y.C. Lee.

My mother was a strong woman. Her battle against Progressive Supranuclear Palsy (PSP) that attacked her body was a prime example of that strength. She passed away on 25th January, 2006 due to complications of PSP. She is always in my heart and I will always be inspired by her strength and determination.

The late Dr. Y.C. Lee, known to all as Y.C., introduced me to the interesting world of GIS and supervised this research throughout his battle with cancer. Despite suffering from cancer, he always managed to maintain a positive outlook on life. YC passed away on 23rd June, 2004. He always kept us laughing. His energetic personality will always be remembered.

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I would like to express my gratitude to the following people who have assisted me to complete this research:

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- Mr. Michael Baldwin, for providing information about the UNB Campus Plan.
- My dearest parents and siblings, for their continuous encouragement and love.
- Last but not least, my dear husband, Richard H.S. Chan, who always stood by me and showed endless support. He gave me lots of valuable suggestions throughout the research and assisted me in solving tonnes of technical and programming difficulties during prototype implementation. A journey is easier when you travel together. Thanks for your company, Richard.

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LIST OF ABBREVIATIONS

AJAX	Asynchronous JAvaScript and XML
DBMS	Database management system
GeoDF	GIS-enabled Online Discussion Forum
GIF	Graphics Interchange Format
GIS	Geographic Information Systems
GIT	Geographic Information Technologies
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IBIS	Issue-Based Information System
ICTs	Information and Communications Technologies
IIS	Internet Information Services
JPEG	Joint Photographic Experts Group
NCGIA	National Center for Geographic Information and Analysis
ODF	Online Discussion Forums
PDF	Portable Document Format
PHP	Hypertext Preprocessor
PPGIS	Public Participation Geographic Information Systems
RSS	Really Simple Syndication
SDSS	Spatial Decision Support System
STU	St. Thomas University
UNB	University of New Brunswick

CHAPTER 1 INTROUDCTION

1.1 Background

"Public participation" encompasses a group of procedures designed to consult, involve, and inform the public to allow those affected by a decision to have an input into that decision (Smith, 1993). Its ultimate goal is to facilitate consensus building. It is a process that requires not only access to information concerning the matters being addressed, but also intensive communication and discussion among the stakeholders. In the community planning process, diverse interests, values and objectives that are inherent in any community form an integral part of the process. It is thus necessary to involve all stakeholders (including but not limited to the planners and the general public) at an early stage of planning before crucial decisions have been made, so that diverse interests can be articulated and reconciled into acceptable community interests. This calls for participatory planning. Since community planning deals with issues that inherently have implicit or explicit spatial dimensions, maps are used frequently in planning discussions to communicate concepts or ideas that are spatially-related.

In the last decade, we have witnessed the growing applications of Geographic Information Systems (GIS) in participatory planning. GIS professionals concerned about community development have developed a framework generally called Public Participation Geographic Information Systems

(PPGIS) to help neighbourhood community groups and individuals use mapping and spatial analyses in community development and public participation (Wong and Chua, 2001). An extensive literature review in PPGIS research and applications in participatory planning reveals that recent efforts in PPGIS concentrate primarily on making GIS or other spatial decision-making tools available and accessible to the general public. For example, numerous PPGIS are now available online to enable the general public explore spatial data over the World Wide Web (Evans et al., 1999; Hackney's GIS Team, 2004; Orlando GIS, 2004). In order to support successful participation in planning, a PPGIS should also meet the principles of the participatory planning approach suggested by Rittel (1972)[1]. These principles stress transparent decision-making that demands a setting that is conducive to mutual understanding among the participants through discussions.

The literature review, however, indicates that relatively little effort in PPGIS research to date has been put into addressing the communication and discussion needs of participatory planning. Simply making PPGIS available and accessible cannot fulfill the principles of the participatory planning approach. For instance, more than half of the PPGIS under evaluation (in section 3.3) only allow participants to submit feedback via a predefined electronic form or email. In most cases, the recipient is a designated government department or a government official. This communication channel can only support the flow of information

[1] Based on Horst Rittel's article "On the planning crisis – systems analysis of the first and second generations" published in *Bedriftsokonomen*, Vol. 8, pp. 390-396. This article is written in Norwegian. An English version is not available. Citation in this thesis comes from Rinner (1999).

between an individual and a government official as opposed to the multi-way flow of information among various participants in an actual discussion setting. Moreover, as discussed in section 3.3, pure text message is prone to be ambiguous and less effective when it is used in describing and discussing the geographic objects, geographic extent, and spatial relationships of the issues being addressed (collectively known as "*spatial context*" hereafter) in a spatially-related discussion situation.

Although a few PPGIS examples allow the participants to post comments and exchange views (Evans et al., 1999; Ventura et al., 2002), those comments are usually not structured or organized making it very difficult if not impossible for the participants to understand the evolution of ideas throughout the discussion process. A better alternative will be using an online discussion forum. Until recently, very few experimental web-based PPGIS have included online discussion forums to support multi-way, structured communication among the participants (*Argumentation Map* by Rinner (1999) and Keßler (2004); *WebPolis* by Xie (2003)). This tool has proven to be useful for sharing views, letting participants understand each other's positions and the evolution of ideas. These systems, however, still require improvements as the online discussion forums in general have not been integrated with the GIS and hence the participants cannot take full advantage of the spatial data handling capabilities of GIS in aiding them to express and communicate the spatial context of the issues being addressed throughout the discussion process.

1.2 Research Objective

The objective of this research is to design and implement a prototype to demonstrate that web-based GIS can be integrated with an online discussion forum to enhance communication during spatially-related discussions in participatory planning.

To determine whether the research objective has been achieved, the present research needs to address the following questions:

- What are the communication needs for spatially-related discussions in participatory planning?
- To what extent have the existing applications fulfilled those needs?
- To what extent has the prototype fulfilled those needs?
- As compare with the existing applications, can the prototype fulfill more communication needs and/or can it meet those needs in a more efficient manner?

If all of the above questions are addressed and the answer to the last question is "Yes", the prototype is considered as being able to "enhance communication". In that sense, the research objective is achieved.

1.3 Approaches to the Research

The author has adopted the following approaches to achieve the research objective:

- **Literature review** that organizes around and relates to two main areas of interest has been conducted to acquire the background knowledge to the research: (i) the theories and practice of participatory planning (such as the principles of participatory planning, and the communication needs arising from spatially-related discussions); and (ii) the web technologies to date for solving the research question.

- **Evaluate the status of existing online PPGIS applications** – The goal of the evaluation is to assess from a technological perspective if existing applications can meet the communication requirements arising from spatially-related discussions in participatory planning. As established evaluation criteria for the evaluation purpose are not readily available, the author has developed the criteria based on the communication needs derived from Rittel's (1972) principles of participatory planning. Then, an evaluation is conducted on selected applications. The results serve as the baseline for a later comparison with the prototype.

- **Design and implement the prototype** – First, the target user group and the intended use of the prototype is determined. Based on the anticipated skill sets of the user group and the intended use of the prototype, user

requirements such as the types and levels of functionalities to be provided, the desired user interface design, and the technological requirements for the prototype can be derived. During the user requirement analysis, the author realizes the significance of "spatial context" of our dialog in spatially-related discussions. This concept is thus formalised such that it can be captured and displayed by the GIS to facilitate the communication of spatial concepts embedded in our dialog during discussions. For the purpose of proof-of-concept, the implementation of the prototype is based on available components or modules instead of implementing an entirely new system from scratch.

- **Evaluate the prototype and compare evaluation results** – The prototype is evaluated against the evaluation criteria developed earlier to determine the extent to which the communication needs can be fulfilled. Then, the results are compared with those for the existing applications to determine whether the prototype is able to enhance communication.

1.4 Scope of the Research

The present research is interested in the technological perspective of online GIS applications in participatory planning, particularly how web technologies can achieve the research objective. Institutional and other non-technical issues related to the design and implementation of the prototype are outside the scope of this research.

Other assumptions for the present research include:

- The prototype is proposed as another means for supporting spatially-related discussions. It intends to supplement rather than to replace the conventional participation methods, such as face-to-face meetings.
- The prototype is intended to support asynchronous distributed spatially-related discussion and participation in a general urban setting. It could be used in similar situations such as rural local resource discussions, although certain adaptations may be required in order to meet the requirements of a specific application.
- The prototype is intended to provide a platform and associated tools to support effective communication of views and opinions among the participants during spatially-related discussions as well as to facilitate mutual understanding. Participants can use the prototype to initiate discussions. The evolution of discussions will also be documented. The prototype, however, does not intend to provide mechanisms to analyse the comments collected or support final decision in the planning process.
- The prototype is not intended to meet the special needs of people with temporary or permanent disabilities.
- It is assumed that discussions will be moderated by a facilitator who is responsible for guiding and maintaining the order of the discussion as well as to provide technical assistance.

- The prototype is implemented for the purpose of proof-of-concept, it does not address the following requirements during design or implementation:
  - Usability is not a prime consideration during prototype design and implementation, although every endeavour has been made to make the system as user-friendly as possible.
  - The prototype is not implemented to cope with the requirements for cross-browser compatibility.

1.5 Significance and Contributions of the Research

The present research pinpoints the significance of communication needs in PPGIS research, an area that has not been examined extensively. It initiates a research in that particular direction and develops a set of criteria for evaluating whether a PPGIS application has been designed to incorporate those needs.

This research realizes the importance of "spatial context" of our dialog in spatially-related discussions. It formalizes this concept such that it can be captured and displayed by the GIS to facilitate explicit expression and exchange of spatial concepts embedded in our dialog in an online discussion environment.

The prototype implemented as part of this research proves that GIS can play the lead role in enhancing communication during spatially-related discussions. It extends the roles of GIS in participatory applications in which GIS is not only

good for supporting exploration, visualization, and analysis of spatial data but can be the backbone of a platform for facilitating the expression and exchange of views and ideas during spatially-related discussions.

The prototype enhances the deliberation and communicative capabilities of existing online PPGIS applications and provides a foundation for future research on PPGIS in the area of deliberation and communicative capabilities enhancement.

1.6 Organization of the Thesis

This thesis is organized into seven chapters. Chapter 1 provides an overview of the present research. It describes the objectives and approaches of the research. The significance and contributions of the research and its scope will also be discussed. Chapter 2 discusses the related theories and principles of public participation in the context of community planning decision-making. It provides the background knowledge to the present research. Chapter 3 develops the evaluation criteria and conducts an evaluation from a technological perspective on selected online PPGIS applications to assess whether they can fulfill the communication requirements for participatory planning. The strengths and limitations of those applications will also be identified, followed by a discussion on the preferred online PPGIS application. Chapter 4 presents the key design considerations for the prototype including the intended use, target user group, user requirements, and enabling technologies, followed by the system architecture. The details about the implementation of the prototype will be discussed in the latter

half of this chapter. Chapter 5 uses two planning scenarios to illustrate in what ways the prototype can enhance communication during spatially-related discussions in participatory planning. Chapter 6 evaluates the prototype based on the criteria developed in Chapter 3 and compares the evaluation results with those for the selected online PPGIS applications to determine whether the research objective is achieved, i.e. web-based GIS can be integrated with online discussion forum to enhance communication during spatially-related discussions in participatory planning. Chapter 7 concludes this thesis by summarising the work completed in this research and outlining the opportunities for future research.

CHAPTER 2 PARTICIPATORY PLANNING AND GIS

2.1 Concepts of Community Planning and Public Participation

2.1.1 Community Planning Process

Hodge (2003) defines community planning[2] as the process of a community of people deciding upon its future environment. It concerns two facets of community: a physical community of buildings, streets, open spaces, and a human community of individual people, groups and social institutions. The *physical community* is the outcome of the community planning process whereas the *human community* includes the proponents and decision-makers in the planning process as well as the recipients of the outcome of the process. The diverse values, objectives, and interests that are inherent in any *human community*, thus, form an integral part of the process. This gives rise to multiple, usually conflicting, objectives. As a result, one of the major goals of community planning is to reconcile the diverse interests into acceptable community interests, the so-called "public interest". It is the interest of the entire public that gives social legitimacy to the outcome of the planning process (i.e., the proposed plan).

2.1.2 Rational-Comprehensive Planning Approach

How can we ensure that the public interest is promoted properly by the planners in the community planning process? The rational-comprehensive

[2] In many planning literatures, the terms "city planning", "urban planning", "town planning", and "community planning" are used interchangeably. Hodge (2003) argues that the term "community planning" is more appropriate for the Canadian setting for two reasons. First, the Canadian settlements of all sizes are involved in planning; all may rightfully be called communities. Second, it conveys the idea that modern planning is an activity undertaken by the community, *involving all* who live in it.

planning approach suggests that a planner would be acting rationally by following five interrelated steps (Robinson, 1972, pp. 27-28):

(1) identify the problems to be solved and articulate goals;

(2) design alternative solutions or courses of action to solve the problems and/or fulfill the goals, and predict the consequences and effectiveness of each alternative;

(3) compare and evaluate the alternatives with each other and with the predicted consequences of unplanned development and choose, or help the decision-maker to choose, that alternative whose probable consequences would be preferable;

(4) develop a plan of action for effectuating or implementing the alternative selected, including budgets, project schedules, regulatory measures, and the like;

(5) maintain the plan on a current and up-to-date basis, based on feedback and review of information to adjust steps 1 through 4 above.

However, this approach is constrained by the fact that each of these steps involves the planners' and the decision-makers' judgement which is based on their knowledge, culture, and values. This drawback casts doubt on the outcome of this approach. It is questionable whether the diverse values, objectives, and interests in any given community can be accurately represented by the "public interest" articulated by the planners and/or decision-makers.

2.1.3 Participatory Planning Approach

Rittel and Webber (1973) argue that planning problems are "wicked problems" that cannot be adequately solved by the rational-comprehensive planning approach. The main features of wicked problems are:

- They cannot be definitively described, being a set of interlocking issues and constraints which change over time. Each attempt at creating a

solution changes the understanding of the problem.

- There are many stakeholders who have radically differing and changing ideas about what might be a problem, what might be causing it, and how to resolve it.
- There is no optimal solution and no termination condition, but the process ends when some resource is exhausted.
- Solutions to wicked problems generate waves of consequences, and it is impossible to know how all of the consequences will eventually play out. Any solution implemented will spawn at least one new wicked problem.

2.1.3.1 Principles of Participatory Planning Approach

To deal with wicked problems, Rittel and Webber (1973, p.162) suggest a planning approach based on "a model of planning as an argumentative process". In the course of this process, "an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgement, subjected to critical argument." Rinner (1999, pp. 21-22) cited Rittel's other work in 1972 about the principles of this approach as follows:

- There are no specialists for solving a wicked problem, but the necessary expertise is distributed over many people who must be integrated in the problem-solving process. The role of experts in dealing with a wicked problem is to guide the process rather than to solve the problem.
- A solution to a wicked problem cannot be imposed by authority; people do not accept being planned at. Affected people therefore must be involved in decision-making at an early stage of planning.
- Each step in working through the problem is based on political and moral attitudes of the stakeholders rather than purely on scientific expertise. The premises of decisions must be transparent to all participants.

- Objectification can be achieved by exchanging information about the foundations of one's personal judgment of a plan, to be understood by other participants.

In summary, the principles of the participatory planning approach call for a planning process that involves both the experts and non-experts (especially those affected by the planning project) at an early stage of the process. In the course of this process, the planning problems and solutions evolve gradually as a result of ongoing discussion among the participants. It thus demands a platform that enables exchange of views and ultimately accomplishes mutual understanding and consensus building among the participants. It is essential that the deliberation process is transparent to all participants so that they can understand each other's positions and make compromises through collaborative efforts. Furthermore, the participants should be given access to the necessary tools and information to enable constructive deliberations and informed decisions.

Based on the discussion in Section 2.1.1, the participatory planning approach is the preferred approach because with public involvement it is more likely to reconcile diverse interests into acceptable community interests.

2.1.3.2 Concept of Public Participation

According to Smith (1993), public participation is the process to "allow those affected by a decision to have an input into that decision". *Public*

participation[3] in this research refers to the involvement of the public in the community planning process. The *public* in general refers to all stakeholders in the community except the government officials – developers, interest groups, and individuals – and the emphasis is on building consensus among them. According to Innes and Booher (2000, p.34), the ultimate purpose of citizen involvement is "to integrate well developed citizen opinion into collective actions and decisions".

2.1.3.3 Benefits of Public Participation

The benefits of public involvement in planning are manifold:

- It is more likely that the interests of the participants can be better reflected in the final outcome, hence giving social legitimacy to the proposed plan.
- It provides formal channels for the collection of local wisdom and knowledge. The information collected is useful input to the design and evaluation of planning options because it is generally agreed that local people understand their neighbourhood far better than the planners of the local planning authority.
- The public can serve as a watchdog over nuisances and matters related to unauthorized development in their neighbourhood.
- Fresh ideas may emerge.

[3] The term "public involvement", "public participation", "citizen participation", and "citizen involvement", are used interchangeably throughout this thesis. They refer to the same meaning.

2.1.3.4 Degrees of Public Participation

(a) Arnstein's Ladder of Participation

Depending on the needs of the decision situation and the disposition of those in control of making decisions, public participation in community planning has been practised in ways that range from evasion to full empowerment (Hodge, 2003; Weiner et al., 2002). In a classic article about citizen participation, Sherry Arnstein (1969) uses a ladder to depict the different levels of power given to the citizen in affecting the outcome of the participation process (Figure 2.1). For ease of reference, the author summarizes the characteristics of each rung alongside Arnstein's ladder.

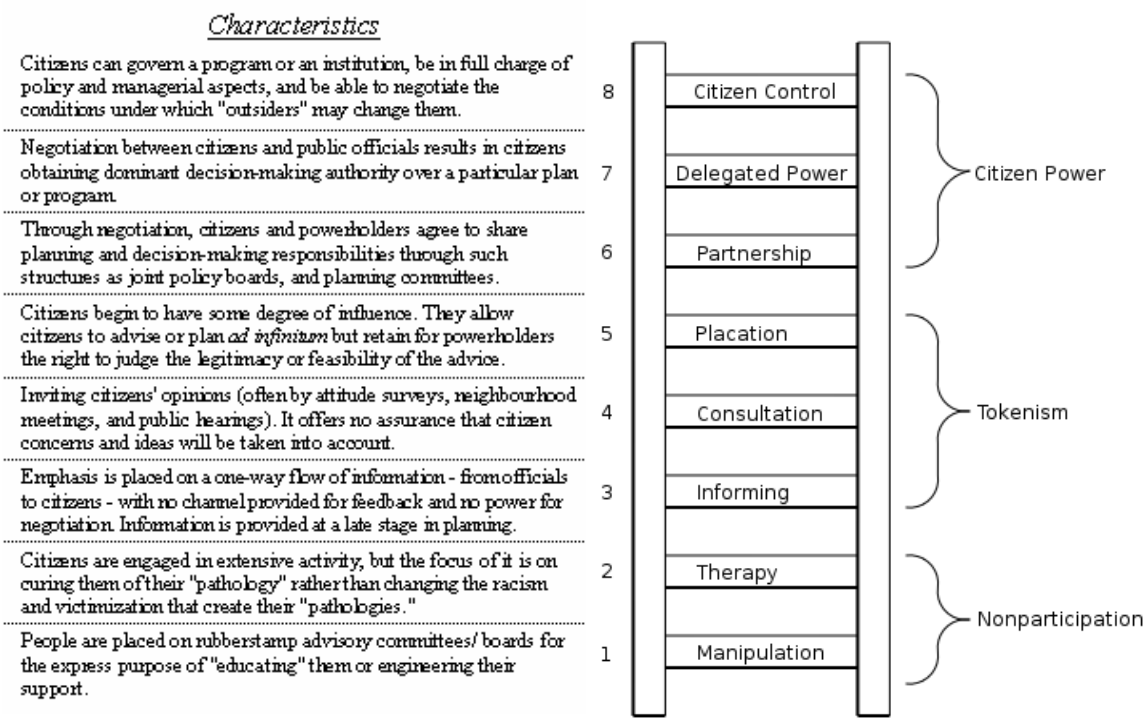


Figure 2.1: Arnstein's ladder of public participation [Modified after Arnstein, 1969]

Arnstein's ladder contains eight rungs of power. The lowest rung represents the least opportunity to participate with successively higher rungs represent increased levels of participation and greater influence on decision-making. With reference to Figure 2.1, the two bottom rungs describe levels of *non-participation* where "their real objective is not to enable people to participate in planning or conducting programs, but to enable powerholders to 'educate' or 'cure' the participants" (Arnstein, 1969). Rungs 3 to 5 progress to levels of *tokenism* that allow the citizens to share a bare minimum of power in decision-making, i.e. "to hear and to have a voice" but there is no guarantee that their voices will be taken into account. Further up the ladder are levels of *citizen power* with increasing influence on decision-making where citizens can "obtain the majority of decision-making seats, or full managerial power" (Arnstein, 1969).

(b) Wiedemann and Femers' Ladder of Participation

Based on selected case studies and the objectives of public participation, Wiedemann and Femers (1993) also use the ladder analogy to consider environmental decisions about hazardous waste management and develop a six-rung participation ladder (Figure 2.2). It assumes that as one moves up the ladder, each successive step embraces the lower steps on the ladder. This model is considered to be more applicable to today's planning context.

Based on the participation objectives of each rung of Wiedemann and Femers' participation ladder as shown in Figure 2.2, Rung 4 represents the first

step to meaningful participation as the public is involved at an early stage where they can define and discuss the relevant issues on the decision-makers' agenda. At Rungs 1 to 3, on the contrary, the public is only involved after important decisions have been made. They can merely react to what the authority offers to them and at most can say "No" to a plan but are not given the right to amend it.

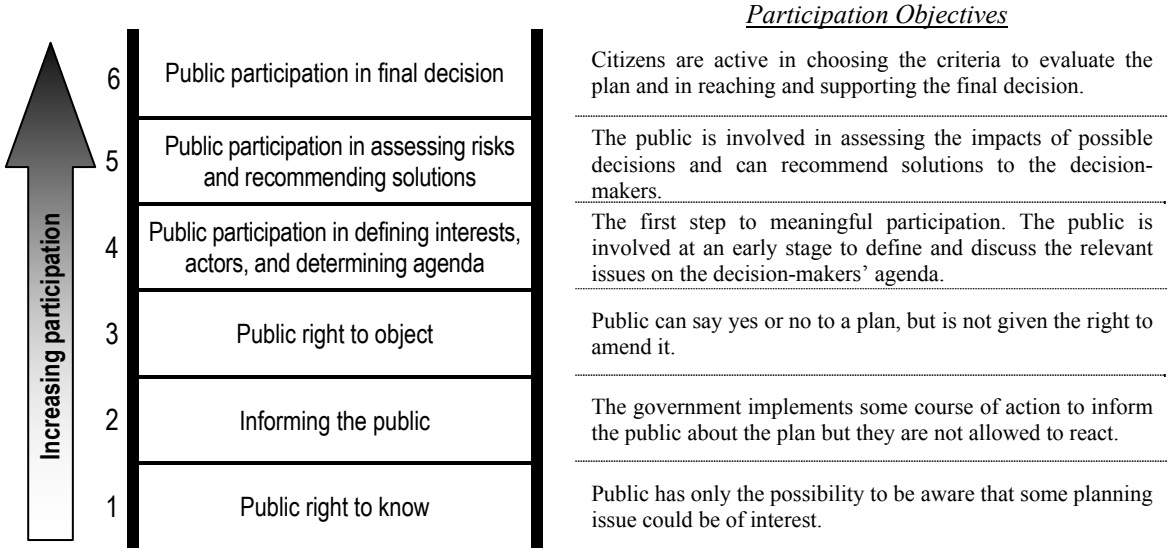


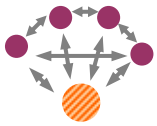
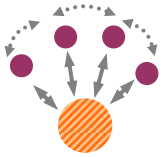
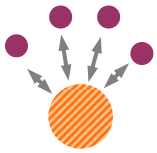
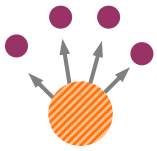
Figure 2.2: Wiedemann and Femers' public participation ladder
[Ladder modified after Wiedemann and Femers, 1993, Figure 2; participation objectives based on Laurini, 2001, p.249]

(c) Discussions

As illustrated in the above, the degrees of participation under Arnstein's and Wiedemann and Femer's models are primarily based on the distribution of decision-making power. If our goal of public participation is to meet the principles of participatory planning approach suggested by Rittel (section 2.1.3.1), these two models seem to have left out another factor that is equally important. Recall that the participatory approach involves intensive discussion and

information exchange among the participants, it is thus necessary to satisfy the communication needs of these activities or the results of participation could be jeopardised. The author thus attempts to supplement Wiedemann and Femers' public participation ladder by addressing the communication needs.

Based on the participation objectives at respective levels of Wiedemann and Femers' participation ladder, the author has derived the corresponding degrees of decision-making power between the public and the planning authority as well as the communication needs in terms of the characteristics of information flow and the type of interaction. The resultant model is depicted in Figure 2.3. For the bottom two rungs, information flows one-way from the planning authority to the public for information and education purposes. Thus, the government has absolute power in the decision-making process. Rung 3 marks the beginning of a two-way flow of information. The planning authority informs the public of certain plans and the public is invited to express if they are in favour of or against those plans. The planning authority in this case still has dominant power in decision-making as the public can only react to its decisions. In short, as Rungs 1 to 3 only support one-to-many interaction, participation activities that fall within these rungs merely act as the government's broadcasting channels rather than enabling meaningful participation. Hence, the author classifies these three rungs under the "broadcast model".

	Objective of Participation	Flow of information and share of power in decision-making	Type of interaction	Model
Rung 6	Public participation in final decision		Many-to-many interaction	Partcipative model
Rung 5	Public participation in assessing risks and recommending solutions			
Rung 4	Public participation in defining interests, actors, and determining agenda			
Rung 3	Public right to object		One-to-many interaction	Broadcast model
Rung 2	Informing the public			
Rung 1	Public right to know			

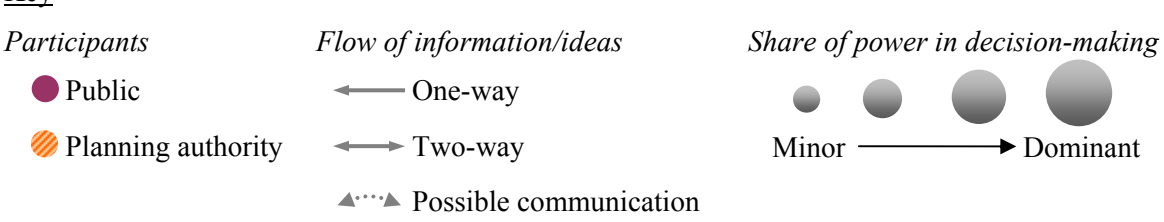


Figure 2.3: Flow of information and distribution of decision-making power at respective level of Wiedemann and Femers' participation ladder

At Rung 4, the public has more influence in the decision-making process by being involved in defining the relevant issues on the decision-maker's agenda. In addition to two-way flow of information between the government and the public, communication among the public begins to emerge. Since the public are given some rights to participate in plan-making, the power of the government becomes less

dominant. At Rung 5, the public enjoys more rights in plan-making and decision-making and there is a more equitable distribution of decision-making power. More active interaction and intensive communication among the participants is expected. Multi-way flow of information is apparent at this level. At the top rung of the ladder, an equal share of power is expected, where the government delegates the decision-making power to the public and has a partnership relationship with them. At this level, communication among all parties is both intensive and extensive. As the participation activities at the top three rungs of the ladder support many-to-many interaction, communication among the participants is encouraged. Hence, the author classifies the upper three rungs under the "participative model". The model in Figure 2.3 illustrates that communication needs in terms of information flow and the type of interaction between the government and the public exert a significant effect on the distribution of decision-making power.

Based on the above discussion, only the uppermost three rungs (Rungs 4 to 6) of Wiedemann and Femers' ladder are likely to satisfy Rittel's principles of participatory planning approach because public involvement is encouraged and takes place at an early stage. Moreover, the exchange of views among the participants is also expected. Hence, it is more likely to accomplish mutual learning and consensus building. The same is unlikely to occur at Rungs 1 to 3 where information and communication flow is restrictive. Besides, the public is only involved at a very late stage when major decisions have already been made by the authority. The lower three rungs of the ladder can at most support restricted participation.

2.1.3.5 Methods of Participation in Planning Decision-Making Process

Different methods have been developed to meet the diverse participation needs at various stages of the planning decision-making process. For example, at the plan preparation stage, surveys are commonly used to collect background data. At the interim stage, pubic meetings are often conducted to obtain public views on draft plans. Table 2.1 summarised the common public participation methods in planning. Alongside each method, the author presents the rungs that a respective method can reach on Wiedemann and Femers' participation ladder based on the model developed in Figure 2.3.

(a) Conventional Methods

As indicated in Table 2.1, most of the popular participation methods can at most reach Rung 3 of the ladder including the most widely used methods, surveys and public meetings. Based on the discussion in the previous section, these two methods fail to meet the principles of participatory planning. Planning meetings, in particular, have been criticised by numerous researchers (Carver, 2001; Jackson, 2000; Kingston, 1998; Wilcox, 1994) as having the following disadvantages that limit the degree of participation:

- The separation into speakers and audience can reinforce the feelings of "them" and "us" with the authoritative decision-makers holding all the knowledge, expertise and information compared to a partially informed public. This becomes stage sets for confrontation.

Table 2.1: Common public participation techniques in planning

Techniques	Characteristics	Wiedemann & Femers' Participation Ladder						
		Rung 1	Rung 2	Rung 3	Rung 4	Rung 5	Rung 6	
Opinion Surveys[4]	– Solicit information/opinion from representative sample of citizens – Same questions are asked of every individual surveyed – Survey types: postal, interviewer, telephone, online	√*						Conventional means
Neighbour notifications	Mandatory requirement to notify adjacent landowners of proposed planning applications, whose comments may or may not be required	√	√					
Exhibitions	– A presentation/exhibit of planning proposal made by planning authority – For education & information purposes	√	√					
Consultation documents	– A compilation of key information on the subject matters to be consulted – May request feedback from readers	√	√					
Written comments	Formally invite public to provide written feedback on planning proposals during mandatory consultation period.	√	√	√				
Public meetings / consultation forums	– Formal presentation by government/ consulting team in open forum – Public is given the chance to voice opinions and ask questions, but has no direct impact on recommendations – Extensively used to solicit information and input on particular issues – No formal votes/decisions are made	√	√	√				
Public hearings	– Similar to the setting of public meetings, but public views are recorded for the purpose of informing the decision makers – Decision-making body makes a decision to approve or reject the proposal	√	√	√				
Citizen advisory committees	Small group selected to represent views of various groups/communities and to examine significant issues and make recommendations to decision makers	√	√	√	√	√		
Basic web sites	– Provides static or interactive information on the subject matters to be consulted – Accepts feedback via email	√	√	√				Web-based means
Online discussion forums	– Facilitates communication and discussion among participants about important issues. – Usually supports online voting/polling.	√	√	√	√	√		
PPGIS[5]	– Utilize GIS technology to support and/or facilitate participation – Depending on individual systems, available services vary from delivery of map information to spatial decision support system	√	√	√	√	√		
		← Restricted participation →						

* The flow of information for opinion surveys is from the public to the government, which is an exception of the general model illustrated in Figure 2.3.

[4] Opinion surveys could be undertaken electronically via Internet.

[5] PPGIS stands for Public Participation Geographic Information Systems. It can be a stand-alone system, although the latest trend is mainly web-based.

- It can easily be dominated by "vocal minority" that may discourage the "silent majority" from participating.
- It is held at a fixed time and place. Thus, people with other commitments are excluded from participation.

Nevertheless, a planning meeting is often used by the government as a means to convince the public to adopt their proposals rather than opening up for exchange of views or consensus building. Carver et al. (1998) thus regard participation activities that are organized in this fashion as "restricted participation". To satisfy the principles of participatory planning approach, we need techniques that can enable effective communication among the participants.

(b) Web-based Methods

As Information and Communications Technologies (ICTs) advance, new participation methods based around these technologies have been developed making online participation possible. Previous research on the subject of using ICTs to support community involvement was undertaken by Ammouri (2002) at the University of New Brunswick. ICTs are considered as having a number of advantages over the conventional participation methods:

- *Remove time and location barriers*: Asynchronous participation becomes possible. The participation tools and data can be accessed anytime and from anywhere with Internet connection (24 hours a day and 7 days a week).

- *Relatively anonymous and less confrontational*: Participation is relatively anonymous and less confrontational as compared to a face-to-face meeting. This may encourage the silent majority to participate.
- *Ability to reach wider audience*: It can reach anyone anywhere in the world provided that Internet connection is available.
- *Supports two- to multi- way flow of information*: It allows the sharing and exchange of information and ideas in an effective manner.

However, the majority of e-government and e-democracy initiatives to date "have been little more than old thinking disseminated using new media" (Bryant and Wilcox, 2006). The majority of e-government projects are based on the conventional top-down approach. For instance, the authority constructs a web site that reflects its own view of the issues, and then invites communities to visit and comment. The authority thus has absolute power in controlling the content of the web site. This resembles a key characteristic of *Web 1.0* applications where web pages are made with "predefined content" produced by the content provider. According to Lemos (2006) and Bryant and Wilcox (2006), *Web 1.0* sites (or traditional web sites) are typically unidirectional where web pages are published within a broadcast model and only one-to-many interaction is supported.

The two-way communication capability of the Internet, however, was not realized until blogs, collaborative web page editing through wikis, online discussion forums, tagging, and RSS (Really Simple Syndication) gained popularity in the past few years. These web sites are designed for user

contribution. They support many-to-many interaction and allow users to communicate and discover knowledge in a collaborative manner. They mark a new phase of web applications now dubbed *Web 2.0* where user participation is emphasized (Davis, 2005; Lemos, 2006; O'Reilly, 2005; Porter, 2005). O'Reilly (2004) uses the term "the architecture of participation" to describe the nature of systems that are designed for user contribution. The transition from *Web 1.0* to *Web 2.0* indicates a power shift from the content provider to the site users. In general, *Web 2.0* is a concept about using the web as a platform to enable and encourage participation. O'Reilly (2005) anticipates that *Web 2.0* will be the design pattern and business model for the next generation of software. It is very likely that the next generation of online participation methods will follow this trend.

2.1.3.6 Argumentation Model

As discussed earlier, an essential prerequisite for successful participation is to satisfy communication needs among the participants. One of the possible solutions to achieve this objective is to deploy an appropriate argumentation model. Argumentation models have been used to capture and structure the flow of ideas in the discussion process. It is particularly useful as the planning problems and solutions evolve gradually from innumerable discussions throughout the life cycle of a planning process which may span over several months to several years (depending on the nature of the planning problems). The argumentation model can document and organize these problems and solutions on an ongoing basis

with a view to supporting continuous and constructive discussions. Besides, this is an essential step to promote mutual understanding among the participants. According to van Eemeren (2003), an internationally recognised researcher in the field of argumentation theory and rhetoric, "an essential characteristic of argumentation is that it always pertains to a specific point of view with regard to a certain issue". It is thus logical to organize argumentation around *issues*. One of the commonly used argumentation models that centred on "issues" is Kunz and Rittel's (1970) *Issue-Based Information System* (IBIS).

IBIS was introduced as a manually operated method to support coordination and planning of political decision processes and in general to treat wicked planning problems. According to Kunz and Rittel (1970, p.2), IBIS was designed to support, document, and coordinate information exchange during an argumentation process. Under IBIS, *issues* are the central elements for structuring the argumentation processes. They are usually expressed in question form (e.g., Is X the reason for Y?). They are the questions to be decided or goals to be achieved. Related *issues* can be grouped under a *topic* for denoting the foci of concerns. Possible solutions to the *issues* are identified as *positions*. Each *issue* may have many *positions*. Each *position* is justified by one or more *arguments* which either supports that *position* or objects to it. This hierarchy can be presented in a tree diagram with each separate *issue* being the root and the *positions* being its children and *arguments* being the children of the *positions* as shown in Figure 2.4.

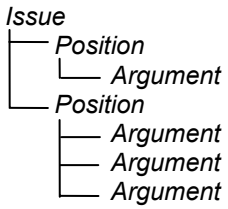


Figure 2.4: IBIS argumentation hierarchy

According to Rinner (1999), there are eight kinds of links in IBIS. For example, a *position* is linked to an *issue by a Responds-to* link. *Arguments* are linked to their *positions* with either *Supports* or *Objects-to* links. *Issues* may *Generalize* or *Specialize* other *issues* and may also *Question* or *Be-suggested-by* other *issues*, *positions*, or *arguments*. Figure 2.5 shows the principal node and link types offered by IBIS.

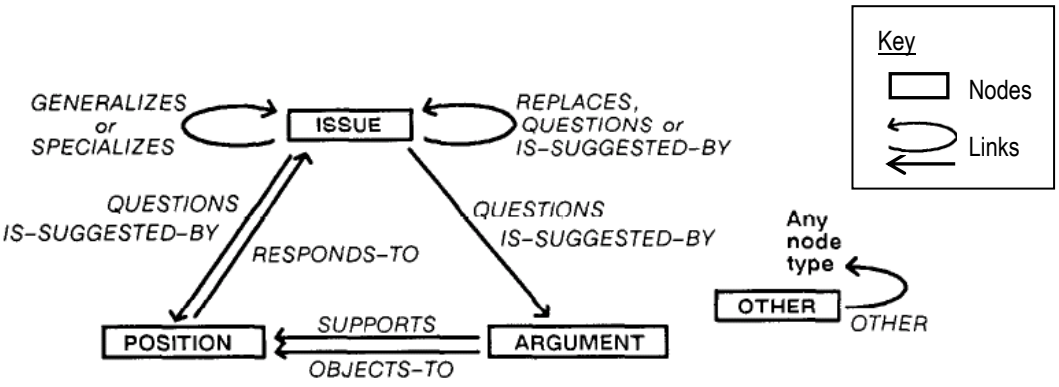


Figure 2.5: Node and link types provided by Issue-Based Information System
[Adapted from Conklin and Begeman, 1988, Figure 1]

A typical IBIS discussion begins with one participant posting an *issue* containing a question such as "how should we solve X?" and a *position* proposing one way of solving X as well as an *argument* supporting that *position*. Another participant may post a new *position* proposing an alternative way in response to the same *issue* and may support that with a set of *arguments*. Others may post

other *positions* or *arguments* which support or object to any of the *positions*. New *issues*, which are raised by the discussion, may be posted and linked into the nodes which most directly suggested them.

IBIS provides a method to keep track of the issues and explicitly reveal the arguments. It provides a simple and yet formal structure for the discussion and exploration of wicked problems.

2.2 GIS and Community Participation

2.2.1 GIS Applications in Community Planning

Since planning issues concerned with geographic matters and many planning decisions are actually spatial decisions, Geographic Information Systems (GIS) have been used by planners for over two decades to assist in community planning due to their powerful spatial data handling capabilities. Various GIS applications in planning have been described in the literature (Scholten and Stillwell, 1990; Stillwell et al., 1999). Stillwell et al. (1999, p.10) argued that "planning and development departments were seen to be taking a lead role in GIS implementation" among other departments of local authorities.

According to Stillwell et al. (1999), GIS had been used traditionally to capture, store, manage and display very large amounts of precise geographical information. Since mid-1990s, desktop mapping packages have been commonly used by the planners to support routine daily functions such as producing maps,

maintaining gazetteers or processing planning applications (e.g., they use GIS to carry out spatial analyses and make planning recommendations based on the results). The planners may also utilize GIS's visualization capabilities to communicate community design at planning meetings. However, the application of GIS in spatial decision-making was ad hoc and piecemeal until the release of Spatial Decision Support System (SDSS). SDSS provides the opportunity for GIS to be used more extensively in the planning decision-making process. It is an integrated system with generic GIS components and the ability to aggregate spatial data and decision makers' preferences into discrete decision alternatives (Ascough II et al., 2002). It is a system specially designed to support spatial decision-making.

2.2.2 GIS Applications in Community Participation

GIS can be a useful tool in the planning decision-making process. However, GIS alone cannot ensure that the outcome is well-accepted by the public unless the public is involved in the process. Moreover, the public should be given access to the relevant tools and data to facilitate meaningful and effective participation. One type of such tools is public participation GIS (PPGIS).

2.2.2.1 Public Participation GIS (PPGIS)

According to Craig et al. (1999), the concept of "public participation GIS" came from the NCGIA (National Center for Geographic Information and Analysis) Initiative-19 (GIS and Society: the social implications of how people, space, and

environment are represented in GIS) specialist meeting held in Minnesota in March 1996. One of the major themes arose from Initiative-19 was the nature of alternative GIS (sometimes known as GIS/2) designs which might better reflect community interests and empower its members (NCGIA, n.d.). According to Schroeder (1996), GIS/2 is "a set of methods and instruments which emphasize process, and which are oriented toward communication about representations as much as toward the representations themselves". Schroeder (1996) summarises the criteria for the design of a GIS/2 as follows:

1. A GIS/2 would increase emphasis on the role of participants in creation and evaluation of data.

2. GIS/2 would accommodate an equitable representation of diverse views, preserving contradiction, inconsistencies and disputes against premature resolution.

3. System outputs would be redefined to reflect the standards and goals of the participants, rather than closeness of fit to standards of measurable accuracy (such as positional accuracy in a Cartesian coordinate system).

4. A GIS/2 would be capable of managing and integrating all data components and participant contributions from one interface. Components would include e-mail, access to data archives, presentation of parallel texts and counter texts in diverse media, real-time data analysis, standard base maps and data sets, sketch map and field note capabilities.

5. The GIS/2 would preserve and represent the history of its own development, and be more capable of handling time components than existing GIS.

Although there are still debates about the definition of PPGIS[6], this term is collectively used "to cover the range of topics raised by the intersection of community interests and GIS technology" (NCGIA, n.d.). In the last decade, "GIS and geographic information technologies (GIT) are increasingly employed in research and development projects that incorporate community participation" (Weiner, et al., 2002, p.3). Numerous application examples can be found in the context of neighbourhood regeneration and urban planning (Allen and Morgan, 2004; Craig and Elwood, 1998; Hudson-Smith et al., 2002; Kingston, 2002; Talen, 1999, 2000), environmental management such as nuclear waste disposal (Carver et al., 1996; Drew, 2003), and resource management such as forest management (Kyem, 2002; Jordan, 2002) – to name just a few. Some expected outcomes of PPGIS include:

- it leads to the incorporation of local knowledge into GIS production and use (Weiner et al., 2002, p.4); and
- it "yields positive returns in terms of group dynamics, consensus building, and joint planning" as it allows users to spatially investigate an issue (Schlossberg and Shuford, 2005, p.16).

2.2.2.2 Online PPGIS Applications

Due to the advancement in ICTs, Internet is now a prevailing form of communication. Online has become a preferred means of service delivery. Weiner et al. (2002, p.9) point out that the growing use of the Internet connects

[6] There are debates about whether the "S" of PPGIS should stand for "Science" rather than "System". Sieber (2001), Schlossberg and Shuford (2003), and Tulloch (2003) also argued that the utilization of the terms of PPGIS are inconsistent across applications and uses. Please refer to the respective papers for details.

community members with GIS and the Internet is a central component of PPGIS delivery. Kingston (2002) suggests that a PPGIS is more robust because of the interactivity and connectivity provided by the Internet.

Web mapping technology is the backbone to online PPGIS applications. Depending on the technologies and the architecture adopted, the degree of user interactivity and GIS functionality varies considerably. For example, *static map publishing* is one of the simplest web mapping applications that mainly supports the distribution of static map images in graphic formats such as Portable Document Format (PDF), GIF (Graphics Interchange Format), or JPEG (Joint Photographic Experts Group). Depending on the applications, users can at most have restricted interactivity with the maps. This type of user requests (for ready-made files) can be handled by a two-tier client/server architecture.

Static web mapping supports more user interactivity and GIS functionality than *static map publishing*. Peng and Tsou (203, p.161) define *static web mapping* as "making maps, conducting queries, and doing some limited spatial analyses in the server". The output is presented on standard web browsers as *static* map images that are generated by the programs in the server. The web server serves as the middleware in this three-tier client/server architecture. Due to the stateless nature of the HTTP (Hypertext Transfer Protocol), interactivity are limited. For example, users cannot select a spatial feature or draw a box on the map images.

More interactivity and intelligence can be added to the client side by using client-side scripts such as JavaScript to make the plain HTML (Hypertext Markup Language) dynamic, and/or client-side applications like plug-ins, Active X controls, and Java applets. This way some user requests can be processed on the client side. Peng and Tsou (2003) define this kind of web mapping application as *interactive web mapping*. Many of the commercial web mapping programs such as ESRI's *ArcIMS*, Integraph's *GeoMedia WebMap*, and Autodesk's *MapGuide*, or open source applications such as *MapServer*, and *GeoServer* are based on similar architecture and technologies.

In general, the combinations of user interactivity and GIS functionalities of a given PPGIS application is one of the many factors that determine the degree of participation it can support. However, as discussed earlier, satisfying the communication needs is an essential factor contributing to the success of a participation attempt. Otherwise, the results of participation could be jeopardised.

2.3 Summary

This chapter begins with a discussion on the different approaches to community planning decision-making. The participatory planning approach is the preferred approach because with public involvement it is more likely that the interest of the public can be better reflected in the final outcome. This chapter goes on to discuss the various degrees of public participation with special reference to Arnstein's and Wiedemann and Femers' participation ladders. The

discussion considers that the two models have not explicitly addressed a crucial factor of participation, i.e. the communication needs of the participants. The author thus supplements Wiedemann and Femers' model by addressing the communication needs. The discussion concludes that for a meaningful participation, the participants should at least be allowed to define the relevant issues on the decision-maker's agenda. Moreover, multi-way flow of information and many-to-many interaction among all parties must be supported. Subsequently, the various conventional and web-based participation methods are discussed. Based on the recent development of web-based applications, it is very likely that the next generation of online participation methods will follow the participative model where user contribution is stressed.

The last part of this chapter reviews the GIS applications in community planning and community participation. It points out that GIS alone cannot ensure the planning outcome is well-accepted by the public unless the public are involved in the process. PPGIS is one of the applications that give the public access to the relevant tools and data to facilitate participation.

In the next chapter, the author will assess whether the current PPGIS applications have fulfilled the communication needs arising from the principles of participatory planning.

CHAPTER 3 EVALUATION OF SELECTED ONLINE PPGIS APPLICATIONS

In this chapter, the author will develop the evaluation criteria for assessing some selected online PPGIS applications. The evaluation will reflect the extent to which these applications can fulfill the communication needs arising from the principles of participatory planning.

3.1 Development of Evaluation Criteria

The goal of the present evaluation is to assess from a technological perspective whether the current online PPGIS applications can meet the communication requirements arising from the participatory planning approach. Specifically, it is most interested in evaluating if the geographic objects, geographic extent, and geographic relationships of the issues being discussed (collectively known as "*spatial context*" hereafter) can be communicated effectively in the participation process.

A review has been conducted on the PPGIS literature to explore whether established criteria for the present evaluation purpose are available. As summarised in Appendix I, there is no widely agreed upon set of criteria for evaluating PPGIS; different researchers have used various sets of criteria. However, the cited references all point to the importance of transparency and accessibility to information and tools. Since no comprehensive evaluation focusing on the communication needs of participatory planning has been

conducted so far, the author attempts to develop a set of evaluation criteria for this purpose. Where applicable, criteria developed by other researchers are adapted into the present evaluation as discussed below.

The evaluation criteria are developed in a three-step process as depicted in Figure 3.1. In the first step, the author translates Rittel's (1972) principles of participatory planning (also discussed in Section 2.1.3.1) into six goals of participatory planning as shown in Table 3.1.

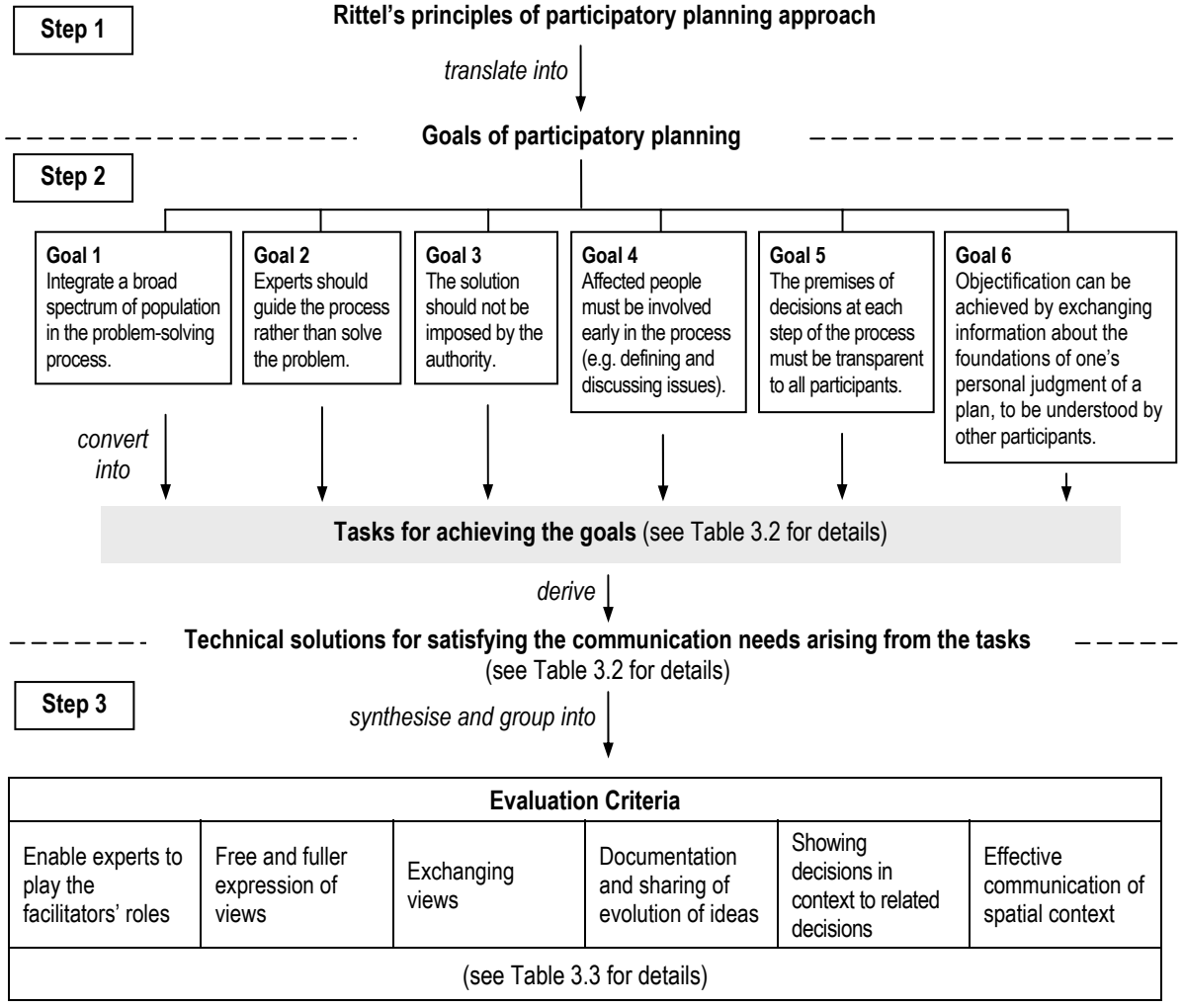


Figure 3.1: Development of evaluation criteria

Table 3.1: Development of goals of participatory planning

Rittel's (1972) principles of participatory planning	Goals of participatory planning
There are no specialists for solving a wicked problem, but the necessary expertise is distributed over many people who must be integrated in the problem-solving process. The role of experts in dealing with a wicked problem is to guide the process rather than to solve the problem.	Integrate a broad spectrum of population in the problem-solving process **(Goal 1)** Experts should guide the process rather than to solve the problem **(Goal 2)**
A solution to a wicked problem cannot be imposed by authority; people do not accept being "planned at". Affected people therefore must be involved in decision-making at an early stage of planning.	The solution should not be imposed by the authority **(Goal 3)** Affected people must be involved early in the process **(Goal 4)**
Each step in working through the problem is based on political and moral attitudes of the involved persons (including the experts!) stakeholders rather than purely on scientific expertise. The premises of decisions must be transparent to all participants.	The premises of decisions at each step of the process must be transparent to all participants **(Goal 5)**
Objectification can be achieved by exchanging information about the foundations of one's personal judgment of a plan, to be understood by other participants.	Objectification can be achieved by exchanging information about the foundations of one's personal judgment of a plan, to be understood by other participants **(Goal 6)**

In the second step, the tasks for achieving the goals of participatory planning are derived as shown under the first column of Table 3.2. Based on the communication needs[7] arising from these tasks, the technical solutions for satisfying these needs are identified under the second column of the table. The technical solutions thus form the basis of the final evaluation criteria. As noted in Table 3.2, the technical solutions for achieving Goal 1 are not incorporated into the final set of criteria because it is assumed that web-based applications, in theory, can meet the communication needs arising from Goal 1. On the other hand, Goal 3 is considered to be closely related to Goals 2 and 4. It is assumed

[7] Numerous researchers (Brandt, 2002; Drew, 2003; as well as Rowe, Marsh, and Frewer, 2004) considered "access to the necessary tools, data, and information" being one of the requirements for transparent communication. However, it is very difficult, if not impossible, to assess if all the "necessary" information have been provided in any given application. Thus, this criterion was not used in this evaluation.

that if Goals 2 and 4 can be met, Goal 3 is automatically fulfilled. Thus, no technical solution is derived directly from Goal 3. Please refer to Table 3.2 for details.

Table 3.2: Technical solutions for satisfying the communication needs of participatory planning

Tasks to achieve the goals of participatory planning	Technical solutions for supporting the required communication needs
Goal 1: Integrate a broad spectrum of population in the problem-solving process To achieve this goal, the authority needs to: T1.1 notify people with interest in the issues about the opportunity to be involved in the problem-solving process T1.2 provide reasonable support (e.g., reasonable time frame; access to information, data, and tools) to encourage participation	Requires a platform that can: S1.1 support an ongoing participation process (T1.1). S1.2 accommodate a large pool of population (T1.1). S1.3 meet the diverse needs and skills levels of the participants (T1.2). S1.4 enable participants to access the information, data, and tools needed for participation (T1.2). *The needs identified in the above are not incorporated into the final evaluation criteria due to two reasons. First, it is assumed that web-based applications can, in theory, satisfy these needs. Second, it is difficult to assess if all the required information, data, or tools have been provided in a given application (S1.4 refers).*
Goal 2: Experts should guide the process rather than to solve the problem To achieve this goal, T.2.1 the role of the experts should be the facilitators, not the decision-makers. The final outcome takes shape at every step along the way as the participants' views evolve. The experts should guide the participants through the entire problem-solving process from identifying and organizing issues, building a common knowledge base, analyzing opportunities and problems, presenting and giving feedback, deliberating, to deciding. T2.2 the participants should have access to the information, data, and tools needed to support decision-making to prevent the authority/experts from dominating or manipulating the process.	S2.1 provide appropriate tools to enable the experts play the facilitators' roles such as (T2.1): S2.1.1 guide participants through the discussion process. S2.1.2 keep discussion relevant to the topic and keep it moving. S2.1.3 encourage different viewpoints. S2.1.4 discourage offensive remarks. S2.2 provide appropriate tools to enable participants identify and organize issues, build a common knowledge base, analyze opportunities and problems, present and give feedback, deliberate, and decide (T2.1). *As it is difficult to assess if all the required information, data, or tools have been provided in a given application, no technical solution is derived from T2.2.*
Goal 3: The solution should not be imposed by the authority *Goal 3 is closely related to Goals 2 and 4. It is assumed that if the latter are fulfilled, Goal 3 is automatically satisfied. Hence, no task or technical solution is derived directly from Goal 3.*	

Table 3.2: Technical solutions for satisfying the communication needs of participatory planning (cont'd)

Tasks to achieve the goals of participatory planning	Technical solutions for supporting the required communication needs
Goal 4: Affected people must be involved early in the process To achieve this goal, T4.1 the authority needs to identify the stakeholders including the affected people. T4.2 the public should be involved at the beginning of the process before important decisions have been made. In particular, they should be involved in defining the problems, setting underlying assumptions and agenda, and deciding the solutions.	Requires a platform that can: S4.1 support the identification of affected people (T4.1). S4.2 provide necessary tools to support the discussion and deliberation needs arising from T4.2 such as: S4.2.1 allow participants to initiate discussions of their own choice (e.g., define problems, set assumptions and agenda, discuss solutions, etc.). S4.2.2 enable participants to use multiple media to support fuller expression of one's views (e.g., text, sketches, maps, or other media). S4.2.3 support multi-way flow of information (i.e., from the authority to the public; from the public to the authority; among the public) to facilitate exchange of views. *S4.1 is not considered as a communication need. Hence, it is not included in the final evaluation criteria.*
Goal 5: The premises of decisions at each step of the process must be transparent to all participants To achieve this goal, T5.1 transparency should be ensured throughout the participation process. It allows participants to understand what is being decided and the rationales for the decisions. T5.2 the spatial context of the discussions must be understandable by all participants. Planning discussion concerns primarily with spatial problems. Spatial context, such as the spatial relationships among geographical objects in concern, the intermediate spatial analyses involved and their results, thus forms an integral part in such discussions. Understanding the spatial context of the discussions is crucial to the understanding of what is being decided and why. T5.3 participants should be able to view the decision history over time.	Requires a platform that can: S5.1 organize the discussion in a manner that shows the evolution of issues from identification to decision-making and make it available to all participants (T5.1). S5.2 store and display the spatial context of participants' views on a map along with the corresponding expressions recorded by other media (T5.2). S5.3 track decision history over time and make it available to all participants (T5.3). S5.4 other transparency considerations suggested by Drew (2003) (T5.1): The platform needs to: S5.4.1 Provide logical referencing system pointing participants to additional information and source documentation. S5.4.2 Show decisions in context to related decisions S5.4.3 Make analysis tools, data and information available and accessible in an appropriate format, and at the appropriate level of details (also suggested by Brandt, 2002; Rowe,Marsh, and Frewer, 2004). *As it is difficult to assess if all the required information, data, or tools have been provided in a given application, S5.4.3 is not included in the final evaluation criteria.*

Table 3.2: Technical solutions for satisfying the communication needs of participatory planning (cont'd)

Tasks to achieve the goals of participatory planning	Technical solutions for supporting the required communication needs
Goal 6: Objectification can be achieved by exchanging information about the foundations of one's personal judgment of a plan, to be understood by other participants To achieve this goal, T6.1 appropriate communication mechanism and tools should be provided to enable the participants to: T6.1.1 freely and explicitly express and exchange their views among each other. T6.1.2 clearly express and exchange the spatial context of the discussion (such as the geographical extent of the issue being discussed, the geographical objects involved, and their spatial relationships, etc.) T6.1.3 understand the concerns held by various participants.	Requires a platform that can: S6.1 use multiple media to enable fuller expression of one's views (e.g., text, sketches, maps, or other media) (T6.1.1). S6.2 support multi-way flow of information (i.e., from the authority to the public; from the public to the authority; among the public) to facilitate exchange of views (T6.1.1). S6.3 provide a structuring mechanism to facilitate the exchange of ideas and understanding among the participants. This structuring mechanism should be integrated with a tool that can aid in the expression and exchange of the spatial context of such ideas (T6.1.2, T6.1.3).

In the last step, the technical solutions identified in the previous step are synthesised as sub-criteria and are grouped under the following broad evaluation criteria (Figure 3.1):

- Enable experts to play the facilitators' roles;
- Free and fuller expression of views;
- Exchanging views;
- Documentation and sharing of evolution of ideas;
- Showing decisions in context to related decisions; and
- Effective communication of spatial context.

Table 3.3 shows how the sub-criteria are synthesised and grouped from the technical solutions. Then, the evaluation questions motivated by the sub-criteria

are set (Table 3.4). They will be used in the evaluation to determine if a selected application can meet the communication requirements for participatory planning.

Table 3.3: Evaluation criteria and sub-criteria

Broad Evaluation Criteria	Sub-criteria	Originated from Technical Solutions #
Enable experts to play the facilitators' roles	Provide appropriate tools to enable experts play the facilitators' roles such as: - guide participants through the discussion process. - keep discussion relevant to the topic and keep it moving. - encourage different viewpoints. - discourage offensive remarks.	S2.1
Free and fuller expression of views	Allow participants to initiate discussions of their own choice (e.g., define problems, set assumptions and agenda, discuss solutions, etc.).	S2.2, S4.2.1
	Enable participants to use multiple media to support fuller expression of one's views (e.g., text, sketches, maps, or other media).	S4.2.2, S6.1
Exchanging views	Support multi-way flow of information (i.e., from the authority to the public; from the public to the authority; and among the public).	S4.2.3, S6.2, S6.3
	Enable all participants to view ideas expressed by other participants.	S5.1
Documentation and sharing of evolution of ideas	Store, organize, and display discussions in a manner that shows the evolution of issues and problem definitions.	S5.1, S5.3
Showing decisions in context to related decisions	Provide logical referencing system pointing participants to additional information and source document.	S5.4.1
	Show decisions in context to related decisions.	S5.4.2
Effective communication of spatial context	Store and display the spatial context of participants' views on a map along with the corresponding expressions recorded by other media.	S5.2, S6.3
	Provide structured organization of the integrated expressions to facilitate understanding of participants' concerns.	S6.3

Table 3.4: Evaluation sub-criteria and evaluation questions

Sub-criteria	Questions motivated by sub-criteria
Enable experts to play the facilitators' roles	
Provide appropriate tools to enable the experts play the facilitators' roles such as: - guide participants through the discussion process. - keep discussion relevant to the topic and keep it moving. - encourage different viewpoints. - discourage offensive remarks.	Does the application provide any tool that enables the experts play the facilitators' roles?
Free and fuller expression of views	
Allow participants to initiate discussions of their own choice (e.g., define problems, set assumptions and agenda, discuss solutions, etc.).	Does the application allow participants initiate discussions of their own choice such as define problems, set assumptions and agenda, discuss solutions, and so on?
Enable participants to use multiple media to support fuller expression of one's views (e.g., text, sketches, maps, or other media).	Does the application provide multiple media such as text, sketches, maps, or other media to enable fuller expression of participants' views?
Exchanging views	
Support multi-way flow of information (i.e., from the authority to the public; from the public to the authority; and among the public).	Does the application support information flow from the authority to the public; from the public to the authority; and among the public?
Enable all participants to view ideas expressed by other participants.	Does the application allow participants to view ideas expressed by other participants?
Documentation and sharing of evolution of ideas	
Store, organize, and display discussions in a manner that shows the evolution of issues and problem definitions.	Does the application store, organize and display discussions in a manner that shows the evolution of issues and problem definitions?
Showing decisions in context to related decisions	
Provide logical referencing system pointing participants to additional information and source documentation.	Does the application provide logical referencing system pointing participants to additional information and source documentation?
Show decisions in context to related decisions.	Does the application show decisions in context to related decisions?
Effective communication of spatial context	
Store and display the spatial context of the participants' views on a map along with the corresponding expressions recorded by other media.	Does the application store and display the spatial context of the participants' views on a map?
	Is the spatial context stored and displayed along with the corresponding expressions recorded by other media?
Provide structured organization of the integrated expressions to facilitate understanding of participants' concerns.	Does the application provide structured organization of the integrated expressions to facilitate understanding of participants' concerns?

3.2 Selection of Suitable Candidates for Evaluation

Table 3.5 lists eleven online PPGIS applications selected for the evaluation. An application must meet two selection criteria to be qualified as a suitable candidate. First, it must be an online application. Second, it must be operational and available for testing when the evaluation was conducted, with the exception of two functions for Applications A7 (*Shaping Dane's Future*) and A10 (*Redevelopment of Chapel Street*) probably due to an enhancement in progress or these functions were no longer maintained by the program developer. The evaluation of these two applications is thus supplemented by relevant articles. General descriptions about the selected applications are summarised in Table 3.5. A review of these applications is given in the next section to serve as background information for the evaluation.

3.3 Review of Selected Online PPGIS Applications

This section reveals a snapshot of the types of services and GIS functions offered by the selected online PPGIS applications as of August 2005 because some of these applications are being enhanced on an ongoing basis. The results are summarised in Tables 3.6 and 3.7. A tick (✓) in the tables denotes that such services or functions are offered whereas a cross (×) represents the opposite.

Table 3.5: Web-based PPGIS applications selected for evaluation

	Project	Description	URL
A1	Erie International Airport Runway Extension, U.S.	Users can view detailed information on the proposed runway extension alternatives for the Erie International Airport.	http://gis.csengineers.com/erie/viewer.htm
A2	Map Hackney, U.K.	Users can explore and query the geographic information of the borough, and create thematic maps.	http://www.map.hackney.gov.uk/
A3	Planning the Portland Metro Area, U.S.	Users can view, query, and print map information about the Metro area of Portland.	http://topaz.metro-region.org/metromap/metromap.cfm
A4	Orange County Interactive Mapping, Florida, U.S.	Users can download GIS data from the site and provide feedback about the data. Annotation and drawing tools are provided to allow users to put notes and annotations on the map. Users can email the marked-up map as an image attachment to anyone.	http://ocgis1.ocfl.net/imf/imf.jsp?site=orangecFL
A5	Resource Management Mapping Service, Illinois, U.S.	Users can add comments and simple symbols on the map and email it as an image attachment to anyone.	http://space1.itcs.uiuc.edu/website/rmms/
A6	Siting Radioactive Waste Disposal Facilities in Britain	Users can access background information relevant to the problem, and use the spatial decision support tool to identify suitable sites according to their perceptions on the constraints and various factors they considered relevant to the problem.	http://www.ccg.leeds.ac.uk/mce/mce-init.htm
A7	Shaping Dane's Future, U.S.	A pilot project to allow users to use the system to visualize maps of the town of Verona or download GIS onto local computer to create maps or analysis.	http://www.lic.wisc.edu/shapingdane/resources/resources-home.htm
A8	Virtual Slaithwaite Project, U.K.	Users can select a geographic feature from or click on anywhere on the map and make comment. When a comment is received by the server, a dot will be created on the map marking where that comment was made. Users can click on each dot to review the corresponding comment.	http://www.ccg.leeds.ac.uk/slaithwaite/
A9	Consultative Development Control System, U.K.	A prototype system that allows users to make comments on a map. Similar to the Virtual Slaithwaite project, users can view other participants' comments by clicking on the respective icons on the map. It also allows users to respond to other participants' comments.	http://146.87.107.105
A10	Redevelopment of Chapel Street, Salford, U.K.	Users can walk or fly through the 3D virtual reality model of the project area (Openspace model) and make comments on the model.	http://www.ties.salford.ac.uk/pg/xiao/openspace-main.html
A11	Argumentation Map, Germany	A prototype system to support discussion based on maps. Discussion contributions are structured to facilitate users understand the evolution of ideas. They are geographically referenced and linked to geographic features.	Downloaded from: http://www.carstenkessler.de/argumap/

Table 3.6: Matrix of services offered by selected online PPGIS applications

Online PPGIS Applications		Services available								
		Information delivery				Ways to collect feedback		View other participants' feedback	Digital 3D model of proposed scheme	Provision of GIS functions[#]
		Documents	Static Maps	Interactive Maps	GIS data download	Comment form / email	Online discussion forum			
A1	Erie International Airport Runway Extension, U.S.	✓	✓	✓	×	✓	×	×	×	○
A2	Map Hackney, U.K.	×	✓	✓	✓	✓	×	×	×	⦿
A3	Planning the Portland Metro Area, U.S.	✓	✓	✓	×	✓	×	×	×	○
A4	Orange County Interactive Mapping, Florida, U.S.	✓	✓	✓	✓	✓	×	×	×	⦿
A5	Resource Management Mapping Service, Illinois, U.S.	✓	✓	✓	×	✓	×	×	×	⦿
A6	Siting Radioactive Waste Disposal Facilities in Britain	✓	✓	✓	×	✓	×	×	×	●
A7	Shaping Dane's Future, U.S.	✓	✓	✓	✓	post notes on maps*	×	✓*	✓	○
A8	Virtual Slaithwaite Project, U.K.	×	×	✓	×	✓	×	✓**	×	○
A9	Consultative Development Control System, U.K.	✓	×	✓	×	✓	×	✓	×	○
A10	Redevelopment of Chapel Street, Salford, U.K.	×	×	3D model	×	post comments on 3D model***	×	✓***	✓	○
A11	Argumentation Map, Germany	✓	×	✓	×	×	✓	✓	×	⦿

[#] ○: Limited (only supports map browsing + select and identify objects); ⦿: Intermediate (includes map browsing + general spatial query and analysis tools); ●: Advanced (includes intermediate tools + advanced spatial analysis tools). Please refer to Table 3.7 for details.

* Based on information given in the article written by Hamilton et al. (2001) as this function was not fully functional at the time of the review.

** Comments were only available for viewing after the consultation was over.

*** Based on information given in the article written by Ventura et al (2002) as this function was not fully functional at the time of the review.

Table 3.7: GIS functions offered by selected online PPGIS applications

Online PPGIS Applications		GIS functions available								
		GIS data download	Organization of GIS data	Map browsing (pan, zoom)	Map making	Query		Mark-up tools (Sketches and annotations)	Indicate location of participant's comments on map	Decision support system (DSS)
						Attributes	Spatial			
A1	Erie International Airport Runway Extension, U.S.	×	Multiple map layers	✓	×	✓	×	×	×	×
A2	Map Hackney, U.K.	✓	6 predefined themes, each w/ several layers; only display one theme at a time	✓	✓	✓	• Buffer • Overlay (as part of spatial query tool)	×	×	×
A3	Planning the Portland Metro Area, U.S.	×	Multiple map layers	✓	✓	✓	×	×	×	×
A4	Orange County Interactive Mapping, Florida, U.S.	✓	Multiple map layers	✓	✓	✓	• Buffer • Measure distance • Calculate area	✓	✓	×
A5	Resource Management Mapping Service, Illinois, U.S.	×	Multiple map layers	✓	✓	✓	• Buffer • Measure distance • Calculate area	✓	✓	×
A6	Siting Radioactive Waste Disposal Facilities in Britain	×	As thematic maps	Static view, no pan/ zoom function	✓	×	Buffer & overlay (integrated w/ spatial decision model)	×	×	✓
A7	Shaping Dane's Future, U.S.	✓	Multiple map layers	✓	✓	×	Measure distance	×	✓[#]	×
A8	Virtual Slaithwaite Project, U.K.	×	1 map layer	✓	×	✓	×	×	✓	×
A9	Consultative Development Control System, U.K.	×	1 map layer	✓	×	✓	×	×	✓	×
A10	Redevelopment of Chapel Street, Salford, U.K.	×	As digital 3D model	✓	×	×	×	×	✓[#]	×
A11	Argumentation Map, Germany	×	Multiple map layers	✓	✓	×	×	×	✓	×

[#] This matrix is prepared based on the GIS functions that were available at the time of the review supplemented by the articles written by Hamilton et al. (2001) and Ventura et al (2002). This particular function was not fully functional when the review was conducted.

In general, the common purposes of the selected applications are to deliver information to the general public as well as to collect feedback from them. However, the types of information to be delivered and the methods of feedback collection vary among the applications (Table 3.6). For example, most of the selected applications deliver documents, and static and/or interactive maps whereas some applications also allow users to download GIS data for analysis with a desktop GIS. In terms of methods of collecting feedback, most applications request users to email feedback or submit an online feedback form directly to the authority. More than half of the selected applications do not allow users to view each other's comments or communicate with each other. Only one of the selected applications (*Argumentation Map*) deploys an open discussion forum to enable users communicating with each other. It is believed that the choice on the methods of feedback collection is influenced by the intended participation objectives of the applications.

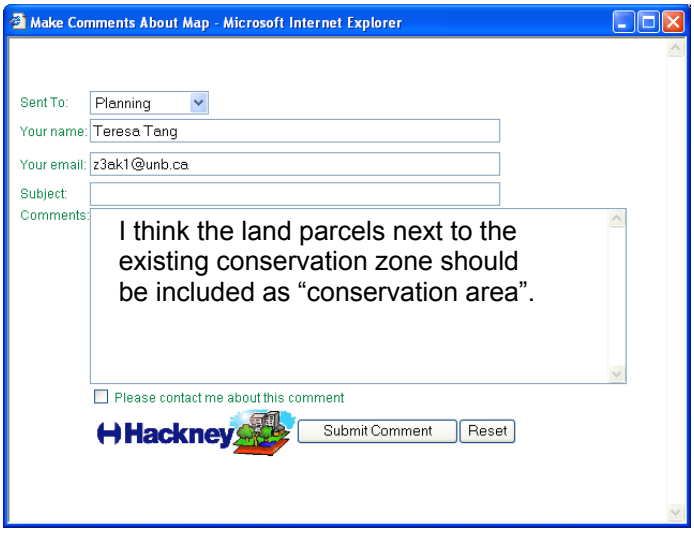
Table 3.8 summarises the type of interaction and the participation objectives that can be supported by the selected applications. It validates the model developed in Figure 2.3 in which applications that achieve the participation objectives of Rung 3 or below follow the broadcast model which only supports one-to-many interaction. On the other hand, applications that achieve the participation objectives of Rung 4 or above follow the participative model which supports many-to-many interaction.

Table 3.8: Types of interaction and participation objectives that can be supported by selected online PPGIS applications

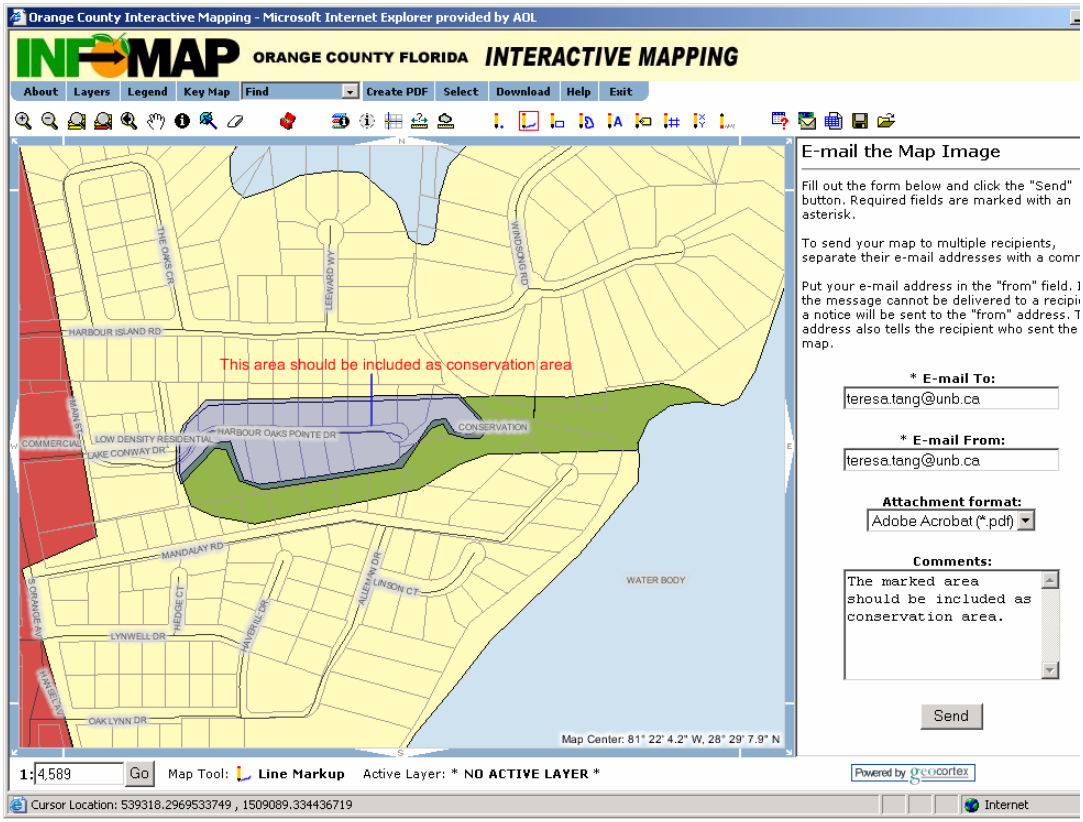
Wiedemann & Femers' Participation Ladder (Figure 2.2 refers)		Online PPGIS Applications										
Rung	Participation objectives	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
		Types of interaction (1:m = one-to-many; n:m = many-to-many)										
		1:m	1:m	1:m	1:m	1:m	n:m	n:m	n:m	n:m	n:m	n:m
6	Pubic participation in final decision											
5	Public participation in assessing risks and recommending solutions						✓*				✓*	
4	Public participation in defining interests, actors, and determining agenda							✓	✓	✓	✓	✓
3	Public right to object	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Informing the public	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1	Public right to know	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

* The function for assessing risks is rather limited in nature. For example, Application A10 only enables users to do visual impact assessment of a proposed plan with a 3D digital model.

Figure 3.2 summarises the communication media that are deployed by the selected applications. More than half of the selected applications (A1 to A6) use email as a means to enable general public to provide feedback. Email messages, however, are prone to be less effective, if not ambiguous, in expressing the spatial context of a discussion (Figure 3.2a). In Applications A4 and A5, however, users can make use of the sketching and annotation tools to help them express the spatial context explicitly on a map which can be sent as an attachment to an email message (Figure 3.2b). As discussed earlier, the transparent exchange of views among the participants is an important requirement for discussions. Email, however, cannot serve as an open platform to fulfill this requirement.

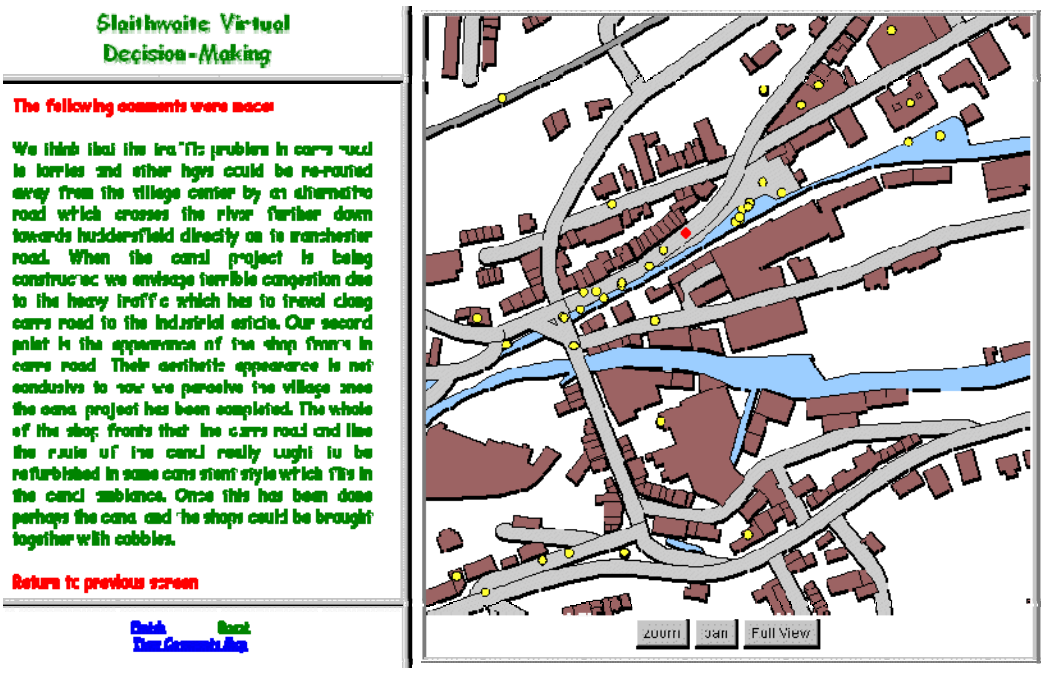


(a) Online feedback form / email (example applications: Applications A1, A2, A3 and A6) [Source: Hackney’s GIS Team, 2004]

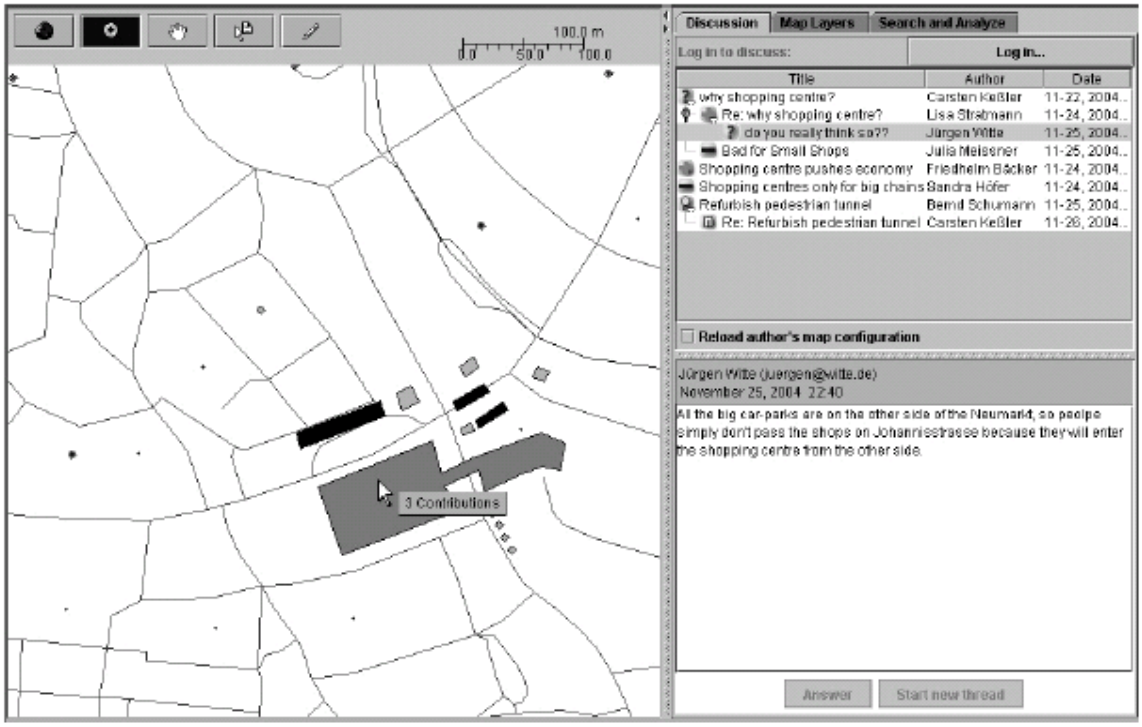


(b) Sketches and annotations as map attachment to online feedback form/email (example applications: Applications A4, and A5) [Source: Orlando GIS, 2004]

Figure 3.2: Communication media deployed by selected online PPGIS applications



(c) Geo-referenced comment tool (example applications: Applications A7, A8, A9, and A10) [Source: Evans et al., 1999, Figure 3]



(d) Online discussion forum links with geo-referenced comment tool (example application: Application A11) [Source: Keßler et al., 2005, Figure 2]

Figure 3.2: Communication media deployed by selected online PPGIS applications (cont'd)

Application A6 also uses email as a communication medium. Unlike others, this application is backed by a Spatial Decision Support System (SDSS) that returns a preferred option after an individual participant has specified the relative degree of importance of certain predefined factors and constraints (Carver et al., 1996). This tool, however, does not support opinion sharing among the participants. Moreover, the preferred option is often generated in a black box. Participants have no idea how the system comes up with this option.

Some other applications (A7, A8, A9, and A10) use geo-referenced comment tools to support the communication of ideas among participants. These tools allow participants to pick a location on the map and make comments on that location. The presence of comments is represented as point symbols on the map (Figure 3.2c). Participants can view individual comment by clicking a point symbol. A major drawback of this tool is that except for the point symbols which denote the whereabouts of a given comment, the spatial context of one's view is largely embedded in the text message. In other words, the spatial context is not expressed and displayed explicitly on the map. Moreover, the comments are not organized which means it is very difficult to figure out how the issues evolve and whether the comments are related to each other.

To facilitate the participants understand how the discussion evolves, Rinner (1999) introduced the idea of linking an online discussion forum with a mapping component which was later further developed and implemented by Keßler (2004)

as a prototype called "*Argumentation Map*" (A11). In this prototype, the discussion contributions are organized by threads. They are geo-referenced and their distribution is shown on a map (Figure 3.2d). This application is good in documenting and displaying the evolution of issues. It is relatively easy to show decisions in context to related decisions. However, similar to the geo-referenced comment tools (Figure 3.2c), the mapping component acts merely as a user interface to access the comments. Spatial context of individual message cannot be communicated effectively.

3.4 Evaluation Results

The actual evaluation is straightforward. Based on the relevant documentation of the selected applications as well as the author's hands-on experience with the applications, each application is evaluated according to the criteria developed in Section 3.1. The evaluation results are summarised in Table 3.9. A cross (×) in the table represents a sub-criteria that is not fulfilled by a given application whereas a solid dot (●) represents the opposite. A semi-solid dot (◉) represents a sub-criteria that is fulfilled only partially by an application.

As shown in Table 3.9, none of the applications can fulfill all of the evaluation criteria. In particular, none of them can meet the requirement for enabling experts play the facilitators' roles. The application that can fulfill most of the criteria is Application A11, *Argumentation Map* (or *Argumap* in short).

Table 3.9: Evaluation matrix

Questions motivated by sub-criteria	Selected Online PPGIS Applications										
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
Enable experts to play the facilitators' roles											
Does the system provide any tool that enables the experts play the facilitators' roles?	×	×	×	×	×	×	×	×	×	×	×
Free and fuller expression of views											
Does the system allow participants initiate discussions of their own choice such as define problems, set assumptions and agenda, discuss solutions, and so on?	×	×	×	×	×	×	●	●	●	●	●
Does the system provide multiple media such as text, sketches, maps, or other media to enable fuller expression of participants' views?	× T	× T	× T	● T,M,S,A	● T,M,A	● T,M	● T,M	● T,M	● T,M	● T,3D	● T,M
Exchanging views											
Does the system support information flow from the authority to the public; from the public to the authority; and among the public?	⦿*	⦿*	⦿*	⦿*	⦿*	⦿*	●**	●	●	●	●
Does the system allow participants to view ideas expressed by other participants?	×	×	×	×	×	×	●**	●	●	●	●
Documentation and sharing of evolution of ideas											
Does the system store, organize and display discussions in a manner that shows the evolution of issues and problem definitions?	×	×	×	×	×	×	×	×	×	×	●
Showing decisions in context to related decisions											
Does the system provide logical referencing system pointing participants to additional information and source documentation?	●	⦿#	⦿#	⦿#	⦿#	●	●	×	●	×	×
Does the system show decisions in context to related decisions?	●	×	×	×	×	●	×	×	×	×	●
Effective communication of spatial context											
Does the system store and display the spatial context of the participants' views on a map?	×	×	×	●	●	×	⦿♦	⦿♦	⦿♦	⦿♦	⦿♦
Is the spatial context stored and displayed along with the corresponding expressions recorded by other media?	×	×	×	×	×	×	×	×	×	×	●
Does the system provide structured organization of the integrated expressions to facilitate understanding of participants' concerns?	×	×	×	×	×	×	×	×	×	×	●
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11

×: Not fulfilled; ⦿: Partially fulfilled; ●: Fulfilled.

T Text (via email or comment form); M Maps; S Sketches; A Annotations; 3D 3D digital model.

* Two-way flow of information (from the authority to the public, and from the public to the authority).

** Comments were available for viewing after the consultation was over.

Via an external site (e.g. the home page of the planning authority)

♦ Only shows the whereabouts of the comments; cannot show other spatial context elements such as spatial relationships.

In summary, apart from making provisions to support facilitators, another area that needs to be enhanced in order to meet the communication requirements for participatory planning is to ensure that the spatial context of a dialog can be expressed explicitly such that the chances of misunderstanding or misinterpreting a participant's opinion could be minimized.

3.5 Discussion: Toward a Preferred Online PPGIS Application

Among the applications under evaluation, the GIS-based sketching and annotation tools deployed by Application A4 has a definite advantage in terms of supporting effective communication of spatial context. However, this alone cannot fulfill the other criteria for effective communication of spatial context as summarised in Table 3.9. The above evaluation reveals that the existing applications have not yet taken full advantage of the spatial data handling capabilities of GIS in aiding the communication of opinions during spatially-related discussions. Moreover, most of the current systems have not put emphasis on meeting the communication needs of participatory planning. Improvement should also be made in the area of enabling the experts play the roles of facilitators.

In the next chapter, the author has endeavoured to design and implement a prototype known as "*GIS-enabled Online Discussion Forum (GeoDF)*" to prove that GIS can play the lead role in facilitating better communication in a spatially-related discussion scenario. The prototype is similar to Rinner (1999) and Keßler's (2004) idea of integrating an online discussion forum with a web-based

GIS, as the above evaluation suggests that online discussion forum is an effective tool for multi-way flow of information. The prototype will focus on integrating the two components (a web-based GIS and an online discussion forum) in such a way that the spatial data handling capabilities of GIS can be better utilized in facilitating effective communication among the participants during spatially-related discussions.

CHAPTER 4 DESIGN AND IMPLEMENTATION OF A GIS-ENABLED ONLINE DISCUSSION FORUM (GeoDF)

The prototype, known as "***G**IS-**e**nabled **O**nline **D**iscussion **F**orum (GeoDF)*", addresses the improvements outlined in the last chapter. It achieves two major goals. The first goal is to enable participants to express their opinions more effectively in a spatially-related discussion situation. The second goal is to facilitate participants to better understand each other's opinion. The key design considerations of *GeoDF* will be discussed in the first half of this chapter, followed by a discussion on the implementation of the prototype.

4.1 Design of the Prototype

4.1.1 Key Design Considerations

4.1.1.1 Intended Use

The prototype is intended to facilitate users to participate in the ongoing discussion of spatially-related issues. This requests for a platform that users should be able to join the discussion at a time and location of their choice (also known as *asynchronous discussion*).

4.1.1.2 User Group

The target users of the prototype are the general public. As the number of expected users will be in the range of hundreds to thousands, Internet is considered an appropriate implementation platform.

Ideally, users joining a discussion via Internet can have their own choice of time and location. In reality, a certain portion of the general public may not own a computer or may not have access to Internet connection. Hence, some people will be using public computers (such as those in the public libraries) to access the Internet. It is very likely that general users of public computers may not have the administrator's privilege to install plug-ins. As a result, the prototype must be operational without the installation of additional software beyond a web browser.

It is assumed that the majority of the general public are either novice or general users of computers. The prototype should be easy enough for any users who have no prior training to use. Moreover, for the purpose of proof-of-concept, the special needs of people with disabilities are not incorporated into the prototype design.

4.1.1.3 User Requirements

(a) Concept of Spatial Context

The issues being addressed in a planning discussion always involve spatial elements. For instance, we may refer an issue as a local, regional, or national issue. This indeed refers to the *geographic extent* of an issue. We always discuss the *geographic features* that we consider are related to a certain issue. For example, we may say a dumping site at a particular location is causing a lot of nuisance to our neighbourhood. Moreover, we often talk about the location of certain geographic features, such as a parking lot adjacent to a grocery store (in which the

geographic location and *geographic relationships between geographic features* are always inseparable). These four spatial elements – namely the geographic extent, geographic features, geographic location and geographic relationships – are collectively known as *spatial context* in this research. They form an integral part of our dialog when we discuss spatially-related issues. Thus, one of the prerequisites for the prototype is to enable participants of a discussion to express the spatial context embedded in their opinions effectively. At the receiving end, the prerequisite is to facilitate other participants (or the recipients) to understand the *spatial context* embedded in others' dialog.

(b) Facilitate Effective Expression of Spatially-related Opinions

When we are discussing issues with a *spatial context* in a face-to-face meeting, we usually use a map to help us express and convey the message. This is because maps are powerful communication tools (Brown, 1979; Rambaldi, 2004; Schulten, 2001; Sui and Goodchild, 2001). They are "arguments that mediate our understanding of the world" (Schulten, 2001, p.5). Brown (1979, p.32) writes "when all other methods of communication fail, the universal language of the simple map and chart comes to the rescue". For example, we can sketch and annotate an oil spillage problem on a base map to illustrate (i) the area affected (*geographic extent*) by the problem; (ii) the (*geographic*) features and the location of the features (*geographic location* and *geographic relationships*) that are affected by the problem. This proves to be more efficient as it helps one to express the problem more explicitly, hence eliminate unnecessary ambiguity and

misunderstanding. It also helps other members of the team to comprehend and understand the problem effectively. This is a typical example of *one picture is worth a thousand words*.

Similarly, in an online discussion environment, we also need maps, as well as sketches and annotations to enable us to express the *spatial context* of our dialog in an effective manner.

(c) Facilitate Understanding of Spatially-related Opinions

As discussed earlier, maps, as well as sketching and annotation tools can help one not only to express the issue but help others to understand it better. There are other prerequisites that the prototype needs to fulfill in order to facilitate better understanding among the participants. In an ongoing, asynchronous online discussion, it is necessary for every participant to grasp the evolution of discussion so that the ideas and opinions can evolve throughout the discussion.

Based on the above discussion, the dialog of each participant in an online discussion environment could consist of two parts, namely the verbal and the spatial (maps, sketches, and annotations) parts. Another prerequisite is thus to enable participants to view these two parts together. The integration between them must be seamless to the users as the sole existence of either part may be meaningless.

4.1.1.4 Enabling Technologies

This sub-section discusses briefly on the enabling technologies within the context of prototype development. In fact, a wide variety of appropriate technologies or software is available. The key considerations for adopting a certain technology or software for the prototype are as follows:

(i) it supports rapid development;

(ii) it is easy to learn and set up; and

(iii) it is readily available and preferably free of charge.

(a) Web Server

Web server (also known as HTTP server) is a core component for all Internet applications. Its major function is to "respond to requests from web browsers via the HTTP (Hypertext Transfer Protocol)" (Peng and Tsou, 2003). *Apache* and *Internet Information Services* (IIS) are the two most widely used web servers that manage requests from the browser and deliver HTML documents and files in response. A web server also executes server-side scripts embedded inside the HTML page to offer dynamic contents. The *GeoDF* prototype will adopt *IIS* (version 5.1) as the web server because the development platform is a Windows system (XP Professional) and it is readily available for installation.

(b) Web Mapping Technologies

As discussed in Section 2.2.2.2, a variety of web mapping technology is available to support map applications on the Internet. Depending on the technologies and the architecture adopted, the degree of user interactivity and GIS functionality varies considerably. In general, a system that supports more interactivity and GIS functionality requires more advanced technologies and more complex architecture.

In terms of choosing an appropriate technology for a given web mapping application, a major consideration is whether it can fulfill the level of user interactivity and GIS functionality of the intended application. In other words, one's decision should not be driven by whether or not it is the latest technologies. ESRI's *ArcIMS* is the selected spatial server for *GeoDF* because it is one of the most widely used spatial servers with a large community of developers who are willing to share their knowledge or even the tools they developed for their Internet mapping applications. There is also strong technical support provided by ESRI. For the purpose of proof-of-concept, the license cost is not a major concern as the University of New Brunswick has a campus license for ESRI software. The client-side browser for the mapping component of *GeoDF* will be based on the *ArcIMS* HTML Viewer as "it is the simplest and fastest to implement" (ESRI, 2002a, p.10). Besides, it employs JavaScript and Dynamic HTML (DHTML) to enhance its capabilities and does not require pre-installation of any plug-in (ESRI,

2002a). It is also suitable for a light-weight web mapping application such as the present prototype.

(c) Online Discussion Tools

Newsgroups and Online Discussion Forums (ODF) are two of the most popular tools that support online discussions. The main difference between Newsgroups and ODF is that additional software, a newsreader, is usually required to participate in newsgroups (Wikipedia, last modified 2 March 2006). On the other hand, visiting and participating in ODF normally requires no additional software beyond the web browser. In this regard, ODF is the preferred tool for the prototype implementation.

phpBB is a popular free and open source customizable bulletin board system that uses PHP (Hypertext Preprocessor) scripting language and supports popular database servers such as *MySQL*. There is a large community of users where support and resource on modifications can be sought easily. The version to be used in *GeoDF* development is 2.0.15.

(d) Database Server

A database server is needed for storing and managing the contents of the ODF. *phpBB* is compatible with numerous database servers such as *MySQL*, *Microsoft SQL Server*, *PostgreSQL*, and *Microsoft Access (via ODBC)* (phpBB Group, 2006).

The selected database server for *GeoDF* is *MySQL*. It is a free open source database management system (DBMS) developed by a Swedish company MySQL AB. It is compatible with PHP and easy to implement. This makes it suitable for simple application such as the present prototype development. *MySQL* version 4.1 or above has spatial extensions. It includes support for a subset of the SQL92 with Geometry Types environment proposed by the Open GIS Consortium (MySQL AB, 2005). The version to be used in *GeoDF* development is 4.1.12.

(e) Servlet Engine/Container

Servlet engine is the container in which the server-side applet can operate to extend the web servers. *Jakarta Tomcat* is adopted because it is free, popular, and compatible with *ArcIMS*. It is also "the official reference implementation for the Java Servlet and JavaServer Pages (JSP) technologies" (The Apache Software Foundation, 2005).

(f) Web Programming Language

PHP (or Hypertext Preprocessor, a recursive acronym) is adopted to develop dynamic web content and application on the server-side. It is a popular open source language. It supports all major platforms such as UNIX, Windows and even mainframes (Orzech and Zend Staff, 2001). It is easy to learn and has good database support with numerous popular relational DBMS including the free open source *MySQL*. It is a suitable web programming language for quick development.

(g) Client-side Programming Language

JavaScript is a popular scripting language that is well-supported by popular web browsers. It will be used extensively in *GeoDF* to provide interactivity to the web pages. In particular, the sketching and annotation tools will be implemented with *JavaScript*.

4.1.2 System Architecture

Figure 4.1 shows the architecture of the *GeoDF* prototype. It is a web-based application that introduces the concept of *spatial context* to an online discussion forum with the support of a web-based GIS and a spatial database. For the purpose of proof-of-concept, the prototype is based on available components or modules instead of implementing an entirely new system from scratch. For example, as discussed above, *ArcIMS* is selected as the spatial server whereas the online discussion forum is based on an open-source bulletin board software, *phpBB*. The sketching and annotations tools are built upon Walter Zorn's (2005) JavaScript graphic tools.

For the purpose of proof-of-concept, the simplest database set up is adopted. The map layers are file-based whereas the textual and spatial context data from the online discussion forum will be stored in a *MySQL* database with spatial extensions. For rapid development, the prototype is built upon two web sites: one for the online discussion forum and another for the web GIS. Details about prototype implementation are discussed in the next section.

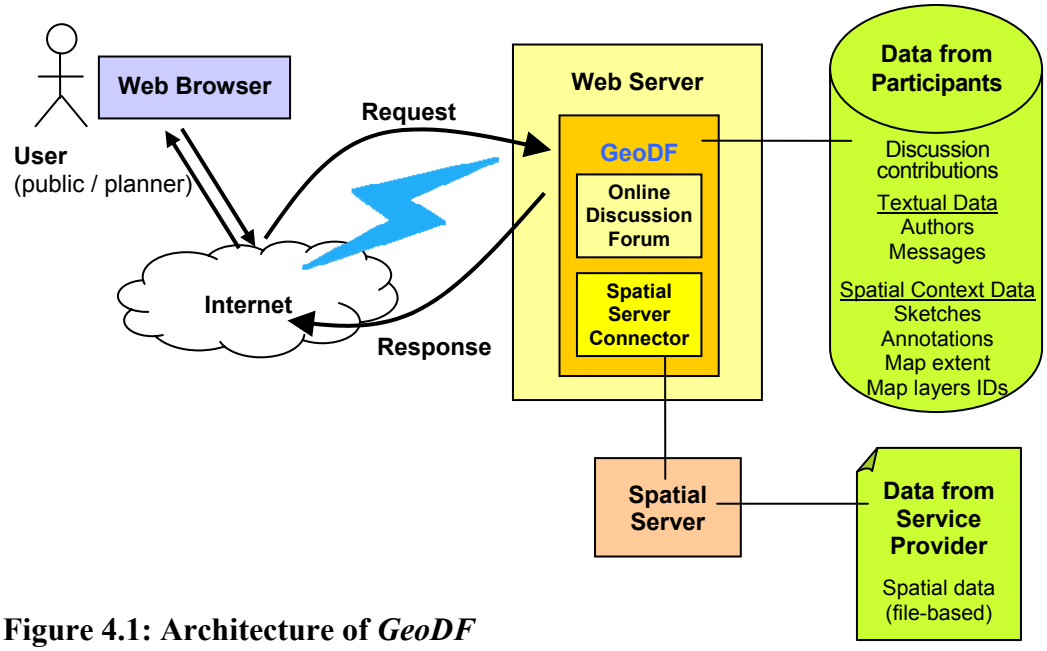


Figure 4.1: Architecture of *GeoDF*

4.2 Implementation of the Prototype

The second half of this chapter covers the implementation of the *GeoDF* prototype. First, the concept of *spatial context* will be discussed. Then, the user interface development and database design will be examined. As the prototype is built upon two web sites, it is necessary to synchronize the mapping component and the online discussion forum. This topic will be discussed in the context of the capture and display of discussion contributions, followed by a brief discussion on the implementation of the function that alerts users about potentially related arguments.

4.2.1 Implementation of the Concept of "Spatial Context"

As discussed in section 4.1.1.3, *spatial context* in this research is a collective term for the geographic extent, geographic features, geographic location and

geographic relationships embedded in our dialog when we discuss spatially-related issues. The implementation of the concept of *spatial context* is thus an essential step in the implementation of *GeoDF* as it is the mechanism that facilitates the effective communication of ideas in a spatially-related discussion situation.

A discussion contribution in *GeoDF* is the ideas, opinions, or information submitted by a contributor via the online discussion forum. It may be a new contribution, which initiates the discussion of a new issue, or a reply to an existing contribution. As depicted in Figure 4.2, each discussion contribution in *GeoDF* is composed of two components, namely the spatial and textual components. It is assumed that the spatial expression of a contributor's opinion can be captured by the following five spatial elements:

- *Map extent* – This refers to the extent of the map viewing by a contributor at the time s/he submits a contribution. It is assumed that the map extent has captured the geographical extent of the issue being discussed.

- *Visible map layer(s)* – Visible map layer(s) refers to the map layer(s) that is/are visible to a contributor at the time s/he submits a contribution. Similar to conventional GIS, related geographic features in *GeoDF* are grouped under the same map layer which can be turned on and off by a contributor. Thus, storing this information has virtually captured the geographic features that a contributor considers relevant to the discussion.

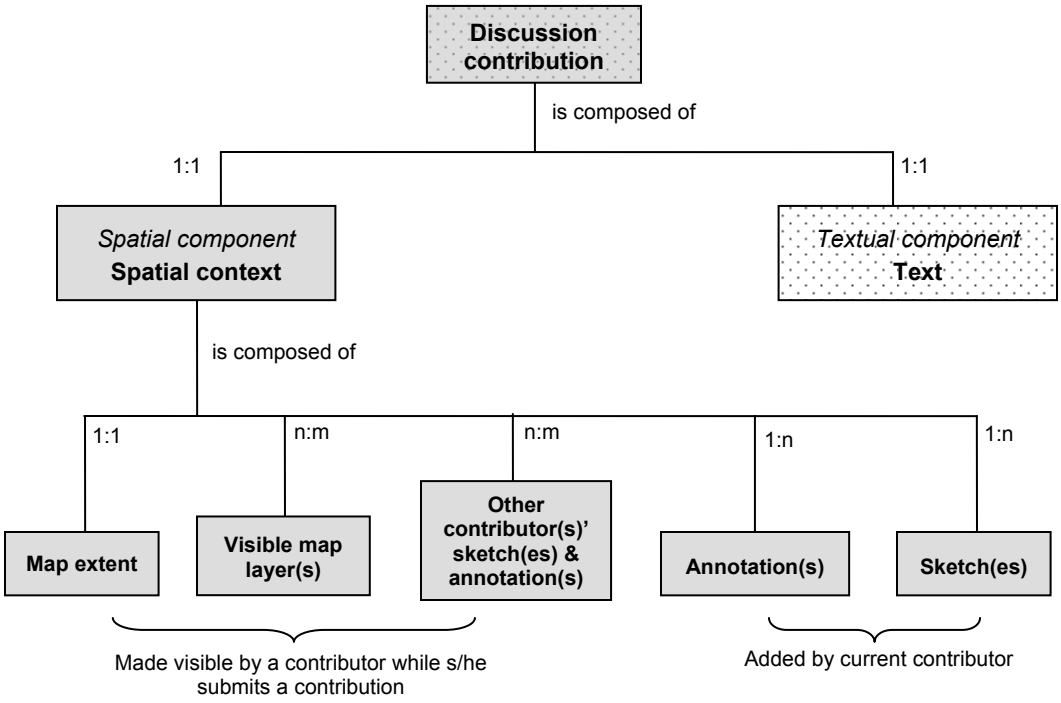


Figure 4.2: Concept of "Spatial Context" in *GeoDF*

- *Sketch(es)* – Each contributor can make one or more sketches on the map. Sketches can serve several purposes in a discussion. One of the purposes is to highlight the geographic object(s) under discussion. For example, a contributor can sketch on a map to indicate the section of a road that requires repairing. One can also sketch a new geographic object, such as a proposed new bus route, for discussion. Sketches can also be used to illustrate the spatial relationships involve in a discussion such as the directions.

- *Annotation(s)* – Similar to sketches, each contributor can make one or more annotations on the map. In most cases, they supplement the sketches to give a fuller illustration of the spatial concepts embedded in a contribution.

- *Other contributor(s)' sketches and annotations* – This refers to the sketches and annotations expressed by other contributor(s). When the current contributor submits a contribution, s/he can include other contributor(s)' sketches and annotations if they are relevant to her/his argument. For example, contributor *A* wants to reply to contributor *B*'s message and *A* may think including *B*'s sketches and annotations can better illustrate the evolution of ideas and the spatial relationships between their sketches.

4.2.2 User Interface Development

To facilitate the textual component of individual contributions to be read alongside the corresponding spatial context, the *GeoDF* web page is made up of several frames. Figure 4.3 shows the frame layout of the *GeoDF* web page. Each frame displays either a HTML or a PHP file that works in coordination with the files in other frames.

As depicted in Figure 4.3b, the *TopFrame* is across the top of the web page. It displays the title and the logo of *GeoDF*. In this frame, the users can also perform keyword search on the contributions, login the system, or register for an account for posting contributions with *GeoDF*. When a user clicks on the logo, it will open a web page that contains some description about the *GeoDF* prototype.

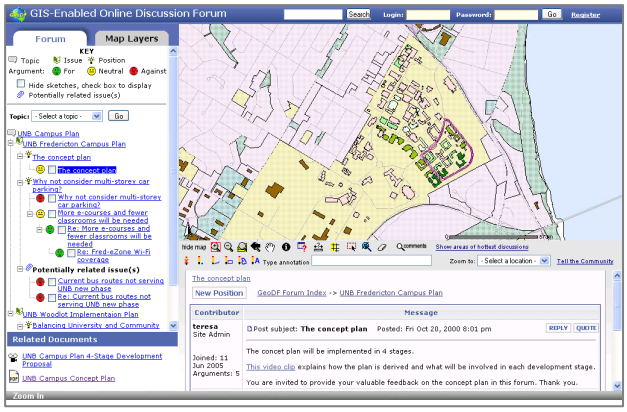


Figure 4.3a: GeoDF web page

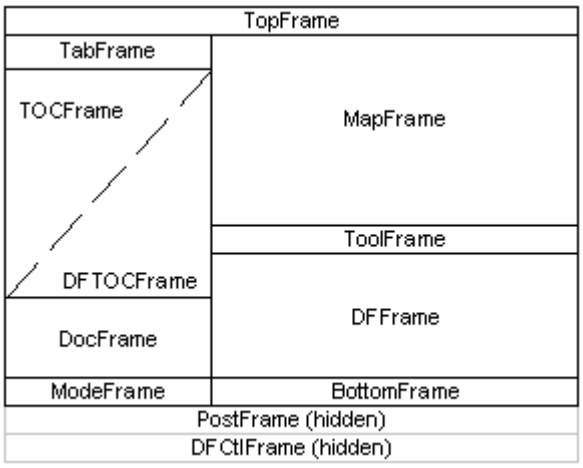


Figure 4.3b: Frames layout of GeoDF

Figure 4.3: Layout of *GeoDF* web page

The *TabFrame* contains the *Forum* tab and the *Map Layers* tab. Only one tab can be shown at one time. When the *Forum* tab is active (clicked), it displays a tree structure in the *DFTOCFrame* to show the course of discussion. The tree structure is also a control panel for turning on and off the *spatial context* of individual contributions. Alternatively, when the *Map Layers* tab is active, it shows the map legend in the *TOCFrame*. This is also where the user can define which map layer(s) should be visible by checking and unchecking the box next to individual map layer.

Below the *TOCFrame/DFTOCFrame* is the *DocFrame* where users can access documents (such as text, audio/visual files, and so on) that are relevant to the selected issue. To the right of the *TOCFrame/DFTOCFrame* are the *MapFrame*, *ToolFrame* and *DFFrame*. *MapFrame* is the largest frame of *GeoDF*. It displays the map image and the spatial component of the discussion contributions. When the

map page is being loaded, it sets a variety of map parameters and loads many of the JavaScript files that enable the functionality of the system.

The *ToolFrame* contains a variety of tools including those come with *ArcIMS* and those developed by the author (*GeoDF* tools hereafter). The *ArcIMS* tools mainly support the exploration of map data (such as pan, zoom, identify, query, and so on) and simple analysis (e.g., measure and buffer). The *GeoDF* tools mainly enable the users to express, communicate, and understand each other's contributions in a discussion situation. These include the sketching and annotation tools found on the second row of the *ToolFrame* and a tool for searching contributions spatially. The latter can retrieve the contributions that fall within a rectangular window being dragged over the *MapFrame*.

The *DFFrame* contains the online discussion forum where users can view individual contributions, reply to them, or post a new contribution. To allow more space for viewing and writing the contributions, users can extend this frame by clicking on the *Hide Map* button (in the *ToolFrame*) to hide the *MapFrame*. The frame size can be reversed to the original by clicking the *Show Map* button.

At the bottom of the web page are the *ModeFrame*, *BottomFrame*, *PostFrame*, and *DFCtlFrame*. The *ModeFrame* displays the tool that is currently selected. The *BottomFrame* is positioned next to the *ModeFrame*. According to ESRI (2002b), its sole function is to visually complete the graphic along that row. *PostFrame* is

responsible for communication with the *ArcIMS Servlet Connector*. It is invisible and contains a hidden form. The *DFCtlFrame* runs a variety of JavaScript to synchronize the mapping component and the online discussion forum of *GeoDF*.

(a) Customization and Extension for ArcIMS

As illustrated in Figure 4.4, the frames layout of *GeoDF* (Figures 4.4a) is adapted from that of the *ArcIMS HTML Viewer* (Figure 4.4b). The author has retained most of the original frames from the *HTML Viewer* except the *TextFrame*, and added a couple of new frames to accommodate an online discussion forum, a tree structure to display the course of discussion on the left, a *TabFrame* to allow toggling between the tree structure and the map layers control panel, and a hidden frame that runs a variety of JavaScript to synchronize the mapping component and the online discussion forum. Other customizations include resizing the frames and reorganizing their positions to achieve the desired user interface.

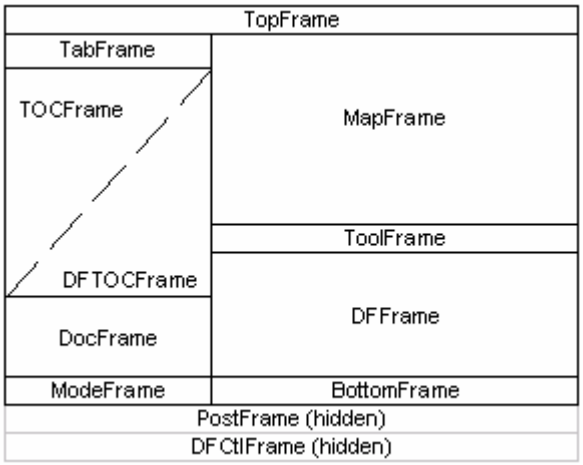


Figure 4.4a: Frames layout of GeoDF

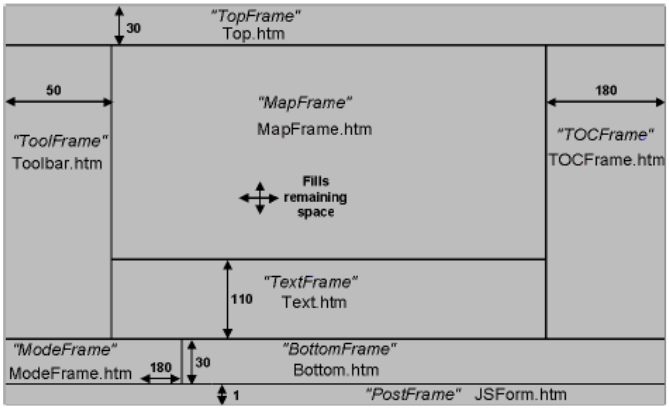


Figure 4.4b: Frames layout of ArcIMS HTML Viewer (ESRI, 2002b, p.12)

Figure 4.4: Frames layout of *GeoDF* and *ArcIMS HTML Viewer*

The map layers control panel/map legend in the *TOCFrame* is an extension for *ArcIMS HTML Viewer* created by David Bollinger (2004) known as *dbGroupToc*. It is capable of grouping any number of map layers into any number of groups which may be collapsed and expanded. The scripts were downloaded from ESRI's Support Centre (http://arcscripts.esri.com/). They are basically configured and customized according to Bollinger's (2004) documentation.

(b) Customization and Extension for phpBB

To meet the requirements for the desired user interface as discussed previously, considerable modifications to *phpBB* are necessary. These include modifications to the relevant template files to reflect Kunz and Rittel's (1970) IBIS structure adapted for the system. For example, the *Category>Forum>Topic>Post* hierarchy used by *phpBB* in organizing discussion contributions is modified to *Topic>Issue>Position>Argument* corresponding to the Kunz and Rittel's IBIS model (Figure 2.4 refers). It is also necessary to modify and simplify *phpBB*'s user interface so as to fit the relatively small frame size that accommodates it.

Contributions in generic *phpBB* are listed linearly in chronological order (also known as "flat view"). In other words, each contribution is not made in reply to a parent contribution. As tracing the evolution of discussion is a core requirement for the prototype, modification is required to make *phpBB* support "threaded view". Fortunately, a modification script, *Moby Threads Mod*, is

available from http://mobythreads.com/. The script is developed by James Wulf, Leo Korogodski, and succeeding developers. After installing the script and making the necessary customization, it is possible to trace the evolution of discussion with the "threaded view".

The tree structure in the *DFTOCFrame* does not only show the course of discussion, it also allows access to individual discussion contributions and is the control panel for turning on and off the spatial context of individual contributions. The implementation of this tree structure is based on the JavaScript files, *ua.js* and *ftiens4.js*, downloaded from http://www.treeview.net/. It is enhanced by additional files created by the author (*gdf_dftoc.php* and *gdfTreeview.php*).

4.2.3 Database Design

(a) Customization and Extension for phpBB

Both the textual (such as the authors, messages, submission time, and so on) and spatial context inputs from the discussion forum are stored in the *MySQL* database. Table II.1 in Appendix II shows the tables created by *phpBB* at the time it was installed. They store the textual input from the online discussion forums, the configuration information for the forum, and all other necessary information required to support the general operations of *phpBB*. Additional tables are created by the author for the following purposes:

- to store the spatial input from the online discussion forums;

- to support the integration between the spatial and textual components of individual discussion contributions;
- to create the linkage between the discussion forum and the map layers defined in the *ArcIMS* configuration file; and
- to support the function of alerting users about potentially related arguments.

The functions of these tables are summarised in Table 4.1.

Table 4.1: Additional tables for storing spatial context input from online discussion forums

Table	Description
gdf_annotations	Stores the details of the annotations submitted with a given contribution.
gdf_file_icons	Defines the icons used in the related documents frame.
gdf_issue_doc	Defines the related documents for a given issue and specifies the document type and its path.
gdf_issue_layer	Defines the default and issue-specific map layers under individual topic. For controlling what map layers to be displayed under which topic and supporting the "potentially related arguments" function.
gdf_maplayers	Defines the map layers deployed in the *ArcIMS* spatial service. Map layer identifiers are in sync with those in the Arc AXL file.
gdf_others_sc	Stores what other contributors' spatial context is visible when a given contribution is submitted.
gdf_related_dc	Stores what arguments are potentially related.
gdf_sc_layers	Stores additional map layers that are visible when a contribution is submitted (only map layers that are not defined under the current issue in *gdf_issue_layer* will be stored).
gdf_sketches	Stores the details of the sketches submitted with a given contribution.
gdf_spatialcontext	Stores the identifiers for the corresponding textual components of individual contributions, the map extent, and the pre-computed centre of the map extent.
gdf_colors	For future enhancement where users can specify colors of the sketches.
gdf_symbols	For future enhancement where users can specify what symbols should be used for the sketches.

Whenever a contributor submits a discussion contribution, the data about the five spatial elements discussed in section 4.2.1 will be stored in the relevant tables listed in Table 4.1. This allows the contributors to share the *spatial context* information with each other and hence facilitate a fuller expression of one's opinions and a better understanding of each other's positions and arguments.

Figure 4.5 illustrates how the textual component of a contribution is linked to its corresponding spatial component in the database. The *gdf_posts* table stores the textual component of a contribution. It is linked to the *gdf_spatialcontext* table via *dc_id*, the identifier for the textual component of individual discussion contributions. The *gdf_spatialcontext* table is linked to other tables that store *spatial context* data (*gdf_annotations, gdf_sketches, gdf_sc_layers,* and *gdf_others_sc*) via *sc_id*, the identifier for the spatial component of individual discussion contributions. The linkage between the spatial component of a discussion contribution and the map layers deployed in the *ArcIMS* spatial service is established through the *gdf_maplayers* table.

(b) Customization and Extension for ArcIMS

To create a successful linkage between the spatial component of a discussion contribution and the map layers deployed in the *ArcIMS* spatial service, the identifiers for the map layers in the *gdf_maplayers* table, *aml_id*, are configured to be in sync with those defined in the *ArcIMS* configuration (.axl) file.

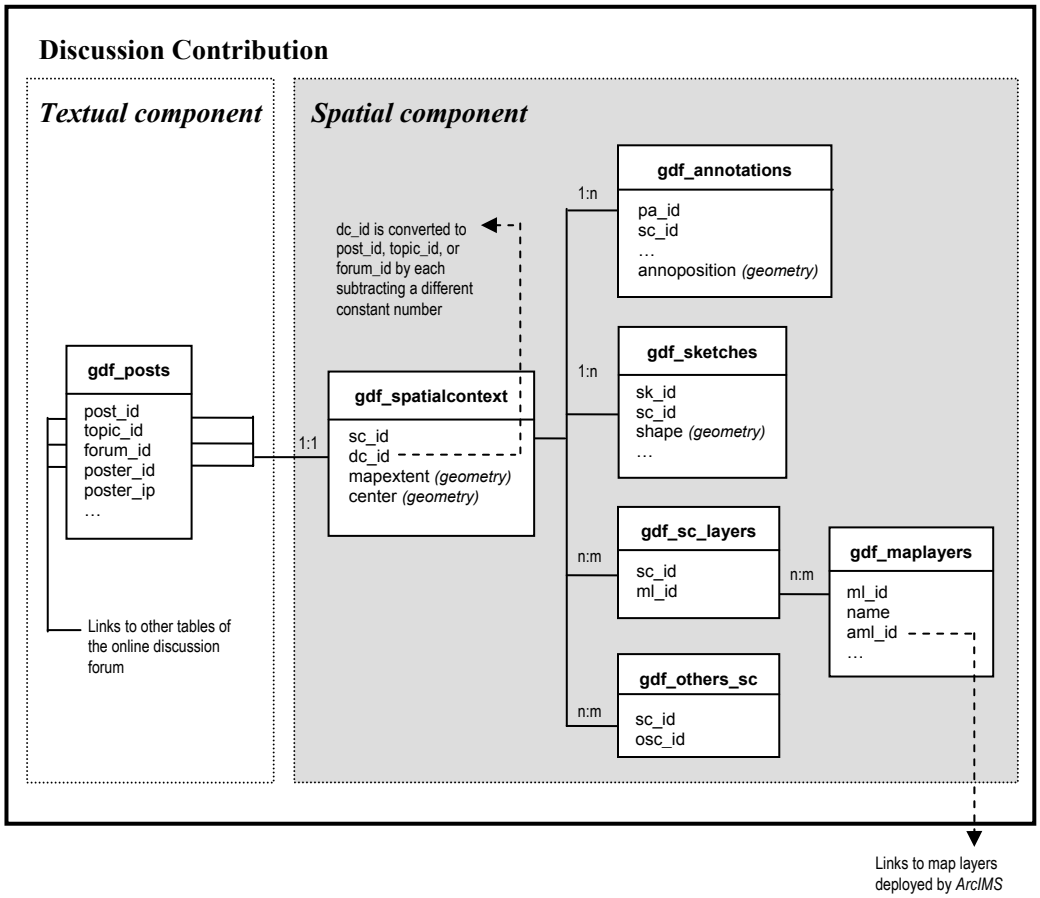


Figure 4.5: Diagram illustrating how the textual component of a discussion contribution (in white) is linked to the corresponding spatial component (in grey) in the database.

4.2.4 Capture of Discussion Contributions

(a) Customization and Extension for ArcIMS

In order to capture the spatial component of the discussion contributions, one of the necessary extensions to the mapping component is the *sketching and annotation tools*. These tools are implemented with JavaScript to enable faster response on the client side. They are built upon Walter Zorn's (2005) *JavaScript vector graphics library* which provides graphics capabilities for drawing circles, ellipses, oblique lines,

polylines, and polygons dynamically into a webpage. The script was downloaded from http://www.walterzorn.com/jsgraphics/jsgraphics_e.htm#docu.

A couple of sketching and annotation buttons are added to the *ToolFrame* for users to access the respective tools. As these (*GeoDF*) tools are not originated from *ArcIMS*, a JavaScript file known as *gdfSketch.js* is created to detect whether the current active tool is a *GeoDF* tool. When a contributor activates a sketching or annotation tool (e.g., the *Draw Point* button) and clicks on the map, it will call the relevant function to store the coordinates of the geometry to be created (a point in this case) in an array on the client side. These coordinates will be passed to the appropriate drawing functions of Zorn's (2005) *JavaScript vector graphics library* (*ws_jsgraphics.js*) to draw the requested geometry on the screen. The geometry and its coordinates are not stored in the database until a contributor presses the *submit* (contribution) button in the online discussion forum.

To keep track of the *current map extent* and the *visible map layers* on the client side, no particular extension is required as it is handled by *ArcIMS HTML Viewer*. However, additional scripts are added in *gdfSketch.js* to keep track of whether other contributor(s)' sketches and annotations are included in a contribution. Thus, when a contribution is finally submitted, all the required *spatial context* information is already gathered on the client side which can be compiled and passed to the server for processing.

(b) Customization and Extension for phpBB

Considerable extensions to *phpBB* are required to support the capture of *spatial context* as it is originally designed to accept textual contributions only. For example, additional JavaScript are included in *posting_body.tpl* to compile the *spatial context* information collected on the client side and add it as form inputs when a contribution is submitted. Modification to the existing *posting.php* is also required. In addition, *gdfPost.php* is created to process the spatial context information submitted with the form and store the information in the database. Additional functions required to support this process are included in *gdf_functions.php*. Figure 4.6 illustrates how the textual and spatial components of a contribution are captured and stored in the database when the *submit* button is pressed.

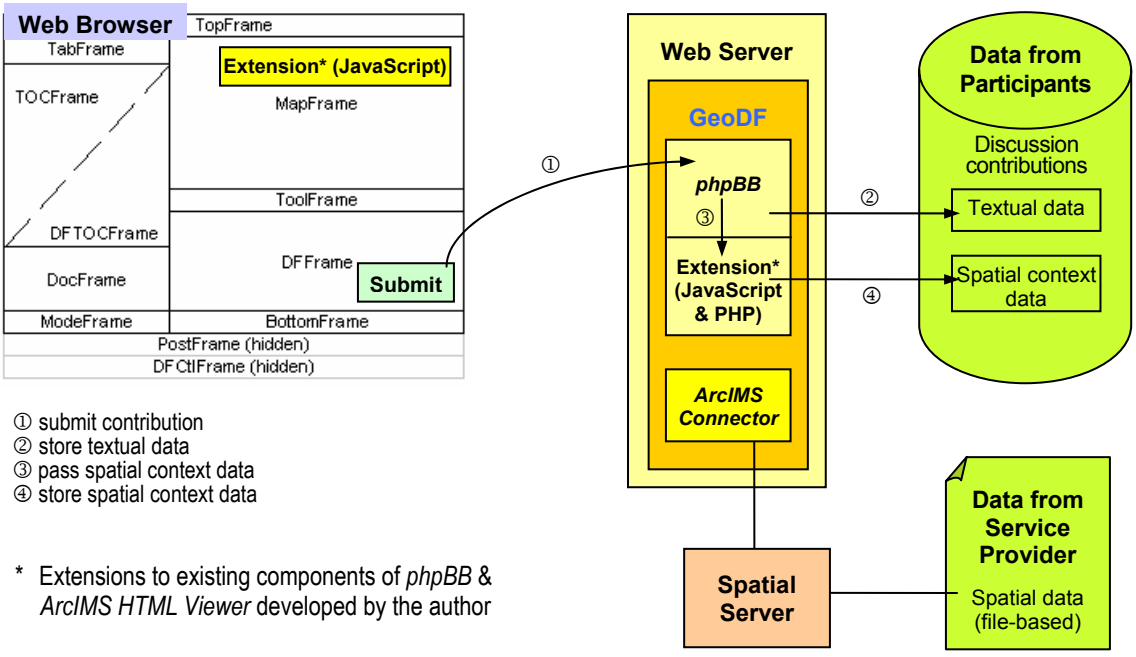


Figure 4.6: Diagram illustrating how the textual and spatial components of a discussion contribution are captured and stored in the database when the *submit* button is pressed.

4.2.5 Display of Discussion Contributions

Once a contribution is processed by the server and the spatial and textual components are stored in the database, they can be viewed by other participants. The typical interaction that triggers the display of *spatial context* of individual contributions is by clicking a hyperlink to a contribution, or by checking a box next to a given contribution from the tree structure in the *DFTOCFrame*.

To facilitate the display of *spatial context*, a JavaScript file, *gdf_clnt_control.js*, and two PHP files, *gdf_svr_control.php* and *gdf_functions.php*, are created as extensions to existing components of *phpBB*. When a contribution hyperlink is clicked, it will send two requests to the server simultaneously (Figure 4.7a). One requests for the textual component (Request #1) and one for the spatial component (Request #2). These requests will trigger a series of actions that display the corresponding content in the various frames of *GeoDF*. Thus, one of the major tasks of *gdf_clnt_control.js* is to synchronize the content among the frames.

Figure 4.7b illustrates how the request for textual component (Request #1) is handled in *GeoDF*. It basically shows the sequence of events leading to the retrieval of a discussion contribution in generic *phpBB*. After a contribution hyperlink is clicked, *gdf_clnt_control.js* will trigger the *DFFrame* to send a request to *phpBB* to get the textual component of the requested contribution.

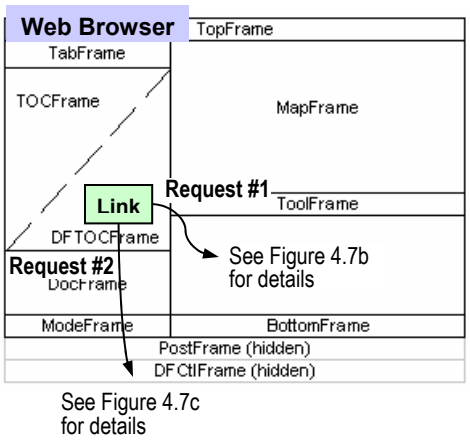


Figure 4.7a: When a contribution hyperlink in *DFTOCFrame* is clicked, two requests will be sent to the server simultaneously.

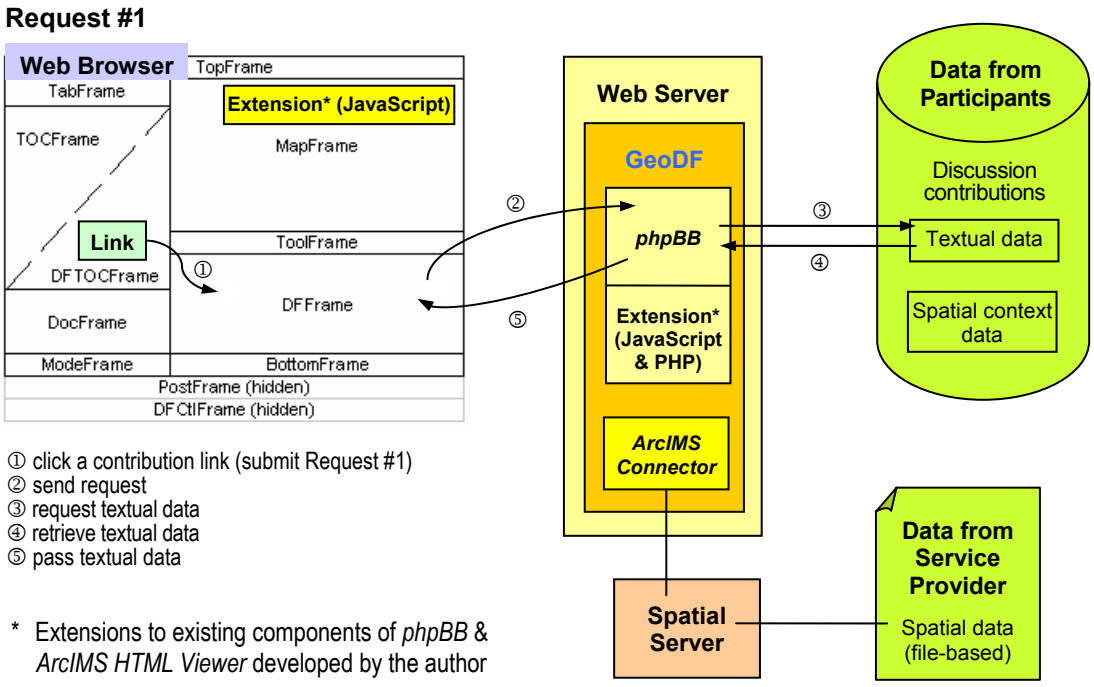
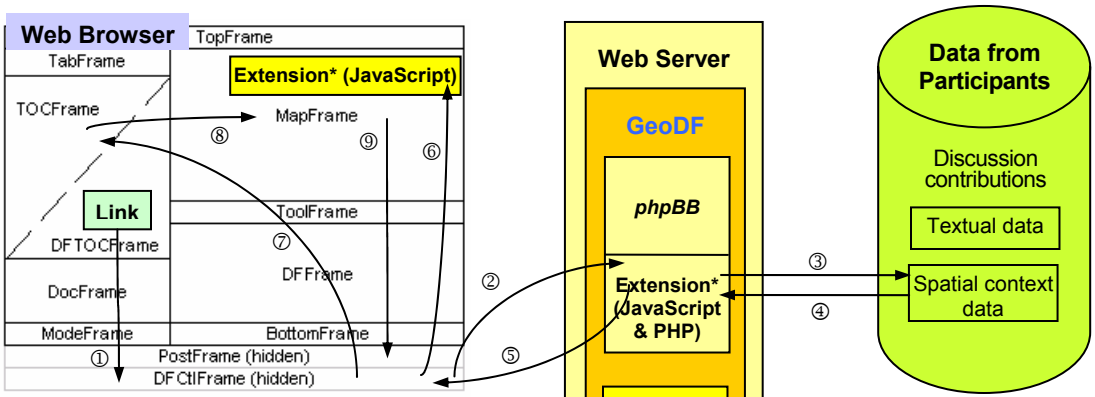


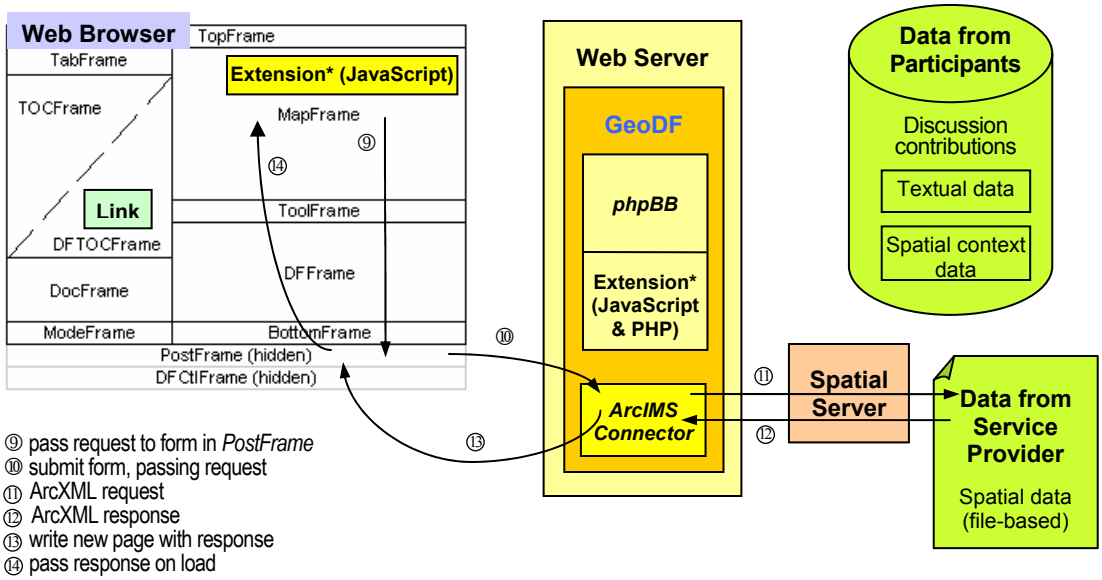
Figure 4.7b: Diagram illustrating the sequence of events leading to the retrieval of textual component of a discussion contribution when a contribution hyperlink is clicked.

Request #2 – Part 1



① click a contribution link (submit Request #2)
② send request
③ request spatial context data
④ retrieve spatial context data
⑤ return spatial context data as JavaScript embedded in HTML page
⑥ call HTML Viewer Extension to draw sketches & annotations
⑦ call functions of dbGroupToc
⑧ call ArcIMS HTML Viewer functions to trigger *MapFrame* to pass a request for refreshing the map based on the map extent and visible layers retrieved from the database
⑨ follow the regular HTML Viewer request-response flow, see Part 2 below for details

Request #2 – Part 2



⑨ pass request to form in *PostFrame*
⑩ submit form, passing request
⑪ ArcXML request
⑫ ArcXML response
⑬ write new page with response
⑭ pass response on load

* Extensions to existing components of *phpBB* & *ArcIMS HTML Viewer* developed by the author

Figure 4.7c: Diagram illustrating the sequence of events leading to the retrieval of spatial component of a discussion contribution when a contribution hyperlink is clicked.

Figure 4.7c shows how the request for spatial component (Request #2) is handled in *GeoDF*. Part 1 of Request#2 illustrates the request-response flow that involves the extensions created for *GeoDF*. After a contribution hyperlink is clicked, it will trigger the *DFCtlFrame* to send a request to *gdf_svr_control.php* to get the corresponding *spatial context* data from the database. These data are then compiled and passed back to the *DFCtlFrame* as JavaScript embedded in a HTML page. While this HTML page is being loaded, the display of corresponding sketches and annotations as well as other contributor(s)' sketches and annotations, if any, will be handled by *gdfSketch.js* and *ws_jsgraphics.js*. The scripts in the HTML page will also call the relevant functions of *dbGroupToc* and *ArcIMS HTML Viewer* to trigger the *MapFrame* to pass a request for refreshing the map based on the *map extent* and *visible map layers* data retrieved from the database. The rest of the request-response flow will follow that for the generic *ArcIMS HTML Viewer* as shown in Part 2 of Request #2.

Similarly, when a contributor's sketches and annotations checkbox is checked, it will go through similar processes as discussed in the previous paragraph except that only a single request for spatial component (Request #2) will be sent to the server.

4.2.6 Implementation of the "*Potentially Related Arguments*" Function

This function informs forum participants about arguments that are potentially related to another issue. The mechanism to determine whether an argument is related to an issue is based on the following assumptions:

- Similar geographic features are grouped under the same map layer.
- Certain geographic features are particularly relevant to a given issue. For example, a map layer that contains the "*bus routes*" is particularly relevant to the issue *bus routes*. In other words, a map layer is regarded as an *issue-specific layer* when it is particularly relevant to a specific issue.
- Map layers that are generally relevant to a given issue are regarded as *default layers* such as the "*road network*" layer under the *bus routes* issue.
- A contributor will include the relevant geographic features in his/her argument by making those map layers visible.
- When an *issue-specific* layer (e.g., map layer *A*) of another issue (say, issue *X*) is included in the argument of the current issue (e.g., the *bus routes* issue), this argument is regarded as potentially related to issue *X*.

The first step in the implementation of this function is to organize the map layers in the database into two broad types, the *default layers* (D) and *issue-specific layers* (I). For example, as illustrated in Figure 4.8, the map layers for road network (map layer # 3) and bridges (map layer # 4) are grouped as *default layers* as they are generally relevant to the *Bus Routes* issue whereas the bus routes map layer (map layer #5) is grouped as *issue-specific layer* as it is particularly relevant to the

discussion about bus routes. The information about the organization of the map layers is stored in the *gdf_issue_layer* table in the database.

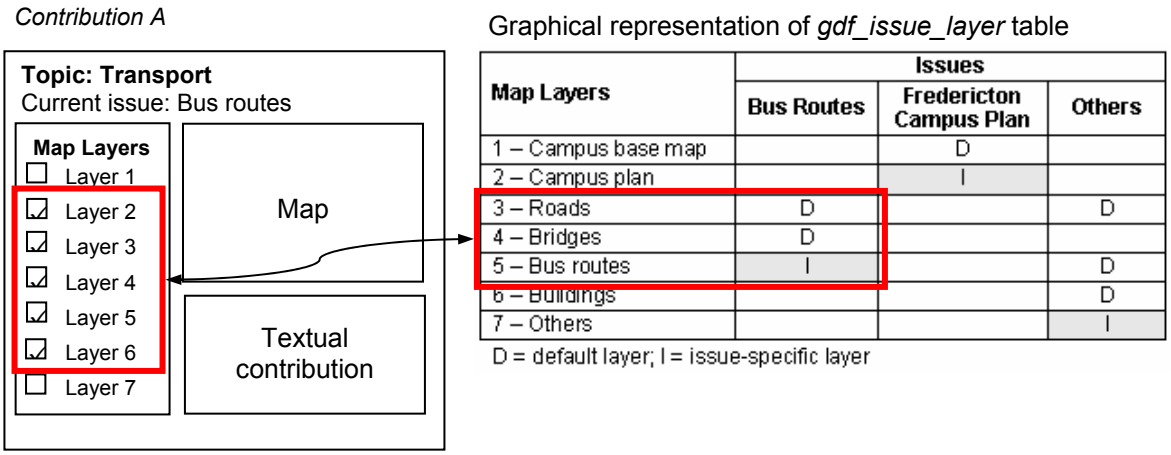
Map Layers	Issues		
	Bus Routes	Fredericton Campus Plan	Others
1 – Campus base map		D	
2 – Campus plan		I	
3 – Roads	D		D
4 – Bridges	D		
5 – Bus routes	I		D
6 – Buildings			D
7 – Others			I

D = default layer; I = issue-specific layer

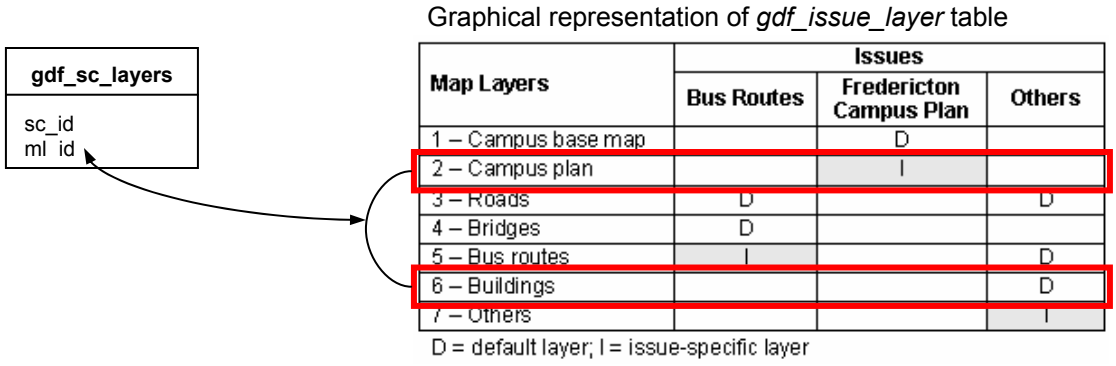
Figure 4.8: Organization of map layers in *GeoDF*

Figure 4.9 uses an example to illustrate how this function is implemented in *GeoDF*. Let us assume that the current issue is *Bus Routes* and *Contribution A* is submitted under this issue. When a contribution (or argument) is sent to the server, *GeoDF* will check whether the list of visible map layers embedded in the contribution contains any map layers that do not belong under the current issue. This will identify Layers 2 and 6. Then, the system will check whether these map layers are defined as *issue-specific layers* under other issues. In this example, Layer 2 is an issue-specific layer under the issue *Fredericton Campus Plan*. Then, the system will flag this contribution as a *potentially related argument* under the issue *Fredericton Campus Plan* as shown in Figure 4.9.

This is an innovative function unique to *GeoDF* as it is not found in any existing PPGIS applications. It is made possible by the implementation of the concept of *spatial context*.



① When *Contribution A* is submitted, GeoDF will look up the *gdf_issue_layer* table to identify map layers that are not grouped under the current issue. In this example, Layers 2 and 6 will be identified and added to the *gdf_sc_layers* table.



② Then, GeoDF will check whether Layers 2 and 6 are grouped as *issue-specific layers* under other issues. In this example, as Layer 2 is an *issue-specific layer* under the issue *Fredericton Campus Plan*, the system will flag *Contribution A* as a potentially related argument to the said issue as shown in the screenshot below.

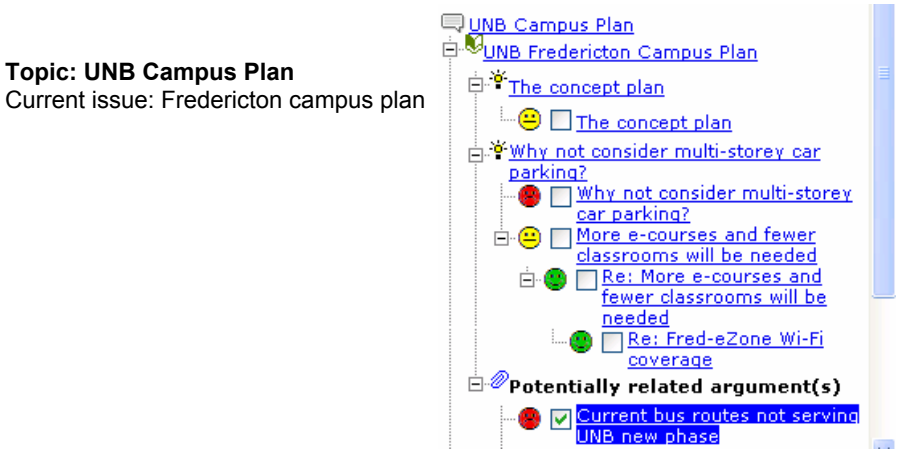


Figure 4.9: Implementation of the "*Potentially Related Arguments*" function.

4.3 Summary

The first half of this chapter presents the major design considerations for the prototype, *GeoDF*. The prototype is intended to facilitate the general public to participate in the ongoing discussion of spatially-related issues. To cater for a large group of users, the prototype is developed as an online application which only requires a web browser. The main objectives of the prototype are to facilitate the expression and understanding of the spatial concepts embedded in our dialog (or *spatial context*) during spatially-related discussions. Based on these considerations, the data model, the types and levels of functionalities to be provided, the desired user interface design, as well as the technological requirements are derived.

The second half of this chapter covers the implementation of the prototype. For rapid development, *GeoDF* is built upon two web sites: one for the online discussion forum and another for the web GIS. Much effort in the implementation process has been put into synchronizing the mapping component and the online discussion forum. Since the concept of *spatial context* forms the backbone of the prototype, the implementation begins with the formalisation of the concept. Then, it is modelled with the corresponding constructs or objects of the web-based GIS, followed by the implementation of the associated database design and the desired user interface.

The next chapter will use two planning scenarios to demonstrate the functions of the prototype with special emphasis on how *GeoDF* can facilitate effective communication in spatially-related discussions.

CHAPTER 5 DEMONSTRATION OF THE PROTOTYPE

In this chapter, two planning scenarios will be presented to illustrate in what ways the prototype can facilitate effective communication in spatially-related discussions. The first scenario will introduce the general functions of *GeoDF* and illustrate how *GeoDF* can facilitate communication and understanding among the participants. The second scenario will illustrate how *GeoDF* can facilitate the participants to initiate discussions and how they can be informed of related arguments to broaden their discussions.

5.1 Scenario 1: University of New Brunswick (UNB) Fredericton Campus Plan

5.1.1 Background

The main purpose of the *UNB Fredericton Campus Plan* is to provide a conceptual physical framework for accommodating the various needs of the Fredericton campus in the coming years. It addresses issues such as building sites, parking, road and pedestrian circulation routes, environmental issues, safety issues, and so on (UNB, 2004). Brook McIlroy Inc. (2003) states in the preface of the consultation document that various methods were used to collect and solicit comments, concerns, and ideas before the plan was finalized, such as meetings with the campus community, Open Houses, and via e-mail. The draft plan was approved by the UNB Board of Governors the plan in October 2003 (UNB, 2004). This section mimics a situation where *GeoDF* is used as one of the consultation methods.

5.1.2 Typical User Interaction with the Prototype

This section outlines the typical user interaction with *GeoDF* in the aforementioned public consultation event from a user's perspective and discusses how communication among the users can be facilitated by the prototype. Typical users of this scenario are mainly the plan proponents, the plan recipients, and the facilitators (or moderators).

5.1.2.1 Plan Proponents

(a) Posting Supporting Data on the Web

To support a meaningful public consultation event, the plan proponents should allow the plan recipients to access the spatial and aspatial data that are used in producing the final concept plan. These data, where possible, should be stored in the server in the form of GIS data so that the plan recipients can explore and perform simple analysis on the data.

(b) Posting Consultation Documents on the Web

The plan proponents can also post electronic consultation documents (e.g., in the form of PDF files) on the web site (Figure 5.1) explaining the purpose of the plan, the various options examined, the rationale behind the selected option, and so on.

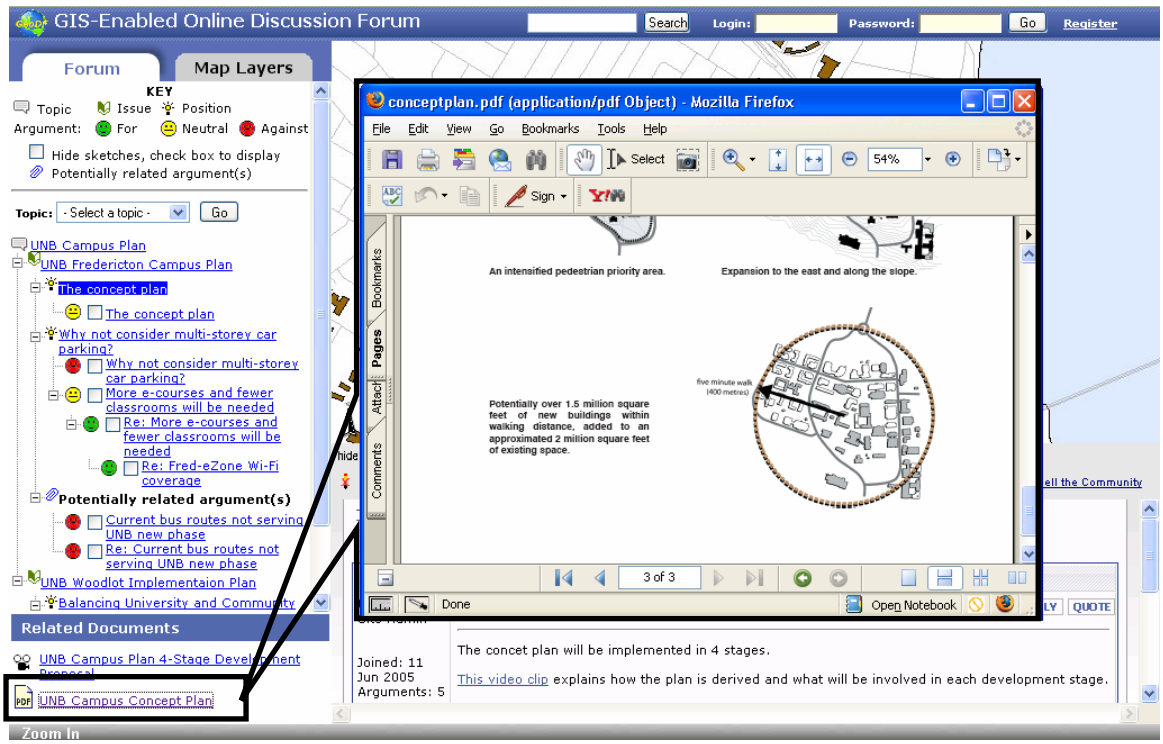


Figure 5.1: Sample PDF consultation document posted on *GeoDF*

(c) Posting Video Clips on the Web

Taking advantage of the modeling capabilities of the web GIS and the multimedia capabilities of modern web browsers, the plan proponents can prepare some Flash video clips to animate the spatial analyses involved, explaining how and why the decisions were made. For example, they can prepare a video clip illustrating the rationales behind the design of the final concept plan as depicted in Figure 5.2a. Video clips are also good for illustrating the temporal changes of the development over the various stages of implementation (Figure 5.2b). Using animated visual (and audio if necessary) aids to convey the spatial concepts and rationales behind the plan is certainly the preferred communication means as compared with posting PDF files on the web. It helps the plan proponents to

express the concepts more explicitly and hence assists the plan recipients better understand the proponents' positions. This is a very important step in promoting the transparent exchange of information among the participants and facilitating informed discussions.

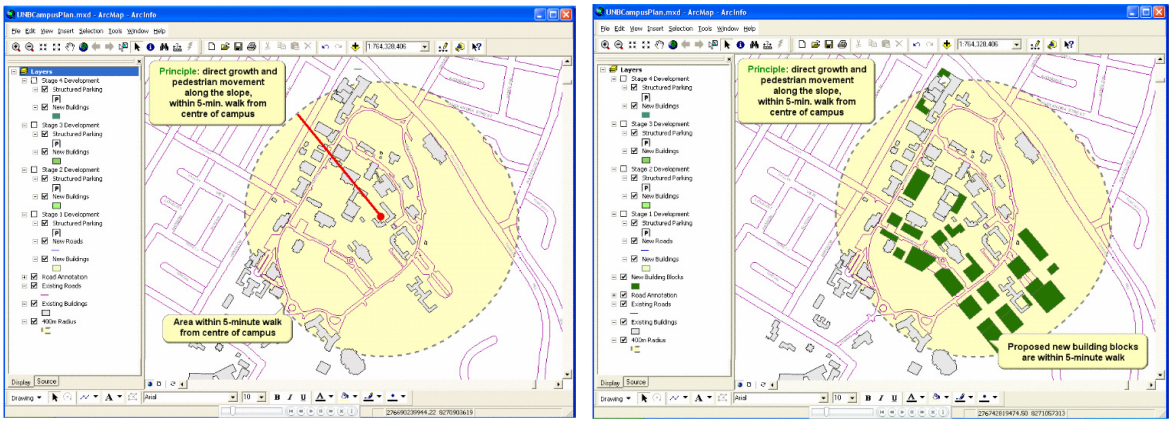


Figure 5.2a Snapshots showing the rationales behind the UNB Fredericton campus concept plan

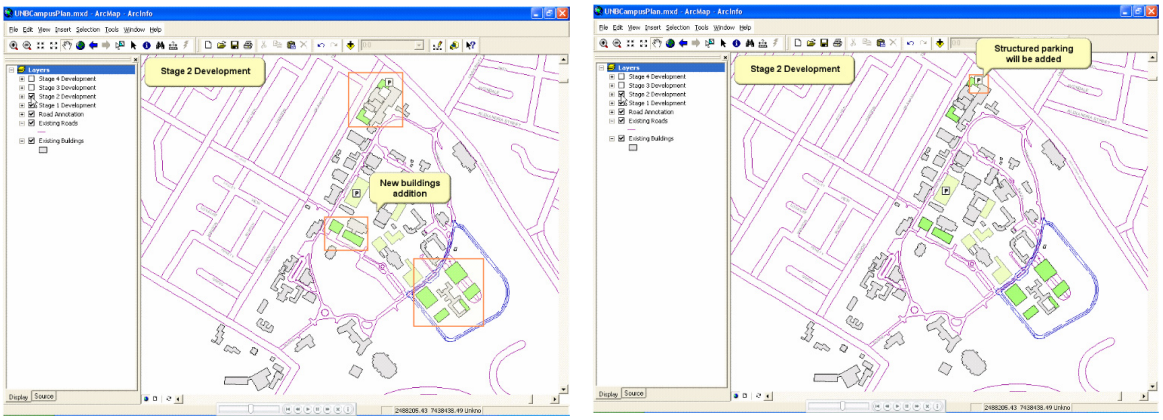


Figure 5.2b Snapshots showing Stage 2 of the implementation plan

Figure 5.2: Snapshots of Flash video clips

(d) Participating in the Online Discussion Forum

Additionally, the plan proponents can utilize the online discussion forum (ODF) to highlight the key concepts about the plan and begin the discussion by inviting interested groups or individuals to exchange feedback, as well as to

propose alternatives to the concept plan (Figure 5.3). Via the tree structure under the *Forum* tab, the plan proponents can switch between different topics, as well as to track and review the evolution of discussions (Figure 5.4). They can also respond to participants' feedback (or contributions), where applicable.

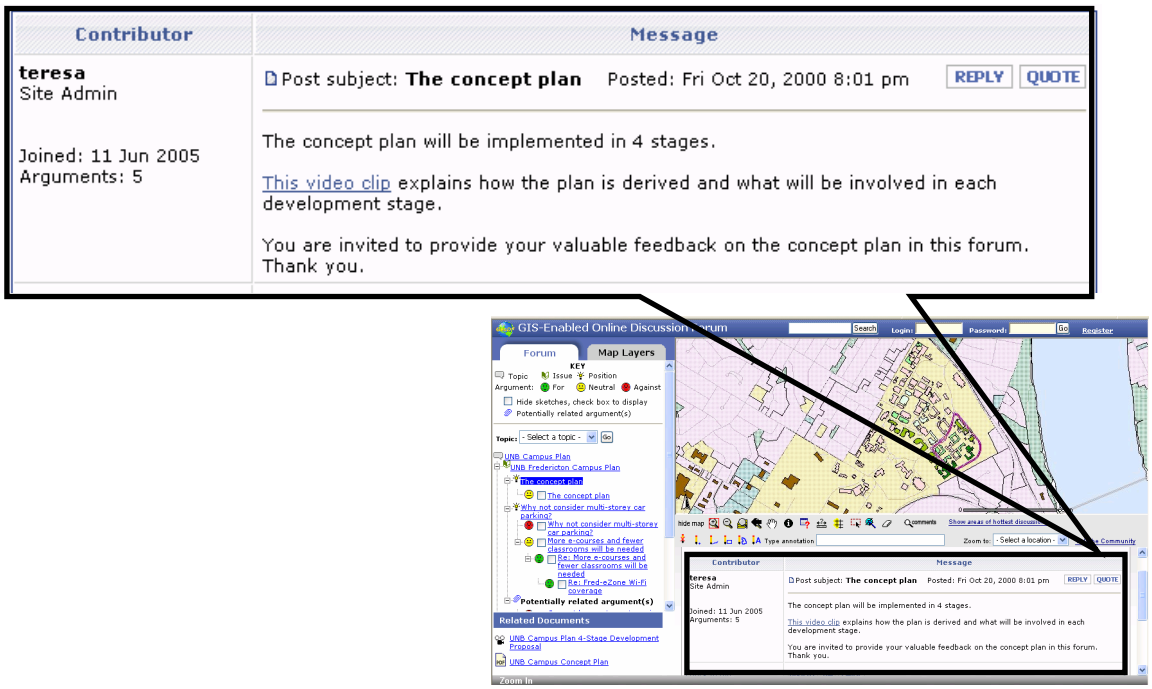


Figure 5.3: Screenshot showing a plan proponent inviting plan recipients to provide feedback over the online discussion forum

(e) Monitoring Plan Implementation

Furthermore, *GeoDF* can act as a channel to collect information from the local residents on any issues (also known as "local knowledge") on an ongoing basis. Local knowledge can reflect local concerns and is useful for continuous monitoring after a plan is implemented (please see section 5.2 for further discussion).

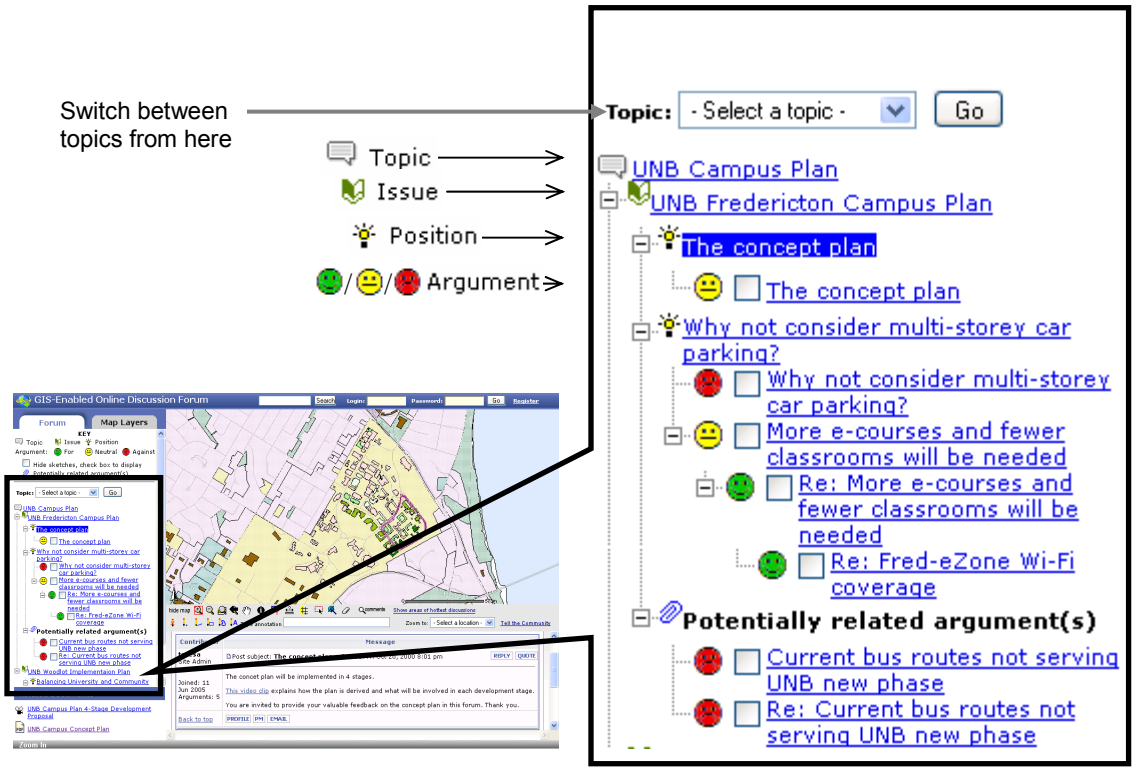


Figure 5.4: Screenshot showing the modified IBIS structure adopted in GeoDF. The arguments are ordered chronologically to document the evolution of discussion.

(f) Informing Target Population of Proposed Plan

The plan proponents can also use the *Tell the Community* function to notify a target population about the draft *Campus Plan*, say the residents who live within a 200-metre buffer area around the campus. To do so, the plan proponents need to first select the campus. Then, they can create a 200m buffer zone around it and the *Tell the Community* function will overlay it with the residents' contact information where information about the draft plan will be delivered (Figure 5.5).

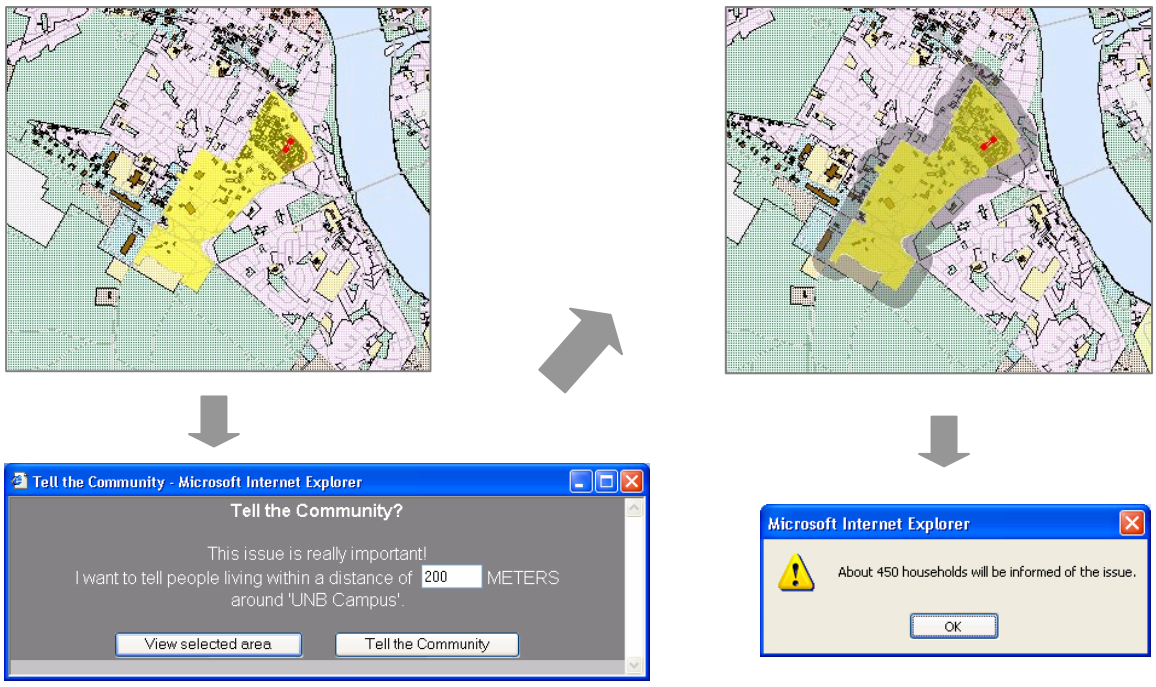


Figure 5.5: The "*Tell the Community*" function of *GeoDF*

5.1.2.2 Plan Recipients

Plan recipients can use *GeoDF* to perform a number of tasks throughout the discussion process such as:

- exploring the data and documents posted by the plan proponents;
- exploring the current status of discussions taking place over the ODF;
- posting contributions on the ODF; and
- replying to existing threads.

A logical order of the expected interaction will be each plan recipient would either explore the data or the current status of discussions first in order to establish a general understanding of what has been proposed and what discussions are taking place at the moment. Then, one may either post contributions on the ODF

to initiate new discussion, or join an existing discussion and reply to existing threads. The expected user interaction for each task will be outlined below.

(a) Exploring Documents and Data Posted by the Plan Proponents

The proposed plan and its associated data can be posted on *GeoDF* in several formats. Depending on the format of the document a plan recipient wants to explore, one may interact with different application programs and obtain various levels of information ranging from general to in-depth information. If the spatial and aspatial data is stored as GIS data in the server, the plan recipients can explore the data with the mapping features of *ArcIMS* such as turning on and off individual map layers, panning, zooming (in and out), selecting/identifying/ querying geographic objects, and so on. Additional mapping features for data exploration are offered by *GeoDF* such as quickly zooming to a predefined list of locations.

Other document formats that are commonly used on the web are PDF and Flash videos. When a plan recipient clicks on a hyperlink to a PDF document, this will trigger a PDF reader (such as *Adobe Reader*) to open the document for viewing. Likewise, a Flash video clip will be played by a Flash player. In general, the users will be interacting with the required applications when they are accessing the multimedia resources posted on the web. Documents prepared in these formats have a major distinction from the GIS data. The former are intended for viewing purpose only. GIS data, on the other hand, can be further explored and analysed

with web GIS application. For example, a user can dynamically request additional information such as identifying geographic features, performing simple analysis like measuring distances, creating a buffer zone around selected features and overlaying it with features on the same or different map layers.

(b) Exploring the Current Status of Discussions

GeoDF users can explore the current status of discussions in several ways. For instance, they can switch between topics from the topic drop-down list. They can trace the evolution of discussions and access individual contribution via the tree structure under the *Forum* tab. With the *Show areas of hottest discussions* tool, they can view at a glance which areas attracted the most discussion contributions. As depicted in Figure 5.6, the darker the gradient color, the more the number of contributions. The plan recipients can also view the distribution of contributions (Figure 5.7a), and use the *Spatial Search* tool to retrieve contributions based on locations by dragging a box over a certain area (Figure 5.7b) and select which contribution(s) to display on the map (Figure 5.7c).

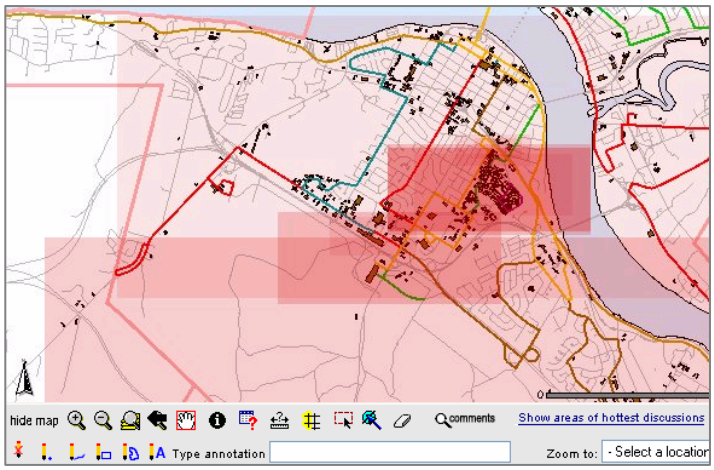


Figure 5.6: The darker gradient colors depict areas that attract more discussions

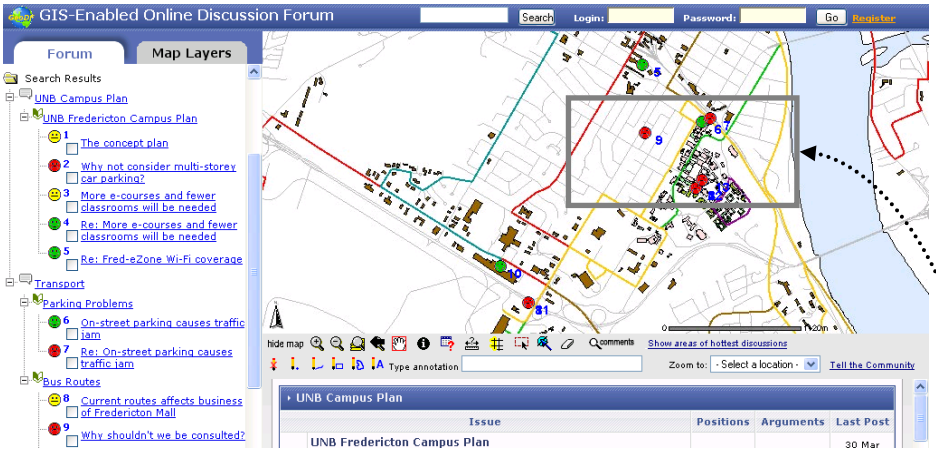


Figure 5.7a: The distribution of contributions is depicted with emoticons

Retrieved by dragging a box over a certain area as shown above

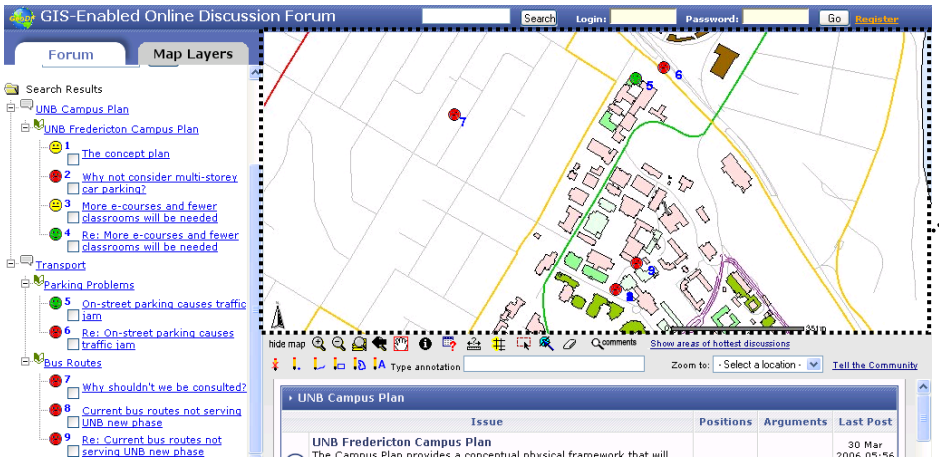


Figure 5.7b: Contributions retrieved by the "*Spatial Search*" tool

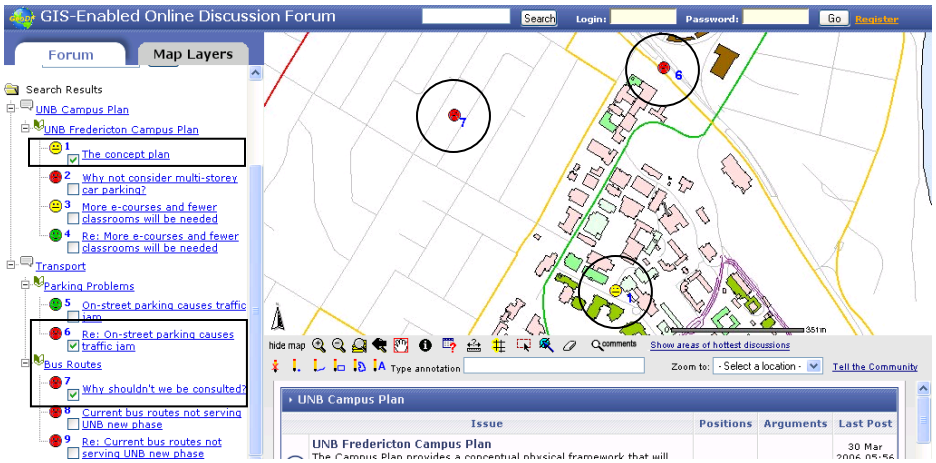


Figure 5.7c: Users can determine what contribution(s) should be displayed

(c) Posting and Replying Contributions on the ODF

To facilitate the identification of contributors and keep track of the participation history of individual contributors, posting new contributions and responding to existing threads require registration. Non-registered users are free to navigate around the web site and browse the discussion threads but only registered users can post contributions with *GeoDF*. All users who want to post threads on the ODF are required to login.

As the major purpose of the prototype is to facilitate communication and discussion among participants, numerous tools have been developed to facilitate the expression of ideas with spatial context. Apart from the conventional ODF where users can use text to express their ideas, *GeoDF* supports users to express their ideas graphically on a map. To do so, a contributor would first turn on the map layers that are relevant to the issue. Then, s/he will set the extent of the map that defines the geographic extent of the issue. The visible map layers and the map extent will serve as a backdrop to the sketches and annotations to be created by the contributor (Figure 5.8). Once a user hits the *submit* button in the ODF, the system will record the following in order to capture the *spatial context* of a contribution:

- The extent of the current map view;
- The map layers that are turned on by the contributor;
- Sketches and/or annotations added by the current contributor; and/or

- Other contributors' sketches and annotations that are turned on by the contributor.

As a result, contributors can give a fuller expression of their ideas as compared with the text-only ODF.

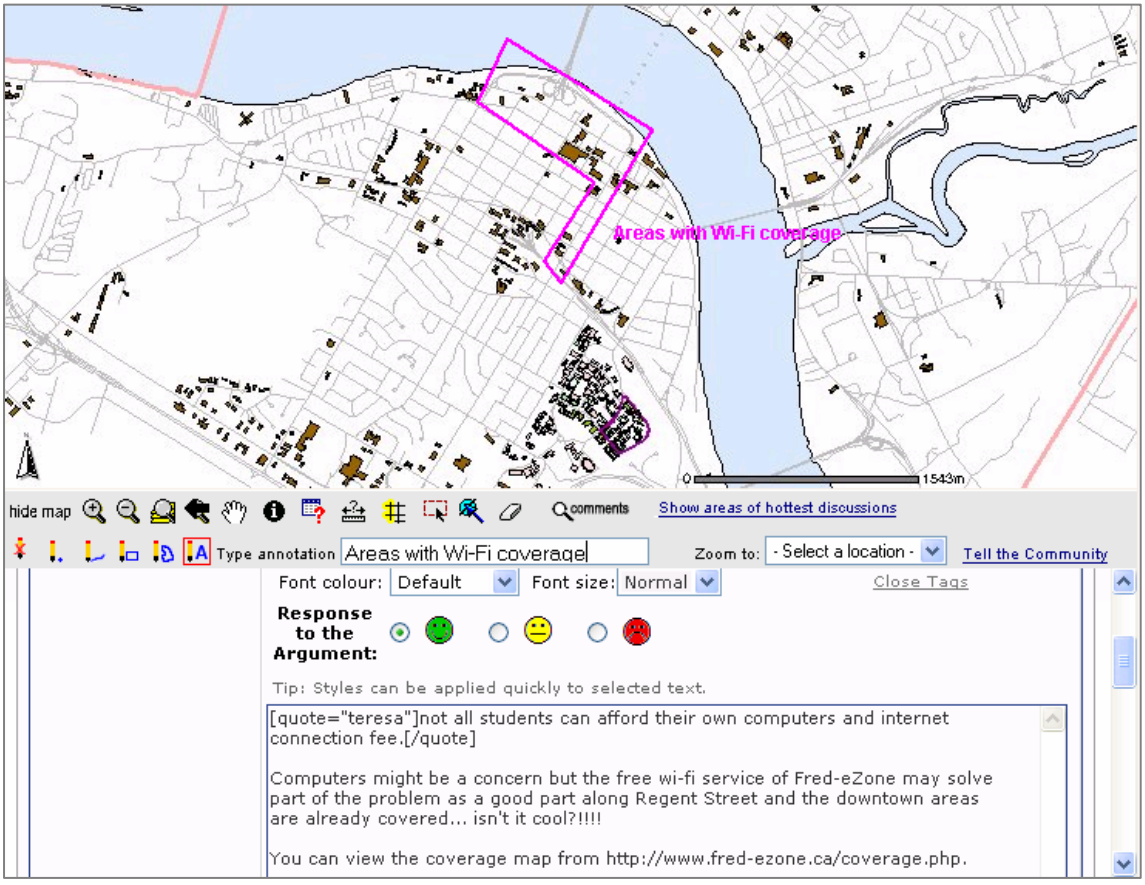


Figure 5.8: Contributors can use the user-defined map layers and map extent as the backdrop to the sketches and annotations to facilitate a fuller expression of their ideas

While a user is typing or viewing the messages in the ODF, s/he can use the *show/hide map* feature to hide the map to give more room for the ODF. They can switch between the show and hide mode at any time and it will not cause the map to redraw.

(d) Sharing of Local Knowledge

After a contribution is submitted to the server, all other contributors can browse that message together with its associated *spatial context* (to be displayed in the form of a map image in the *MapFrame*). This can facilitate participants to share their knowledge about the neighbourhood (or local knowledge). This platform can also function as a watchdog over nuisances and matters related to unauthorized development in their neighbourhood. This can quickly draw the attention of fellow residents and the government officials to take timely actions, if necessary.

(e) Informing Target Population of Important Issues

Like the plan proponents, the plan recipients can also utilize the *Tell the Community* function to notify a target group of residents in a specific geographic location about certain issues and invite them to join the discussions. Other potential interaction of the plan recipients will be demonstrated in the second scenario.

5.1.2.3 Facilitators

(a) Moderating the ODF

Discussions via *GeoDF* can be mediated or moderated by facilitators (or moderators). According to ISU (2003), a facilitator is responsible for leading a group of individuals in a guided discussion about a specific topic. Among the literature on facilitators and group facilitation (Bacal, n.d.; Corcoran, 2004; MECD, 1996; ISU, 1992, 2003; Richardson and Connelly, 2002), the major roles of a facilitator include:

- To "introduce the topic and provide the timeframe for discussion" (ISU, 2003);
- To keep the discussion focusing on the topic in question and moving within the allotted time (Corcoran, 2004; ISU, 2003);
- To "ensure that the group works as a constructive and cohesive unit" (MECD, 1996);
- To encourage different viewpoints (ISU, 1992, 2003; MECD, 1996) and "encourage sharing ideas" (ISU, 1992);
- To "help relate and tie together ideas" (ISU, 1992);
- To "bring all the views, values, feelings, and concerns to the table for discussion to find common ground" (ISU, 1992);
- To remain neutral (ISU, 1992, 2003; MECD, 1996; Richardson and Connelly, 2002);
- To "avoid answering questions", but "ask questions to stimulate discussion, if necessary" (ISU, 2003);
- To "summarize points that are made for clarification and understanding" (ISU, 2003); and
- Should be "listening without interrupting" (ISU, 2003).

A facilitator could be an expert in the subject matter. However, their role is not to defend the topic being discussed. They must remain neutral (neither supporting nor objecting to the topic) and not to participate in the discussion but to perform the role of tying related ideas together and asking the right questions to stimulate discussions. Since the discussions are taking place over the Internet using web-

based tools, a facilitator of *GeoDF* should be skilful in using ODF and have a good understanding of how the system can facilitate communication in the discussion process so that s/he can advise the users how to utilize *GeoDF* to meet their discussion and communication needs. For example, a facilitator can make use of Flash video clips to demonstrate to the users how to navigate, explore, and understand the data and the contents of the discussion forum; how to post a new contribution or reply to an existing contribution in the ODF; how to express their ideas with the textual and sketching and annotation tools offered by *GeoDF*; or how to use the analysis tools to generate new information or develop alternative options.

(b) Maintaining the Order of the ODF

As discussed above, one of the major roles of a facilitator is to maintain the order of the ODF. *GeoDF* utilizes the built-in moderating mechanisms of *phpBB* to support moderated discussions. For example, they can add, delete, edit, and move a topic or an issue; they can also move, delete, lock, unlock, or split a position (Figure 5.9). They can also edit individual argument if offensive content or profanity is found. Additionally, there is a word censor function that will automatically remove the specified unacceptable words and replace them with the corresponding replacements. As a facilitator, s/he can exercise ban control on the users. For example, a facilitator can ban users from using the system by their username, IP address, and hostname (phpBB Group, n.d.). For detailed description of moderators actions, please refer to the *phpBB Userguide* (phpBB Group, n.d.).

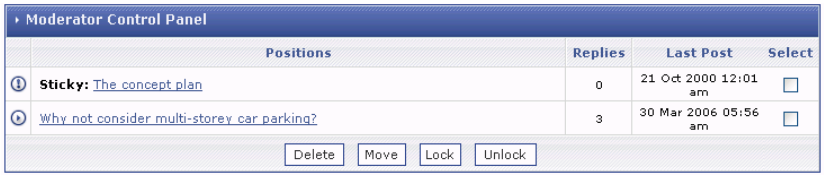


Figure 5.9: Moderator's control panel of *phpBB*

5.2 Scenario 2: Fredericton Transit Routing

5.2.1 Background

According to the City of Fredericton's web site (2006), Fredericton Transit is run by the Transit Division of the City that "operates 25 buses on seven routes, Monday to Saturday, from 6:30 am until 11:00 pm providing safe, affordable mobility to those in the community who do not have access to or choose not to use a private vehicle". Since 2004, St. Thomas University (STU) has reached a deal with Fredericton Transit making the transit services available to all STU students as part of their compulsory fees. As a result, the routes serving between the downtown area and the malls via university and the STU student residence become more frequent and Fredericton Transit becomes a popular transportation means among the students especially the STU students. The author, being a frequent transit passenger, understands that the transit passengers have lots of concerns about the scheduling and routing of the bus services. This section mimics a situation where *GeoDF* is used to help the transit passengers express their concerns and initiate discussions about the bus routing and scheduling issues among fellow passengers on one hand, and help the transit service provider collect passengers' opinions via a relatively informal discussion setting on the other hand.

5.2.2 Typical Interaction with the Prototype

Unlike the last scenario, the plan recipients (the transit passengers) will participate in the discussion actively as they expect the service provider to understand the problems of the existing schedule and routing such that their concerns could contribute to the decision regarding future arrangements. The core groups of actors in this scenario are essentially the same as the previous scenario. They are the plan recipients (such as the transit passengers, and people who are not necessarily passengers but are affected by the routing arrangements), the plan proponents (the transit provider in this case), and the facilitators. In fact, the expected interaction is very similar to that outlined in the previous scenario. The major difference between the current and the previous scenario lies mainly in the nature and the content of the discussion. To avoid repetition, this section will only highlight the interaction caused by the unique nature and content of this discussion scenario.

5.2.2.1 Plan Recipients

(a) Initiating Discussions

As mentioned earlier, the transit passengers are very concerned about the routing and scheduling arrangements for the existing bus services. Taking advantage of the communication aids provided by *GeoDF*, the transit passengers can utilize this platform to initiate discussions about how the current arrangements have affected their commuting behaviour. Figure 5.10 shows a discussion initiated by the shop owners at Fredericton Mall discussing how fewer routes and the less

frequent bus service have influenced the customers' choices on where to shop and eat. As depicted in Figure 5.10, with the aid of the spatial discussion tools (annotations, sketching, and mapping functions), *GeoDF* can convey the geographical extent of the issues effectively. For example, both Participants #1 and #3 considered the issue was not only confining to Fredericton Mall but also the wider area in its neighbourhood covering Regent Mall, whereas the pizza shop owner (Participant #2) was more focused on the premise itself. One can imagine that without the spatial discussion tools, the geographical extent embedded in their discussion cannot be conveyed as effectively with a text-based ODF.

(b) Considering Potentially-Related Arguments

As discussed earlier, a number of spatial elements will be stored in the database when a contribution is submitted. This information is required to support the operation of certain spatial functions of *GeoDF*. One of those functions is the ability to inform users about arguments that are potentially related across issues. A detailed discussion on the operation of this function can be found in Section 4.2.6. Figure 5.11 illustrates the sequence of actions that triggers this function. In Figure 5.11a, two students were expressing their concerns about areas in the campus that were not well-served by the current bus routes under the *Transport* topic. An enlarged view of the *Map Layers* tab (on the left) illustrates that the campus plan map layers were turned on by the contributors when the contributions were submitted (Figure 5.11a). As these map layers belong to *issue-specific* layers of another issue (*Fredericton Campus Plan*), the system will

assume that these two arguments/contributions (under *Bus Routes*) are potentially related to the discussions under the issue *Fredericton Campus Plan* and hence create a hyperlink in the latter to inform the participants that they are potentially related (Figure 5.11b). This function can facilitate participants to consider and understand related arguments in an effective manner. It is realized by the concept of *spatial context* introduced by the present prototype.

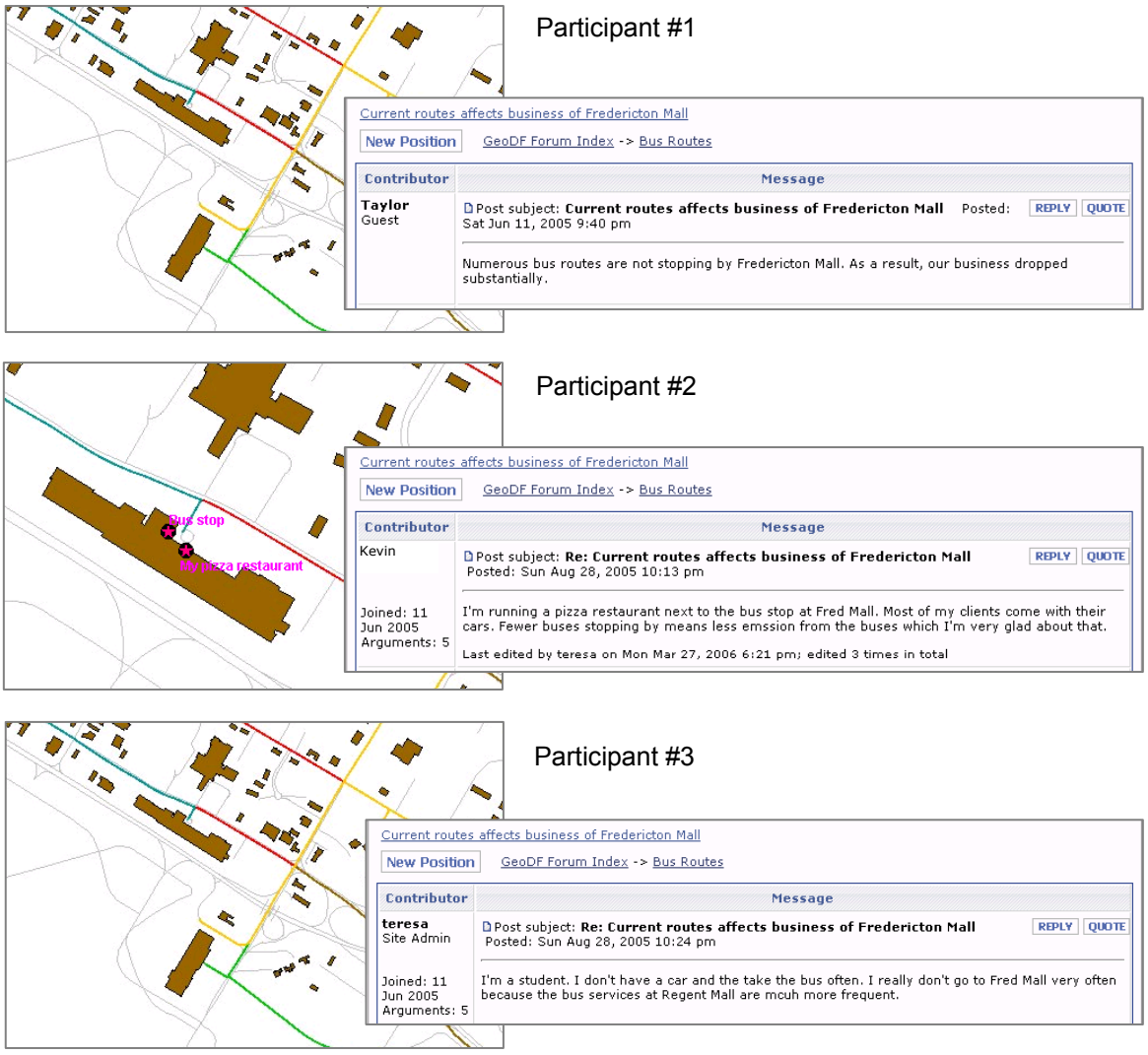


Figure 5.10: Screenshots showing how the concept of "Spatial Context" has facilitated participants in expressing the geographic extent (or scale) of the issues being addressed

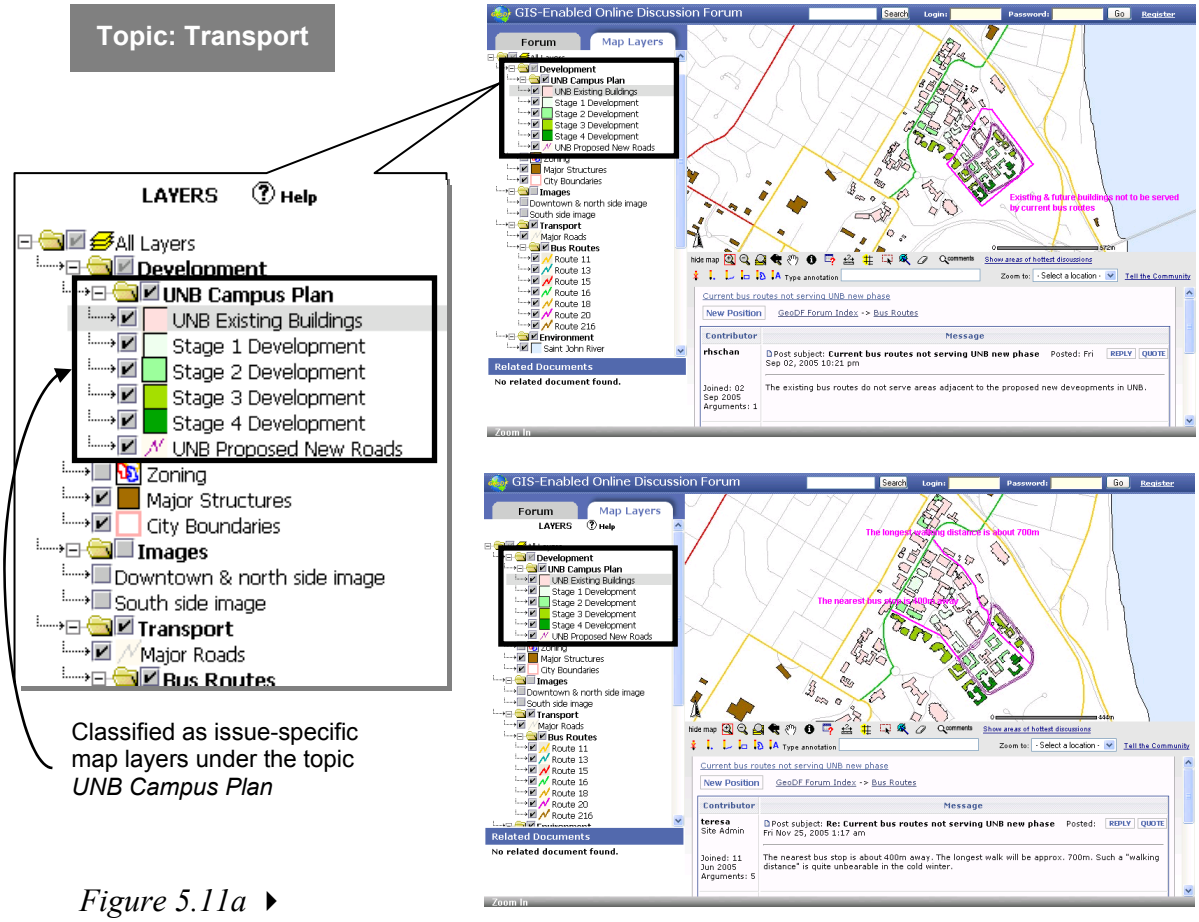


Figure 5.11a ▸

Figure 5.11b ▾

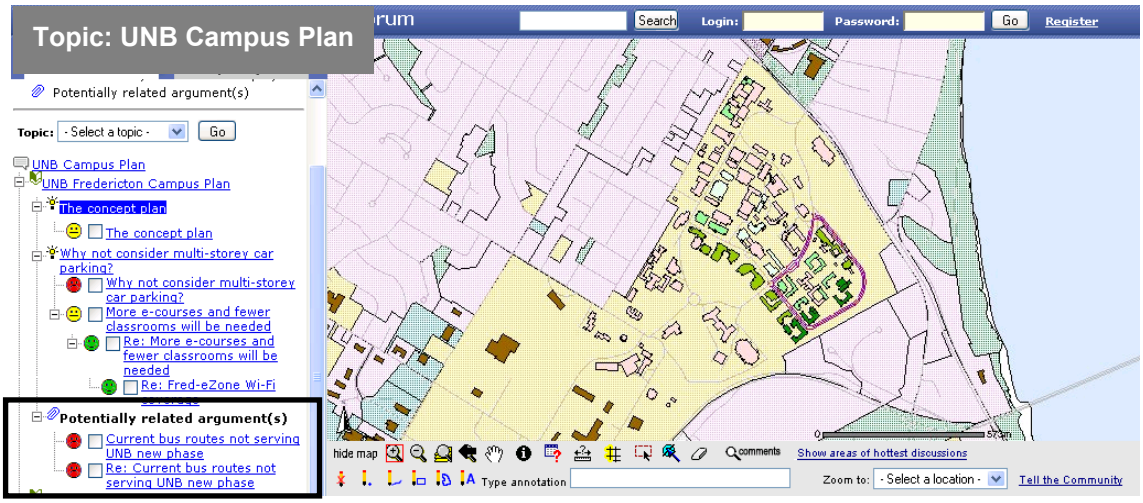


Figure 5.11: Sequence of actions that triggers the system to inform participants of the presence of potentially related issues

(c) Performing Simple Spatial Analysis

As discussed in section 4.1.1.2, the target user group is general users and hence only some simple spatial analysis tools such as *measure* and *buffer* are offered. With these tools, users can discover new information from the spatial dataset. For example, when discussing the existing bus services, a user can use the *measure* tool to measure the walking distance between the existing bus stops and the UNB new phrase. As shown in Figure 5.12, new information can be discovered with the spatial analysis tools, which provides supplementary information for the discussion.



Figure 5.12: Simple spatial analysis tools such as the *measure* tool can help users discover new information from the spatial dataset

5.2.2.2 Plan Proponents (Transit Provider)

(a) Collecting Passenger Opinions

The transit provider can use *GeoDF* to collect passenger opinions on an ongoing basis. They can join the discussion and provide feedback to the passengers, where applicable.

(b) Discussing Alternatives

They can also discuss with the passengers about alternative routing options to meet their concerns. They can explain to the passengers the rationale behind current arrangements and seek their opinions on routing and scheduling proposals and come up with a plan that can strike a balance between the various concerns and make modifications accordingly. The transit provider could use this discussion tool to gauge passenger opinions and involve them at an early stage before major decisions have been made.

5.2.2.3 Facilitators

Generally speaking, the expected interaction of facilitators is essentially the same as that discussed earlier regardless the issues. The facilitators will be involved in moderating and maintaining the order of the online discussion forum. Appropriate tools are provided by *GeoDF* to meet these purposes. For details, please refer to Section 5.1.2.3.

5.3 Summary

The two planning scenarios in this chapter demonstrate that *GeoDF* can facilitate the participants to express the *spatial context* embedded in their dialog explicitly on the map. As a result, it facilitates a better understanding among the participants. *GeoDF* also enables users to understand the evolution of discussion, and initiate their own discussions. It is also capable of supporting users to consider related arguments to broaden the discussions.

In the next chapter, *GeoDF* will be subject to an evaluation to determine whether it can satisfy the evaluation criteria previously derived in Chapter 3.

CHAPTER 6 EVALUATION OF THE PROTOTYPE

In this chapter, an evaluation based on the criteria developed in Section 3.1 has been conducted on the prototype. The results are then compared with those for the existing applications to conclude whether the prototype has achieved the research objective in Section 1.2.

6.1 Evaluation Results for *GeoDF*

The evaluation results are summarized in Table 6.1. The last column of Table 6.1 summarizes the way in which each sub-criterion is fulfilled in *GeoDF*. Detailed discussions on how each criterion is achieved are given in the chapters on design and implementation (Chapter 4) and prototype demonstration (Chapter 5). Readers can follow the section numbers cited in Table 6.1 for further details. Except for a few criteria that are fulfilled by the built-in functions of the online discussion forum software, the majority criteria are generally achieved initially through the formalization of the concept of *spatial context* which is then implemented through appropriate modelling, database design, and coding.

Table 6.1: Evaluation results for *GeoDF*

Questions motivated by sub-criteria	*GeoDF*	In what way is this criterion fulfilled?
Enable experts to play the facilitators' roles		
Does the system provide any tool that enables the experts play the facilitators' roles?	●	This requirement can be met by the moderating functions offered by the online discussion forum software, *phpBB*. No additional functions were added by the author in this respect.
Free and fuller expression of views		
Does the system allow participants initiate discussions of their own choice such as define problems, set assumptions and agenda, discuss solutions, and so on?	●	This requirement can be met by the built-in functions of *phpBB*. The current set up of *GeoDF* only allows registered uses to initiate new discussions so as to deter abusive usage by irresponsible users.
Does the system provide multiple media such as text, sketches, maps, or other media to enable fuller expression of participants' views?	● [T,M,S,A]	*GeoDF* allows users to use multiple media such as text, maps, and mark-up tools to enable fuller expression of one's view. Most importantly, with the implementation of the concept of *spatial context* (Section 4.2.1 refers), the *spatial context* elements that are embedded in a dialog can be expressed explicitly on the map with the mark-up tools and other associated functions developed by the author (Chapters 4 and 5 refer).
Exchanging views		
Does the system support information flow from the authority to the public; from the public to the authority; and among the public?	●	Facilitating multi-way flow of information is a core function of *phpBB*. *GeoDF* has been configured as an open platform to encourage multi-way flow of information.
Does the system allow participants to view ideas expressed by other participants?	●	The current set up of *GeoDF* allows anyone to view the contributions, though only registered users are allowed to post new contributions or reply to existing contributions.
Documentation and sharing of evolution of ideas		
Does the system store, organize and display discussions in a manner that shows the evolution of issues and problem definitions?	●	*GeoDF* has adapted Kunz and Rittel's (1970) IBIS argumentation model and the threaded discussion forums (*phpBB* enhanced with *Moby Threads Mod*) [Sections 2.1.3.5 and 4.2.2 refer] to facilitate the documentation and display of the evolution of issues.
Showing decisions in context to related decisions		
Does the system provide logical referencing system pointing participants to additional information and source documentation?	●	The *DocFrame* in *GeoDF* is dedicated for accommodating documents (e.g., text, audio/video files, etc.) that are relevant to the selected issue (Section 4.2.2 refers).
Does the system show decisions in context to related decisions?	●	This is facilitated by several ways including (i) via hyperlinks; (ii) the threaded view of the discussion forum; (iii) placing related documentation in the *DocFrame*; (iv) moderator/facilitator can move or split contributions to organize relevant decisions; and (v) the "potentially related arguments" function implemented by the author (see Section 4.2.6 for details).
Effective communication of spatial context		
Does the system store and display the spatial context of the participants' views on a map?	●	The author has formalized and implemented the concept of *spatial context* to take care of the capture and display of the *spatial context* of individual discussion contributions (Sections 4.2.1, 4.2.4, 4.2.5 refer).
Is the spatial context stored and displayed along with the corresponding expressions recorded by other media?	●	In the database, the *spatial context* and the corresponding textual contribution are linked by unique identifiers (Section 4.2.3 refers). The user interface of *GeoDF* is specially designed to facilitate the textual contribution to be read alongside the corresponding *spatial context* (Section 4.2.2 refers).
Does the system provide structured organization of the integrated expressions to facilitate understanding of participants' concerns?	●	The discussion contributions are organized by the IBIS argumentation model and the threaded view discussion forums. Since each contribution is linked to its corresponding *spatial context*, the integrated expressions are structured.

×: Not fulfilled; ⦿: Partially fulfilled; ●: Fulfilled.

[T] Text (via email or comment form); [M] Maps; [S] Sketches; [A] Annotations; [3D] 3D digital model.

6.2 Discussions

6.2.1 Comparison of Evaluation Results between *GeoDF* and the Selected Online PPGIS Applications

Table 6.2 uses the same evaluation criteria to compare the functionality of *GeoDF* with those for the selected major online PPGIS applications originally summarized in Table 3.9. Among the twelve applications listed in Table 6.2, *GeoDF* does especially well in supporting *moderated discussions* and *effective communication of spatial context*. As shown in Table 6.2, *GeoDF* is the only application that *enables experts to play the facilitators' roles*. With reference to Table 6.1, this is achieved through the moderating functions of the online discussion forum software, *phpBB*.

In terms of supporting *effective communication of spatial context*, *GeoDF* is the only application that fulfills all of the three sub-criteria. This is achieved through the formalization and implementation of the concept of *spatial context* which takes care of the capture and display of *spatial context* of individual discussion contributions. For instance, the *spatial context* and the corresponding textual contribution are linked in the database by unique identifiers and the user interface of *GeoDF* is specially designed to facilitate the textual contribution to be read alongside the corresponding *spatial context*. As *GeoDF* has adopted the IBIS argumentation model and the threaded view discussion forums, each contribution and its corresponding *spatial context* is organised to facilitate the understanding of participants' concerns.

Table 6.2: Comparison of evaluation results

Questions motivated by sub-criteria	Selected Online PPGIS Applications											*GeoDF*
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	
Enable experts to play the facilitators' roles												
Does the system provide any tool that enables the experts play the facilitators' roles?	×	×	×	×	×	×	×	×	×	×	×	●
Free and fuller expression of views												
Does the system allow participants initiate discussions of their own choice such as define problems, set assumptions and agenda, discuss solutions, and so on?	×	×	×	×	×	×	●	●	●	●	●	●
Does the system provide multiple media such as text, sketches, maps, or other media to enable fuller expression of participants' views?	× T	× T	× T	● T,M,S,A	● T,M,A	● T,M	● T,M	● T,M	● T,M	● T,3D	● T,M	● T,M,S,A
Exchanging views												
Does the system support information flow from the authority to the public; from the public to the authority; and among the public?	⦿*	⦿*	⦿*	⦿*	⦿*	⦿*	●**	●	●	●	●	●
Does the system allow participants to view ideas expressed by other participants?	×	×	×	×	×	×	●**	●	●	●	●	●
Documentation and sharing of evolution of ideas												
Does the system store, organize and display discussions in a manner that shows the evolution of issues and problem definitions?	×	×	×	×	×	×	×	×	×	×	●	●
Showing decisions in context to related decisions												
Does the system provide logical referencing system pointing participants to additional information and source documentation?	●	⦿#	⦿#	⦿#	⦿#	●	●	×	●	×	×	●
Does the system show decisions in context to related decisions?	●	×	×	×	×	●	×	×	×	×	●	●
Effective communication of spatial context												
Does the system store and display the spatial context of the participants' views on a map?	×	×	×	●	●	×	⦿♦	⦿♦	⦿♦	⦿♦	⦿♦	●
Is the spatial context stored and displayed along with the corresponding expressions recorded by other media?	×	×	×	×	×	×	×	×	×	×	●	●
Does the system provide structured organization of the integrated expressions to facilitate understanding of participants' concerns?	×	×	×	×	×	×	×	×	×	×	●	●
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	*GeoDF*

×: Not fulfilled; ⦿: Partially fulfilled; ●: Fulfilled.

T Text (via email or comment form); M Maps; S Sketches; A Annotations; 3D 3D digital model.

* Two-way flow of information (from the authority to the public, and from the public to the authority).

** Comments were available for viewing after the consultation was over.

\# Via an external site (e.g. the home page of the planning authority)

♦ Only shows the whereabouts of the comments; cannot show other spatial context elements such as spatial relationships.

In terms of supporting *free and fuller expression of views*, *GeoDF*, like some of the selected PPGIS applications, can fulfill this requirement. It allows participants to initiate discussions of their own choice and provides multiple media including text, maps, sketches, and annotations to enable fuller expression of one's views. Among the applications listed in Table 6.2, *GeoDF* is one of the two applications (the other one is *Application A4*) that provide relatively sophisticated mark-up tools to facilitate effective expression of views.

Regarding the support for *exchanging views*, *GeoDF* supports multi-way flow of information and allows participants to view each other's ideas. Making use of the functions of *phpBB*, *GeoDF* has been configured as on open platform to encourage flow of information among the various participation parties. The current set up allows anyone to view the contributions. However, only registered users are permitted to post new contributions or reply to existing contributions.

In terms of supporting *documentation and sharing of evolution of ideas*, both *Application A11* and *GeoDF* have adopted the IBIS argumentation model and threaded view discussion forums for this purpose. *GeoDF*, on the other hand, has adopted an optional tier, *topic*, in the IBIS argumentation hierarchy to group related issues. Additionally, it allows participants to include others' textual and/or spatial contributions in their reply contributions. The cumulative effects of these two enhancements lead to a more efficient documentation and display of the evolution of ideas.

Concerning the support for *showing decisions in context to related decisions*, Table 6.2 illustrates that *Applications A1, A6,* and *GeoDF* have fulfilled this requirement. For *Application A1*, the decisions relevant to respective options are prepared in the form of static maps. For *Application A6*, users can specify the relative degree of importance of certain predefined factors and constraints and view the combined results of their preferences (or the preferred option) on a map. However, as the preferred option is generated in a black box (see Section 3.3 for details), it is unclear how one decision has led to another. *GeoDF*, on the other hand, has supported this function in a more efficient manner. It is facilitated in several ways such as dedicating a specific area on the web page for related documents; users can trace related decisions from the threads in the discussion forums; moderators can move or split contributions to organize relevant decisions. Most importantly, the author has implemented a *potentially related arguments* function so that participants can consider potentially related arguments across topics.

To sum up, the *GeoDF*-related entries in Table 6.2 demonstrate that the author has taken into account the communication needs for participatory planning in her design and implementation of *GeoDF*. In particular, the author's prototype design attempted to address key functional shortcomings of other major existing applications as described in Chapter 3, such as supporting moderated discussions and effective communication of spatial context. Most importantly, the mechanism that integrates the textual and spatial components of discussion contributions in

GeoDF makes good use of the spatial data handling capabilities of GIS in assisting users not only to express their opinions explicitly but also help them understand each other's opinions, which lays the foundation for consensus building. Moreover, it encourages participation as users can freely and explicitly express their opinions with the platform offered by *GeoDF*. In other words, it can fulfill the communication needs arising from participatory planning from a technological perspective as discussed in Section 3.1.

6.2.2 Limitations of the Evaluation

As discussed before, the present evaluation approach is technological in nature. Ideally, it will be helpful for follow-on empirical research to be conducted with real users in a real life participation discussion to verify the evaluation results presented in this chapter. However, due to limited time resource, it is not possible to incorporate an empirical study as part of the present research. This follow-on research is now being undertaken by Zhao and Coleman (2006) in cooperation with the City of Fredericton.

The next chapter will sum up the work completed for the research and outline future research opportunities.

CHAPTER 7 CONCLUSIONS

This chapter concludes the thesis by summarizing the work completed for the research and discussing future research opportunities. Major findings of the research will be highlighted in the concluding remarks.

7.1 Summary of Work Completed

The objective of the research is to design and implement a prototype to demonstrate that web-based GIS can be integrated with online discussion forum to enhance communication during spatially-related discussions in participatory planning. The following tasks have been carried out to accomplish this objective.

7.1.1 Acquiring Background Knowledge About the Research

First, an extensive literature review on the following areas of interest was conducted to acquire background knowledge about the research:

- the theories and practice of participatory planning;
- the communication requirements for spatially-related discussions in participatory planning;
- the communicative capabilities of web technologies such as web-based GIS and online discussion forum in a spatially-related discussion setting; and
- the technological requirements for the integration between web-based GIS and online discussion forum.

The significance of communication needs in participatory planning stood out during the literature review. It is an area that has not been examined extensively in the PPGIS literature. The theme of the research was thus set.

7.1.2 Evaluating Existing Applications

An assessment on existing applications was then conducted to find out the extent to which they can fulfill the communication needs of participatory planning. The following sub-tasks were carried out to accomplish this task.

- First, the purpose of the evaluation was defined. It assessed from a technological perspective whether the selected online PPGIS applications can satisfy the communication requirements arising from the participatory planning approach.
- Since established criteria for the present evaluation purpose are not available, the author developed a set of evaluation criteria from the principles of the participatory planning approach. First, the *principles* were translated into the *goals* of participatory planning which were later converted into various *tasks* for achieving the *goals*. Then, the *technical solutions* for satisfying the communication needs arising from those *tasks* were synthesised and grouped into *evaluation criteria*. Please see Figure 3.1 and Section 3.1 for details.
- After the evaluation criteria were established, eleven online PPGIS applications were selected for evaluation. A detailed review of each application in terms of the availability of services and GIS functions was

conducted to serve as background information to facilitate the evaluation. The evaluation results served as the baseline for a later comparison with the prototype.

- The evaluation revealed that existing applications have not yet taken full advantage of the spatial data handling capabilities of GIS in aiding the communication of opinions during spatially-related discussions.

7.1.3 Designing the Prototype

The above evaluation provided insight into the direction a preferred online PPGIS application should proceed. Other key design considerations for the prototype were identified, including the intended use, target user group, and user requirements in terms of facilitating the expression and understanding of the spatial concepts embedded in one's dialog (or *spatial context*). Based on these considerations, the data model, the types and levels of functionalities to be provided, the desired user interface design, as well as the technological requirements were derived. Please refer to Section 4.1 for details.

7.1.4 Implementing the Prototype

For the purpose of proof-of-concept, the implementation of the prototype is based on available components. For example, the mapping component is based on a proprietary spatial server *ArcIMS* whereas the online discussion forum is based on an open-source software *phpBB*. Since the concept of *spatial context* forms the backbone of the prototype, the implementation began with the formalisation of the

concept. Then, it was modelled with the corresponding constructs or objects of the web-based GIS. The associated database design was later completed, followed by the implementation of the desired user interface. Please refer to Section 4.2 for details.

7.1.5 Evaluating the Prototype

Based on the evaluation criteria developed earlier, an evaluation was conducted on the prototype. It is found that, unlike the existing applications, the prototype can fulfill all of the communication needs. Moreover, they can be fulfilled in a more efficient manner. Hence, it is concluded that the research objective is achieved. In other words, web-based GIS can be integrated with online discussion forum to enhance communication during spatially-related discussions in participatory planning.

7.2 Opportunities for Future Research

This research emphasises the significance of communication needs in PPGIS research and implements a prototype (*GIS-enabled Online Discussion Forum [GeoDF]) that allows* participants' to communicate spatial concepts efficiently during discussions. The following areas are identified for future research or further enhancement of the deliberation and communicative capabilities of future PPGIS.

As discussed in Section 6.2.2, empirical research is not incorporated into the

research due to limited time resource and the scope of the present research. It will be useful if empirical research such as usability testing can be conducted with real users in a real life participation discussion environment so that the current findings can be verified.

As mentioned in Section 2.1.3.4, *Web 2.0* is an emerging trend for many new web-based applications especially those designed for user contribution. Thus, future online application methods will likely follow this trend. Since users are the content contributors in *Web 2.0*, uploading GIS data by the users may become one of the required functions in future applications. However, since this involves compatibility issues in terms of data format and data model, further research in this direction will be required.

Another direction for future research that is worth examining is to investigate how the technologies of *Web 2.0* such as AJAX (**A**synchronous **JA**vaScript and **X**ML) can improve the user experience and further enhance the communicative capabilities of *GeoDF*. The user interface of *GeoDF* is more or less similar to the existing desktop GIS whose users are mostly trained. The future trend should be moving towards anyone, with or without GIS training, can use PPGIS right away. Openshaw (1999, p.436) anticipates that citizens in the future use products with GIS inside do not need to know what it is or caring about it.

As discussed in Section 2.1.3.2, public participation is the process to “allow

those affected by a decision to have an input into that decision" and public refers to all stakeholders in the community. Thus, the spirit of public participation is to involve every one of the community in the process. However, like the existing PPGIS applications and many other online applications, the human-computer interaction with *GeoDF* is based on the conventional mouse-and-screen-based browsers. The special needs of people with permanent or temporary disabilities such as hearing, visual, physical or cognitive impairment have not been accommodated in the application. More research should be done in this direction to understand their communication needs and examine how such needs can be incorporated into the application. Otherwise, they will be excluded intentionally in the participation process.

7.3 Concluding Remarks

This research pinpoints the significance of communication needs in PPGIS research and develops a set of criteria for evaluating whether a PPGIS application has incorporated those needs in the design. Another contribution of this research is the formalization and implementation of the concept of *spatial context* in a prototype known as *GIS-enabled Online Discussion Forum* (*GeoDF*) such that participants' opinions can be communicated explicitly and efficiently during spatially-related discussions.

However, the author agrees with Weiner et al. (2002, p.5) that PPGIS is not a panacea. As discussed in Section 1.4, online PPGIS applications such as the

prototype are just another means of participation. Like other participation methods, online PPGIS application does not automatically lead to better decisions. However, it can improve the decision-making process "by ensuring that decisions are soundly based on shared knowledge, experiences and scientific evidence, that decisions are influenced by the views and experience of those affected by them, that innovative and creative options are considered and that new arrangements are workable, and acceptable to the public" (Blaschke, 2004).

Besides, even the best designed collaborative process intended to be fully inclusive cannot guarantee everyone is willing to take part in the process. Furthermore, the openness of the government continues to be one of the major obstacles to the future penetration of online PPGIS. This is confirmed by the evaluation results that only one out of the six applications that attain Rung 4 or above of the participation ladder is adopted by the government; others are experimental applications developed by the academia (Table 3.8 refers). Unless the government is willing to share the decision-making power with the public, the government will persist to implement PPGIS applications that only fit the broadcast model of participation.

The other obstacles to the future penetration of online PPGIS are the differential access to data and technology. This issue must be addressed in the future. Otherwise, some people will be excluded intentionally in the participation process if online PPGIS becomes the prevailing participation method in the future.

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APPENDIX I PPGIS EVALUATION CRITERIA USED IN CITED REFERENCES

Areas for Evaluation	Criteria	Sources
PPGIS principles	**Functions / tools required** - allow the public to explore and experiment with the data and information sources which are available and provide the opportunity to formulate different scenarios and solutions to decision problems **Understandable by the participants** - be understandable by all sectors of the community who wish to be involved and not tied up in technical jargon. **Quality of information** - provide information and data that are both explicit and bipartisan **Foster trust and transparency** - foster a high degree of trust and transparency that can be maintained within the public realm to give the process legitimacy and accountability.	Carver, et. al., 2001
PPGIS and community development principles	**Integrate the components of a working GIS** - the elements of a working information system should be created within each local community - it should include: ▪ data sources ▪ a clearinghouse operation ▪ a service provider ▪ community research analysts ▪ community organizations and participants ▪ sources of support to meet the cost **Rights of information access** - participants should have the adequate access to affordable information and analysis tools **Community priorities and capacity building** - capacity of local organizations and coalitions to guide agendas should not be compromised - Mechanisms are required that allow local organizations to participate in the process from the beginning	Brandt, 2002

Areas for Evaluation	Criteria	Sources
	- Education is important in helping local organizations to understand how to use the data **The value of co-production** - local involvement expands the data gathering process and leads to richer data **Increase the capacity of local community system to use the technology** - Mediator is important in the transfer of technical knowledge and skills. The goal is to make consumers better at utilizing the results of technology. **Integrate into a broader community development process** - Data initiatives should be linked to broader community development process such as neighbourhood wide strategic planning - Organizations and local leadership need to develop the capacity to respond to the challenges facing their community on an independent, locally controlled basis.	
Transparency	**Clear** - Comprehensible/Intelligible - Unambiguous - Easily detected - Easily seen/heard - Visible (no hidden meanings) - Precise and simple - Contains minimal jargon **Integrated with other decisions** - Comprehensive (process fully laid out/full disclosure) - Takes a "big picture" view - shows decision in context to related decisions - Consolidated – described in a single document - Provides logical referencing system pointing users to additional information and source documentation - Contains detailed table of contents and indices **Accessible** - Allows citizens to have access to important meetings of government officials - Allows citizens to request and receive government documents	Drew, 2003

Areas for Evaluation	Criteria	Sources
	- Makes of detailed documentation and databases available - Promotes two-way access to information (stakeholders have access to government legislation, and government has access to stakeholder values) **Truthful and Accurate** - Truthful and accurate, free from deceit - Messages undiluted (information delivered effectively without altering content) **Logical and Rational** - Follows a rational defensible plan, clear to a broad array of stakeholders - Committed to scientific credibility (sound, dependable, leading edge) - Processes are consistent, standardized, formalized, flexible, expandable - Identifies clear decision points (and opportunities for involvement) - Able to track decisions and policies over time - Electronic information includes descriptive information (metadata) so can be interpreted by all - Uses available technologies to improve access to declassified or formerly classified information **Accountable** - Analyses subjected to independent assurances of credibility (i.e., peer review) - Shows that activities meet goals of policies - Shows linkages between decisions and implementation; i.e. records milestones (activities), follows cost and schedule changes, provides rationale for changes, etc. - Provides rationale behind decisions - Reassures the public - Responds to stakeholders in timely fashion - Provides adequate time for stakeholders to be involved **Open/Involve stakeholders** - Allows concerned citizens to see openly into government activities - Allows citizens to have input into government decisions and rule making - Undertakes budget preparation, execution,	

Areas for Evaluation	Criteria	Sources
	and reporting openly - Allows stakeholders consistent opportunities to make suggestions during decision process and to appeal decisions - Provides early notification of opportunities - Seeks wide ranging early advice on key proposals - Provides clear and coherent messages - Describes impact of public/stakeholder input - Provides user friendly interfaces - Promotes inter-institutional cooperation and coordination with the Hanford Tri-Party Agreement, internal organizations, and stakeholders	

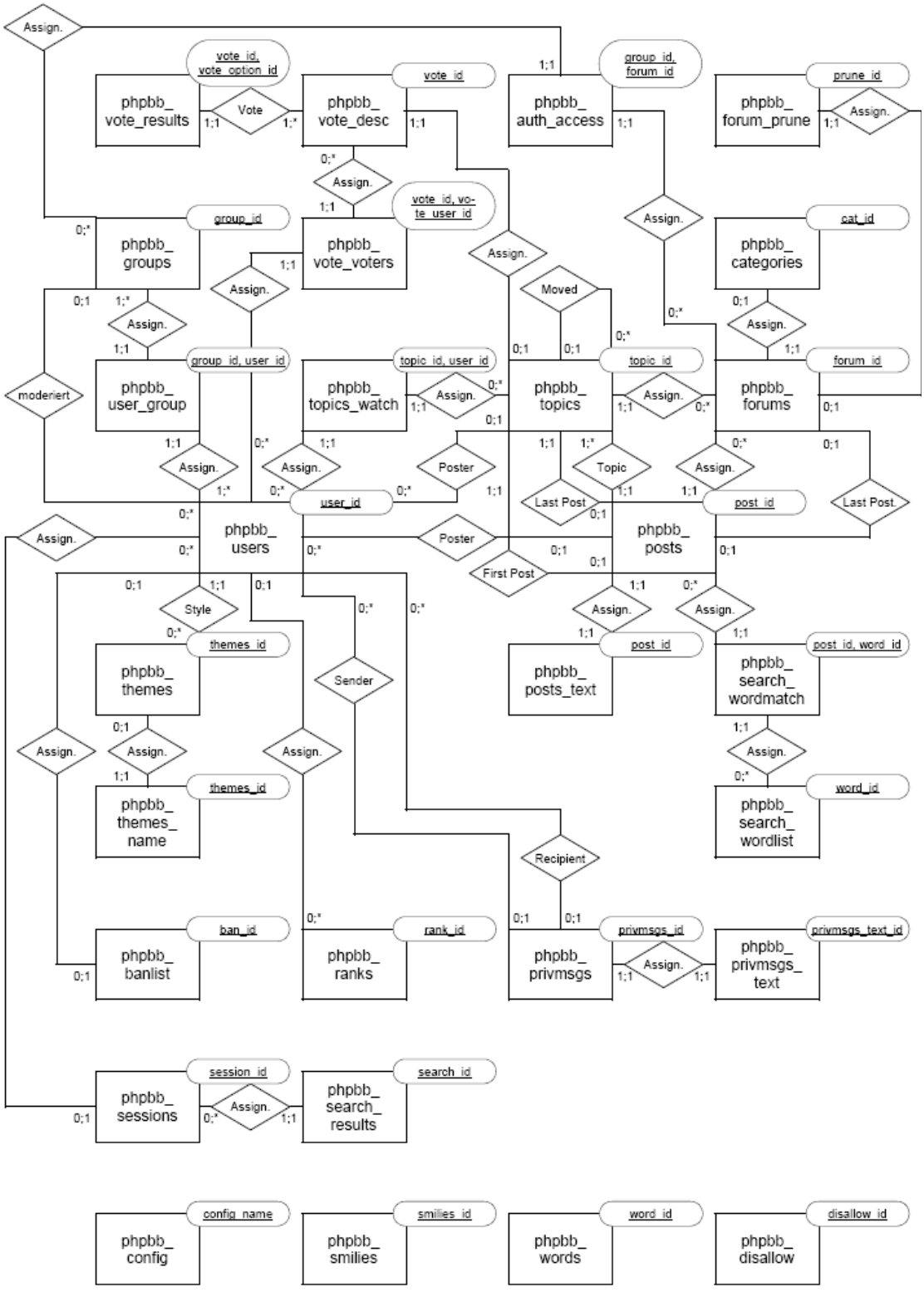
APPENDIX II phpBB DATABASE DOCUMENTATION

Table II.1: *phpBB* database tables description
(Source: phpBB Doctor, 2005a)

Table Name	Table Description
phpbb_auth_access	The base forum permissions are stored in phpbb_forums in the various "auth" columns. This table contains additional permissions or overrides based on group membership.
phpbb_banlist	List of banned users. Users can be banned by IP address, by email address, or you can ban a specific user by their user ID.
phpbb_categories	Categories are the first level of organization for your board. Each forum belongs to a category, while a category may have one (or more) forums. Permissions, however, are set at the category level. If (because of permissions) a user ends up with an empty forum list for a category, then that category is not displayed on the forum index.
phpbb_config	Board configuration values. The values are in a name / value pair. For example, a name of "sitename" has a value of "phpBB Demo". The values in this table may be provided by a default phpbb install, or there may be additional values added by various mods. These values are maintained via the **Configuration** option on the ACP.
phpbb_confirm	This table (available only in 2.0.12 or newer by default) is the result of a back-port of the visual confirmation code for Olympus.
phpbb_disallow	A list of usernames that will not be allowed on your board. Wildcards are allowed. For example, a value of admin* would prevent anyone from creating a username that starts with the letters "admin", and thereby (perhaps) impersonating an administrator.
phpbb_forums	Forums for your board. Each Forum belongs to a category. A forum contains Topics. User permissions are defined at the forum level, not the category level. That means that you can have forums with different levels of permissions within the same category. The optimal number of forums per category is open for debate.
phpbb_forum_prune	Contains information about pruning frequency if Auto-prune is enabled
phpbb_groups	A group of users
phpbb_posts	Posts for your board. Each post is part of a Topic.
phpbb_posts_text	The text for the post
phpbb_privmsgs	Private message summary
phpbb_privmsgs_text	Private message text
phpbb_ranks	Ranks for users

Table Name	Table Description
phpbb_search_results	Table used to store (temporarily) user search results. This table is not generally manipulated manually, only by search.php.
phpbb_search_wordlist	List of all words appearing in any post on your board. As each post is stored, it is broken down into words. New words are stored in this table and assigned a unique key. That key is used to cross-reference words with posts for searching.
phpbb_search_wordmatch	Cross-reference list of posts to words, used by the search algorithm. Essentially this is a listing of which words in the word list appear in which posts. It is used to provide a very effective way to search a large amount of text very efficiently.
phpbb_sessions	Table used to track user session
phpbb_smilies	Smilies list
phpbb_themes	Themes detail information
phpbb_themes_name	Themes
phpbb_topics	Topics for your board. A Forum contains Topics. A Topic contains Posts.
phpbb_topics_watch	Flag table to allow users to subscribe to a topic. When further posts are made, the user is notified.
phpbb_users	Base user information, preference settings, and so on.
phpbb_user_group	Cross-reference table between users and groups they belong to. Note that in the phpBB 2.x product every user is a member of **at least one group**.
phpbb_vote_desc	Poll item descriptions
phpbb_vote_results	Poll votes
phpbb_vote_voters	A record of which users have voted in polls
phpbb_words	Words that will be replaced (censored). It includes the source word and the replacement word. The original intent of this table (I believe) was to allow censoring of inappropriate content. You can also use it in creative ways like substituting correct spellings, redirect links to competitor web sites, or anything else that you can think of.

For the structure of individual tables, please visit http://www.phpbbdoctor.com/doc-tables.php and click on individual table for details.



FigureII.1: ***phpBB*** **2.0.x data scheme (Entity-Relationship Model)**
(Source: Kordowich, 2003)

Table II.2 File components of generic *phpBB*
(Source: phpBB Doctor, 2005b)

Path	File Name	Description
/	common.php	This code does general housekeeping chores, things that need to be done before any templates (like page_header) are called. Currently is manages the $HTTP_XX_VARS arrays (clearing out any unexpected values), checks server settings (magic quotes, etc.), includes a bunch of other files used on every page (constants.php, template.php, sessions.php, and so on).
/	config.php	Contains the database connection info (username, hostname, database, password). This file is created during the installation process, and should not be edited unless you're moving from one host to another. MODs that update this file could be considered risky.
/	extension.inc	This file contains essentially one line of code... the extension (extention) for the php files. This was done in order to support versions with different extensions (php3 versus php) without recoding the entire application. You'll see $phpEx in almost every phpBB file; this is replaced by the extension defined in this file.
/	faq.php	This is the FAQ (Frequently Asked Questions) manager. When you request a FAQ, it will load the requested language file, or if nothing is requested, the default lang_faq.php. The FAQ format is very easy to manage; you can edit it with any text file once you understand the format. Just be sure to escape any quotes with the backslash \' otherwise you'll get errors.
/	groupcp.php	The Group Control Panel. Users can use this program to view public groups and their members, to join or leave a group. Group moderators use this program to add or remove members from their group.
/	index.php	The forum index. In a default installation the index lists the categories and forums that a user is authorized to view.
/	login.php	The process of logging in and out is managed by this code.
/	memberlist.php	The list of members for your phpBB board.
/	modcp.php	MODCP = Moderator Control Panel This code includes moderator options to split, move, lock, and delete multiple topics at the same time.

Path	File Name	Description
/	posting.php	Handles posting and editing tasks.
/	privmsg.php	The main code for the private message system
/	profile.php	This is really just a shell that loads or calls other included files. The file / function is based on the mode passed on the URL, which can include register, viewprofile, editprofile, activate, and others.
/	search.php	Search your topics and posts. Also used to search for users, believe it or not.
/	viewforum.php	From the index you click to view a forum, which calls this code. This page displays topics within the forum, sorted by most recent activity.
/	viewonline.php	Who's online on the board within the past few minutes? The default period is 5 minutes but it can be easily changed.
/	viewtopic.php	Viewtopic is the third step down. Index shows categories and forums, viewforum shows topics in a forum, viewtopic shows the posts that make up the topic. The default order is oldest first, newest last. This can be changed with a MOD.
/admin/	admin_board.php	Manage the general configuration options (phpbb_config)
/admin/	admin_db_utilities.php	Back up or restore your database
/admin/	admin_disallow	Manage the banned user list (phpbb_banlist)
/admin/	admin_forumauth.php	Manage forum permissions (phpbb_auth_access?)
/admin/	admin_forums.php	Manage the forums and categories (phpbb_categories, phpbb_forums). This program is used to create / edit / delete / reorder forums and categories and also to resync forum statistics.
/admin/	admin_forum_prune.php	Do forum pruning (phpbb_forum_prune)
/admin/	admin_groups.php	Manage the phpbb_groups table
/admin/	admin_mass_email.php	Send out emails to groups, or to all forum members Uses a "bcc" strategy to avoid sending out a huge number of emails, but may be more likely to be identified as SPAM that way
/admin/	admin_ranks.php	Manage the phpbb_ranks table
/admin/	admin_smilies.php	Manage the smilies available on your board (phpbb_smilies)
/admin/	admin_ug_auth.php	User Group permissions page
/admin/	admin_users.php	Admin tool to review / update / edit / delete user accounts (phpbb_users)
/admin/	admin_user_ban.php	Here you can control the banning of users.

Path	File Name	Description
		You can achieve this by banning either or both of a specific user or an individual or range of IP addresses or hostnames. These methods prevent a user from even reaching the index page of your board. To prevent a user from registering under a different username you can also specify a banned email address. Please note that banning an email address alone will not prevent that user from being able to log on or post to your board. You should use one of the first two methods to achieve this.
/admin/	admin_words.php	Word censors (phpbb_words)
/admin/	index.php	Admin index... uses frames to display various admin pages as "modules"
/admin/	pagestart.php	Provides a similar purpose to "common.php" for regular pages... is used to set up / validate the session for an admin user
/admin/	page_footer_admin.php	As the name says
/admin/	page_header_admin.php	As the page name says
/db/	db2.php	DB2 database functions
/db/	msaccess.php	Microsoft Access database functions If you're really using MS Access for your forum database you are a brave, brave person :-)
/db/	mssql-odbc.php	Microsoft SQL Server database functions
/db/	mssql.php	Microsoft SQL Server database functions (non-ODBC)
/db/	mysql.php	MySQL 3.x database functions
/db/	mysql4.php	MySQL 4.x database functions
/db/	postgres7.php	PostgreSQL database functions
/includes/	auth.php	phpBB Authorization functions
/includes/	bbcode.php	phpBB BB Code parsing and related functions
/includes/	constants.php	various constants used throughout the phpBB system
/includes/	emailer.php	includes functions related to sending email
/includes/	functions.php	Various functions such as get_db_stat(), create_date(), and so on
/includes/	functions_admin.php	Various admin functions that were split out to a separate file to allow them to be called from multiple locations
/includes/	functions_post.php	Functions related to posting, like managing the search tables, inserting and updating the post, topic, and forum tables, and so on
/includes/	functions_search.php	Functions related to searching. Includes clean_words(), split_words(), add_search_words(), remove_common(),

Path	File Name	Description
		remove_search_post(), and username_search().
/includes/	functions_selects.php	Functions to build drop-down selectors used in various locations in phpBB
/includes/	functions_validate.php	Various validation functions
/includes/	page_header.php	Standard page header called in almost every phpBB page. This code sets up session variables, calls the appropriate header template, and populates it with various standard variables.
/includes/	page_tail.php	The "footer" counterpart to page_header.php
/includes/	prune.php	Contains the functions used to manage the forum / post pruning process
/includes/	smtp.php	SMTP mail functions
/includes/	sql_parse.php	I've never looked at this file, have no idea what it does
/includes/	template.php	Template processing system... this is the code that is responsible for turning template variables into actual content.
/includes/	topic_review.php	If the user has requested a post "preview" during the posting process, then topic_review.php is called.
/includes/	usercp_activate.php	Code used to activate users Included (called from) in profile.php usercp = user control panel
/includes/	usercp_avatar.php	Avatar management functions Included in (called from) profile.php usercp = user control panel
/includes/	usercp_confirm.php	New file in 2.0.11 (?) from a backport from 3.0, adds visual confirmation as an option Included in (called from) profile.php usercp = user control panel
/includes/	usercp_email.php	If users are allowed to email via the board, this file is used
/includes/	usercp_register.php	Registration code. However, this code is also used for editing an existing user profile as well as new registrations. So the filename is a bit confusing. It might should have been called usercp_profile.php instead. Included in (called from) profile.php usercp = user control panel
/includes/	usercp_sendpasswd.php	Code used when user requests a new password Included in (called from) profile.php usercp = user control panel
/includes/	usercp_viewprofile.php	Used to view a user profile. Note that this is a completely separate process from **editing** a profile, which is done with usercp_register.php instead.

Path	File Name	Description
		Included in (called from) profile.php usercp = user control panel
/language/lang_english/	lang_admin.php	Admin-related language entries
/language/lang_english/	lang_bbcode.php	BBCode notes in FAQ format, called from faq.php
/language/lang_english/	lang_main.php	Main language file, contains strings used throughout the phpBB system. The strings are referenced via this include file in order to create a separate file for translators to work with.
/language/lang_english/	search_stopwords.txt	A list of words that will be eliminated from the search_words table. Use this list to prevent frequently used words from filling up your search database.
/language/lang_english/	search_synonyms.txt	A list of words that will be substituted in the search_words table. This allows you to search for various spellings (or misspellings) of common words like "teh" for "the" or "flavor" and "flavour"
/language/lang_english/email/	admin_activate.tpl	The template file for the "welcome" email when admin activation is required. This template is for the email sent to the ADMIN and not to the user.
/language/lang_english/email/	admin_send_email.tpl	This template contains the header sent out on all mass emails. If you want to change the text that appears at the top of your mass emails from your board, this is where to go.
/language/lang_english/email/	admin_welcome_activated.tpl	This template contains the information sent out to a user after their account has been activated.
/language/lang_english/email/	admin_welcome_inactive.tpl	This template contains the body of the email sent out to a user after they have registered when ADMIN ACTIVATION is required. See also user_welcome_inactive.tpl for the text sent out when USER ACTIVATION is required.
/language/lang_english/email/	coppa_welcome_inactive.tpl	This template contains the text for the email sent out when COPPA has been invoked. COPPA is a privacy restriction for children under 13.
/language/lang_english/email/	group_added.tpl	This template contains the text of the email sent out when a user has been added to a group.
/language/lang_english/email/	group_approved.tpl	This template contains the text of the email sent out when a user has been approved for group membership. For certain types of groups a user will "apply" for membership. When the group moderator approves their application, this email is sent.
/language/lang_english/email/	group_request.tpl	This template contains the text for the email

Path	File Name	Description
		sent to the group moderator when a user has requested membership. See also group_approved.tpl which contains the email sent after the application has been approved.
/language/lang_english/email/	privmsg_notify.tpl	This template contains the text for the email sent when a new private message has been received. Note that this email is sent based on the user profile setting user_notify_pm from the phpbb_users table.
/language/lang_english/email/	profile_send_email.tpl	This template contains the text for an email sent via the board. This template is not used at all if the board configuration "User email via board" is turned off.
/language/lang_english/email/	topic_notify.tpl	This template contains the text used in the email sent to a user that is watching a topic when the first new reply is sent.
/language/lang_english/email/	user_activate.tpl	This template contains the text used in an email when a user is required to re-activate an account. If a user changes their email address then this email may be sent.
/language/lang_english/email/	user_activate_passwd.tpl	This template contains the text used in an email when a user has requested a new password.
/language/lang_english/email/	user_welcome.tpl	This template contains the text used in an email that welcomes a new user to the board. This template is used when no activation (ADMIN or USER) is required.
/language/lang_english/email/	user_welcome_inactive.tpl	This template contains the body of the email sent out to a user after they have registered when USER ACTIVATION is required. See also admin_welcome_inactive.tpl for the text sent out when ADMIN ACTIVATION is required.
/templates/subSilver/	agreement.tpl	This template is used to display the COPPA agreement during the registration process. Called from **usercp_register.php**.
/templates/subSilver/	bbcode.tpl	This is not a normal template, as used in the rest of phpBB. This template contains the mappings from BBCode to HTML, and is referenced in includes/bbcode.php only. For example, if you wanted all images processed via BBCode to include a border (or some other attribute) then you could edit this file. If you wanted all URL references to open in the same window instead of a new (_blank) window this is the file. There is a MOD from the phpBBDoctor that allows you to customize links so that links on the same server will open in the same window, but external links will still open a new window. Called from **includes/bbcode.php**.

Path	File Name	Description
/templates/subSilver/	confirm_body.tpl	This template is the confirmation box displayed when a user will be required to confirm an action. An example might be deleting a topic or post via the moderator control panel. Called from **admin/admin_styles.php**, **groupcp.php**, **modcp.php**, **posting.php**, and **privmsg.php**.
/templates/subSilver/	error_body.tpl	This template is the error message box displayed when an error has occurred. An example is the message that a user sees when they leave the subject blank on a new topic. Called from **admin/admin_mass_email.php**, **admin/admin_users.php**, **includes/usercp_email.php**, **includes/usercp_register.php**, **posting.php** and **privmsg.php**
/templates/subSilver/	faq_body.tpl	This is the generic template used to display FAQ entries. Called from **faq.php**.
/templates/subSilver/	formIE.css	This style sheet contains additional items specifically for Microsoft Internet Explorer. It appears in the subSilver theme but may not appear in all available themes for phpBB.
/templates/subSilver/	groupcp_info_body.tpl	This template is used to list groups from the group control panel. Called from **groupcp.php**.
/templates/subSilver/	groupcp_pending_info.tpl	This template is used by group moderators. It will show a list of all pending members and allow them to bulk approve / deny membership. Called from **groupcp.php**
/templates/subSilver/	groupcp_user_body.tpl	This is the user (rather than the moderator) view of group information. The user's current group memberships will be displayed, non-member groups will also be listed. Called from **groupcp.php**.
/templates/subSilver/	index.htm	This file may or may not exist in this location. It's designed to keep casual browsers from getting a directory listing of the files in this folder.
/templates/subSilver/	index_body.tpl	This template is used to display the board index, including cateogry and forum information. If you have something that you want to display on your board index and nowhere else, this is the file. If you have something that you want to see at the top (or bottom) of every page on your board look at overall_header.tpl and overall_footer.tpl instead. Called from **index.php**.

Path	File Name	Description
/templates/subSilver/	jumpbox.tpl	The forum "jumpbox" appears on many different pages in phpBB. This template is used to provide the layout for that feature. The template is referenced only in **includes/functions.php**, specifically the function make_jumpbox(). But that function is called from many different files in the phpBB system.
/templates/subSilver/	login_body.tpl	This template contains the layout information for the login screen. Note that this is for the dedicated login screen, not the (optional) login box that often appears on the bottom (or top) of the index page. Called from **login.php** as you might expect.
/templates/subSilver/	memberlist_body.tpl	This is the template that contains the layout for the member list. If you want to add anything to the member listing (like ranks, avatars, or other profile information) then you would need to edit the calling program **memberlist.php** as well as this template.
/templates/subSilver/	message_body.tpl	This template is similar to error_body.tpl but is used for general messages instead. This template includes redirect code that will send you on to another screen after reading your message. An example would be the message that confirms your new post has been entered, then after a slight delay, forwards you on to review your post within the topic. Called from **includes/functions.php**, specifically from the function message_die() which is used in nearly every php file used in the phpBB system. Note that there are two "message body" template files, one is dedicated for ADMIN use only.
/templates/subSilver/	modcp_body.tpl	This is the template that is first used by the moderator control panel (modcp.php) to display a list of topics. Called from **modcp.php**.
/templates/subSilver/	modcp_move.tpl	This template contains the layout code for the moderator Move operation. It includes the destination forum selector as well as a checkbox option for shadow topics. Called from **modcp.php**.
/templates/subSilver/	modcp_split.tpl	This template contains the layout code for the moderator Split operation. It includes the destination forum selector as well as an interface that allows the moderator to select which post(s) from the topic to split. Called from **modcp.php**.
/templates/subSilver/	modcp_viewip.tpl	This template contains the layout code for the moderator View IP address option. It allows a

Path	File Name	Description
		moderator to view the IP address for a post, see other users that have posted from the same IP address, look up the IP address, and other IP-related functions. Called from **modcp.php**. The modcp.php code is itself called from viewforum.php and viewtopic.php.
/templates/subSilver/	overall_footer.tpl	There are two footer layout files: overall_footer and simple_footer. The overall_footer.tpl is the layout used for most of the pages generated by phpBB. Popup boxes (like the PM notify or the smilies selector) use the simple header and footer. If you want something to appear at the bottom of every primary page of your forum then you would edit this file. This template is called from **includes/page_tail.php**
/templates/subSilver/	overall_header.tpl	There are two header layout files: overall_header and simple_header. The overall_header.tpl is the layout used for most of the pages generated by phpBB. Popup boxes (like the PM notify or the smilies selector) use the simple header and footer. If you want something to appear at the top of every primary page of your forum then you would edit this file. This template is called from **includes/page_header.php**
/templates/subSilver/	posting_body.tpl	No description provided
/templates/subSilver/	posting_poll_body.tpl	No description provided
/templates/subSilver/	posting_preview.tpl	No description provided
/templates/subSilver/	posting_smilies.tpl	No description provided
/templates/subSilver/	posting_topic_review.tpl	This template is used as a "layer" by the posting process. If the user has requested a post "preview" then topic_review.php is called, which loads this template. Called from **topic_review.php**.
/templates/subSilver/	privmsgs_body.tpl	No description provided
/templates/subSilver/	privmsgs_popup.tpl	No description provided
/templates/subSilver/	privmsgs_preview.tpl	No description provided
/templates/subSilver/	privmsgs_read_body.tpl	No description provided
/templates/subSilver/	profile_add_body.tpl	No description provided
/templates/subSilver/	profile_avatar_gallery.tpl	No description provided
/templates/subSilver/	profile_send_email.tpl	No description provided
/templates/subSilver/	profile_send_pass.tpl	No description provided
/templates/subSilver/	profile_view_body.tpl	No description provided
/templates/subSilver/	search_body.tpl	This is the template that contains the layout code for the search input form. If you want to

Path	File Name	Description
		alter the options available to your users for searching, you would probably modify search.php and this file. Called from **search.php**.
/templates/subSilver/	search_results_posts.tpl	The search routine offers several output formats. When searching the forum content (as opposed to searching for users) the user can opt to see the results as POSTS or TOPICS. This template is used to display the results in POST form. Called from **search.php**.
/templates/subSilver/	search_results_topics.tpl	The search routine offers several output formats. When searching the forum content (as opposed to searching for users) the user can opt to see the results as POSTS or TOPICS. This template is used to display the results in TOPIC or "summary" form. Called from **search.php**.
/templates/subSilver/	search_username.tpl	The search routine offers several output formats. When searching the forum for a specific user (as opposed to searching for post or topic content) this template is used to display the results. Betcha didn't know that the search routine was used to search for users as well as topic / post content, did you. :-) Called from **includes/functions_search.php**.
/templates/subSilver/	simple_footer.tpl	There are two footer layout files: overall_footer and simple_footer. The overall_footer.tpl is the layout used for most of the pages generated by phpBB. Popup boxes (like the PM notify or the smilies selector) use the simple header and footer. The variable $gen_simple_header is used to trigger the switch from the overall footer to this simple version. This template is called from **includes/page_tail.php**
/templates/subSilver/	simple_header.tpl	There are two header layout files: overall_header and simple_header. The overall_footer.tpl is the layout used for most of the pages generated by phpBB. Popup boxes (like the PM notify or the smilies selector) use the simple header and footer. The variable $gen_simple_header is used to trigger the switch from the overall header to this simple version. This template is called from **includes/page_header.php**
/templates/subSilver/	subSilver.cfg	This file is a bit interesting in that it's not really template or layout code, but it is related to a specific "theme" and so appears in the

Path	File Name	Description
		theme folder. It's essentially a series of array assignments that determine where the various images called by phpBB's code are located. It is called from the **setup_style()** function which is located in the **includes/functions.php** program file.
/templates/subSilver/	subSilver.css	External style sheet for the subSilver theme. It should be noted that by default this file is not used. You have to edit templates/subSilver/overall_header.tpl and remove the style elements from the template, and establish a link to the external style sheet.
/templates/subSilver/	theme_info.cfg	This file is similar to the subSilver.cfg except that it contains color and style settings as entered in the Admin Control Panel. No edits are generally applied directly to this file, as you would use the ACP instead.
/templates/subSilver/	viewforum_body.tpl	This template contains the structure for the topic listing for a selected forum. Called from **viewforum.php**.
/templates/subSilver/	viewonline_body.tpl	This template is used to display the online user list when the "Who's Online" link from the index page is accessed. Called from **viewonline.php**.
/templates/subSilver/	viewtopic_body.tpl	The viewtopic templates use a "layered" approach. This specific template file is used to display the post data for the selected topic. For other layers see the viewtopic_poll_ballot and viewtopic_poll_results template files. The popular attachment MOD also adds a template layer called from viewtopic.php, but is not documented here as it is not part of the official 2.x distribution. Called from **viewtopic.php**.
/templates/subSilver/	viewtopic_poll_ballot.tpl	The viewtopic templates use a "layered" approach. This specific template file is used to display poll voting options to members that have not yet voted. Called from **viewtopic.php**.
/templates/subSilver/	viewtopic_poll_result.tpl	The viewtopic templates use a "layered" approach. This specific template file is used to display poll results to members that have voted, members that have not voted but have requested to see poll results, and to guests (who can't vote in a default phpBB configuration). Called from **viewtopic.php**.
/templates/subSilver/admin/	admin_message_body.tpl	Admin template
/templates/subSilver/admin/	auth_forum_body.tpl	Admin template
/templates/subSilver/admin/	auth_select_body.tpl	Admin template
/templates/subSilver/admin/	auth_ug_body.tpl	Admin template

Path	File Name	Description
/templates/subSilver/admin/	board_config_body.tpl	Admin template
/templates/subSilver/admin/	category_edit_body.tpl	Admin template
/templates/subSilver/admin/	db_utils_backup_body.tpl	Admin template
/templates/subSilver/admin/	db_utils_restore_body.tpl	Admin template
/templates/subSilver/admin/	disallow_body.tpl	Admin template
/templates/subSilver/admin/	forum_admin_body.tpl	Admin template
/templates/subSilver/admin/	forum_delete_body.tpl	Admin template
/templates/subSilver/admin/	forum_edit_body.tpl	Admin template
/templates/subSilver/admin/	forum_prune_body.tpl	Admin template
/templates/subSilver/admin/	forum_prune_result_body.tpl	Admin template
/templates/subSilver/admin/	forum_prune_select_body.tpl	Admin template
/templates/subSilver/admin/	group_edit_body.tpl	Admin template
/templates/subSilver/admin/	group_select_body.tpl	Admin template
/templates/subSilver/admin/	index_body.tpl	Admin template
/templates/subSilver/admin/	index_frameset.tpl	Admin template
/templates/subSilver/admin/	index_navigate.tpl	Admin template
/templates/subSilver/admin/	page_footer.tpl	Admin template
/templates/subSilver/admin/	page_header.tpl	Admin template
/templates/subSilver/admin/	ranks_edit_body.tpl	Admin template
/templates/subSilver/admin/	ranks_list_body.tpl	Admin template
/templates/subSilver/admin/	smile_edit_body.tpl	Admin template
/templates/subSilver/admin/	smile_import_body.tpl	Admin template
/templates/subSilver/admin/	smile_list_body.tpl	Admin template
/templates/subSilver/admin/	styles_addnew_body.tpl	Admin template
/templates/subSilver/admin/	styles_edit_body.tpl	Admin template
/templates/subSilver/admin/	styles_exporter.tpl	Admin template
/templates/subSilver/admin/	styles_list_body.tpl	Admin template
/templates/subSilver/admin/	user_avatar_gallery.tpl	Admin template
/templates/subSilver/admin/	user_ban_body.tpl	Admin template
/templates/subSilver/admin/	user_edit_body.tpl	Admin template
/templates/subSilver/admin/	user_email_body.tpl	Admin template
/templates/subSilver/admin/	user_select_body.tpl	Admin template
/templates/subSilver/admin/	words_edit_body.tpl	Admin template
/templates/subSilver/admin/	words_list_body.tpl	Admin template

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Tang, T.M.Y., and D.J. Coleman (2005). "Design of a GIS-enabled Online Discussion Forum for Participatory Community Planning." *Proceedings of the 98th Annual CIG Conference*, Westin Hotel, Ottawa, ON, 13-15 June 2005.

Conference Presentations:

Presenter, "*Design of a GIS-enabled Online Discussion Forum for Participatory Planning*", 4th Annual PPGIS Conference, organized by Urban and Regional Information Systems Association (URISA) held at Cleveland State University, Cleveland, Ohio, U.S. on 31 July-2 August 2005.

Presenter, "*Design of a GIS-enabled Online Discussion Forum for Participatory Community Planning*", 98th Annual CIG Conference, organized by Canadian Institute of Geomatics (CIG) held at Westin Hotel, Ottawa, ON, on 13-15 June 2005.

Presenter, "*Design of a GIS-enabled Online Discussion Forum for Participatory Community Planning*", 13th Annual Atlantic Institute Student Research Conference (AISRC), organized by Université Laval, Québec, QC, on 19-21 May 2005.

Co-presenter (with Dr. David Coleman), "*Public participation GIS and prototype application*", Workshop on Web Mapping for the 21st Century in Health, Environment, and Public Safety Disciplines, organized by the New Brunswick Lung Association held at Wu Centre, University of New Brunswick on 3 March 2005.

Presenter, "*GPS-based Internet Transit Tracking for Fredericton Transit*", Conference on Climatic Change & Sustainable Communities: Real Problems, Real Solutions, organized by The New Brunswick Environment Industry Association (NBEIA), held at Sheraton Hotel, Fredericton, N.B. on 23-25 September 2003.