Spatializing science and technology studies: exploring the role of GIS and interactive social research

by

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Abstract

This thesis is an interdisciplinary study based on the interplay between science, technology and society in order to inform the design of knowledge exploration systems. It provides a rationale for the integration of science knowledge, geographic information, with digital libraries to build knowledge and awareness about sustainability. A theoretical reconceptualization of knowledge building is provided that favours interactive engagement with information and argues against a traditional model of science production and communication that is linear and unidirectional. The elements of contextualization, classification and communication form the core of the reconceptualization. Since many information systems entrench the traditional model of science production, the three elements are considered in light of library and information science and geographic information science. The use of geographic information systems is examined to identify how they can be used as part of a social learning model for scientific, social, cultural, and environmental issues to further assist people in connecting to place and sustainability.

Empirical data was collected from four case studies. One case study centred on the design and development of a web-based digital library called the Georgia Basin Digital Library, another two case studies focused on the use of part of this digital library with youth, senior and environmental groups in south-western British Columbia. The remaining case study observed a community deliberation to consider how knowledge exploration systems might support deliberation in future processes. The case study research confirms that collaborative research with communities is a fruitful way to engage with sustainability issues. Such collaborations require consideration of institutional arrangements, information collections, relationship building, technology transfer and capacity building.
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List of Abbreviations

ESRI  Environmental Research Systems Institute, Inc.
CHiRP  Community Habitat Resources Project
CS#1  Case Study #1: Coquitlam, BC
CS#2  Case Study #2: Whistler, BC
CS#3  Case Study #3: Bowen Island, BC
CS#4  Case Study #4: Design and development of Georgia Basin Digital Library
GBDL  Georgia Basin Digital Library Project
GBExplorer  Georgia Basin Explorer – web application built from the conceptual design of GBDL
GBFP  Georgia Basin Futures Project
GIS  Geographic Information Systems
GVRD  Greater Vancouver Regional District (now known as Metro Vancouver)
LIS  Library and Information Science
OGC  Open GIS Consortium
PPGIS  Public Participation Geographic Information Systems
RMOW  Resort Municipality of Whistler
SSK  Sociology of Scientific Knowledge
STAR  Sustainability Tools and Resources
STS  Science and Technology Studies
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This thesis is dedicated to
the life lived by my Auntie,
Krishna Devi Talwar
(1930-2003)

I am forever shaped by two worlds.
1 Introduction: Bridging between science, technology and society for sustainability

This thesis is an interdisciplinary study about geographical knowledge, where I use place as a focus for an exploration of technological issues related to developing knowledge and awareness of sustainability. The seeds for this project germinated as the development and use of the internet was reshaping how individuals and groups communicated and worked together locally and globally. These developments generated questions about the role geographic information and geographic information systems (GIS) could play in knowledge and awareness building in a world increasingly characterized by personal computing and interconnected networks of people and technology.

This work also emerges from my interest in experimenting with the design and development of geographic information for use in web-based environments by novice users of geographic information technologies. To that end, I embark on a theoretical reconceptualization of the use of spatial technologies that favours interactive engagement with information and argues against a traditional model of science production and communication to support users exploring ideas about local place and sustainability. Conceptually, sustainability embraces environmental, social and economic concerns and their interrelationships in the present and, importantly, over time. Using a case study approach, I provide an assessment of the use of emerging technologies by diverse communities of practice to serve self-defined objectives related to sustainability. I provide methodological recommendations on the design, development and evaluation of community-based knowledge and awareness building technologies. As a result of the case study research, I have provided findings about the use of spatial technologies in the types of community contexts I examined, which included knowledge discovery, technology transfer, and community decision making (or deliberative) processes.
In this introductory chapter, I frame the central issues that will be discussed throughout the subsequent chapters. These include a discussion of models of scientific knowledge production, communication models and information sharing and my efforts at reconceptualizing and extending science communication models and technology use for interactive engagement with core concepts of sustainability. Under scrutiny is the prevalence of a unidirectional model of science production and use that hinders a rich sharing of lived experience with published or peer-reviewed scientific knowledge (Jasanoff & Wynne 1998, 43). I argue that information and information technologies play a role in reinforcing this model, which becomes manifest as technological determinism and instrumental rationality\(^1\) (MacKenzie & Wajcman 1999). I also consider whether the role of information is sufficiently problematized within the established critiques of positivism, as found in the literatures of the sociology of scientific knowledge and science and technology studies.

### 1.1 Research premise

The initial spark for this research resulted from my curiosity about how the effectiveness of digital libraries could be augmented by integrating content, services, users, and technology in new and exciting ways (Marchionini & Fox 1999). That succinct editorial in a library and information studies journal provided a useful and resonant conceptual approach within which to consider the dimensions of a digital library that could be applied to geological information (Brodaric \textit{et al.} 1999; Talwar \textit{et al.} 1999). The initial exploration followed the route of pragmatics – how to build something that would encapsulate the meaning structures that geologists hold in their heads such that other professionals and knowledgeable lay-people would be able to gain access to relevant information in text, image and map forms (Brodaric & Gahegan 2002; Brodaric & Hastings 2002). This entirely practical response stemmed from an intuitive approach to a simple problem: could more and different people make use of geological and geographical information to make policy decisions? Traditionally, geological information has been developed and targeted toward

\(^1\) These concepts are described in more detail in chapter 2.
mineral exploration and energy supply fields, whereas the application of geological interpretations could extend into other domains such as biology or forestry if a more holistic perspective were adopted. In short order, my conceptual problem space was extended from supporting access to disparate information in geology to an interdisciplinary digital library that might ultimately enter into socially-relevant decisionmaking.

Throughout this dissertation, my goals are to:

- Explore the potential role of information and geographic information in building knowledge and awareness about sustainability;
- View GIS as an edge science that can blur boundaries between science and communication and to explore whether GIS can be used fruitfully as an enabling technology in an interactive social setting;
- Conceptualize a geolibrary as a kind of ‘metaGIS’ and to determine the implications for its use in exploring information about sustainability;
- Identify successful approaches to make use of GIS for the public to explore their community and identify key issues of concern;
- Articulate how the challenge of understanding sustainability provides a useful framing to explore the capabilities of web-based GIS and digital library technologies.

The implications of these issues lead me into the territories of the nature of knowledge production and communication, the sociology of scientific knowledge, user interaction design, information and communications technologies, social learning, knowledge management, geographic information systems, public decision making and community engagement issues. The theoretical implications of these literatures are woven into my arguments in Chapters 2 and 3 to create an interdisciplinary perspective on the list of issues I have raised above.
1.2 Research context

Throughout much of my doctoral research work I operated within a team research environment. I had the great pleasure of being part of an extremely talented group of researchers who were equally committed to furthering ideas about the use of geographical information systems and web-based technologies in order to facilitate dialogue about people’s concerns around sustainability. As a research team, we were interested in designing the conceptual framework for an online spatial information system – something we called a digital library and that others have called geolibraries (Goodchild 1998a, 2000a). These geolibraries would serve to make information 1) available and 2) meaningful to concepts of sustainability. One of our starting points as a research team was the notion that putting sustainability into action might be facilitated by a system that promotes building awareness and generating knowledge about local issues. Furthermore, we assumed that this could be related to broader theoretical concepts of sustainability.

A challenge that this research environment presented for the dissertation was to identify my own contributions to this research endeavour, as required by the academic process of producing a dissertation. Throughout this thesis, I represent my own ideas and arguments for why and how to deploy information systems in order to engage users in merging local and expert knowledge so that they could develop a view of environmental, social and economic issues that resonate with their lived experiences and their desired futures. While these are my own ideas, they have been deeply informed by my interactions with other team members and collaborators.

1.3 Methodological framework

I adopted a case study methodology for this dissertation research. Four case studies that co-exist in a complementary fashion were used to address the research issues identified in section 1.2. Each of the case studies addresses different elements of the research process,
from exploration (conceptual design of the Georgia Basin Digital Library\(^2\) and the web application called GBExplorer\(^3\)), to description (the studies of GBExplorer use in Coquitlam and Whistler, BC) and finally to observations on the use of spatial technologies for neighbourhood land use planning on Bowen Island, BC.

The case studies include

1) an examination of how youth and seniors used GBExplorer to build awareness and knowledge about sustainability in Coquitlam;
2) an exploration of how technology transfer can enhance local capacity in Whistler;
3) the use of participant observation to shape my perspective on how community dialogue can be supported with information technologies on Bowen Island; and
4) the design and development of the Georgia Basin Digital Library (GBDL) concept and the instantiation of these concepts into a web-based software application called GBExplorer.

Three of the case studies were located in communities, including the City of Coquitlam (case study #1), the municipality of Whistler (case study #2), and the municipality of Bowen Island (case study #3). The fourth case study (case study #4) reflects on the design and development of GBExplorer that formed the basis for the case studies in Coquitlam and Whistler. All of the communities are located in south-western British Columbia amidst a backdrop of increased population growth and limited opportunity (i.e. land base) to accommodate the growth. The region has established itself as an innovator in terms of sustainability in action through the Greater Vancouver Regional District’s Livable Region

\(^2\) I use distinct terminology to differentiate between the conceptual ideas of the web-based geolibrary for sustainability (Georgia Basin Digital Library) and the resultant application, GBExplorer, that was the software engineered, spatial data management, and user interface. The GBExplorer is the artefact of the concept of GBDL.

\(^3\) The Georgia Basin Explorer application can still be located through its original development site here: [http://www.georgiabasin.info](http://www.georgiabasin.info). Note that since this research has been completed operational aspects of the GBDL prototype have been transformed into a new application called Phoenix (in Canada) and GeoSemantica (in South America). It is available here: [http://phoenix.geosemantica.net](http://phoenix.geosemantica.net). A discussion of these implications and results of the research occurs in chapter 6.
Strategic Plan, the City of Vancouver’s recent Eco-density initiative, and through numerous green-building developments within the region (City of Vancouver 2006; GVRD 1996).

1.4 Structure of the dissertation

The purpose of my research is to characterize and critique the use of GIS and digital libraries for information providers and information seekers. My particular position is that these technologies have fallen short of their capabilities because they are used within a practice that does not fully address the social dimensions and implications of scientific inquiry.

The chapters in this dissertation are structured to guide the reader through the key theoretical elements to provide insights into knowledge and awareness building about sustainability. Briefly, in chapters 2 and 3 I focus on the relevant literatures of science and society studies and the use of GIS, respectively, to provide the necessary grounding for the selection of research methods covered in chapter 4. A description and some results for three of the case studies are provided in chapter 4. In chapter 5 I describe the components of Georgia Basin Digital Library while in chapter 6 I discuss how some community groups engaged with the GBExplorer application to share stories and perceptions of local sustainability issues (case study #1 and case study #2). Chapter 6 also presents some results from the observations from the community planning process on Bowen (case study #3) and reflects on the design of GBExplorer (case study #4). In the final chapter I provide some recommendations on the interplay of institutions, actors and technologies for knowledge exploration.

In chapter 2 I provide an overview of science production models and their critiques in an effort to reconceptualize the role of information and knowledge communication within the critiques of science represented in the sociology of scientific knowledge (SSK), science and technology studies (STS), and the social shaping of technology critiques. The SSK and STS critiques of science production are helpful in advancing our understanding of the interplay
between issues of concern to scientists and issues of concern to society. However, because of its emphasis on technical artefacts and science production, I postulate that the STS literature in particular does not sufficiently problematize the role of information and, by extension, what we commonly know as information technologies. I hope to add some reasoned reflection on this role to the discussion and in so doing extend these critiques of science production in a useful way.

The model that I propose in chapter 2 will also be reviewed and discussed with respect to extending the notion of digital libraries into a balanced integration of technology, community, services and content as proposed by Marchionini and Fox (1999). In particular I will argue that such an integration may be a useful approach to overcome technological determinism in the library and information sciences field’s research into digital libraries in the late 1990s and early 2000s (Borgman 1999; Chowdhury & Chowdhury 1999; Frew 2000; Marlino et al. 2001; McCray & Gallagher 2001; Toms 1999).

In the subsequent chapter, I follow with a more in-depth discussion of GIS in light of key issues raised from the social shaping of technology literature. Chapter 3, then, is where I provide a critique of the history and culture of GIS use. The impetus for this work was my realization that the potential for information technologies was underrealized in both academic and professional environments. These ‘technologies’ were geographic information systems and digital libraries. My bias was, in the first instance, that GIS were not exploiting the “IS” in “GIS” enough. Instead of becoming a more meaningful “IS” because the spatial dimension was being managed explicitly, these systems were often being used as glorified drawing packages, their analytical potential thus squandered, and they thus failed in facilitating the coherent and persistent management of both spatial and non-spatial data sources.

There are many parallels between the development and use of GIS and digital libraries, such as integrating diverse data types and classifying data for retrieval and analysis. In both
cases, there remain questions concerning whether and how these technologies contribute to societal knowledge. The products of GIS procedures have lacked a mechanism by which they can be returned to a knowledge collective and there has been no explicit provision to manage or steward these newly derived information assets/products. GIS implementations in the public domain have seen limited success as a means of integrating information among science and social science disciplines. Some of the limiting factors in Canada and BC include data access, training, spatial literacy, education and cost.

In recent years, participatory GIS has emerged as a field of inquiry to address questions related to the use of GIS by and for the public. As a result, urban and regional planning – particularly land-use, density and transportation planning concerns – have been a focus of participatory GIS research. By addressing issues of power, information stewardship, interdisciplinarity, public participation and metaphor within GIS, in chapter 3, I situate GIS practice within a new model for interactive social research using information technologies that was presented in chapter 2. During the course of the dissertation research, the field of public participation GIS (PPGIS)\(^4\) expanded considerably. The first use of the term occurred at the International Conference on Empowerment, Marginalization and Public Participation GIS, Santa Barbara, California 14-17 October 1998\(^5\), and since the first PPGIS conference in 2002 there have now been numerous meetings on the topic in the United States, Europe and Australia.

In chapter 4 I discuss the methods and how they were undertaken within this research. Using a blend of research approaches that included literature reviews, participant observation, and case study methodologies, I have engaged in an inquiry that embraces the deep connections between theory and practice for the design and implications of embedding

\(^4\) The terms public participation GIS (PPGIS), participatory GIS, and community GIS are terms that are interchangeably used to denote the use of GIS within public processes and usually where members of the public, or some organized group of the public, engage directly with the technology. The term PPGIS is used throughout the thesis.

\(^5\) See http://www.iapad.org/ppgis_principles.htm
technologies within social learning and policy processes. The research is divided into four case studies; three of which are described in this chapter. I provide the background and setup information on the case studies undertaken during this research: 1) the use of part of the GBExplorer application with community users in Coquitlam, BC, 2) the adaptation and use of part of the GBExplorer application with a community organization located in Whistler, BC and 3) a description of a series of community and technology engagements with the municipality of Bowen Island through the development of GBDL and subsequent research projects. The case studies represent different phases of the research and are not intended to be of a comparative nature but, rather, to provide support for how I developed the theoretical and conceptual frameworks about the development and public use of information technologies.

The design and development of the Georgia Basin Digital Library, which serves as the fourth case study, is detailed in chapter 5. The Georgia Basin region serves as the regional backdrop for a series of case studies that took place as part of a larger study. I explain the conceptual model used as a basis for the design of the Georgia Basin Digital Library. This conceptual model was intended to provide an alternative model of science communication that takes advantage of advances in web-based technologies for spatial information and embraces popular notions of communities of practice, social learning and civic science literacy (Brown & Duguid 1991; Chermack & van der Merwe 2003; Dillon 2000; Jonassen et al. 1999; Lewenstein et al. 2001; Robinson 2003; Roth & Lee 2002; Wenger 1998). The premise was deeply rooted in the belief that providing context to information is central to meaning-making. The project designers assembled a cross-disciplinary team with expertise in cognitive science, computer science, geographic information systems, and library and information science.

In chapter 6 I discuss the results of the case study work, where components of GBExplorer were used with senior and youth groups in Coquitlam (case study #1) and in Whistler, BC where I worked with a collective of community groups interested in environmental
conservation and community mapping (case study #2). I also provide findings from my experience within the community of Bowen Island as residents conducted a public consultation for the Snug Cove village plan, an official amendment to their Official Community Plan (case study #3). In addition, other spatial information technologies (visualization) and environmental and social indicators were used in a public dialogue series on Bowen Island. Observations gleaned from this experience contribute to the commentary on the relationship between deliberative processes and the use of information technologies. This chapter also includes reflections on the design of GBDL (case study #4).

My last chapter articulates conclusions and recommendations about the key dissertation research issues, including the role of geographic information in exploring issues related to sustainability, the design of a web-based digital library to provide a shared knowledge space to explore multiple perspectives and epistemologies about sustainability supported by information representation in the form of documents, narratives and spatial data. One of the primary outcomes of my research provides support for the notion that the process of introducing information technologies to new users ultimately affects its use. I discuss the outcomes from what was learned from the case studies about interactive engagement, knowledge discovery, technology transfer and the use of technology in participatory processes. Areas for future research are identified, most notably the need for increased attention on the institutional implications of interactive and participatory research that can support and advance the ways in which collaborative research is undertaken among organizations such as academia, government and communities.
2 A theoretical perspective: science, technology & society studies and information exploration

2.1 Introduction

In this chapter, the design of information systems for knowledge building and sharing is considered. The conceptual design of knowledge exploration systems that are meaningful for modern social and environmental issues necessitates a discussion of interplay between society, science knowledge and technological innovation. The elements that form the cornerstone of this conceptual design are derived from a synthesis of the literature from the sociology of scientific knowledge (SSK), science and technology studies (STS), and social shaping of technology, viewed from the perspective of information studies.

Many information systems entrench a pervasive, traditional model of how science knowledge is produced and shared. The current critique of this traditional model has been developed to specifically comment on the design of information and communications technologies and how they shape the negotiated territory between science, technology and society. Two domains of information science are implicated in this critique. The first domain is the field of library and information studies where there has been a lack of critical engagement from a philosophical perspective (Budd 2001; Hjorland 2005, 47; Sundin & Johannisson 2005). The absence of such critical engagement has limited the opportunity to explore the theoretical foundations of library and information science in more depth (Hjorland 2005). It also reveals the irony that a field concerned with the management, storage, mediation and search for different knowledge claims yet lacks consideration of the epistemological foundations for these claims (Sundin & Johannisson 2005, 24). The second domain of interest is web-based geographic information systems (GIS) used to support the creation and sharing of experiential and locally-relevant knowledge in forms that are visually and narratively rich (see chapter 3). This builds on previous work to engage with GIS from a critical perspective (Kwan 2002; Schuurman 1999; Schuurman & Pratt 2002). Rather than relying on traditional instrumentalist and deterministic views of technology,
information systems can be designed as a process relationship that focuses on the management of collective knowledge. Such an approach will transcend a prescriptive or reductionist view of how that collective knowledge is created, managed, and accessed. It can also assist in moving beyond an instrumental view of technology towards one that is more nuanced and meaning-laden.

2.2 Science & society

Questions of what science ‘is’ received considerable attention in the 1970s as a response to positivism. Scientific knowledge has been subject to scrutiny from disciplines such as the history and philosophy of science, sociology, cultural anthropology and the philosophy of technology (Feenberg 1995, 1999). These disciplines continue their critical explorations of whether science and its methods are separate and distinct from humans’ social and cultural contexts (Barnes 1974; Bloor 1976; Ihde 2002; Shapin & Schaffer 1985). In turn, this has raised questions about the production of scientific knowledge claims and how one claim comes to dominate another.

The doctrine of essentialism of kinds advanced by Putnam (1973) postulates that the role of science is to uncover essential properties that underlie the natural world, where nature possesses a unique and understandable structure in and of itself. By uncovering these essential properties, science takes on the role of explaining the natural worlds’ division into kinds. However, Bryant (2000) argues that the complexity of the natural world belies this doctrine of essentialism of kinds and its objectivist position. Bryant draws attention to weaknesses in the objectivist approach, namely the lack of regard for human perspective. By employing internal realism, she concludes that knowledge of the world can “never be pure, direct or unmediated, since experience (knowledge) requires prior conceptualization or structuring, it requires the adoption of perspective [and thus,] perspective allows for more than one true description of the world” (Bryant 2000, 37).
The sociology of scientific knowledge discipline also critically examines the notion that science results in uncontestable truths that are subsequently used to determine societal implications and associated policy responses. This notion has been referred to as ‘speaking truth to power’ and carries two implications: (1) that scientific uncertainty has been reduced sufficiently to make a claim about scientific knowledge and (2) that the political domain (i.e. society or policy) will base its response on the objective knowledge claim (Jasanoff & Wynne 1998). The ‘truth speaks to power’ notion continues to persist in society. It often underpins regulatory and legal frameworks that use science as a basis for judgments (Jasanoff 1987).

A vast and influential scholarship has emerged that takes issue with the linear, ‘truth speaks to power’ model of scientific knowledge production and claim-making (Collins & Pinch 1994; Gibbons 2000; Gibbons et al. 1994; Jasanoff & Wynne 1998; Knorr-Cetina 1981; Nowotny et al. 2001; Sarewitz 1996; Wynne 1992). Many of the early studies focused on the actual practice of laboratory science and on the notions of scientific controversy and how disagreement affects scientific claim-making (Latour & Woolgar 1979; Lynch 1985). These studies examined how science is conducted in laboratories and other settings where knowledge claims become stabilized. This led to a wealth of empirical observations about the settings of innovation as well as narratives about how science is actually practised (Knorr-Cetina 1981; Latour 1987; Shapin & Schaffer 1985). These studies called into question the role and nature of replicability in the scientific method by highlighting local effects within laboratories. Latour (1987, 15) notes “other people shy away from the disorderly mixture revealed by science in action and prefer the orderly pattern of scientific method and rationality”. In so doing, differences were highlighted between how science should proceed (rigourous and objective manner) and the messy, contingent, and localized procedures that actually occur within a specific laboratory.

Although society has been informed by science for over half a millennium, this relationship has recently undergone some re-thinking in order to signal a closer interaction between science and society (Gibbons 1999, 2000; Gibbons et al. 1994; Nowotny et al. 2001). These
authors acknowledge that such a claim is not particularly bold but insist that the idea bears repeating (Nowotny et al. 2001, 2). Indeed, it continues to bear repeating, particularly in light of the emergence of new settings, such as knowledge systems and web-based GIS that contribute to a reconfiguring of how individuals and groups engage in new knowledge production and sharing.

2.2.1 Social contract with science

At the close of the 20th century, many researchers were calling for a rethinking of the science-society relationship that included identifying key areas of scientific inquiry for the next century (Cutter et al. 2002; Gibbons 2000; Goodchild 2000b; Lubchenco 1998). The previous century of scientific endeavours had provided society with improved medical understanding of our minds and bodies and greater understanding of the evolution of the earth (Lubchenco 1998).

During the Second World War, the scientific research effort was keenly focused on augmenting military power through the creation of the atomic bomb. The scientific research agenda for the post-war era in the United States sought to shift from a military and security emphasis to other benefits of the use of science for the material betterment of society, particularly economic betterment (Bush 1945a). Key areas of focus included medical research (war on disease), and basic scientific research (the U.S. reliance on fundamental research from Europe diminished due to rebuilding efforts), and the training of scientists (Bush 1945b). Gibbons (2000) notes that the prevailing contract between science and society has been one where the expectation of science is to produce reliable and credible knowledge and that those discoveries would be communicated to society. Similarly, the persistent thread throughout Bush’s research program is the betterment of society as a direct result of scientific work. In his view, science provides the “swiftest communication” between individuals (Bush 1945a).
The idea that scientific information, including the outcomes of social scientific research, should serve some societal or public purpose was reinforced by Lynd (1939 in Innes 1998). Bush (1945a) argued that scientists in the post-war period should turn their attention to the management of the vast store of scientific knowledge that existed and synthesize it in some manner to derive societal benefits from existing knowledge. Bush’s position identifies knowledge management as a key challenge for the scientific endeavour. In a more recent twist on a similar argument, Willinsky (1999) suggests that a key challenge within the social sciences is for the public to be better served by what we already know. Even though a progression from scientific knowledge to social science and policy impact is expected from the enterprise of science, Innes (1998, 53) notes that “the literature offers few examples of when social science or formal information, specifically, has influenced public decisions because of its substance”.

The policy domain is directly implicated in this underlying notion that science can directly benefit society since policy instruments are used to govern collective behaviours and social norms. However, there are numerous examples, particularly in land use planning, that highlight the inability of increased scientific information to transform policy outcomes (Feldman 1989; Szanton 1981; Caplan 1975). Jasanoff (1987) has also noted a similar challenge in environmental policy and health regulation. Lindblom and Cohen (1979) call into question the usability of the formal information produced by experts (in Innes 1998). Indeed, there is more literature documenting the failure of information to influence decisions than demonstrating success, as Innes (1990) has contended. Although it is easier to show that there are strategic and symbolic uses for information, as outlined by Weiss (1979), it “remains difficult to demonstrate that the information produced for policy making does serve instrumentally rational purposes” (Innes 1998, 60). Sarewitz’s (1996) ‘myth of infinite benefit’ also discounts the idea that increased science and technology will lead to more public good and notes that although the sociology of scientific knowledge literature has effectively countered this myth, it remains prevalent in the policy arena and influences policy decisions. It seems counterintuitive that public good would not be enriched by more
science and technology. But one of the major reasons for this lack of connection is the problematic nature of the conceptualization of science and technology that underlies this unidirectional model of science impacts on policy (i.e., as argued against in the preceding sections). A more useful way forward would embrace the co-production of scientific knowledge where a focus can emerge on qualities and characteristics of socially-robust knowledge (Gibbons 2000; Gibbons et al. 1994; Nowotny 2003; Nowotny et al. 2001). This approach provides a foundation from which the ‘myth of infinite benefit’ can be cast aside in favour of an open, dynamic, multivalent relationship between science, technology and society.

The issues raised within this chapter extend the science-technology scholarship into the challenge of knowledge building and social learning. Knowledge systems that support a reconfiguration of the interaction between science and society need to be designed to reinforce and enable a more pluralist model of information sharing and discovery. In a similar vein that the sociology of scientific knowledge and social studies of science raised questions and critiqued of the traditional, linear science production model from, there also exists a set of questions about technological progress (Pinch & Bijker 1984). This is the focus of the next section in this chapter.

2.3 Technology & society

Originally the meaning of technology referred to the study of arts and crafts and encompassed the knowledge that masons and painters should possess. As the standardization of trades and skills became more common at the beginning of the 19th century with the advent of engineering schools, a shift in the meaning of the term “technology” took place. Its meaning transformed from one of arts and crafts to “include and emphasize purposeful invention and, by implication, the strategic deployment of such inventions” (Rip & Kemp 1998). As such, the sense of utilitarian, functional, and dedicated purposefulness began to infuse society’s view of and approach toward technology: it became an instrument to be taken up and used for some practical reason.
In terms of technological innovation, scientific knowledge has traditionally been expected to yield advances and growth in material production. The assumption that technology is asocial and that its outcomes are predictable and well-defined is known as technological determinism (Sorensen & Williams 2002; Winner 1986, 1993). Such determinism implies that the development of technology follows a predictable path that is independent and beyond influence from cultural or political spheres. However, the risk of treating technology as exogenous is recognized by the critiques from the social construction of technology and the social shaping of technology (Bijker et al. 1987; Bijker & Law 1992; MacKenzie & Wajcman 1999; Pinch & Bijker 1984). These critiques are closely connected and informed by the sociology of scientific knowledge.

They suggest that, in an effort to bring technology and society together, the view of technology as exogenous to society needs to be overcome (Rip 2003). When technology is exogenized, it is separated from society. This cannonball view, where technology is akin to a wrecking ball crashing into the brick wall that guards society, reinforces the sort of linear models of technology diffusion that suffer the same limitations as speaking truth to power. In such a view of technology, society is impacted by technology in a unidirectional manner. Such a view undermines the notion that there is a mutual interaction between technological artefacts and society and, as such, also reinforces the misguided idea that society and human behaviour (such as the reaction to a new technology) can be wholly predictable.

Research into the social shaping of technology, an outgrowth of the critiques of technological determinism, focuses attention on technology developers and technological design as artefacts that are socially shaped (Russell 1986; Russell & Williams 1987). The social shaping of technology research agenda is grounded in the notion that the relationship between technology and society is highly interactive. Technology can act as a catalyst, engendering a shift occurs in the social order that enables new options for actors and strategies to make use of the destabilized situation (Sorensen & Williams 2002). When a
technology is introduced, if it is transformed from an alien element into a familiar and embedded one, then it has integrated with the actors and the meanings they attribute to the technology. This is referred to as domestication. Entrenchment is the outcome of the collective process of domestication wherein the technology becomes part of a stable sociotechnical configuration (Sorensen 2000). As technologies become entrenched they provide opportunities for reflexivity and interactivity that contribute to technology being viewed as an object of policy and not just an instrument of economic growth (Sorensen & Williams 2002; Woolgar 2000). Technology is given meaning through a collective process in which actors shape the catalyst, domestication and entrenchment of technology. The notions of catalyst, domestication and entrenchment are germane to the issue of how to design knowledge exploration systems because the successful design and use of such a system necessarily involves these stages.

A co-production approach between science and technology offers a useful framing point for the design of scientific information systems that are socially relevant. Thus, the creation of a socially robust information system must incorporate co-production elements into its design:

As technology moves from the restricted domain of technological institutions and becomes more pervasive in economic and social life, it impinges upon the activities of a wide range of decision-makers with more general remits. Thus today, information and communication technology has become an issue across virtually all policy domains and sectors.

(Sorensen & Williams 2002, 4)

This weaving of socially relevant or socially robust knowledge into policy domains extends to the artefacts that deal with the storage, manipulation, management and transfer of information, namely the information and communications technologies referred to above.

Engagement with socially robust knowledge can also be considered from a social learning perspective. Jonassen et al. (1999) discuss a shift in how technology is used in educational environments toward enabling learners to construct knowledge through engagement. They
describe ways for technology to support individual and social meaning making that build on the idea that learning results from thinking that is engaged by activity. In addition, they assert that learners do not actually learn from teachers, technologies or well-structured databases of neutral information. Rather, people learn from experiencing phenomena, folding this into the experiences and information already known, and then reasoning and reflecting on the phenomena. Bruner (1990) views this process as one of meaning making.

Relating and classifying new knowledge against what is already known draws attention to the importance of context of the experience (Brown & Duguid 1991; Wenger 1998). New knowledge is anchored within the informational context surrounding it which includes how the learner constructs that knowledge in light of what the learner already knows. Experiences and perceptions shape the knowledge production experience. “Knowledge-building requires articulation, expression, or representation of what is learned (meaning that is constructed)” (Jonassen et al. 1999, 5). In order for an information system to support such knowledge-building activities, the system must support an individual user in articulating or expressing what they are learning, experiencing and how this relates to their world. Since no two people have the same experiences and their perceptions of the world differ, there are multiple perspectives on the world: a successful information system must be designed to accommodate these perspectives.

This section identified the relationship between technology and society as co-informed, or socially shaped, in a manner similar to the way in which science and society are co-informed. As such, a more nuanced model of the interaction between science, technology and society is advanced to overcome limitations of linear models of scientific knowledge production or technological innovation. The next section explores how these ideas point to three key elements that must be considered in the design of information systems to support the sharing of socially robust knowledge.
2.4 Beyond linearity – contextualization, communication, and classification

Given the aforementioned concerns about the linear transformation model between science and policy, or between technology and society, it is useful to consider ways of reconfiguring an approach to knowledge building that eschews such a tradition. Society is currently being transformed into an increasingly networked society, demonstrated by the widespread public use of the internet and communications technologies (Berners-Lee 1999; Capurro & Hjorland 2003; Castells 1991, 1996). Thus, it is also important to discuss how an information or knowledge-based society could contribute to an agenda that moves us beyond such linear transformations in decision making and knowledge exploration.

At the root of the problems with instrumental rationality and technological determinism is the unidirectional, linear relationship between science and decision making. Where, then, does the issue of building awareness of new knowledge (not new knowledge production per se) become situated and what role does it assume in light of the convincing critiques from SSK and STS that support the co-production of knowledge? Three constitutive elements that should be considered in the design of such a system are proposed. These include 1) the context of the knowledge, 2) its classification and 3) the communication model on which such a system is based. Taken together these elements, referred to as the 3C approach, are presented as important criteria for the design of knowledge systems that do not inadvertently reinforce linear models between science, technology and society. The 3C elements are discussed in turn below and their implications for design are explored in the subsequent sections.

2.4.1 Context

There are many examples of the importance of local context in the environmental policy field. For example, Honadle (2003) provides a thoughtful account of the need for attention to context, to local settings, in his work on linking environmental policy to people and place. Drawing on a series of examples from his extensive work in developing nations, he emphasizes the importance of context for natural resource and environmental policy to
promote sustainable development. Many of his examples address the challenges of technology transfer in the agricultural sector in Africa. The seemingly simple example of importing a plough from India to Tanzania faced unanticipated problems when it was discovered that the bullock required to pull the plough is a completely different size in Tanzania than in India. The imported solution fails because the full spectrum – the social and the problem context – were not taken into account prior to introducing the instrumental solution. This is also important in light of the popularity of ‘best practices’ from one location being imported to another as a means to build on a local experience. The act of taking the technological solution out of context and reapplying it elsewhere calls into question whether we should be reconsidering the idea of best practice and replacing it with a ‘best process’ that would take into account the local context of the problem as well as socially- and culturally-relevant factors. This notion of best process has been proposed in the health promotion literature (Green & Krueter 1991).

The previous example highlights that modern societies are increasingly complex. Any conceptualization of the relationship between science and society must grapple with this shifting complexity. This is occurring as the tacit contract between science and society is shifting from one where science speaks to society to one where, increasingly, society makes demands and speaks back to science. The blurring of the boundaries between science and society has implications for rethinking knowledge and the processes and products that are involved in its generation, construction and access (Gibbons 1999, 2000; Gibbons et al. 1994; Nowotny et al. 2001).

Gibbons uses the term contextualization to describe the process of how modern society is shaping, and is shaped by, science. Nowotny (2004) asserts that contributing to joint problem solving is more than simple juxtaposition of different types of expertise but, rather, knowledge and expertise are transgressive. She frames the notion of knowledge ‘seeping’ in both directions between science and society where multiple actors bring key skills and expertise to a context of application, where the value-added quality of context infuses the
definition of good science that integrates societal values. Therefore, the importance of context is underscored as a key element that supports the transgressive nature between knowledge and expertise.

By adopting a research approach that is interactive, the research activities can benefit from and be enhanced by the diverse contexts in which the research is situated (Caswill & Shove 2000; Robinson 2008; Scott et al. 1999; Woolgar 2000). Indeed, many contextual factors such as the process of how science is conducted or how technology is engaged can drastically affect research outcomes, particularly when public stakeholders are involved. As Beierle & Konisky (2000) have noted “the process of participation appeared to be more important than the context in which participation took place...successful participation ...related to features of...process”. The important elements of interactive research include deliberative process, two-way communication between the participants and the government agencies, and obvious government commitment to the process. Such interactivity highlights the reality that contextual factors have implications for stakeholders.

### 2.4.2 Classification

Classification is the “process by which human beings group together particular entities and treat them as equivalent in some sense or senses” (Bryant 2000, 11). Kwasnik (1992; 1999) sees classification as the meaningful clustering of experience. This supports the idea that classifications can be socially constructed. In cognitive terms, it is a means to develop relationships between entities, allowing some to cluster and others to remain distinct, based on certain criteria. Associations between specific concepts are held within the brain, this structure leads to understanding. Metaclassification examines the foundations and shifts of features within classification systems in general and examines the shape and structure of taxonomies and categories (Bowker & Star 1999).

Humans classify to communicate information in the aggregate (Bowker & Star 1999). Classification is an attempt to create order out of chaos, to develop linkages and
understanding by grouping and relating ideas or concepts. In their exploration of how classification systems have been designed and used, Bowker and Star examine how semantic conflicts are managed by reviewing theories of formal and informal classification. The pre-existing cognitive model of Miller, Galanter and Pribram (1960 quoted in Bowker and Star 1999) stated that people derive formal, abstract plans and then execute them. In the 1980s, the failure of formalism was acknowledged with the inability of expert systems to capture tacit knowledge. This was reinforced with Suchman’s (1987) work on the situated action perspective that led to a critique, and explanation, of artificial intelligence’s inability to formally specify the mind. Bowker and Star offer a reconsideration of formal and informal classifications and note that the two operate in conjunction, often seamlessly, such that the two systems can become indistinguishable and are lost to the historical record. Traces of politics and bureaucracy are often incorporated and persist in classifications. As a result, classification also becomes an instantiation of the social and political forces operating concurrent to the establishment of a scheme (Bowker and Star 1999, 54).

Classification schemes represent views of how the world or a particular domain may be ordered. Such a scheme is typically manifested through language and this language is open to interpretation by all users. It is for this reason that within the library community, controlled vocabularies and reserved names were developed to inject some consistency into schemes that were to be widely applicable. The implementation of classification schemes sometimes suffers from the need to establish a single (one-to-one) entry between an information object and a classification, which can prove to be prohibitively restrictive.

From a philosophy perspective, Bryant (2000, 45) observes that scientific classification of natural (non-manufactured) objects is not simply a reflection of the way the world is structured but includes an element of choice and decision on the part of the scientist doing the classifying. This is reminiscent of earlier arguments presented from the SSK and social constructivists that view the scientist is an actor in his/her own network. Recall, from earlier in this chapter, that knowledge of the world requires the adoption of perspective thus
allowing for multiple views of the world. This pluralist approach suggests that scientific classification is not clear-cut but a process in which humans play a role in the categorization process.

The endeavour of classification – or ‘sorting into kinds’ – is based on three principles: 1) objects are similar or different in more that one way, 2) classification is not solely based on lists of attributes but also includes some holistic or inferential reasoning and, 3) human concepts are sensitive to context and not stable across all situations. This framing of human categorization blurs the distinction between expert and lay classification; indeed it indicates that expert classification is more similar to lay classification than many believe. The contextual nature of classification is reinforced by “the temporary consensus which form around particular definitions of science tends to be an index of contingent social and institutional interests rather than a more lasting description of essential core characteristics” (Bryant 2000, 47). Bryant’s arguments provide insights and support for the idea that classification and the process of categorization is a pluralist account of the world, thus reinforcing the requirement that information systems operationalize the ability to access and explore multiple perspectives on an issue.

2.4.3 Communication

Shannon and Weaver (1949) developed a transmission model of information communication where an information packet is transmitted linearly between a sender and a receiver in order to maximize the efficiency of telephone cables. This mathematical model did not explicitly treat the content of the information packet as relevant but merely something that required transmission between the end points of a source and a destination. The information content could be decoded using commonsense and would occur objectively without interpretation from the receiver. In their model, information from a sender was encoded, transmitted through a channel, and the receiver decoded the original message from the signal. This simplistic model of human communication led to further research between communication and information theory. However, the model is typically faulted
because it does not consider the meaning of the information packet but, rather, treats the information as any other commodity capable of being shipped from point A to point B.

Although the transmission model was developed by engineers and is mechanistic and functional in its framing, it has endured in popular language through such common phrases as “convey meaning” and “getting an idea across”. The persistence of such ideas in our everyday language is also – arguably – a direct result of the idea that science is ‘communicated to’ the public or stakeholders under the prevalent model that is not consistent with the claims of SSK scholars about the actual practice of science or the way it interacts with the policy process. Together, the transmission model of communication and the idea that science informs the public or policy have reinforced ideas of technological determinism and instrumental rationality in the communicative acts of society at large.

The conduit metaphor frames a transference model of human communication where ideas, in the form of words, need to get across from a sender to a receiver (Reddy 1979). The conduit metaphor is based on four core ideas:

1) language functions like a conduit, transferring thoughts bodily from one person to another; (2) in writing and speaking, people insert their thoughts or feelings in the words; (3) words accomplish the transfer by containing the thoughts or feelings and conveying them to others; and (4) in listening or reading, people extract the thoughts and feelings once again from the words.

(Reddy 1979, 290)

In this metaphor, “the speaker puts ideas (objects) into words (containers) and sends them (along a conduit) to a hearer who takes the idea/objects out of the word/containers” (Lakoff & Johnson 1980, 10). The implications for learning from the conduit metaphor of knowledge transfer is that learning would then be unproblematic, effortless and accurate and could even be expected to be consistent among receivers.

Reddy notes that the threads of the conduit metaphor are everywhere in society and that the implications of this metaphor may bias our thinking. The conduit metaphor reduces human
communication to the transmission of messages without a deeper conceptualization of meaning-making. Reddy proposes an alternate paradigm that is based on the idea that successful human communication involves an increase in organization. His alternative metaphor serves to draw awareness to the persistence of the conduit metaphor. The limitations of the conduit metaphor reinforce the reality that some statements have no meaning without a context for the statement—that words are not always sufficient to convey meaning if not contextualized.

Habermas (1984) outlines a new way of building rational knowledge in his *Theory of Communicative Action*. Devised on the premise that scientific knowledge is not the only valid knowledge, he suggests including other types of valid knowledge such as instrumental, ethical and aesthetic knowledge. In their article on a transdisciplinary research group in suburban planning, Després and colleagues (2004) provide a succinct summary of these other forms of valid knowledge, according to Habermas. Instrumental knowledge refers to pragmatic knowledge, the knowledge of how to go about things. Experienced professionals, technicians or workers are generally the main channel for this knowledge. Ethical knowledge, however, corresponds to customs, beliefs, values and past experiences which bring people to determine what is wrong and what is right on specific issues. Citizens and elected officials are key sources for these types of knowledge. Aesthetic knowledge comprises images, and refers to aesthetic experiences, tastes, preferences and feelings that help define what is beautiful and what is ugly. Although experts can express their ethical and aesthetic position, non-experts are as skillful in doing the same because they too experience everyday life in ethical and aesthetic ways.

For Habermas, cognitive rationality or scientific knowledge alone cannot explain everything (Després et al. 2004). The four types of knowledge he describes, scientific, instrumental, ethical and aesthetic, can come together when the people holding these different types of knowledge interact and communicate. It is in this type of interactive communication that knowledge can be augmented and emerges out of the process of engagement. This process,
where holders of these different knowledge types “learn to listen and understand each other is called intersubjectivity” (Després et al. 2004). This argument for the need to support multiple types of meaning is helpful in supporting pluralistic perspectives on knowledge generation and sharing. Taken with the previous argument concerning how the conduit metaphor uses a linguistic argument to emphasize the importance of context, these arguments imply that contextualization and multiple forms of communication are integral criteria for socially robust knowledge systems.

Germane to the issue of the design of knowledge exploration systems is the Habermasian idea that any communication process involves a mediated dialogue of generating mutual understanding among stakeholders, exploring different viewpoints and understanding different perspectives. The result of such a process is a communicative rationality where mutual understanding from multiple viewpoints is achieved. By incorporating design elements that support communicative action rather than a transmission communication model, a knowledge exploration system will be more suitably equipped for the social sharing of knowledge.

This line of reasoning is supported by the notion that the iterative and co-evolutionary nature of the relationship between science and society is shaped by the actors, their motivations and social norms. The outcomes of such processes are emergent from the very interaction that takes place (Robinson 2003, 2004).

2.5 Implication of this theoretical approach for knowledge sharing in libraries

Libraries are one of the most enduring of human institutions\(^6\) and are often viewed as cultural dimensions of society insofar as historical societies used libraries and were affected by libraries (Lerner 1998). Libraries have acted as repositories of knowledge since Ptolemy and his librarian, Demetrius, gathered together books of Greek poetry, Hebrew scriptures

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\(^6\) The Library of Alexandria is one of the earliest examples of a civilization gathering, managing and classifying written works (see Lerner 1998 for additional information on the evolution of libraries).
and other manuscripts. The advancement of libraries as we currently know them is intertwined with the history of the advancement of science:

In the *Advancement of Learning* (1605), Francis Bacon divided all human knowledge into History (memory), Poesy (imagination), and Philosophy (reason), for each of which he offered further subdivisions... Thomas Jefferson used this adaptation of “Lord Bacon’s table of science” as the basis for arranging his own book collection in 44 “chapters”. When his books were sold to the United States government, a modification of his classification scheme was used in the Library of Congress for several decades, and it has some influence on the design of the modern Library of Congress Classification.

(Lerner 1998, 133)

Libraries have exercised the role of building collective knowledge for a community of scholarly researchers through the development of collections within university libraries. The public library, in the sense that we now use the term, emerged in response to the need of an evolving democracy to socialize immigrants for urban industrial society (Lerner 1998). Materials traditionally collected by public or academic libraries included books and journals, as these materials were deemed to have both intrinsic worth and permanent reference value. The dominant ethos of a library is the selection and preservation of material for the permanent use of a wider community and to serve as a cultural meeting space (American Library Association 1939). With advances in telecommunication and the associated rise of digital information, access to information has increasingly replaced the provision of books as focus.

Library and information science (LIS) manifests itself within the domain of applied research and problem solving. This domain provides a rich professional practice but lacks critical engagement with the research tenets that underlie this practice (Bishop et al. 2003; Budd 2001; Hjorland 2005; Sundin & Johannisson 2005). Until recently, there had been little research to indicate that the LIS discipline had reflected on how positivism had infused its approach as a neutral conveyor of objective knowledge claims. Value neutrality is “highly regarded as a professional outlook for librarians” (Dick 1995, 217). The research agenda
within LIS has largely been occupied with the “library’s structural and functional characteristics...determined by its definition as an institution contrived to consume, preserve, transmit and reproduce high culture in printed form” (Harris 1986). Thus the field faces a curious paradox since LIS, a domain that concerns itself with the classification, management, storage and retrieval of knowledge (objects) and knowledge claims, performs minimal critical examination of the knowledge structures and epistemological foundations on which it is based (Sundin & Johannisson 2005).

Although some researchers are beginning to address the need for theory in information science (Buschman 2006; Capurro & Hjorland 2003; Stonier 1991; Webber 2003) and others are increasingly drawn to explore epistemological foundations for LIS (Budd 2001; Buschman 2006; Dick 2002; Fallis 2002; Hjorland 2005; Stonier 1991; Sundin & Johannisson 2005), the field is nascent and may be fruitfully informed by a conceptual model that builds on the critiques in the sociology of scientific knowledge to guide the design of interdisciplinary information systems. Libraries and information science have historically dealt with the production and transmission of knowledge (Lerner 1998). Together with a proliferation of information (Shenk 1997; Wurman 1989), and advances in information technologies, it is worthwhile to consider whether these factors taken together might create an opportunity for libraries to reengage with their public good role as a way to connect people with knowledge in novel ways. Given the importance of communication, contextualization and classification in the design of successful information systems, these three elements and their relevance to LIS are explored in the following sub-sections.

### 2.5.1 Classification of information

Classification schemes have assisted librarians and information managers with the categorization and management of knowledge in a wide spectrum of fields from medical diseases to formal classifications for flora and fauna. At a practical level, classification schemes structure and organize large volumes of data and information to facilitate retrieval. Linktyping has also been use to develop context in hypertext to establish a point of view
from related pieces of information (Kopak 1999). Structured searches by professionals and advanced users exploit the strengths of a classification scheme to return limited and focused search results when a specific information need is defined. Browsing is another method of information retrieval typically characterized by a heuristic approach to acquiring information where the desired outcome is not known at the outset. The process is usually informal and is not task-oriented (Bates 1990; Marchionini 1995). When browsing, the user does not have a clearly defined problem space but engages in a browsing strategy and assesses the results against the poorly-defined problem. The assessment process often results in a revised conceptualization of the information need and a re-engagement in a retrieval strategy in an iterative manner. With browsing, rather than search strategies, it is less straightforward to evaluate whether returned search results satisfy the information need since when browsing, the problem definition is less clear. To support knowledge exploration about a complex and multidisciplinary topic such as sustainability, the ability to browse concepts can enable users to uncover and make novel concepts meaningful. The ability to browse, therefore, is an important requirement for knowledge exploration systems.

Browsing is a form of information seeking and retrieval and numerous models have characterized the process. Interestingly, some of the insights from the sociology of scientific knowledge resonate with aspects of the information retrieval process. For example, Belkin’s (1980) anomalous states of knowledge model suggests that capturing and acknowledging the user’s cognitive viewpoint is equally important as how well the object, i.e. document, is classified. Given that information seeking is an activity that engages a significant portion of the population, the user-centred perspective is crucial and supports other work along these lines by Bates (1990), Belkin (1980), and Dervin et al. (1992). Marchionini’s (1995) characterization of the information seeking process rests on two key tenets: dynamism and interactivity. As humans engaged in daily life, we develop skills that support our efforts to uncover new knowledge and seek out information. In addition, we have the ability to integrate new knowledge within our pre-existing understanding of the way the world
works, which reinforces the co-production of knowledge. As a result, information becomes situated within our context of operation that influences our attitudes, behaviours and the way we approach looking for information. It also related to how we assign meaning and to the cognitive categorizations that form in the mind. In this way, we can understand information as a building block in the process of altering a person’s knowledge (Marchionini 1995).

In the Information Search Process Model, Kuhlthau (1993) characterizes the process of searching for information as an interplay between the cognitive, affective and physical spheres (i.e. thoughts, feelings and actions). This provides a broad continuum along which to characterize the information search process. Other approaches to information seeking for complex or ill-defined problem solving have identified multiple axes and dimensions of consideration in order to capture the interplay between the user’s state, the information, uncertainty and the shifting problem domain (Chang et al. 1993; Rice et al. 2001; Waterworth & Chignell 1991). How information is structured and managed, and whether this occurs from a user-centred and pluralist perspective is a consideration in the design of a system that aims to explore, conceptually and with examples, a complex topic such as sustainability.

2.5.2 Communication of information

Library and information science have been understood with a focus on communication (Budd & Raber 1996; Sundin & Johannisson 2005). One of the failings of the Shannon-Weaver model discussed earlier is the failure of the model to address meaning-making. Metaphor is basic to our thinking (Berger 2000). In their examination of how human cognition is informed by metaphor, Lakoff and Johnson (1980, 3) note that “[m]ost people think they can get along perfectly well without metaphor. We have found, on the contrary, that metaphor is pervasive in everyday life, not just in language but in thought and action. Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphoric in nature”. The use of metaphor, then, is extremely useful for communicating
new concepts such as explicating the internet as an ‘information highway’ and adding the term ‘digital’ to library to create a ‘digital library’ to explain an electronic collection of texts or documents. But confusion can arise when the dominant metaphor is unclear, which we have seen in the predicament of terminology, or identity crisis, that surrounded the early digital library development (Borgman 2000).

In practice, it would be useful to the design of knowledge exploration systems if there was an explicit recognition that knowledge is socially constructed and, as a result, that design of information systems must accommodate this in some way. This configuration supports an interactive knowledge sharing. Eventually, the configuration may evolve into one that facilitates decision support. However, care must be taken not to assume that increased knowledge alone influences decision making either institutionally or with individuals, as indicated by Green & Krueter (1991).

2.5.3 Context for information
Motivated by an interest in overcoming the split between research and practice, Wilson (2003) suggests phenomenology as a philosophical device to help alleviate this split, and relies heavily on intersubjectivity to ground his arguments. The ways in which scientific knowledge claims can be shared and begin to address nuances in meaning can benefit from an intersubjective approach that acknowledges the contextual nature of science knowledge, whereby we “experience the world with and through others” (Wilson 2003: 447). This perspective is relevant to the present discussion because it echoes the need for information systems to at once integrate multiple perspectives –not to integrate neutrally but rather to accommodate a plurality of viewpoints.

A general model for information behaviour can be of benefit to more than the field of library and information studies. Wilson’s (1997) general model may benefit such fields as consumer behaviour, innovation research, health communication, and organizational decision making. This serves as an important acknowledgement that LIS does not have a
monopoly on research into information needs and information behaviour which may also be informed from sociology, psychology and other disciplines, including science studies and geographic information research.

The field of library and information science can be subsumed by pragmatist positions which impose a goal-oriented, purposive-inquiry similar to the demands that are expressed in information needs and seeking studies that are explicitly task-oriented. A weakness in such an approach is a limited ability to accommodate browsing and knowledge exploration. The term social epistemology was originally coined by Egan and Shera over fifty years ago to provide a framework to examine and analyze the production, distribution, and utilization of intellectual products in society (Egan & Shera 1952). Fallis (2002) draws on their work, indicating that the management of digital information can provide concrete applications for social epistemology and reinforces the need for stronger epistemological tools in library and information science, see also Sundin & Johannisson (2005). How society and information science are co-informed relates to how knowledge is generated, constructed, acquired and shared in a society, and has implications for how the intellectual products of society and social learning unfold.

The widespread use of information technologies in learning environments has become a topic of interest in educational technologies and social learning. In their review of constructivist learning approaches, Jonassen et al. (1999) establish five attributes of meaningful learning: 1) intentional learning, 2) active learning, 3) constructive learning, 4) cooperative learning, 5) authentic learning. By creating links between learning approaches and the proposed 3C approach, elements of a knowledge exploration system can also contribute to a social learning model. Different types of constructivist learning can be related to knowledge exploration activities (Table 2.1).
### Table 2.1 An extension of the constructivist learning model from Jonassen et al. 1999 with reflections on the implications for knowledge exploration and the 3C approach.

<table>
<thead>
<tr>
<th>Attribute of meaningful learning</th>
<th>Description</th>
<th>Relationship to knowledge exploration</th>
<th>3C Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intentional learning</td>
<td>Goal-oriented learning</td>
<td>Information seeking; clear task definition</td>
<td>Classification</td>
</tr>
<tr>
<td>2. Active learning</td>
<td>Learners are engaged by a meaningful task in a natural and adaptive human process.</td>
<td>Browsing; curiosity-based learning; adaptive</td>
<td>Context</td>
</tr>
<tr>
<td>3. Constructive learning</td>
<td>Activity is insufficient for meaningful learning. When learners begin to construct mental models and intertwining new experiences with prior knowledge, they can construct new meaning.</td>
<td>Information in context; burden of learning is on learner; socially constructed; relationship between new and existing knowledge</td>
<td>Context</td>
</tr>
<tr>
<td>4. Cooperative learning</td>
<td>Humans naturally seek out others to assist with problem solving; work naturally in knowledge-building communities</td>
<td>Process that embeds knowledge exploration is critical; support collaborative and individual learners with technology.</td>
<td>Communication / Context</td>
</tr>
<tr>
<td>5. Authentic learning</td>
<td>Engage learners in higher-order thinking to resist oversimplified views of the world.</td>
<td>Maintain context for information; avoid rote learning.</td>
<td>Context</td>
</tr>
</tbody>
</table>

Thurk and Fine (2003, 108) note that “because studies of knowledge construction stop at the point of consensus formation, they tell us little of how knowledge is socially shared or the role that technology plays in that process.” But, as the literatures discussed in this chapter reveal, the domains of science studies and information science are interested in questions of the interplay between science, technology and society along the lines of how information generally and scientific and technical information in particular can delineate different perspectives on an issue. A knowledge exploration system that engages all of these domains and takes into account issues of context, classification and communication of scientific and public knowledge may take on the form of a boundary object:

> Boundary objects are objects which are both plastic enough to adapt to the local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have
different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation.

(Star & Griesemer 1989, 393)

In this way, the knowledge exploration system, as a technological artefact, can be flexible enough to serve multiple functions and occupies the negotiated space of knowledge construction or meaning making between science, technology and society.

2.6 Knowledge building and information exploration for sustainability

Sustainability, or sustainable development, has been defined in various ways over the past thirty years. Encapsulated as humans living in harmony with nature (meeting its present and future needs), the concept of sustainable development gained momentum internationally from the Bruntland Report (World Commission on Environment and Development 1987) to the Earth Summit in Rio de Janeiro in 1992 and the World Summit on Sustainable Development held in 2002. One of the most widely cited definitions originates from the Brundtland report and positions sustainable development as the ability to meet the needs of the present without compromising the ability of future generations to meet their needs (World Commission on Environment and Development 1987, 43).

In an examination of sustainable development concepts, Mebratu (1998) provides a three phase chronological evolution to the terminology and concept development prior to the Brundtland Commission in 1987. The first phase, Pre-Stockholm (until 1972) saw attempts to develop theories of environmental limits based on population expansion as the root cause of unemployment, illness and poverty (Mebratu 1998). Between the UN Conference in Stockholm in 1972 and the 1987 WECD conference, sustainable development was further advanced by recognizing that environmental and development issues should be considered concurrently (Mebratu 1998). The final, post WECD phase, encompasses the increased international focus on sustainable development, which included the UN’s development of Agenda 21 that emphasized altering local practices to affect global shifts.
Robinson (2004) argues for an approach to sustainability that is integrative, action-oriented, and that engages local communities. Meppem and Gill (1998, 123) classify definitions of sustainability into positivist or normative terms where positivist science is a body of systematized knowledge concerning what is and a normative science is a body of systematized knowledge relating to criteria of what ought to be. If we continue to build information systems that are solely focused on an inventory approach to cataloguing and archiving the products of positivist science then we are no closer to operationalizing an information system that supports the shift towards sustainability through knowledge exploration. Nor do we benefit from opportunities to engage in interactive social research with such technologies and with new forms of partnerships between researchers and society (Caswill & Shove 2000; Robinson 2008; Robinson & Tansey 2006).

The Brundtland report focused on the need to create political systems that support citizen participation in decision making. Over the past two decades since the report was released, sustainable development or sustainability (the latter term will be used throughout this document) has emerged as a persistent force with respect to globalization, population growth, and human health. The evolution of the concept has increasingly drawn on the aspects of governance and social equity in addition to ecological carrying capacity and economic development. The oft-referred to ‘three-legged stool’ analogy, where the sustainable development challenge is often framed as one of balancing each leg, environment, society, economy such that they are all in level harmony is a useful metaphor. The importance of governance and democratic processes to address sustainability echo the equity notion idea that underpins the need to balance and reconcile three spheres that do not necessarily need to be as opposed as they seem.

The definition from the Bruntland report has been widely used and was helpful in developing a global view of the planet’s future as well as a collective or global responsibility towards the planet and its inhabitants, as reflected in the report’s title, Our Common Future.
This work led to many initiatives at varying scales form local to global to begin to address the issues of sustainable development, although many met with frustration in their attempts to address such complexity (Mebratu 1998) which towards the end of the last century was often exacerbated by overwhelming amounts of information (Mebratu 1998; Shenk 1997; Wurman 1989, 2000) and an accelerated pace of change that challenged people’s realizations sustainability outcomes (Senge 1990). While sustainability as a holistic concept can be viewed globally, ways forward identified by the Bruntland report included local agendas that may, when taken collectively, could lead to global scale shifts away from practices and policies that compromise a sustainable future. This raises important questions about what a sustainable future looks like and how societies might transition towards these. Building on the Brundtland definition, Robinson and colleagues (1996) advocate extending the definition to include social practices and human beliefs and attitudes such that these normative dimensions form an integral part of the definition of sustainability. Given that the future is unknowable and that future state is a core element of moving towards sustainability, there needs to be consideration about the ecosystem, its carrying capacity as well as the adaptive capacity of human and natural systems. Forecasting takes historical trends and projects these forward into the future without considering that humans have the capacity for individual and societal choice. However, a backcasting approach frees the analysis from business-as-usual trends so that the desired future is articulated and, working backwards, the feasibility of that future and the policies needed to achieve it are determined through scenario analysis (Robinson 2004; Robinson & Tinker 1997; Robinson 1996) whereby the desired future state is articulated and considered in light of the policies and practices that might enable societal shifts in that direction. Indeed, sustainability is often framed as a journey and a transition (National Academy of Sciences 1999; Robinson 1996). The process of achieving this is one that is collective, uncertain and adaptive (National Academy of Sciences 1999).

Sustainability science recognizes the limitations of “reductionist disciplinary approaches to understanding systems” (Blackstock & Carter 2007, 344) and is a term originally coined by
(Kates et al. 2001). Kates and his authors view sustainability science as a geographical endeavour that is place-based, temporal and integrative. By addressing the spatio-temporal domains and the integration of four key areas including biological, geophysical, social and technical, sustainability science considers how human and earth ecosystems are interdependent. This area of research shines additional light on the issue that addressing sustainability at different scales from global, national to local may take on very different forms from national scale assessments of biophysical conditions to local scale strategies to enhance community resilience and adaptive capacity. Some advocate particular attention at the local scale as a helpful in working towards tractable sustainability solutions (Prugh et al. 2000). Others have tried to develop scaleable solutions for organizations or governments (Robert 1999; Robert et al. 2002). Given that the policy context for sustainability is crucial to shifting societies onto more sustainable paths, it is also vital that appropriate spatial and temporal scales of analysis are determined in order to enable decision makers to leverage policy-oriented, collaborative research (Robinson, Carmichael, VanWynsberghe et al. 2006, 166).

Even though there are variations on a similar theme for the definition of sustainability and that these are often vague and ambiguous, the concept has had considerable use since the Brundtland report. And while it remains difficult to deliver on the hope of sustainable development because of these differing views (i.e. what should be developed or what should be sustained) the essence of the concept of sustainable development is to reconcile the imperatives of ecological carrying capacity, the provision of adequate material standards for all in terms of economics, and social governance systems that embrace the values that enable people to lead their lives (Robinson & Tinker 1997).

The notion of citizen participation has become more prevalent and aligns well with the prescriptions for community capacity building, knowledge generation and augmentation of social capital through learning organizations put forth by Crawford (2000) and for social justice by Pezzoli (1997). However, the sustainability field has been plagued by top-down
government programs on sustainability rather than citizen-led or citizen-engaged approaches that could galvanize interested parties to explore action-oriented ways of achieving sustainability. Indeed, from his experiences in the UK, Barr (2003) notes that that process of engagement is commonly seen in government circles as a problem of awareness: that environmental problems do not register on citizen’s radars of concern. The policy response by governments on the issue of lack of awareness is to design education campaigns and improve information and knowledge dissemination with the expectation that a shift in attitude and, presumably, behaviour would actually result directly, and unproblematically, from such programs. This type of response is based on the unidirectional view of science-society interaction and on a one-way model of communication from a single, expert view on the problem. Instead, more interactive and dialogue-based approaches have a far greater potential to raise awareness and enable people to become engaged with sustainability ideas.

Because of the integrated nature of sustainability, a robust means of integrating and aggregating relevant information sources that may be brought to bear on issues relating to sustainable development (i.e. transportation, air quality and water availability, among many others). Organizational mechanisms to support the management of the knowledge generated within this discipline reveals a logical area of overlap between sustainability studies and library and information science. An increased focus on local governance within the sustainability dialogue may also lead to an increased need to represent, manage and store what a community determines is valuable for its social, economic and ecological sustainability. In turn, the information technologies that support exploration of sustainability must be able to incorporate and engage local knowledge, values and preferences.

In order to address the design issues of knowledge exploration for sustainability, a wide ranging set of literatures was brought to bear on the issue. The intent of the 3C approach is to weave through these disciplines to forge a path across the boundaries of science
knowledge, technological knowledge, information management, and public participation. Another goal is to be able provide some meaningful commentary on the social sharing of knowledge based on further empirical work on these design issues (see chapter 4). This has required an interdisciplinary approach.

Interdisciplinarity is a way to overcome the fragmentation of knowledge across disciplines. Recently, studies that are highly collaborative and whose research teams succeed in working across boundaries have been called transdisciplinary to emphasize their highly collaborative approach. Klein documents the evolution of the use of the terms interdisciplinarity and transdisciplinarity (Klein 1990, 1996, 2004a, 2004b) and an exploration into these issues is complemented by numerous other researchers in the sustainability, global climate change and land use planning fields (Després et al. 2004; Heintz & Origgi 2004; Nowotny 2004; Robinson 2008).

2.7 Conclusion

The design of information and knowledge systems can support a model of science and society that is interactive and co-produced, if consideration is given to three elements: context, classification and communication. By thinking critically about how these elements are configured within information system design, a system that supports the sharing of socially robust knowledge can be developed. To do so, the information content of the system should be classified to provide context and support meaning making by way of metaphor. The system design should also facilitate interactive forms of communication in order to democratize engagement and support multiple perspectives.

As these three elements are incorporated into information system design, they provide a foundation for the exploration of complex interdisciplinary issues such as sustainability. As a result, such a system can be an enabling technology to address sustainability as an emergent property of the interplay of values, beliefs, science knowledge and societal priorities of an economic and social nature.
The implications of the ability to incorporate the 3C elements—contextualization, communication and classification—as part of the design of an information system will be revisited later in the dissertation in light of building a prototype information system that incorporates these elements (chapter 5) and using the application within a series of case studies on sustainability (see chapter 4 for a discussion of methodology). Beyond the challenges of incorporating the 3C elements into the information system design lies an important research contribution: developing an understanding of the role of such systems within diverse social environments in order to ensure that an instrumentalist solution is not perpetuated and that the temporal issues of managing collective knowledge over time are addressed (chapter 6).

In the next chapter, consideration is given to the use of geographic information systems in ways that contribute to the exploration and sharing of socially robust knowledge that builds on the 3C elements of context, classification and communication.
3 Extending the theoretical perspective to geographic information systems use

3.1 Introduction
Geographic information systems (GIS) are computerized systems that allow for the storage, access, display and management of spatial information. GIS resulted from a convergence of influences, including advances in computation, databases, graphical representation, mapping overlays, and applications within land and resource management in the late 1960s (Foresman 1998). In this chapter, standard and emerging uses of GIS are presented. In particular, a central focus is placed on public participation and GIS. Opportunities to overcome previous limitations of the use of GIS technology in meaningful public engagement settings are discussed. Furthermore, attention is drawn to options that could extend the role of GIS and secure an integral place in the management and exchange of local knowledge. In so doing, this chapter explores ways in which GIS use is shaped by social processes and could offer fruitful contributions as a mediating technology for community engagement and social learning.

3.2 GIS use
GIS use is divided into three categories: i) representation, ii) communication, iii) analysis. GIS communication devices rely particularly on its visual representations of space, most often Cartesian space, that may appear on a computer monitor or as cartographic output such as paper maps generated from a GIS. Analytical uses of GIS tend to involve data integration and spatial analysis to generate new information, often in response to a defined problem.

3.2.1 Landscape representation
Geographic information systems have a rich Canadian history. The Canada Geographic Information System was developed by Roger Tomlinson and others in the 1960s for the
Canada Land Inventory. The land inventory was created to assist with land use decisions and to manage natural resources within the vast Canadian territory (Tomlinson 1998). It was an initial example of the use of computer systems to represent, store and manage geographic information that described the use of land parcels and their geometries to perform basic analytical functions, such as computing land area by different use categories (Goodchild 1998b). Emerging on the heels of the quantitative revolution in geography, the early geographic information systems were developed to catalogue and store information (Foresman 1998). Satellites orbiting the planet logging vast amounts of data that are subsequently used to determine land use and land cover, particularly following the adoption of GIS in the forestry and mining sectors. The culture of GIS use at the outset was heavily dominated by the quantitative assessment of potential resources, including timber harvesting and natural resource extraction. They have also provided captivating synoptic images of earth from space for the first time, providing people with a view of the entire territory. Earth observation data also serves as a frequent data provider to GIS, as a precursor to topographic and thematic map creation.

3.2.2 Maps as communication devices

Technological changes within the cartographic community fostered the growth of both digital cartography and geographic information systems. These advances were firmly rooted in cartographic traditions particularly from the seventeenth century onward where “European map makers increasingly promoted what we would describe today as a standard scientific model of knowledge and cognition” (Harley 1992, 232). Within this standard cartographic model, maps depicted physical, topographical relationships and were originally created to determine locations and distances between places. In addition to representing physical landscapes, maps portray relationships such as those between people and nature.

The inventory or cataloguing approach aims to document or reflect the current state of land usage, occupation, and activity and, as such, seeks to objectively or unproblematically
represent the physical landscape and its associated processes. In so doing, it positions the map as a communication device to semiotically represent the ‘world out there’ through the map design that depicts spatial relationships using symbology (Crampton 2001).

Maps act as a communication device, where the object of mapping is to produce a ‘correct’ rational model of the terrain (Harley 1992). Indeed, maps have played a central role in the communication of spatial information throughout history. The communicative role of maps is task-oriented: maps depict inventories and categorizations of land features and socioeconomic data (such as Canada’s multicultural heritage or gross domestic product). This task-oriented communication then creates a particular focus for the design and use of maps which is oriented towards conveying concepts, messages or ideas. “Under the map communication model the goals of cartography are to produce a single, optimal (best) map, which presents information clearly, and which is based on known factors of map use” (Crampton 2001). There is already distortion from representing a geoid on a flat sheet of paper and many features are included or excluded for the sake of legibility and coherence (Monmonier 1996). It is important then to carry a “healthy scepticism” about maps – to examine them critically as they are often afforded a highly-credible status, much like statistics, even when this may be unjustified.

Harley (1989) takes aim at how cartography artificially divided theory and practice since its richness as a bidirectional communication device was hindered by an undialectic use of maps. It was hampered by the requirement for maps to unproblematically ‘reflect’ or convey the underlying power structure between what is ‘known’ as fact or universal knowledge claim. Crampton (2002) frames the disjuncture as one between ontical inquiry (what is there) and ontological inquiry (what is possible). The ontological stance is more encompassing in that it accommodates pluralist views and provides more room for negotiation to allow humans to negotiate the world in which they live (Foucault 1985 in Crampton 2002).
Just as the social construction of science questions the objectivity of science practice and scientific results, the constructivist argument has been put forth within GIS to encourage a shift in thinking from a realist view, where GIS is representing the real world adequately but with imprecision to a view in which GIS products such as maps and resultant analyses (in the form of maps or newly generated database tables) may be viewed as artefacts that are co-produced, a result of the experience of engaging with the technology (Schuurman 1999, 2002).

3.2.3 Spatial analysis

The advent of GIS has enabled previously labour intensive spatial analysis functions to take place with greater ease. Unwin (1997) offers four useful categories (originally, views) of spatial analysis ranging from (i) data manipulation (arguably the most fundamental of GIS operations), (ii) spatial statistical analyses – where many GIS still require augmentation from external statistical applications, (iii) “a geography-based and data –driven view of spatial analysis rooted in the quantitative revolution of the 1960s and 1970s in geography, and (iv) a spatial modelling view common with decision support systems and dynamic modelling environments (Unwin 1997).

Algorithms allow topological relationships to be revealed, lines generalized, and annotation to be controlled. Many GIS packages embed analytical procedures, ranging from performing simple queries on spatial database records to allowing users to conduct spatial analyses, such as map overlays, nearest neighbour analysis, inverse distance weighting, and volumetric calculations. Such capabilities provide the spatial modeller, or expert user, with a suite of analytic techniques suitable for problem-solving in the biophysical or social sciences. With the widespread use of personal computers and the reconfiguration of GIS software for desktop use, such techniques are also increasingly available to less expert users.

The previous section provided a framework in which to consider how GIS has been most commonly used over the past three to four decades. This framework considered GIS use
from the point of view of providing 1) an inventory of known quantities, initially natural resource based and more recently business, telecommunications and other networks; 2) a means of map communication and; 3) analytical applications that may be components of a scientific analysis or support for policy decisions. GIS was critiqued as an instrument of the quantitative revolution in geography when social theorists and cultural geographers began to question the tenets on which GIS activities are based (Lake 1993; Pickles 1995; Schuurman 2000b).

As a technology, GIS permeates the boundaries between academic research and the GIS industry, that create the products and provide professional analytic services. In addition, the early adoption of GIS by many levels of government solidified the technology as part of the information management approach in order to deliver on their public service mandates. A forest company may use a GIS to prepare its five-year development plans to indicate proposed logging activity. Meanwhile a forest conservation society may be using GIS to identify endangered habitat and argue that the forest company should alter its proposed logging. Both are instruments of the organization’s activities and in this example, each ‘side’ perpetuates the view of GIS as a neutral technology to further their own aims.

### 3.3 Barriers and limitations to the use of GIS

Early GIS implementations were hindered by barriers of data access, data quality, cost of both hardware and software, and lack of skilled personnel (Obermeyer 1999; Obermeyer & Pinto 1994). The use of GIS facilitated the study of geographical phenomenon by providing users with rapid processing of spatial analysis. However, phenomena are distributed over time, as well as over space: the difficulty of handling this temporal dimension was a significant limitation of early geographic information systems (Langran 1994).

Most national land management agencies in developed nations began to address the first two limitations by establishing spatial data infrastructure programs on national scales (e.g. US (1994), UK (1996), Canada (1996), Australia and New Zealand (1997)). The rise of
personal computing power throughout the late 1980s and early 1990s cleared the way for desktop GIS use that reduced a barrier to use. Commercial software costs remain an impediment and, although college and university education systems have responded to the demand for skilled personnel and began teaching technical application of geography in degree and diploma-granting organizations, the lack of adequately trained personnel remains a limitation.

Even within the GIS profession, concern has been expressed that the field suffers from a lack of trained analysts (Kemp 2003). A debate surrounding whether GIS professionals should be certified has been occurring for more than a decade (Goodchild and Kemp 1992; Obermeyer 1993; Kemp 2003). The accreditation debate draws attention to the particular skills that GIS professionals possess and provides the opportunity to reflect on aspects of the GIS curriculum that may need to shift to allow explicit inclusion of ethical and social dimensions of GIS training in order to ensure that the GIS professionals are aware of the social ramifications and responsibilities associated with their expertise.

The ability to share geographic information has been identified as having the potential to resolve many social and environmental issues. Large scale data sharing requires significant data standardization. The move towards data standardization for topographic data raised a number of issues, such as data interoperability, metadata and standards, and the costs of sharing spatial data (Clement et al. 1998; Evans et al. 1998; Gahegan et al. 1998; Harvey et al. 1998; Klinkenberg 2003; Sears 2001; Sheth et al. 1998; Vckovski et al. 1998). In Canada, students frequently gain little or no experience working with public databases due to cost or restricted terms of use (Klinkenberg 2003; Sears 2001).

Since data availability is a primary limiting factor for GIS use, access to all forms of data becomes a fundamental need for a fully operational GIS. The issue of who within an organization or between organizations has access to data, then, can affect power relations between those who have access to spatial information and those who do not. This issue
increases in importance when spatial information can be useful for policy setting and decision making where government agencies or industry have access to specialized datasets and trained professional analysts. In contrast, community groups have historically lacked the ability to develop equally powerful counterarguments and evidence due to poor data access or a lack of technical capacity. In response, many non-profit groups and community-academic alliances have been formed to develop the skills necessary to redress the power dynamic and support a more even dialogue about issues such as natural habitat, urban planning, neighbourhood design or public health.

When using GIS in community or neighbourhood settings, the outcomes have often indicated that the use of the technology has the mixed result of simultaneously marginalizing and empowering users (Craig et al. 1998; Elwood & Leitner 1998; Howard 1998; Leitner et al. 2002; Meredith 1999). Other issues raised include the lack of connectivity both in the technical and conceptual sense between the stakeholders and the GIS (Carver 2001).

GIS also suffers from non-data-related limitations. The organizational implications of GIS were much discussed in the late 1980s and early 1990s as more and more large national agencies and private companies began using GIS (Obermeyer & Pinto 1994). For some, it was the first time that they needed to consider organizational data policies. In these instances, the increased development and deployment of GIS meant that, overall, an increased awareness of information management, more generally, could occur within these organizations.

GIS and information management are messy, dynamic processes. Instead of developing ways to allow the messiness to exist, many organizations have tried to adopt a reductionist approach to simplify and limit the messiness. It may be more useful, however, to develop strategies to cope with the messiness and uncertainty.
The lack of data, for reasons of cost or access, limited technical skills and inadequate engagement with the social dimensions of GIS use have contributed to limited success in the non-expert use of GIS. Over the past fifteen years, advances in computing have resulted in more widespread access to GIS technology. This technological advancement has contributed to a more widespread engagement with GIS by community and neighbourhood organizations. In some cases, the technical capacity gap is fulfilled through partnerships with universities (Elwood 2002; Elwood & Leitner 1998; Ghose & Huxhold 2005), but data access issues often remain. However with more widespread use and as a result of the development of standardized spatial data infrastructures, some of these barriers are slowly being addressed. As GIS is used in participatory settings, new limitations such as resolution may become more prominent as the scale of analysis becomes larger.

3.4 Rise of participatory use of GIS

Within geography, three waves of critiques of GIS have occurred (Schuurman 1999). The first phase (1990-94) took the form of human geographers criticizing GIS research and applications for its positivist slant (Lake 1993), claimed value-neutrality, and ontological separation between subject and object (Schuurman 1999, 2000a). The second phase (1995-96) saw GIS scholars welcoming the critiques that expressed key shortcomings in the technological approach but also arguing that there was a lack of understanding of GIS on the part of its critics. The latter phase (1997-2000) saw a closer working relationship between the social theory and GIS scholars within geography. Since the turn of the millennium, numerous studies have considered the use of GIS in public participation settings (Craig et al. 2002; Elwood 2006; Elwood & Ghose 2004; Ghose 2001, 2007; Ghose & Huxhold 2005; Sieber 2000, 2003; Talen 1999, 2000).

An emphasis on the use of GIS emerged in the early to mid 1990s as scholars began to examine the social and political consequences of such digital technologies (Goodchild 1998b). Concerns about the bi-directional impact between GIS and society began to be discussed in the late 1980s and early 1990s. The GIS and Society literature of the 1990s drew
attention to the societal impacts of GIS use (Aitken & Michel 1995; Curry 1994; Lake 1993; Miller 1995; Obermeyer 1993; Pickles 1995); it also extended a debate around the political economy and epistemology of GIS and, in particular, power relations associated with its use (Harris & Weiner 1998). Numerous research activities further developed aspects of human and societal impacts of GIS use. In particular, the National Centre for Geographic Information and Analysis’ Initiative 19 and the Varenius Project extended this research considerably (Craig & Elwood 1998; Craig et al. 1998; Goodchild et al. 1997; Hirtle & MacEachren 1998; Janelle & Hodge 1998; Miller & Han 1999).

The field of public participation GIS (PPGIS) is a growing area of research and has involved considerable use of case studies to examine the use and application of GIS. This work has focused attention on GIS use at regional, local and neighbourhood scales. Taken as a body of literature, these case studies have generally concluded that the use of GIS in local settings helps to reveal power relations among actors who negotiate the process of using GIS within a decision making context. The power relations stem from economic, educational, social, cultural and political constraints affecting full access to GIS functionality. The case studies also highlight use in first and developing worlds particularly for resource management and decision making (Craig et al. 2002). The PPGIS literature has focused on neighbourhood development and planning that adopts a stronger, user-centred focus (Elwood & Leitner 1998; Talen 1999, 2000). From a community point of view, the opportunity to map at a meaningful scale and to represent significance (natural, cultural, social, economic or political) in a participatory planning process is an enabling one and offers a new way to exert power.

Recent advances in web-based technology, distributed computing and spatial information infrastructures to manage the sharing of spatial data have been considerable. This has provided the ground work necessary for the emergence of a more participatory focus on the use of GIS and an exploration of information technology to facilitate the sharing of spatial data (Goodchild, Egenhofer, Fegeas et al. 1999; Onsrud & Rushton 1995). It also formed part
of the focus of some of the early research in the Varenius project (Goodchild, Egenhofer, Kemp et al. 1999). These results have implications for issues of power that relate to information control by calling into question who owns the data and who accesses it. If data access is restricted to an elite set of users, there is no equitable foundation for dialogue or resolution of contested issues. Moreover, the legitimacy of analyses may also be questioned because, for example, different spatial interpolation techniques can produce diverse results depending on the resolution of the data or assumptions about data quality.

As advances in information and communications technologies occurred during the 1990s, there were opportunities for increased and diverse kinds of stakeholder interaction with GIS that could support interaction that was neither co-located nor temporally coincident (Balram et al. 2003; MacEachren 2001; Shiffer 1998). Shiffer (1998) characterized the types of interaction as a 2x2 matrix of temporal and locational settings for public participation and GIS that include direct human communication and interaction with GIS technologies (same time, same place). The opposite extreme shifts to an interaction model where users engage individually with distributed technology (different time, different place). User reactions and comments may take the form of posts in online discussions, letter writing or opposite-editorials in newspapers. Relationship and trust building can occur more quickly with the co-located and contemporaneous style of interaction. However, the flexibility of access is an advantage when the interaction is determined by each individual. As a result, the design of PPGIS engagement processes may derive additional successes by melding these two types of interactions. This would provide flexibility and context to the user experience.

### 3.5 Gaps in PPGIS research: narratives, geolibraries, and evaluation

As a field of inquiry, PPGIS research explores the participatory settings, techniques and use of GIS by non-experts. While this raises many fruitful directions for on-going study, three particular directions are considered in this section: i) narratives, ii) geolibraries, and iii) evaluation. Given that the map and image metaphor is a pervasive element in the GIS, it is proposed that the use of narrative elements within GIS could provide context and useful
support for the human-computer interaction that takes place when users engage with GIS technology. This would allow the user experience to extend beyond one of communication to more interactive engagement that resonates with the users’ lived experience and view of the world. The concept of a geolibrary refers to a library filled with georeferenced information including, but not limited to, spatial data as well as spatially-referenced images, texts and videos (Goodchild 1998a). This content is managed by classification techniques such as data description (metadata) and data standardization. Since PPGIS activities engage non-experts in the use and application of GIS, the desired outcomes are often related to land use planning and policy decisions or have an educational purpose, such as social learning. Such outcomes require more than linear innovation models that are focused on communication. They demand that evaluation measures are based on co-production of knowledge and diverse perspectives.

3.5.1 Capturing sense of place with narratives (Context)

The experience of using GIS may be enhanced by the ability to explore diverse datasets and to use the analytic capabilities of GIS to generate new knowledge. Maps are often described as compelling and highly communicative for the representational information they portray using symbols for features, topological relationships and cartographic style. The interaction experience of using GIS in participatory decision making or land use planning processes could greatly benefit from an infusion of storytelling and narrative elements that would anchor the map representation within the lived experience of place.

Approached as a place-based technology, GIS may be used to create a shared sense of place among people. Through the negotiation of such ‘shared’ concepts, participants undergo a process of interpretive flexibility by attributing meaning and utility to the geographic information system. Relph (1997, 208) addresses this sense of place as “an innate faculty, possessed in some degree by everyone, that connects us to the world. It is an integral part of all of our environmental experiences and it is only because we are first in places that we can then develop abstract arguments about environment, economy or politics”. His
argument is that the sense of place is derived from human experience, such that critical reasoning skills flow from the specific (embedded in place) to general (applicable across place). This may result in exclusionary practices or non-shared cultural experiences or inequitable participation in social activities, for example, exclusion on the basis of culture. Within geography, sense of place is viewed critically as a way to understand the nuances of what is positively and negatively reinforced with the notion of place and such discussions can be enhanced with the inclusion of narratives and storytelling to contextualize sense of place.

The addition of narrative elements to the GIS user experience also raises interesting questions with respect to overcoming the tendency for GIS to empower and marginalize participants. In particular, does the combination of storytelling with fuzzy spatial locations (approximation over accuracy) help lessen the divide between empowered and marginalized users? Do issues of trust, such as those presented by Harvey (2003), affect the cases where marginalization occurs? Does the ability to represent personal or experiential perspectives, through user-developed narratives within a PPGIS, assist in overcoming issues of either trust or marginalization? The shift from institutional data providers such as government agencies, which produce quantitative spatial datasets, to individuals, who develop qualitative textual or multimedia data, could result in a fruitful blending of quantitative and qualitative perspectives.

### 3.5.2 Links to libraries (Classification)

GIS offers some new ways to organize, manage, and access spatial information, which in turn suggest the importance of recognizing GIS as sociotechnical systems –that engage the human mind with computational capabilities. With the shift to increased interconnectivity of systems on the world wide web and proliferation of data (Shenk 1997), managing and organizing the volume of information available becomes more challenging. Information management and classification have historically fallen under the purview of libraries (Lerner 1998); therefore, the library role of GIS requires the same kind of rethinking as any
other GIS role, such as land use planning support, land use inventory, and map communication. A key element of this rethinking is the notion that libraries and the concept of libraries have something to offer GIS use in terms of a model of information and knowledge sharing (McGlamery 1995). The connection between GIS and libraries has been explored quite consistently over time with traditional map libraries being interested in providing services to their patrons as desktop GIS and spatial data became readily available for use with desktop GIS (Cobb 1995; McGlamery 1995).

Monmonier (1996) reminds us to view maps as an authored collection of information—much as a reader should approach a book of individually authored articles. However, map users receive little or no training—unlike readers. Operationally, making data available is often confused with making it accessible. Unless the conceptual criteria of context, communication and classification, as outlined in chapter 2, are provided to scaffold the user’s experience with spatial information, the user may be at a loss to derive any benefit from engaging with the technology. The current parallel to the original development of GIS as a land inventory system is the internet-ready spatial data inventory where clearinghouses of objective information can be accessed remotely and used for a myriad of purposes. The development of national and global spatial data infrastructures support this objective, which contributes to solving the problem of data availability but does not necessarily address the issue of how accessible or usable that spatial data is to clients because the context of its use is not typically provided.

The design of the world wide web was intended to support social interactions rather than the commercial and advertising purposes that have come to dominate over the past decade. Initially the intention was to create a means of interaction that was dynamic since, as a new technology, the use of the world wide web was experiencing interpretive flexibility during its development. As the originator of the world wide web, Tim Berners-Lee (1999, 165) indicates:
My original vision for a universal Web was as an armchair aid to help people do things in the web of real life. It would be a mirror, reflecting reports or conversations or art and mapping social interactions. But more and more, the mirror model is wrong, because interaction is taking place primarily on the Web. People are using the Web to build things they have not built or written or drawn or communicated anywhere else.

The interactive design of the world wide web can effectively support the development of geolibraries. The geolibrary concept provides a useful option for reconceptualizing the use of GIS (Crampton 2001). A geolibrary is a collection of georeferenced information that is distributed and accessible online (Goodchild 1998a; Mapping Science Committee 1999). One of the earliest examples of a geolibrary is the Alexandria Digital Library, a research project from the University of California at Santa Barbara that explored problems related to designing, developing and maintaining a distributed digital library for geographically-referenced information. Boxall (2003) notes that the geolibrary metaphor provides a bridge between the library and GIS communities and that its evolution as a concept paralleled that of the national spatial data infrastructures that were addressing some of the data standardization issues to facilitate spatial information retrieval between distributed georeferenced collections.

Geolibraries play a role as the technology that enables the social sharing of geospatial information. In this way, they connect separate domains and effectively become boundary objects, as indicated in chapter 2 (Star & Griesemer 1989). Geolibraries can offer a more flexibly structured, multi-perspective approach to geographical information and knowledge, as informed by the concept of boundary objects and through the social shaping of technology lens, which includes the concepts of interpretive flexibility, stability and closure.

From the point of view of information management, any map, atlas and other physical artefact that houses data or are spatial representations may be viewed as a text. It is useful to think of documents as ‘texts’ if that helps to further the argument that maps need to be
seen in the context of meaning-making rather than simple communication devices. Considering them as texts should also reinforce the recognition that GIS use would be enhanced if the technology included ways to both represent and explore different perspectives and contexts to allow users to construct knowledge. This knowledge construction argument supports the extension of GIS as a learning model about human interaction with place.

### 3.5.3 Evaluation of PPGIS (Communication)

A common indicator of success in technology adoption is abundant and frequent use. This expectation typifies a unidirectional model of technology adoption, is an example of technological determinism, and does not consider how social settings shape the use of technology. There has been a lag in developing evaluation measures that address the outcome of engagement with technology and that are able to determine what meaningful impact (and according to whose meaning) technology engagement has fostered. There is general agreement that the addition of GIS to participatory planning processes is a useful approach to increasing public involvement and dialogue on planning decisions that may have broad impact on the current or future state of the community (Al-Kodmany 2000; Carver & Peckham 1999; Elwood & Leitner 1998; Holden 2000; Howard 1998; Shiffer 1998; Snyder 2001; Stillwell et al. 1999). The persistent tension that PPGIS researchers uncover is that the use of GIS in such processes can simultaneously empower and marginalize the participants (Craig et al. 1998; Harris & Weiner 1998; Meredith 1998; Talen 1999).

At the heart of the challenge for PPGIS evaluation is the fundamental question: What should be evaluated? The use of PPGIS involves the public or a set of stakeholders engaging with spatial information technologies for dialogue or decision making. This presents three possible foci for evaluation: 1) the outcomes of the entire process (summative evaluation); 2) the role of the technology in the process (sociability evaluation); and 3) the technology itself (usability evaluation). In human-computer interactions, evaluation is useful when focused on specific questions; goals, equations, and metrics can form an evaluation approach (Preece
Cronbach’s (1980) advice, “…an evaluation ought to inform and improve the operations of the social system” would fall in line with a summative evaluation. Rossi et al. (2004) include both a description and measure, using judging standards or criteria, of the entity being evaluated. Hacklay and Tobón (2003) drew heavily on human-computer interaction and usability evaluation to advocate a user-centred design for PPGIS that includes an iterative development cycle.

3.6 Conclusion

It has taken nearly 40 years for GIS to begin to realize its potential in terms of broad use for socially-relevant issues. Over that time, GIS has had a growing impact on society as a result of increased use and through the elimination or attenuation of early barriers to its use. Taken together, the issues raised in this chapter support the use of GIS as part of a learning model for environmental, cultural, social, economic and science issues. The active integration and construction of these components may contribute to learning and knowledge building about an interdisciplinary issue such as sustainable development. By incorporating elements such as narrativity into an information management construct like a geolibrary, the use of GIS and public participation GIS can be further explored by considering ways to integrate spatial data and qualitative data that indicate how people are connected to place.
4 Methodological approach

4.1 Introduction

The nature of geographic research varies widely from the study of earth and atmospheric systems to research on human and behavioural systems and to the study of spatial representations of human and earth systems. The current research lies at the intersection of spatial technologies, information access, and the production and use of spatial information by the general public and others interested in sustainable development.

In chapter 2 an important gap within the field of science, technology and society studies was identified: the limited consideration of geographic information systems and information and communications technologies. The theoretical framework outlined in chapter 2 emphasizes the value of personal experience, local knowledge and context. This theoretical framework highlights the danger of selecting research methods that may reinforce the unidirectional relationship between science and policy. From a methodological point of view, it is also important to be wary of unidirectionality in the relationship between the research practice (described in this chapter), theory (described previously in chapter 2), and the discussion of outcomes (chapter 6) and comments that are drawn from the rich knowledge base developed throughout the course of this work.

Methodological approaches were selected for this project on the basis of their potential to contribute to an understanding of the relationship between the design of information and communication technologies and the processes in which these systems may be used to build awareness, generate new knowledge, or support decisions. To briefly recap, the current research questions include: 1) exploring the role of geographic information in developing awareness and building knowledge about sustainability; 2) determining whether GIS can be used as an enabling and transforming technology in an interactive social setting; and 3) establishing how a geolibrary may be used to explore sustainability concepts. To
accomplish these research objectives, multiple research methods were employed, including literature reviews, interactive research, interaction design, case studies and participant observation.

Literature reviews were conducted to situate the overall research problem and to devise the methodological approach and are manifest in the theoretical and practical gaps identified in chapters 2 and 3. These reviews also provided the foundation within which to develop the research goals and for the case study research design (Yin 2003). An interdisciplinary approach was necessary to address the numerous aspects at play in an examination of new technologies being used to support real-life situations that engage with place-based issues such as land use planning. The research methods selected are aligned with the research goal, as identified in chapter 1, where the method was applied (Table 4.1).

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<tr>
<th>Research Inquiry</th>
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<td>Literature Review</td>
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<td>1) Role of geographic information in awareness &amp; knowledge building for sustainability</td>
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<td>2) GIS as enabling and transforming technology</td>
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<td>3) Geolibrary as metaGIS &amp; how geolibrary is used to explore sustainability</td>
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<td>4) Why understanding sustainability is useful technological challenge for geolibraries and digital libraries</td>
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<td>5) Identify approaches for GIS use by the public</td>
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Table 4.1 Identification of research methods applied to each research goal outlined in chapter 1.

Interactive research and interaction design are additional methods employed during the development of the technical application (GBExplorer) that was used within the community case studies (see chapters 5 and 6).
Case study methodology, coupled with participant observation, was applied to uncover the processes and meanings at play in community contexts where the technical applications and social interactions met. Four case studies were undertaken and each case served a different purpose in the research design. Three of the case studies were located in communities in southwestern British Columbia, including the City of Coquitlam (case study #1, henceforth referred to as CS#1), the municipality of Whistler (case study #2, CS#2) and the municipality of Bowen Island (case study #3, CS#3). The fourth case study (CS#4) reflects on the design and development of the web-based application, GBExplorer, that formed the basis for case studies #1 and #2 in Coquitlam and Whistler, respectively (see Figure 4.1).

The objectives of the four case studies were to explore and describe: i) the creation of the GBDL concept and the instantiation of a software system, GBExplorer (CS#4); ii) how different community groups used GBExplorer to extend their municipal community engagement process for seniors and youth (CS#1); iii) how the application technology was transferred and modified for use by a consortium of community groups in Whistler (CS#2); and iv) how and why spatial visualizations were used for a public planning process on Bowen Island, BC (CS#3).
4.2 Description of methods

In this chapter, the merits and suitability of each research method are discussed in turn. Descriptions of how the methods were applied are also provided with a focus on the workshops and community forums, which served as the field sites for data collection. The implications and reflections on the research outcomes are discussed in chapter 6 and linked to the outcomes with the theoretical framework presented in chapter 2. Below, the research methods are explained; they include literature reviews, interactive research and interaction design, case study, and participant observation.

4.2.1 Literature reviews

Extensive literature reviews were conducted in order to develop and justify the hypothesis that a unidirectional view of the science/policy relationship is too limiting for public knowledge systems. Consequently, literature reviews were conducted into this project’s four major research themes: 1) science and technology studies, 2) public participation and GIS, 3) digital library design, implementation and evaluation, and 4) the use of information and communication technologies in (a) deliberative public decision making / dialogue processes and (b) for communicating science information for various types of users. Conducting a literature review carries a persistent tension between providing sufficient detail and depth to describe the research problem without succumbing to oversimplification and maintaining the fluidity of a generalist’s perspective to recognize patterns and useful ideas among the diverse literatures and perspectives (Law & Mol 2002). The reviews contributed to the 3C elements and their implications for library and information science presented in chapter 2 and discussed in light of GIS technology in chapter 3.

The PPGIS research agenda is concerned with how and why GIS are used within social groups interested in local planning issues (e.g. environmental activists, non-governmental groups, and neighbourhood groups; (Craig et al. 2002). The predominant approach in the field is to conduct and document case studies that identify a spatial problem, fundraise, train, apply spatial analysis techniques, analyze results, and proceed to the next problem.
As a result, there are numerous case studies within the literature that document a diverse array of GIS applications in local settings. As such, PPGIS needs to be treated as a science and not solely as a technology (Tulloch 2003).

Although they have increased substantially in the interim, at the outset of this doctoral study there were very few web-based PPGIS applications. Noticeably absent were PPGIS applications that were suited to many different communities and issues; most were site-specific developments that offered one-off solutions (Leitner et al. 2002). As a result of the literature review, a case study method was adopted to examine the use of GBExplorer in community settings and to better understand how and why it was used in these environments (Yin 2003).

The review of the literature suggests that it would be fruitful to extend GIS functionality into a web-based environment coupled with digital library technologies (Carver et al. 2001). In so doing, the hybrid system could begin to address each field’s deficiencies. These two technological approaches present similar shortcomings, notably the lack of evaluation structures and narrowly defined domains of use. They were outgrowths of older technologies or models that had shaped their context of use. From the library perspective, digital libraries were shaped by the institutional model of a physical, bricks-and-mortar library that played the role of collective knowledge keeper in a society. From the GIS perspective, the model is an instrumental view of technology where GIS is a “tool” for conducting spatial analysis and examining spatial relationships and the model of GIS use is dominated by this perspective as well. What was envisioned here was an information experience that was more process- and product-oriented in such a way that it could engage with new information in a way that was compelling and made meaningful by those who both contributed to it and made use of it. In this way, the purpose of the work was not to build a ‘website’ that would be the panacea of information about the Georgia Basin. Rather, it was an attempt to reconceptualize the nature of engagement with socially-relevant, place-based information in context. The practical implications are that human-computer
interaction and traditional usability studies are inadequate because they are constrained by their unidirectional view, and they are technologically deterministic.

4.2.2 Interdisciplinarity context: Sustainability

Interdisciplinarity or transdisciplinarity is identified as a research approach because it shaped the design and development of the Georgia Basin Digital Library. The nature of interdisciplinary research is holistic and integrative – its innovation often results from synergies between seemingly disparate areas of research (Desprès et al. 2004; Klein 1990, 1996, 2004b; Lau & Pasquini 2004; Mitcham 2003; Nowotny 2004). “Something about the geographic turn of mind wants to see the big picture, is not content with unrelated fragments, and wants to grasp how the pieces fit together in place” (Hanson 1997). With a focus on knowledge generation and exploration the GBDL sought to create a ‘living’ web environment that would parallel people’s web-like existence in the world (Berners-Lee 1999).

Sustainability, or sustainable development, is often defined as a balance between social, economic and environmental supply and demand to meet current and future needs (WECD 1987). Examining sustainability more procedurally to address issues of agency (knowledge to action), temporality (decisions now have implications for sustainability later) and choice (what is the spectrum of possible choices that can contribute to achieving sustainability?). It can be helpful to think of sustainability as the emergent property of a discussion about desired futures that is informed by some understanding of the economic, social and ecological implications of different choices (Robinson 2004).

In essence, the novelty of the development of the Georgia Basin Digital Library is that it merged sustainability (as a problem sphere), geographical information systems (as representations of that problem sphere) and digital library technologies (as both content and media for that problem sphere) together into a technology and process dynamic. To accomplish this a multi-disciplinary team was required to support the development of the
application and the furthering of the research agenda on the relationship between technologies and community process. The team included natural scientists, social scientists, computer scientists, and geographic information systems specialists. The nature of interdisciplinary research is reflected pragmatically in a diverse team of talent that converges to address innovation. Interdisciplinarity necessitates and entrenches disciplines; there cannot be ‘inter’ discipline without the \textit{a priori} existence of disciplines in and of themselves.

4.2.3 Interactive research and interaction design

This section addresses interactive research and interaction design as methodologies for application development and community-based research activities, respectively. User-centred design is a popular component of computer software and web application design. As it suggests, this type of design considers the end-user at the outset of system design, invoking a shift from what is merely technically feasible to what is acceptable to the anticipated users of the system. Typically, this involves conducting user requirement analyses, determining the personas of intended users, and encapsulating user goals to identify both scenarios of use and specific tasks that the users would undertake (Hix & Hartson 1993; Nielsen 2000; Preece 1994, 2000; Shneiderman 1998). Motivated by a desire to create ever more effective, efficient and user-friendly systems, user-centred design has surged in utility as increasing numbers of businesses and agencies begin to rely on the world wide web to provide information and sell products. From the point of view of creating a new type of web functionality that combines elements of geospatial data integration and digital resource management, a user-centred design approach was adopted to specify a generic user for the GBDL (Harrap \textit{et al.} 2000). This provided boundaries from within which to scope the technical and functional requirements of the system (i.e., what does the application need to do? What does it need to look like?).

Interactive social science research may be thought of as a meta-research method above interaction design. It has been defined as “a style of activity where researchers, funding
agencies and ‘user groups’ interact throughout the entire research process, including the
definition of the research agenda, project selection, project execution and the application of research insights.” (Robinson & Tansey 2006; Scott et al. 1999). The research undertaken within the Georgia Basin Digital Library project involved the partner agencies of the University of British Columbia (UBC) and Natural Resources Canada in the definition and execution of research goals. The Georgia Basin Futures Project, also underway at the same time at UBC, had adopted an interactive approach to the development of game-like software and community engagement activities to support the development of sustainable future scenarios for the Georgia Basin region (Carmichael et al. 2004; Robinson, Carmichael, VanWynsberghe et al. 2006; Robinson & Tansey 2006; Tansey et al. 2002; VanWynsberghe et al. 2003). In turn, this doctoral work scoped case studies that fit within the research objectives of both organizations.

The Georgia Basin Futures Project (GBFP) was a five-year regional participatory integrated assessment project that engaged experts and the general public in an exercise to explore and identify desirable, sustainable future scenarios for the Georgia Basin region to the year 2030. This exploration took into account the implications, strategies, and policies that would bring about such desired futures (Robinson, Carmichael, VanWynsberghe et al. 2006). The overall goals were to develop a picture of how participants think and feel about sustainability issues and to determine how the use of integrated assessment modelling tools affects the values, attitudes, beliefs and behaviours of those who use such tools (Tansey et al. 2002).

Community engagement, partner collaboration, and the use of computer tools to explore aspects of sustainability were research themes where the GBFP and GBDL had synergies. The community of Bowen Island was one of three municipal case studies in GBFP and one of the first to use QUEST. QUEST was used in a workshop setting to develop a collective

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7 QUEST is a computer scenario-generation modelling system designed to help users create an explore future scenarios for their region and to acquaint them with the necessary social, environmental and economic trade-offs associated with their envisioned future (Carmichael et al. 2004; Tansey et al. 2002).
desired future for Bowen Island. Both the GBFP and GBDL operated and focused attention on the interface between science, technology and society and the projects’ research themes and outcomes are relevant to the other and go some measure to advance understanding of how to conduct collaborative and interactive social research.

The interactive social research approach, as well as the interdisciplinary perspective, the case study methods and participant observation, were all adopted to reinforce the notion that fieldwork is at once political, personal and professional (Hyndman 2001).

4.2.4 Case study methodology

Case studies are social science research techniques that are widely used within the academic fields of sociology, economics, anthropology, history and psychology to understand complex social phenomena—particularly when the phenomena are contemporary and occur in a real-life context (Yin 2003). Increasingly, they have been adopted as teaching methods in law, management science, medicine and public policy (Yin 2003). Often employed to answer ‘how’ and ‘why’ type research questions, case studies are explanatory or descriptive devices that uncover operational relationships that unfold temporally and spatially.

The goal of the Georgia Basin Digital Library (GBDL) was to develop awareness and understanding of issues related to sustainability. The project aimed to develop the conceptual framework for a community-focused digital library that could promote the integration of natural science and socio-economic information for the purposes of sustainability within the Georgia Basin region. The development of the conceptual framework was broken down into five research themes that included interface design, community engagement, visualization, knowledge representation and knowledge architecture. Interface design focused on elements relating to human-computer interaction, including the use of a library metaphor to frame the user experience of exploring ideas about sustainability. The community engagement theme was an effort to promote understanding and instigate involvement in issues that relate to sustainability in the
Georgia Basin region. Under the visualization research theme, work was conducted to explore new manners of representing geospatial data, focusing specifically on three-dimensional landscape visualization in an effort to bring geospatial data into a familiar environment for the user. The knowledge architecture theme focused on translating the conceptual ideas into a prototype software application and the data model design to manage relationships between thematically complex spatial data and associated attribute, image and text data. The knowledge representation theme explored the development of ways to create understanding and interrelationships of concepts surrounding sustainability and developing a means of linking these concepts to geospatial data in an effort to enhance understanding. This particular research theme resulted in a component of the GBExplorer application known as Local Stories. Local Stories incorporated an interactive map, which allowed users to select a location on the map and compose a narrative description of the significance of that place with respect to sustainability, as defined by the participant. In this way, the Local Stories application provided a testbed for linking the experience of place through narrative with an interactive map display.

An objective of the case studies was to determine the role of Local Stories in developing community capacity—defined as citizens as a group realizing the potential of their social, economic, environmental, cultural and political assets to develop their community in a manner that suits their needs (Crawford 2000). As a result, case study selection hinged on identifying a group of users that was pre-existing (don’t come together just for this purpose) and had an on-going project that they felt would be enhanced by the incorporation of Local Stories and/or other elements of GBExplorer. Another consideration in terms of case study selection was whether the community group would have some technical skills (information technology management, programming skills) to customize, adapt and maintain the application to suit their needs over time. This would provide some indication of any knowledge architecture changes the GBExplorer development team could consider into a future design phase to make the application more readily customizable by different sets of users.
4.2.5 Participant observation

Berger (2000, 161) notes that participant observation is a “form of field research that lack(s) the control and structure typically found in experiments”. Supplementing the case study methodology with participant observation contributes to an understanding of the patterns of interplay between actors in a given setting or group that is being studied. Also, it helps determine what questions to ask informants. As well, it can be an unobtrusive means of gleaning information about individual and group behaviour (Berger 2000). Typically, the researcher is faced with a trade-off between familiarity and neutrality; an alternate slant is to view the researcher as providing a particular perspective. When conducting participant observations, it is important to capture the setting, the participants, the nature and purpose of the group, the behaviour of people in the group, the frequencies and durations of behaviour (Berger 2000). It can be useful to draw threads through these high-level themes to postulate the effect of the setting on the behaviour, who (and who is not) participating, for what reason and what happens in the setting. Some concerns with participant observation include focus, the effect of the observers on behaviour, unrecognized selectivity –observers implicitly include and exclude observations as a function of becoming part of the process and of their expectations of it.

Case study research is undeniably messy. “Imperfect engagement is better than no engagement or a paralyzing angst” (Hyndman 2001, 265). Hyndman notes that the practice of fieldwork, which for this purpose is coincident with the case study approach, is an exercise in communication, trust and timing. Relationships must be established with potential case study groups to explore the possibility of working together. Once this relationship is established, it requires further development to parameterize the relationship between the community group (and the researcher). All of these steps are highly contingent on establishing the trust and credibility of the researcher and, importantly, an alignment between the case study research objectives and the community groups’ objectives.
Berger (2000) indicates that ‘mind reading’ can be problematic when the observer crosses a line between recording what people do and attributing a motivation or cause to the behaviour. There is a dance between suggesting and determining patterns of motivation for certain behaviours and over-interpreting on the basis potentially unfounded assumptions. It is important to be aware of the tendency to determine what people think on the basis of their actions – these are not necessarily causally connected, and the participant-observer can only ever observe actions.

4.3 Case study descriptions
The Georgia Basin Digital Library Project established a conceptual framework for the design and development of a knowledge exploration system for the Georgia Basin region of British Columbia. A prototype application, GBExplorer, was developed based on this conceptual framework. GBExplorer consists of a series of web-based services aimed at promoting community-based learning and participatory planning. The GBExplorer application instantiated conceptual ideas into a set of five functional groups, called modules, that were made publicly accessible via the internet. The ‘News & Information’ module culls sustainability-related stories from local and international sources; ‘Ideas & Perspectives’ provides functionality to explore different concepts of sustainability, ‘Local Stories’ is a community mapping application, ‘Library Collections’ searches distributed sources for spatial data, and ‘Future Scenarios’ connects with the GB-QUEST scenario modelling game to allow users to create their desired future for the Georgia Basin in the year 2040. The rationale underlying the selection of the design elements in GBExplorer, as well as a description of each of the modules in the application, is described and discussed in the next chapter.

Once a prototype application had been developed to instantiate the philosophy of a visually-compelling, narrative- and place-based exploration of current society, its use in different contexts could be explored to provide a more nuanced understanding of the strength and suitably of GBExplorer for supporting individual and collective explorations of
place. The descriptions of CS#1 and CS#2 that follow in the next section focus on how different community groups used the Local Stories module.

During 2003 and 2004, workshops on the use of Local Stories were conducted with two different communities. In the City of Coquitlam, BC, workshop participants included the non-profit Smart Choices Society and the city’s department of Leisure & Parks. In Whistler, BC, the participants consisted of a network of community groups. The Whistler experience served as a technology transfer case study as participating groups adopted the Local Stories application and customized it for use by their membership. Lastly, CS#3 was based on participant observation of a sub-area plan review in the community of Bowen Island in 2004.

The case studies in Coquitlam, Whistler and Bowen built on the experience of designing and developing the GBDL and its associated prototype application, GBExplorer (Fig. 4.2). Each of the case studies addresses different elements of the research process from exploratory (development of GBExplorer), to descriptive (the use studies in Coquitlam and Whistler; the community planning discussions within the Bowen Island Community Forum). As noted earlier, the GBFP and GBDL operated simultaneously and Bowen Island provided a point of overlap with each project undertaking a case study there although at different times and to observe different processes.
In Coquitlam, workshop participants were interested in how the application could support socially oriented community processes (bring demographic groups together such as seniors, youth and decision makers). In Whistler, the community groups had a predominant interest in natural habitat issues. The third case study, with the Municipality of Bowen Island, built upon a pre-existing research partnership between UBC and the community. The subsequent sections in this chapter describe the genesis and conduct of each the case studies as well as data collection and analysis techniques.

4.3.1 Case Study #1: Smart Choices Society (Coquitlam, BC)

Located roughly 30km east of Vancouver, the municipalities of Port Moody, Coquitlam and Port Coquitlam are commonly known as the Tri-Cities. Together with two adjacent villages, Anmore and Belcarra, the five municipalities form the Northeast sector of the Lower Mainland region of Greater Vancouver (Figure 4.3). The Northeast Sector has a total
The small communities of Anmore and Belcarra contribute about 2,200 people to the overall number reported for the Northeast Sector.

The Smart Choices Society is a non-profit agency created in 1999 when the City of Coquitlam applied for an Industry Canada “Smart Communities” project grant. The Smart Communities Initiative from Industry Canada held a national competitive process, accepting proposals from communities who detailed how they would create informed, engaged and connected communities using information technology to stimulate economic prosperity. The initiative sought demonstration projects of smart community principles, “a community with a vision of the future that involves the use of information and communication technologies in new and innovative ways to empower its residents, institutions and regions as a whole” (Industry Canada 1998). Industry Canada awarded a total of twelve geographically diverse projects: one in each province, one within the three territories and one First Nations smart community demonstration project.

The twelve ‘demonstration’ projects, as they were referred to by Industry Canada, would serve as living laboratories for testing new technologies on the ground. The intent was to have the twelve communities try different approaches to see what works best; there was no
on-going funding commitment for other communities nor was there an upfront strategy for how communities, other than the twelve selected, would actually benefit from the experimentation that would take place in the demonstration projects. At the time, the diffusion plan for best practices seemed to rely exclusively on osmosis since Industry Canada lacked any formal mechanism to evaluate the demonstration projects. However, the participating communities anticipated social and economic advantages as a result of the smart communities program in the form of direct grants for technological infrastructure development.

The Smart Choices Society includes the City of Coquitlam, the City of Port Moody, the area’s school district and Douglas College, a post-secondary training institute located in Coquitlam. They focused their efforts on the creation of an ‘innovation’ centre – physical infrastructure in the form of a newly-constructed building to house meeting rooms, highspeed computer access, a coffee shop and business development services available for local entrepreneurs. This was coupled with significant human and financial resources to develop a web-based community portal that they named Citysoup.ca. The portal provided web hosting services for businesses to promote and market their goods and services online. In addition, it provided residents with community event information such as recreation program schedules and registration and a directory for local businesses.

The use of Local Stories with community members in the Tri-Cities took place through a relationship that developed with Community Solutions (a United Way sponsored program on Sustainability Study Circles), the City of Coquitlam and the Smart Choices Society of British Columbia. Working with representatives from the City of Coquitlam’s Leisure & Parks division, several workshops were held with community residents using an adapted version of Local Stories. Through discussions with the community engagement coordinator of the Smart Choices Society, community groups were identified and prioritized based on their interest in and likelihood of deriving some benefit from participating in a workshop.
Five groups were identified: 1) seniors, 2) youth, 3) arts organizations, 4) sports organizations and 5) community organizations. The Smart Choices Society Community Engagement Coordinator identified the first two as priority groups because they met regularly and because the coordinator felt that the staff organizers for the senior and youth groups were amenable to incorporating the workshops into their winter programming.

Local Stories provided some value-added technology to the existing design of the Citysoup.ca web portal since the pre-existing online mapping component only provided map viewing capability and was not designed to receive data from its users via a map interface. The existing online mapping component provided location information for businesses and community services. The addition of Local Stories offered a two-way communication between the citysoup.ca portal and the residents, as well as a means of communication and knowledge sharing among resident groups. This idea was raised and received support from the citysoup.ca community engagement coordinator who was looking for ways to get different constituents interested in using the web portal. The technical details of incorporating Local Stories within the citysoup.ca architecture were discussed and resolved over a series of meetings and phone calls between the two technical teams. As a result, Local Stories became accessible via the citysoup.ca portal as well as directly through georgiabasin.info.

Workshop sessions on the use of Local Stories were held with four different community groups in Coquitlam. These included the Coquitlam Youth Council and three different organized groups of seniors. The Coquitlam Youth Council’s mission is to provide a voice for all youth. The Council arranges community projects geared towards youth and their families, such as fundraising activities for cancer research and activities to connect with other teen committees. The Youth Council meets with a local elected councillor on a monthly basis to voice their youth-related concerns. The seniors groups operate out of two main hubs located at community centres within the city: the Dogwood Pavilion and the Pinetree Community Centre. At the Dogwood Pavilion, two potential groups were
approached by their community coordinator to participate. The first is a small group of about eight seniors who have established a small computer lab with five workstations and a server in an office of the centre. They provide instructional workshops to other seniors on basic computer skills, introduction to word processing, the internet, email, spreadsheets and multimedia software (i.e. manipulation of digital images). The second was the Dogwood Lifewriters group. This larger group of about twenty seniors come together to share life stories. Invariably, since many of the seniors are from the Tri-Cities area, the stories that they write are personal histories of place. Similar to the Dogwood group but based out of a different facility, Pinetree Community Centre, this third group of seniors engages in activities such as games, arts and crafts, fitness classes, and organized bus trips.

An additional group participated in the Tri-Cities workshop. At the request of the Leisure & Parks division, a workshop was conducted in Coquitlam with the city’s Leisure and Parks Services Management Team. The Leisure and Parks Services Management Team is tasked with working with the community to create opportunities, through leisure and parks, to encourage healthy lifestyles. They develop, maintain and administer programs, recreation facilities, parks and hiking trails.

Seven workshops were conducted in Coquitlam, BC between February and April of 2004. The workshop format was aimed primarily at a) familiarizing participants with the Local Stories application within GBExplorer, b) to allow them the opportunity to use the system and c) discuss the potential for use within their community groups. Workshops were held with one youth group, three groups of seniors, and, at the request of the Leisure & Parks division, a workshop was conducted with municipal staff. The workshop format took place, when possible, in the information technology lab at the municipal hall in Coquitlam. This instructional setting had twelve networked computer workstations as well as whiteboards, data projector and screen at the front of the room. The workshops were conducted with the approval of the UBC Behavioural Research and Ethics Board. The workshops were designed and facilitated with the assistance of a planning student from UBC who wanted to
focus on the Local Stories application for her master’s thesis (Murphy 2004). The following agenda was followed in all of the workshops:

- An introduction, including round table of participant introductions (10 minutes)
- Presentation and review of Local Stories (10 minutes)
- Adding your own stories (60 minutes)
- Wrap-up and next steps (10 minutes)

In the workshop introduction, participants were provided with some background on the GBDL and informed of the facilitators’ interest in exploring ways for their local knowledge to be recorded and shared with residents and decision makers. They were given a demonstration of the Local Stories application, which included interface explanation, basic map navigation and the identification of media with which to construct a story (html, images, sound). The remainder of the session, usually about an hour, was devoted to free exploration by the participants. They were invited to use the application to create stories that were of interest to them. This task was left deliberately open ended, although in the demonstration session, two or three example stories were provided to act as a springboard to generate ideas for the assembled participants. The workshop facilitators were available to provide technical and user support.

A brief questionnaire (see appendix A) was administered on an optional basis. The Citysoup Community Engagement Coordinator encouraged the use of a survey instrument with the groups she had prioritized since it would also provide her project with helpful data that they had not yet collected. These workshops provided an opportunity to observe the participants as they created their own local stories and reacted to a) the idea of such an application and b) the actual workings of the prototype application.
4.3.2 Case Study #2: Community Habitat Resources Project (Whistler, BC)

The uptake of Local Stories by community groups in Whistler originated with a slightly different focus, brought about by the conglomeration of actors in that community. The Resort Municipality of Whistler (RMOW) officially adopted the Natural Step™ framework in 2000. This is a significant endorsement for sustainability principles by the official decision-making body for the community. As a result of the adoption of the Natural Step Framework, the community is committed to public consultation and values-based decision making on behalf of the RMOW.

Whistler is a world-class ski resort community and is rapidly evolving into a year-round destination resort community with skiing activities from November to April and mountain biking and hiking in the summer season. The community started expanding about twenty-five years ago and continues to grow. Key local issues centre on a balance between the resort lifestyle and the natural setting of the Whistler valley and surrounding mountains. Specifically residents are concerned about the availability of affordable housing and growth management. There is such a vast, and inflated, market for recreational homes that average income earners are unable to afford housing and, as a result, commute from the near-by communities of Squamish and Pemberton (InterVISTAS Consulting Inc. 2007; Points of View Research & Consulting Ltd. 2002).

Development pressures are substantial in the Resort Municipality of Whistler. The high demand for land for seasonal and residential housing developments threaten wildlife corridors, sensitive and critical habitats and sharpens the need to create a harmonious relationship between the natural environment where the mountain terrain supports a world-class ski and mountain bike resource and the built environment that accommodates year-round residents, seasonal residents, and tourists. Such concerns are being addressed
by a coalition of eleven community groups\textsuperscript{8} that joined forces, received grant funding and created the Community Habitat Resources Project (CHiRP) in 2003.

Collectively, they created the following mission for CHiRP: “To create a web-based vehicle that involves all community members in natural habitat monitoring and protection” (CHiRP, 2003). With funding from the Community Foundation of Whistler, the group met in early 2003 to identify their priorities and to allocate the funding they had received to accomplish their stated mission. One of the primary activities the group decided to tackle was an amalgamation of their diverse information holdings in an effort to provide a summary of the state of knowledge of the Whistler region. This data integration exercise was intended to accomplish two things: 1) data synthesis and 2) data sharing among the organizations. In effect, in order for each group to better meet their own individual mission statements, they needed to combine forces and integrate their data resources to provide a more robust approach to habitat monitoring that would cut across their individual interest area such as birds, bears or mountain biking.

A major goal of the CHiRP was “to strengthen and foster community involvement at a grass roots level to further the awareness and protection of our natural habitat” (CHiRP backgrounder 2003). Their approach included the development and integration of spatial data to catalogue and map known habitat of bears, birds, and other wildlife. They had planned to launch a website to provide information on their project and were hoping to deliver their spatial data inventory through an online map viewer. In addition, some of the community groups represented recreational use of habitat such as off-road cycling, skiing and land uses of the municipality.

Following a presentation on the Local Stories module, the steering committee of the Community Habitat Information Resources Project (CHiRP) decided to enter into an agreement with Natural Resources Canada and the GBDL project to re-use the technology

\textsuperscript{8} A description of each group is provided in appendix B.
developed in prototype form for GBExplorer. The steering committee had become quite intrigued with the story upload functionality that the module provides. They felt that the interface and the storytelling component made the application more compelling and could increase attractiveness to both their website and cause. They had considered other applications such as ESRI’s ArcIMS (Internet Map Server) and the Community Mapping Network but decided to use the Local Stories module. The board elected to pursue a partnership approach where the GBDL team provided some guidance to the process while CHiRP customized the Local Stories application for their own use. The Local Stories application was built onto the OpenGIS mapping technology (freeware) called MapServer that originated at the University of Minnesota.

One aspect of Local Stories that was received particularly favourably was that “the CHiRP site could include links to ‘stories’ embedded in the maps. The stories could be provided by the public, telling people about experiences in different areas, and giving a heads-up about what visitors to the area should look for. Other stories could include educational information about a habitat or species, and links to various reports and studies” (Mitchell 2003). The organizer of CHiRP referred to the draw of the storytelling function within Local Stories as “one of the things people might be able to relate to and use on the Internet, pointing to a spot on a map and getting the story from someone who’s been there. It’s a great way of capturing the community, and getting the community involved. It really makes the landscape speak” (Mitchell 2003).

Since CHiRP had dedicated funding to support both a part-time project manager and a part-time GIS specialist, they decided to re-deploy Local Stories within their own web application. As such, they provide a case study that emphasizes the reusability of the technical architecture of GBDL. The primary work with Whistler then became an issue of technology transfer. The theory and implementation decisions that support Local Stories

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9 Mapserver is an Open Source development environment for building spatially-enabled internet applications, available from http://mapserver.gis.umn.edu/
emphasize broad access to what is commonly viewed as a specialized technology. The intent of Local Stories is more ubiquitous access to locally-relevant spatial data with a strong emphasis on user-generated content.

A series of meetings took place in September and October 2003 to i) conduct a needs assessment of mapping requirements and ii) develop a workplan to fulfill the functional requirements. The CHiRP GIS specialist was hired in October 2003 and held discussions with all eleven CHiRP community organizations to gain an understanding of their data holdings and data display requirements. This needs assessment is provided in appendix C. The range of identified needs varied from group to group: some groups already had spatial data of habitat while others required a means of digitizing some of their habitat data in order to make use of Local Stories’ mapping function. The GIS specialist for CHiRP felt that an “open source” solution (which has no direct cost implications) was a good choice for the CHiRP member groups and that it may provide a means for the mapping activity to continue beyond the end of the CHiRP project in 2005 (T. Howlett 2004, pers. comm.).

A site visit was conducted to the CHiRP management team in November 2003. The purpose of this session was to assist in the installation and setup of the mapserver software and to provide a version of Local Stories that the GIS specialist could then modify and customize over the course of the next few months as the development of both the website and datasets proceeded over the winter. The lead technical developed for GBExplorer participated in this visit.

The CHiRP website launch took place on May 24th, 2004 in Whistler. During the launch, the member organizations received a demonstration of the CHiRP mapping application by the GIS specialist and the project manager. The resultant application had two primary components. The first component was a map browser view that allowed for the display of map information, toggling between layers with much of the dataset composed of natural habitat data on bears and birds. The second component was the Local Stories module that
provided a means for the general public and the members of the community organization to contribute to the knowledge base by adding their own stories. In discussions with participants at the event, it became clear that several participants felt very positive about the development of the Local Stories and mapping components and indicated that it was exactly the kind of support they wanted for their community groups.

From a technology transfer perspective, the GIS specialist indicated that her experience in developing the open source web-based mapping application was no more difficult than using standard commercial software. One benefit of using an open source application was that the open source GIS community was available whenever problems arose. The GIS specialist posted questions to the open source community over the 6-month development period and also had access to the GBExplorer developer for questions via email. Subsequent to the launch of the application, the GIS specialist was invited to present the experience of developing the CHiRP site to a conference of mapserver developers who meet annually to exchange ideas and to foster the strong collaborative loyalty within the open source community. CHiRP’s development of their own version of Local Stories served as an example that the GBDL conceptual ideas could be modified for other uses and exist as a stand-alone application for general community mapping activities.

**4.3.3 Case Study #3: Snug Cove Village Plan Review (Bowen Island, BC)**

Located in the heart of Howe Sound, a twenty minute ferry ride from West Vancouver, Bowen Island is a rural community with about 3000 year-round residents and another 1500 seasonal residents. Incorporated as a municipality within the Greater Vancouver Regional District in 1999, Bowen Island residents faced the task of taking a greater degree of local control over the island’s natural and built environment. The community of Bowen Island figured prominently throughout all phases of this thesis research – indeed for the entire phases of the Georgia Basin Digital Library’s conceptual development and for the design of the GBExplorer prototype.
The programming team worked with a school group during the design phases of Local Stories as the grade 8 social studies class conducted a term project on the natural habitat in the lands behind the school. The students collected digital photographs and composed stories relating to the flora and fauna on the island using Local Stories. In this way, the design team was able to collect direct feedback on the interface elements and to identify any hurdles in using the application. Adjustments included adding numbers to the data input screen to help users navigate through point digitizing, story creation and image or sound file upload.

In parallel projects, the community developed a sense of community practice (Crawford 2000) and undertook data collection on the natural and socioeconomic conditions on the island. These data were initially compiled by students in the Capilano College Environmental Studies program and some of the students continued the data collection as a summer project which resulted in the publication of a “state of the environment” report for Bowen (Julian & Bailey 2001). A parallel volume compiled over fifty layers of spatial data into a map atlas for the community (Shoji et al. 2000). Metadata were described for these spatial layers and eventually all the information was provided to interested parties in the form of a cd-rom, available for purchase for $10. This served as a diverse dataset against which to design the GBDL. Bowen featured repeatedly throughout the research process from pre-prototyping some of the conceptual ideas of the GBDL into a locally available cd-rom and website (Journeay & Dunster 2002) to the Community Forum that was held in the winter of 2004 to consider a proposed amendment to a planning document.

Rather than discuss all of these interactions here, the focus will be on one process, which is the review of a draft village plan within the municipality’s Official Community Plan. An official community plan is “a statement of objectives and policies to guide decisions on planning and land use management, within the area covered by the plan, respecting the purposes of local government” (Revised Statute of British Columbia 1996). Public consultation is a requirement of the review process. The case study will focus on this
Community Dialogue, which consisted of a series of public forums in the winter of 2004. It will also draw on previous activities including a case study by Savelson (2004; Savelson et al. 2005), undertaken as part of the GBFP, to highlight trends in the subsequent discussion in chapter 6.

The Snug Cove Village Plan draft 5 articulates a neighbourhood scale plan and is of importance to all residents since the area encompasses the island’s sole ferry terminal, the link to the mainland for transportation, employment, and access to goods and services. Endorsed by the municipal council, the Community Forum process was a citizen-led dialogue series designed to discuss the recommendations within the Village Plan. The process was led by a facilitation team of three residents who held five dialogue sessions between January and March of 2004. The purpose of the Community Forum was “to ensure that people are involved in the decisions that affect them; giving them an opportunity to be part of and influence the process, and ensure that people understand the logic and reasoning behind the decisions that are made” (Journey et al. 2004).

The sessions included an introductory presentation and discussion of the Snug Cove Village Plan draft 5 which took place on January 18, 2004. This was followed on February 15, 2004 by a dialogue session on one of the key issues for the Village Plan which is traffic and ferry marshalling. Two sessions were held at UBC’s Landscape Immersion Lab, which used immersive landscape visualization with hypothetical models of housing development in a part of Snug Cove to consider the questions: “How might a community use decision support tools and do they help?” These workshops had lively discussions about the densification options articulated in the Village Plan. Community indicators such as population, water consumption, energy consumption were used interactively to stimulate dialogue and respond to participants’ queries. These workshops took place on February 18 and 24, 2004 and were attended by 5 and 8 people, respectively. A summary workshop was held on March 7, 2004 where participants were able to review a draft report and articulate their reactions to the process. The table below summarizes the workshops in the
Community Forum process, which all took place on Bowen Island—except for the two visualization workshops that took place in a lab at the University of British Columbia.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Objective</th>
<th>Location</th>
<th># attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18 Jan 2004 Presentation &amp; discussion of Snug Cove Village Plan, draft 5.</td>
<td>Collect feedback and preference selections.</td>
<td>School</td>
<td>110</td>
</tr>
<tr>
<td>2</td>
<td>21 Jan 2004 Presentation &amp; discussion of Snug Cove Village Plan, draft 5.</td>
<td>Collect feedback and preference selections.</td>
<td>Legion Hall</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>24 Jan 2004 Presentation &amp; discussion of Snug Cove Village Plan, draft 5.</td>
<td>Collect feedback and preference selections.</td>
<td>Municipal Hall</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>15 Feb 2004 Traffic and ferry marshalling options discussion</td>
<td>Explore these two issues in more detail (and with visualization) as a result of the feedback from the first three workshops.</td>
<td>School</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>18 Feb 2004 Visualization of futures for Bowen</td>
<td>Visualize examples of densification in keeping with the land use guidelines in the OCP.</td>
<td>UBC – Landscape Immersion Lab</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>24 Feb 2004 Visualization of futures for Bowen</td>
<td>Visualize examples of densification in keeping with the land use guidelines in the OCP.</td>
<td>UBC – Landscape Immersion Lab (didn’t attend)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7 Mar 2004 Reflecting results back to the community</td>
<td>Present results of series of workshops back to participants.</td>
<td>School</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 4.2 Bowen Island Community Forum Sessions.

The first three workshops took place over the course of one week and all contained the same information. Three workshops were provided at staggered times to allow for scheduling conflicts and to give residents the opportunity to acquire an understanding of the key issues
under consideration in the Village Plan. The facilitators provided the residents with prepared workbooks that outlined the set of workshops over the course of a two-month period and framed the main issues presented in the Village Plan as well as voting forms to identify key guiding principles in each of the five categories.

The issues were divided into five categories including the built environment (scale, character, and aesthetics), land use, natural environment, transportation and economic activity. The built environment included the guiding principles of maintaining heritage character, promoting a pedestrian-oriented environment, preserving the village ambience, and enhancing the park ambience (there is a regional park in the Snug Cove area). The land use guiding principles included promoting the village as a social, economic and cultural hub of the island, accommodating higher residential densities and accommodating a mix of land use elements. The transportation guiding principles included creating an aesthetically pleasing entry to Snug Cove, balancing the functions of Government Road (currently used for ferry marshalling, consumer retail and pedestrian), and exploring solutions for ferry marshalling and parking. Economic activity guidelines included supporting and generating small and local business opportunities, providing for a mix of commercial activities and balancing development regulations and community values. The natural environment guidelines included protecting and preserving unique environmental features and sensitive ecosystems and to adopting a balance in managing new development.

The workshops were structured by the facilitators to introduce each category in turn, review the associated guiding principles, and to allow time for small table (groups of 6-8) discussions of the examples provided for that category. Following this discussion, workshop participants were given an opportunity to indicate their degree of support along a six point scale (from ‘I agree to the guiding principles’ to ‘I veto the guiding principles’). This input was subsequently tallied and mapped by the facilitators to gauge whether the responses were clustered together or were wildly variant.
Another workshop was added to the schedule when it became clear that more discussion was needed around the options for ferry marshalling and transportation in Snug Cove. Since every islander takes the ferry to and from Bowen, they all have experiential knowledge about ferry transportation, departing and arriving in Snug Cove and also have a range of opinions concerning how the area will or should change over time as population growth alters the previous reality. The final workshop served as an opportunity to synthesize the results of the feedback.

4.4 Data collection, analysis and results

In the workshop series in Coquitlam (CS#1), I led the workshops and observations were recorded by a colleague. She recorded field notes of impressions and occasionally there were opportunities during the sessions to compare impressions. In addition, we conducted verbal reflections with each other immediately following the sessions and further observations were recorded following the workshops. In addition, a short questionnaire was administered at the end of each workshop. These surveys served as a means to gauge generic user information such as frequency of computer use, frequency of internet use, and an overall ranking of the utility of Local Stories. Twenty-three surveys were returned from four sets of workshop participants (2 different groups of seniors, a youth group, and city staff). The seniors groups completed fewer surveys than other groups because many were novice computer users and were still engaged in story creation at the end of the workshop. About 74% of the respondents were women and just over 85% of respondents used the internet on a daily basis. All respondents had been computer users for at least two years. All the respondents indicated that the application was at least somewhat useful with 95% indicating that it was useful or very useful (Fig. 4.4).
In terms of the ease of navigation of the interface, the results were split with about half the respondents indicating that the interface was easy to navigate and about 40% indicating that they did not find it easy to navigate or that parts were easy and other were not (mixed, see Fig. 4.5). The map interface required a great deal of zooming and panning to obtain the desired area and some users found this frustrating, “hard to find certain places on the map” (Respondent 4), “once I figured out where to click, I found where I wanted to be quite easily” (Respondent 7) and others did not find the navigation difficult, “very clear and easy to follow” (Respondent 10). It should be noted that the orthophoto available for the region, which was used as the base map, was not of the highest resolution so some users may have found it difficult to orient themselves due to the spatial resolution of the available image. However, this did not prevent them from grasping the relevant concepts and creating local stories.
The Whistler case study (CS#2) employed participant observation during a series of meetings and email exchanges to establish the terms of reference of the relationship between CHiRP and GBDL. Also, observations were recorded during a half-day session to assist the technical lead of CHiRP to build the new server to run Local Stories as well as the CHiRP website, which was under construction at the time. These recorded observations were reviewed and analyzed for emergent themes to provide an analysis of CHiRP’s concerns and challenges in transferring and augmenting Local Stories for their purposes. Contact was maintained with the lead technical developer for GBExplorer to gauge the frequency and type of interaction and mentoring he provided to the CHiRP application developer. CHiRP launched the application in May 2004 (Fig. 4.6).
In the Bowen case study (CS#3), observations were gathered during the lead up to the forum process in preparatory meetings with the facilitators and and field notes were taken during each island workshop session and during one of the two UBC visualization lab sessions. These notes were transcribed after each session. In addition, a content analysis were conducted on documents relating to the forum, including newspaper articles, posts on the online community discussion forum, the workbook for the workshop, the written feedback comment sheets returned from each participant for each of four themes, and the facilitator’s final report. The content analysis included the development of a set of codes or categories with a frequency analysis using a standard word processor (Denzin & Lincoln 1994; Thomas 2003).
During the Community Forum process on Bowen, key comments were noted: these included some frustration with the selection of guiding principles that some deemed “too motherhood” to have any value, particularly when participants wanted to know how the guiding principles would be achieved in order to determine whether it was a priority for them. At the end of the large group session, the tone in the room was one of frustration. This may have been a reflection of the difficult nature of the discussion on how to accommodate future growth and maintain the island way of life even though this means something slightly different to everyone. This sense of frustration was also reflected in numerous postings on the community’s online forum immediately following the first session: “They certainly didn’t do things the way I would have done them”; “All we did was talk, talk talk. I want action! Bowen has to move forward!” (Bowen Online Forum, 22 Jan 2004).

4.5 Conclusion

An overview of the methods applied in this research project and a detailed description of the research activities that were undertaken has been provided in this chapter. Details concerning each community’s use of Local Stories and spatial technologies are presented and discussed in chapter 6, where the research results are oriented into a set of categories that comprise relationship building, engagement, task orientation, and technological adaptation. In the next chapter the design of GBDL is presented along with a description of how those conceptual ideas were manifest in the GBExplorer application.
5 Setting the context: The design and development of the Georgia Basin Digital Library for sustainable development

5.1 Introduction

“All social research sets out with specific purposes from a particular position, and aims to persuade readers of the significance of its claims; these claims are always broadly political” (Clough & Nutbrown 2002). In that tradition, one of the current research goals is to reform the culture of technological support in decision making. This requires paying attention to the interplay and power dynamics between groups of social actors and the technologies that can support the processes of building awareness of social, environmental and economic issues. In doing so, it is also important to explore a space where expertise and local experience find a comfortable balance between the authentic, the legitimate and the valuable.

The starting point for this research endeavour is the notion that that GIS technologies have typically been developed and used in ways that view the information associated with spatial data as neutral. The view driving the current research is that this approach is misguided and has contributed to a failure to realize the full potential for widespread public use of GIS technologies as an exploratory tool for knowledge discovery, creation and sharing.

The purpose of the specific research activities undertaken for this dissertation was to contribute to the design of a system that merges web-based GIS functionality with digital library technologies (i.e. information management capabilities) to extend the overall information experience that users commonly experience on the web. An additional research purpose was to encourage use through user contribution and bi-directional communication – to increase the validity of the plurality of opinions and evidence that lend support to an

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10 A version of this chapter has been published elsewhere (Talwar et al. 2003).
individual or group’s point of view. This persuasive element is not intended to merely increase the quantity but to extend the quality of participatory voices in debate.

As indicated in chapter 2, studies of knowledge construction do not tend to deal with how knowledge is socially shared even though it has been demonstrated that the material technologies that generate and standardize representations also mediate the sharing of knowledge (Thurk & Fine 2003). These claims have implications for notions of individual and collective agency, the nature of people’s interactions with information, the credibility and reliability of information, accessibility of both content and meaning, and its relevance.

This chapter describes the design and development of a conceptual framework and prototype web-based geospatial digital library for the Georgia Basin region of British Columbia. In so doing, this chapter serves two purposes. The first is methodological: to provide a description of the first of four case studies completed as part of this dissertation work. The second is contextual: to create the backdrop for discussion of two other case studies by way of explaining the GBExplorer application that was used in the Coquitlam and Whistler case studies. These are described in the next chapter.

5.2 Study area: Georgia Basin
The Georgia Basin region of southwestern British Columbia which occupies nearly 46,000 km² of land and sea, is experiencing considerable population growth in an environment of extensive natural diversity. Nearly three million people currently reside in this region roughly demarcated by the drainage basins of the Strait of Georgia (BC Stats 2000). The population is expected to grow substantially, to approximately 5 million people, by the year 2040. The area has served as a focal point for numerous sustainable development-related research projects over the past ten years. The design and development of the Georgia Basin Digital Library is a place-based approach to engaging with sustainability issues. The project was initiated to complement research themes within the Georgia Basin Futures Project, so a brief description of that project is provided as context for other sustainability research
taking place coincident with the design and development of the Georgia Basin Digital Library.

The Georgia Basin Futures Project (GBFP) was a five-year project designed to explore the reconciliation between global carrying capacity and human well-being in the Georgia Basin over a forty year timeframe (2000-2040). The region was selected due to its wealth of natural and human resources. Compared with other highly populated and rapidly growing areas, the Georgia Basin’s environment is less degraded, which creates a site of high potential for reconciling human well-being and natural limits (GBFP Backgrounder 2001). The GBFP engaged communities throughout the region with a suite of tools, processes and research focused on the subject of sustainability. The intention of the project was to engage the public and local and regional decision makers in a collaborative dialogue about sustainability to develop potential future scenarios for the Georgia Basin. These future scenarios were explored using Georgia Basin QUEST (GB-QUEST) which is a computer simulation game that embodies expert understanding about how complex ecological, social and economic systems work (GBFP Overview, 2001). It provides users with a way to create one or more desirable futures and to explore policy mechanisms that could actualize the desired future scenario that they created. This research has contributed to regional sustainability by connecting to real world decision making and planning through university - community relationships over the course of the project (Robinson 2003; Robinson, Carmichael, Tansey et al. 2006; Robinson, Carmichael, VanWynsberghe et al. 2006; Robinson & Tansey 2006; Tansey et al. 2002; VanWynsberghe et al. 2003).

The Georgia Basin Digital Library (GBDL) project was a two-year project (2000-2002) to develop a conceptual framework for a web-accessible spatial digital library. This research grant secured a partnership commitment between the recipient, the Sustainable Development Research Institute at the University of British Columbia and one of the contributing sponsors, Natural Resources Canada (Earth Sciences Sector). The original aim of the GBDL project was to design and develop a conceptual framework for such a system.
The initial premise was that individuals need a familiar and understandable frame of reference in which to assess the complex interrelationships between the ecological, social and economic systems of which they are a part. The understandable frame of reference echoes the sense of place that people can establish with their surroundings (Relph 1976). A shared sense of place is an important element in developing a meaningful understanding of what sustainability may mean in the context of a region or community, and for making informed decisions about a collective future. It was comprised of the following six research components:

<table>
<thead>
<tr>
<th>Research Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Design</td>
<td>Development of a user interface that represents the desired functionality of the site while demonstrating usability and familiarity to the user.</td>
</tr>
<tr>
<td>Community Engagement</td>
<td>Involvement of the community in an effort to promote understanding and instigate involvement in issues that relate to sustainability in the Georgia Basin region.</td>
</tr>
<tr>
<td>Visualization</td>
<td>Development of new manners of representing geospatial data, focusing specifically on three-dimensional (3-D) visualization, in an effort to bring geospatial data into a familiar environment for the user.</td>
</tr>
<tr>
<td>Knowledge Representation</td>
<td>Development of a means of creating understanding and interrelationships of concepts surrounding sustainability and developing a means of linking these concepts to geospatial data in an effort to enhance understanding.</td>
</tr>
<tr>
<td>Knowledge Architecture</td>
<td>Development of an architecture that manages relationships between thematically complex polygonal data, specific observations and associated attribute, image and text data.</td>
</tr>
<tr>
<td>Scenario Modelling</td>
<td>Display and integration of backcast scenario models developed through GB-QUEST that represent issues relevant to the Georgia Basin such as water, agriculture and neighbourhood planning.</td>
</tr>
</tbody>
</table>

Table 5.1 Research themes in Georgia Basin Digital Library Project (GBDL Final Report, 2002).

The linkage between GB-QUEST’s future context and the GBDL framework to encapsulate some current information on the Georgia Basin and public perceptions of sustainability created the potential to explore the temporal component of sustainability issues at a regional scale. The GBDL project was distinct from GBFP but maintained tight linkages, particularly around community engagement and linkages to future scenario development. Placing the
technology in context, it is important to stress that the GBDL design intended to address the fragmentation of digital spatial data (Journeay et al. 2000). The goal was not simply to build a website but to examine the use of the web for information exploration and for engagement with non-market, learning-based activities. Over the course of this work, the scope evolved into a system that supports knowledge exploration (including knowledge generation) and could support decision activities.

The next sections describe one of the methods employed in this thesis – interaction design. The application and its conceptual tenets have been described elsewhere (Talwar et al. 2003) and what follows is a reworking of this piece to reinforce methodological implications of interaction design as it was carried out as part of the GBDL. The process of designing and creating the GBDL was foundational to the subsequent individual case study research into the use of spatial technologies with community groups is described in detail in the next chapter.

The overarching goal of the GBDL was to develop awareness and understanding of issues related to regional sustainability. To accomplish this, GBDL integrated web-based geographical information systems (webGIS), knowledge representation, community mapping, sustainability, and public participation techniques. More specifically, the project developed a conceptual framework and specifications for a digital library that emphasized user services over archive or advanced search functionality. This acknowledged that the expected audiences of the GBDL project would not typically be familiar with web technology beyond the browser level and would have little background in interpreting research data and reports. One of the key goals of the project was to provide functionality that was both accessible and non-intimidating to such an audience.

In the course of the project, it became apparent that a manifestation of the conceptual framework into a prototype application, GBExplorer, would provide shape and depth to ideas that were evolving. This represents an important shift in thinking between building a
website of information and creating a research prototype, which is ultimately what the GBDL was. The crux of GBExplorer was the functional and technical architecture that will help promote the integration of natural science and socio-economic information for the purposes of awareness building around sustainability issues at community and regional scales. An overview of the conceptual design and a description of the online components is provided in the next section.

5.3 Conceptual framework for the Georgia Basin Digital Library

The disaggregated nature of information has led to processes that fall short of embracing a holistic approach to decision making about a collective future (Journeay et al. 2000). The transition to sustainability, in this region and elsewhere, includes the challenge of place-based knowledge building and integration (National Research Council 1999). Libraries have played a fundamental role in managing information collections, a role that is being reexamined in the face of the societal shift toward the pervasiveness of information technology and the World Wide Web. Over and above their function as an intermediary between knowledge repositories and users, libraries offer the potential to stimulate new thought and foster the growth of our collective knowledge resources (Lerner 1998). The ability to create a familiar and understandable frame of reference that assists in meaningfully representing and communicating these complex and interdependent ecological, social and economic systems is a necessary reality of charting a desired course for future generations.

The rapid expansion of internet technologies and the proliferation of data led to the development of strategies and systems to organize materials for retrieval in order to remain afloat and navigate through a swell of information (Wurman 2000). Even the most simple web searches return a multitude of results and may overwhelm the user (Shenk 1997). This can be particularly evident in cases where the user learns while browsing and, as a result, may require a conceptual framework to guide the information selection process. While greater access to information may be desirable, the ability to contextualize the shared
knowledge would improve the usability of the information by providing a conceptual network of how an information object is related to others in the collection. An ideal representation would present the information context side-by-side with the search results. In some ways, this mirrors the process of searching through adjacent materials on a library shelf with items classified thematically.

Digital libraries have been characterized as the balanced development of four axes including 1) digital content (documents such as texts, images, maps, datasets, audio, and video), 2) technology to manage and serve content, 3) services to meaningfully structure and 4) user access to content and services (Marchionini & Fox 1999). This constructive definition acknowledges the services that are supplied by libraries and the users that they serve; it also recognizes that librarians and their institutions often serve as intermediaries in connecting users with relevant content to address their concerns. Providing a surrogate for the type of assistance that has traditionally been supplied by professional librarians may be a necessary element in creating a useful web-based digital library experience. On the whole, digital libraries offer a useful strategy for the structuring, management and sharing of digital information sources.

While digital library technologies have offered a useful metaphor, just how to design the necessary components that will help structure content meaningfully and represent it in an accessible manner remains unclear. Data and information are the building blocks to understanding. Without a network of understood concepts, few things make sense or have meaning. Education researchers refer to the background knowledge that frames learning and provides context towards learning new concepts as scaffolding (Bransford et al. 2000). Building scaffolding is recursive; the context is established by nesting ideas into broader contexts, and so on. However, it is unclear where this process needs to stop; the depth of scaffolding is determined by the needs of the user, which are not available to the digital library system directly.
Even though a formal solution to this scaffolding dilemma was not available, for problems where some human element is evident, scaffolding may be built via storytelling since the framework for the information – the story – is a human universal with immediate and comforting overtones. Storytelling, however, is sufficiently general and abstract that it is difficult to handle directly in a computational system; some compromise between structure, to support the system architecture, and storytelling, to support scaffolding, is needed.

Pattern languages, developed to provide such support for citizen-led architectural design by Alexander et al. (1977), provided a way to organize implicit knowledge about how people solve recurring problems. Although used originally in the realm of architecture and urban design, pattern languages have also been used to create reusable code within object-oriented programming, thus demonstrating their utility in both a human and computational setting. In pattern languages, the issue to be resolved is encapsulated as a problem statement, followed by a general description of the problem and context. An image or representation is provided to accompany the problem discussion and the pattern is completed with a solution statement. A title provides an overall description to the package. Relationships between the patterns are established using links between titles – hypertext – and form a conceptual network. Narrative form within the problem discussion may provide the necessary scaffolding to create context for the user and if the stories can be captured in a semi-structured manner, their relationships may be conveyed in an online environment by using a concept map or semantic network corresponding to the hypertext linkages between the different patterns. Although this overall structure was more complex than simple static pages of stories or a dynamic system based on computational techniques, the blend of storytelling with hypermedia provided a mix of familiarity and a usable structure that tried to address how a digital library might support scaffolding.

As previously stated, the GBDL aimed to foster an awareness of sustainability issues. The question of how best to build scaffolding for a diverse set of users also relates to how the concepts and their associated content are managed. A fundamental component of the conceptual framework was the distinction between data, information and knowledge. For
the purposes of GBDL design, data were viewed as syntax, information was structured or interpreted data, and knowledge was the human understanding of information generated by using structured information in a particular context. While knowledge may be an amorphous concept, it is often categorized as explicit or implicit. Explicit knowledge can be symbolically encoded within a computer system through the use of ontologies expressed through concept taxonomies and rules (Gruber 1995). Implicit knowledge refers to tacit meanings that humans develop through interactions with each other and their environment and cannot be captured as easily. However, the use of more loosely structured devices, such as stories, provided a useful analogue to the way humans acquire knowledge. Significant attention was given to the development of a knowledge model that accommodates multiple conceptual perspectives (ontologies) on geospatial information and links concepts to occurrences (such as an image or a story). The technical implementation of this architecture is described below in a discussion of the prototype application, GBExplorer.

The use of geospatial information and map representations were key pillars in the conceptual framework. In addition to conveying the spatial relatedness of concepts, maps are representations that describe a setting, awaken curiosity and enchant the imagination. While cartography can represent place by reflecting a correct rendition of the terrain, maps can also play a crucial role in representing socially constructed views of place and can act as commentaries (Harley 1989). A map can then become a representation of diverse cultural, political, ideologic, class and gender views. In increasingly pluralist societies, maps and geographic information help communities coalesce by delivering usable products and by building both spatial and human relations (Craig & Elwood 1998). Maps can also add form to individual and collective reality and stimulate curiosity about the unknown (Aberley 1993).

Recall from chapter 2 that in the mid-1990s GIS researchers paid more attention to the relationship between society and GIS (Aitken & Michel 1995; Curry 1994; Harris & Weiner
Numerous research activities further developed aspects of human and societal impacts of GIS use. In particular, the National Centre for Geographic Information and Analysis’ Initiative 19 and the Varenius Project extended this research considerably (Craig et al. 1998; Curry & Eagles 1999; Goodchild et al. 1997; Hirtle & MacEachren 1998; Janelle & Hodge 1998; Miller & Han 1999). These literatures exemplify the interplay between the social and the technical where, as outlined chapter 2, the use of GIS in participatory settings is mutually constituted rather than being technologically determined. As noted in chapter 3, the PPGIS field is a growing area of research and has involved considerable use of case studies to examine use of GIS and how it is applied. Many of the examples highlight use in first and developing worlds, particularly for resource management and decision making (Craig et al. 2002). The PPGIS literature has focused on neighbourhood development and planning that adopts a stronger, user-centred focus (Talen 2000). From a community point of view, the opportunity to map at a meaningful scale and to represent significance (natural, cultural, social, economic or political) in a participatory planning process is an enabling one and offers a way to exert power. PPGIS research has an emphasis on non-expert users of the technology and adopts a user-centred approach to inform the design of the application. These approaches informed the conceptual framing of GBDL, particularly the use of narrative in Local Stories and to need to present multiple points of view within Ideas & Perspectives (see next section).

For the GBDL, issues of access, empowerment, marginalization, and scale are closely coupled with its use. The integration of the webGIS, concept network and storytelling components are viewed as a step towards overcoming some of the access issues and to address the scaffolding problem. In so doing, it may be possible to create a space that allows for the inclusion of multiple knowledges (scientific, socio-cultural, local, etc.) and that represents a deeply meaningful sense of place. Finally, if these maps are explicitly linked to stories, then a situated storytelling environment can be constructed that honours the individual, the community, and more abstract knowledge in equal measure. The following
section outlines the prototype application that instantiates many of the issues raised in the conceptual framework.

5.4 GBExplorer application

The prototype online application that was developed, GBExplorer (http://www.georgiabasin.info), was divided into five sections: 1) News & Information, 2) Ideas & Perspectives, 3) Local Stories, 4) Library Collections and 5) Future Scenarios. News & Information was updated regularly from syndicated internet news sources, provides users with an opportunity to view and suggest new stories and websites representing topics related to sustainability. Ideas & Perspectives integrated the use of semantic networks, webGIS and hypermedia to provide a rich and multi-faceted context for exploring sustainability concepts and their relationships. Local Stories provided a web-based mapping application for exploring and generating user-driven content. Library Collections provided search and browse functionality, access and display of document surrogates (i.e. metadata) and direct access to map, document, image, audio and video collection content.

5.4.1 News & Information

News & Information was a quick reference source that allows users to access pertinent news reports on issues related to sustainability. The news reports were gathered by online news services and filtered according to theme and geographic scope. The application used pre-assigned keywords to mine the news provider’s report database and appropriately group content for display within thematic divisions of community, economy or environment (Fig. 5.1). The application clustered returned content into local, regional and national stories. The content was generated dynamically to assure currency and novelty.
GBExplorer obtained news-related content from two news services: 1) tidepool (http://www.tidepool.org) and 2) moreover (http://www.moreover.com). Tidepool is a bioregional online news service that selects news stories, deemed to contribute to a conservation-based economy, from over thirty providers. Moreover is an extensive news source that accesses over 4000 news sources. The Tidepool news service provided content related to regional sustainability issues and moreover provided a breadth of coverage at a national scale. The sole burden for GBExplorer was the selection of appropriate search keywords. The content generation remained with original sources, news, science and current affairs reporters, who provided encapsulations and brief explanations of newsworthiness. News & Information provided a service to mine credible news sources for
stories of potential interest and relevance to GBExplorer users. GBExplorer users were able to contribute news stories and relevant websites to enrich the sphere of awareness building and allow for greater community participation.

5.4.2 Ideas & Perspectives

The prototype used an existing pattern language for regional sustainability that had been developed by Ecotrust, an environmental non-governmental agency (Ecotrust 2001). It was implemented in GBExplorer within a diagrammatic representation of the patterns that are captured in story and problem-solution form. The semantic network was used to explore the concepts by direct navigation, where an item selected with the mouse becomes the new centre of the displayed network and reveals new details through links and dynamically dropping old links. In this fashion the concept of semantic distance is directly captured, since the semantic network shows one conceptual level – one scaffolding level of detail – at a time. The network was linked to the hypermedia frame that displayed the narrative so that navigation triggered a full hypermedia pattern language item to be loaded in the frame, which in turn triggered the display of a contextual map. For example, the concept of ‘quality of life’ is described in a narrative and accentuated with images (Fig. 5.2).
The strength of Ideas & Perspectives lies in presenting the user with multiple perspectives on a concept such as quality of life. Points of view from non-governmental organizations, community groups, the academic community, and federal, provincial or municipal governments can be represented within this framework to give a breadth of perspectives on aspects of sustainability. In principal, the semantic browser can be used to take a theme and crosscut the spectrum of opinions on the issue, showing different perspectives in the community or between community, government, and academics. The network-pattern-map mode of representation resists polarizing an issue and achieves some progress toward including multiple representations and views of concepts and the network of their relationships. It offered a means for the user to reorganize their own views in order to
understand the links in someone else’s; thus simultaneously preserving their own frameworks of meaning and relating them to new ones (Berners-Lee 1999).

In the GBExplorer, one structured pattern language was implemented for a conservation economy developed by Ecotrust to provide a perspective on social, environmental and economic links for the regional area. At the local scale, an overview of local flora and fauna and economic information was available for Bowen Island that was constructed as a quasi-pattern language at the local scale that included local examples in text and narrative form (Julian & Bailey 2001; Shoji et al. 2000).

Since Ideas & Perspectives included a linked map frame that illustrates a sustainability concept, such as water availability, with a spatial representation of water well locations, it was possible to directly represent spatial data to correspond to a particular concept. In effect, this was a means of situating and spatially contextualizing a core concept of sustainability from a given perspective. The linkage between the map and the semantic network of sustainability concepts reinforced a view of mapping as a means of communicating ideas within a cultural and political context (Barnes & Duncan 1992).

### 5.4.3 Local Stories

Local Stories was a community mapping module that provides the facility to create and share local views on issues of interest and importance. It was a means of reflecting on priorities and of describing personal or collective connections to place. This extended the interactivity from the ability to select to the ability to create (Berners-Lee 1999). A particularly user-centred module, the core functionality was to provide an opportunity to generate content by contributing a narrative or exposition on a subject that is then situated on the landscape (Fig. 5.3). It offered the opportunity to develop local content and to manage, store and access local knowledge.
Local Stories is a starting point along the path toward creating an exploratory mapping environment where place is entrenched with lived experience. Local knowledge was constructed and shared through an interactive map and narrative interface. In addition to developing locally based content that may be juxtaposed with scientific or social publications, this interactive module represents a shift in cartographic perspective from the map as a communication device to the map as an exploratory environment (Crampton 2001).

One of the key obstacles to realizing sustainable development is how to shift community awareness, thinking and practices to allow dialogue around community development.
decisions such as land use planning and growth management. The Local Stories module used the Green Map System of icons as a way to identify spatially significant sites of interest on a geospatial base such as a digital orthophoto or vectorized base map of the region. The Green Map System is a globally connected, locally adaptable eco-cultural program for community sustainability (Brawer 1995). The system includes 125 green map icons that capture the interconnection between nature and the built environment. The icons, mapped on to a location, identify a wide-ranging assortment of features such as an eco-spiritual site, a museum, a local artisan, a bike path, a community garden, bird or wildlife habitat, a fair trade shop, or a farmers market. While there is general agreement on the meanings of icons, local mapmakers are encouraged to determine a precise definition for their purposes. The Green Map System offered a well-used set of icons that could easily be applied to categorize and represent resident’s experiences.

Local Stories merged webGIS, narratives and the green map icons into a set of functionalities that promotes two-way interaction. Its interactivity allowed for local knowledge to be developed, shared and explored by members of a community. Its use with community groups in Coquitlam and Whistler, BC are described in chapter 4.

5.4.4 Library Collections
Library Collections was based on the integration of information to support discovery, access and the generation of new ideas. While much of the overall GBDL project focused on extending relationships between web-based mapping capabilities, semantic web browsing and the integration of the narrative element, content is a fundamental component of any knowledge resource. With an increase in information technologies and the development of digital libraries elsewhere, the research team was more interested in supporting access to existing content than adopting a centralist approach to gathering, structuring and organizing existing datasets. The primary purpose, then, of the Library Collections module is to provide access to existing web-enabled information sources in a distributed networked environment (Fig. 5.4).
In response to data fragmentation, national agencies such as the Federal Geographic Data Committee in the United States and Natural Resources Canada in Canada have begun to develop spatial data infrastructures to start to establish well-structured datasets and standards for their ubiquitous access. The functionality within Library Collections is compliant with the Canadian Geospatial Data Infrastructure and conducts a distributed search to return dynamic map layers from the Open GIS Committee compliant web map service applications.

Library Collections represented a departure from the exploration and community grounding of Ideas & Perspectives and Local Stories since the data that were provided were
technical, with full metadata and little requisite explanatory framework. However, the long-term goal of Ideas & Perspectives is to provide sufficient scaffolding and technical content that a persistent visitor could acquire the skills to use technically sophisticated tools and complex scientific data. Were the providers of the data to contribute framework material in pattern language form this would provide process and semantic metadata to their contributions that are typically lacking in digital library archives. Ideas & Perspectives thus had the potential to be a door into data use and operational knowledge, and Library Collections provided the corresponding data access point.

5.4.5 Future Scenarios
Future Scenarios is a means of connecting GBExplorer users with the scenario models developed within GBFP using GB-QUEST™. The development and use of GB-QUEST™ was a central component of the GBFP. It offers users the ability to design a desirable future through a series of choices about regional priorities, the global condition, and ecological and social resilience. The game-like application provides a platform to view desired futures that are normatively determined and discuss trade-offs in achieving that future. Model results are presented for a 40-year time period. The Future Scenarios module acted as a placeholder for direct linkage to GB-QUEST™ output scenarios in order to provide some temporal fluidity to the information experience between the region’s current state, in Library Collections, and its desired future, in the form of scenarios.

5.4.6 Application architecture
To implement the prototype application, the system architecture and technical framework were developed to provide the functional requirements outlined previously. GBExplorer was built on a three-tier web services architecture: i) presentation tier, ii) services tier and iii) information tier (Fig. 5.5). This architecture separates function, implementation, and information, which greatly simplified application maintenance and facilitated on-going development. The presentation tier made requests to the services tier, which was composed of presentation and information services that accessed multiple distributed data stores in the
The presentation and information services were implemented as XML-based web services that are accessible through the hypertext transfer protocol.

Figure 5.5 GBExplorer application architecture

These services can be consumed by clients outside of the GBExplorer providing other organizations with access to the library’s knowledge base. The information tier was composed of several distributed information stores including an administration database that houses all registered users and provided access control to modules such as Local Stories and Library Collections. The information tier also contained a knowledge database for managing ontologies and that used an ontology-based data model (Brodaric & Gahegan 2002; Brodaric & Hastings 2002).

The GBExplorer implementation was based on standard technologies and protocols at the time, as established by the Canadian Geospatial Data Infrastructure and the Open GIS Consortium (OGC). The map engine was built using MapServer (http://mapserver.gis.umn.edu/). MapServer is an Open Source development environment
for creating spatially enabled internet applications and was chosen for its OGC compliance, cost and flexibility. The development team used an open source php (http://www.php.net) extension developed and maintained by DMSolutions (http://www.dmsolutions.on.ca) to directly access the MapServer C application programming interface (API). Direct access to the MapServer API combined with support from DMSolutions was necessary for integration with the GBDL services tier. Technical requirements and architecture of the GBDL are described in detail elsewhere (Brodaric et al. 2003; Harrap et al. 2006).

5.5 GBExplorer use
As described in the previous chapter, the case studies about the use of GBExplorer centred on the Local Stories module since it was this module that seemed to capture people’s imaginations and spark their curiosity about the application. Developed in part to overcome a gap in the broadcast mode of web interaction (i.e. one-way from information provider to information consumer), Local Stories provides a space for local knowledge to be created and shared among community members. Many communities have developed online information resources for its residents; few extend beyond this information provision use of the web environment. For example, the Tri-Cities region had created a community portal that allowed residents to access a suite of information. The portal also included a web-based GIS that let residents view spatial information (maps) and gain a range of useful information about their neighbourhood from the locations of schools, retail establishments and hiking trails to aggregated spatial views of indicators like crime rates. However, this application environment did not allow users to enter their own information. As a result, the community engagement coordinator in Coquitlam responded enthusiastically to the concept of Local Stories and it was incorporated within their community portal and workshops were held with groups interested in its use (see chapter 4 and chapter 6). For the municipal staff responsible for running programs with community groups, the idea of incorporating Local Stories into their programming was seen as an innovative way to promote and structure dialogue among both seniors and youth (J. Rowledge 2004, pers. comm.)
The Local Stories workshops were designed to introduce the concept of local place-based storytelling through a webmap interface and to accomplish three functions: 1) explain how the application works, 2) demonstrate its use, and 3) co-locate participants to discuss their contributions to overcome the potential isolation that may occur with web-based interaction. Held in computer labs, these workshops included youth groups, seniors, writers and local government staff. Local Stories is about telling stories that hold meaning for residents in a given community. Such an explicit emphasis on storytelling is enchanting to many users. Many quickly identify the demographics in their community and lament that the personal and community histories of their region dwindle as people age and pass away. Historical societies, libraries, writer’s groups, and community development agencies appreciate the contextual importance of accessible stories – meaningful and available – that Local Stories facilitates. Others have expressed interest in using Local Stories for advocacy to raise awareness about local priorities on political issues.

The other components of GBExplorer (News & Information, Ideas & Perspectives, Library Collections and Future Scenarios) were all developed and informed by elements of the 3C framework developed in chapter 2. They provide the mechanism to examine sustainability information from different angles. News & Information is a quick reference source of web-based syndicated news stories related to the three interwoven themes of sustainability – economy, environment and society. By connecting with different news stories (local, regional) users can have broad access to sustainability themes through simple communication technologies. In addition, the set and categorization of keywords into a structure that assists the automatic filtering of news stories is a form of classification scheme that was applied to regional, national and international digital news sources.

In the original conceptual design of GBDL, the Future Scenarios was the module that would provide the most direct link to outputs from the GBFP’s QUEST futures modelling application. As envisioned, the Future Scenarios module would provide access to scenarios that had been created as well as allowing users to adjust their modelling preferences in an
effort to generate resultant indicators that moved them closer to their desired future goals. As built within GBExplorer, this module was able to provide a tutorial on the use of QUEST and background to the sub-models that are used within the GB-QUEST application. Even though this module was the least complete in terms of the original design specifications, the significant amount of research, discussions, prototyping and user functionality design that went into its conceptual design also served to inform the overall user experience for the stand-alone GB-QUEST application. In these ways, some of the 3C elements, particularly context and communication contributed to informing the GB-QUEST design. Since GB-QUEST considers world influences on the region and has a strong user interaction component (where users select their preference and their desired futures), it created a situation where GB-QUEST and GBDL were collectively a strong set of applications that were used to explore spatial and temporal aspects of sustainability in the Georgia Basin region.

Library Collections provided a focal point for the distributed, dynamic access to data sources of geospatial, text and image resources that were searchable via keyword, classification or spatial coordinates. From a use perspective, future design refinements would also consider and explore the potential link between Local Stories and Library Collections. This link would provide an opportunity to consider in greater detail the social sharing of knowledge between stories explicitly tied to place (and retrieved by navigating a map interface) as in Local Stories and more extensive classification and cataloguing that resulted from the searchable metadata created for the data and information records within the Library Collections module. Library Collections accessed distributed content through various open protocols mechanisms but that its collections could also be built up through the use of Local Stories. The questions that this approach raises are ones related to the credibility and reliability of the information generated through Local Stories and how that can be related to more traditional or standard information resources that have defined criteria for inclusion into a knowledge repository.
Apart from Local Stories, the Ideas & Perspectives module garnered attention from prospective research partners. This was due in large part to this module's emphasis on the contextual element of the 3C framework. The use of pattern languages to encapsulate the strong interconnections of sustainability concepts from the point of view of a non-profit organization provided the starting point (Ecotrust 2001). From there, the GBDL designers considered other ways to incorporate sustainability relationships as pattern languages which were represented in comprehensive community reports (Crawford 2000; Julian & Bailey 2001). Once two full conceptualizations of sustainability were represented, the module could be extended to include multiple points of view on sustainability from government agencies, other non-governmental organizations, community groups, and academics which could have had the end result of providing a breadth of perspectives on sustainability and potentially the ability to identify areas of convergence and divergence on the topic. In this way, some merging of technical functionality between the content-generation functions of Local Stories and the structuring of a conceptual classification of sustainability would have augmented the usability of the Ideas & Perspectives interface to allow the dynamic generation of a sustainability perspective similar to the way dynamic stories are generated within Local Stories. Regardless, the development of Ideas & Perspectives served to further expose people to a plurality of views about sustainability as a means to support social learning and social knowledge sharing as advocated by Thurk & Fine (2003).

In establishing research partnerships with prospective case studies, many indicated that the breadth of functionality from the modules could have positive influences on their programs and sustainability objectives. However, Local Stories seemed to always capture the most attention and was the application that was most directly and easily incorporated into ongoing programs. For this reason, of all the modules, Local Stories was the most used. The research undertaken as part of the GBFP more deeply explored the role and use of future scenarios for sustainability among a series of community cases in the Georgia Basin. Bowen Island was a case study for both projects as such created a strong community backdrop.
where sustainability and the design of the community was important for many residents. These projects then informed the design of the Community Forum process that was undertaken by the facilitators for that community engagement process.

A key design parameter and research question in GBDL was how to make the technologies easily adaptable to a given community or group’s objectives. The adaptation and re-use of the GBExplorer prototype concepts and technologies constitutes another form of its use which was examined in Whistler, BC. The participating individuals and communities often express an interest in incorporating elements from GBExplorer into their existing projects and applications. This underscores the importance for the technological development to be sufficiently streamlined and flexible to integrate with a community’s pre-existing systems.

In the latter stages of GBExplorer development – as the technology started to mature – it was merged with functionality that had been developed independently in partnership with the GBFP, called STAR. STAR, an acronym for sustainability tools and resources, helped community groups self-organize to manage and accomplish sustainability goals. It incorporated functionality to plan projects, locate other community sustainability projects and showcased project outcomes. Collaborative functionality to enable groups to come together included an event calendar and discussion forum. By pairing knowledge exploration functionality in GBExplorer, particularly with Ideas & Perspectives, Local Stories and Library Collection, with the action-oriented collaboration tools of STAR, the support to community groups was enhanced. The tight linking between the applications was a technological manifestation of linking information with action. The use of the combined applications achieved successes in a follow-on (successor) project located in South America for the Canadian International Development Agency. In this instance, library collections was used for the management of distributed geoscience information and the collaboration tools used to coordinate work activities among technical working groups in 7 South American countries.
5.6 Conclusion

The entire GBDL project represented an attempt to overcome some of the major shortcomings identified through an examination of the culture of GIS use (see chapter 3) and to merge these findings with digital libraries in a manner consistent with the theoretical arguments for more interactive and contextual processes outlined in chapter 2. The projects’ six themes included interface design, visualization, community engagement, knowledge architecture, knowledge representation and scenario modelling. The GBDL’s conceptual framework emerged through discussions and prototyping, which were eventually manifest in the GBExplorer set of applications. The breadth of functionality available in GBExplorer achieved some measure of accommodating extractive and interactive forms of social research, albeit with a strong intent to support transformative processes and social learning at the local scale. The current project contributed to the design requirements of the application by demanding greater interactivity between published or ‘objective’ information and local knowledge to enable a technological solution to the unidirectional flow of scientific and research information. The research goals of the current project was to examine how novice users could engage with the application and to identify criteria for how a place-based, local knowledge application might assist community groups in managing their collective knowledge over time.

In the next chapter, I discuss key issues that emerged for the two case study communities that used GBExplorer, including relationship building between researcher and user, technology transfer, capacity building with new users and the types of web experiences that GBExplorer enables.
6 Exploring transformations: case studies of technology in process

6.1 Introduction

The literature from the fields of science and technology studies (STS) and social shaping of technology provides insights into the sites, processes and outcomes of scientific and technological advancements. STS provides a foundation from which to consider the interplay between social actors and information (including scientific information) that is enabled by information technology applications, such as geographic information systems and digital libraries. Information and communication technologies are doubly articulated, both as media that have significance in themselves and as media for carrying specific sets of meanings (Couldry 2003). This dualism can be extended to GIS and digital libraries if viewed from the social shaping of technology perspective, whereby the technologies have significance in and of themselves as technological innovations and they facilitate the construction of meaning when users engage and shape the technological artefacts to generate new knowledge or understanding. “The relationship between material technologies and the knowledge these tools support is under explored in the organizational literature, despite the fact that material technologies that produce mechanical representations simultaneously mediate their sharing” (Thurk & Fine 2003, 109). The context of use and the material technology interact with one another. Along these lines, the use of GIS and digital libraries exist as both technology and process. The broader milieu of their development and use helps to reframe GIS and digital libraries within social activities such as learning, problem-solving and sharing experiences.

A case study approach was adopted to describe and explain the socio-technical interactions of community groups engaging, adopting and applying GBExplorer\(^{11}\) (see chapters 4 and 5). Two of four case studies focus on this issue specifically and include the use of part of the GBExplorer application (Local Stories) with three groups in Coquitlam, BC (CS#1) and the

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\(^{11}\) See Chapter 4 for a description of the workshops; see chapter 5 for an explanation of the modules in GBExplorer.
technical adaptation of the GBExplorer application with a community organization located in Whistler, BC (CS#2). In addition, observations were recorded during a set of workshops with citizens from the municipality of Bowen Island where spatial information technologies and geovisualizations, were used in part to support a community planning dialogue process. This case study (CS#3) afforded the opportunity to think about the use of spatial technologies in another type of participatory process, namely neighbourhood-scale land use planning. The last case study comprises reflections on the overall development of GBExplorer and evaluates it in light of the STS concepts of stabilization and closure for sociotechnical systems (CS#4)\textsuperscript{12}.

The four case studies represent different phases of the research and are not intended to be of a comparative nature. They are presented here as empirical evidence to illustrate the shaping of my theoretical and conceptual frameworks about the development and use of information technologies. The case studies also gave rise to the conclusions from the research. With respect to drawing conclusions from the cases, the development of these theoretical agendas and conceptual frameworks transcend the individual cases (Sorensen & Williams 2002, 29). The implications of all the case studies, taken together, point to a set of emergent themes about the use of sociotechnical systems in different case study environments. To that end, consideration is given to the ways in which context, communication, and classification—the categories of analysis and evaluation that emerged from the theoretical discussion in chapter 2—may extend from the design of the knowledge exploration system to be manifest in the social settings where the technology was used.

6.2 The use of GBExplorer by community groups

The goal of the case studies was to focus at both the conceptual design level and the practical level. This entailed providing the conceptual intent of the GBDL Project as a whole (knowledge building about sustainability and some web-based tools to support engagement

\textsuperscript{12} A discussion of the fourth case study (the design and development of GBExplorer, CS#4) and its relationship to the 3C elements occurs at the end of chapter 5.
with these ideas) and interacting with the GBExplorer application that served as the instantiation of the conceptual ideas. On one hand, it was important to explore the tractability of the conceptual GBDL idea—a digital library of concepts and a means of digitally displaying and developing local knowledge and priorities—with users. On the other, it was also important to obtain feedback on specific elements in the technological implementation of the system. This approach also contributed to the goal of better understanding how to support the information management and decision support needs of sustainability-oriented community groups via a place-centred storytelling mechanism.

It is worth noting that at the time the workshops were conducted in Coquitlam and Whistler, the GBExplorer application would not have been considered a technology that had achieved stabilization. Therefore its use in the workshop setting was not intended to examine an example of linear technology diffusion but rather, one of ‘innofusion’ (Fleck 1988). The term results from linking the processes of diffusion and innovation and is used to define the way in which artefacts, rather than being fixed at the design stage, are transformed in their implementation and use, in the course of the struggle to get the technology to work in useful ways at the point of application. This notion of innofusion contrasts with the idea that stable artefacts are diffused into their use environments without any negotiation between the technology and the process in which it is applied. In this sense, the case study work with GB-Explorer was an attempt to instigate, and draw conclusions from, a specific innofusion process. Such an approach is more user-centred, interactive and co-informed, consistent with the design arguments presented in Chapter 2.

The findings from two case studies, Coquitlam (CS#1) and Whistler (CS#2) are discussed in turn in the next two sub-sections. In each case, the use of the Local Stories module of GBExplorer was adopted by the groups although they applied the technology with different aims. The experiences in each of the settings provided some insight on where the technology can be applied and provided an opportunity for the design and development team to acquire feedback on system function, as well.
6.2.1 The use of Local Stories in Coquitlam (CS#1)

In Coquitlam, Local Stories was used with a youth group, with seniors and with municipal staff. The results from the questionnaires indicate that the participants generally found the application to be useful and the interface reasonably straightforward to use, except for some map navigation issues that were frustrating but did not present a complete barrier to use. The participants were able to acquire technical skills for basic map navigation, such as pan and zoom to control the map display. This was particularly evident with the seniors groups who had more limited experience with computer use than younger participants.

The youth groups found the application very straightforward to use and created stories quite quickly. The seniors found it much more difficult to use the application because of more limited computer skills. However, the seniors tended to offer more thoughtful perspectives on their story creation, often referring to their motivations for living in a particular community or to the circumstances that brought them to the community. The youth participants, however, tended to create stories of recent, rather than historical events.

During preliminary dialogues with the case study liaisons in Whistler and Coquitlam, efforts were made to encourage the idea that the workshops would offer each party the opportunity to reconsider and reshape their community engagement activities to consider local values by generating public narratives about the community. In turn, and over time, the on-going use of the application would encourage individuals to become more engaged in municipal affairs and could have implications for a form of direct democracy. Our attempts to undertake this shift suggests that tools that enable groups and individuals to create and locate their own narratives, which serve as a reflection of their concerns or priorities, can be empowering technologies that provide additional credibility to the community groups’ priorities. For example, at one session in Coquitlam, a participant suggested that they could create stories about a local property that had old growth trees that he felt should be preserved for environmental reasons but that the land owner was planning
to cut down to subdivide the lot. The participant saw that he could use the Local Stories application to both highlight an issue of direct importance to him and highlight the issue for other residents.

6.2.2 The use of Local Stories in Whistler (CS#2)

Local Stories use in Whistler focused on an adaptation and redeployment of the application onto the Community Habitat and Resources Project’s internet server. The management team for the CHiRP project elected to redeploy Local Stories and create a mapserver implementation to alleviate cost concerns and to develop their local capacity in delivering web applications. In so doing, the case study actually focused on how the group decided to customized Local Stories for use among their groups. The eleven community organizations came together into a project that focused on integrating diverse datasets, including spatial data, to accomplish a knowledge exchange goal and to highlight gaps in habitat data. The GIS technician that was hired to work on the project conducted a user needs assessment to confirm the expectations of the participating community organizations on our advice. The required functionality was articulated as follows:

We’d like to find a way to import these stories, once every so often, into new map layers for the browser. The information gathered by the stories module should be something that we can extract from the website and distribute to the various partners, especially in those instances where the public input would be useful to guide work being done by partner organizations outside CHiRP. For example, if we collect bear sightings, we can extract that information and forward it to the Jennifer Jones Whistler Bear Society or to Michael Allen, a local bear researcher, for consideration in their bear research.

(Howlett 2003)

The cost barrier can be particularly challenging for community organizations in small communities. For example, in Whistler the decision to use Local Stories and GBExplorer as part of their web interface was partly a result of the high cost of using an off-the-shelf solution like ESRI’s Internet Map Service, which would have cost thousands of dollars for the participating organizations who were mainly non-profit societies. Cost has been a long-
standing hurdle for many participatory or community GIS projects and is a very common limiting factor to the widespread access and use of spatial information by the general public, as evidenced by studies over the past decade (Campbell & Masser 1995; Elwood & Leitner 1998; Sears 2001). These problems are not trivial. They indicate a need for a new model of using technology to interact with community planning and decision making.

The technology transfer between the GBDL research team and the CHiRP management team of the Local Stories application was successful. The GIS technician built her own technical capacity and proficiency in using mapserver and in customizing the open source GIS application to in the manner requested by the CHiRP members. The CHiRP groups’ original requirement was to share data, and, this was successfully achieved through the web launch in May 2004 with many participants expressing favourable responses to the application.

A key difference between the Coquitlam use of Local Stories and the Whistler use of the application was that the Whistler application focused on the technology transfer and provided insights into whether the deployment of the GBExplorer technology could be achieved by community groups. The GIS technician had GIS programming skills and had recently graduated from a GIS diploma program. This skillset was sufficient to install, modify and customize the Local Stories application. An interesting outcome for the community was that the GIS technician was made aware of open source GIS technology as a result of the engagement with the GBDL research team. She made use of online discussion forums for mapserver implementation and relied to a more limited extent on the GBDL programmers to assist with minor troubleshooting. Following the launch, the CHiRP GIS technician presented the CHiRP Local Stories application at a mapserver conference in Ottawa. Her motivations to participate in the conference were focused on how she wanted “to give back to the mapserver community” (T. Howlett 2004, pers. comm.). Her sentiments echo others’ who participate in the open source community, “open source programmers are
not motivated by monetary incentives but by the rewarding sense that they are working to increase the welfare of others” (Hars & Ou 2002).

The impact of her presentation and of the broader utility of developing such applications for use by groups who may take them in different directions was observed by a summary report on the conference:

I also learned about CHiRP, a MapServer implementation in Whistler, BC, Canada that provides habitat mapping for the community which includes lots of tourists as well as residents. Its creator was concerned about "giving back" to the community after it aided her in this, her first MapServer implementation. What she didn’t realize was that her implementation is now yet another resource for the community as a whole. Several people echoed her concern that they were "taking and not giving back. It’s my sense that everyone was indeed giving back in subtle and perhaps non-technical ways, by spreading the word about open source GIS and in other less obvious ways.

(Schutzberg 2004)

In the longer term, the CHiRP group experienced some volunteer burnout and loss of dedicated staff to the project when the GIS technician took a more secure position with a consulting company because her own livelihood was contingent on uncertain future funding. This, in effect, limited the group’s original intention to conduct an active engagement program with segments of the general public. However, the technology adoption model was successfully implemented and provided further insights to the GBDL design team about models for re-use of the Local Stories technology. Broader implications germane to CS#1 and CS#2 are discussed further in section 6.5

6.3 Snug Cove Village Plan Review, Bowen Island (CS#3)

Based on observations of the Community Forum process on Bowen it is clear that, even though people are sceptical about public process (others’ motivations, the decisions that are taken, how those decisions are arrived at), people do, inherently, want to invest in public processes. The observations recorded as part of the Forum process were based on dialogue and observation with participants. A key question cannot be answered from this
methodological approach is the development of an understanding of those that choose *not* to participate in the process and why they do so. Many of the participants at the January sessions of the Snug Cove Village Plan review were active members of various advisory committees to the municipal council (such as the Sustainable Community Advisory Committee or the Transportation Advisory Committee). As such, they often held more detailed information about specific issues than would be held by members of the public who did not meet weekly to discuss recommendations for Council.

Throughout the community forum process the role of map information was relatively subdued in the Bowen sessions. At the first large public meeting, numerous maps were placed on the wall at the back of the room and some digital map images were projected onto one of two screens at the front of the room. At one point in the Bowen Community Forum a perspective on community decisions was shared. Through commentary and conversations with participants it became apparent that people held different expectations of their elected officials. In one case a participant observed, “but why are you asking me this? I elected you so that I wouldn’t have to worry about this, why don’t you do your job?” Whereas other participants very clearly wanted to make recommendations to council about how to address a decision and felt that council members should enact their point of view as their elected official.

As part of the Community Forum process, two workshops were held at UBC\(^\text{13}\) to invite Forum participants to use visualization tools as part of the neighbourhood planning exercise. The workshops presented spatial visualizations depicting different housing densities for a standard set of lots within Snug Cove. The Community Forum facilitators felt that by experiencing the visualizations, the participants would gain an appreciation of the aesthetic differences in different density scenarios and how they might impact water or

\(^{13}\) The UBC workshops were conducted by the Collaborative for Advanced Landscape Planning. As indicated in chapter 4, I observed the workshop as part of my observations of the community planning process on Bowen Island.
energy resources on the island if such densities were approved in other neighbourhoods on the island. For the university researchers involved, it was an opportunity to measure the impact of such visualizations in a land use planning application.

The results of this work on the effectiveness of the visualizations are published elsewhere (Salter et al. 2008); however, observations were recorded as part of one of the visualization processes and these provide general insights into the question of how the use of spatial technologies may be reconfigured. The participants in the workshop observed that the visualizations provided a “focus for discussion” and that they were powerful and compelling. Perhaps the most telling comment for their perceived utility was “imagine how great it would be if something like this could work in Council”. One of the key messages that the participants took away from the sessions at UBC was the benefit of exploring different scenarios as a way to explore the dimensions of an issue. Similar to the intent of Local Stories, the ability to explore different scenarios can also be a powerful learning outcome which has been documented in other studies (Carroll 2000; Carver et al. 2001; Chermack & van der Merwe 2003; Robinson 2003; Robinson, Carmichael, VanWynsberghe et al. 2006; Robinson & Tansey 2006).

The Bowen Community Forum process represents quite a different case study from the others conducted as part of this research. In many ways, it presented the opportunity to look over the fence beyond knowledge and awareness building to gain some modest insights into how dialogue processes aimed at community consensus building and decision making are conducted. In this connection, the learning opportunities that arose from participating and observing this process served to emphasize how important it is to consider and carefully plan community engagement activities. This learning on the importance of process is directly germane to the design of future public participation and GIS engagement experiences that may be conducted in future.
6.4 Reflections on the design of GBDL (CS#4)

The original objectives of GBDL were to develop the necessary conceptual framework for a Web-based digital library that seamlessly integrates natural and social science information (GIS maps, images, and text) into a comprehensive information resource to support sustainability research, community-focused decision making and public consultation activities in the Georgia Basin region of western Canada. Comments in this section are divided into (1) design and (2) the learning that took place within the research team about the range of options for how apply GBExplorer and the technical architecture that was used to develop it.

The development of the GBExplorer application took place with an awareness of the iterative design process of technology development (Dix 2000). However, at the outset, a significant challenge for the design team was to suitably explain the concept – its traditional and novel components – to potential benefactors of the research work. This is the classic research and development paradox of trying to represent an idea that does not yet exist.

The project proceeded with the (emerging) technology available at the time in order to give shape to new ideas about how the internet could be used to support social learning. Use cases were developed, paper prototyping was undertaken to determine functionality requirements, and illustrated mock-ups of interface design were generated through numerous brainstorming and preliminary research sessions. This is particularly salient given the interdisciplinary nature of the application. In digital library circles, the novelty of the application rested in its emphasis on the need to provide context for information assets within a digital library collection. The importance of context for information was highlighted through the Ideas & Perspectives module of GBExplorer, where the intent was to provide various perspectives on sustainability (i.e. from a level of government, from a non-profit and from different spatial communities). In addition, the Library Collections module centred on the access and retrieval of information and, in particular, the management of spatial and non-spatial information within the same collection. The ability
to address bi-directional communication was novel for 1999 (the time of the GBDL research proposal) and predated the popularization of blogs and wikis14.

An early motivation in the GBDL project was to identify pressing societal problems where geoscience knowledge could positively contribute. As we concluded elsewhere “geoscience information is often overlooked precisely where it is most needed because of the complex interplay of spatial, temporal, and descriptive styles of information presentation that geoscientists use; bridging this gap for interested members of the greater community will help to bring geoscience issues into the public debate” (Harrap et al. 2006, 37). The use of geoscience knowledge was also of interest because the research team included geologists and staff from the Geological Survey of Canada, part of Natural Resources Canada. This interest was also manifest in how science agencies that collect scientific data for knowledge advancement and for the public good could contribute to the sustainability issue. Many of the team members found it fruitful to position themselves as the facilitators or interpreters between scientific ideas and social settings that would enable interested groups to explore sustainability information.

The research team had a long-standing relationship with Bowen Island. Prior to project initiation, a college environmental science class studied environmental systems on Bowen that produced a state of the environment report for the island. At the same time, the Bowen Island Forest and Water Management Society was successful in a funding request to create a collection of spatial data relating to environment and habitat data for the island. This project built on a previous decade of volunteer effort to map local streams and identify plant species and other environmental datasets. It produced a map atlas of spatial data that related to the state of the environment report (Julian & Bailey 2001; Shoji et al. 2000). As a

14 Both a blog and a wiki are user-generated content devices used on the web. Blogs have taken the form of on-line personal journals where individuals post events of their day or provide current issue commentary. A wiki is a piece of server software that allows users to create and edit web content. It encourages democratic use of the web and provides a means for non-technical web users to generate content (http://www.wiki.org/wiki.cgi?WhatIsWiki)
result of a these separate initiatives, early prototyping of GBDL concepts were explored during the production of a cd release of the information contained in the map atlas (Journeyay & Dunster 2002). The GBDL research team also worked with the Bowen Island School during testing of the Local Stories interface by working with a social studies class that collected stories about the physical environment in the meadow behind their school. This informal use of Local Stories by the middle school children (ages 13-14) provided early insights into needed changes to the map interface and navigation functions.

In an interactive way, the results from CS#1 and CS#2 were reincorporated into subsequent releases of GBExplorer. Technical improvements to the interface were also adjusted based on feedback from the workshop sessions. Some technical frustrations that users experienced, such as the amount of clicking in the map interface to orient themselves to the desired location, were difficult to adjust due to the software implementation selected. In some cases, adjustments were out of the immediate control of the developers. However, since the primary map viewer used open-source software, the suggested recommendations for improvements for GBExplorer would also benefit a wide range of other applications when it was revised by participants in the open-source community.

These last two examples of early prototyping with small groups on Bowen Island and responding to interface issues resulting from the Coquitlam and Whistler case studies are examples of how the application was dynamically revised to meet user needs. The Bowen example, in particular, informed the conceptual design of GBDL as needing to address community concerns and to provide widespread access to local knowledge. This type of interactive research is an example of weak interactive social research (Robinson and Tansey, 2006) in that the potential users were not explicitly brought into project design and planning discussions but rather their needs were anticipated based on previous engagement with them. To shift this toward strong interactive research, the partners would need to be involved from the outset and fully shape the research process.
Based on the experience in the various case studies, it was recognized that a potentially fruitful extension of the work conducted within this study would be to refine the GBExplorer application to further enhance its transferability to non-technical users. A current research project that uses spatial visualizations to depict diverse local impacts resulting from climate change has benefited from the experience of the Bowen Island Community Forum process to devise a suite of processes, tailored to different user groups (Sheppard 2006). Within this project, a set of visualizations on localized impacts of climate change were developed. They were then used as part of a study with the general public that compared learning outcomes on climate change by using or withholding the visual elements. This work has occurred as an outgrowth of the methodologies that were tested in the Community Forum process on Bowen Island, where the possibility of such visualizations and dialogue processes may impact local level decision making and community priority setting about land use planning.

6.5 Case study conclusions

With respect to the design of GBDL, the issue that garnered the most attention was the focus on geospatial information and the place-based focus of the application. That maps and spatial data play a core role in the implementation of GBExplorer was clearly attractive to those who were interested in maps and what they can convey. Most participants in the workshops (CS#1, CS#2) would begin by locating their home on the orthophoto and making comments about their immediate surroundings. This result points to issues of what scale of information is of interest and relevant. Many people think that their local issues are not important to others outside their jurisdiction, suggesting that communities of practice is an idea that has failed to gain traction or, at least is difficult to predict the spatial scale at which it operates.

GBExplorer is a very flexible implementation and does not provide the user with a linear path through the application. In some cases, particularly with the seniors who were less computer savvy, a user could experience confusion about where to begin with the
application and also question the scope of its application. A design element that received careful consideration from the research team was how to organize the user-generated content. In an effort to support community groups in maintaining some group identity in a web environment, project “spaces” were developed within Local Stories to allow the community groups to self-moderate their content development. The technical implication of this design decision was that a login system had to be created to track users and the groups to which they belonged. In the workshops with the seniors groups, the login and registration posed a considerable challenge since they needed to create a username and remember their password. It also raised questions for many about issues of security and privacy of the content that they would add. Many were uncomfortable with the (false) idea that they might be tracked down and have private information about them stolen. Although this seems to be more indicative of media sensationalism, it does, however, indicate potential barriers to on-going operational use of these types of applications. In contrast, the youth participants were completely comfortable with the login process and often added html tags directly into the story input boxes to further personalize their stories. While these comments speak more generally to familiarity with computers and online experience, they also indicate that more widespread use of online applications can be expected with future generations.

The Whistler case study provided additional fuel to the idea that other parts of GBExplorer, in particular Library Collections and the collaboration functions from the STAR application, might be fruitful to explore for data sharing amongst small teams of researchers. By applying the technical architecture to such knowledge sharing and collaboration issues, GBExplorer-type applications could be helpful in task-oriented functions of sharing and accessing distributed geospatial data, as well as in collaborative work such as multi-author report writing amongst a research team. The reconfiguration of the 3C elements can also be fruitful for other knowledge domain areas such as the management and sharing of geological information. The successor to GBExplorer, GeoSemantica, has been modified to support such applications amongst geological engineers in South America. While not a
focus of the research as presented in this thesis, the experience is worth mentioning since it
highlights that there is also merit in using GBExplorer within narrower thematic fields. It
underscores the flexibility of the application and reinforces the importance of data
standards and, thus, the classification element of the 3C approach. The context in this
example is more constrained, focusing on geological information specifically, than how
context was conceptualized for GBExplorer.

At Bowen it became clear that these community-led processes intersect episodically and in
counterintuitive ways within the decision making structure of a community. For example,
the three facilitators for the Community Forum process obtained council endorsement for
the process. This meant that council would receive a final report and a presentation on the
outcomes; it would take information into consideration as it established the final wording
for the neighbourhood plan. However, the decision making process quickly moved away
from the substantive problem of ‘what decisions might improve sustainability’ to ‘what is
achievable in the timeframe’. Not only are the processes messy but there are also no clear
avenues within which to ask the truly difficult, yet pressing, questions of a community with
respect to sustainable development, including: What are the limits to growth? What is our
relationship toward externalities that will impact us directly? People are very interested in
these questions as evidenced by the discussion during the community meetings but it
remains very difficult to deal with the complexity of the problems involved. These
complexities include the need to develop new institutional arrangements that are
 collaborative to address these issues across scales and between jurisdictional authorities.
The project-based approaches need some overarching structure to link them more
cohesively and more apparently, particularly in the minds of community partners. The
community partners can offer the some cohesion via their on-going participation but
realistic expectations needs to be established to stave off volunteer or participatory burn-
out.
The lack of familiarity and comfort with an open dialogue-based process that is exploratory and provides guidance for future decision making was difficult for many to resolve. Rather, there was greater comfort in a less integrated and more isolated approach that would take one decision at a time without being able to obtain a holistic picture of the possible outcomes. The comments from the Bowen Forum that indicate that there is “too much talk and not enough action” are in contrast to the demands by the participants to “make reasoned choices” and “consider the consequences of our decisions”. It is extremely challenging for people to reconcile the need to see demonstrable effects from community processes and their frustrations about the time, information resources and human resources needed to thoroughly consider the range of consequences resulting from their choices. The desired intent of the organizers of the Bowen Community Forum process was to create a space for respectful dialogue that was tolerant and supportive of a diversity of perspectives in the community, the complex public policy questions about the ways in which the community could grow and change made it difficult for some to tolerate the perspectives of their fellow citizens.

The experience with Bowen suggests that it is difficult to continuously engage community members in an on-going dialogue. Another important issue that the case studies raised about the use of information technologies as part of community engagement processes is how to engage those that do not tend to participate. This is a complicated issue but one that warrants further exploration in order to determine whether there are other vehicles besides face-to-face interaction and web interaction, strategies that might employ different multimedia or even try to engage groups in a more targeted fashion in order to encourage a more pluralist debate about sustainability issues.

The experience of using GBExplorer in Whistler and Coquitlam suggests several lessons for future applications. The expertise required to operate these kinds of tools, the cost involved, issues of accessibility and the need for clear identification of appropriate target audiences are all requirements of a successful process.
The experience of trying to undertake these case studies strongly suggests that there exists a fundamental challenge for processes of this kind in the way information is framed and received by people. It would seem that people are not familiar or even comfortable with reflexive and reflective processes of community engagement on complex public policy questions. Also, they do not appear to be comfortable with the idea that scientific knowledge is socially constructed. This is compounded by what might be called a media effect: sensationalization that leads to argumentativeness and a resistance to listening to others.

Another issue that all the case studies raised was a curiosity about community mapping exercises and an interest in developing community map-based information. As a result, it would be useful to explore some of the issues raised in this discussion, such as technology transfer, knowledge discovery and technology when planning other PPGIS projects. It would be useful to conduct a meta-analysis of community GIS initiatives that, like GBExplorer, involved multiple agencies (academic, government and community). This would provide a helpful comparison to identify the pre-conditions that lead to collaboration, whether similar challenges consistently emerge, how the funding arrangements are maintained and how the processes evolve. The intermingling of spatial information with narrative storytelling proved to be a compelling synergy and merits further exploration.
7 Conclusion

In this thesis, an interdisciplinary study about how to reconfigure the use of geospatial technologies to explore sustainability issues was undertaken. This research work is best encapsulated as a fluid interplay of theory and practice and, in some respects, is an instantiation of recommendations that originate within the STS and the SSK literatures on how to wrestle with socio-technical problems. This chapter draws attention to the outcomes about the relationships between technology, knowledge exploration, sustainability and geographic information suggested by this research. In addition, implications of the case study research are discussed. Comments on the merit of the 3C approach, presented in chapter 2, are provided and linked to the overall outcomes of the case study research. Avenues for further research are also identified.

7.1 Interactive engagement – the case of Local Stories

The concept of Local Stories – where individuals and community groups could share their perspectives on an issue by linking it to place – was universally compelling, particularly with the community group representatives with whom the case study partnerships were established. Many of these people had job responsibilities that included community engagement about either social or environmental issues. As such, the coordinators were seeking activities for their groups to engage in that would contribute to community-building activities. Knowledge sharing and community mapping fit their activity criteria.

In the Whistler case study, it was evident at the outset that the environmental non-governmental organizations were interested in a GIS approach to build knowledge and awareness for Whistler residents about their local environment and community character. The Whistler case study participants were keenly interested in the ability for users to generate information through Local Stories in addition to be able to upload and share spatial datasets. One of the key outcomes of this case study was a clear endorsement of the concept of enabling data creation by users of the system. Prior to engagement with the
GBExplorer application, the Whistler group would have been restricted to a data dissemination approach which, at the time, may have limited the community engagement objectives that they wanted to achieve by developing a mapping application. The community leaders in the case studies often held the perception that access to additional information would lead people to alter their behaviour or could trigger them to become more involved in local issues, even though they were aware that this specific issue was not being examined through this study.

In both the Whistler and Coquitlam case studies, the prominent and captivating feature of GBExplorer was the capability for user interaction and user generated content, developed interactively using the map-based interface in Local Stories. In addition, the narrative conceptualization of “local stories” was attractive for the youth groups in Coquitlam and the seniors’ group that met to discuss life writing. The use of spatial technologies was reconceptualized to favour interactive engagement with information. Together with the focus on user-generated content, the use of the Local Stories application enabled participants to explore an alternate model of knowledge creation and sharing that relied on contextualization and communication. This also indicated that interactivity can support individuals in questioning their own mental models about the credibility of their own experiential knowledge and the value of sharing their perspective, even though they may not consider themselves an ‘expert’ on the subject. In effect, this may empower users to thoughtfully reconsider their own contribution to issues they had previously thought could only be addressed by scientists and experts for example one participant commented that, “this tool has great potential to bring people’s voice forward in planning activities”.

7.2 Outcomes for knowledge discovery

The 3C Approach for the design of knowledge exploration systems, presented in Chapter 2, draws attention to the communication, classification and contextual elements of knowledge building. GBExplorer, through both the Library Collections and Local Stories modules, provided users with the ability to discover datasets and stories through a spatial search
function that enabled users to benefit from structured searches (e.g. by document titles or authors). In addition, they could search spatially either by place name or Cartesian coordinate (direct input or by drawing a box on an index map) to retrieve documents, images, and spatial data that were relevant to a given spatial location. GBExplorer, then, provided users with the capability to discover spatially relevant content. It achieved this by classifying information holdings with spatial locations as well as other standard metadata or cataloguing information. By taking advantage of advances in OpenGIS, the search was extended to other web mapping services that GBExplorer connected to dynamically using standard protocols. In this way, users could also discover distributed information holdings relevant to their search terms.

Users were able to engage in browsing activities for the locally-developed content that was keyed to the green map icons. This functionality accomplished the GBDL design objectives of contextualizing the information spatially and thematically. Thus, with a quick glance, a user could discern any spatial clustering of the stories and gain an overview of the types of stories represented by the icons. While this presentation relied in part on standard map communication models to convey content, users’ attention was drawn to the local scale and on their own potential story contributions. As a result, the application facilitated a shift in the communication model by allowing user-generated content to be included. Observations from the workshops indicated an overall positive response for the use of the map interface particularly because it focused their attention locally.

Between these two modules, the design criteria of being able to support both search and browse functionality was realized. Thus, different styles of information seeking were accommodated. In the Whistler case, the implementation established a clear delineation between searching through map datasets on habitat that were provided as standard GIS layers and the ability to browse for local stories. In this way, individual cases could tailor the technical implementation to accommodate their preferred method of knowledge discovery.
The complexity of the issue of sustainability did pose some challenges for engaging the uninitiated public. However, it was clear from comments in the workshop, such as “this is a great way of involving everyone in the community and develops a great map sense”, that by contextualizing information within a map-based interface, an application such as Local Stories could be used to highlight existing community activities that supported sustainability.

7.3 Outcomes for technology transfer

A design and development goal of GBDL was that the application would be open-ended and flexibly adapted for use by other groups. The diffusion model for the application focused on identifying both technical capacity and social relevance for the application meant that it could be applied by groups with highly diverse mandates. For this reason, the Coquitlam and Whistler cases were pursued because the technical capacity was resident and their experiences in transferring the technology could be explored. The technical teams from Coquitlam and in Whistler benefited from direct interaction and technical support from the GBExplorer programmers. They received assistance with the server configuration and any troubleshooting with the installation to enable it to function smoothly. They were also able to customize how Local Stories looked within their own web application. The importance of customization has also been observed in other socio-technical studies, “[m]any tools today – especially computer programs – use customization as a marketing strategy. Customization generates knowledge that is locally, rather than universally, meaningful” (Thurk & Fine 2003). The ability to embed and customize Local Stories in another web application enabled the groups in Coquitlam and Whistler to take ownership of the application and was an important factor for group identity within both cases. Each group continued to use Local Stories for between one and two years prior to collaborative involvement with the GBDL team. Staff turnover and lack of continued funding were the primary reasons for why the web installations were eventually discontinued.
There are institutional implications that stem from the issue of technology transfer, including longer-term organizational commitment. A popular model of technology diffusion that sees a link between academic research and industrial innovation is to commercialize aspects of research that can be further incubated and developed in the private sector if there is a viable market for the technology or innovation (or one can be developed). With the GBExplorer application, there was no clear path for its continued and on-going development within the university since key members of the research team resided in a government institution. However, it was not clear at the end of the GBDL project in 2004 whether the government partner, Natural Resources Canada, would embrace an on-going mandate of development and refinement from a corporate perspective. Since that time, the GBExplorer application has been reconfigured for geological data sharing among natural hazard scientist in seven countries in South America.

Lack of organizational clarity about the role of technology development within a federal science and technology department limited wider exposure to GBExplorer within the organization and sustained funding for application development is constantly in jeopardy. This indicates that organizational direction setting can often be limited in scope. In addition, large organizations, particularly in government, have difficulty embracing innovation. Funding cycles and shifts in research agendas to align with government priorities, which change rapidly and are often based on short timeframes, have also meant that government research activities suffer from fragmented project-based approaches. A crucial technical design decision to use open-source technologies to program and build the application offers a potential for longevity of the application amidst an apparent lack of commitment within Natural Resources Canada. The open-source community may present the best option for the continuity of the application since further elements would be developed as members in the community were interested and motivated to do so. It may also serve to propagate parts of the technology into new application areas.
One of the key pre-conditions for establishing interactive research collaboration is mutual benefit. All parties involved need to see the potential value of engaging in the partnership, typically to advance their own mission or mandate. The timeline of activities requires negotiation between collaborators so that each accomplishes their objectives within the required timeframe. This is particularly important when project-based activities rely on future funding for the continuation of their activities. In these cases, the partnership can be fruitful because it can be reflected to funding agencies as value-added to their initial investment in a project. However, project-based activities can also increase staff turnover due to lack of job security and may contribute to volunteer burn-out in fundraising activities and proposal development. For these reasons, institutional arrangements for interactive social research may require adjustments to overcome the overhead and fragmentation that can result from project-based activities.

### 7.4 Outcomes for technology in participatory processes

Case study methodology, coupled with participant observation, revealed the processes and meanings at play in community contexts where the technical applications and social interactions met. These interactions were grounded in a process and all the contextual elements of that process—how it comes about, antecedent conditions, formal and informal interactions with participants—are all extremely important to enriching participatory experiences with the use of technology. For the land use planning process on Bowen, one participant framed the purpose as “the process is about having a discussion around this is what we’d like Snug Cove to look like”. Through the Community Forum process on Bowen, the facilitators were very conscious about anticipating whether the use of the visualizations would enhance the community discussion on the planning document. The Bowen Community Forum process also indicated that process is extremely important, particularly when a decision-making outcome is desirable. Many communities rely on volunteer members to participate on formal advisory committees or through informal discussions within the community.
How to most effectively approach the design of community engagement processes and the use of spatial technologies within these processes is a fruitful direction for further research. This should include a detailed assessment of the prior knowledge that participants have about key information sets and whether different types of presentations of spatial information are useful to different members of the community (i.e. general public, elected officials, or staff). On-going collaboration or study with groups would be beneficial, particularly to further examine the applications and processes that can support decision making. If the decision environment is treated more explicitly then it becomes less trapped in the thematic realm of ‘what decision is at stake’ and more focused on the on-going process of decision making or, ‘what are the decisions we face currently?’ Longitudinal studies of process-based approaches could offer fruitful insights on how these science-society and technology-society interactions are configured.

The Bowen Community Forum process demonstrated that spatial technologies such as GIS can operate at the edges of a process and serve as negotiations or boundary objects within a dialogue process. People bring different understanding to the presentation of map-based information and fold that into their pre-existing knowledge of place and their local community with some observing that “I could see on screen what was only a guess previously”. Although the Community Forum process was intended to be led by the participants, it was difficult for the participants to take ownership and become invested in the process. They seemed to view it as the initiative of the facilitators with a participant making the observation that “there is a perception that those who control the information are controlling the process”. People interpret others’ motivations and information becomes a powerful pawn within this process. The power dynamics that undergird any community decision making process play out differently given the specific contexts and issues at stake. In the Bowen process this included, for example, repeat attendance at workshops in order to vocalize views and reinforce positions.
The outcomes from the process on Bowen raise issues about the settings of community engagement with technology. Increased attention to direct democracy as a result of the proliferation of internet access and users over the past 15 years has offered new ways of soliciting public comment and has also resulted in an increased focus on transparency and decision making. Some of the longer term impact of such community decision processes relate to whether such processes have transformative power to shift from public consultation to meaningful settings where public dialogue and debate occur as a matter of course. Some participants in the Bowen process saw it as a discrete activity with a particular mandate that was separate and distinct from previous discussions on transportation, land use planning and the growth and development of the island community. For many communities in British Columbia, the time frame of official community plan or regional growth strategy reviews is about every 5-7 years. These strategic planning exercises are often community-wide occasions for residents to voice their priorities about directions for community development. This seems like a reasonable cycle for communities to engage in broad dialogue processes that might be supported with information technologies such as GBExplorer. It could reduce volunteer burn-out and focus fundraising for consultation and information gathering. However, continuous, sustained engagement with fewer, yet targeted, groups within the community would provide continuity.

Community groups or local governments may also want to consider how they attract and welcome newcomers into the community. There may be opportunities at this juncture to communicate directly with new residents and identify how local decisions are made and the degree to which public consultation is encouraged. It would also seem to be useful to promote technology such as a geolibrary as an artefact of community memory about the key decision points in the community. This is perhaps something that a group of local historians and archivists might take on as a task of community record keeping of public dialogue events. The settings in which these interdisciplinary and information-oriented projects occur are important and often overlooked. The identification of groups who are willing to shoulder the responsibility for community-scale knowledge that is widely
accessible would also go some measure to enhancing the usefulness of GBExplorer type applications for decision making.

7.5 Implications of the case studies
The implications of the case studies have been categorized into information collections, relationship building, technology transfer and capacity building. They are discussed in turn below. Limitations of the case studies are also discussed in this section.

7.5.1 Information collections
During the case studies it became evident that community members placed importance on conducting an assessment of the status quo of knowledge prior to engaging in information sharing. However, it is often difficult to persuade volunteers to build on the previous experience and knowledge of other volunteers because it is difficult to synthesize meaningful knowledge out of all the historical community processes that have taken place. Moreover, while the concept of community or organizational memory is extremely attractive—particularly to have information systems that support these—it is difficult to achieve in practice due to the fragmented and time-limited nature of many community-led initiatives. With more widespread acceptance, some of the technological innovations of GBExplorer, such as the Library Collections module, could contribute to overcoming the issue of accessible, community-relevant information.

Digital library work is shaped by the four dimensions of technology, community, services and content (Marchionini & Fox 1999). The complex interactions among these four dimensions stimulate innovation and augment collective intelligence (Marchionini & Fox 1999). This reinforces the view that there is a central role for the content (i.e. Library Collections in GBExplorer) that interacts through the ability to explore related concepts (i.e. Ideas & Perspective in GBExplorer) because of the social learning that takes place through engagement with a digital library system. The early conceptual design of GBDL was certainly influenced by this design space configuration for digital libraries. One of the
contributions from GBDL to the digital library concept as articulated by Marchionini and Fox (1999) was to expand the definition of ‘content’ to include user-generated content which serves also to diversify the type of content available for a beneficial interaction.

It was apparent throughout these case studies that the compilation and display of information helps to address the desire to know what is already known. For example, in Whistler, the “mapping tool would enable users to view the many different layers of data that have been (and will be) collected for the Whistler area. They would be able to turn layers on and off and move around the map using standard zooming and panning tools” (CHiRP Needs Analysis 2003). On Bowen, numerous participants indicated the need to fill data gaps prior to taking any positions on decision making, whereas others felt that the information inventory will always require updating and if they waited until it was ‘finished’, they would not have any hope of implementing their decisions. This was noted in particular with regards to heron nesting sites in the Snug Cove area on Bowen where transportation needs with regards to ferry travel on and off the island might impact some sites. The desire for completeness can lead to frustration at spending so much time examining what is already known rather than ‘doing’ anything. In the Whistler example, participants were also keen on creating a data inventory across the participating organizations. The purpose was partially to “see what’s there” but also to identify gaps in information holdings so they could prioritize data collection (fundraise or seek out existing information from other agencies). Learning about the pertinent issues for the participants in the case studies is a necessary part of the process of interactive collaboration. For these reasons, it is important to start the data synthesis phase early in the process of any interactive collaboration.

7.5.2 Relationship building

Relationship building is a crucial component in undertaking successful interactive research. This takes a significant amount of personal investment of time, negotiation of roles and responsibilities, and clarifying expectations in order to build trust with organizations and
groups who engage actively in the research. The experiences in Coquitlam and Whistler suggest that trust among and between groups may be the single most limiting factor to the success of local initiatives. Each community is laden with histories of relationships with both government and industry over economic, ecological and social issues and this can be a factor in establishing a new partnership.

Inter-institutional agreements and partnership agreements were required in all cases. In establishing the partnerships, it was sometimes necessary to engage in a marketing exercise to highlight the benefits of using GBExplorer within different community settings. This finding reinforces the idea that it is difficult not to advocate the benefits of the system as a means of enticing participation and involvement from partners. For partnerships to solidify, they need to be of mutual benefit to the partners. The longer-term implications (i.e. more than two years) were discussed at the outset of establishing the partnership agreements with community groups. The GBDL research team felt that establishing the partnership via a federal agency would alleviate some of the concerns about short term involvement. On the whole, this proved to be true, and the technological applications that were conceptualized and realized as part of GBExplorer have persisted and been altered to respond both to technical changes and procedural ones. However, the funding mechanism that provided continued development support to GBExplorer was time-limited so the long-term future of the application is currently in question.

7.5.3 Technology transfer

The GBExplorer application was purposefully developed using open standard technology to enable portability and customization by different user groups. The research and development work that went into creating GBExplorer could be modified by other technical users to provide them with a web-based mapping application or to allow them to customize functionality of GBExplorer to suit their needs. The application proved to be reasonably straightforward to transfer to both the technical team in Coquitlam as well as the GIS manager in Whistler. However, in both cases, some learning occurred with the technical
team who were adopting GBExplorer. This presents an unanticipated result of technical learning acquired from installing and implementing the system rather than from end-users.

7.5.4 Capacity building

By working with representatives from community groups to adopt and incorporate aspects of GBExplorer into their own web applications, both technology transfer and capacity building were accomplished. Technical staff within the organizations worked with GBExplorer programmers to customize and adapt the application for seamlessly accessibility from within their own web applications. In this way, they enhanced their capacity to customize and maintain their local GBExplorer application. In addition, through the user workshop process, basic web-based mapping capacities were developed and enhanced by using the Local Stories module. This created an environment for some social learning related to some of the sustainability and environmental concepts accessible through the green map icon set for the mapping of local stories. The Whistler and Coquitlam case studies provided some lessons about the process of community engagement and the use of technology within such processes. For example, it was important to have key technical and institutional support to use GBExplorer. It became clear that GBExplorer is difficult to use because its versatility overwhelmed some users. By providing a novel way for people to share information that was keyed to knowledge exploration, it also became clear that some users preferred to operate within a narrower context of fulfilling a specific goal. In this way, some users approached the system with an expectation that it could contribute to solving a problem (i.e. what can be done to preserve this type of habitat). In effect, some saw the system as a black-box to provide answers. This may have been due to the way the workshop introduction emphasized the idea that options for sustainability could be explored through the user content that was created.
7.5.5 Limitations of case studies

Insofar as the cases served to provide insights about public engagement processes using spatial technologies to explore sustainability concepts, they also draw attention to some limitations in the research. While the diversity of the case studies is a strength of this exploratory research, it would have been potentially informative to be able to deeply explore evaluation criteria or mechanisms that could be developed for this type of interactive social research particularly when technologies are applied for various purposes such as information exploration, technology transfer and system design. Pre- and post-testing methodologies have been applied in the assessment of some transdisciplinary projects to determine both scientific and social effects of the research (Walter et al. 2007). While such approaches hold substantial promise, they would have been difficult to apply to these case studies herein since the GBExplorer application was not a stabilized artefact at the outset of the thesis work. This could be explored in future work and could indeed form the sole basis for another dissertation. In fact, many of the research fields that have informed this research also indicate a research gap in the evaluation of the social uses of technologies such as GIS and digital libraries (Bishop et al. 2003; Corbett & Keller 2005; Hacklay & Tobón 2003; Maclaren 2001; Marchionini 2001).

Work in this evaluation vein may also benefit from a meta-analysis of more case studies that use different types of spatial technologies, mapping applications and sustainability indicator work to inform knowledge exploration processes related to sustainability. This type of meta-analysis could contribute to the development of a typology consisting of three axes: i) sustainability issue to be explored, ii) suitable technologies to support information exploration or decision analysis and iii) types of users (these might be based on experience, technological proficiency, organization or agency, demographics or other relevant characteristic). Such a typology would need to take into account the functionality or technical elements of the information technology design as well as the design and structure of both the research and public engagement process. It might build on some of the work of Shiffer (1998) that examined the use of GIS for planning support that considered whether
the engagement could be asynchronous and disparate (different time, different place) or
dynamic and co-located. Another dimension to this question could also address how
knowledge applications on the web are often solitary or individual activities might be
informed by synchronous, multi-player online games that have become increasingly
popular in the last decade. This is the type of engagement that informed some of the
precursor designs to the GB-QUEST application.

Another limitation of this work is that the relationship building that took place with
organizations that did not ultimately result in a collaborative research partnership were not
fully analyzed to deepen the understanding of what constitutes a successful collaborative
research arrangement. It may have provided additional insight into why and who chooses
not to participate which is often quite a difficult, yet important question to consider in
community engagement processes. In particular, there was a group that was interested in
producing video clips of oral histories told by First Nation elders to First Nations youth in
the Vancouver area. The project would allow the youth to exercise creativity and learn
technical skills in digital media and video production while also connecting with their own
history. While they had expressed interest in using Local Stories and possibly Ideas &
Perspectives to manage the digital media that they were to create, the partnership never
solidified. It would have been interesting to interview some of the participants in that
project to gain insights into how they ultimately completed the activity. Funding and
capacity were issues at the time of discussion that limited further participation but a
retrospective analysis could be helpful to inform the typology of users described above.

There were some elements in the conceptual framing of GBDL that were not instantiated
into the GBExplorer application. In many cases, this was the result of technological
limitations at the time; for example, some of the elements could be programmed but the
time lag to execute the functionality in a web environment would take too long and
adversely affect the user experience. As a research team, we had the intention of
encapsulating government policies on sustainable development (i.e. provincial or federal) to
be included with the two that were created for the Ideas & Perspectives module but due to capacity limitations we weren’t able to develop the necessary relationships to achieve this. In addition, the design team also discussed the ability to dynamically generate pattern languages but we met with technological limitations to actually implement this functionality.

Finally, I think one of the limitations to the work is that the idea of GBDL was quite a novel concept at the time and, as such, some had difficulty embracing the breadth of the functionality and the flexibility of the application. Interestingly, it is possible that since it was a new idea, people may have found it overwhelming or challenging to relate to because they lacked the scaffolding of concepts such as GIS and digital libraries to fully realize the ways in which they might employ GBExplorer to further their own learning and exploration about sustainability.

### 7.6 Implications for 3C framework

The 3C framework comprised a rethinking of the way context, classification and communication were configured for the design of knowledge exploration systems. The rationale for reconfiguring these elements was provided in chapter 2. This rationale included the need for scaffolding or contextualizing scientific information, the need to standardize classification schemes for structured searching. The systems must also enable browsing as a means to discover and explore knowledge resources, and the need for the design to accommodate more than a unidirectional, linear communication model to allow multiple perspectives on an issue to be explored. The GBExplorer web-based application was the result of an experiment in trying to configure these elements in a coherent way in order to explore ideas about sustainability. The use of a geospatial and place-based approach to explore sustainability was a core concept in the design of GBExplorer and, as a result, it enabled a local focus on sustainability issues. This provided a foundation for people to question how they as individuals or a group could self-organize to identify and
prioritize issues. However, with the senior and youth groups, it also raised deep questions about the agency these groups have with political decision makers. For this reason, one of the key outcomes of the GBExplorer case studies indicates that these types of knowledge exploration systems need to be further explored within a contained decision-making environment as just one piece of the decision support approach.

It is also worth considering whether the GBExplorer implementation was a good way to implement the 3C framework. Some specific instances within GBExplorer that address each of the 3C elements are presented below (Table 7.1). Of particular note, the place-based context for the creation of local stories provides context and also reinforces multiple points of view on an issue. The idea of local content generation was always well-received within the workshops, although with the youth and senior groups it was often unclear what merit there was in providing such perspectives since they did not self-identify as experts and therefore felt disempowered to provide their perspectives. For these reasons, it would beneficial to explore the use of an application like Local Stories for a very specific decision-making issue.

The design of GBExplorer also paid close attention to the emerging geospatial data management standards in development by the Canadian Geospatial Data Infrastructure and the Open GIS Consortium. In so doing the technical infrastructure enabled connections to distributed datasets. However, with the community-scale focus, one of the challenges, as noted in the Whistler study, was still focused on the compilation of basic spatial data at an appropriate scale. For this reason, data availability still remains an issue. More widespread use of an application such as GBExplorer could reinforce the need for broader access to spatial data resources relevant to community groups that want to get involved in local sustainability planning. GBExplorer provides the technical infrastructure to connect to distributed data sources but inter-institutional arrangements, data privacy and security issues must still be addressed.
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<thead>
<tr>
<th>GBExplorer Implementation</th>
<th>Case Study Outcome</th>
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<tr>
<td><strong>Context</strong></td>
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<tr>
<td>▪ Place-based, local focus on issues</td>
<td>▪ Place focus resonates but individuals’ own sense of agency is challenged; emphasis on local scale has merit (CS#1, CS#2, CS#3)</td>
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<tr>
<td>▪ Exploration of sustainability concepts</td>
<td>▪ Need to improve ability to cross-scales (local-regional-global) to explore sustainability issues and impacts (all)</td>
</tr>
<tr>
<td>▪ Modules: Ideas &amp; Perspectives, Local Stories</td>
<td></td>
</tr>
<tr>
<td><strong>Classification</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Use of green map icons as a taxonomy of story-types</td>
<td>▪ Useful to explore in small numbers (CS#1, CS#2)</td>
</tr>
<tr>
<td>▪ Ability to browse stories</td>
<td>▪ Cumbersome to explore if too many (CS#2)</td>
</tr>
<tr>
<td>▪ Metadata standards applied (Z39.50)</td>
<td>▪ Enables data discovery with Library Collections which is preferable over a list of geospatial data layers typically provided by internet mapping applications (CS#4)</td>
</tr>
<tr>
<td>▪ Modules: Library Collections, News &amp; Information</td>
<td></td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
</tr>
<tr>
<td>▪ User-generated content</td>
<td>▪ Empowering for individuals but also draws attention to voicelessness often experienced by groups such as seniors and youth. (CS#1)</td>
</tr>
<tr>
<td>▪ Open GIS Consortium web map services implemented to connect to geospatial data on other servers</td>
<td>▪ Standards-based approach reduces need to develop redundant content and to access published datasets. However, it does not overcome the need to develop local scale content relevant as a backdrop for the creation of local stories (CS#2)</td>
</tr>
<tr>
<td>▪ Modules: Local Stories, News &amp; Information</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.1 Explanation of the GBExplorer implementation of the 3C framework linked to case study outcomes.

Overall the 3C framework has merit with respect to the design of knowledge exploration systems. Additional issues identified throughout the case study work identified the important procedural implications of how such applications can be applied and used. These procedural or process implications cannot be overlooked if applications such as these are to take on more operational use as knowledge management and knowledge sharing opportunities within, among and between organizations that need to allow collective wisdom to emerge throughout a conversation about sustainability, decision making or land use planning activity. It would be useful to further explore how such an application can best be situated within a decision-oriented, community engagement process.
It was clear from the case studies that some users felt that using the technology was an alienating or isolating experience even though they had been brought together in a familiar group setting as part of a workshop. An additional observation from the workshop processes indicated that decisions or threats of a change in the social, political or economic order within the local community is more likely to galvanize participation in a community engagement process. In such a way, the use of applications like GBExplorer tend to be used in a more reactive way (i.e. we need to self-organize against an issue) rather than as a proactive, or even matter of course, means of community engagement. With a growth trend in participatory processes—direct democracy—and the need for increased transparency within public decision making processes, it would seem that the role of applications like GBExplorer, which enable multiple perspectives and local priorities to be highlighted, merit further consideration in light of public decision making.

7.7 Theoretical contributions
The theoretical rationale for this research, outlined in chapters 2 and 3, involved drawing on seemingly disparate literatures and weaving them together in such a way that they contributed to the original objectives of the research. A primary result from this research is a clarification of the interplay between theory and practice as it plays out in real world contexts of people moving through their communities and their daily lives. The examination of geographic information systems and the recent emergence and extension of the field of critical GIS, since Schuurman’s (2000) thesis, indicate that scrutinizing the role of geographic information and analysis warrants further attention from social theorists and critical geographers to draw critical attention to the assumption that information products, scientific or otherwise, are neutral and value-free. The table below outlines the theoretical contributions from this thesis based on the key disciplinary literatures that have been brought together in this work.
<table>
<thead>
<tr>
<th>Area of Research (Key References)</th>
<th>Contribution from this study</th>
<th>Thesis Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library and Information Science / Geolibraries (Budd &amp; Raber 1996; Goodchild 2000c; Sundin &amp; Johannisson 2005) Critical GIS (Schuurman 1999, 2000b) Public Participation GIS (Craig et al. 2002; Ghose 2001) Interactive Social Research (Caswill &amp; Shove 2000; Robinson, Carmichael, VanWynsberghe et al. 2006; Robinson &amp; Tansey 2006)</td>
<td>• Proposed model (3C) for engagement with place and sustainability that includes contextual, communicative and classification elements to support knowledge building and sharing and draws from social shaping of technology • Addition of narrativity to engage social and technical aspects of GIS use • Design of the process of engagement for using the technology is as important as the design of the technical application • Collaborative research provides nuanced understanding of the settings of interaction between technology and society</td>
<td>Chapter 2</td>
</tr>
</tbody>
</table>

Table 7.2 Theoretical elements presented and extended with this research.

The design of digital library systems was extended to include considerations of context, communication and classification elements. The notion of a geolibrary involves a shift from thinking of a collection of spatial information to the explicit consideration of place as a context for the exploration of sustainability ideas. In so doing, the process of linking science, technology and society was spatialized. The GBExplorer application effectively applied narrative elements within Local Stories and by adopting a pattern language with Ideas & Perspectives. A deeper understanding of the settings of interaction, for decision making or knowledge sharing, resulted from collaborative research within the case studies. The execution of the case study methodology highlighted the importance of how the process of community engagement is designed. Consideration of who is included, who participates, what is considered, what agency the participants have, and what skills and capacities need to be developed are all factors that require careful consideration when establishing participatory processes.
The concept of sense of place was paramount in the Local Stories application and this concept resonated strongly within all the case studies. The External Advisory Committee on Cities and Communities had the “profound value of place” among its top recommendations for enhancing and sustaining the vibrancy and resilience of Canadian communities over time, and applications like GBExplorer could form part of processes that contribute to further developing that value (External Advisory Committee on Cities and Communities 2006).

This research examined knowledge and awareness building about sustainability and the role of information in process. It is important to acknowledge that the entire endeavour highlights how people and contexts shape technical applications. Given that this research was initially conceptualized as an instrumentalist, cannonball view of the adoption and use of technology, the conclusions relating to context, social and technical interaction are relevant for how knowledge is socially shared.

This dissertation demonstrates that traditional approaches to knowledge sharing, based on a unidirectional model of communication from experts to public users were limited in fostering engagement with local scale concerns. Such traditional approaches are unable to encompass key aspects of newer theoretical understandings of the nature of the relationship between both science and society and technology and society. As a result they can be problematical with respect to building awareness and knowledge about complex issues, such as sustainability, that may benefit from increased engagement at the local, place-based scale where residents have experiential knowledge to contribute. The lack of mechanisms to facilitate the exchange between scientific and local knowledge may limit deeper exploration of social issues of concern. The alternative approaches developed and applied here offer the promise of reconfiguring engagement among individuals, community groups, their elected representatives and local government staff to reconsider how community dialogue and knowledge building takes place and how it can be supported in systematic ways by linking scientific, technologic and social constructs together.
7.8 Implications for future research

The dissertation points to a number of avenues for further research. Case study participants identified the potential for GBExplorer to be used to help people connect with each other. As a result, further study could link the use of Local Stories with the formation and maintenance of social capital (see Ellison et al. 2007) to identify whether certain uses of a place-based narrative device, such as Local Stories, play a role in the establishment or maintenance of social capital.

The Georgia Basin Digital Library and the GBExplorer were designed to be easily customized for use in a diverse range of settings. In so doing, the types of users that may find the application beneficial and the types of activities that the system could support are far-ranging. It would be fruitful to further explore whether the flexibility provided by the system design is beneficial and to investigate any correlations between the kinds of users (professional, project-oriented, curiosity-driven, etc.) and the types of functionality (mapping narratives, managing data collections, or devising a semantic pattern as in Ideas & Perspectives) that they use to beneficial ends. Along these same lines, a link to demographic information on system users many also contribute to an understanding of the diverse contexts that the application could support.

Another productive avenue to explore would involve merging the functionality of Ideas & Perspectives with that of Local Stories to create a tighter link between an individual’s mental model of sustainability (captured through a pattern language (Alexander et al. 1977) or taxonomy within Ideas Perspectives) and how that relates to empirical examples in local places. Another way to approach the coupling of these two modules would be to use a collection of stories created with Local Stories to inform the creation of a sustainability perspective in Ideas & Perspectives. In so doing, insights may be gained on how sustainability is structured as an emergent property of engagement (Robinson 2003).
Lastly, the institutional implications of interactive research bear more profound consideration. Many of the outcomes discussed such as volunteer burnout, insecure funding arrangements, personal reputation and dynamics, project-based activities, shifts in organization mandates and the ongoing requirements from community groups and local decision makers to have public input on activities and decisions all point to the need for a rethinking of institutional arrangements for social research. It would also be very attractive to consider evaluation research nested within further exploration of institutional arrangements in order to systematically explore social effects relating to the use of sociotechnical systems for knowledge sharing among individuals and organizations.
Bibliography


GVRD. (1996). Livable Region Strategic Plan: Greater Vancouver Regional District, Policy and Planning Department.


Murphy, E.S. (2004). The Integration of Storytelling and Technology: Can It Contribute to Community Process? Unpublished Master's Thesis (Planning), The University of British Columbia, Vancouver, BC.


Appendix A: Local Stories survey

Local Stories Survey

The responses to this questionnaire will help the researchers evaluate participants’ use of Local Stories and will contribute to future improvements.

(Please circle one of the following)

1. How long have you been a computer user?
   - 0-6 months
   - Over 6 months – 2 years
   - 2-5 years
   - Over 5 years

2. How often do you use the Internet?
   - Daily
   - 2-3 days a week
   - Once a week
   - Never

3. Do you enjoy using the Internet and participating in online activities?
   - Yes
   - No
   - If yes, why?
   - If no, why not?

4. Did you find the layout of Local Stories easy to navigate?
   - Yes
   - No
   - If yes, why?
   - If no, why not?

5. On a Scale of 1 to 5 with 1 being not useful and 5 being very useful, how useful do you think Local Stories is?
   - 1
   - 2
   - 3
   - 4
   - 5
   - Comments: ____________________________________________________________
   - ____________________________________________________________

6. Please indicate which age group you are in.
   - 13-19
   - 20-35
   - 36-50
   - 51-65
   - over 65
7. Gender:  Female   Male

8. How would you best describe your household? Do you:

Live with a partner    Live with a parent

Live with 2 parents    Live alone

Live with roommates

Thank-you for taking the time to fill out this questionnaire! We appreciate it. All findings will be kept confidential and will only be used for academic research purposes.
Appendix B: CHiRP membership
Membership in Community Habitat Resources Project

Whistler Naturalists Society
The Whistler Naturalists main mandates are to a) increase interest in, and understanding of, local natural history and b) research and monitor local flora, fauna, and the physical environment to help guide conservation efforts.

Association of Whistler Area Residents for the Environment (AWARE)
We are a membership centred organization that exist to improve our quality of life by protecting our natural heritage and moving toward environmental sustainability.

Jennifer Jones Whistler Bear Society
The Society’s mandate is to protect the well-being and lives of bears by establishing a healthier coexistence between people and bears.

Resort Municipality of Whistler (RMOW)
The RMOW is the local government for the resort community. Incorporated in 1975 as a “resort municipality”, it is responsible for providing local services and community infrastructure including water, sewer, roads, drainage, fire protection, park and trail maintenance, recreation, and cultural services.

WhistlerBlackcomb, Habitat Improvement Team (HIT)
The goal of HIT is to support our local environmental groups, such as: Whistler Fisheries Stewardship Group, AWARE, Jennifer Jones Whistler Bear Society, and the Whistler Interpretive Forest with projects relating to habitat improvement. Environmental education and community building are also core values of the group.

Whistler Fisheries Stewardship Group (WFSG)
The Whistler Fisheries Stewardship Group is made up of people from the Rotary Club, Angling Club, Whistler/Blackcomb, Chateau Whistler Golf Course, Whistler Golf Course, Nicklaus Norrth Golf Course, RMOW, AWARE and other committed members of the community. The WFSG monitors the health of Whistler waterways, and carries out rehabilitation projects, along with a strong public education component. Our volunteer base is strong and make our stream water quality monitoring and Wetlandkeeper programs possible.

Whistler Forum for Dialogue
The purpose of the Forum is to promote and foster the application of dialogue in the development of opportunities for lifelong learning, community consultation and enhancing democratic and civil society.

Whistler Off Road Cycling Association (WORCA)
WORCA has a membership base of over 1000 riders and was formally established as a society in 1997, “to advise and represent to government, private enterprise, and the general public in matters concerning mountain biking in the Whistler area”. We work to education cyclists in the safe and responsible use of mountain bikes; promote the appreciation and care for public lands; secure and maintain appropriate mountain bike access to public lands; encourage participation in recreational and competitive mountain biking to people of all ages and abilities; ensure that mountain bike access and sustainable trail planning become an integral part of the recreational philosophy and planning in the RMOW and Garibaldi Park; and understand the balance of expectation between the different user groups.

**The Whistler Museum and Archives Society (WMAS)**
WMAS is a non-profit society that works to acquire, collect, preserve, research, interpret and exhibit cultural material. We offer summer educational workshops for children, school programs and ESL tours throughout the year, and on-going adult education programs such as the Black Bear Workshop Series. We design and maintain satellite exhibits throughout the community as a way of presenting the museum to the community. The WMAS is unique in that we reflect 100 years of resort life in the Coast Mountains. Our mission is to collect, preserve, study, and interpret the natural and human history of the region. Our vision is to become one of the leading institutions in the preservation and interpretation of mountain life.

**Cascade Environmental Resource Group Ltd.**
Cascade Environmental Resource Group Ltd. Has provided environmental consulting services in the Whistler area for the past 14 years. The range of services offered by Cascade Environmental includes ecological studies, impact assessments, resource management, commercial recreational studies and geographic information systems.

**Whistler Centre for Sustainability (WCS)**
WCS is a non-profit society created to promote and support more sustainable practices in Whistler. It is based on an earlier initiative of the “Early Adopters” of The Natural Step Framework for sustainability which is now called “Whistler. It’s Our Nature”. In 2002, Whistler. It’s Our Nature received a national aware from the Federation of Canadian Municipalities as a model, integrated sustainability initiative for municipalities. Program areas of the WCS have included symposiums, speaker series, workshops, a school pilot project, toolkits, learning groups and various tangible actions towards a sustainable society. The WCS Board of Directors come from the Early Adopter organizations. This now includes the Resort Municipality of Whistler, Tourism Whistler, Whistler Blackcomb, Whistler Chamber of Commerce, AWARE and Fairmount Chateau Whistler.
Appendix C: CHiRP needs assessment

CHiRP Needs Analysis
November 7, 2003

Target User Groups:

In the short term, there will be three main user groups for this application. Depending on expandability there might later be the addition of a fourth group who might use the site for more advanced academic or research based queries.

In general the website will be aimed at the community and its visitors. User groups are broken down as follows:

**User Group 1**
Who?: CHiRP Partners
Key requirements:
- Access to all CHiRP data sets
- Ability to update and/or verify data entered by users
- Ability to retrieve detailed information about data
- Ability to search for data

**User Group 2**
Who?: Members of the local community
Key requirements:
- Access to all CHiRP data sets
- Ability to submit their own data (in the form of points)
- Ability to retrieve detailed information about data
- Ability to search for data

Sample Questions:
- I saw a bear yesterday – Can I add that to the map?
- What kind of fish will I find in Alta Lake?
- Have there been any bear sightings by my house?
- Where might I be able to see a bufflehead?

**User Group 3**
Who?: Visitors
Key Requirements:
- Access to all CHiRP data sets
- Ability to retrieve detailed information about data
- Ability to search for data

Sample Questions:
- Where are the hiking trails in the area?
- Where is there bear habitat?
- Is there a website where I can find out more information about Lost Lake?
- Where is my hotel?
- Where can I go birding?
**Functionality:**

In a general sense, we want the users to have access firstly to a simple map-browsing tool. This tool would enable users to view the many different layers of data that have been (and will be) collected for the Whistler area. They would be able to turn layers on and off and move around the map using standard zooming and panning tools. The user should be able to click on an item on the map and retrieve information that item. This could include tabular data, simple meta data and/or links to other information related to that site (this could include other web sites).

To allow the users the ability to actually get involved in habitat mapping, we’d like to invite them to add their own features to the maps. We’d like to be able to do the equivalent of what is being done currently thought the Local Stories module. Users should be able to view other people’s stories and add their own. ‘Stories’ will be grouped using descriptive icons. We’d like to find a way to import these stories, once every so often, into new map layers for the browser. The information gathered by the stories module should be something that we can extract from the website and distribute to the various partners, especially in those instances where the public input would be useful to guide work being done by partner organizations outside CHiRP. For example, if we collect bear sightings, we can extract that information and forward it to the Jennifer Jones Whistler Bear Society or to Michael Allen, a local bear researchers, for consideration in their bear research.

**Future Enhancements:**

The current functionality available in those modules discussed above would satisfy us initially, however additional functionality is likely to be required once partners have had a chance to use the site, and test its usefulness. Already partners have been thinking about advanced ways they’d like the website to be used. For example, the Whistler Off Road Cycling Association would like users to be able to notify WORCA of areas where erosion and trail damage is occurring along Whistler’s many bike routes. The Whistler Naturalists have expressed an interest in having users search for a particular bird species and then retrieve a map of where that species has been sighted in the community. These types of functions require us to develop a tool which would allow for more analytical queries. These queries are also very specific to each user group so we would have to investigate how to organize these types of queries in such a way that they can occur independently but not detract from the overall aim of the site.

**Skill Levels:**

There will be a range of skill levels across these four user groups so we need to develop a site that is easy to understand and use. We want people who do not regularly use the internet or computers to be able to understand the site and how it works, similarly we’d like advanced users to be able to get all that they need out of the site.
Technology:

The site needs to be compatible with as many operating systems and software packages as possible. We need the site to work with a range of system setups. Considerations should include:
- Operating systems
- Web browser (software and versions)
- Internet connections speed

Measures of Success:

The success of this project has been expressed by the partnership in two ways so far. This will have been a success if:

1) It leads people to be better stewards of the land. If it leads to stewardship activities taking place as a result of information gained from the website.
2) The website helps to show how little habitat information actually exists for Whistler’s animals, plants, etc. and how there are many gaps in the information we have about our valley’s environment.

Additionally we might want to use web activity as a measure of how well we are doing. If we spend time creating a site but then do not follow through on promoting it through the community then we will have worked in vain.

Appendix D: Guide to using Local Stories

How to Guide for Using “Local Stories”

Using Internet Explorer type the following into the “address bar”:

www.georgiabasin.info

- Click on the “Local Stories” tab
- You’ll see three magnifying glasses, select the one over the Tri-Cities area.

Viewing Stories
You can browse the stories that others have created by clicking on the icons on the map.

Creating your own story
If you want to create a story, you will need to be logged in.

To login, click on the “login” button in the upper right hand corner of your screen.

For first time users: click on “Register with us”

- You are presented with a form to fill out and you will need to select a username (i.e. your first name) and a password. If you already have one for citysoup.ca, you can use the same one.
- Click on “submit” once you have filled in the form.
- Then, click on “login” and type your username and password.
- Click on the “Create a story” button just below the map frame.

You will be presented with a few steps to add your story:
1. Click on the part of the map that you want to associate with your story
2. Select one of the icons to put your story into a category that is meaningful for you
3. Give your story a title by typing into the box
4. Type your story, essay, poem, dialogue into the box
5. If you would like to add multimedia, select this and then browse your local computer to select an image, give the image a title and caption, if you wish.
6. If you are satisfied with your story and decide that you would like others to be able to view it, click “share story”

For more information contact: Sonia Talwar (stalwar@interchange.ubc.ca)
13 Feb 2004 v0.2
Certificate of Approval

PRINCIPAL INVESTIGATOR
Gurstein, P.C.

DEPARTMENT
Comm & Regional Planning

NUMBER
B04-0146

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT

CO-INVESTIGATORS:
Murphy, Siobhan, Geography; Talwar, Sonia, Geography

SPONSORING AGENCIES

TITLE:
Evaluating Local Stories in a Community Setting

APPROVAL DATE
MAY 25 2004

TERM (YEARS)
1

DOCUMENTS INCLUDED IN THIS APPROVAL:
March 15, 2004 Assent form / Consent forms / Survey form

CERTIFICATION:

The protocol describing the above-named project has been reviewed by the Committee and the experimental procedures were found to be acceptable on ethical grounds for research involving human subjects.


Approval of the Behavioural Research Ethics Board by one of the following:
Dr. James Frankish, Chair,
Dr. Cay Holbrook, Associate Chair,
Dr. Susan Rowley, Associate Chair

This Certificate of Approval is valid for the above term provided there is no change in the experimental procedures