AN INFORMATION SYSTEM FOR GOVERNMENTAL LAND USE AND DEVELOPMENT REGULATIONS: A CLIENT-ORIENTED PROTOTYPE USING HYPERTEXT LINKS

By

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ABSTRACT

Like several cities and districts in British Columbia, the Corporation of the District of North Vancouver has experienced budget cutbacks and a downturn in permit revenues in recent years. The District needs to do more with fewer resources. Like other local governments, the District identifies Customer Assistance as a major strategy to improve accessibility to planning information to both staff and clients.

The Corporation of the District of North Vancouver's Experimental Information System for Governmental Land Use and Development Regulations is intended to answer the most commonly needed planning information about getting land use and development regulation for any given property / lot / area. It is especially intended for those unfamiliar with the regulation nomenclature and policy process. It is also intended for policy staff, land owners, developers, nearby residents, and municipal or senior government staff responsible for administrating regulations and providing information to the public.

The District of North Vancouver's experimental computer-based kiosk uses hypertext links and related software to coordinate, select and display information from a variety of text documents such as by-laws and regulations; a GIS (Geographic Information System) that includes map layers with land parcel boundaries, roads and other rights-of-way, topography and zoning districts; site plans and other information accessed through a CAD (Computer Assisted Drafting) program used in connection with development permit applications as well as infrastructure projects; and data base files such as registers of easements and property tax assessment information.

Practically, if the land parcel selected is within 30 metres of a stream, its development is regulated by provincial regulations as well as municipal zoning. The prototype uses a GIS to
check both zoning and proximity to streams, and displays only the provisions that are applicable to that site. This selectivity is important in making a mass of regulations comprehensible to users with a particular question or issue in mind.

A unique feature of this system is that it selects only the information that is relevant to a selected location, and within that, leaves details such as definitions and specifics of regulations in the background which stay available through interaction with the user. This respects the user's interests and his or her current position on a learning curve. This way of providing information facilitates the eventual face-to-face contact between a client and planning staff. The hands-on information provided helps both parties to communicate more effectively as they have a common basic knowledge of the issue to be discussed which helps to speed up application permit processes.

Development of the computer system has been carried to the level of a working prototype system that shows the concept can be implemented and has merit. While this research and development project was initiated as a M. Sc. thesis in Planning, it is now ready to be transferred to a B.C. municipality or company for full-scale development and implementation.
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The computer development of this "information system for governmental land use and development regulations: a client-oriented prototype using hypertext links" is the result of a twelve months research and development partnership with the Corporation of the District of North Vancouver. Many have contributed to this project and deserve special mention. This thesis has been generously funded by the scholarship Fond de la Connaissance et d'Avancement de la Recherche (FCAR), a Quebec graduates students financial assistance agency and by the District of North Vancouver which bought appropriate software.

While all the contributors cannot be named, a special acknowledgment goes to Mr. John Jackson, a long-term GIS expert now working for the District as the GIS Coordinator. Beside his vast technical and human expertise, Mr. Jackson is a high-standing professional who can envision and work on the forthcoming use of computer technologies in various domains such as planning. A special and personal thank you goes to my long-term life partner, Marielou Verge, who owns this project and its provincial and national excellence of planning awards as much as I do. Finally, a distinguished mention goes to my main academic supervisor, Mr. Henry Hightower. Beside his involvement in this winning project, I wish him and members of his family a great time in his new retired Sunshine Coast life style.
CHAPTER 1. INTRODUCTION

**Brief Overview**

This thesis uses some modern computing technology to construct a tool for planners, their managers, their political masters, and the citizens whom all of these serve. The zoning by-law is but one part of a complex system of land use and development regulation. A variety of problems is attributable to the complexity of this system, and the tool is intended to address some of these problems.

This document is part of the thesis project. However, there are two reasons why this document does not represent the thesis as a whole. One reason is based in information technology, the other in the misfit between an interactive and nonlinear tool and a static and linear verbal presentation.

The information technology problem is that the tool works in a setting in which a mass of data and software is available and frequently changing. In order to demonstrate the value and the practicality of the tool, it was constructed on a municipal computer network that serves planning and related departments in the District of North Vancouver. In an important sense that will be explained in Chapter 3, the thesis is a system which in its present implementation is inseparable from data stored and updated on the North Vancouver District computer system. The problem which this thesis addresses includes the fact that a static, ink-on-paper document is not the most useful format for some kinds of planning information. In order to demonstrate this, one must go to a different medium, and this cannot be done within the bounds of an ink-on-paper thesis.
Project Text, Demo, and CD

The thesis exists in three complementary formats. One is a functioning demonstration version in the North Vancouver municipal hall, the version in which a user of the tool makes choices about what the tool creates based on the user's current interests, knowledge and preferences, and on the current status of development and planning in North Vancouver. The second format is the present document, which states the problem that the tool addresses and the rationale for its design. Ideally one would have the tool at hand when reading the thesis document, in order to see what it does while reading about why and how it works the way it does. The third format is a more portable version of the working model, a CD-ROM which presents a snap-shot of the real working interface.

Significance of Project

Like several cities and districts in British Columbia, the Corporation of the District of North Vancouver has experienced budget cutbacks and a downturn in permit revenues in recent years. The District needs to do more with fewer resources. Like other local governments, the District identifies Customer Assistance as a major strategy to improve accessibility to planning information to both staff and clients.

As is the case with others municipalities, The District of North Vancouver suffers from a lack of a comprehensive integration of its land use and development information. Its database applications were developed over a long period of time, each addressing specific issues. For the District, a customer assistance strategy has several aspects and complex ramifications. One of these is an increasing need for giving access to both staff and the public to complete and accurate land use information.
Overview and Organization

First, an examination of the current "state of the art", both of Canadian and American sources was necessary to place this planning computer system in the context of changes taking place throughout the planning practice. This background was required to examine experiences from other cities and to capture the best ideas. It was also needed to validate the rationale and the problem statement undertaken by this project. This background was important to validate the planning and computer design criteria used for the development of this computer planning kiosk. Second, definition of technologies and other resources paved the way to illustrate the demo capabilities. The results are outlined through a non-technical demonstration of how the system works. This is followed by a discussion and conclusions regarding its full-scale development and implementation.

Scope and Limitations

This project is an experimental project. During the demo, a few lots located in developed as well as in developing areas are available. The idea for selecting a few lots is to demonstrate the development of such system directly on computer, as opposed to creating a conceptual model without developing application skills. This thesis demonstrates the tool but it does not provide its general availability.

The scope of this experimental project is closely related to the existing context of the Corporation of the District of North Vancouver. The scope was defined after we looked at the existing work already in application on GIS. Planning teams also made recommendations regarding appropriate properties and areas for case-studies.
Summary

The District of North Vancouver suffers from a lack of a comprehensive integration of its land use graphical and textual databases. Those databases applications were developed over a long period of time, each addressing specific issues. A combination of GIS and hypertext becomes a mechanism to integrate such heterogeneous database applications on a lot-by-lot basis.

Both municipal staff and the public need a tool to create and modify land use information collaboratively. Accessibility to this interrelationship allows users to improve their knowledge of local planning regulations. The prototype, by summarizing and giving access to regulatory information on a lot-by-lot basis, is in considerable demand to facilitate and accelerate land development approval processes for both municipal permits approval officers and the public.

The prototype proposes an implementable solution to a lack of efficient access to land use information. It proposes a practical vision by which a local municipality can organize, share, and coordinate its land use information. Through computer applications, the prototype meets the needs of different users. It informs both staff and clients about regulatory information applicable to a given property or area. The interactive capability allows user-driven requests to the prototype for information. While this chapter identifies the problem and introduces a practical and implementable solution to it, chapter 2 defines the planning context in which this solution takes place.
CHAPTER 2. BACKGROUND

The Regulatory Environment

Coordination of governmental land use and development regulations is needed to achieve greater effectiveness in land-use decisions, enforcement and monitoring. Public attitudes, values and education are critical to effective planning processes and decisions.

The District provides land use and development regulations that primarily relate to zoning regulations, zoning strategies and planning policies. For example, frequently when a municipal planner deals with a client asking for a building permit or a biologist from Department of Fisheries and Oceans, clients ask for more than the technical nature of a land use regulation. Members of the public as well as elected and government staff want quick access to all levels of land use information in order to put what they read and talk about in context. They want to obtain the whole picture behind a land use regulation.

Land Use and Development Regulations: Governments Objectives and Concerns

The District of North Vancouver, conjointly with senior governments, produce land use information for several contractors, developers and citizens throughout several types of land-use development and approval processes. A recent government initiative Partners in Protecting Aquatic and Riparian Resources (Canada, DFO and Fraser River Action Plan and B.C. MoELP, 1994), requires a long term coordination of data collection and management between governments. The PPARR identifies four broad objectives to achieve greater effectiveness in planning efforts:
1. Senior government staff need to improve their knowledge of local planning regulations. Similarly, local governments need to be kept informed of new legislation;

2. To be useful, data or information has to be accessible to a broad range of users;

3. Coordination for sharing information between municipal departments and senior government agencies is required to achieve greater effectiveness in land-use decisions, enforcement and monitoring;

4. Public attitudes, values and education are key components of municipal planning strategies.

This decentralization of land use information from senior governments to local municipalities creates a challenge for them. The District of North Vancouver is now asked to produce part of this environmental information through a number of parallel efforts with senior governments. This shift also means the District becomes responsible for producing and organizing such information, and for making it available through local regulatory tools and related processes.

Another recent government initiative is the *Guide for Planners and Developers* (Canada, DFO and B.C. MoELP, 1993). It proposes a “one-stop shopping” for government services as a key component to help all levels of government to move towards greater coordination of their roles. It specifies that a “one-stop shopping” system could allow local governments and local citizens to screen projects which require provincial and/or federal referrals. This would dramatically reduce the complexity of development approvals.
Most of the governmental land use and development regulations reside on different platforms. For example, taxation information is stored on DOS-type spreadsheet such as Lotus, bylaws on Windows-type in MS-Word, and some parcel graphical information on GIS and others on CAD. In other words, the information is still in transition from DOS type system to full integration in MS-applications. It is difficult to develop data management capabilities, multi-user access, concurrency control, data security and data integrity, all key components of a customer assistance strategy or "one-stop shopping" services. By using a geographic information system (GIS) as an anchor and hypertext as a navigator that links all the databases together on a lot-by-lot basis, the prototype centralizes on one platform, most of the land use zoning and Official Community Plan (OCP) queries regarding a property and/or an area.

**Key Users of Regulatory Information**

Both governments at all levels and clients need a tool to find and exchange regulatory and Official Community Plan (OCP) information quickly and easily. For example, municipal staff and clients contribute a common perspective in the design of a municipal zoning bylaw and its process. The information they create is interrelated with other government information as well as with policy documents such as a local Official Community Plan (OCP), and the Land Development Guidelines for example.

These interrelationships are now part of any attempt to create a common regulatory information system. This ensures users, both governments staff and clients, accessing such a system, are given enough information to make appropriate linkages among a huge volume of land use information.
**Sources of Information on Work Done Elsewhere**

Several Canadian and US planning departments are already involved in the development of various computer planning support systems. Up to now, most of the efforts have taken place in response to the same lack of database integration identified earlier. One recent Canadian experience is the city of Ottawa's Z-Ref system (City of Ottawa, Planning Department, 1994). As the city of Ottawa experienced, zoning regulations turn often into a tangled mess after years of application. This makes it harder to find information both for the city staff and the public. When Ottawa approached the task of writing a new zoning bylaw, the city wanted to tame the tangle. Part of the solution is a computer program called Z-REF. It is a multi-disciplinary program that reduces complex municipal databases and policy documents into an easy-to-use format. Another Canadian experience is the city of Montreal's zoning management system (Reney, Michel, 1993). From decentralized neighbourhood offices, the public can get access to a centralized zoning database. With their taxation identification number, users can pinpoint zoning designation, permit applications, and taxation information.

In the United States, several cities and counties have various types of planning support systems. For example, beside the popular and widely used "tracking permit systems", the city of Santa Rosa's kiosk informs the public about permits, approvals, and processes to complete their zoning activities (Fricker, Mary; 1995).

In all cases, the development of those planning support systems began after local municipalities experienced budget cutbacks and a downturn in permit revenues. They needed to do more with fewer resources. The development of those systems was supported by councils as they allowed the cities to provide higher level of services in a more cost effective manner by:
• Allowing both government staff and clients to instantly determine what the regulatory information is for any given property and/or area;

• Allowing electronic consultation between staff and the public on any given regulation. This results in measurement criteria, against which performance and effectiveness can be measured, thereby allowing for objective modifications to improve effectiveness;

• Allowing planning staff to be proactive as opposed to reactive.
### The State of the Art: Systems Existing Elsewhere

#### Table 1. Computer systems regarding land use information: A brief profile of previous Canadian and US experiences

<table>
<thead>
<tr>
<th>City of Santa Rosa</th>
<th>City of Ottawa</th>
<th>City of Montreal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Information</strong></td>
<td>From a multimedia interface, permits applicants are able to work their way through some of the process. Users can find in English or in Spanish, such things as whether they need a permit, which kinds of permits, how to fill out application forms and how to prepare a site plan.</td>
<td>From a hypertext Windows interface, user can retrieve most of the zoning information, its related zoning strategies and related OCP policies. Both staff and the public accessing the system are given enough information to put what they read in context.</td>
</tr>
<tr>
<td><strong>System capability</strong></td>
<td>The system incorporates on-screen reproductions of the permits and applications, using text, sound, full-color graphics and video.</td>
<td>Supported by a glossary of terms, users can tailor the information received to their level of expertise and interest. User can search by location, key words, bylaw reference numbers.</td>
</tr>
<tr>
<td><strong>Next steps</strong></td>
<td>The system will be tied into the city’s computerized data. When the applicant fills in an address, the computer automatically will fill in much of the rest, such as what the zoning is and what the general plan calls for.</td>
<td>Connecting the hypertext interface with the GIS database through dynamic links to multiple databases.</td>
</tr>
</tbody>
</table>
In the above table, computer zoning information systems were developed to give the cities staff and the public, better access to obtain regulatory information. In all cases, the rationale to support the development of such a product was to increase effectiveness and to create a more user-friendly and integrated option to retrieve land use information.

In the three examples, cities wanted to see a format more suitable for regular amendments and better coordination among municipal departments involved in land use information. These three examples provide an overview of the existing solutions developed throughout Canada and United States to deal with the issue of retrieving regulatory information.

Part of the solution is a PC Windows computer program. It combines map-based information via GIS applications and regulatory information linkages via hypertext applications. The 2000’s trend is a Windows-based client-server database application. Such system operates with dynamic links to multiple land use databases. These systems are flexible, easy to update, user-friendly and compatible with Internet. As shown in the next table, the proposed District of North Vancouver’s lot-based, GIS-Hypertext system is based on these characteristics.
Table 2. District of North Vancouver’s System: Design Criteria

<table>
<thead>
<tr>
<th>Interface</th>
<th>District of North Vancouver’s design criteria</th>
<th>Author’s design criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Flexibility</td>
<td>• Utility</td>
</tr>
<tr>
<td></td>
<td>• Easy to update</td>
<td>• Integrity</td>
</tr>
<tr>
<td></td>
<td>• User-friendly</td>
<td>• Usability</td>
</tr>
<tr>
<td></td>
<td>• Internet compatible</td>
<td>• Aesthetics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Costs of production and time to implement</td>
</tr>
<tr>
<td>Technical components</td>
<td>• Is able to issue SQL calls to a database server such as Oracle;</td>
<td>• Lot-by-lot basis</td>
</tr>
<tr>
<td></td>
<td>• Is able to invoke GIS program such as calling Arcinfo to show a lot.</td>
<td>• GIS links</td>
</tr>
<tr>
<td></td>
<td>• Windows using TCP/IP to talk to a UNIX host</td>
<td>• Dynamic links to multiple databases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Close integration with Autocad Microstation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Database independence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Server hardware independence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Familiar windows graphic user interface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scaleable from individual department to full municipality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Multiple document interface</td>
</tr>
</tbody>
</table>

**Summary**

The Corporation of the District of North Vancouver’s Experimental Information System for Governmental Land Use and Development Regulations is intended to answer the most commonly needed planning information about land use and development for any given property / lot / area. It is especially intended for those unfamiliar with the regulation nomenclature and policy process. It is also intended for policy staff, land owners, potential developers, nearby
residents, and municipal or senior government staff responsible for administrating regulations and providing information to the public.

The District of North Vancouver's experimental computer-based kiosk uses hypertext links and related software to coordinate, select and display information from a variety of text documents. These include by-laws and regulations; a GIS (Geographic Information System) that includes map layers with land parcel boundaries, roads and other rights-of-way, topography and zoning districts; site plans and other information accessed through a CAD (Computer Assisted Drafting) program used in connection with development permit applications as well as infrastructure projects; and data base files such as registers of easements and property tax assessment information.

Practically, if the land parcel selected is within 30 metres of a stream, its development is regulated by provincial regulations as well as municipal zoning. The prototype uses a GIS to check both zoning and proximity to streams, and displays only the provisions that are applicable to that site. This selectivity is important in making a mass of regulations comprehensible to users with a particular question or issue in mind.

Following this chapter about the planning context in which this computer system takes place, a discussion of how this system works and is built up is warranted.
CHAPTER 3. TECHNOLOGIES AND RESOURCES

Network, Data and Software

As the management of land use and development regulations becomes more complex with increasing numbers of players and components, Geographic Information System (GIS) and hypertext technology are being promoted as important and necessary tools to manage such data. Before defining what GIS and hypertext are, the more general topic of organizing and mapping as it relates to a corporation's strategy for managing land use and development regulations is necessary.

In deciding what information to include, how to map it and link it with a textual database, several questions arise.

1. What questions does a corporation such as the District want to answer?
2. What confidence levels does a corporation want in its answers?
3. What level of compatibility does a corporation want between GIS and hypertext?
4. Does a corporation want to share its land use information and does it need land use information from others?

The first question concerns the purpose of the GIS-hypertext system: what does the District want to do and for what area? The second, third and fourth questions concern the scale and accuracy needed from the GIS-hypertext system, which in turn determines both the graphical and textual data collection strategies. For example, more field work and cross-department research is required to obtain data for site-by-site analysis as opposed to broad municipal strategic planning. The final question deals with issues about standardization of scales, classification systems, boundaries and inventory methods, as well as data compatibility. This
compatibility issue is crucial, in view of the increase in partnerships and integrated planning and management, as well as the increase of on-line services through the Internet.

The software chosen for this project is Guide 3.0 (InfoAccess Inc. 1995) and was selected for the following reasons:

- Windows-based interface;
- Availability: IBM and Macintosh-compatible hypertext system;
- No chunk or node size screen limitation;
- Easy-to-learn user-interface for authors and users.

Guide 3.0 is a hypertext authoring tool to create and edit electronic documents. This authoring tool includes a word-processing, graphic menus to control the presentation of imported graphics, zoom and pan images. Guide includes a macro scripting language and, as with any other programming language, it is able to reconfigure windows and to communicate with external applications such as GIS and MS-applications. Its main advantage on other hypertext software is that it runs in a UNIX environment. This is fundamental for this project to ensure the prototype runs on the District of North Vancouver’s internal computer network.

**Hypertext: A Brief Profile**

For the purposes of this thesis project, a hypertext system can be defined as a way of organizing text in a computer that allows the linkages of designated points in a text or other media to other place. It allows rapid retrieval of information by following paths of these associative links. A hypertext system provides flexible access to information by incorporating the notions of navigation, annotation and tailored presentation (Bieber, 1993).
Hypertext consists of units of information known as nodes or chunks (Meyrowitz, 1989). Links provide connections between nodes and allow users to move from node to node according to their information needs. Links are also referred to as buttons and can be activated with a mouse or touch screen (Permit Department, City of Santa Rosa, 1992). To use a planning analogy, links take the user from one textual chunk or node of information to another, much the same way as streets take an individual from one building to another (Hashim, 1990).

A bylaw document does not have a modularity problem: there are no nodes in a bylaw document that require reading previous pages. A planner or other interested party looks at a bylaw document in search of specific information. The document is not usually read in its entirety which is a key point for the use of hypertext.

The modular structure of a bylaw is in keeping with hypertext applications. Each section within a bylaw document is a chunk of information and can be considered an envelope. Each envelope has a title and represents a hypertext node. When the envelope is closed the viewer can read its title, and when opened, the viewer can look at its contents. One envelope may have other envelopes inside it, and these envelopes may themselves contain other envelopes creating a hierarchy.

The demo contains an envelope for each chunk of text that has a heading. A zoning bylaw regulation, for example, may be in an envelope named "uses generally permitted" which would exist with others in a larger envelope called "zoning strategies." This would reside in a still larger envelope entitled "planning policies." which would be found in the outermost envelope, corresponding to the zoning information system as a whole.
Current Hypertext Limitations

Some difficulties arise from the very nature of hypertext. Solutions to challenges such as disorientation from too many choices and inappropriate links are necessary to achieve the benefits of a system incorporating hypertext. The wide scope of hypertext can become confusing when a user follows a long chain of hypertext. One can easily become mired in a collection of details and related issues (Boyle and Snell, 1990).

There is no ideal solution to such problems, although as demonstrated by the Ottawa, Montreal and Santa Rosa systems, one possible method is to limit the number of links and the amount of details that are related to each node. Another solution is using an Information Mapping's Method. This hypertext methodology provides criteria for analyzing, organizing, writing, sequencing and formatting information to improve the design of a hypertext system (Horn, 1989).

Organization of Hypertext Paths

The following web view explains how the access to the information on zoning bylaws, related zoning strategies and policies is organized. There are two paths of access, one a lot-based application and the other based on general bylaws and objectives applicable to the whole municipality. The first path allows the user to access the specific zoning information on a lot by lot basis, taking the address or taxation reference number as a key access.
Figure 1. District of North Vancouver’s Land Use Information System: A Computer Architecture

System Access:

- Address or lot #
- Upper Capilano Neigh.
- Lower Capilano
- North Lonsdale/Delbrook
- Lynn Valley
- Deep Cove
- Alpiner

Current Zoning Designation

- Develop, Permit Area
- Single-Family Res. 1/2-4
- Multiple-Family Res. Zone 1-6
- Low-Rise Res. 1-4
- High-Rise Res. 1-3
- General Commercial Zone 1-7
- Waterfront Industrial Zone
- Comprehensive Development Zone

General Overview

- Employment
- Environment
- Heritage
- Institutions
- Leisure
- Transportation
- Utilities

General Uses

- Uses generally permitted
- Uses prohibited in all
- Use of highway
- Home occupation
- Height exception
- General siting
- Siting exceptions
- Commercial vehicles, etc.
- Outdoor customer service area

Specific Uses

Size, shape, siting of residential & accessory buildings

Zoning Strategies

- Use
- Use Regulations
- Envelope
- FSR
- Lot area / frontage
- Yards
- Landscaping
- Parking / loading
- Site plan control
- Design advisory panel
- Heritage conservation
- Covenants (IF5)

Environmental Protection & Preservation

- Aquatic Areas
- Slope Protection
- Soil
- Trees
- Permit Application
- Enforcement

Policy (OCP) and senior govern. policies

Policy (OCP) and senior govern. policies
The above web view is an example of a typical path taken for a search of information on one property located in North Lonsdale/Delbrook neighborhood. In this example, the user chose the following path:

- North Lonsdale neighbourhood;
- Single-Family Residential 1100 sq. m.;
- General Uses;
- Uses generally permitted;
- Related zoning strategies;
- Related planning policies;

A different path could be taken to meet different needs. This web view illustrates how a user can navigate back and forth between this regulatory information by following paths depending on the type of information he/she is looking for. Other means of gaining access to the information include key words, addresses, and bylaw references numbers.

**GIS: A Brief Profile**

GIS is an interactive tool: not only is it a sophisticated mapping tool, but it also carries spatial and database query capabilities. GIS is a computerized mapping system that captures, stores, displays, analyses and generates map-based information (Colnett and Moore, 1995), making it different from other forms of computer-based mapping such as engineering maps (CAD) or drawing programs (Illustrator or CorelDraw). GIS has mapping functions, can store
large amount of information about polygons and lines, and is capable of responding to spatial queries such as what relief surrounds a specific neighborhood.

GIS can also work in interaction with other software applications. Custom database software can be developed to interact with GIS software to perform both ecological and economic analysis of a specific area. For example, by digitizing and incorporating aerial photographs into GIS, a computer analysis can provide information on environmentally sensitive areas and predict employment rates for various combinations of human uses.

In GIS language, a residential unit constitutes one distinct layer called, for example, Addresses and Street Names. This layer is part of several others such as cadastral, utilities, relief, easements and restrictive covenants that were built from several hundred alphanumeric coordinates taken from the Provincial 1: 20,000 TRIM digital base maps. Both the Greater Vancouver Regional District and Environment Canada share a satellite image of the Lower Mainland referenced to the 1: 20,000 provincial TRIM base maps (Colnett and Moore, 1995).

Databases and Other Resources

Zoning bylaws, zoning strategies and planning policy documents are not read in the same way as other documents or books. These materials are typically highly cross-referenced with internal and external reference schemes. Such a structure helps the user to access zoning bylaws, zoning strategies, and planning policy documents in a none linear fashion: specific parts of a zoning bylaw such as "general uses" or "use of driveways" can be located quickly without reading the entire bylaw. The selected hypertext software was designed to identify and utilize all of these existing structural elements and use them in building hypertext documents.
This GIS-Hypertext system is built from the four databases described below. The first two, zoning bylaws and GIS legal map-based, were already in existence; the zoning template and lot view check list were created specifically for this project.

**Databases Used:**

1. **Zoning bylaws:** Corporation of the District of North Vancouver’s zoning bylaws #1965 and #6515 already formatted into Microsoft Word, version 6.0.

2. **GIS legal map-based:** Corporation of the District of North Vancouver’s GIS zoning layouts built into ArcView.

3. **Zoning template:** A management tool to link together zoning bylaws, zoning strategies, and planning policies.

4. **Lot view check list:** A one page list of all potential regulatory information applicable to a lot or an area, divided into four sections each representing a level of government.

**Zoning Template: An Innovative Land Use Information Management Tool**

This zoning template consists of strategies that translate land-use policies into zoning concepts, providing a solution to the lack of connections between zoning regulations and related planning policies. The strategies introduce regulations and administrative concepts that are intended to implement planning policies. The format used to present the complex information is a template that outlines the effect a municipality can have on development through zoning restrictions (City of Ottawa, Planning Department, 1993). The template is designed on the basis of relevant Sections of the B.C. Municipal Act including 587(a), 589, 692, 930.1, 932(j), 976(5), and 978. Most of the zoning strategies and policies outlined in this template are taken from the
Corporation of the District of North Vancouver's Official Community Plans and planning staff reports.

**Clients and Servers**

Hypertext relationships between the demo and the District of North Vancouver's GIS and Excel databases are created by programming a set of procedural calls. The demo uses an Windows-based object-oriented programming language to make dynamic links to multiple databases. On screen, when a user clicks on a button, a programming call is launched. This call invokes a client database such as ArcView and makes the link with an appropriate section of a GIS map for example.

This way of sharing the land use information fits with the current trend of replacing old host based computer applications with client server applications. In this new approach, the data are held on a Search Query Language (SQL) compliant relational database server under UNIX. The client presentation screen runs in Windows and applications are spread between the UNIX server and the Windows client. The District's computer network runs on Intel-based personal computers with 8 Mb of RAM and uses TCP/IP to talk to a UNIX host.

**GIS and Hypertext: A Step Further**

A new level of municipal zoning information management began with the use of GIS. A further step has now been taken with the use of hypertext, and in some cases, hypermedia: the two can be combined to form a more suitable format for meeting the various needs of multiple clients including the general public. This gives both staff and clients looking for regulatory information expanded options and increased autonomy on how to get the desired information.
While the validity of the prototype is seen as the concept itself, the feasibility of it is explored through the development of the demo. The following figure presents an organization chart of the demo. It provides technical and non-technical information regarding access to the demo and the interrelationships between principal databases. It summarizes the technologies and resources used for the development of this experimental system and how all the various databases interact with each other.
Figure 2. District of North Vancouver's Land Use Information System: How does it work?

INSIDE ACCESS: DIRECT DIAL IN

OUTSIDE ACCESS: INTERNET HOME PAGE

INTERNAL NETWORK

TCP/IP&HTML

Protocol Windows interface

Protocol Windows interface

ArcView 2.1

HYPERTEXT MANAGEMENT SYSTEM

LOGiiX

GIS DATABASE

LOT BY LOT BASIS

GRAPHICAL & TEXTUAL DATAFILES

Multiple users
Links with all departments
CHAPTER 4. RESULTS: DEMO’S CAPABILITIES

Results

The demo demonstrates that a combination of GIS and Hypertext allows for the development of dynamic links to multiple land use information databases. The demo shows that integration of the information is possible with minimal disruption of the existing application and information platforms such as CAD applications and MS-applications.

Demo Capabilities

The demo gives zoning information for four lots located within the District of North Vancouver. Each lot refers to a different type of zoning: residential (RS1), commercial (C1), development permit area (DPA), and industrial (II).

The four lots each have their own characteristics. The residential property has a restrictive covenant that protects the stream that runs through the backyard. The commercial property holds a one-storey heritage building above which the owner wants to add residential spaces, or infill. The industrial site is adjacent to a major river and contains contaminated soils due to industrial activities. The development permit area has several creeks that running through it, with covenants imposed by both provincial and federal agencies.

While three of these four sites are located in a “developed area”, the fifth one a development permit area, is located in a “developing area”. Without duplicating the demo, the following three examples demonstrate pragmatic applications and illustrate how the system operates.
Example #1: Residential lot

Characteristics:

- Current zoning designation: Residential Single-Family 1 (RS1);
- Type of building: Duplex;
- Special characteristics: stream running through the backyard;
- Type of request: building a day care centre with capacity for 60 children;
- Customer request: is it allowed? if yes, what are the conditions?;
- User: Jane, new to the system.

Demo Capabilities

The client uses a computer terminal in a local branch of the municipal library. Following a two minute tutorial session explaining the operation of the system, the user types the address of the property on which Jane wants to obtain information regarding the construction of a day care centre. The next window requires the user to make a choice between a first lot-based zoning information path and a second path applicable to the whole municipality.

Jane clicks on the first path and instantly reads a main window containing general property information. She wants to learn the legal boundaries of the property in order to ensure the neighbor’s shed does not extend into her lot as the backyard is to be used for playing space for future day care children. Using the mouse, Jane clicks on the “GIS View” button and a GIS view of the lot is displayed. It indicates the legal boundaries of the property along with the size and location of the principal and secondary buildings, confirming that the neighboring shed does not encroach onto the property. While Jane looks at this GIS view, she sees the presence of a protected riparian zone along the stream that goes through the backyard.

Once back on the main window, Jane clicks on a button called red flags to get more information about this protected riparian zone. This button contains a menu of two options,
restrictive covenants and the Environmental Protection and Preservation Bylaw. Before going further, Jane clicks on ‘restrictive covenant’ to understand its meaning. Through a pop-up definition window that appears, she reads that it is an agreement between a private landowner and a Crown corporation or agency, a municipality, or a local trust committee under the Land Title Act. The pop-up definition window also contains a graphic showing where the restrictive covenant occurs on the property.

She decides to click on the “restrictive covenant” button to get more details about this legal tool and the restrictions attached to it for her property. Jane learns that such riparian zones could be protected by the installation of a fence if the main residential building is extended or an additional use such as a day care centre is created.

Once again in the main window, she learns that her property is zoned RS1. Jane clicks on the word RS1 to get access to the definition of this technical term again through a pop-up definition box. Back in the main window, she clicks on the button called “RS1-Use” to know if her proposal of building a day care centre is allowed under the current zoning designation.

The system supports two ways of knowing if a day care centre is allowed under the current zoning designation RS1. One is by selecting a “search query” in the menu located at the bottom of the window and typing the key words “day care facilities”. In this case, the user prefers the second way of navigating through the zoning document via the appropriate buttons. The user finds that day care centres are regulated under a zoning category entitled “home occupation”.

Once the user gets to the “home occupation” window, Jane reads that the zoning bylaw allows a day care centre in a house zoned RS1 as long as the total number of children is equal to
or fewer than 20 and the “floor space ratio” does not exceed 20% or 46 square meters. If the user is not familiar with the term floor space ratio and wants to learn what the bylaw requires, the user can click on the term and a pop-up definition box will appear.

Jane would now like to know why she must respect such regulations. Her plan is to incorporate a 60 square meter day care centre into an existing residential house. She clicks on a button called “rationale” located just after the 20% or 46 square meters zoning regulation and finds several reasons to support this regulation, such as maintaining neighborhood character ensuring the house retains residential use as its primary function. For each reason given, Jane accesses the related planning policies identified in the Official Community Plan. She decides to print out all this information on an attached printer and study the material at home.

Back in the main window, Jane disagrees with these regulations and their rationales and decides to challenge these regulations via an amendment. She clicks on a button called “amendment” to get information about this process and obtains information on how to apply, who is responsible, where to go and how long it takes for a typical amendment.

Jane is also invited to make an annotation regarding the section of the bylaw with which she disagrees. Jane clicks on a button called “annotation” and a box opens above the appropriate section of the bylaw. Jane writes her arguments about those regulations and why they should be modified. In this case, she feels that the 20% or 46 metre regulation prevents both spouses from being self-employed at home. When Jane closes this annotation box, the system displays a thank you message in which she learns that the planning staff reviews all annotations on a monthly basis. Jane learns that for this month, 15 citizens have made similar comments regarding the same regulation. On the basis of this electronic consultation, the planning staff studies any
proposed modifications through a pro-active planning approach. The planning staff can then inform citizens on how their suggestions are being considered and eventually implemented.

Once Jane presses the “exit” button at the bottom of the active window, the demo returns the user back at the beginning of the system and allows the user to leave the system.

Current Situation

Currently, the means of obtaining such zoning information is for a customer to call a zoning permit officer. On the phone, the customer explains the details of the project, such as its location and size. This can turn into a difficult conversation with the customer not fully understanding the regulations, their purpose and their background.

In such cases, the zoning permit officer explains the links between zoning regulations and how they are formulated in the OCP. After the zoning permit officer goes through these initial zoning elements, the zoning permit officer tries to explain what a FSR means in that context and how it applies to the case of a day care centre. In general, the only way to explain such technical zoning terms is for a zoning permit officer to read the bylaw definition over the phone and hope the customer is able to understand the definition.

After going back and forth between these two steps, the customer realizes quickly that all this zoning information has strong political overtones. The customer understands that zoning regulations are vehicles to shape and control existing and future land-use activities in her neighborhood according to a political vision defined by her neighbors.

Almost instantly, the phone conversation switches to the political intentions behind such regulations. The customer wants to know what objectives the municipality is trying to reach with
regards to day care centres. The zoning permit officer begins to talk about the zoning strategies behind the regulations and their related planning policies identified in the Official Community Plan. Often, the zoning officer has to refer the client to another staff member within the municipality or to another government level. In such cases, the client has to go through the same process again.

This type of phone conversation varies from 5 to 30 minutes, depending on the level of cooperation between the zoning permit officer and the customer, and the ensuing frustration. It is natural for someone who sees her project refused because it falls outside of the zoning regulations, to challenge the system. The customer is rarely satisfied with a single specific explanation. What a customer wants to know is “why” such a regulation exists and “how” it was approved by the community as well as by the municipality. Overall, a customer who looks for zoning information wants to understand the complete picture. The customer wants to obtain enough information to understand as well as challenge these regulations with which she does not agree.

This initial phone conversation with a zoning permit officer is often how the customer learns about the required legal documents and the many fees that must accompany an application. In most cases, this first conversation is also a way for the customer to see how serious the municipality is with the enforcement of the zoning regulations. The customer wants to be confident that the zoning regulations are respected by all other property owners and she is not the only one who must modify her project to meet the zoning requirements. In most cases, modifying a project means increasing the expected costs and the customer wants to make sure it is worth while.
Example #2: Commercial lot

Characteristics:
- Current zoning designation: Commercial General 1 (C1);
- Type of building: bakery in a single story building;
- Special characteristics: Heritage building;
- Type of request: adding residential units above the bakery;
- Customer request: is it allowed? if yes, what are the conditions?;
- User: Leon, Architect consultant hired by the owner.

Demo Capabilities

This user knows the system due to previous experience and gains access to the system via the Internet. Leon knows already the zoning designation and all the regulations applicable to this project. However, as a consultant, he wants to double-check all the information to ensure he begins his work with accurate information. After typing in the address, Leon works in the main window confirming the zoning, the cadastral identification number and so forth.

Leon clicks on the GIS view to see if there is any difference between his legal plans and those of the municipality to avoid confusion when he submits the construction building form to the development department. Leon realizes that the building owned by his client has been recently classified as a heritage building.

On the third section of the main window, Leon clicks on red flag to get details about the implications of a heritage building designation. He learns that modification of a heritage building has to be approved by a heritage building committee.

Navigating back and forth between the heritage building bylaw and its related objectives, Leon finds three purposes that guide the heritage building committee during the approval processes.
• To develop a heritage zoning strategy which encourages the retention of heritage buildings;

• To ensure new development or additions to existing buildings in or adjacent to heritage resources contribute to and are compatible with neighborhood scale and character;

• To apply standards that are in accordance with the Planning Act, and to remove or replace zoning standards which are ineffective or of questionable legality such as bedroom counts, parking subject to site plan control or owner occupancy.

Back on the main window, Leon clicks on Commercial 1 (C1), confirming that this zoning designation allows the existing bakery and would allow residential units within the applicable height, coverage and setback limits. Navigating for further details, Leon accesses the building code regulations applicable for this type of infill project such as fire safety.

Leon also confirms that a platform is necessary to distribute the loads within the existing structure. Leon clicks on the rationale regarding a platform and finds this building code regulation is linked to the zoning setback regulations in which an eleven foot setback is required on south and east property lines.

Back on the main window, Leon clicks on the red flag button to get information about design issues and types ‘design criteria for infill projects.’ Instantly, he gets access to the appropriate section of the design approval bylaw. Leon finds that the principal criteria to accept or refuse such a project is based on matching the density with the surrounding area. The
municipality’s design criteria attempts to break up the building masses rather then create a “box” above a commercial structure such as a bakery.

An annotation warns Leon about some of these design criteria, stating that some regulations are under review by a task force. Any existing regulations to be updated or changed will be replaced by the new ones as soon as they are officially adopted by the Council.

Back in the main window, Leon wants to obtain the complete check list the approval staff uses to analyze similar project applications. By typing “design check list” into the search query box, Leon gets access to a list which contains seven points ranging from planning and zoning issues to a building’s structural layers. He decides to print out this information on his own office printer and then clicks on the exit button to leave the system.

The integration of such check lists as early as possible in the design phase through to construction of a project helps speed up project approvals. This minimizes unexpected design changes, reduces the chance of unplanned mitigation or compensation requirements and enforcement action under the Planning Act and the Building Code.

Current Situation

Currently, this initial check involves several phones calls and visits to the City Hall Planning Department to pick up “self-help” brochures and ask the staff questions. Problems arise when a staff member cannot give the consultant more details beyond what is written in the brochures. The most a staff member can do is give him the updated check lists upon which an application is evaluated.
Example #3: Industrial lot

Characteristics

- Current zoning designation: Industrial 1 (II);
- Type of building: cement plant;
- Special characteristics: contaminated soils exist adjacent to a river;
- Type of request: what can the municipality do to protect the river from contaminants?;
- Customer request: How it is regulated? and how it is enforced?;
- User: Louise, Elected city council member responding to citizen complaint about the cement plant and its impact on the river environment.

Louise, as the mayor, is asked a question from an angry citizen during the question period at a regular city council meeting. Last weekend, he and his son were walking along the river and found that the water at the embouchure of the creek was discolored. As the citizen describes his concerns, Louise types the address of the cement plant, obtains a GIS view of the site and sees that there is a creek running through the plant site. As the mayor, Louise recalls that the municipality recently adopted a new environmental bylaw to deal with such issues.

The mayor asks the citizen to give more details about what he and his son observed the previous week. As the citizen describes the coloring water, Louise selects “search query” from the menu and types “stream protection and riparian zone”.

The mayor gets instant access to a note called “tracking actions” showing all recent actions taken by the municipality to stop this source of pollution. Louise reads a note from the environmental officer and discovers that the municipality started investigating the site two weeks ago in conjunction with the DFO and the MoELP. Preliminary samples indicate that court action will likely be required to deal with this case. The problem at present falls under the DFO’s jurisdiction. The note also explains who is responsible for this case and how many citizens have
made complaints about this issue. The mayor responds to the citizen with this latest information and is able to provide reasonable response to the citizen's concerns.

**Summary**

The following figure summarizes the technologies used and how this computer planning system operates. This figure presents the system from a user point of view in which the various planning information are linked together on a lot-by-lot basis. The computer terminal could be located at the City Hall, library, or at a community fire hall.
Preparing for the Future

Considering current use patterns, local municipalities are certainly the “common sense” locations to establish information systems for governmental land use and development regulations. Such coordinated information systems already exist in several local municipalities via on-line Word Wide Web servers. The District of North Vancouver presently takes a leading role by making regulatory information available on its Word Wide Web home pages.

However, the District’s web home site does not offer the same capabilities as the demo does: while some regulatory information is available, there is little substance. There are no features like a glossary of terms, searches by street address, key words, numerical markers such as bylaw references, GIS lot views and annotations. Most of the municipality’s web pages do not turn information into useful and valuable data. The demo is thus designed from a land use and development perspective. Zoning bylaws, technical background (rationale), official plans, zoning strategies, planning policies, statistics and maps are all linked together on a lot-by-lot basis. Municipality web pages such as those of the District make some regulatory information available but without this new integrative approach.

Through allowing searches by location, key words and numerical markers such as bylaw references, information is transforming into a first level of integration. Organizing the regulatory information on a lot-by-lot basis, according to the specific characteristics of every lot, is turning information into a second level of integration. Integrating GIS mapping capabilities and hypertext
technology via the development of dynamic link interfaces is creating a third degree of integration.

The Word Wide Web provides access to some government regulatory information. However, as long as the information is not organized and planned according to a clear corporate mandate, home pages will continue to be a wide network to access some regulatory information but not a navigation tool to search through valuable governmental information.

Even if the number of municipalities offering home pages is growing, complaints about their lack of content and out of date information are growing too. One of the reasons is that the process of creating and revising HTML documents is tedious manual work.

The Next Step: Full-Scale Implementation

Full-scale implementation of this project would give users the ability to access the most commonly needed planning information regarding land use and development regulations for a given property, lot or area. This project envisions the development of a computer-based planning kiosk similar to a bank machine: a corporation like the District of North Vancouver could begin by providing information for the regulatory information most often demanded by customers, and could provide additional services over the years according to customers changing needs and corporate mandate.

Template-Based Production

To reach full-scale implementation, the strategy is to build the system with hypertext software which includes a template-based architecture, allowing the submission of native source
files from any major word processor or graphics program. A template-based architecture creates a highly customized hypertext system without modifying the original files.

A template-based architecture sets up, in advance, the key components of the system, including text formatting, hypertext links, expandable headings, pop-up notes and window sizes. Once the template is set up, it is saved for later use, making frequent zoning bylaw amendments, for example, an easy task; simply reload the appropriate sections of the template and press the translate button. As the template works on structure rather than content, revisions are feasible on a regular basis.

A template-based hypertext software such as Guide Passport of InfoAccess Inc. allows one for the reloading of the template with different source files. The template automatically remaps the information and regenerates the same system. Guide Passport's template creates a computerized set of Windows-based programming functions, in effect becoming a computer map with internal programming functions. If one part of the map is modified to make revisions of a zoning bylaw, for example, the other parts of the maps keep their hypertext capabilities. The revisions are made possible by reloading the appropriate section of the computer system while retaining the programming frame and hypertext functions of the entire system.

**External Access: HTML Transit**

HTML Transit software of InfoAccess Inc. generates automatic HTML publications for the Internet and municipal internal networks. This transit software automatically translates the lot-based, GIS-hypertext template-based system into on-line ready applications.

HTML Transit is an appropriate tool for land use information systems requiring frequent revisions. This software uses the same template used by Guide Passport and stores every file
attached to the whole hypertext system previously created in Guide Passport. The template-based architecture allows one to specify, in advance, exactly how the land use information would appear and act on-line (InfoAccess Inc., 1995).

This combination of Guide Passport and HTML Transit almost eliminates the need for separate source files and electronic formats. As opposed to a typical municipality’s WWW home site, this combination operates from original document file such as zoning bylaw or the Land Development Guidelines. This combination produces hypertext system and HTML for the WWW without tedious manual work.

**CAD, GIS and Hypertext Integration**

Through the use of programming functions, the demo links together CAD, GIS and hypertext databases: multiple applications are called from one platform to another via dynamic links on the network.

Engineering and other departments who need to use CAD for designing their information would continue to do so. Planning departments, for example, would continue to use CAD for designing development proposals. Once the development is officially accepted by the City Council, the final proposal is converted from CAD to GIS and stored in the GIS database onto the appropriate lot or area. This ensures that the user accessing the hypertext system for this specific lot or area is given the most up-to-date information.

This way of integrating CAD applications with GIS resolves several of the current problems of how to share information among municipal departments and also works for the development approval process. Before officially approving a land development proposal, local municipal departments and clients must go through several drafts. As long as the development
drafts are under review, they do not need to be entered into the GIS system because they are not yet official.

This integration gives CAD technicians access to GIS landscape information. During the development review process, this integration allows a CAD design to be superimposed onto a GIS lot view. This superimposition ensures that the development approval staff gets access to all the landscape information already stored in the GIS for a given property. Also, the duplication of effort to produce land development information is avoided and a check of the accuracy of the GIS information is allowed.

Currently, CAD staff spend a lot of time designing on CAD landscaped information already available on the GIS. Once a development proposal is officially accepted, a CAD design becomes useless and only available through a microstation which is incomprehensible to non-professionals.

The demo uses both CAD and GIS for their respective capabilities. While CAD is used to create several types of information, GIS is definitively more powerful for the storage of land use information, its presentation and availability for a broader audience. The demo proposes to continue using CAD for municipal internal designing tasks but it suggests the usage of GIS as the final platform to store, present, share and access the property information.

**Full-Scale Implementation: Criteria**

The demo is a concrete hypertext reference system. It opens the door to review and critique from which information systems for governmental land use and development regulations can grow. A technical and financial review of a full-scale implementation of this system is
beyond the scope of this project. However, it is possible to pave the way for future review and critique through five categories.

- **Utility**: The first question in reviewing a hypertext system is whether it actually helps the user perform the intended task, such as looking for zoning information:

- **Integrity**: The integrity of a hypertext document is the extent to which the information contained in the document is complete, up to date, and clear:

- **Usability**: The extent to which a user can effectively and efficiently use the hypertext system, including ease of learning and error handling:

- **Aesthetics**: The extent to which the system is esthetically pleasing. This is a subjective criteria but good graphics design and appropriate use of color features are important:

- **Costs / benefits analysis**: An approximate financial statement on how much money is required for full-scale development. There are several corporate financial options available for working out the required investment. However, by proposing a neighborhood by neighborhood implementation process, investment can be amortized over a longer period of time. Others financial options include various development and implementation partnerships with senior levels of government and with B.C. Assessment for example. Another financial option includes advertisement. While most of the B.C. local governments do not use Internet-type advertising as a financial source yet, it could become a reliable option as other traditional sources such as taxation and transfers payments are frozen. For example, the development of the
proposed computer-based planning project could be financed with the help of such advertising as many other public organizations are starting to do.

The future of this planning support system is indeed exciting. With the public becoming more and more aware of their changing communities and desiring increased input into how their communities are managed, the growth potential of this project is vast. On one hand, various clients including the public are looking for accurate and up to date information, and on the other the municipal planning managers are looking at ways to increase the quality of services without increasing corresponding costs. Such a system as proposed here meets the needs and concerns of both parties and promises a new future for the relationship between planning departments and their communities.
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APPENDIX 1: GLOSSARY OF TERMS

CAD: Computer Assisted Drawing.

DOS: Disk Operating System.

Geographic Information system: GIS is a computerized mapping system that captures, stores, displays, analyses and generates map-based information. GIS has mapping functions, can store large amount of information about polygons and lines, and is capable of responding to spatial queries.

HTML: Hypertext Markup Language is a set of codes that can be inserted into text files to indicate special typefaces, inserted images, and links to other documents. The main use of HTML is to publish information on the Internet.

Hypertext: Electronic documents that present information that can be connected together in many different ways, instead of simply sequentially as is done in a book. A hypertext document typically starts with a computer screen full of information (text, graphics, and/or sound). The user then will have different options as to what related screen to go to next; typically, options are selected by a mouse or touch-screen.

Internet: is a cooperative message-forwarding system linking computer networks all over the world.

SQL: Structured Query Language. A standard query language used by several programs that manipulate large databases.

TCP/IP: Transmission Control Protocol / Internet Protocol. TCP is used to establish and maintain sessions between users and supports an application program interface (API). IP
provides for network interconnection and uses global source and destination addressing schemes.

**UNIX**: An operating system, or family of operating systems.

**WWW**: is a loosely organized set of computer sites that publish information that anyone can read via the Internet, mainly using HTTP (Hypertext Transfer Protocol). Each screenful (page) of information includes menu choices and highlighted words through which the user can call up further information, either from the same computer or by linking automatically to another computer anywhere in the world. The information is organized in a web of tremendous size, and the links are created by the author of each page.
APPENDIX 2: CD-ROM