THE LAND SURVEYOR IN A DISTRIBUTED INFORMATION ENVIRONMENT

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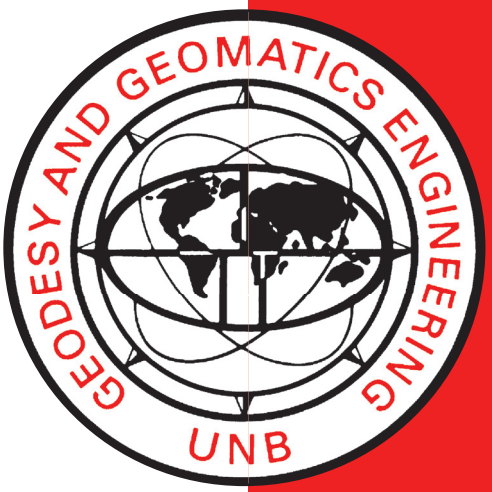

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PREFACE

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THE LAND SURVEYOR IN A DISTRIBUTED INFORMATION ENVIRONMENT

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PREFACE

This technical report is a reproduction of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Engineering in the Department of Surveying Engineering (now the Department of Geodesy and Geomatics Engineering), May 1993. The research was supervised by Dr. John McLaughlin, and funding was provided partially by the Natural Sciences and Engineering Research Council of Canada.

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Abstract

A number of circumstances have conspired to exert pressure on the land surveying profession. Concern for the natural environment and technological developments are among the major factors that currently threaten the provision of traditional land surveying services. In response to these pressures, the thesis proposes a new role for the land surveyor which has its basis in the land and resource management process. From this process is derived the primary function of the land surveyor namely, land information management. To complement this function, the SURVUS model is introduced. It depicts the land surveyor as having direct access to a network of distributed databases of land and other information that will enable the provision of information services to a wide variety of clients.

The SURVUS model is the conceptualization of a future environment that currently does not exist. The implementation of the SURVUS model, which is the goal of this thesis, is dependent upon the support of an infrastructure. The national spatial data infrastructure provides a framework through which members of the profession can envision their role as land information managers. Participation in the development of the infrastructure is viewed as one of the means by which land surveyors can successfully implement the SURVUS model. Implementing changes within the existing surveying firm is also necessary for implementing the SURVUS model.

The SURVUS model represents an evolutionary change for the land surveying profession. In that light, a strategy is designed for implementing the SURVUS model, which takes into account a wide variety of issues relating to the surveying profession including, specialization, marketplace pressures and opportunities, and environmental protection, among others. The strategy outlines the various stakeholder actions which are based on five guiding principles.

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Acknowledgements

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- my wife Nicole for her unfailing support, enthusiasm and understanding.

1. Introduction

> *a professional that works for a local clientele, heavily dependent on the local economy and with limited space to manoeuvre.*
>
> [Jacques, 1993, p. 2]

This self-portrait of the typical land surveyor is not the type of image that characterizes a confident and robust profession, nor does it offer enticement for recruiting. It can, however, be viewed as an indication that the profession must re-assess its role in society if it expects to remain viable. This representation of traditional land surveying is the result of a number of circumstances which have conspired to exert pressure on the profession. The most significant pressures come from technological developments and from concerns for the state of the natural environment.

During the post World War II era, the land surveying profession embraced land development as its primary activity in response to the national priority for housing and infrastructure needed for economic growth. The recent growing public debate over environmental issues, however, has had the effect of shifting these priorities to the point where land development is being constrained by calls for sustainability. To continue the dependence on land development would not only be uneconomical from the business perspective, but would also be contrary to the profession's societal obligations. Viewing the land surveyor's role within the land management process is the most appropriate response to deal with this pressure.

The second source of pressure comes from technological developments which, in the surveying industry, is recognized as being a catalyst for change. It forces change in the nature of the work. It confuses professional status and it challenges those charged with surveying education [Moore, 1978]. It alters manpower requirements in both quality and quantity [Task Force, 1991]. These pressures are part-and-parcel of this particular period

in our societal development which has been variously described as 'The Post-Industrial Society' [Bell, 1973], 'The Third Wave' [Toffler, 1980] and 'The Insidious Revolution' [Eason, 1988]. The common element in all of these descriptions is the growing importance of information in our society. These commentators describe microelectronics as the cause of the revolution, giving people the ability to rapidly store, process and communicate information in a cost effective manner.

In this light, it is expected that the operational environment of the typical land surveyor will undergo some significant changes over the next decade. The changes are readily evident. Microcomputers and total station survey instruments have allowed the automation of some data collection and data management activities, which has changed the nature of the tasks within the surveying office and in the field as well. Over the next decade, however, the changes will be more dramatic and occur even more rapidly. Communicating with clients, and gathering and disseminating information will occur in a network environment of distributed databases. This new environment will offer challenges and new opportunities for those who embrace it.

1.1 Goal of Thesis

The combination of the concerns for the natural environment and the imminent distributed information environment have provided the impetus to re-examine the role of the land surveyor; a role whose activities will involve land information management. The goal of this thesis is to support the claim that a new role is needed; to define this new role; and to develop a strategy for its implementation. The thesis may otherwise be called a long-term business strategy for the land surveying profession as it enters the information age.

1.2 Thesis Outline

A broad range of issues will be discussed in Chapter 2. The primary purpose is to provide the necessary background information to support the claim that a new model of the role of the land surveyor is needed, and to outline and discuss the main issues that will form the foundation on which the new model will be developed. It will involve the examination of the surveying profession through its different stages of development. A discussion of the subjects of specialization and professionalism will be followed by an examination of the effects on the land surveyor of the environmental movement and the distributed information environment.

It will be shown that the land surveying profession's specialization under the land measurement and land development paradigms has lead to the abandonment of the land management perspective. It will be argued that the profession's continued viability is dependent upon the re-incorporation of land and resource management as its primary objective.

Land and resource management is the foundation on which is built the model of the new role of the land surveyor. In Chapter 3, the land management process is discussed. Land information management, one of several land management processes, is described as the land surveyors' primary function. This involves the provision of land information to decision-makers within the land and resource management community.

The combination of the land information management function and the imminent distributed information environment has lead to the conception of the SURVUS model. The SURVUS model depicts the land surveyor as an information manager with direct access to a network of databases of land and other information, enabling the provision of information services to a wide variety of clients. SURVUS is not an acronym, but rather refers to land surveyors planning for themselves a role in the information services industry.

The SURVUS model is the conceptualization of the new role of the land surveyor, the realization of which is dependent upon a supporting infrastructure. To that end, the concept of the national spatial data infrastructure is introduced. The land surveyors' participation in the development of the infrastructure is discussed as one of the primary means by which the SURVUS concept will come to fruition. The final section of Chapter 3 deals with the environmental dimension of land management and the various ways in which the surveying profession can participate therein.

The pressures from technological developments and the environmental movement have had an effect on the demand traditional surveying services. Chapter 4 will examine those pressures and provide an assessment of the marketplace for land information. It is argued that by embracing the land information management perspective, these negative pressures may give rise to positive opportunities. Some of the topics discussed in this Chapter include: information as a basic ingredient of the decision-making process; information as a commodity; and public and private sector market opportunities.

The need to embrace the SURVUS concept is the result of changes occurring in the land surveyors' external environment. Successfully implementing the SURVUS model will similarly require changes within the existing land surveying firm. The aim of Chapter 5 is to assess the nature of those changes by viewing the firm as an organization comprising four interdependent components, tasks, technology, people and structure. The strategy employed in developing a new model of the surveying firm is based on an analysis of its past and present forms . The trends extracted from a comparison of these forms, combined with knowledge of the changing external environment and research on organizational change, provide valuable insight into the type of modifications that the organization's components require. The model will entail a description of the characteristics of the four organizational components, and suggestions for implementing the necessary changes.

Finally, Chapter 6 involves the design of an implementation strategy for the SURVUS model. The strategy brings together all of the disparate issues and topics discussed in the body of the thesis to form a cohesive and coherent blueprint for the land surveyor. It states five guiding principles which act as long-term objectives that provide direction for profession's members. These principles are necessarily stable and susceptible of little change.

The strategy outlines the actions required on the part of three surveying community stakeholders: the surveying educators, the professional associations, and the individual land surveyors. Educational and legislative reforms are among some of the recommendations for the first two stakeholders. The individual surveyors in private practice must take a proactive approach to both the monitoring and the implementation of changes in the internal organization and the external environment (existing infrastructure). The process of matching the infrastructure requirements with the capabilities of the surveying firm will lead to identification of market opportunities needed to sustain the profession's members.

1.3 Contribution of Research

The thesis provides a comprehensive analysis of the land surveying profession and the many issues affecting its well-being. The research shows that there are a number of factors currently having a detrimental effect on the profession. The new role of the land surveyor described herein, and the implementation of the proposed strategy will ultimately contribute to the long-term viability of the land surveying profession.

2. Background

The aim of this chapter is to lay a foundation on which to build a model of the future role of the land surveyor. The contents of Chapter 3 will outline and discuss that model. There are a number of elements concerning that model that require consideration. Chief among them is the past and present role of the land surveyor in society. After all, one should understand where one is, and where one has been, when determining where one should go. Also included is an examination of issues related to professionalism, specialization, and the duty to serve, as well as the ability to serve the public interest.

Two additional topics considered essential elements of the model are: the natural environment; and the distributed information environment. Few readers need be reminded of the problems that face our natural environment. Land surveyors should be aware that changing social attitudes may necessitate similar changes within the profession. Of particular significance is the surveyors' involvement in the land development process. The final topic deals with the distributed information environment. The proliferation of information technology that enables all types of groups and individuals to gather and disseminate information, will likely change the nature of the land surveying business. These topics can be classified as change agents, forcing the profession to rethink its position from a number of perspectives.

2.1 Land Surveying – Past and Present

An understanding of history serves many purposes. Among them is the desire to understand present circumstances by examining the sequence of past events. It is also used "to extend the past, or what is to become the future, as far as possible into the past, thereby constructing an image of continuity, consistency and determinacy" [Lepenies and Weingart, 1983, p. xvii]. The concept of social inertia as introduced by Keen [1981] is particularly

relevant to this discussion. In essence, a society or group will tend to remain in a state of rest or uniform motion until acted upon by outside forces. In order to effect change, a popular strategy is to convince the group that they have always been in motion and that their future direction is a logical extension of the familiar past.

The additional benefit of examining the past is to identify the root of present problems, which if properly diagnosed, can be rectified or avoided in the future. In this section, a review of the surveyor's role in society, and how it has changed over time, will be presented. This will include an examination of some of the elements that have remained constant as well as those that have changed. As indicated above, the goal is to gain an understanding of the past and present to be used in forging the future.

2.1.1 Ancient Societies

In ancient societies and continuing through the Middle Ages, the surveyor's role remained relatively unchanged. The focus was the creation and maintenance of the cadastre as the basis for administering land resources and generating revenue through taxation. Over time, the only changes to occur were in the surveying tools. Improvements in technology produced tools that were more accurate and sophisticated [Hannigan, 1990].

Perhaps the most famous of surveys was recorded in the year 1086 and published in what is known as the Domesday Book. After William the Conqueror invaded England, he ordered a survey of all of England to investigate the condition of his new acquisition and to create a tax register. Information contained in the Book was comprehensive and reflected the situation of England at the time, which was primarily concerned with agriculture. Some of the information gathered included: the names of landholders and their dependents along with their status or vocation; the extent of land and the different types of land use including improvements; the presence of natural resources such as wood and water; and the type and quantity of livestock and farming implements [Finn, 1973]. While the Domesday Book

was an instrument used to establish a basis for taxation, its wider purpose was to provide land related information needed in managing the country's resources.

Although no explicit mention is made of the land surveyor, one could argue that those charged with the collection of that information were indeed our predecessors; performing similar tasks with little if any instrumentation. The nature of their work was of such significance that it was entrusted to only certain individuals. "William the Conqueror ... sent men of proved discretion on circuit throughout the kingdom. A careful description of the whole country was made by these men ... this was gathered into a book" [Finn, 1973, p. 1].

From an historical perspective, the Domesday Book reveals the importance of land information in the management of land resources. The corollary is the importance of the individuals whose tasks was the gathering of that information. Their 'proven discretion' being an essential quality, is the antecedent of modern day professionalism. The primacy of land information and those involved in its collection is also evident in more recent times.

2.1.2 Exploration

After the discovery of North America the land surveyor was mandated to classify and inventory the land's resources. During this period of exploration, measurements of latitude and longitude were among the surveyors' daily routines, as was the collection of a variety of land related information. A perusal of diaries, journals and reports of the early surveyors shows that observations were made about the soil, climate and vegetation. Information about the local native culture, including its hospitality and potential for the fur trade, was also collected [Hamilton and McLaughlin, 1981].

As one of the notable surveyors of the time, Samuel de Champlain made invaluable contributions to the development of the nation. Although Champlain was considered a navigator, the subject of the majority of his surveys was land rather than navigation, and as

such he is considered 'the dean of land surveyors in Canada'. His accomplishments are numerous and varied. He performed settlement and topographic surveys, charted numerous waterways and coastlines, and carried out the first exercise in practical triangulation. He was a diplomat pursuing the cause of Canadians in the Old World, and went on to become the first Governor of New France. Certainly one reason for Champlain's enduring legacy is that he was not only considered a surveyor, but also played the role of explorer, navigator, soldier, engineer, mapper, colonizer, commander, author and administrator [Thomson, 1966]. Given the status and historical significance that such a man brings to the profession, it is not surprising that surveyors call him one of their own.

An additional element that contributed to the prominence of early surveyors was their desire to delve into the unknown. Thomson [1966] attributes their successes in exploration, surveying and mapping to an insatiable curiosity for whatever lay just over the horizon or around the next riverbend. While the rewards associated with their pursuits were of great significance, the potential costs in terms of risking life and limb were also great. Champlain, for example, was wounded by an arrow during an encounter with Indian foes, while on a mapping expedition [Thomson, 1966].

2.1.3 Settlement

The New World, following the period of its exploration, was mainly concerned with settlement. A number of factors led to an inflow of immigrants, one of which was the American Revolution. The government of Quebec, which included what is presently known as Ontario, was under a great deal of pressure to subdivide and allocate land for the influx of United Empire Loyalists, who fled from the United States [Aylsworth, 1937]. In 1783, the first instructions were issued to survey five townships in the vicinity of Kingston, Ontario [Anderson, 1936]. As the survey fabric was laid out for settlement,

land surveyors recorded the type of terrain and forest encountered as well as the availability of water among other natural features [Hamilton and McLaughlin, 1981].

The land surveyors' impact on social organization during the settlement period was also quite significant. Beyond simply laying out lots, the surveyors' design and subsequent modification of survey systems were a response to the settlers' requirements. In Ontario, for instance, the introduction of the double-front township system was a response to the shortcomings of the single-front system. In the latter , the settlers only occupied one side of the road allowance. The former provided that settlers occupy both sides of the road allowance, effectively doubling the work force for road construction and maintenance. Occupancy of the front of the lot encouraged the leaving of a forest windbreak at the rear, which was needed to protect crops from wind damage. The new system also facilitated the establishment of schools and churches as a result of creating more densely populated areas [Hietala, 1977]. Further modifications to the township systems in Ontario reflected the need to accommodate topography and minimize initial surveying costs as well as subsequent administrative costs [Sebert, 1980].

With settlement being a priority, the creation of the survey fabric and the maintenance of land tenure information were indispensable activities. The collection and maintenance of other land related information used to assess the suitability of land for settlement and other purposes were equally important to the process. These being the functions of the land surveyor, they warranted supervision from the highest political level. The position of Surveyor General, reporting directly to the colonial Governor, is not only a recognition of the importance of his functions, but an attestation to the preponderant status of the profession's predecessors.

The status of the profession during this period was linked with its powers in the land management process. The primary source of power did not come from the ability to make

decisions, but rather the authority to implement decisions. The Surveyor General was in effect a land manager with the responsibility of granting land [Hamilton and McLaughlin, 1981]. With the authority to control land use and distribution, the Surveyor General and the profession as a whole held a great deal of power that brought with it a certain status. Unfortunately, that authority soon waned, as did the status.

It has been argued that, as more and more land was settled, the land surveyors' status diminished. Hamilton and McLaughlin [1981] suggest that once the settlers had located and occupied their land there was no longer any need for more land information. At the time, the administrative attitude toward the land was that once it had been alienated from the state, the state was no longer concerned with surveys. This 'laissez-faire' attitude was a reaction against the over-administered, over-regulated European feudal land tenure system that had motivated emigration in the first instance. The result that accompanied a reduction in the availability of land for settlers was a Surveyor General's Office that had diminished in size and relevance. The surveying profession in general suffered the same fate [Hamilton and McLaughlin, 1981].

While this change had a detrimental effect on the status of surveying, it was not the sole cause of the profession's fate. Roberts [1981] provides additional insight, attributing some deficiencies during this period to regional and economic trends. In the eastern provinces, the profession was crippled by railroad construction. Railway engineering took the best and brightest surveyors to plan and execute massive railway projects. The middle majority of surveyors became involved in railroad right-of-way surveys, including tangent and curve layout as well cut and fill estimations. As the railway opened up the West, new settlers, including farmers from the Eastern provinces, moved to take advantage of large land grants. The result was a collapse of land values in the East, to the point where the remaining surveyors had little economic incentive to justify professionalism [Roberts, 1981].

Education during this period had a profound effect on the surveying profession. Civil engineering courses offered at the university level were mainly surveying related. Accompanying the railway boom, however, was a shrinking presence of surveying content in the engineering schools as the need for bridges and structures shifted the curriculum content. The beginning of the twentieth century saw the growth of electrical and mechanical engineering schools to the detriment of the surveying profession. By this time, surveying education had taken a back seat to the emerging professions [Roberts, 1981].

The introduction of the automobile near the turn of the century had an important impact on society and the profession over the next several decades. The development of road networks led to a migration of people from their rural settings to the cities. The period following World War II saw a growing population fueled by returning soldiers and an influx of immigrants from war-torn Europe. The concomitant demand for housing provided the rebirth of the surveying profession [Roberts, 1981].

2.1.4 Subdivision

The massive housing requirements that characterized post World War II society provided the surveying profession with a number of opportunities. The amount of surveying required for subdividing land, for setting out houses and laying out roads and infrastructure was enough to give the surveyor an economic basis on which to reestablish the profession. According to Roberts [1981] this was a period of relative affluence which afforded the surveyor an opportunity to begin setting standards to effect a growing sense of professionalism.

The affluence that accompanied the surveyors' involvement in the subdivision process did not come without a price. According to Hannigan [1990] the onslaught of burgeoning technology in the mid-twentieth century caused surveyors to suffer a confusion of image and role in society. The role of the professional became associated with technology, and

the maintenance of that image required the professional to occupy a place at the leading edge of technology. For surveyors, the only way to keep pace was to reduce their breadth of field. Specialization was the obvious course of action.

Land surveyors, in an attempt to meet society's need for housing, chose to narrow the focus of the profession's attention to boundary demarcation and retracement, and topographic mapping; two integral activities of the subdivision process. Reference to the latter as the 'bread and butter' of surveying is an indication of the profession's primary focus. These specialized activities were no longer viewed under the umbrella of land and resource management, but rather as processes of the narrower land development paradigm. The result was a profession that concentrated its efforts on the search for higher measurement accuracy, by placing the emphasis on the tools and techniques [Hannigan, 1990]. The fact that land surveyors in general, had become, and continue to be, inextricably associated with the transit and tripod is partly attributable to those efforts.

2.1.4.1 Specialization

The post World War II period is characterized by an increasing depth of knowledge in many, if not all, disciplines. The popular and perhaps only strategy for dealing with this overabundance of knowledge has been specialization. Two different types of specialization exist.

In his writings on the subject of the division of labour, Friedmann [1961] makes the distinction between a specialist and a specialized worker. The specialist is an individual whose sphere of activity, based upon a previous professional training, is reduced to a point which is the prolongation and crown of that training. On the other hand, the specialized worker "carries out a fragmentary job ... without having received, or usually receiving later, any general training such as would form a background explaining or illuminating his unit of work by connecting it with the whole process" [Friedmann, 1961, p. 88].

It would seem that one of the attributes that distinguishes the specialist from others is the knowledge and understanding of the bigger picture. This includes working toward the common goals as elucidated by the bigger picture. Although many individuals would classify themselves as specialists by virtue of training and experience, their connection to and knowledge of the broader perspective may indicate otherwise. While surveying is the focus of this research, much can be learned from the experiences of other professions.

An examination of specialization within the field of home economics offers some insight into this issue. The field of home economics has yielded the specialized areas of dietetics, interior design and retailing. This development can be attributed to three factors. This field is dominated by women who have become increasingly interested in careers as opposed to the traditional homemaking role. The competition for students has led to an emphasis on career development within the university programs in order to attract these students. Lastly, the emphasis on research activity in higher education requires researchers, generally at the Ph.D. level, with specialized interests and training [Butler et al., 1987].

At issue is the ability of home economics programs to continue to fulfill their original mandate. The traditional mission is to improve family well being. Over the last several years, home economics in the university setting has been viewed as a collection of specialized programs designed to prepare professionals for specific career opportunities. The result, however, has been the weakening of the link between specialists and the overall goal of improving family well being [Butler et al., 1987].

Two alternatives are readily apparent. The first is to redefine the overall mission. Fortunately, more than sixty percent of those surveyed by Butler et al. [1987] , including both specialists and generalists, believe in the validity of the mission, which brings about the second alternative: the search for new ways of fulfilling the mission. It was suggested

that energies be focussed on creatively designing the curriculum of specialized programs to incorporate the mission and philosophy of home economics [Butler et al., 1987].

Differentiating the specialist from the specialized worker is no trivial task. The growing knowledge base in all disciplines coupled with technological advances and the accelerating rate of change of both, will likely make that distinction more elusive. One of the manifestations of the specialization paradigm, from a professional point of view, is the presence of individual specialists with a narrow view of their role in society; individuals who pursue and promote their interests often to the detriment of the wider cause. In some instances, professionals become technologists, pursuing technology for technology's sake. It should come as no surprise then, that society has lost confidence in professionals as the latter seem to place their aspirations ahead of those of society, contrary to their primary mandate [Hannigan, 1990].

2.1.4.2 Specialization and Land Surveying

From the land development perspective, land surveyors are indeed specialists. From the land management perspective, however, classification as a specialized worker may be more appropriate, as our connection with a sense of the bigger picture is at best tenuous. As a result of emphasizing the tools and techniques used for measurement, the profession has lost sight of its original mandate. Land surveyors, in previous periods, were overseers of the land, with land and its management as their primary goal. Today we are land measurers; a much narrower perspective that permits only an insular view of the land. As the land development paradigm has provided the profession's rebirth, it is generally from this perspective that surveyors view the land – something to be developed.

It has been argued that specializing in land development had the effect of severing the profession's responsibility for stewardship of the land [Ballantyne, 1990]. The degree to which the concept of land stewardship was embraced by the surveying profession, prior to

the aforementioned subdivision period, is uncertain; the fact that land stewardship was abdicated by the profession during the subdivision period is unquestioned. Being characterized as the land developer's 'yes-man' is by no means a flattering depiction of the land surveyor. It is, however, an indication of where the profession's loyalty lies. Had there been a sense of stewardship within the surveying community, throughout this period, land development today might be viewed in a much different light.

While the allegiance to land development has been financially rewarding for the profession, it could be argued that it came at the expense of professionalism. By opting for the economic rewards available in the development process, the land surveyors placed their aspirations ahead of their societal duty. The resulting distrust of the profession by the public is therefore not surprising. Of particular concern, however, is the public's diminishing acceptance of land development in its present form. The profession's inability to respond to those concerns is related to specialization – the narrow land development perspective.

Specialists and specialized workers make important contributions to society, in their own particular way. Society, however, expects and deserves a surveying profession that is more than simply a collection of specialized workers. When their view of the bigger picture becomes blurred by the tools and techniques, specialists take on the character of the specialized worker, whose motivation, actions and responses differ greatly from those expected of a true specialist. From an educational perspective, the challenge is to find creative ways of incorporating a sense of the bigger picture into the specialist's curriculum.

2.1.5 Summary

This brief historical review has demonstrated the role of surveyors over time, working initially under the broad mandate of land and resource management, and then narrowing the focus to the land development business. The common thread that links surveyors

throughout history is their involvement in the creation and maintenance of the cadastre, and their provision of land information to those sectors of society creating a demand.

History has also shown that our predecessors played important roles in society; at various times gaining unmeasured status and respect for their contributions. Needless to say, a large part of that status came from their participation in the decision making process; the power to make decisions, and the power to implement decisions. Attaining these positions in society was the result of a number of factors including: contributions from a wide perspective as in the case of Samuel de Champlain; the spirit of innovation and the insatiable curiosity that spurred the exploration of the unknown; and the ability to respond to society's needs.

Whereas the profession had attained a certain status during the settlement period, it soon waned under pressure from circumstances seemingly beyond its control, not the least of which was the diminishing supply of land for settlement. The railway that brought with it a decreasing land value in the East, also took from the profession its best and brightest individuals, offering them challenges that would satisfy their curiosity and spirit of innovation. Whether the diminished status was due to a lack of foresight or an inability to adapt to these changes, remains unknown.

It was suggested that the post World War II emphasis on land development, while providing a rebirth for the profession, led to a preoccupation with measurement and technology which detracted from its duty to society. By narrowing the focus, the land surveyor had become a mere specialized worker from the land management perspective. As a consequence, the profession lost sight of its stewardship role in pursuit of economic rewards, and placed its aspirations ahead of its duty to society. Understandably, the surveyors' professional image has come under scrutiny from the public.

2.2 The Professional Surveyor

While today land surveyors perform a number of tasks including topographic, hydrographic, engineering, and control surveys, their recognition as professionals is generally related to the duties performed in cadastral or boundary surveys. In relation to boundaries, the land surveyor's role is twofold: the creation of new evidence as in the marking of boundaries in a new subdivision and the interpretation of old evidence in the retracement of original boundaries [Lambden and de Rijcke, 1989]. In the latter situation, the surveyor re-monuments the old boundaries for the benefit of future generations. In other words, the surveyor is "working to preserve and perpetuate the survey fabric which contributes to the identification of individual land parcels" [Allred, 1989, p. 472]. This is the primary public duty for which surveyors are responsible.

2.2.1 The Legislated Professional

In Canada, the land surveyor is a recognized professional through statutes of the provincial legislatures. There are in fact eleven separate statutes governing the professional affairs of land surveyors; one for each of the ten provinces and one at the federal level. The statutes call for the creation of private organizations made up of members of the profession, which are given the responsibility of governing the profession. The statutes confer the power of licensure, and the authority to set standards, to adopt a code of ethics, to maintain competency within the profession and to discipline practitioners [Allred, 1989]. Whether it is inferred or explicitly stated, the statutes confer upon the profession the exclusive right to practice cadastral surveying [Allred, 1989].

The right to self-government and the exclusive right to practice in the field cadastral surveys are privileges granted by the legislatures. The responsibility that accompanies those privileges is the duty to serve the public interest. In providing opinions on boundaries, the land surveyor has a judicial position, acting as both judge and jury. One

indispensable element of that judicial position is the requirement for impartiality when re-establishing a boundary.

A boundary is the division between two legal estates; usually held by the client and the neighbour. The surveyor's duty is to respect the rights of both parties. To act in favour of the client may result in abrogating the bona fide rights of the neighbour. Preventing this type of conflict is the justification for impartiality. In a wider context, the combination of gathering evidence, through the use of technical knowledge, and weighing evidence, through the application of the law, is what distinguishes the surveyor from a technician and establishes the professional status [Hallman, 1973].

Few would argue over the ability of the profession to fulfill its legislated mandate. Given the number of Canadian legal decisions, land surveyors have had few decisions set aside by the judiciary [Wittman, 1982]. The effect of that contribution to society is immeasurable. Although rarely enunciated, a functional and stable land tenure system is a fundamental element of modern Western economies. Land surveyors contribute to the stability of society by preventing the unskilled from marking boundaries that may encroach on the bona fide rights of others [Brown, 1961], and by participating in the creation and maintenance of a reliable record keeping system, the cadastre, to prevent conflict [Dale, 1976].

If the surveyors' contribution to society is as fundamental as discussed above, why then do members of the profession and the public at large continue to question the profession's status?

2.2.2 Professionalism

Over the last several decades, as witnessed in the journals of all the North American surveying societies, organizations and associations, one of the most common topics of discussion has been that of professionalism. Whether or not the land surveyor is indeed a

true professional continues to be argued today. Most authors agree, however, that legislation and licensing of land surveyors does not alone make a professional. Brown [1961] claims that in a narrow sense, and from a historical perspective, there are only three professions: theology; law; and medicine. In our desire to attain the status of these learned professions, land surveyors must approach the attributes of a profession, which according to Brown [1961] are:

1. Superior education in a field of knowledge.
2. Service to the public.
3. Independent judgement and liability as a result of that judgement.
4. Code of Ethics.
5. Providing services to those unable to pay.
6. If fees are charged to those able to pay, fees are dependent upon knowledge rather than labour or product.
7. The possibility of gaining highest eminence without necessarily earning much money.

One might question the desirability of such a comparison, as the intervening period since Brown's article has witnessed much change in these professions. Their status in the community has been adversely affected by scandals in the church, by a drastic increase in litigation, and by a very costly health care system, among other factors. The comparison, however, is based on the consummate nature of their character. Prior to the comparison, then, the reader should be aware that a contrast with perfection will serve to highlight the surveyors' deficiencies.

It is interesting to note that there is no mention of legislation or state sanctioned monopoly over a particular field of activity. It is clear that professional status goes well beyond the legislated mandate. For the moment, items 1, 2, 3 and 4 are self explanatory. Item 5, however, seems to contradict good business practices. Brown [1961] points out

that doctors are obligated to tend to the sick regardless of their ability to pay; that the clergy is always there for those in trouble; and that lawyers defend criminals, even those unable to pay for the service. While the state often provides the medical and legal services for those unable to pay, the fact is that the need for land surveying services will never attain the same degree of necessity. On this point then, it is unlikely that a comparison can be made between the surveying profession and the three original professions.

Charging fees based on knowledge rather than labour or product is one of the distinguishing features of a professional. Brown [1961] believes the knowledge gained through education and experience is the basis on which demand is created, and fees are charged, for services. Competing on the basis of lowest cost or lowest bid is one of the reasons that surveyors have found their professional status to be so elusive. When services are provided based on the lowest price, the profession is reduced to a business. Whereas money is not a defining element of a profession, it is important to convey to the public the ability to successfully manage one's financial affairs. Outward appearances form a part of an overall picture – that of a professional. Those surveyors using antiquated instruments and operating from the backroom of a dwelling contribute little to the profession's standing in society [Brown, 1961]. In this instance, both the professional standing and business abilities are suspect.

Perhaps one of the least considered elements of that outward appearance is the survey technician, who is in many instances the surveyor's representative to the public. It is, to a large degree, the survey technicians on the roadside and on the construction site that convey the profession's image. The general public, from whom surveyors seek recognition as professionals, has little if any contact with the professional in the office. It is imperative then that survey technicians are treated in a professional manner, and that they in turn treat the public with the same respect.

Item 7, the possibility of gaining highest eminence without necessarily earning much money, can be manifested in a number of situations including: involvement in community affairs and voluntary or charitable organizations; service on professional committees; writing articles for the profession's publication; aiding the profession by articling students for licensing; and advancing awareness of the profession by public speaking; to name a few.

It is clear that as a collective, the surveying profession does not measure up to all those attributes of the three original professions. Storr [1980] believes that too much emphasis has been placed on the attainment of status, when the true concern is whether professionals are in fact professional. That determination can only be done on an individual basis. Many authors agree that professional status must be earned. Any single individual can attain the highest eminence as a professional by pushing his knowledge, behaviour, conduct and ethics to the forefront, and by serving the public well. The unfortunate repercussion is that those individuals that attain that status often distance themselves from their profession to avoid being tarred by the same brush [Brown, 1961].

2.2.3 Engineering and the Duty to Society

One of the unique elements of surveying education within Canada, is the marrying of two professions under the theme of Surveying Engineering. These programs, currently offered at the University of New Brunswick and at the University of Calgary, provide the necessary training for students to go on to be licensed as both registered land surveyors and as professional engineers. Having already discussed the role of the land surveyor in previous sections, it is appropriate and necessary to explore the role of the engineer in society, as a number of land surveyors are also licensed as professional engineers.

The distinction between science and engineering is an appropriate point of beginning. In general, scientists are primarily concerned with discovering, understanding and

codifying the phenomena of the physical world. The result of their efforts is new knowledge made available in published papers. While engineers also study the natural phenomena and create new knowledge, in general, their objective is to apply that knowledge for social benefit [Black, 1976]. As a group, engineers have been given the primary responsibility for the interpretation of technology. This involves the design, installation and support of the technical infrastructure upon which our modern society functions [Hyde and McLean, 1992].

In section 2.2.2, one of the seven attributes of a profession was listed as service to the public. Hyde and McLean [1992] depict the engineer as the intermediary between the physical world or natural environment and society as a whole. In this capacity, the engineer has worked to adapt the environment, initially for human survival, and later for human comfort and convenience. The same authors, however, challenge the engineers' inherent ability to act as mediators between the natural environment and society, and hence their capacity to serve the public.

In their research paper *Alienated Engineers: Part of the Problem*, Hyde and McLean [1992] put forward the thesis that engineers are alienated from both the society that they serve and the environment that they manipulate, and as such have only a limited capacity to fulfill their mandate; to mediate the complex relationship between humans and nature. An overview of their work follows. Additional information is also taken from Hyde [1992].

2.2.3.1 Ties to Society

The relationship between the engineer and society is affected by three interlocking "tight circles": recruitment; education; and the workplace. Studies have shown that students recruited into engineering programs have chosen that particular career path firstly because of an interest in math and science, and secondly because of the career and financial possibilities. Those same individuals ranked the advice of parents as seventh, and the

support of friends as tenth, in the list of factors that motivated their career choice. This suggests that students are strongly motivated by intellectual and material pursuits, and detached somewhat from the influence of family and friends.

A study of U.S. engineering students showed that the majority were recruited from "small town" America, where becoming an engineer was an advance over the social position of their fathers. Whereas these students demonstrated high ability in general aptitude examinations, they were coming from an environment where college attendance was not the norm [Eichhorn, 1969]. Within the adolescent culture, then, there would be no interest in college. It follows that those who chose to attend college could not have been fully integrated into the adolescent culture. Had these students been more people-oriented, they would not have had the psychological resources to consider college and an engineering career. Their ability to move away from home and embark on a college education, once again suggests very loose ties between the individuals and their peers and family.

The second "tight circle" relates to the students' educational environment. The curriculum for one, emphasizes the elements of efficiency, reductionism, competition and discipline. These have the effect of limiting the students' ability to engage in humanities studies, which might otherwise broaden their understanding of themselves and their surroundings. The authors identify several circumstances that conspire to limit the student. Having chosen engineering as a career prior to, or during, their first year of university shows a commitment to a particular focus in their studies. Taking the time to study the humanities is a distraction from the real goal of their education, as they see it. This is reinforced by the demanding and time-consuming character of the curriculum, which emphasizes the use of time as a resource that should not be wasted. The regimented nature of the curriculum precludes the student from engaging in self-directed studies at a stage in life when many young people begin to explore fundamental philosophical issues.

Two other elements of the educational system are also significant. The structural arrangement of the engineering faculties has the effect of segregating students from other parts of the university where students and faculty are exploring questions from a much wider perspective. The other element is related to the style of student interaction with their professors. In this instance the sole focus is on problem solving; the tie that binds the student and professor. Outside the classroom setting, there is little or no social contact between the two. Again, these elements suggest a disinclination for social interaction.

In the third "tight circle" – the workplace – technology competes successfully for the engineers' attention. Under certain circumstances, the engineer is depicted as having to make a choice between a fulfilling professional relationship with technology and a fulfilling family life. While individuals in every occupation are faced with the dilemma between career and family, for engineers, there is a particular phenomenon that goes beyond the typical dilemma. The phenomenon of technological virtuosity is a compulsion which motivates some people in their interaction with technology or technique. This love of challenging technological problems is often so powerful that it can cause individuals to forgo moral reflection on the social implications of the work they undertake. The following quote demonstrates the nature of the phenomenon:

> When I asked Lockheed missile ballistics programmer Fred about the political implications of his job, he responded 'I enjoy what I do very much. When you get into the political aspects of the thing, well, that sort of bogs me down.' Fred confides, 'I really feel that there's a lot of money being spent on things that could be better spent elsewhere. Like we're making these big nasty missiles, and everyone hopes that they'll never be used. It just seems that they could build bridges, help people someplace else.' At the same time Fred acknowledges that at work, 'We don't talk much about that kind of thing. I think the people around me feel the same way.' [Hayes, 1989, p. 150]

In the workplace, engineers govern their own actions by virtue of the disciplinary process. The process, however, is motivated by the engineers' understanding and

interpretation of the public good. The great majority of disciplinary actions involve the civil and structural engineering specialties, although they comprise much less than half of the professional membership. It is argued that the nature of the work performed by these specialties is so publicly visible that errors are easily detected. The work performed by many of the remaining professionals, however, becomes incorporated into the social fabric to such an extent that public scrutiny is virtually impossible. The onus, then, falls on the engineers to scrutinize the work of their peers in relation to their interpretation of the public good.

The fact that so few disciplinary actions occur on this basis can be attributed to at least two factors. While the possibility exists that very few mistakes are being made by these engineers, a more likely explanation is the engineers' understanding of the public good. Having limited social ties may cause a distortion of the engineers' interpretation of the public good in relation to the general public's interpretation. The other factor relates to technological virtuosity. Challenging the work of peers on the basis of the public good may result in loss of employment. That may translate into a loss of material possessions, and more importantly, the loss of opportunity to interact with technology.

2.2.3.2 Ties to the Environment

From the studies reviewed by Hyde and McLean [1992] there emerged a profile of individuals entering the science and engineering disciplines. In general, these individuals show a preference for mechanical, scientific and quantitative activities over aesthetic pursuits. They prefer dealing with objects rather than humans, and have a propensity for order and stability. These are the same characteristics used to describe "thing specialists", one of four personality types used to classify attitudes toward the ecology. As expected, "thing specialists" exhibit the least amount of concern about the ecology [Gray, 1985].

This suggests that engineers, in addition to having loose ties with humans, are also detached from the environment.

Hyde and McLean [1992] believe that these "tight circles" must be broken in order for the profession to be more responsive to both the society that it serves and the environment that it manipulates. The place to begin addressing these problems is the educational system which, according to the authors requires a complete revamping. A new curriculum should be designed which would eradicate the problems noted above, namely: separation of engineering from the social context; separation of engineering from the environmental context; preference for technological challenge over human interaction; and overdependence on quantification.

Although this characterization of engineers has been presented without the benefit of opposing viewpoints, it has served to raise the awareness of important issues whose implications reach far beyond the engineering disciplines. Perhaps the most significant aspect of Hyde and McLean's [1992] research is that it demands personal reflection and challenges each reader to assess its validity.

2.2.4 Land Surveying and the Duty to the Public

As highlighted earlier, one of the important elements that distinguishes the professional from others, is service in the public interest. It was shown that the land surveyor's duty to the public comes from the judicial position in boundary retracement and demarcation. The value to society of such a service is truly immeasurable. From the public's point of view, however, that is only a limited conception of what is expected from the profession. The privilege of self-governance is accompanied by a responsibility to the public; a responsibility which is defined and enforced by the profession. As pointed out in the previous section, our recruitment, education and working environments have conspired to limit our understanding of what is meant by the public good. As a consequence, our self-

defined duty to society is quite narrow in its scope. Had the public defined our societal duty, it would likely have encompassed a much broader mandate.

There are thus two somewhat related causal factors that have impaired the surveying profession from truly serving the public interest. The first, as noted above, is the detachment from the social context as explained by Hyde and McLean [1992]. The second factor is related to the profession's specialization under the land development paradigm, where the focus shifted away from the land and was redirected toward technology.

Developing a response to remedy this situation is necessary for two reasons. First and foremost, as a profession, it is our duty to serve the public interest. The second reason is related to the continuing viability of the profession. The land development that so propitiously regenerated the profession may, if the allegiance continues, be the surveyors' death knell. The nature of land development has changed a great deal over the decades, and its intensity will likely never reach the levels attained during previous boom cycles. Although the state of the economy is certainly a factor, an even stronger contributor is the growing concern for the state of the natural environment.

2.3 The Natural Environment

The issues discussed thus far have dealt primarily with the profession, its strengths and weaknesses, and how it has changed over time. An examination of past and present circumstances has revealed a surveying profession whose narrow focus in recent times has lead to an overdependence on the land development paradigm. While the concept of land development is by no means sinister, if it is pursued without regard for stewardship, the resulting effects on the environment can be devastating. Although agreement on the level of degradation will likely never be reached, there is evidence to suggest that societal concern over the state of our natural environment will continue to grow. The following

section offers a rationalization of the profession's current specialization and an explanation, in political terms, of the inevitable growth of the environmental movement.

2.3.1 The Political Framework of Environmentalism

The profession's dependence on the land development paradigm over the last several decades may be explained in terms of the political and social agenda that characterized this period. O'Riordan [1981] argues that there is a hierarchy of goals, and that resources tend to be expended on those goals which have been given priority. As a nation matures, the higher priority goals become fulfilled, which then frees up resources for dealing with lower priority goals. A ranking of national objectives is shown in Figure 2.1.

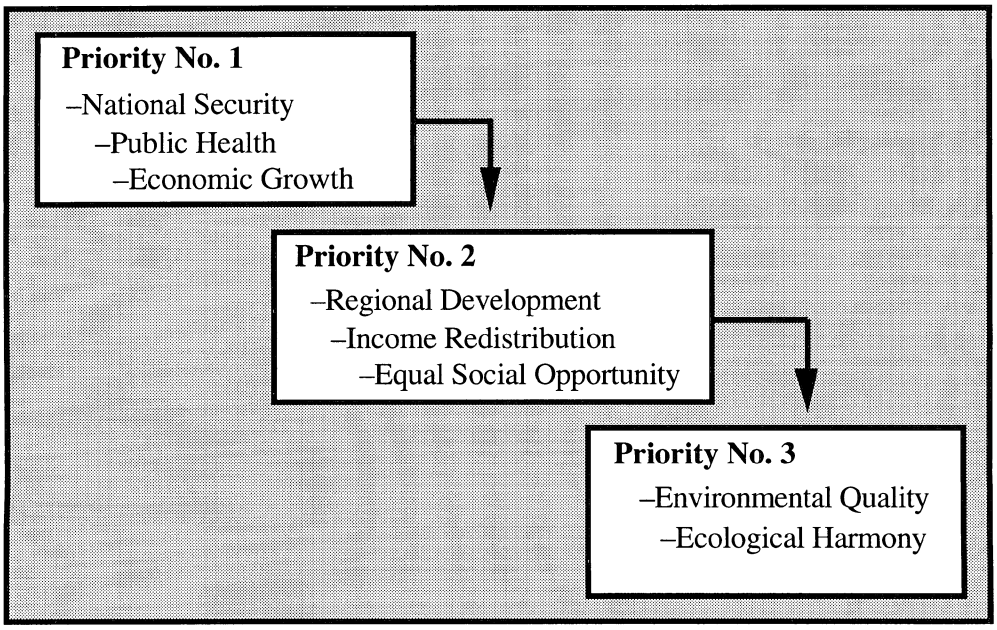

Figure 2.1: The Hierarchy of National Goals (after O'Riordan, 1981)

O'Riordan [1981] provides a detailed examination of the goals listed in Figure 2.1 [pp. 19 –27]. What is significant from his analysis is the observation that "if threatened, those goals found higher and to the left in the diagram displace those lower and to the right, in the

sense that resources would be removed from the latter to protect the former" [p. 19]. A militarily vulnerable nation, for instance, is not likely to concentrate its resources on the establishment of social reforms [O'Riordan , 1981], let alone the protection of ecologically sensitive areas.

The political priorities for a post-World War II Canada are plainly visible in the above figure. National security was a major issue with the onslaught of the Cold War. Economic growth and employment were also major issues, as they continue to be today. That growth required, and was accompanied by, development in its many forms. Land development was one of the means by which the surveying profession contributed to this national objective. It is also worth noting that the profession's involvement in the surveying and mapping of Canada's landmass was an integral part of the national security objective.

If one examines the top ranking objectives in the context of our current situation, a shift in priorities becomes apparent. For instance, the end of the Cold War has diminished the threat to national security. While health care is becoming increasingly expensive, Canadians overall enjoy relatively good health. And although Canadians have amassed a large public debt, the economy itself is relatively stable, when compared to less wealthy or developed countries. While these objectives will remain top priorities, their stability has unfettered resources for accomplishing lower ranking objectives.

In terms of the second ranking priorities, Canada has, for some time, dedicated resources to regional development through, for instance, the Atlantic Canada Opportunities Agency and its predecessors. The Human Rights Act and 'equal pay for equal work' legislation are but a few of the examples of efforts to establish social equality. As Canadians work toward the realization of these goals, more and more resources become freed for lower ranking objectives. It follows then that the third ranking objective, namely

the state of environmental quality, will be commanding the attention not afforded to it earlier.

The introduction of Canada's *Green Plan* in 1990 is a significant indication of the level of concern about the ongoing deterioration of our natural environment. It is also an indication of a shift in national priorities. This federal government initiative outlines policies, programs and standards whose goals will be to clean, protect and enhance Canada's land, water and air, renewable resources, the Arctic, parks, and wildlife. Among its many objectives is the promotion of sustainable development [Canada, Environment, 1990]. This objective is particularly relevant to the surveying profession.

The introduction of sustainability will have the effect of constraining future development activities. This, in turn, will limit the business opportunities for the profession that has become overdependent on land development. Given that land development is often viewed unfavourably in relation to environmental concerns, it behooves the surveying profession to respond. The formulation of a response, however, should be based on an understanding of the fundamental issues surrounding the environmental debate.

2.3.2 The Environmental Debate

In the not too distant past, the environmental movement was viewed as a handful of fringe radicals rebelling against large corporations. Charges that the latter were polluting the air and water fell on the deaf ears of a population that was busy consuming the products that caused the pollution. More recently, however, the general public has responded, to varying degrees, to the concerns enunciated by those fringe groups. In general, the public agrees that there is a problem with the state of our environment. The disagreement arises in identifying the nature of the response. There are two philosophies which have widely

differing views of the root of the problem, and the subsequent remedies. The ecocentric mode and the technocentric mode are ideologies representing opposite ends of a continuum.

2.3.2.1 The Ecocentric Mode

In the book *Environmentalism*, O'Riordan [1981] discusses the ecocentric ideology. Those subscribing to this mode believe that all things operate according to natural law, and that nature maintains them in a delicate balance – a natural order. The intervention by man, however, has seriously disrupted that natural order, essentially breaking the web of life. If left to continue on this degenerative path, the ecocentrics believe it will lead to the destruction of mankind. As a part of their philosophy, ecocentrics preach the virtues of reverence, humility, responsibility and care, and recognize the environmental limits of human activity [O'Riordan, 1981].

2.3.2.2 The Technocentric Mode

O'Riordan [1981] also discusses the technocentric mode and outlines their belief system. The technocentrics view the environment and its constituent elements as resources to be used in the pursuit of human objectives. That pursuit involves the application of rational, value-free, objective scientific techniques by a professional elite of managerial specialists. With an emphasis on management, manipulation and control this particular philosophy clearly adheres to the concept of man's supremacy over nature. This is in sharp contrast to the ecocentric view of the centrality of natural law, where man's sense of dominance over nature is replaced by reverence toward nature. For this reason, most ecocentrics do not consider technocentrics to be environmentalists.

Most individuals involved in the debate can generally be classified somewhere along the continuum between these two perspectives. Based on the nature of land surveying education, it would not be surprising to find that a majority within the profession subscribe to the technocentric mode of viewing the environment. A brief historical review of modern

Western philosophy may enlighten the reader as to the origin of our present day perspective.

2.3.2.3 Philosophical Origin of Modern Science

The development of science, in modern Western society, is based on a mechanistic view of the world, where the qualities of reductionism and dualism prevail. The origin of this philosophy has been attributed to individuals such as Francis Bacon (1561 – 1626) and René Descartes (1596 – 1650). Deemed the Baconian–Cartesian position or attitude, it is viewed by many environmentalists as the root cause of present environmental mismanagement and disruption [O'Sullivan, 1986].

At the heart of their philosophy is the aspiration for man to become both the master and possessor of nature. The Baconian–Cartesian position advocated the use and development of scientific knowledge to reach that end. The term dualism is used to describe the separateness of man and nature and the subsequent dominance of man over nature. The mechanistic view comes from Descartes' idea that the universe is similar to a clock–like mechanism, which could be understood by examining its constituent parts. From this idea came the reductionist paradigm, whereby smaller and smaller areas of subject matter are studied in greater and greater detail [O'Sullivan, 1986].

2.3.2.4 The Failure of Reductionism

The problem with the reductionist paradigm in relation to environmental management is the assumption that the various scientific disciplines can discover and understand the properties of a complex system – one composed of interacting parts – by studying the properties of the separate parts. While physics, chemistry and biology have made tremendous strides in the last fifty years within their respective disciplines, the natural laws elucidated by them remain insufficient to guide us toward the solution of most environmental problems [Commoner, 1973].

An illustration of the inherent limitations of the various disciplines' ability to manage our natural environment, is given by Savory [1988]. Four colours of modelling clay: red; green; yellow; and blue, are used to represent four scientific disciplines whose task is the study and management of the natural environment. While there are in fact thousands of disciplines studying various aspects of the environment, only four are used here for simplicity. At this scale the environment is represented by the colour grey, which is arrived at by combining the four colours or disciplines above. The following scenarios highlight the inability of the disciplines (red, green, yellow, and blue) to effectively deal with the environment (grey).

Scenario 1. *Single Specialized Disciplines.* Four separate colours, each having considerable knowledge of their individual colour. Unfortunately, there is no focus on grey because they have no knowledge of grey.

Scenario 2. *Multidisciplinary Team.* The four colours are brought together , which allows some communication between the colours, although discussion amongst the colours is difficult because of different disciplinary jargon. While the team has now focussed on grey, they still have no knowledge of grey.

Scenario 3. *Interdisciplinary Team.* The four colours are brought together in teams consisting of equal parts of red, green, yellow and blue, which signifies that each colour now has perfect knowledge of the three remaining team colours. This has created perfect communication and understanding amongst the colours in addition to the focus on grey, but once again, there has been no creation of knowledge about grey.

Although each scenario is problematic, the common dilemma is a lack of knowledge and understanding of the environment itself. The remedy, as elucidated by a number of authors [Commoner, 1973; O'Sullivan, 1986; Savory, 1988] is the adoption of a new

paradigm, one which embraces the concept of holism. Gaining an understanding of the whole, requires a shift in focus away from the detail of the individual parts and toward the interaction among the parts. Some authors believe this is possible only when the sciences become adisciplinary; without the artificial boundaries imposed by man, that truly do not exist in nature [Commoner, 1973; O'Sullivan, 1986].

2.3.3 Holism

Embracing the concept of holism will be no trivial task as its foundation is the antithesis of our current reductionist paradigm. Eradicating this paradigm, however, is simply not practical. The short and medium term solutions lie elsewhere. In his book, Savory [1988] developed the Holistic Resource Management Model which seemingly recognizes the prevalent nature of reductionism and simultaneously incorporates the elements of holism. Considering that Savory's [1988] book is more than 500 pages long, the following description of the Model is at best brief.

The Model stresses the need to identify the whole that is to be managed. Whether it is a farm, a watershed, a provincial park, or a national economy, each represents a whole that both comprises smaller wholes and forms part of larger wholes. This apparent dilemma is resolved by defining the wholes in terms of the four ecosystem building blocks: mineral cycle; water cycle; succession; and energy flow. From the perspective of the whole then, a comprehensive goal is formulated based on three criteria: quality of life; production; and landscape description. The desired goal is achieved by applying tools both natural and human according to a series of guidelines.

The presence of dualism – man managing nature using tools – in a holistic approach, seems to indicate that the Model falls somewhere between the ecocentric and technocentric view of the environment. By asserting that all things follow a natural order, the Model's classification would likely tend toward the ecocentric mode. The three scenarios, presented

in the previous section, that describe the limitations of the various disciplines in managing the environment, are followed by a fourth scenario using this Model.

Scenario 4. *Holistic Approach.* Surrounding the grey is a collection of various disciplines – single specialized, multidisciplinary and interdisciplinary. While in previous scenarios grey has been examined from the disciplines' perspective, the Holistic Model selects grey and looks outwardly from grey at all the knowledge available from these disciplines. Knowledge of grey is made possible by selecting it as the management whole. The goal is then formulated, and subsequently achieved by the application of tools and guidelines [Savory, 1988].

Although the Model seems simple in its conception, its implementation on any scale remains a formidable task. The selection of a management whole and the formulation of a goal require unprecedented cooperation and participation from the many groups involved in resource management, including politicians and the scientific disciplines among others. These groups are, through implicit interpretation of the three first scenarios, being held accountable for the failure of previous attempts to effectively manage various aspects of the environment. The Model's developer is in essence challenging these groups to view their work in relation to a whole, and to establish and work toward a common goal.

2.3.4 The Land Surveyor and the Environment

An examination of the environmental debate has demonstrated the widely varying perspectives through which different individuals and groups view the environment. The surveying profession's present day perspective – the technocentric mode – is a result of the prevalent nature of the reductionist and dualist paradigms. Based on the previous discussion of disciplinary scenarios, the land surveying profession may be classified as the single specialized discipline, or at best part of a multidisciplinary team, unable to focus on a management whole. Specialization under the land development paradigm has impaired the

surveyors' ability to view land as part of a greater whole, and is partly responsible for the lack of participation in the formulation of a goal.

Part of the remedy, as elucidated in previous sections, is to view the land surveyors' role from a land and resource management perspective. Identification of the whole; formulation of goals; and working toward those goals, are the activities that truly characterize a profession. Participation in the land management process can take many forms. While the first two activities are within the surveyors' purview, it is perhaps in the third activity that our profession can make the most impact.

The call for environmentally sensitive decision-making by the *Green Plan* is underlined by a need for timely and accurate information as one of the inputs into this process. The brief historical review of the surveying profession in section 2.1 highlighted the need for land information in the management of land resources. It also showed the provision of land information as one of the profession's primary missions. While that role has remained constant throughout our history, the recent specialization in land development has narrowed our concept of land information. The type of information, the audience requiring that information and their use of that information are all much different when viewed from a holistic land management perspective. The provision of land information to decision makers is thus part of our profession's contribution to arresting and reversing the degradation of the natural environment.

2.4 Distributed Information Environment

The final topic to be discussed as background to the development of a new model of the role of the land surveyor is the *Distributed Information Environment*. While such an environment does not yet truly exist, the presence of many of its components suggests that its realization is only a matter of time. Although many important issues have been raised in this chapter, none will have a more profound impact on the profession than this particular

topic. In this section a brief description of the environment will be presented along with an examination of its effect on the land surveyor.

2.4.1 Distributed Information

The proliferation of information technology has enabled everyone to create and store information in electronic form. This capability is changing the nature of many industries. In surveying and mapping, most public and private agencies are either involved in creating digital information or converting it from analog to digital form. While the degree to which this has been accomplished varies from one jurisdiction to another, the inevitable result is a series of databases of digital information held by custodians at their respective locations. Thus, one of the characteristics of this environment is a series of databases of information distributed over a geographical area. That alone, however, is insufficient.

A truly distributed information environment is one which enables the dissemination of the information amongst all the various custodians and others interested in their holdings. Although many elements are required to develop this environment, there are two fundamental components acting as enablers. Database management technology and communications technology are the critical elements that enable the effective management of information as well as the ability to share it amongst the various producers and users. If the creation of this environment was solely a technological venture, it would have been a reality by now. While technology is an enabler, many other elements must be in place.

2.4.2 Spatial Data Infrastructure

Bringing together the many elements under a single framework is likely the best strategy for developing a truly distributed information environment. One conception of that framework has been advanced by the Mapping Science Committee [1992] as the National Spatial Data Infrastructure (NSDI), which is defined as:

> The total ensemble of geographic information at our disposal that describes the arrangement and attributes of features and phenomena on the Earth, as well as the materials, technology, and people necessary to acquire, process, store, and distribute such information to meet a wide variety of needs. In its broadest sense the infrastructure also includes the cultural, environmental, economic, political, legal, and educational values and institutions that support, facilitate, and shape its character, including the forms in which spatial data are represented and utilized throughout society. [p. 16]

A portrayal of the Infrastructure in terms of its component elements, as dictated by the reductionist paradigm, may provide a better understanding of the NSDI as a whole. McLaughlin and Nichols [1991] describe the six components as:

1. Databases, Metadata, and Sources.

2. Data Networks.

3. Technology.

4. Institutional Arrangements.

5. Policies and Standards.

6. Users.

The elements of the NSDI, by themselves, have become familiar topics in recent years through the various discussions on land information systems. Their unity under the theme of Infrastructure represents the next step in the development of the distributed environment. It also serves to provide the many and disparate individuals with a sense of the bigger picture. It is only through the integration of these elements that access to the wealth of information about our land resources is possible.

Whereas the NSDI is an initiative under discussion in the United States, Canadians have played a role in its conception (e.g., McLaughlin and Nichols [1991]). At present, however, very little is being done in this area in Canada. That, however, should not prevent Canadians from embracing the concept, as the need for such an initiative is readily apparent.

2.4.3 Land Surveying in the Distributed Environment

The need for such an environment has arisen from the recognition that the information exists but that its access is hampered by a number of impediments. The value of accurate and timely information in the land management process is evident. Providing that information is, as stated earlier, one of the mandates of the surveying profession. Thus, as both a source and user of land information, the land surveyor has a vested interest in the development of the distributed information environment.

One of the manifestations of this impending environment is the growth of a new discipline – geomatics. It is defined as "the collection of those disciplines that use sensing, mensuration, computer, and communications technology to acquire and manage spatially-referenced information." [Task Force on the Status of the Geomatics Industry in Canada, 1991]. It is born of the need to integrate the various means of collecting and processing spatial data along with the means of disseminating it to the end user. While the surveying and mapping community currently represents the majority of the geomatics membership, the mission of this new discipline calls for the expertise of a host of other professionals.

Geomatics, in essence, provides a new perspective of the existing mission of the surveying profession. One difference lies in the emphasis on digital information that is integrated through the processes of collection, analysis and dissemination. There is also a recognition that the expertise required to integrate these processes comes from many disciplines. More importantly, however, is the assertion that the land surveying profession is not the exclusive source of land information. Although this may be viewed as an indication of competition for the surveying profession, the opposite is also true; geomatics allows the opportunity to build mutually beneficial relationships with individuals from other disciplines that share a common goal.

Being part of a larger whole necessitates participation, cooperation and understanding amongst its component parts. As one of the elements of the distributed information environment, land surveyors must determine how they fit into this whole.

2.5 Summary

The purpose of this chapter has been to form a foundation on which to build a model of the future role of the land surveyor. The model is to represent an evolution rather than a complete change in direction. It was shown that the land surveyor's role throughout history has been the creation and maintenance of the cadastre and the provision of land information in support of the management of land and its resources. What has changed over time, has been the context in which these functions have been performed. The context, in essence, is represented by the different periods in our history: exploration; settlement; and subdivision. Currently focussed on the latter, members of the surveying profession have become specialists under the land development paradigm. The result of this specialization has been the abandonment of the land management perspective.

An examination of specialization and professionalism has revealed a surveying profession that has emphasized tools and techniques to the detriment of a wider societal duty. By virtue of the recruitment, education and working environments, land surveyors have a very narrow view of their duty to society. By placing the focus solely on land development, surveyors have put their aspirations ahead of their societal duty, and not surprisingly the public's perception of the profession has been adversely affected.

The growing public concern for the deteriorating state of our natural environment was also discussed. A shift in national priorities is an indication of the approach of a new era; one in which land development will be constrained by calls for sustainability. There is an irony in that the allegiance broken in the middle of this century, between the surveyor and land stewardship, to regenerate the profession, must now somehow be restored if the

profession is to remain viable in the next century. The land surveyor will have a difficult but necessary task of re-incorporating land stewardship into the profession's edict.

While this new era will be characterized by concern for the natural environment, it will also witness change from technological developments. The imminent distributed information environment, caused by the proliferation of information technology, will change the way people collect and disseminate information.

The new model of the land surveyor is based on a land management perspective, where the focus is placed on land and not tools. The role, in essence, is to provide land information which will enable environmentally sensitive decision-making in the land and resource management process. Performing this function in a distributed information environment is one of the challenges facing the surveying profession. Although the tools will enable the surveyor to operate in this environment, they form only a part of the equation. In order to avoid the trappings of technological virtuosity, it is important to remember that land and its effective management is the ultimate objective of the land surveyor.

3. The Land Surveyor

In the previous chapter the dominance of the land development paradigm in the land surveying profession was discussed. It was suggested that a continued dependence on this narrow perspective would be detrimental to the profession. The objective of this chapter is to reexamine the role of the land surveyor from a land and resource management perspective. From this perspective will be derived the primary function of the surveying profession – land information management. Based on this function, a model describing the role of the land surveyor as a land information manager with access to distributed databases of land and other information will be presented and discussed.

The transition to the role of land information manager is largely dependent upon the support of a spatial data infrastructure. It will be shown that the land surveyor is both a source of land information and a user thereof, and as such is an integral part of the infrastructure. For this reason, the role of information manager requires the surveyor's participation in its development. The infrastructure components and their relationship to the land surveyor will be discussed.

Land and resource management will be described in terms of three functions, one of which is the protection function. One of the many benefits arising from the examination of land and resource management is the opportunity to assess the profession's role in society and in particular how that role meets society's requirements. The final section of this chapter will address the profession's involvement in environmental protection.

Embodied in this research is the theme of evolutionary change. One of the primary benefits of examining land management is that it offers a vantage point from which the profession can view itself in relation to the changes occuring in it. From this perspective, land surveyors have the opportunity to both react to the changing environment and to effect change within that environment.

3.1 Land and Resource Management

Land management is defined as the process of making and implementing decisions about how land and its resources are distributed, used and protected [Nichols, 1992]. It is important to recognize that the power to make and implement decisions with respect to the land rests with those who hold the property rights. They may be private individuals or corporations, or public corporations or agencies. While a landowner possesses the rights to use and dispose of property, those rights are tempered by responsibilities and restraints established through public policy. For instance, while the management of private land may be viewed as a private matter, much of it is performed within guidelines established by public policy and enforced by public institutions. The myriad requirements for public agency approval in the land development process is one indication of the extensive public sector involvement in private land management.

3.1.1 Functions and Perspectives of Land Management

As shown in Figure 3.1, land management consists of three functions: distribution; development; and protection of land resources. These functions, in turn, can be viewed from three perspectives namely: institutional; economic; and environmental. While the objective of land management is to improve the use of land and the quality of all forms of life [Dale and Fisher, 1991], a more explicit statement by Nichols [1992] with regard to a long term objective is the principle of sustainable development. This term has been defined by the World Commission on Environment and Development [1987], also referred to as the Brundtland Report, as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [p. 43].

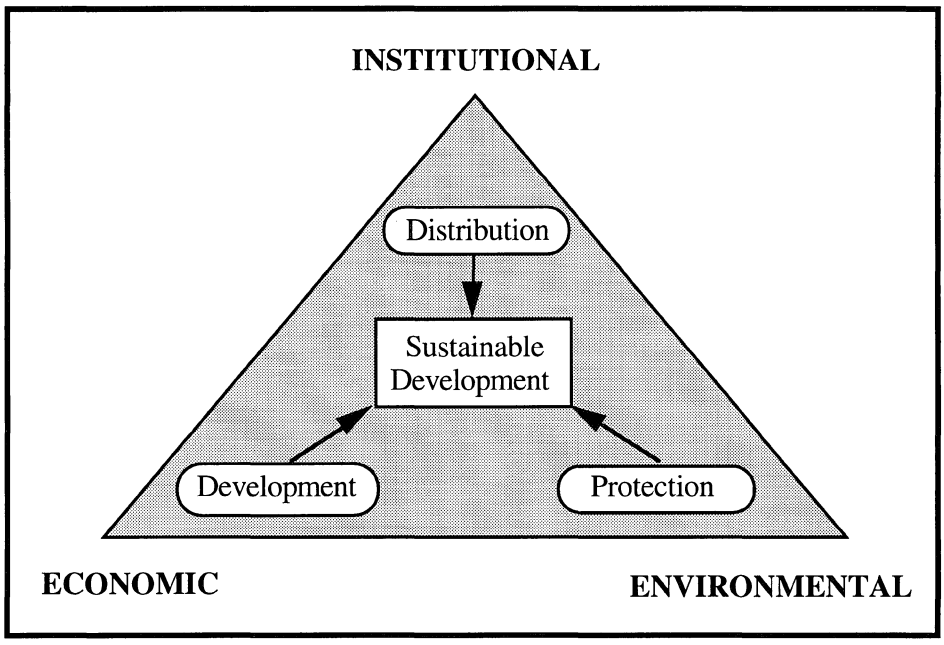

Figure 3.1: Land Management Functions from Three Perspectives (from Nichols [1992]).

Land development is generally viewed from an economic perspective, with the primary goal of creating economic wealth, which in turn allows for social development in its many forms. Land development may be undertaken for the production of food, the extraction of natural resources, the construction of housing and accompanying infrastructure, or the creation of recreational areas. In most instances, development is undertaken when the gross benefits are equal to or exceed the expected costs. Although different motivations exist, development decisions are frequently based on monetary considerations [Barlowe, 1978]. Developing land to its highest and best use such that it provides an acceptable rate of return on investment is often the primary motivation.

The distribution function is generally viewed from an institutional perspective, where the primary concern is not the land itself as in the development function, but rather the property rights that define the relationship between the owner and the land; who can do

what where. This function includes the institutional arrangements and legal mechanisms that describe the rights themselves as well as the manner in which these rights are acquired and transferred. Land registration systems, the courts, and urban and rural planning commissions are but a few of the institutions involved in the distribution function.

Both the development and distribution functions are familiar topics for the surveying profession. Surveyors, as discussed in chapter 2, have placed their primary focus on the land development process. In addition, their involvement in the land registration process has enabled a familiarity with the distribution function. The third function of land management, however, has received a disproportionately small share of the profession's attention. The goal of the protective function is to ensure that the environmental costs of land development activities are brought to bear in the land management process. This is considered necessary because the economic system has been unable to take account of environmental costs. According to the Council on Environmental Quality [1971]:

> When the full production costs are included in the prices of the final products, the market allocates resources efficiently. If, however, all costs are not included – for example, the costs to society of environmental degradation – then the resulting prices of the products are too low. When products are underpriced, consumption of them is higher than it would be if all costs were included. Consequently, compared with other products, too many resources are devoted to their production. To the extent that the costs of preventing undesirable environmental impacts are not reflected in the price of goods and services, the market fails to allocate resources efficiently, and too much waste is produced. [p. 102]

From the environmental perspective, land and its resources are integral components of ecosystems in which there exists complex relationships between the biotic, abiotic and cultural elements. The biotic features are characterized as living organisms such as crops, natural vegetation, fish, wildlife and humans. The abiotic features are those resource elements that are characterized by the absence of life such as soils, climate, water and

geology. The cultural features are resource elements characterized by the influence of human activity such as population, recreation and infrastructure [Light, 1992]. There is clearly a close relationship between the land and all three of these ecosystem building blocks. There is also a recognition of the interdependence of ecosystem elements and the detrimental effects that results from their imbalance [Savory ,1988]. The goal of the protection function in land management is therefore to ensure that a balance is maintained in the relationship between these elements.

While in theory it is easy to distinguish between the different functions and perspectives of land management, in practice they are intertwined to the extent that their demarcation becomes less pronounced. The protection of land resources, for instance, can be accomplished through the distribution function which may take the form of legislative restrictions on certain developments. Protection from an economic perspective can, for instance, be achieved by purchasing the right to pollute, whereby the environmental costs are translated into monetary terms. The adoption of less destructive practices may be achieved by gradually increasing the purchase price of these rights to the point where polluting becomes uneconomical [Nichols, 1992]. In addition, it is also possible to undertake development whose primary goal is the protection of resources such as parks and wetlands.

What is perhaps most significant is the combination of the three functions working together in the attainment of the common goal – sustainable development. Any function on its own would likely be unable to meet societal needs in either the short or long term. This is the justification for examining land development from a land management perspective.

3.1.2 Processes of Land Management

Land management can be described in terms of its stages or processes. Nichols [1992] has outlined these processes, as shown in Figure 3.2. The land management process is

applicable to all sectors, whether private, public or quasi public, and may be undertaken at any scale. Whether it involves the owner of a small parcel of land, a farmer, a municipality or a provincial government, the management process is essentially the same. Its complexity, however, will likely increase with the size and number of properties as well as with the uses to which the land will be subject.

The land management processes may be followed explicitly with well defined boundaries separating the processes, and those whose task is the execution of those processes. Land management may also be carried out in an implicit or intuitive manner by as few as a single individual. In this case the distinction between the processes would tend to become blurred. In reality, the management process would likely resemble the latter scenario as opposed to the explicitness of the former. A description of each process follows.

Monitoring: The process usually begins with monitoring the surroundings of the management unit to determine where actions and decisions are needed. It may take the form of a simple visual inspection of the land or the use of remote sensing techniques. The process may also involve gathering information from lending institutions or public or private agencies who hold records that may influence possible future actions. The monitoring process is, in theory, revisited at the end of the management process to assess the results of the operations that were undertaken [Dale and McLaughlin, 1988].

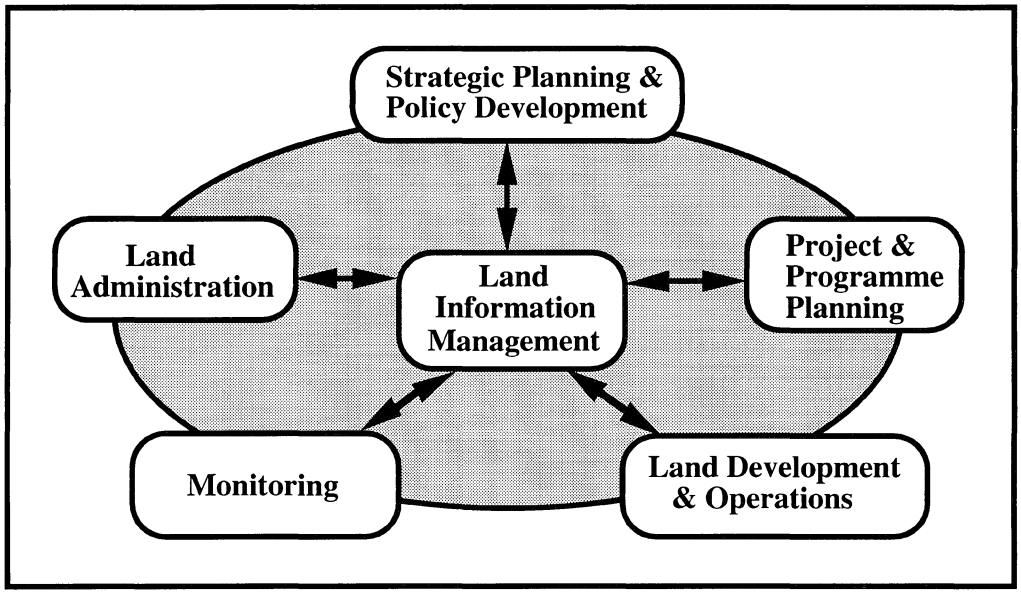

Figure 3.2: Land Management Processes (from Nichols [1992])

Strategic Planning and Policy Development: Based on the information at hand, policies are developed which outline the broad goals and acceptable procedures for attaining those goals. Strategic planning involves the identification of needs and constraints, as well as the development of alternative courses of action that will enable the fulfillment of the defined goals [Nichols, 1992]. The call for sustainable development from the federal government's *Green Plan* is one such policy objective. The use of public consultation and environmental impact studies are among some of the procedures deemed acceptable for attaining that objective. This process is also applicable to the local land owner seeking to develop a property. The overall objective, for instance, may be to maximize the rate of return of a certain fixed investment over a short period of time. This would likely preclude the development of rental properties perhaps in favour of freehold housing. The strategic planning stage would involve the assessment of need for such a development, the identification of impediments such as environmental

regulations or soil deficiencies, and of course the determination of its financial viability. The end result of this process is the selection of a particular course of action.

Project and Programme Planning: Emphasis during this stage is placed on the establishment of more detailed objectives and the organization of resources allocated for achieving those objectives. It also includes the design of evaluation criteria by which the proposed course of action may be assessed [Nichols, 1992]. In the case of the land developer this may include the preparation and tendering of contracts for services, the scheduling of the various development activities, the delineation of any new boundaries required for the development, and the securing of approval from the appropriate public agencies.

Land Development and Operations: This stage involves the execution of those activities identified in the previous stage. For the land developer, the demarcation of boundaries to represent the new lot fabric, the installation of infrastructure, and the construction of houses are some of the typical operational activities. This stage is not limited to the activities of the land developer. It may involve the coordination and mobilization of various public and private organizations to bring about an environmental strategy such as the implementation of a coastal zone management plan [Nichols, 1992].

Land Administration: This process has as its primary purpose the management of the land tenure system [Nichols, 1992]. Land tenure is defined as the rights, responsibilities and restraints people have with respect to the use and benefit of the land. It is within this process that the developer acquires the right to develop land, and through which is provided with notice concerning restraints and responsibilities. Land administration is the process by which the distribution

function of land management is accomplished, and as such is necessary for both development and protection activities.

Land Information Management: Each of the above processes is characterized as a decision-making process. As a means of minimizing uncertainty in the latter, land information is recognized as an essential ingredient. The primary goal of land information management is the provision of land information in the land management process, which in turn will, with all other things being equal, result in an improved use of land and its resources.

3.2 Land Information Management

Land information management is a field of expertise whose origin is based on the recognition that information about land is a necessary component of any effective land resource management process. It can be considered as a means to an end, whose ultimate goal is better land management. This is achieved by treating land information as a corporate resource, worthy of the same attention afforded to capital and labour. The immediate objective of land information management is to provide the decision-maker with the appropriate information, in an appropriate form, at the appropriate time in the decision-making process. Zwart [1991] describes it as "the function of providing land related information to groups of users in a form and of a type required by them to complete the task at hand" [p. 259].

One way to approach this topic is to examine land information management in terms of its three components: land; information; and management. One of the problems associated with land is the numerous perspectives with which it is viewed. Lawyers, for instance, perceive the land as property rights. A farmer may view the land as a source of production. An engineer may see the land as space on which to build, and the geologist may view it in

terms of its mineral potential. Thus an appreciation of these different perspectives is necessary as each application requires a different type and form of information.

Information has often been referred to as a resource. Its characteristics, however, differ greatly from those of a traditional material resource. When consumed, information is not destroyed. When passed on to the next consumer, information also remains with the first consumer. Unlike a bundle of goods, information cannot be divided into parts for consumption. It must be consumed as a whole [Dale and McLaughlin, 1988]. For these and other reasons, information is treated differently than other resources. The same piece of information, for instance, will have a different meaning for different consumers. Placing a value on the information will be difficult. Determining its owner may also be problematic. Allowing access to it may violate someone's privacy. These are but a few of the concerns.

Management is the art and science of making decisions in support of certain perceived objectives. The management process includes *monitoring* the environment to identify where decisions and actions are needed; *planning,* which involves the development and analysis of alternative courses of action; *policy-making,* which involves the selection of a particular course of action; *operations,* in which the selected course of action is implemented; and, further *monitoring* to evaluate the implementation. In every stage of this process information is required as one of the basic inputs for decision-making [Dale and McLaughlin, 1988].

3.2.1 The Land Surveyor and Land Information Management

The land surveyor's role, when examined from a land management perspective, falls directly within the bounds of the field of land information management. McLaughlin [1981] describes the role of the land surveyor as providing "in cooperation with allied professionals, ... the physical, social, and institutional information necessary for the

allocation, development and conservation of man's land resources" [p. 303]. It is important to recognize, however, that land information management is not the exclusive domain of the surveying profession. By its very nature, it encompasses the numerous professions and occupations concerned with the collection, analysis and dissemination of land information.

Among the many challenges facing the surveying profession is the need to view its work in terms of information provision rather than, for instance, simply an exercise in land measurement or boundary retracement. In response to the need to shift away from the old paradigm, the surveying program at Laval University in Quebec has developed a profile that defines the profession's work in terms of its basic functions rather than its component disciplines [Task Force on the Status of the Geomatics Industry in Canada, 1991]. Seven main functions have been identified: data capture; data processing; data structure and storage; data interpretation and analysis; data representation; data distribution; and data management.

Under the old paradigm, the emphasis was usually placed on the data capture and analysis functions, whereas the representation and storage of information were often considered secondary activities. From a land information management perspective, each of these functions represents a critical component of the information management process, where the neglect of one would adversely affect the entire process.

The impetus to reexamine information practices within the surveyor's office has partly been the result of the introduction of information technology, which has provided the opportunity to streamline the information management process by making possible the integration of these functions. A prerequisite to instituting the latter is the requirement to formalize the information flow procedures, as the technology is unable to cope with human

idiosyncrasies that characteristize the informal or intuitive procedures currently employed in the non-digital workplace.

3.2.2 The SURVUS Concept

It is the combination of viewing the land surveyor's role in the context of land information management, and recognizing the imminent development of a distributed information environment, that has led to conception of the SURVUS model, shown in Figure 3.3. Briefly, the SURVUS model depicts the land surveyor as an information manager operating with direct access into a network of distributed databases of land and other information. It is within this environment that the surveyor will provide information services to a wide variety of clients, who themselves have access to the network. The term "SURVUS" is not an acronym, but rather refers to the surveyors planning for themselves a role in the information services industry.

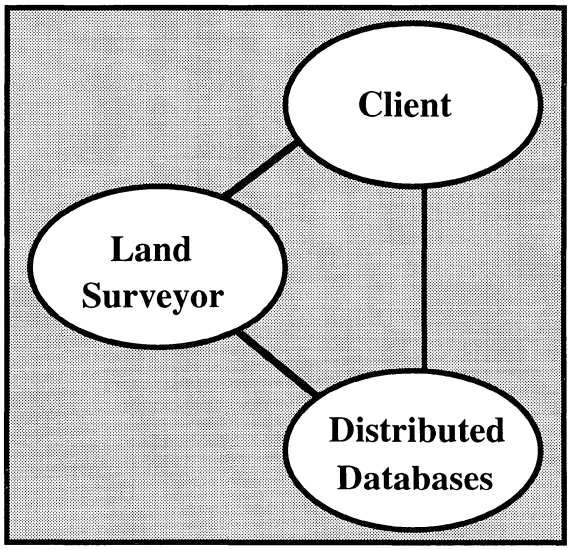

Figure 3.3: The SURVUS Model

The three elements of the model include the land surveyor, the client, and the distributed databases. The communications network is represented by the lines joining these three elements. The transformation of this model into reality is the long term objective of the SURVUS project, which was undertaken to explore the issues, constraints, and opportunities that such a model presents. For an indepth review of the SURVUS project the reader may consult Anderson and Moore [1992]. Some of the topics examined in the report include the availability of digital information, the technology trends and requirements, as well as the institutional constraints. The latter topic is addressed in greater detail in the thesis by Anderson [1992], which examines such issues as access, privacy, ownership, pricing, liability and security of land related information in the context of a distributed information environment.

The SURVUS model is the conceptualization of the role of the land surveyor in a distributed information environment. It depicts the land surveyor as both an information provider and user, whose functions are performed in the context of land information management. The primary impediment to the realization of SURVUS is the lack of infrastructure to support the functions that are proposed by the model. Thus, the logical point of beginning is a discussion of the role of the land surveyor in the development of an infrastructure.

3.3 The Land Surveyor and the Spatial Data Infrastructure

In section 2.4.2 the elements of the National Spatial Data Infrastructure (NSDI) were introduced. They include: databases, metadata, and sources; data networks; technology; institutional arrangements; policies and standards; and users [McLaughlin and Nichols, 1991]. As both a user and source of information, the land surveyor forms an integral part of the infrastructure, and thus has a vested interest in its development. Figure 3.4 illustrates the relationship between the SURVUS model and the field of land information

management, where the importance of those services offered by allied professionals is acknowledged. Figure 3.4 also illustrates the infrastructure elements and their relationship to one another.

The databases and metadata are depicted as the Distributed Databases. It is important to note that the databases may also be under the custodianship of the Land Surveyor or Other Professionals and Specialists. The data networks are represented by the straight lines joining all the various elements. The technology, institutional arrangements, and the policies and standards are all represented by the small dark rectangles at the network junctions. The users comprise the Client, the Land Surveyor, and the Other Professionals and Specialists. A more detailed description of these infrastructure elements follows.

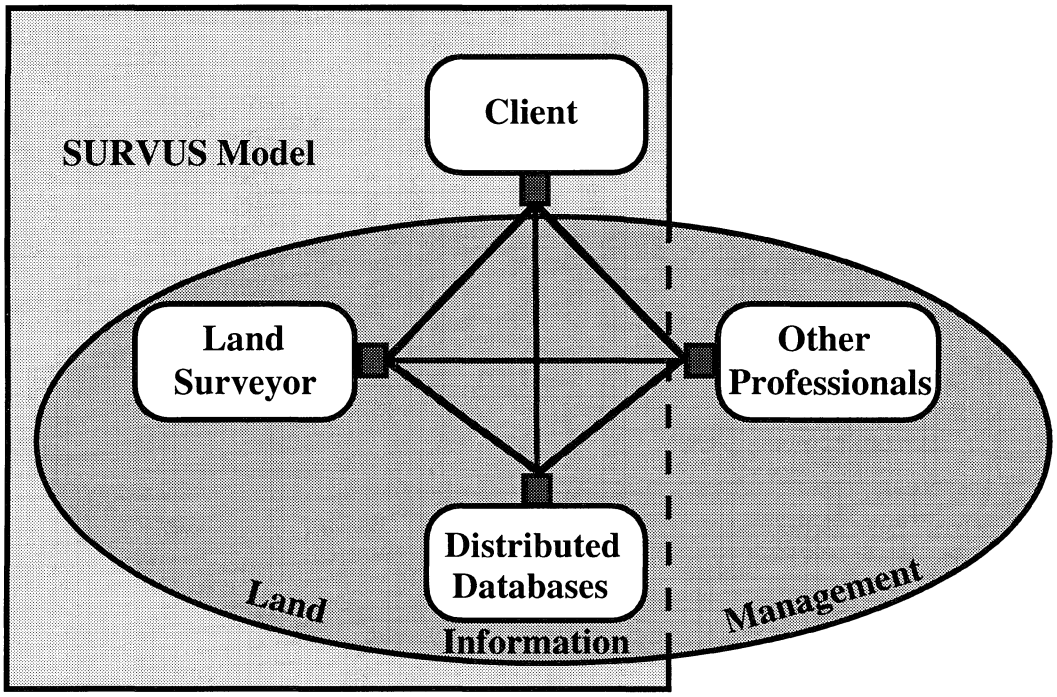

Figure 3.4: The Land Surveyor and Spatial Data Infrastructure

3.3.1 Databases and Metadata

The land surveyor in private practice has a number of valuable assets. These usually include office and field equipment and may also comprise real estate. The specialized labour force that carries out the daily tasks of the private practice also classify as assets, as does the surveyor's own expertise. The organization's other major asset is the store of information that has accumulated through the years of practice. This information has traditionally been in the form of field notes and plans, stored in a filing cabinet and accessed through a manual indexing system. Many surveyors derive income from their store of information by allowing their fellow surveyors to purchase copies of their records. The manual procedures can prove cumbersome and time consuming if an office visit is required to verify the applicability of the information being searched. This, however, does not discount the possibility that information in a digital format may also be problematic. The place to begin then is within one's own organization.

The value of one's store of information is maximized when it is accessible to those who require it, including the custodian land surveyor as well as surveyors from other local firms. The first step towards maximizing its value is to ensure that proper information management procedures are instituted. Some of the topics that fall within this domain are: redundancy, security, indexing, storage, and retrieval; all of which are applied to ensure that information is permitted to flow with minimum impedance. The application of these procedures should not be limited simply to the field notes and plans, but rather encompass all the functions performed in the surveyor's office that involve the use of information.

3.3.1.1 The Integrated Survey Office

An initiative resulting from the SURVUS project has been undertaken by Gillis [1993] with the aim of developing an Integrated Survey Office (ISO). The objectives of the ISO are:

1. Proof of the SURVUS concept and continuation of investigation via a hands-on experiment;
2. To demonstrate leading edge survey office technologies to students, and to allow students hands-on experience in a totally automated environment;
3. To demonstrate the same technologies to the surveying industry, and to measure and demonstrate the efficiency gains of an automated surveyor's office over traditional operating environments. [Gillis, 1993]

The project involves the examination of all the various functions that are currently performed in a surveyor's office as well as future capabilities which include, among other things, access and dissemination of information in a network environment. One part of the initiative will be the consolidation of information concerning accounting, payroll, personnel, equipment, client, job detail, control data, and indices to hard copy data, which will all reside in a central database. This will permit a more effective management of the surveyor's information.

Gillis [1993] has also developed a preliminary relational schema which describes the relationships between the Client, Accounts, Job, Parcel, Coordinated Points, and Hardcopy or Digital Graphical Data, to be developed in relational database management system which will allow a search on any of these keys. In addition, some initial work has been completed on the integration of the various software packages which were originally designed as standalone products. The current application software packages are generally incompatible with one another, which acts as an impediment to flow of information in the office. One of the priorities of the ISO is the integration of word processing; accounting; computations such as a coordinate geometry package; graphics packages such as a CAD system; geographic information systems; as well as communications packages such as the modem, the facsimile and electronic mail, to allow access to outside data sources and to permit queries from outside organizations.

The end result of the ISO initiative will be the provision of a platform, in an academic setting, through which all current and future survey office functions will be performed including: data access and capture; data processing; data storage; data interpretation and analysis; data representation; data dissemination; and data management. In essence, it will enable the land surveyor to interact in a distributed information environment. Although the ISO is formidable undertaking, its implementation is a critical element of the SURVUS concept, which offers the possibility of substantial efficiency gains in existing office functions and offers the possibility of developing new services

3.3.1.2 The Survey Information Network

While permitting access is an important element of maximizing the value of information, one may also assert that its value can be increased by consolidating disparate data sources, since the value of the whole is often greater than the sum of its parts. The application of this principle is, in part, the basis for an initiative of the New Brunswick Land Surveyors which has led to the incorporation of SINET Services Inc., where SINET is an acronym for Survey Information Network. The objective is to establish an automated digital repository for coordinate related survey information, on a province-wide basis, which could be easily accessed by all parties [Geoplan Consultants Inc., 1991].

One motivation for this undertaking is the establishment of a vehicle through which members of the surveying profession could venture into the information services industry. While new business opportunities may result from the SINET venture, the initial goal is the provision of a service to members of the profession which will support the research activities that precede most field surveys. In other words, SINET will provide, in the best case scenario, one location through which surveyors can deposit, search and retrieve all existing survey information for any given area in the province. The goal is to reduce to a minimum, the amount of time that the surveyor spends in conducting research. Although

an exact figure representing the efficiency gains is as yet undetermined, it is potentially substantial. It is felt that the overall benefit in both the research activities and the experience of working in a digital environment should outweigh the costs, and thus provide the impetus for member participation.

As the surveyor's information is often considered a strategic resource, there may be some initial hesitation to expose it through such a venue. Any reluctance or uneasiness about participating may be overcome by the economic incentives possible through such a venture. The more information that one has deposited in the network, the more likely it is to be accessed by fellow surveyors. When information is retrieved from the network, the depositing member is credited and the retrieving member is debited. While the details concerning the exchange of monetary consideration are as yet undetermined, one may assert that the economic motivation alone will act to diminish some trepidation.

3.3.1.3 Other Database Initiatives

While dealing with one's own store of information is the best beginning point for involvement in the distributed information environment, the surveyor should also be concerned with the database initiatives of other organizations. In the course of daily business activities, land surveyors deal with a host of organizations for collecting the necessary land related information. Ownership, property mapping, zoning, utility right-of-way, Crown lands, and coordinate control, are but of few of the types of information that are needed to conduct field survey activities. In many instances, this information is under the custodianship of individual organizations and its procurement, in a timely fashion, currently requires a visit to each location. This is perhaps the most time-consuming aspect of the research that precedes field survey activities.

As many organizations are currently involved in some type of automation, their repository of information is being placed in databases to allow more efficient management

and ultimately to permit remote access for users. The New Brunswick Geographic Information Corporation (NBGIC) has the responsibility for assessment, ownership, property mapping, base mapping, and survey control information. NBGIC is currently involved in the automation process and expects to offer access to its data store in the near future. This will have a tremendous impact on the surveyors' research activities. As users of this service, land surveyors have a vested interest in its implementation.

Although the manual search for information at each location is time-consuming, one is generally assured that all needed information is available on site. This may not be the case for information retrieval via a remote database. While a database search may only take a few moments, if all the required information is not available over the network, many of the benefits of automation will have been lost. As an organization may typically have several types of customers, each requiring information in a slightly different form, their database design and implementation would likely reflect the concerns expressed by their prominent users. If surveyors have not participated in either the system design or implementation stages, their concerns would likely not be addressed. The end result is a database that meets only a portion of their requirements.

When the Province of Ontario Land Registration Information System (POLARIS) became operational, the title searching process for land surveyors and others was to have been greatly enhanced. In some respects the process had indeed been improved. One shortcoming, however, was the omission of the description that accompanies each instrument as it appears on the Grantor-Grantee index. In the manual index, when an instrument is registered, there is usually a description of how that instrument affects the property at hand. With such a description, the title searcher is able to ascertain the instrument's applicability to the project at hand and determine whether or not it should be inspected. This can save an enormous amount of time in the research process. Without these descriptions, the title searcher must invest the time in consulting each individual

instrument to determine its applicability. One may question the efficiency gained through automation in those instances where numerous instruments are involved.

3.3.1.4 Metadata

Metadata is defined as being data that describes data. In other words, given a data set, the metadata may describe its scale, its producer, its date of origin, the instrumentation used in its compilation and analysis, its cost and any other attributes that may useful to the recipient. More importantly, metadata provides notice of the existence of data and information concerning its location. Data directories are one of the mechanisms through which data can be located. These directories may also contain other metadata elements.

Land surveyors typically have dozens of sources of information that must be consulted in the course of researching and completing survey projects. The knowledge of what information to get and where to get it from is second nature to most surveyors. As mentioned above, gathering that information is usually done by visiting each location and determining the applicability by viewing the information. It is often through these visits that much of the remaining metadata is ascertained. From the surveyors' perspective, metadata is merely the codification of the information attributes that they deal with on a regular basis. However, as land surveyors represent only a fraction of the infrastructure users/sources, their metadata represents only a portion, albeit important, of the infrastructure's total.

Metadata, in the context of the infrastructure, has important ramifications for the land surveyor. As the holders of metadata, surveyors currently have a strategic advantage in knowing the whereabouts of their various information sources and the ability to interpret the metadata. With the development of data directories other professionals and infrastructure users will have access to the same information. In this respect, land

surveyors can use their skills and expertise in the manipulation and interpretation of spatial data to aid those infrastructure users requiring assistance.

While the codification of metadata in data directories may dampen the surveyors' current strategic advantage in locating information, it will conversely open the way for access to data sources previously untapped by the profession. And in much the same way that surveyors will offer their services in the interpretation of data with which they are familiar, other professionals will likewise offer similar services to surveyors.

In summary, the only way to ensure that a distributed information environment is suitable for land surveyors is by participating in its creation. Ensuring that the information contained in databases and metadata is complete and in a form usable to surveyors is one of the reasons why the profession should be involved in the initiatives of organizations with whom they have dealings.

3.3.2 Data Networks

The goal of the National Spatial Data Infrastructure is to create an information highway through which all sectors of society can access and disseminate information. The state of our current infrastructure for information transfer is analogous to a backwoods trail, which is at best awkward, and unsuitable for rapid, voluminous traffic. The common means of transferring digital data is through the dial-up modem. While it is being used by certain segments of society, it remains intimidating for new users. Coleman [1993] explains that the introduction and subsequent widespread use of facsimile machines, by virtue of their ease of use, is a testament to the failure of modem-based data communications.

Because it is still in its infancy, the distributed information environment is characterized by modem-based communications which inhibits the use of certain applications. As it matures, however, the data networks will have expanded bandwidth capacity and will support more powerful applications. One such application is the client/server model which

is the target processing environment of the Information Technology Strategy Steering Committee [1991] for the government of New Brunswick and a number of other organizations as well [CANARIE Associates, 1992].

3.3.2.1 The Client/Server Model

In the client/server model, a client machine makes a request for certain data from the server machine over a network. The server machine then sends the desired data back to the client machine. The most common server is the file server which moves files back and forth between it and the client. Another category of server is known as a database server which may receive, for instance, Structured Query Language (SQL) commands, often sent from within an application program running on the client machine. The command is processed by the server and the requested data is sent back to the client. Instead of transferring entire files over the communication lines, only that data which was requested is sent over the network. These models are most common in Local Area Networks. Their implementation outside that environment is currently problematic.

The prerequisite element for the implementation of the client/server model is a network which connects various sources of data with those who want access to it. Datacor, an affiliate of NBTel, the New Brunswick telecommunications utility, has implemented a province wide high speed computer network known as NB*net. The network has data transfer speed (bandwidth) of 56 Kbits/s, with the capability of conversion to 1.54 Mbits/s (T1) at a later date. Users subscribe to the network and are charged a rate proportional to the size (bandwidth) of their connection. The network is operated by the UNB Computing Centre and is based on the Transmission Control Protocol/Internet Protocol (TCP/IP) communications standards [MacNeil, 1991]. TCP/IP is a set of network protocols that specifies the details of how computers communicate and standards for interconnecting networks and routing traffic [Comer, 1988]. These protocols are most often associated

with Internet which connects many universities, government research labs and military installations around the world.

There are a number of factors that will determine whether or not a connection into NB*net is justified. First and foremost, there must either be information sources available through the network that the surveyor can draw from, or the presence of users interested in the surveyor's own data store. If such a connection is warranted, other factors such as the frequency of use, the quantity of information being transferred, the types of applications to be supported, and the financial resources available for these transactions, must be assessed to determine the type of connection.

3.3.2.2 Connections into the Network

There are several types of connections through which users can gain access into NB*net. Each alternative depends on the frequency of use and the volume of data that is to flow across the network. The most powerful connection is a dedicated line into the network with high speed (bandwidth) transmission capabilities. This permits the transparent use of the client/server model within local application programs. It would also permit the transfer of large data files such as digital map products and remote sensing information. This alternative would be appropriate for large organizations who make frequent use of the service and could justify the large capital outlay. The fixed monthly service and maintenance fees may be prohibitively expensive for the SURVUS model.

Other options within the NB*net model include the installation of a dedicated serial line which has slower transfer rates and accordingly lower service charges. This mode of connection also permits the development and use of the client/server model, but may prove too slow for some applications. While the transfer of large files is possible through this serial connection, the limited bandwidth would likely make it an awkward process.

The network may also be tapped through a dial-up serial line which would be appropriate for the casual user. Slower transfer speeds and the inconvenience of dialing are the price to be paid for lower service charges. This option does not permit the use of the client/server model because the request for data from the client is not accomplished within its application program. Each of these three options is offered on a fixed monthly fee basis, the price of which varies with the speed of the connection and the number of users in the organization [MacNeil, 1991].

3.3.2.3 Telecommunication Trends

A recent telecommunications initiative involves the simultaneous transmission of data, voice and video over a network. Bell Canada is offering a new service called Microlink, which provides access to powerful telephone lines based on the Integrated Services Digital Network (ISDN) standards [Surtees, 1991]. The integration of digital transmission and digital switching technology has provided the base for implementing ISDN. The ISDN describes a suite of standards that enables users to transmit data, voice and video over the same telephone line [Stallings, 1989]. In essence, the Microlink service provides the subscriber with one telephone line that performs all the services ranging from DATAPAC computer services to high speed video-conferencing and facsimile services [Surtees, 1991].

A significant obstacle to the realization of a distributed information environment has been the cost of telecommunications. With the recent deregulation of the Canadian telecommunications industry, the cost of transmission bandwidth has decreased and will continue on a downward trend [CANARIE Associates, 1992]. As these costs decrease, there will be more opportunities for smaller organizations, such as surveying firms, to make use of the networks.

3.3.2.4 The CANARIE Project

The CANARIE (Canadian Network for the Advancement of Research, Industry and Education) project is a private sector-led initiative that proposes to enhance Canada's existing backbone network – CA*net – which links the regional networks, including NB*net, and supports the national R&D and educational communities. The current capacity of 56 Kbits/s is approximately one ten-thousandth of the peak capacity of other major networks around the world. It is argued that traffic growth and user expectations for enhanced services will outstrip the current network. The plan, therefore, is to eventually provide a peak bandwidth of 10 Gbits/s [CANARIE Associates, 1992].

CANARIE's goals are:

- To enhance the competitiveness of Canadian industry through the development and use of state-of-the-art communications networks;
- To provide an environment in which the Canadian information technology industry, and in particular, those smaller firms which have traditionally faced significant access barriers to both technology and markets, can accelerate the development of future generations of networking technologies, products, applications, software and services; and
- To support effective research, development and education through enhanced collaboration and access to the information and resources worldwide. [p. 9]

3.3.2.5 Summary

As is true with the other infrastructure elements, the existing networks for transferring data are in an evolutionary period. Restrictions on their use from either economic or technical factors will eventually wane. Although network developments and improvements will occur independently of the surveying profession, there remains the task of keeping abreast of the issues that relate to the applicability of such networks in the provision of the surveyors' services.

3.3.3 Technology

Technology, that is information technology in particular, is the driving force of the movement for the establishment of the spatial data infrastructure. In many respects, it is acting as a pulling agent. Society and its institutions are constantly being challenged to employ the technology to its best and highest use. Although it offers tremendous potential for improvements in many sectors of society, the institutional arrangements that govern those sectors are such that only incremental shifts are possible.

Figure 3.4 depicts the land surveyor, the other professionals, the database custodians and even the users as having access to the technology. Factors such as decreasing costs and increasing user-friendliness are leading to the commoditization of the technology, which will permit widespread access to the distributed information environment. The result for surveyors and others may be a loss of exclusivity in the technology. Dealing with this eventuality will require the effective management of technology on the part of surveyors. For this reason, Chapter 5 addresses issues related to technology management.

3.3.4 Standards

The current spatial data infrastructure is characterized by the presence of heterogeneous information systems. In other words, the various infrastructure sources and users employ the hardware and software products of different vendors. As more systems become available in the marketplace, the heterogeneous nature of the infrastructure will become solidified. While the competition inherent with a multitude of system vendors provides a healthy atmosphere for capitalism, it gives rise to problems of interconnectivity. The lack of technical spatial data standards is a major inhibitor to the sharing of information through heterogeneous systems.

3.3.4.1 The Need for Standards

An example given by Kottman [1992] highlights some of the problems with exchanging data between heterogeneous systems: A sender has prepared a data set containing highway, road and bridge information, and successfully sends it to the receiver, who is interested in determining "the number of highway bridges in the data set area". In order to obtain the correct answer, the receiver must know the criteria with which bridges were defined. The sender may have only included bridges of length exceeding 20 metres. The sender may also have defined bridges to include highway bridges, railroad bridges, and road bridges. Without these and other details concerning the data set, any question asked may receive a misleading answer. This is but one justification for the adherence to standards.

3.3.4.2 Technical Data Standards

The technical standards required for sharing digital spatial data have been grouped into four categories by Clarke [1992]: *data models*; *data quality*; *data features*; and *data transfer*. The data model is the concept used to define data in the database. The common model types currently being used include vector models, raster models, relational models as well as combinations of these three. Data quality may be determined by a number of measures including positional accuracy, attribute accuracy, and lineage. The lineage is a description of the origin of the information, and the various transformations to which it has been subjected [Clarke, 1992].

Developing standards for data features is particularly important in situations where data is shared across jurisdictional or disciplinary boundaries. The concept of a parcel of land, for instance, is sometimes different for property assessment and land registration purposes. Also, in the previous example, the lack of precise definitions for road, bridge and highway features lead to ambiguity in the data set which in turn became valueless for certain

applications. Lee and McLaughlin [1992] view standards development in this regard as being twofold. Efforts should first be directed toward developing a standard method for feature definition, which would be followed by the development of standard features within the various user communities.

Data transfer standards refer to the set of rules for encoding data into fields, records and files, and are dependent upon the data model. The transfer standards may also include metadata and quality attributes [Clarke, 1992]. There is currently a plethora of transfer standards dealing with raster, vector, relational and combinations thereof, a listing of which is provided in Kottman [1992]. The establishment of a national spatial data infrastructure, however, requires the conformation of these many disparate standards.

3.3.4.3 The Spatial Archive and Interchange Format

The inadequacy of the exchange standards developed by individual system designers to meet national infrastructure requirements has provided the impetus for the Canadian General Standards Board to strike a Committee on Geomatics. The Committee's task is the development of a national standard for exchanging geographical information. The result has been the adoption of a draft national standard known as Spatial Archive and Interchange Format (SAIF). It provides the means for dealing with both raster and vector data, is appropriate for representing data at different scales and accuracies, and is designed to be vendor independent [Canadian General Standards Board, 1991].

SAIF is described as being a general interchange standard from which subsets can be derived to form defined formats. DIgital Geographic Exchange STandard (DIGEST), for instance, which is implemented in the Digital Chart of the World, is described as a defined format. The distinction between these two types of standards is demonstrated in an analogy with pipes. The general format is viewed as a large pipe and the defined format as a narrow pipe, where the latter in theory fits within the former. The defined format is made

up of a subset of the general format. This makes possible the development of any number of defined format which are derivatives of the general format. This particular approach to standards development originates from the recognition that different defined formats are required to support the needs of different applications [Canada, Department of National Defence, 1992].

Participation in the development of standards has in large part been limited to federal and provincial government agencies. Private sector participation in these initiatives has been minimal. The Task Force [1991] recommends private sector participation as a means of communicating its concerns in standards development. The land surveyors' participation in these initiatives may be an effective means of familiarization with standards and their applicability to the flow of information in a distributed environment.

3.3.5 Institutional Arrangements

The institutional arrangements describe the relationships between all the various users and information custodians. Until these relationships become firmly established there will be restrictions on the ability to share information. Maintaining security, protecting privacy and limiting liability are some of the major issues that require attention. The arrangements are also necessary for establishing and maintaining the accounting procedures used to credit database custodians and debit database users. Many of these issues have been dealt with in the thesis by Anderson [1992], who discusses in detail the necessary components of an access and privacy policy for information in a distributed environment. The key components of that policy are presented in Appendix I.

3.3.6 Summary

The collection of these various elements under the umbrella of the spatial data infrastructure provides a framework through which members of the surveying profession can envision their role as land information managers. Database initiatives within the

profession and those of organizations with whom the profession has dealings were identified as important undertakings. Participation in standards development and keeping abreast of data network developments and opportunities were also presented as essential activities. Taking part in the establishment of institutional arrangements that deal with access, privacy, ownership, pricing and other information issues is seen as an important means of voicing the profession's concerns and solidifying its relationships within the infrastructure.

One of the objectives underlying the development and creation of a national spatial data infrastructure is the desire to improve the management of land and its resources. In this section the surveying profession's participation in the infrastructure development was described as an essential part of the role of land information manager. That role in turn defines the profession's involvement in land and resource management. There is evidence, however, that the provision of land information into the decision making process represents only a part of the profession's mandate. The following section will examine the land surveyor's role in environmental protection.

3.4 The Land Surveyor and the Protection Function

Figure 3.1 described land management in terms of its three functions. As mentioned earlier, the members of the surveying profession are well acquainted with both the development and distribution functions by virtue of their involvement in the land development process. In regards to the protection function, the profession has played, at best, only a minimal role. The continued neglect of the environmental dimension of land management would be detrimental to surveyors from both the business and professional perspectives.

The profession's duty to society, when viewed from the land management perspective, should center around the objective of sustainable development. It is unlikely that the

profession can work toward that goal from the narrow land development perspective. Without some knowledge and understanding of the environmental dimensions of land management and the environmental consequences of land development activities, surveyors will be construed as part of the problem instead of being part of the solution. By embracing the land management model, surveyors may participate in the formulation of management objectives, and can work towards meeting society's long-term requirements.

From a business perspective, the same concerns that have brought about the calls for sustainable development are signs that the subdivision era is coming to a close. As a substantial amount of the profession's work has been derived from land development, the continued dependence on these activities as a source of demand growth would be a strategic business error. The current impediments on development projects such as the fixed link between New Brunswick and Prince Edward Island arise mainly from environmental concerns. These concerns may in the end be the cause of the project's cancellation. It is quite likely that the future will see development projects, in increasing numbers, being subjected to the same fate.

3.4.1 Land Ethic - Environmental Perspective

The provision of land information in the land management decision making process was identified as one of the means by which surveyors contribute to the promotion of environmentally responsible decision-making. While this is an important role, more pro-active approaches have been advocated. Ballantyne [1990] has levied criticism on the surveying profession for their abdication of land stewardship during this century, and believes that a Land Ethic is an effective means of redressing the current situation. He has suggested the inclusion of a Land Ethic in the profession's Code of Ethics, which would place upon the land surveyor the responsibility of safeguarding the health of the land.

The International Federation of Surveyors (FIG) also believes that it is the profession's responsibility to contribute to environmental protection. While they too consider the surveyor's expertise in monitoring changes in the environment to be the profession's primordial contribution, they also believe that individual surveyors should be more pro-active in their adherence to the concept of environmental protection. In particular, FIG [1991] states that each surveyor's commitment to environmental protection shall always require:

- an assessment of the environmental consequences of professional activities in a responsible way;
- constant efforts to secure the recognition of environmental planning and management aspects in the fulfillment of any project; and
- prompt and frank responses wherever possible to public concerns on the environmental impact of projects.

The Association of Professional Engineers of Ontario is also proposing similar stewardship amendments to their Code of Ethics. The Environmental Task Force [1993] has drafted a statement concerning the role of the engineer and the practice of engineering:

> Members recognize that stewardship of the environment is everyone's responsibility and that environmental protection is essential to public welfare. In order to achieve the long-term objective of sustaining our environment, we must harmonize human activities with the environment and implement conservation and environmental strategies.
>
> Each and every member of the Association has a duty to use their knowledge, not only of engineering, but also of the sciences, the law and economics to have proper regard for the environment as it is affected by their work. [p. 8]

There is clearly some movement within the professions in recognizing the potentially negative effects that their practices have on the environment. Amendments to the Code of Ethics may prove helpful in discouraging the land surveyor's involvement in destructive development activities such as: urban sprawl; and the ruination of prime agricultural land

and sensitive watershed ecosystems. The successful incorporation of such amendments would also witness the wane of the use of the term 'developer's yes man', as surveyors would be required to consider the land not only as an economic commodity, but also as an element of an ecosystem whose imbalance generates immeasurable costs.

Although a Land Ethic, in theory, would seem to be an effective mechanism for environmental protection, in practice, its enforcement will be problematic. The different interpretations of environmental degradation, the prevailing reductionist paradigm and the presence of 'thing specialists' within the surveying profession represent significant barriers to its successful implementation. As noted by Hyde [1992], the engineering profession has its own understanding of the meaning of the public good, and as such only brings disciplinary actions against members whose mistakes are too obvious to overlook. In this regard, reaching a concensus on the meaning of what constitutes a violation of the members' environmental protection obligation will be a daunting task. The similarities between the engineering and surveying professions suggests that the latter will also encounter enforcement problems in regards to a Land Ethic.

3.4.2 Environmental Education

Meaningful participation in environmental protection and the prevention of conflicts in establishing and enforcing ethical behaviour among the surveying profession's membership require changes in the nature of surveying education. The latter has traditionally emphasized the land development aspect of the profession's role in land management where the economic dimension usually prevails over the environmental dimension. Redressing this deficiency should be a priority.

One option for surveyors that are currently in the workplace, is the use of continuing education programmes as a means of building a foundation of knowledge about the environmental dimensions of their work. Perhaps through a collaboration of the

profession's governing bodies and the university surveying programmes there could be developed a single or series of courses that address environmental concerns by introducing, for instance, Savory's [1988] holistic resource management model. Some of the profession's membership are almost certain to reject such a proposal. Its viability would likely depend upon a high percentage of participation.

In this regard it is felt that the environmental theme would likely be better received during the formal professional education rather than afterwards. For instance, the traditional first year surveying course at the university level exposes the student to the fundamental tools and techniques used for measuring the land and its fixtures. As the student advances through the programme, there is a continued emphasis on the tools and techniques with only limited mention of a professional context. As an initial step it is suggested that the first course be replaced by one whose goal is to provide a framework in which the student can view the entire profession, its functions and how they relate both to society and to the natural environment. In other words, the course would integrate the prevalent reductionist paradigm with a holistic approach.

A more radical approach has been suggested by Hyde [1992] whose design of a first year engineering curriculum incorporates the philosophy that students should seek and value a profound understanding of themselves and their social and ecological community ties. During the first term, students are brought to a remote location and housed in sparsely furnished facilities lit and heated by solar technology. Guided by environmentalists, the students work at making the community function at the logistical and emotional levels, and are given the opportunity to connect with rural ecosystems and express their engagement through artistic media. Students are then grouped into study teams to plan, in cooperation with resource people, their studies to be undertaken during the next part of the term. The aim of these studies is to gain an understanding of the ecosystems which includes elements

of physics, biology and chemistry. All of these studies, however, are based on living systems and phenomena observed in nature [Hyde, 1992].

Hyde [1992] describes the second term as beginning with a week-long canoe trip accompanied by an environmentalist to explore a watershed and visit a hydro-electric reservoir and powerhouse. Students are then introduced to their task for the term which involves planning and carrying out an analysis of a human community in a small town through the study of its ecology, technology and economy. In order to gain a better understanding of long-term economic development, the students interview a cross-section of community residents. The final part of the term is used to assess the technological expertise required to build the town and make it function. Students gain an understanding of the roles that the different engineering disciplines play within the community, and of the skills they view as important and which serve the community well [Hyde, 1992].

Throughout the year the students are encouraged to think, write and talk about the learning process. Hyde [1992] believes that at least four important benefits are derived from this educational approach. By the end of the year students have made progress in: exploring participatory government; modelling sustainable development; preparing for independent study; and recognizing the limitations of ecosystems. This educational experience aims to strengthen the student engineers' ties with society and the natural enivironment. Although this represents a radical departure from the norm of engineering education, Hyde [1992] feels that the problems that the curriculum addresses are of such importance that only a major reform will suffice.

It is clear that any effort toward meaningful participation in environmental protection must be underpinned by knowledge of ecosystem elements and their reactions to human intervention. To continue to participate in land development activities without some understanding of the environmental costs incurred, may be construed as a derogation of

professional duty. Whether it be through continuing education programmes or educational reform, there is clearly a need for the profession to take measures in ensuring that it fulfills its societal obligations. If it is not dealt with from inside the profession, it may likely be dictated from the outside.

3.4.3 Information Management - Institutional Perspective

Another means by which the surveying profession can participate in environmental protection is through the distribution function of land management. Land administration is the land management process whose primary purpose is the management of the land tenure system. Land tenure was described in section 3.1.2 as being the rights, responsibilities and restraints people have with respect to the use and benefit of the land. Nichols [1992] describes land registration as the primary means by which the information management function of land administration is achieved. The land surveying and legal professions are the primary participants in the land registration process. Surveyors participate in this process through the creation and maintenance of the cadastre.

Nichols [1992] believes that land registration systems can play an important role in providing monitoring and enforcement facilities for land regulation by relating individual rights to other information. These may include environmental regulations and new types of interests such as aboriginal and community rights. Unfortunately, the traditional role of land registration systems has been that of a mechanism for conveyancing real property. This usually includes a record of the rights but often omits the restraints and responsibilities that accompany those rights. From an information management perspective, land surveyors can advocate and campaign for reforms to provide better mechanisms for linking these various information sources in order to obtain a complete picture of the land tenure affecting a parcel of land [Nichols, 1992]. In this regard, the public will be given notice of their obligations as well as their rights.

3.5 Summary

The overall objective of the surveying profession is the effective management of land and its resources. It was shown that the primary means by which the profession contributes to that objective is through the process of land information management. From this process was derived the SURVUS model, which depicts the land surveyor as a land information manager whose access to distributed databases of land and other information offers the potential for improving traditional survey practices and enabling the development of new services.

The SURVUS model, however, is the conceptualization of the future role of the land surveyor. It will not come to fruition without the support of an infrastructure. As an important part of realizing the SURVUS concept, land surveyors have a vested interest in participating in the development of the spatial data infrastructure. The infrastructure elements were outlined and discussed in terms of their state of maturity and the degree to which the surveying profession can participate in their improvements or implementation.

The examination of the land and resource management model identified some important points. Firstly, the model was described in terms of its three functions and perspectives. It was argued that surveyors' participation in land management through the land development function alone was insufficient to attain the objective of sustainable development. In order to fully participate in that objective, surveyors must acknowledge and embrace the environmental protection function. To continue to disregard this dimension of land management would be an abrogation of the profession's duty to the public.

Secondly, as noted above, it was through the land management model that was derived the process of land information management, in which can be categorized all of the surveying profession's activities. The added benefit of embracing the land information management paradigm is the ability to remove it from the land management model and

apply it to areas where the activities are not related to land management. As will be discussed in Chapter 4, there is a small but growing community of land information users that do not fall within the land management model. Their information requirements, however, can be met through the land information management model.

4. The Marketplace

> *The demand for surveys has diminished over the last five years, ... it seems that the next five years will not be much better.*
>
> [Jacques, 1993, p. 2]

A recent membership survey by the Canadian Council of Land Surveyors described the slowdown in the marketplace for traditional surveying services as a subject of great concern for most land surveyors. The consensus arising from this survey was that the most important element in sustaining the profession is the development of new market opportunities [Jacques, 1993].

The aim of this chapter is to explore the dynamics of the marketplace for land information as they apply to land surveyors. It is felt that the information presented herein will be a useful precursor to the development and exploitation of market opportunities. The presentation begins with an examination of the current surveying services being offered by the profession and the pressures being exerted thereon. While these pressures will initially be described as having a negative impact on surveyors, it will be shown that by embracing the land information management perspective these pressures may give rise to opportunities.

Included in the assessment of the land information marketplace is a discussion of the decision-making process and the impact that information has therein. Information is one of the basic ingredients of the decision-making process. It has the ability to reduce uncertainty and lead to more effective decisions. As information providers, land surveyors must have an appreciation of the types of decisions being made in those areas where market opportunities may exist, and an understanding of the type of information required to support those decisions.

The land information marketplace is discussed in terms of the public and private sectors. Specific market opportunities for land surveyors are presented with examples from both sectors. From a spatial data infrastructure perspective, the public sector represents a significant proportion of both sources and users of land information. Activities at the municipal level offer significant market potential for land surveyors. From the private sector perspective, the use of surveying expertise in support of environmental audits is a natural adjunct to the profession's current activities and may provide opportunities for the venturesome surveyors.

The final section of the chapter deals with the topic of information as a commodity, whose value may be increased by a number of factors. Although technology plays a role in adding value to information, it is the information management practices that reduce impedances to the flow of information, and thus add value.

4.1 Pressures on Current Surveying Services

A number of circumstances have conspired to exert pressure on the surveying profession in the provision of its traditional services. Pressure is being felt by developments in technology, concern for the natural environment, the emergence of alternative service delivery organizations, and competition from public sector agencies. All of these different circumstances have the potential to adversely affect the demand for traditional surveying services.

4.1.1 Technology

The Canadian Encyclopedia [1988] defines technology as "the skills, tools and machines used by members of a society to convert material objects into products useful to themselves." The changes that occur in technology are often accompanied by changes in the relationship that exists between members of society and those who possess the skills,

tools or machines. The pervasive nature of information technology is putting many of the tools that were once the exclusive domain of the surveying profession in the hands of the general public. As the technology becomes more user-friendly and more cost effective, the long term effect will likely be a diminished demand for the profession's services as they exist today.

4.1.1.1 Geographic Information System (GIS)

Low end GISs and inexpensive digital mapping tools now allow casual users to produce their own mapping products for their own applications [Task Force, 1991]. The access to digital base and property mapping coupled with the facilities to manipulate that and other data has the potential to cut into existing professional services. With these capabilities in hand, it has been suggested that the current purchasers of traditional surveying and mapping products may at some point in the future become producers themselves, in essence competitors of the surveying and mapping community [Task Force, 1991].

GIS technology offers the potential for better management of land information, at a level that is difficult to replicate in a paper environment. Surveying, like many other industries, is replete with inefficiencies that are inherent in a world whose documentation is mainly paper based. Data gathering efforts are often duplicated because of an unawareness of the existence of previous efforts. Even if information has been discovered, in a paper world it is often difficult to manipulate the data to meet the requirements of the application at hand. It is often more cost-effective to repeat the data gathering effort.

The determination of the existence of data, its access, its manipulation, its assembly with other data sources, and other functions become more practical by virtue of being in a digital environment. In the long term, the technology will enable the institution of better data management practices which will alleviate much of the inefficiency that exists today.

Instead of conducting entirely new data gathering efforts, as is often done, the profession's work will be viewed more as updating existing databases. The inefficiencies have, in essence, been a source of work for members of the profession. Abating the former will likely translate into a loss of demand for current services.

4.1.1.2 Global Positioning System (GPS)

In much the same that GIS is aiding in the management of spatial data and the creation of digital data products, GPS is offering the capability of data capture and position fixing to the casual user. This is made possible by a decline in capital costs for GPS equipment coupled with a rise in user-friendliness. These two concurrent trends are expected to continue in such a way that some of the traditional purchasers of these surveying services will be capable of meeting their own requirements, thus bypassing procurement from the profession [Task Force, 1991].

4.1.1.3 Remote Sensing

The Multi-spectral Electro-Optical Image Sensor (MEIS) is an aircraft-based sensor with a pixel resolution of one metre. Recent efforts in the City of Guelph, Ontario have demonstrated that the MEIS is an effective means of detecting change between the existing cadastral database and the imagery, and is suitable for updating the large scale base mapping for the City. The imagery has been integrated with the municipal GIS and provides a wealth of new information. It was shown to be an improvement over traditional photography by providing automated feature recognition using spectral signatures from the imagery [Linders, 1993].

As will be discussed in a subsequent section, providing updating support for municipal databases is one of the areas in which surveyors may find market opportunities. While the level of detail attainable through remote sensing may be surpassed by conventional terrestrial surveying methods, the requirements of many users may indicate that the imagery

is more than adequate for their purposes. The imagery, and in particular its integration with a municipal cadastre, may prove to be a more effective means of updating databases than those offered by surveyors. In short, remote sensing may provide competition to surveyors for this future market opportunity.

4.1.2 The Natural Environment

As discussed in chapter 2, the surveying profession began a resurgence in the middle of this century when the need for housing and land development became integral components of the national strategy for economic growth. Specialization under the land development paradigm was an appropriate response at the time, since economic growth was a high ranking national priority. Canada's vast landmass was viewed as a frontier that held an abundance of resources whose exploitation would fuel economic growth. The problem, however, as Richards [1990] explains, is that frontier life is characterized by an absence of limits. As the public has come to realize, the earth has only a finite amount of resources, and their unfettered exploitation by humans is having a devastating effect on the natural environment.

The growing prominence of this issue is causing a shift in the focus of national priorities such that economic growth is becoming tempered by concern for the quality of the natural environment. Land development provided the profession's sustenance and permitted it to grow because that period was characterized by a frontier mentality. With the decline of this cultural mentality comes a new era for the land surveyor. Land development will be constrained by calls for sustainability. The amount of future land development will likely never attain the levels at which the profession has become accustomed, primarily as a result of the diminished availability of suitable land. The city of Scarborough, for instance, remains the only municipality within the Metropolitan Toronto area that is still undergoing the development of new subdivisions from rural lands [Sussman and Lau, 1993].

4.1.3 Alternative Services

Pressure on existing surveying services is also being felt by the presence of alternative services. Title insurance companies are one example of such a service. Their emergence may be viewed as a competitive force directed toward existing surveying services.

4.1.3.1 The Real Property Report

The Real Property Report, otherwise known as a building location survey, represents a significant amount of the land surveyors' work. In New Brunswick, for instance, of the total 11,520 surveys conducted by land surveyors in 1990, approximately 5,700 were Real Property Reports [Geoplan Consultants Inc., 1991]. At 50 percent, it is not surprising that this type of work is considered the profession's 'bread and butter'. This type of survey involves the location and depiction of the man made and other features within a parcel of land. It also involves the retracement of boundaries to which these features are referenced. The purpose of the Report is to give notice of the location of boundaries by survey monument, and to identify the location of any encroachments, or the existence of lesser interests such as easements. It is used by owners and lenders to determine the quality of the extent of title of a parcel of land being purchased and/or mortgaged. It is in essence a mechanism for determining the risk of the investment.

By virtue of legislation, the surveying profession has been conferred with the exclusive right to practice cadastral surveying, which has given them a monopoly on the provision of Real Property Reports. The consuming public has, for years, questioned the value of this service [Kirby, 1980], and to date has had virtually no other available options. This may soon change with the emergence of title insurance companies, whose service may be viewed as competition for the surveyor's Real Property Report.

4.1.3.2 Title Insurance

According to de Rijcke [1992] there are currently two or three companies licensed to sell title insurance in the province of Ontario. The insurance is seen as a means of eliminating liability in situations where title problems can not be solved. The corollary is that it provides the ability to insure for risk without ascertaining the nature of that risk. The surveyor's Real Property Report has been the traditional means by which risk is ascertained. As such, both the Real Property Report and the title insurance can be classified as risk minimizing tools, whose value as seen by the consuming public, the legal profession and money lenders may easily be compared. When title insurance is more cost effective, the likely result will be a reduced demand for Real Property Reports [de Rijcke, 1992].

de Rijcke [1992] also points out that the sale of title insurance must be accompanied by a Certificate of Title issued from a solicitor entitled to practice law in the province. This Certificate refers to the quality of title and not necessarily the quality of the extent of title. The latter is the exclusive domain of the surveying profession. While the determination of quality of the extent of title is certainly recommended, it is not necessarily required.

4.1.4 Public Sector Cost Recovery

Another source of competitive pressure is coming from the public sector. Government managers being pressured by budget cuts, have begun to adopt cost recovery as a means of generating additional revenue. Many in the private sector are uncomfortable with the user-pay arrangements, as it is often considered a double taxation scheme. Still worse, however, is the movement by some public agencies to develop their own value-added products to generate revenue to compensate for budget shortfalls. The creation of value-added products is generally viewed as the mission of the private sector. The resulting situation is a series of government agencies competing with the private sector, where the

latter is in effect subsidizing its competition. While the public sector development of value-added products may currently only affect a small number of private sector producers, there is the possibility that as more surveyors view their work in terms of value-adding information, the effect may be more widespread.

4.1.5 Analysis

The first step in developing a response to these pressures is for land surveyors to recognize that the essence of their business is neither surveying nor measurement, but rather the business of managing land information. This includes all of the functions ranging from the data gathering activities to the dissemination of land information. To view the business in more restricting terms would be a death knell for the surveying profession. Many industries have come to the same realization; they must look beyond their particular specialization to remain viable. Those that choose not to do so may suffer severe consequences.

For instance, Levitt [1975] describes the demise of the railroad industry and suggests that the primary cause was related to an inability to view the railroad as being one element of a much larger transportation industry. The movement of people and goods is an apt description for both the railroad and the much larger transportation industry. By maintaining their focus on the railroad itself, they failed to realize that the movement of people and goods could be done by alternate means. By taking this position, the railroad precluded the possibility of providing integrated transportation services to meet their clients' needs. The alternative transportation sectors were viewed as competition, when in fact from a transportation perspective their role is actually complementary. At least part of the railroads' problems have arisen because their focus was on their own expertise and not on their clients' requirements.

The surveying profession could be subject to the same fate if the measurement and land development paradigms continue to dominate their market focus. While there will always be a need for these services, they are unlikely to be sources of market growth. By viewing their work in terms of land information, however, there is every indication that a viable profession could emerge.

From the land information management perspective, many of the pressures outlined above can be converted into advantages for the profession's members. The technology, for instance, can be used to aid in the delivery of existing services. It can also be used to develop new products and services. The environmental concerns, which on one hand are constraining land development, can simultaneously be transformed into opportunities. The provision of information in support of environmentally sensitive decision making is a market area with significant potential. As well, in many instances those who provide alternative services can be viewed in a complementary rather than a competitive light.

4.1.6 Summary

The combination of these pressures on land surveyors likely signals the close of an era in which the profession enjoyed both a high demand and a monopoly in the provision of traditional surveying services. While this by no means signals an end to the profession's involvement in these services, it does indicate the need for surveyors to be able to compete in an increasingly complex marketplace that will demand value for its dollar. It also indicates that surveyors will require a better understanding of the marketplace in order to develop appropriate responses to these pressures.

4.2 The Land Information Marketplace

Land information management was described as the surveyors' primary function, which involves the provision of land information to those who need it, in a form usable to

them, and at a time appropriate for their needs. The fundamental objective of the SURVUS model is to fulfill the information requirements of the end-users and clients. The evolving nature of the marketplace, however, has made a difficult task of identifying the clients and users, and their requirements. Notwithstanding, a marketplace assessment by Kennedy [1991] has resulted in the development of a model consisting of three overlapping market segments. The three segments are:

- Spatial Information Infrastructure;
- General Geomatics; and
- Spatial Information Applications.

Before providing the description of each market segment, it is worth noting that all three segments fall under the umbrella of land information management, while only the first two can be classified as land and resource management activities. It was through the land management model that was derived the land information management process. That process, however, may be removed from the land management model and applied to areas where the decision making affects activities other than land management. This is one of the benefits of viewing the land surveyor's role from the land management perspective. It is also an indication of the breakdown of traditional concepts of surveying and mapping services. It is partly the result of the proliferation of information technology, and is one of the justifications for the development of the spatial data infrastructure. The description of each segment follows.

The *spatial information infrastructure* market segment represents the land and resource management decision-makers, and the databases used to support their activities. Included in this segment are the three levels of government and the utility and resource companies that have a stake in managing land and its resources [Kennedy, 1991]. The *general geomatics* market segment represents the project-based clients requiring specific services such as cadastral, control or engineering surveys, or aerial photography or mapping.

Typical clients may include land developers, resource companies, or private citizens [Kennedy, 1991]. The distinction between these two segments is that the former is programme-based, and the latter is project-based. The two segments are similar in that they both involve decision-making in the management of land and its resources.

The third segment is known as the *spatial information applications* market. It merits particular attention because it falls outside the traditional land management model. This segment is characterized by the use of land related information for purposes other than land management. It comprises a broad range of users whose access to information technology has provided them with capabilities to use land related information for their own applications. Kennedy [1991] outlines the range of users to include retailers, marketers, publishers, police forces, emergency medical services, transportation companies, travel agencies and private citizens.

4.2.1 Land and Resource Management Community

The primary users of land information belong to the spatial information infrastructure and general geomatics market segments, and may be categorized as being part of the land and resource management community. The list of individuals, and private and public organizations involved in land management is endless. To attempt any type of tabulation of these users of land information would be nonsensical.

For the purposes of this paper, it is important to recognize that each of these users requires different types of information which are dependent upon their particular application. Understanding the information needs requires a certain amount of knowledge of the particular land management specialty. Addressing individual specialties is beyond the scope of this research. Instead, it is suggested that the reader explores and becomes informed of the various land management applications. One can not over-emphasize the

need to understand specific land management applications if one expects to provide information services to support these activities.

The alternative to examining individual land management applications is to take a more general approach by examining how decisions are made within organizations. Information is in essence one of the basic ingredients of the decision-making process. As the purpose of information is to affect the decision-making process, the successful information provider requires some understanding of the fundamentals of that process. The analysis of the decision-making process will demonstrate that different types of information are required for different types of decisions. A generic framework of decision-making is outlined and discussed below.

4.2.2 The Decision Making Process

Gorry and Morton [1987] discuss the implementation of management information systems in organizations and have concluded that the failure of these systems often results from a poor understanding of how decisions are made at different levels in an organization. While their discussion is directed toward system designers, the points that they have raised are applicable to those seeking to provide information services to decision-makers.

The authors state that management activities in an organization can be classified into three categories, namely: *strategic planning*; *management control*; and *operational control*. Each of these management activities differs in terms of a number characteristics. The authors acknowledge that the boundaries separating these management activities are not as clearly defined in the practical world as they are in theory. As guidelines for use in the implementation of information systems, however, they offer valuable assistance. The following sections describe the activities and outline their particular characteristics.

4.2.2.1 Strategic Planning

This managerial activity as described by Gorry and Morton [1987] involves the selection of objectives for the organization and the dedication of resources to fulfill those objectives. Strategic planning is often performed by a small number of high level managers whose creative and non-repetitive style of decision-making requires a wide variety of information from sources that are usually external to the organization.

With an eye on exploiting the strategic planning activities of organizations as a niche market for information services, the Information Group West Corporation (IGW) of Calgary developed *News Alert.* Carrie [1991] states that IGW developed the information product for executives with the goal of providing up-to-date information on competition, industry and general economic trends. The product provides a synopsis of these themes which is compiled from multiple sources. The product development was described as being "painfully ponderous", as the concept of information as a product is still relatively new to the business community [Carrie, 1991].

From their experience, IGW has learned a number of important lessons. They have come to realize that information must be packaged as a product for it to be recognized as a commodity with value. They also found that clients were interested in being able to sample the product; in being able to request modifications to the product; and lastly in playing a part in the product development. It is through this latter activity that IGW was able to test the product by allowing the end users to either confirm or reject its assumptions and to suggest possible alternatives [Carrie, 1991].

4.2.2.2 Management Control

According to Gorry and Morton [1987], managers at this level ensure that resources are obtained and used efficiently to meet the organization's objectives. One of the important characteristics of this activity is that it involves interpersonal relationships. It is through

these relations that managers obtain information both from above in the strategic planning area and from below in the operational control. The type of information that they require falls along a continuum between strategic planning and operational control. It is interesting to note that with the development of information systems and the current economic climate, the popularity of this level of management is slowly waning [Drucker, 1990]. There is plenty of evidence, mainly through the news media, that middle management positions are being phased out. Thus, for an information provider, developing market opportunities in this area might be problematic.

4.2.2.3 Operational Control

Managers making decisions at the operational control level are primarily concerned with ensuring that specific tasks are carried out in an efficient and effective manner [Gorry and Morton, 1987]. The information requirements at this level differ greatly from those of a strategic planner. By virtue of being task oriented, the operational control decisions require information that is well defined and narrow in its scope. The information is also usually very detailed and often originates from within the organization. The information is used frequently and as such must be accurate [Gorry and Morton, 1987].

4.2.2.4 Analysis

Whereas each of the above management activities may be viewed as a market opportunity, the operational control decision-making process would seem to offer the greatest potential for land information providers. The type of information used in this process parallels in many ways our current conception of land information. The task orientation of this process requires information that is well defined, very detailed, accurate, frequently used and narrow in its scope. Land information can be described in similar terms.

A number of studies reviewed by Keen [1981] dealing with the actual decision-making process employed by senior managers, seem to acknowledge the assertion that the operational control process offers the greatest potential for land information providers. It was observed that under pressure, decision makers discard information, avoid new alternatives as well as outside expertise, and simplify the problem down to a manageable level. As well, there is a tendency to repeat what has worked in the past. The research shows that formal analysis of quantified information plays only a minor role in complex decisions. Instead, negotiations, habit, rules of thumb and muddling through seem to best describe the decision making process.

As the decision-making process becomes more complex, the use of information as a basic input becomes less important. The strategic planning process is thus a more difficult candidate for information providers as the requirements lacks structure. The structured nature of the operational control decision-making process, however, suggests that information is an important and useful ingredient. In the short term, the latter process would seem to be an area of great potential for land information providers. Research developments in artificial intelligence and expert systems, however, may in the long term result in methods of structuring complex decision processes and give rise to formal information requirements.

A fact of particular interest in the operational control level is that information usually originates from within the organization. As will be discussed in the following section, organizations in the public sector represent the single largest establishment involved in land information management activities. As such, they have traditionally performed their data gathering efforts with in-house resources. The emerging trend of privatization, however, suggests that there may be opportunities for the private sector in meeting the information requirements of public sector agencies.

4.2.2.5 Summary

The above discussion should be helpful in assisting the information provider with making an assessment of the types of decisions being made and the types of information that may be required in that process. When seeking to provide information services in support of land management decision-makers, an understanding of their information needs is critical, and includes being mindful of the particular management activity being targeted. Land surveyors may find market opportunities in the public sector as land information management represents a significant portion of its mandate, which supports its land management activities. These opportunities may arise through privatization. A discussion of this topic and its impact on surveyors is presented below.

4.2.3 The Public Sector

The public sector represents a significant share of the spatial information infrastructure market segment. This sector is involved in all levels of the land management decision-making process, and performs much of its own land information management activities. All three levels of government are responsible for their respective public lands, and as such must keep records to support their mandate. In addition, they often exert some control over privately owned lands within their jurisdiction. Ownership of road allowances, for instance, is usually vested in the municipality. The same municipal government is responsible for establishing and enforcing zoning regulations affecting private property. Similar scenarios of public land ownership and control over privately held land also exist at the provincial and federal government levels.

In order to support these land management activities, government departments are charged with the collection and maintenance of land information records. For that reason, it is not surprising that government has been the site for most of the development and implementation of land information systems, and explains the fact that government is

currently the largest repository of land information. In terms of the spatial data infrastructure, government agencies represent both the largest segment of users and sources of land related information.

As information users, the land surveyors' challenge is to gain access to the wealth of information contained in these databases as a means of effectively fulfilling their clients' information requirements. As information providers, the land surveyors' challenge is to determine the ways in which they can meet the public sector information requirements in the form of database updating or maintenance. Although these challenges seem formidable, they are not outside the realm of possibility, as the benefits of private sector participation in the provision of public services have been demonstrated in a number of jurisdictions [Ascher, 1987].

4.2.3.1 Privatization

Privatization is an emerging trend in the public sector which aims at increasing private sector participation in the provision of public services. Its increasing use is the result of a number of factors. Among them is the desire to reduce the cost of government and the belief that the private sector is more agile in responding to changes. The efficiency gained by private sector participation is very often translated to cost savings for the government. As well, there is a recognition that the opportunities given to the private sector through privatization can generate other benefits such as new products or services [Moore, 1992].

A major form of privatization, commonly known as contracting out, consists of using the employees of a private firm to perform the services or create the products which were once performed or created by public servants. In the surveying and mapping industry, contracting out began in the 1970's when the federal government began using private sector firms to assist it in the mapping of Canada's landmass. The advantages gained through

such ventures prompted the provincial governments to institute similar contracting out policies [Lapp et al., 1978].

4.2.3.2 Opportunities in the Public Sector

At the federal and provincial levels the mapping initiatives are nearing completion, and much of the work that remains will involve updating. The result of these mapping initiatives has been the creation of large databases which will form a part of the infrastructure. Keeping these databases up-to-date will be a significant and costly challenge. While there may be opportunities at these levels for updating databases, the area of greatest potential for land surveyors is at the municipal level. The Task Force [1991] has identified the municipal databases as potentially significant market opportunities for the private sector, as a result of the growing trend toward abandoning in-house data gathering activities.

4.2.3.3 Municipal Governments

While municipal governments vary greatly in size from one jurisdiction to the next, their responsibilities are generally similar. Sussman [1992] has listed a number of the common responsibilities which often include: the construction and maintenance of the physical infrastructure such as roads and sewers; the protection of life and property through police, fire and ambulance services; the control of physical development through land use planning; the provision of recreational facilities such as parks; garbage collection; the coordination of public transportation; and the assurance of public safety through the issuing of building permits and through fire, health and building inspections.

The common element linking these responsibilities is the spatial component. For that reason, many municipal governments have recognized the benefits of using GIS to manage their land related information in support of these activities. While these databases are at varying degrees of maturity in different jurisdictions, their creation and maintenance in

whatever form are nonetheless essential for effective government. The transfer to the private sector of database creation and maintenance activities will depend upon a number of circumstances. It is felt that the land surveyor's circumstances may be conducive to such a transfer.

The flexibility derived from the use of the private sector in the provision of public sector services places the private land surveyor in an advantageous position. The land surveyor is familiar with the local government and makes frequent use of their data store. The local surveyor is often a part of the land development activity that necessitates the database updates. The surveyor owns and operates a community based business and has an established professional reputation. As well, the essence of the surveyor's business is the gathering of spatial data that reflects the changes in the community's landscape. The combination of these factors suggests that the land surveyor is in a favourable position to take advantage of information provision and database updating opportunities at the municipal level. One of the many challenges for the land surveyor, however, will be to ascertain their information requirements and devise means of fulfilling them.

4.2.3.4 Other Opportunities

The SINET project, described in Chapter 3, is initially to be employed by surveyors as a means of sharing information for pre-survey research purposes. There is the possibility, however, that the successful implementation of SINET could lead to other opportunities. In New Brunswick, the NBGIC commissioned a study to examine the possibilities of instituting an active survey control network using the Global Positioning System (GPS) satellites as an alternative to the current survey control network. The active control network would consist of a number of fixed control stations, throughout the province, emitting signals to permit the use of differential GPS when establishing the position of survey markers [Hamilton, 1993]. By developing information management skills in the initial

stages of SINET, surveyors could place themselves in a position to assume the responsibility for managing the information used in the active control network.

4.2.4 The Private Sector

As land surveyors in private practice have an existing client base from both the private and public sectors, any listing thereof would be tautology. In its stead, the reader is challenged to examine the benefits that existing clients could reap from the implementation of the SURVUS model. In the first section of this chapter the existing surveying services were portrayed as being under pressure from a number of factors. While these factors were depicted in a negative light, from the proper perspective, each may also be viewed as having a potentially positive impact. From a land information management perspective, where the primary objective is to provide, in cooperation with others, land related information to users at a time and in a form usable to them, these factors may indeed improve services to the end user.

4.2.4.1 Private Sector Opportunities

The title insurance companies, although currently few in number, were depicted as presenting competitive pressure on the surveyors' services. As these services are comparable in many ways, they may be viewed as complementary. In fact, there may even be a reciprocal exchange of information on properties. As both the surveyor and the insurer collect and use parcel based information, there may be opportunities for developing mutually beneficial alliances that will enable improvements in meeting end-user requirements. For surveyors, there is the possibility that title insurance companies will require more detailed information than is usually provided in the Real Property Reports.

de Rijcke [1992] believes that more emphasis will likely be placed on the land surveyor's comments regarding deficiencies found during the survey. For instance, more information may be required about the date of origin of an encroachment, the nature or

stability or permanence of an encroaching structure, the extent of field work performed, and discussions with neighbours or other witnesses.

While any number of scenarios may result from the introduction of these insurance companies, surveyors have a duty to inform the public and the legal profession of the benefits that accrue from the Real Property Report, and the consequences of foregoing the latter. Although a proactive marketing approach of the surveyors' services is certainly necessary, it must be followed by efforts to improve the value of the service being offered to the consuming public.

4.2.4.2 Environmental Audits

The Real Property Report is usually commissioned by prospective purchasers or the lending institutions that provide their financing in order to ascertain risk in the extent of title. These potential purchasers are being subjected to another form of risk as well. When purchasers acquire title to a property, they may also assume responsibility for events that have occurred as a result of actions of previous owners. These actions may include among other things the contamination of soil, the burying of waste, or the dumping of toxic substances. The effect of these actions may be the contamination of surrounding ground water. These actions may also preclude new owners from undertaking some types of development. As a means of ascertaining liability and minimizing risk in these instances, there is a growing demand for property audits.

According to Snyder [1993], the property audit may comprise as many as three phases. Phase 1 is the environmental audit, whose objective is the qualitative determination of any environmental degradation to the subject property. This determination is made by conducting an historical review of the property; a walkthrough inspection; and personal interviews which lead to the preparation of a final report. If justified by the report, Phase 2 is initiated. This phase is known as the Site Assessment, which involves the quantification

of the level of degradation and may include the testing of water and soils among other things. The third phase is known as Site Remediation, which aims at reversing the ill affects detected in the previous phase. Snyder [1993] also points out that standards have been implemented for the conduct of Phases 2 and 3, while Phase 1 procedural standards may emerge this year.

The issue of liability associated with the environmental degradation of a property has many facets and is necessarily jurisdiction dependent. For instance, liability is absolute and requires no proof of negligence; the owner is responsible. Liability is also retroactive; in Boston, for example, all of the owners spanning as far back as 150 years may be held accountable. As well, the liability is judged on the present day standard, even though previous actions were in compliance with standards in force at that time [Snyder, 1993]. The costs associated with such liability may include: reduced land use potential and land value; direct clean-up costs; or civil actions (Toxic Torts) [Snyder, 1993].

The historical review of a parcel of land, which represents the initial stage of the environmental audit, is an information intensive search. The most difficult task involves gaining access to the disparate sources of information necessary for a thorough review of the property. Snyder [1993] has listed some of the sources that may be consulted in the course of the environmental audit: title search; historical land use archives; municipal business directories; aerial and historical photographs; topographic and property maps; tax assessment records and maps; geological and hydrogeological maps; planning and zoning maps; municipal plans and services; fire department records; building and other permits; newspapers; court decisions; and environmental agency files.

The environmental audit may be undertaken by various environmental specialists to ascertain the health of a property. Most major banks have instituted a policy to request such an audit for commercial and industrial mortgages, for fear of liability arising from

actions of their predecessors in title [Snyder, 1993]. The threat of losing one's investment in a property whose value may decline or whose use potential may be substantially diminished, is ample justification for determining and minimizing risk.

The similarities between the Real Property Report and the environmental audit suggest that their combination would be a natural evolution for surveyors. The sources of land related information used by the surveyor are quite similar to those used by the environmental specialist. Land surveyors can offer their expertise in the research activities. In addition, as both the Report and the audit are parcel based risk assessment tools needed by prospective land owners and their creditors, the creation of a partnership or alliance between the professionals could result in the provision of a potentially valuable service to the public.

4.2.5 Spatial Information Applications

Kennedy [1991] identified the spatial information applications market segment as a small but growing source of demand for land related information. A short list of these users was provided at the beginning of this section. As was also mentioned, this group of users is outside the realm of land and resource management, and typically lacks experience in dealing with land information. While land surveyors may view this segment primarily as users to whom they may supply land related information, there is another service that may emerge from this growing segment of users.

Baker [1992] points out that the increasing use of desktop mapping and GIS packages by a growing segment of society is giving rise to the new cartography, which is characterized by uncertainty in maps. Prior to this era, one could generally expect a certain level of accuracy in both position and content of the information portrayed on maps, because the mapping community followed certain standards. The specialized knowledge that surveyors and mappers brought to the production of maps was one of the factors that

implied reliability. Now that virtually anyone can create a map, neither the general public nor the mapping community can take for granted the reliability that once existed and was implied in the work.

In the distributed information environment, surveyors will be able to offer their expertise in cartography and geodesy to those casual users that may require it. This may include those involved in map creation using GIS and the like or position determination using GPS. The interpretation of metadata for these users was also discussed as being an area where the surveyor's specialized knowledge could be employed.

4.3 Information as a Commodity

In the previous section it was shown that information was one of the basic ingredients of the decision-making process. It was also pointed out that information must be packaged in such a way that the consumer views it as a resource or commodity with economic value. This section will examine the elements that contribute to the value of information. The similarities between the value-adding components discussed below and the functions of land information management outlined in the previous chapter are not coincidental. As information flows through each land information management function – i.e., capture, processing, ..., dissemination – its value invariably increases.

The value of information is closely related to the circumstances surrounding the decision-making process. The value is related to who uses it, when it is used, and in what situation it is used [Ahituv and Neumann, 1982]. To illustrate the concept of information as a commodity whose value depends upon circumstance, the authors provide an analogy with water as the commodity. Providing a glass of water to a wanderer in the Sahara desert will yield a far greater economic return than that to be had by providing the same glass of water to a person lost on a glacier in the Arctic.

Mowshowitz [1992] provides a framework depicting the key areas by which one may add value to an information commodity. The Chinese boxes in Figure 4.1 signify a logical rather than a physical containment of these value-adding dimensions. For information providers, each of these areas represents a market opportunity to the extent that it provides some benefit to the end user. A discussion of each of these dimensions and their applicability to the land information provider follows.

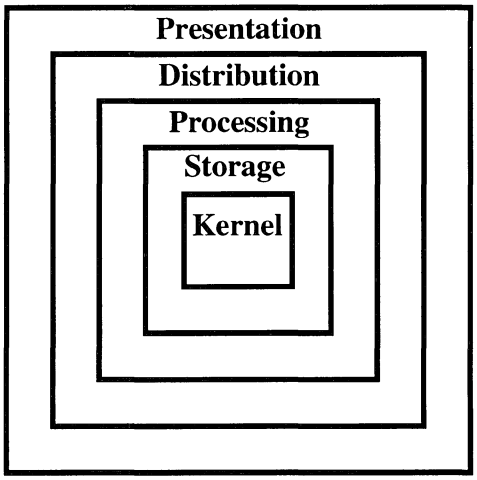

Figure 4.1: Chinese Box Model of Information Commodity
(from Mowshowitz [1992]).

4.3.1 Kernel

The kernel of an information commodity is the content of the information itself. The content attributes relate to the meaning of information to decision-makers [Ahituv and Neumann, 1982]. These authors have outlined five such attributes, namely: accuracy; relevance; exhaustiveness; redundancy; and level of detail. Again, the applicability of each of these attributes depends upon the nature of the decision being made.

Land surveyors are well acquainted with accuracy and its implications in boundary retracement and depiction as well as in the construction field. Without belabouring the subject, surveyors should be aware that those levels of accuracy are not required in many

situations. For instance, many of the users of property maps are primarily concerned with the relative position of parcels of land, where the exact locations of boundaries is often of little consequence.

The relevance of information is a major determinant of its value. Information is said to be relevant if it leads or might lead to a different decision, or if it confirms a decision that has already been made [Ahituv and Neumann, 1982]. If it is irrelevant, then the information has little if any value. Exhaustiveness refers to the completeness of information. In some circumstances, an exhaustive search may be unwarranted. For instance, if given an area in which rare species of trees are present, it may not be necessary to depict each and every one in order to affect a decision; the mere presence of a single tree may affect the outcome.

Surveyors have traditionally viewed redundancy in measurement as a means of ensuring the production of a quality survey. In this sense redundant information may be used to affirm a decision that has already been made, while not revealing anything new. Redundant information is also useful when attempting to convey a particular message. By distributing or posting a plan of zoning amendments to all the households in a particular area, in order to gain support for a particular position, and thus affect the decision maker, one has created value by virtue of information redundancy.

Presenting information at the proper level of detail (aggregation level) is another means by which one can increase its value. Theoretically, the proper (or optimal) level of detail is one under which more detail would not improve the decision, and above which further aggregation would worsen the decision [Ahituv and Neumann, 1982]. Its determination is no easy feat. The contrasting needs of a property owner erecting a fence and of a corporation planning a route for toxic waste disposal, highlight the varying levels of detail required by decision-makers.

For the most part, the content attributes of information are not unfamiliar to land surveyors. By explicitly presenting them in the context of value-adding information, one should be able to employ the appropriate attributes which correspond to the decisions being made.

4.3.2 Storage

The second dimension through which information may be value-added is storage. It includes both the medium of storage and the access method [Mowshowitz, 1992]. Surveyors have traditionally stored their information in filing cabinets and the like and have used paper indexes for accessing the information contained therein. One can add value to this store of information by exploiting the main attributes of storage, namely: capacity; speed of access; reusability; reliability; and longevity [Mowshowitz, 1992], through the use of information technology. The floppy disk and the CD/ROM have added a great deal of value to a number of information products. Reference manuals, encyclopedias and the Digital Chart of the World are but a few examples.

4.3.3 Processing

Processing involves both the hardware and software that is used by people from all sectors of society. Processing and storage are very closely related. For instance, the relational database management system offers capabilities for storing information, processing it, and retrieving it with the use of the Structured Query Language (SQL), which is a de facto industry standard. While SQL allows the database custodian to perform numerous processes, it also offers an access mechanism for other individuals interested in the store of information. Adding value to information by processing is now commonly performed by surveyors with coordinate geometry packages, computer aided design software, and in some instances, with the use of geographic information systems.

4.3.4 Distribution

The distribution component of an information commodity adds tremendous value by virtue of transferring it from the producer to the consumer. The communications hardware and software, which includes the network connecting the various parties, are the primary contributors to this value-added dimension. One of the main attributes affected by this component is that of timeliness of the information commodity. Ahituv and Neumann [1982] describe timeliness as consisting of a class of attributes, such as currency and frequency, that all relate to the time factor in information updating and retrieval.

Land surveyors are quite familiar with requests for last minute surveys and would be more apt to provide these services if the distribution mechanisms for land information were in place to support these efforts. Retrieving ownership information as well as all available survey information in the area through simple database queries would allow the surveyor to greatly minimize research time. The distribution mechanisms would permit the transfer of relevant information to field staff to support their task, and in turn permit the field staff to return the results of their field work. An efficient flow of information throughout the entire operation would permit surveyors to better fulfill their clients' requests.

4.3.5 Presentation

Presentation is the final link between the producer and consumer of the information commodity. For land surveyors the style of presentation of a plan of survey has become more or less standardized through regulations governing practitioners. From a traditional perspective, surveyors have placed their emphasis on the data gathering efforts, and looked upon the presentation of the final product as a necessary evil [Hamilton and McLaughlin, 1981]. From the land information management perspective, the presentation of the information commodity is as critical an element as the content itself, and plays a major role in contributing to its value.

Mowshowitz [1992] identifies two important components of the presentation dimension: internal; and external factors. The latter factor relates to the physical environment in which the information is displayed. In this case, lighting and ergonomics may play a significant role. The internal factors relate to the characteristics of the devices used to display the information such as colour, screen size, and emphasis. Another important element, which is somewhat related to the internal factor, is the use of visualization as a means of enhancing or augmenting the human ability to visually process information [Reshke, 1991].

Visualization takes advantage of the knowledge we have regarding human vision and the cognitive processes. One of the primary goals of visualization is to allow the information consumer to commit to long term memory the images presented, via the visual system and then the short term memory. This is achieved by exploiting colour, depth and form perceptions, and by minimizing obstacles such as confusing, ambiguous, and extraneous information both visual and audio. There are two broad categories of visualization techniques that have gained prominence through technological innovation: transduction; and computer graphics [Reshke, 1991].

The transduction process uses sensors to detect and record energy either actively through, for example, X-Ray, or passively through photographs and the like. Image analysis tools are then used to interpret or enhance the image. Computer graphics, on the other hand, are employed to generate images completely within the computer. These technologies allow the user to visualize objects from different perspectives through rotation and translation, to make spatial queries, and even navigate through the computer image. While some of these techniques may currently be rather costly, their value in terms of effectively representing information and affecting decision-makers may prove worthwhile.

4.4 Summary

It was shown that a continued emphasis on the land measurement and land development paradigms would be detrimental to the viability of the surveying profession. Viewing their work in terms of land information management was discussed as the primary means by which surveyors could transform current market pressures into future market opportunities. Effective land information management aims at reducing the impedance to the flow of information. Each information management function can be categorized as a value-adding component. The appropriate use of information technology was discussed as one means of maximizing both the flow and value of information.

A theme of particular importance presented in this chapter is the need to understand the information requirements of the end-user. While the great majority of these users come from the land and resource management community, there is a small but growing segment of users that fall outside the traditional concept of land information users. As an information provider seeking market opportunities, the land surveyor will require an appreciation of the particular management application and the types of decisions being made therein.

One of the tenets of land information management is the cooperation among professionals in meeting the information requirements of users. Scenarios of surveyors collaborating with other land information providers were presented as being mutually beneficial for all parties involved including the clients. The similarities between the Real Property Report and the environmental audit suggest that the surveyors' expertise is well suited for combining these activities. One of the greatest obstacles facing the majority of people involved in the management of land and its resources is gaining access, in an efficient manner, to the disparate information sources required for their purposes.

A significant portion of the information sources that must be consulted in the process of an environmental audit or pre-survey research are under the custodianship of government agencies or departments. As the public sector represents the largest segment of both spatial data infrastructure users and sources, access to its data store is viewed as crucial for meeting clients' information requirements. Access is also viewed as a potential market opportunity for land surveyors. Database maintenance at the municipal level was described as being within the realm of possibility. Capitalizing on this opportunity will require, among other things, the development of institutional arrangements and policies that govern the conduct of parties in relation to the issues of access, privacy, liability, security and pricing. Addressing and resolving these issues is one of the motivations for the concept of the national spatial data infrastructure.

The pressures from technological developments, new forms of competition, and environmental concerns have complicated the nature of the marketplace for traditional surveying services. An appropriate response to these pressures would include, among other things, placing more emphasis on the marketing dimension of the business of surveying. This includes market intelligence; the proactive search and assessment of the changing needs of existing and potential clients, and also includes the active promotion of the benefits derived from surveying services.

5. The Land Surveying Firm: An Organization

The preceding chapters have focussed primarily on the examination and analysis of factors related to the land surveyors' external environment. The introduction of the concept of the land surveyor as part of the national spatial data infrastructure and the changing nature of the marketplace were described as major external influences. These, in turn, will play a significant role in shaping the land surveyor's internal environment. The objective of this chapter is to examine the various constituent elements of the typical land surveying firm and to assess the changes required to successfully implement the SURVUS concept. The most appropriate means of assessing these changes is through the organizational framework.

The land surveying firm will be discussed in terms of an organization that consists of four interdependent components. The strategy to be employed in developing a new model of the surveying organization is based on an analysis of its past and present forms. The trends extracted from a comparison of these forms combined with knowledge of the changing external environment and research on organizational change, provide valuable insight into the type of modifications required. This information will be employed to develop of model of the surveying firm suitable for implementing the SURVUS concept. The model will entail a description of the characteristics of the four organizational components, and suggestions for implementing the necessary changes.

One of the characteristics of the post-industrial economy is the growing prominence of information technology. As a result, there is a sense that technology is the driving factor behind many of the changes facing the surveying profession. Both the spatial data infrastructure and the SURVUS concept rely heavily on information technology for their success. Although technology is certainly an important component of the emerging distributed information environment, from an organizational perspective, it is only one of

many components. Over-emphasizing technology can have a detrimental effect on an organization, and effective technology management will be crucial for success. To that end, surveyors must be aware that technology should not drive the organization, but rather the organization should drive technology. That is, technology should be viewed as a tool to aid properly trained people in the completion of well defined tasks within a structure that permits its effective use.

5.1 The Organizational Framework

According to Leavitt [1972] an organization is a rich, volatile, complicated but understandable system composed of four components or elements: *tasks, technology, people, and structure.* Figure 5.1 depicts the organization in terms of these complex interrelated components. An attempt to change a single component within an organization without due consideration for its related components would yield less than satisfactory results.

It is worth noting that one element of an organization's strength is the amount of capital resources that it has at its disposal. Access to capital is no trivial matter, particularly for small business enterprises. An examination of issues related to access to capital resources is beyond the scope of this research.

5.1.1 External Environment

The ellipse enclosing the organization in Figure 5.1 is the boundary separating it from the external environment. While the boundary seems to depict a discrete and isolated unit, no business or organization is an island unto itself. The organization's four constituent elements are each affected in different ways by external factors. Society, clients, governments, and other organizations all have a stake in shaping the behaviour of organizations [Leavitt, 1972]. As discussed in the preceding chapters, the land surveyor's

external environment is undergoing a number of changes in the form of: the distributed information environment, technological developments, and the state of the natural environment, among others.

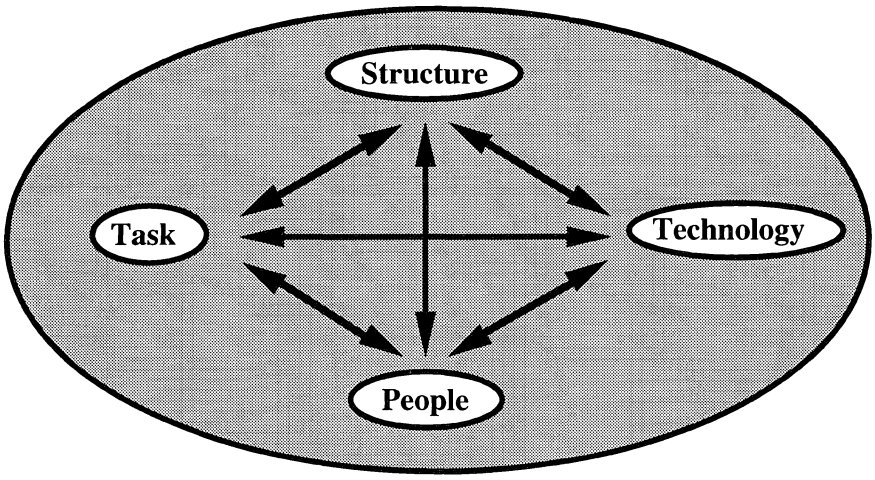

Figure 5.1: The Elements of an Organization (from Leavitt [1972])

Although external factors play a significant role in shaping the internal workings of an organization, the converse is also true. An organization can act to influence and reform its external environment. These two statements represent the essence of the argument for the development and implementation of the SURVUS concept. It is both a response to the changing external environment, and an action plan for affecting it. A brief description of the four elements is presented below.

Structure: The structure is the system used to define the relationships that exist between individuals in the organization. The complexity of the structure is usually proportional to the size of the organization. Large organizations often require charts and flow diagrams to depict the locations and levels of authority, the different roles that

individuals play, and their lines of communication. The structure of the typical surveying firm is relatively flat and lacks the complexity confronting managers in larger organizations.

Tasks: The tasks performed within an organization produce the outputs that satisfy clients' needs. More often than not, the output from a surveying firm is a plan of survey of one form or another. Many of the tasks involved in this production are governed by regulations of the professional licensing body, which often include: research; application of the appropriate statute and case law; and the form and content of the final product.

People: The employees of a surveying firm work within the structure to perform the necessary tasks using the appropriate technology to create the final outputs. The people dimension of an organization is truly complex. Making individuals work as a system in concert with the other systems of an organization is no trivial task. Many managers describe the management of people as being the most challenging activity within their organization. Employees must possess the skills necessary to use the technology, the personalities to work within the structure, and the capacity to adapt to changes in other systems. Providing an environment where employees can be fulfilled by their contribution to the organization is one of the many requirements of management.

Technology: Technology is often associated with automation, which places the focus on using tools to perform work previously reserved for human beings [Leavitt, 1972]. When technology is introduced into an organization, it will invariably affect the other systems. People may require new skills. The structure may change. The tasks may differ. The following sections will examine technology in relation to the land surveyor.

5.1.2 The Importance of Technology Management

As one of the leading forces in this new information environment, technology has been a mixed blessing. It has provided many useful and time saving tools for the surveyor. The rapid pace of technological change, however, demands a certain level of knowledge about

the technology in order to make informed decisions concerning the tools used for day to day tasks. As time progresses there is every indication that the dependence on these tools will continue to grow. If the transition into the role of information broker is to be successful, the surveyor must have the ability to manage technology in general, and to manage technological change in particular.

5.1.3 Over-Emphasis on Technology

The issue of technology management is particularly important for surveyors, as past circumstances seem to indicate a lack of success in this area. As was discussed in Chapter 2, there is concern both within the surveying community and in society in general that members of the profession in recent decades have been the subject of the phenomena of technological virtuosity. This has manifested itself through an emphasis on tools and techniques in the search for higher measurement accuracy. It has been shown that this love of challenging technological problems can act to overshadow the social and other implications of the work undertaken.

Hannigan [1990] and Raymond [1981] have both pointed out that the surveyors' concentration on the technical aspects of surveying have had a detrimental effect on their administrative and professional roles in land information management. Whether knowingly or not, the emphasis on technology has left an enduring, albeit undesirable, legacy for surveyors. Being associated with the tripod and transit is not only a reflection of public opinion of the profession, but a testament to the surveyors' efforts vis-à-vis the management of technology.

While technology is certainly an important component for interacting in the distributed information environment, it is only one of many elements that truly define the profession. One would not wish to update the image of the profession to a point where it is the technology that provides our definition. Personal computers and satellite receivers will one

day become as obsolete as the tripod and transit. While the association with high-technology has the potential to attract more students to surveying programmes and create an contemporary image of the profession in the public's eye, it will require a continuous updating campaign as the technology changes. As the profession is still dealing with the image problems from decades old technology, it would seem that a de-emphasis of technology in terms of the surveyors' image would offer long term sustainability.

5.1.4 Diffusion of Technology

A major concern raised in Chapter 3 is the diffusion of technology. In time, the commoditization of information technology will place much of these tools within the reach of many sectors of society. Lower costs and increasing user-friendliness are among the main contributors to this trend. It may thus become increasingly difficult for surveyors to maintain exclusivity in the technology. As was depicted in Figure 3.4, all those involved in the infrastructure, including users and other professionals, will have access to the technology. King and Grover [1991] have pointed out that although information technology can provide a competitive advantage, it is often short-lived because competitors too can acquire the technology. In order to sustain a competitive advantage there is a need to identify the information-based opportunities.

5.1.5 The Need for Technology Management

Perhaps the most conspicuous example of technology mismanagement is that of a land surveyor who purchases a powerful and expensive GIS only to have it collect dust in the corner of the office. Whether the motivation for such a purchase was to explore new market opportunities or develop some in-house expertise, the land surveyor's attempt was clearly unsuccessful. There may be a number of explanations for this unfortunate incident: the lack of existing expertise; an inadequate amount of resources dedicated for training –

time, money, and personnel; a limited supply of digital data; insufficient knowledge of the marketplace; or an extremely persuasive systems salesperson.

All of the factors listed above are among the typical inhibitors to successful systems implementation. While there is no foolproof prescription for successfully managing technology, there is a wealth of literature that describes the subject in the context of an organization. During the research for this thesis, it was discovered that the lion's share of the recent literature was dedicated to the design and implementation of information systems within large organizations. The lack of literature dealing with small and medium sized firms has compelled the author to derive from the existing literature on large firms, information that is applicable to the typical land surveyor. Perhaps the most significant message emerging from this literature is the necessity of viewing technology in terms of the organization.

In the example above, it is suggested that the land surveyor did not take into consideration that a change in technology required simultaneous changes in the other systems within the surveying firm. By viewing the surveying firm as an organization and instituting the appropriate changes in the related systems, the land surveyor might have been more successful. The new technology may require changes in the structure of the firm, as in a delegation of responsibilities to the individual operating the technology. The individual will most certainly require special skills and training to make effective use of the technology. And finally, the tasks to be performed should be clearly defined. The technology may be used to replace or automate existing tasks, or may be used to perform new tasks. It is not difficult to visualize the extent to which each of the organization's systems is dependent upon the other.

5.2 The Surveying Firm: Past and Present

In Canada the average surveying firm currently has eight employees [Jacques, 1993], which makes it a difficult task to compare it with a large organization. While some of the characteristics of the latter are directly applicable to the typical surveying firm, it is the size of the former that tends to accentuate the degree to which these characteristics become either advantages or disadvantages in terms of adapting to changes. The ability to adapt to change is a prerequisite for the SURVUS model which is in essence an innovative concept that will require changes in all of the organization's systems. An assessment of these changes will be partially based on an examination of past and present forms of the typical surveying firm.

The shape of surveying firms that conducted business ten or twenty years ago is much different than that of today's firms. Each of the organization's systems has evolved in one way or another. The system most inclined to induce change is technology. The following sections will explore that evolution by describing the form of these systems as they existed approximately a decade or two ago. Information derived from a comparison of each system with its counterpart as it exists today will be used to develop a model of the surveying firm of the future.

5.2.1 Technology

Roberts [1981] described the twenty year period beginning in the 1960's to be one of massive technological change for the surveying profession. The most notable change was in the instrumentation. During this period, the transit and the chain were replaced by the automated theodolite and electronic distance measuring (EDM) equipment. Other familiar forms of technology that once dominated the surveyor's office include the field book and pencil (pen), the slide rule, calculator and drafting table, the Leroy set and velum, and the filing cabinet. While some of these remain in use today, it is not difficult to visualize those

that are currently in transition. Each of these tools has been used to perform different tasks within the office. The separateness of these tasks, which will be described in the following section, has been partly dictated by the nature of the tools employed.

The use of technology has become more intensive over the years. As a percentage of total sales, private sector geomatics firms invested 10% in technology in 1979, which grew to 27% in 1991 [Task Force, 1991]. Today the typical surveying firm uses electronic theodolites and total stations; microcomputers; coordinate geometry, computer aided drafting and other software; plotters; and the facsimile machine. While it is not an absolute certainty, there are indications that as society grows more dependent on information technology, the use of paper will decrease. In that sense, the surveyor's office can be described as being in transition from a paper-based operation, to one in which digital information will be the norm. The co-existence of filing cabinets and the paper field notes with floppy disks and hard drives is one indication of the current transition.

5.2.2 Tasks

As mentioned earlier, the tasks are performed to create outputs, which in the case of the surveying firm are usually in the form of plans of survey whether they be cadastral, topographic or geodetic. From an output perspective, the most significant change to occur in recent years has been a growing demand by clients for digital products. In terms of tasks, there has been a number of changes brought about by the technology. The sequence of tasks has remained relatively unchanged throughout the years.

The process usually begins with a telephone request for a survey which is followed by research and field measurement activities. Computations and the application of appropriate case and statute law, drafting, quality control and the delivery of the plan by a courier are among the activities that have characterized the typical surveying firm for many years. While new technology has affected field measurement activities, the most profound

changes to date have occurred in the computations and drafting activities by virtue of the microcomputer.

The ability to up-load the data from a total station survey instrument to the computer for processing and drafting is one indication of the trend toward the integration of activities that were once separate and distinct. Although the research at the front end, and the delivery at the tail end of the process have remained virtually unchanged through the years, they will eventually be subjected to similar changes from technology. It is interesting to note that to date the only task to avoid pressure from technology is the application of the law to cadastral surveys. The future, however, may witness developments in expert systems that are able to capture and apply that specialized knowledge.

5.2.3 People

With an organization of eight employees, today's typical surveying firm may have two party chiefs, two field technicians, an office technician, a secretary and at most two licensed surveyors. A comparison with surveying firms of the past on the basis of number of employees is rather difficult because of the number of variables involved. The state of the local economy and the management skills of the proprietor have an enormous effect on the size of a surveying firm. Instead, a comparison of skills, education and the effect of changing technology will be used to derive information about the people system of the surveying firm.

In Canada, the most significant change for the profession during this period was the abandonment of the apprenticeship system for professional licensure in favour of university education. This change was brought about by the recognition that the apprenticing system was unable to convey to its pupils the high level of mathematics and sciences required to comprehend reforms in surveying and mapping computations [Roberts, 1981]. One of the characteristics of the apprenticeship system is the lack of infusion of knowledge from

outside the profession. This, in turn, creates an atmosphere which is conducive to maintaining the status quo, and in which innovation is the exception rather than the rule.

The introduction of more sophisticated equipment, the increasing complexity of surveying work, and the need for more accurate title descriptions and surveys were some of the justifications for increasing the surveyors' standards of training. It was also recognized that the apprenticeship programmes made a difficult task of maintaining a uniform level of professional competence, which in turn adversely affected the status of the profession [Love, 1975].

Technology has played an important role in changing the shape of the surveying firm. One of the job categories that has been largely phased out in recent years by technology is the draftsperson. Automated drafting is now commonly performed by either the party chief, office technician or the surveyor, which is an indication that the skills level of the employees is on the increase. As well, the level of education is on an upward trend. Since 1985, there has been a decrease in the percentage of high school graduates employed by the geomatics private sector [Task Force, 1991].

One other significant change in the surveying firm during this period has been the streamlining of the field crew from a three person operation to a two person survey crew, which is the direct result of the EDM. The introduction and subsequent widespread use of the EDM in surveying firms was preceded and accompanied by university level courses dedicated to the study of the intricacies of this tool. The analogy with today's courses in GIS, suggests that the future may witness the latter's commonplace usage. One difference, however, lies in the fact that the EDM automated the linear measurement task and was the direct replacement of the chain. The GIS, on the other hand, offers the capability to perform tasks that have no counterpart in existing or past forms of the surveying firm. In

its most basic form, the GIS represents a tool that can assist in the management of digital data, which can be justified in terms of replacing existing activities.

5.2.4 Structure

At first glance, the structure of the typical surveying firm seems relatively stable and simple. Throughout the years though, there have been some subtle changes. The relationships between the licensed surveyor(s), the party chiefs, the other field staff, the office technician(s), and the secretary have been in evolution. The duties that each perform are no longer easily separable and there is some evidence of a shifting of responsibilities. For instance, the migration of the licensed surveyor from the field into the office environment, has resulted in the delegation of more responsibilities to the party chief. As the surveyor's primary representative in the field , the party chief is expected to exercise professional judgement in collecting and weighing evidence. Although the ultimate liability is borne by the surveyor, the growing demands placed on the latter by external and internal forces dictate the relinquishment of certain responsibilities to other employees, which alters the structure of the firm.

The technology is another element affecting the structure of the surveying firm. The office technician whose duties may have included maintaining field equipment, organizing field notes and plans, and working on the computations or drafting for field projects, may now have become the resident computer systems specialist. As the dependence on technology grows, the technician may become the single major source of input into purchase decisions for hardware and software within the firm. This has the effect of altering the structure by shifting the responsibility for office and field technology away from the surveyor.

One of the dangers with this scenario is that the technician may make decisions about technology without having a sense of its effect on the organization as a whole. Eason

[1988] discusses this problem in terms of large organizations, whose information technology experts, often found in the Management Information Systems (MIS) department, implement technology without knowledge of its effects on the other organization's systems. The result may be the creation of conflict between the technology and the overall objectives of the organization. This is what is meant by technology driving the organization.

One of the characteristics of the structure that has remained relatively unchanged, pertains to the relationships that exist external to the surveying firm. These relationships have been built on mutual involvement in the land development process, and often include affiliations with land developers, construction firms, civil engineering firms, and the legal profession, among others. Building and maintaining these linkages is an important part of the overall success of the firm. The management skills needed to develop these affiliations will play a significant role in the surveyors' future as the interdisciplinarity of land information management becomes more apparent.

5.2.5 Summary

The comparison of past and present forms of the typical surveying firm has highlighted some important trends, not the least of which is the interdependence between the four organizational components. Perhaps the most significant trend is the increased dependence on technology which has acted as the change agent for the other elements within the firm. Over the years there has been a trend toward the integration of tasks that were once separate and distinct by virtue of the technology employed. The comparison has also shown an increase in the skills level and educational background of the people within the firm. The evolution of the structure of the firm is characterized by the surveyors' delegation of an increasing amount of responsibilities to employees. The other structural element

considered an important part of the success of the firm is the linkages formed with external organizations.

5.3 Innovation and the Organization

Prior to the development of a model of the future form of the surveying firm will be a review of recent literature pertaining to organizations and how they adapt in the face of technologically-induced change. The review will provide insight into the characteristics of the organization that are conducive to change and innovation. This will be followed by a discussion of innovation in relation to the surveying firm.

SURVUS is essentially an innovative concept that will be made possible through technological and other developments. It is both a process innovation and a product innovation. Gattiker [1990] points out that process innovations involve those changes affecting the methods by which outputs are produced, whereas product innovations are aimed at the outputs themselves. Very often the result of an adaptation in the process technology leads to new and innovative products. In the case of SURVUS, the access, analysis and dissemination of digital land related information represents a shift away from the traditional means of acquiring information and offers the opportunity to develop new products and services.

5.3.1 The Dimensions of Innovation

Gattiker [1990] describes innovation from a number of perspectives. They may be thought of as dimensions, two of which are presented here. The first dimension relates to the type of innovation: *incremental* and *radical*, which represent opposite ends of a continuum. Incremental innovation involves the introduction of technology new to an organization that is very similar to its present technology and that requires little change in the processes of the organization to be used effectively. In this sense, the status quo is

maintained. Radical innovation, on the other hand, involves the introduction of technology quite different from that which the organization has previously used, and which therefore requires significant changes to the processes to be used effectively. A radical innovation interrupts the status quo [Gattiker, 1990].

The second dimension of innovation refers to the time frame in which the innovative technology is adopted by the organization. They are: *reactive adaptation*; and *proactive adaptation*. Reactive adaptation occurs when an organization begins to institute the necessary internal changes only shortly before the introduction of the technology. Proactive adaptation occurs when an organization anticipates and assesses the needs for internal change and then introduces them in a gradual manner prior to adopting the technology. Employee participation in the technology acquisition and adaptation processes is one characteristic of the proactive approach [Gattiker, 1990].

It is clear that the ideal time frame for the acquisition and adaptation of technological innovations is through the proactive approach. The choice between radical and incremental innovations, however, is more tenuous. For an organization to successfully adapt to a radical innovation, it will have to exhibit extreme flexibility. If survival depended upon it, a radical innovation may be necessary. To maintain the status quo, however, as is the case with incremental innovations seems, at first glance, contrary to the concept of innovation. Both Keen [1981] and Davis [1987] extol the virtues of incremental innovation, but provide the added feature that the status quo in itself must represent change. In that sense, if the status quo is actually constant motion, a series of tactical decisions over time can add up to a radical strategic redirection, where each individual step is incremental in nature [Keen, 1981].

5.3.2 Innovation Within Organizations

Gattiker [1990] separates organizations into four categories according to their ability to acquire and successfully adapt technological innovations. His analysis is based on two factors: strategic choice and environmental determinism, which may otherwise be described as factors internal and external to the organization, respectively. A description of these two factors is presented below. The four organizational types are slotted into the matrix shown in Figure 5.2. The typical surveying firm will be classified within this matrix. The organizational characteristics that are most likely to lead to the successful adaptation of technological innovations are described and a comparison is made with the existing surveying firm to determine which of its organizational systems require modifications.

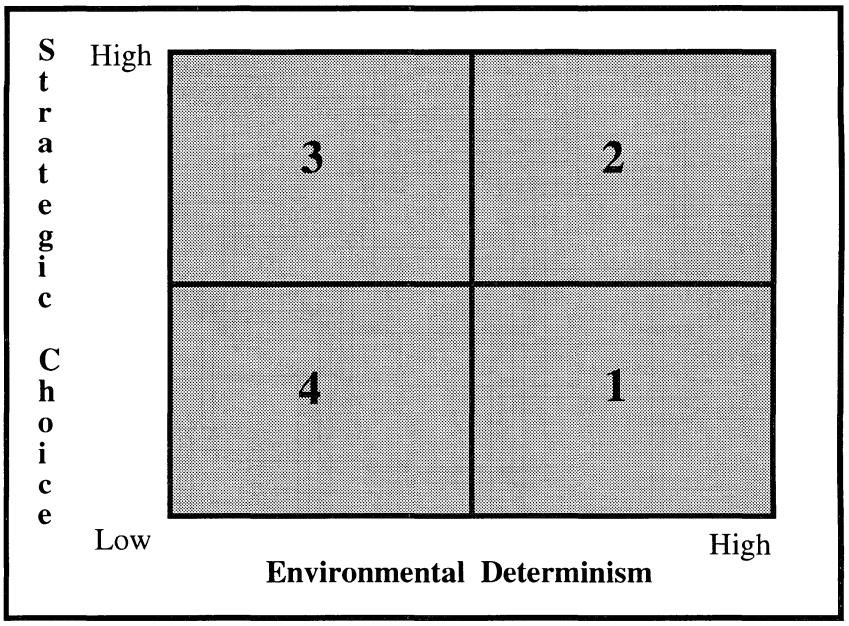

Figure 5.2: Relationship of Strategic Choice, Environmental Determinism in Technology Acquisition, and Organizational Adaptation (after Gattiker [1990])

5.3.2.1 Strategic Choice

Strategic choice refers to the robustness of each of the organization's systems and of the relationships between them. In essence, it may be described as the relative health of each system and its ability to adapt to change. Sufficient technical resources and expertise, access to financial resources, flexible structure, appropriate management expertise, and adaptable personnel are a few of the characteristics of high strategic choice. As the elements of strategic choice are to a large extent controllable by the organization's management, their enhancement represents perhaps the most significant instrument for remaining viable.

5.3.2.2 Environmental Determinism

Environmental determinism may be described as the extent to which external factors dictate changes in the internal systems of an organization and, in particular, the time frame in which those changes take place. For instance, a high level of environmental determinism often results in reactive changes, whereas a low level permits a proactive approach to instituting change [Gattiker, 1990]. Environmental determinants include such subjects as: the state of the economy, interest rates, government regulations, competition, the demand for the organization's products or services, and the supply of qualified personnel, to name a few. The inherent nature of environmental determinism suggests that management has little or no control over the existing external factors.

5.3.2.3 The Type 3 Organization

Gattiker [1990] describes the Type 3 organization, which is characterized by high strategic choice and low environmental determinism, as being the most successful in adapting to technological innovations. The flexibility and abundance of internal resources and the lack of external constraints allows these organizations to take a proactive approach to technology acquisition and organizational adaptation. The strategy offered by Gattiker

[1990] for organizations slotted in other quadrants of the matrix, is to aim at attaining the status of the Type 3 organization by either increasing the firm's strategic choice, lowering the environmental determinism, or both.

5.3.3 Innovation and the Surveying Firm

According to Jacques [1993], the profile of the typical land surveyor is that of "a professional that works for a local clientele, heavily dependent on the local economy and with limited space to manoeuvre" [p. 2]. This profile is based on a nation-wide survey conducted by the Canadian Council of Land Surveyors, and thus represents the land surveyors' perception. The limited manoeuvring space seems to indicate that surveyors operate with a high level of environmental determinism. It may also indicate a low level of strategic choice, which would characterize the typical surveying firm as being a Type 1 organization.

What is apparent from the above profile is the sense that this is a reflection of the traditional concept of surveying services. That is, surveyors are experiencing the limitations inherent in the land development and land measurement paradigms, which are, in essence, the cause for the high level of environmental determinism. It is this author's contention that by embracing the land information management perspective, land surveyors can reduce their level of environmental determinism. This will be accomplished by exploiting the various market opportunities identified in Chapter 4. The current untapped and uncharted markets translate into a decreased number of environmental determinants, the level of which is difficult to predict. The state of the marketplace, however, suggests the presence of a window of opportunity, which will shrink with time as the level of environmental determinism increases.

This propitious one-time event – a sudden decrease in external constraints by virtue of embracing the land information management perspective – requires increasing the

surveying firm's strategic choice in order to take full advantage of the opportunities presented. Increasing the strategic choice involves innovation and change, the dimensions of which were described above. The proactive approach is by far the most logical choice in terms of innovation time frame, and the one which is most likely to lead to success for many organizations. The incremental form of innovation is also an appropriate selection for the surveyor, particularly as one considers change from the spatial data infrastructure point of view. Over time, a series of technological and institutional developments will see the birth of the infrastructure which at that time may be considered a radical change if the previous series of seemingly innocuous innovations went unnoticed.

An important issue arising from the above discussion relates to the implementation of changes in an organization where change is not one of its common features. Many forms of resistance may surface as a result of introducing change. Strategies for dealing with resistance will be discussed below.

5.3.3.1 Resistance to Innovation and Change

If change and innovation do not form part of the surveying firm's edict, undertaking a radical innovation in the initial stages may be the necessary precursor to instituting incremental change for the long term. When change is not the norm, it will almost certainly be met with resistance which must be overcome if the innovation is to be successful. Markus [1983] has developed three theories which attempt to explain the cause of human resistance to organizational change brought about by technological innovations.

The first theory explains the resistance as being caused by factors internal to the person or group that is resisting the new system. The common human characteristic that all people resist change is given as an example of this theory. Keen [1981] uses the term 'social inertia' to describe this characteristic. That is, no matter how hard one pushes or pulls, there never seems to be any movement

The second theory is based on the idea that the resistance originating from the person or group is a result of factors inherent in the system or technological innovation. Under this theory, resistance would occur if, for example, there were technical deficiencies in the system, the system had poor ergonomic design, or the system was not user friendly [Markus, 1983]. The author explains that while the two theories view the resistance as emanating from different sources (i.e. internal and external to the person or group), most system implementors hold true the two theories simultaneously.

The third theory proposed by Markus [1983] views resistance as emanating from the interaction of the characteristics of the people with the characteristics of the system or innovation. A technological innovation that changes the balance of power in an organization will be resisted by those who lose power and accepted by those who gain it. In this instance, the interaction of individuals in an organization with a system that alters their autonomy is the likely cause of resistance.

The central themes of these three theories are conspicuously similar to three of the four organizational systems outlined at the beginning of the chapter. Markus [1983] has termed the theories as People-Determined, System-Determined, and Interaction Theory, which have a one-to-one correspondence with the People, Technology, and Structure systems of the organization. Identifying the source of resistance is an important precursor to dealing with it. As one might expect, each theory has its own tactics for dealing with resistance, which are presented below.

People-Determined

- educate users (training)
- coerce users (edicts, policies)
- persuade users
- user participation (to obtain commitment)

System-Determined

- educate designers (better technology)
- improve human factors (ergonomics, man-machine interface)
- modify packages to conform to organizational procedures
- user participation (to obtain better design)

Interaction Theory

- fix organizational problems before introducing systems
- restructure incentives for users
- restructure relationships between users and designers
- user participation is not always appropriate [Markus, 1983].

The appearance of resistance is simply an indication that the innovation, as designed or implemented, is problematic. More particularly, resistance will likely occur in those organizational systems that have not undergone the necessary modifications. From this perspective, resistance provides useful clues as to what went wrong and where, and may be viewed as an opportunity to rectify the situation [Markus, 1983]. Avoiding resistance, however, before it occurs is the result of a well designed and implemented innovation. The final section of this chapter will address the issues related to improving the surveying organization's internal systems to increase strategic choice and thus offer greater possibilities for successfully implementing the SURVUS concept.

5.4 The Surveying Firm: Present and Future

The trends derived from the analysis of past and present forms of the surveying firm will be combined with knowledge of the changing external environment to help develop a model of the future form of the surveying firm that will be suitable for implementing the SURVUS model. As well, there are a number of researchers who have developed hypotheses and concepts of the future form of organizations suitable for the information economy. These will be presented and discussed in relation to SURVUS. While there is

always a certain danger associated with predicting the future, the real risk lies in the denial of a future that is different from today. As Eason [1988] points out, "the one feature of the future about which we can be reasonably certain is that rapid change will always be with us" [p. 216].

It would be rather bold of the author to state that there is one organizational model that will suit the implementation of SURVUS. "Given that there are many choices it is not possible to present one Utopian view of the organization in the information age" [Eason, 1988, p. 216]. For that reason, the model will be limited to a description of the characteristics of the four organizational components that would provide an atmosphere conducive for the successful implementation of the SURVUS concept. The following sections will explore the nature of the changes for each of the four organizational systems.

5.4.1 Introduction

The reader will notice the overlap between the organizational components which is difficult to avoid by virtue of their interdependent nature. The tasks, for instance, are closely related to the skills, which are also related to the people component of the organization. Similar overlaps occur with other systems throughout this section. In following the theme that technology strategy should flow from the business strategy, the most appropriate organizational component to begin with is the tasks. The tasks produce the outputs which fulfill the needs of clients in the external environment, which is the essence of the business strategy.

5.4.2 Tasks

The tasks that will be undertaken in the surveying firm can be characterized as land information management activities. The surveyor will be concerned with ensuring that information is able to flow from the data gathering through to the data dissemination activities with minimum impedance. Through each task, the land surveyor will be adding

value to the information. The activities may be separated into three categories, each very much dependent on the other, namely: technological, institutional, and managerial.

5.4.2.1 The Technological Dimension

The technological component of ensuring the effective flow of information will involve tasks such as: data capture, data processing, data structure and storage, data representation, data distribution, and data management. These tasks are currently being performed in an environment which is both paper-based and digital. This duality has placed restrictions on the ability to integrate the various tasks, because of the nature of the technology employed. As more digital tools become available, however, the trend will be toward the integration of tasks. For instance, pre-survey research will no longer involve leaving the office. The search and retrieval will be done over the network. The use of the courier or personal delivery of survey products will be replaced by the digital dissemination over the network.

The shifting of the land surveyor from being predominantly in the field to working almost exclusively in the office was the first indication of the trend toward a de-emphasis on field data gathering activities. This trend is evident in the public sector land information management functions, where data gathering activities represented 45% in 1970, and are expected to decline to 10% by the year 2000. The data storage, manipulation, and presentation activities are expected to increase over this decade. Future data gathering activities will be focussed on updating, upgrading and refining databases [Zwart, 1991].

In the new environment, the most important tasks will be performed in the office. This shift is happening in other sectors as well. In manufacturing, for instance, the production facilities have historically played the dominant role, which relegated the office to a secondary activity. The growth of the service sector, however, has resulted in office work

becoming the primary activity [Gattiker, 1990]. The diversification of General Motors into the provision of financial services is one example of this trend.

5.4.2.2 The Institutional Dimension

The institutional tasks are separate from the technological tasks in that they address issues related to the information itself. Gaining access to databases, ensuring privacy, and dealing with liability and security issues are among the major tasks under this heading. As these tasks are not part and parcel of their traditional training, surveyors should seek out information and guidance on these subjects if they expect to interact in the distributed information environment. The area in which surveyors have much to offer in terms of dealing with land-related information is in its analysis, interpretation, verification, and certification. The knowledge and application of land law, and the expertise in measurement and data quality are a few of the important skills that surveyors possess and will apply in the completion of the above-mentioned tasks.

5.4.2.3 The Managerial Dimension

The two preceding dimensions will be ineffective, and perhaps impossible without a full complement of managerial skills. The surveying firm operating in the distributed information environment will be composed of organizational systems much more complex than their current counterparts. The task will be to make these complex and evolving systems function in unison.

Perhaps the most significant of all the managerial tasks will be continual process of developing an understanding of the changing external environment, one dimension of which includes market intelligence. Levitt [1975] states that the difference between selling and marketing is that "selling concerns itself with the tricks and techniques of getting people to exchange their cash for your product ... marketing ... view(s) the entire business process as consisting of a tightly integrated effort to discover, create, arouse, and satisfy

customer needs" [p. 176]. One could argue that surveyors have traditionally sold their services. The Task Force [1991] has characterized the profession's membership as "waiting for the phone to ring" [p. 80] in the hope that clients will come to them. This traditional approach has been relatively effective for the profession because they have enjoyed a monopoly in their service provision. Pressures in the marketplace are dictating the necessity to take a more proactive approach.

5.4.3 Technology

According to Don Tapscott, vice president of technology at DMR Group Inc., the main objective of the first era of investment in information technology was the automation of clerical and other functions which led to increased productivity [Blackwell, 1992]. While productivity gains will continue, the level at which they increase will only be incremental. Instead, continued investment in information technology will be made in order to deliver new products and services. The tangible benefits of increased productivity will give way to the intangible benefits resulting from the use of technology. Blackwell [1992] lists the following intangible benefits:

- improve product quality;
- improve customer service;
- get products to market faster;
- gain competitive advantage.

5.4.3.1 The Integration of Technologies

The efficiency gains and the intangible benefits will arise through the integration of the various tools employed in the performance of tasks within the office. Eason [1988] points out that the technology now provides the means to integrate information handling systems which had previously been separate activities; data processing on large mainframe computers, text on typewriters, photocopiers and printing machines, and communications

via the telephone, radio and television. The result of the integration of these and other activities is the formation of a single 'information technology'. The emergence of GIS and GPS in the marketplace being packaged as a single system is evidence of this trend. *Microsoft Works*, a software package that brings together the disparate applications of word processing, spreadsheet, database, graphics, and communications is another indication of this trend.

Information technology that will likely characterize the SURVUS office include: microcomputers, laptops, and hand-held computing platforms suitable for field activities, database management systems, storage devices, both communications hardware and software and applications software to handle text, graphics, and images, as well as character recognition; the total station survey instrument and GPS equipment. A graphical user interface may likely be the mechanism through which these disparate applications will be combined.

5.4.3.2 Technology Standards and Substitutions

One of the primary objectives in the SURVUS office is the ability to communicate effectively with the external environment: to establish and maintain connectivity. The key principle in attaining that objective is adherence to industry standards [Anderson and Moore, 1992]. Within the surveying community, for instance, the DOS-based computing platform is the de facto standard. The relational database management system which offers a common language (SQL) for database queries and updates is another example of a de facto standard. Efforts to introduce new technologies such as the OS/2 operating system, or to improve older existing technologies such as UNIX through the graphical user interface, place pressure on the DOS environment.

The pressures exerted on established technologies by the introduction of a new and better one, often has the effect of pushing the established technology to institute

improvements in an attempt to resist being replaced [Steele, 1990]. Microsoft *Windows* and *Windows NT* (New Technology) are examples of efforts aimed at resisting replacement of the DOS environment through improvements. One of the important technology management tasks, according to Steele [1990], will be to maintain the proper balance between the effort devoted to existing technology and the effort directed at the search for its replacement. It is worth repeating though, that the technology strategy should flow from the business strategy, and not vice versa.

5.4.4 People

There are likely to be substantial changes in the people system of the SURVUS organization. The primary cause for this change will be the integration of tasks that will occur as a result of the technology. More of the land information management functions will be performed at one location – a workstation for lack of a better term. More than likely, almost all of these tasks will be performed by a small number of well trained individuals. The first issue arising from this observation is the nature of the skills required by the firm's staff to function in this environment.

5.4.4.1 Skills Level

With more responsibilities being delegated to the employees, their skills level will necessarily need upgrading. Gattiker [1990] separates skills into two categories: procedural and declarative. Procedural knowledge refers to *how to do something*, while declarative knowledge refers to *knowledge about something*. The apprenticeship system that produced the previous generation of land surveyors conveyed upon its pupils the procedural knowledge of how to perform surveys. The university educated surveyors, on the other hand, are taught knowledge about surveying. This has enabled surveyors to work within a known set of well defined principles, which has allowed innovation to occur. This assertion is reinforced by Gattiker [1990], who believes that increasing the

amount of declarative knowledge in the organization's people will facilitate the innovation process, and will diminish resistance to change.

One of the characteristics of not only the SURVUS organization, but most firms operating in the information economy, will be the demand upon employees to work smarter though not necessarily harder or faster. In many cases, the procedural knowledge will be easily automated with technology employed by people with skills appropriate to integrate the systems and procedures. While the increase in declarative knowledge is espoused by Davis [1987], he is of the opinion that that alone is not sufficient.

In an everchanging world, people who possess declarative knowledge tend to revere facts, and as facts are based on the past, the ability to innovate is constrained. An individual who reveres facts is more likely to resist change because change represents the future for which no facts exist. Davis [1987] believes that imagination and creativity, which are derived partly from the liberal arts education, are essential components of innovation. The skills associated with the exploration of thoughts, ideas, theories and concepts that go beyond what is generally accepted as fact, are amenable to those of the "problem-identifier". Land surveyors are classified as "problem-solvers" [Tyler et al., 1992]. The latter, according to Davis [1987], have a vested interest in the continuation of the problem remaining unsolved. Without the ability to identify problems, the problem-solver cannot envision the next challenge, and as such remains bound to the past.

Due to the scope of this thesis, only a cursory view of the necessary skills can be presented. One that is worthy of mention is the technology skills. Gattiker [1990] states that the technology skills of an individual should include the appropriate use of the technology to perform the job-related tasks, which also involves knowing how to deal with, or preferably prevent, technology break-downs. Technology skills also include knowledge of the legal, safety, and ethical considerations when using the technology.

While it may seem that the procedural knowledge ranks third behind declarative knowledge and imagination, in reality, it is the combination of the three and their application to the tasks at hand that contribute value to the organization. Determining the appropriate combination for different job related tasks will be necessary when considering training options or recruitment possibilities.

5.4.4.2 Training and Recruitment

To cope with changes in the external environment, the organization requires a work force that is willing to adapt and learn new skills continuously. Gattiker [1990] states that in-house training given by the firm provides more procedural knowledge than that given by educational institutions, where the latter, as stated earlier, provides the individual with more declarative knowledge. In addition, substantial declarative knowledge may help an employee comprehend more easily the work content and organizational changes caused by technology acquisition.

One of the characteristics of a healthy organization is that employees are treated as assets who have a stake in the firm's performance. To that end, managers/owners must invest in these assets if they expect a reasonable return. In 1972, Harold Leavitt wrote about the apprenticeship system that produced managers for large organizations. Individuals would traditionally work their way through the ranks until they became executives, at which point they knew all of the facets of the organization, and were expected to remain top-notched managers for the next several decades until retirement.

During that time though, the rate at which knowledge was generated began to increase significantly, which had the effect of making these top managers obsolete. The reason for this was that the relative value of experience as compared to the relative value of new knowledge had decreased. The solution as proposed by Leavitt [1972], was not the dismissal of the soon-to-be obsolete manager, but rather re-education. If the obsolescence

cycle was six years, then a one year investment in that individual over the cycle period would reap benefits for both the individual and the organization.

Organizations two decades later are faced with the same dilemma. The increasing amount of new knowledge has serious implications for the continued viability of many firms. As we enter the knowledge-based economy, the infusion of new knowledge into the organization will be paramount. One strategy is to invest in the re-education of the employees. Another strategy for infusing new knowledge is through recruitment efforts. If the firm is to succeed in the long term, the principles of continuous re-education of employees and the treatment of employees as stakeholders must form part of the organization's edict. The added benefit of a systematic training effort is that it increases the employees' acceptance of technologically-induced organizational change [Gattiker, 1990].

5.4.4.3 Managing People

According to Drucker [1990], the information-based organization will be populated by knowledge specialists, who endow upon data its relevance and purpose transforming it into information. The knowledge will be at the bottom of the organization in the minds of specialists performing various tasks with a large degree of autonomy. Managing a group of specialists will tax even the most seasoned of managers. Imagine, for instance, the formidable task of directing a university department with six different specialties, each of which has their own disparate vision and direction toward which agreement may never be reached. As Dale and Fischer [1991] point out in reference to the land surveyor, "a largely technological education does not prepare the educated mind to deal with human beings" [p. 16].

One of the unfortunate results arising from the distributed information environment is the removal of the land surveyors and a larger number of their employees from the field and into the office setting. Many surveyors and their technical field staff derive much

enjoyment from their interaction with the natural environment, whether it be rural or urban. The SURVUS office will also preclude out-of-office visits for pre-survey research at the location of other surveying firms or public information repositories. The discontinuation of the pleasurable activities of interacting with people and nature will undoubtebly be met with resistance from employees if adjustments are not made. Given the discussion in Chapter 2 concerning technological virtuosity, it would be highly undesirable to have a firm of employees interacting solely with technology.

Strategies to mitigate the aforementioned ill effects may be manyfold. The most obvious strategy is to create a pleasant office environment that is conducive to working at a desk, the design of which should be made with employee participation. Gattiker [1990] offers six characteristics of the office environment that will vary dependent upon the need. They include: openness, density, accessibility, brightness, ambient environment, and ergonomics. Another strategy may involve individuals alternating between field and office assignments, which is made possible by the presence of highly trained employees who understand many facets of the organization's tasks. In addition, well trained individuals who to a large degree direct their own work, will have a great deal of autonomy and will be remunerated accordingly. In fact, that autonomy may even involve working from a remote location, which provides the individuals with great leeway in determining the nature of their surroundings.

As the SURVUS office becomes more of a knowledge-based firm, the position of the secretary will likely go one of two ways. The clerical functions will be almost completely automated which makes the secretarial position obsolete. Many of the business inquiries will be dealt with over the network by the appropriately skilled individual. The telephone will primarily be used by information seekers expecting expert advice. Either the secretary is given the necessary training and education to convey to the client the advice sought , or

that task is performed by the appropriately skilled individual, and the secretary becomes obsolete.

5.4.5 Structure

The relatively stable and simple structure of today's surveying firms will undergo many changes in its transition to the SURVUS model. For that reason, the structure must be flexible in order to adapt to the organizational changes. Gattiker [1990] believes that a strong organizational culture is one element that provides an atmosphere conducive to change. Two elements of the structure that are discussed below relate to internal and external components.

5.4.5.1 Internal Delegation of Responsibilities

The integration of tasks within the office will lead to fewer people doing more specialized work, the nature of which will require more autonomy on the part of the individual. It is not realistic to presume that the land surveyor will have the necessary skills to perform all of the tasks within the office. This will be the most significant of changes, as the surveyor has traditionally been capable of performing all of the tasks with varying degrees of proficiency. For that reason, the surveyor will be delegating an increasing amount of responsibility to highly skilled employees.

Drucker [1990] believes that the hierarchical structure of today's organizations will give way to a much flatter structural form in the future. The current decline in the number of middle management positions is one indication of this trend. He describes the structure of the information-based organization as being synonymous to a symphony. Each musician is a specialist playing the same score and being directed by a single conductor, without any intermediaries. In the SURVUS organization the land surveyor will be a generalist charged with designing the strategic objectives of the firm, which will be dependent on the input of the firm's employees, and will act as the common element joining the various specialists.

The example of the office technician as the default resident computing systems expert was discussed in a previous section. As the information technology becomes more integrated into the firm's overall strategy, this individual's time is likely to become solely dedicated to technology management. In his analysis of large organizations in the midst of change, Drucker [1990] has observed the conversion of line departments from performing work that contributes directly to the outputs of the firm, to centres for training and the maintenance of standards. In the SURVUS organization, the office technician may be charged with tasks involving in-house training, the maintenance of existing technology, the review of new technology, as well as the review of, and adherence to, technical standards.

5.4.5.2 External Structural Modifications

It is evident from the analysis of the three preceding organizational systems that the SURVUS concept is an ambitious undertaking; an undertaking in which the typical land surveyor must draw upon many resources. It is a virtual certainty that the surveyor will be required to seek resources and expertise from outside the SURVUS organization. The activities undertaken in the firm have been characterized as dealing primarily with land information management, which as described earlier is not the exclusive domain of the surveying profession. A host of other professionals consider the provision of land information to be within their sphere of activity. In this regard, one of the challenges facing surveyors will be the removal of boundaries enclosing the surveying discipline, which limit contact and exposure to other disciplines.

A number of commentators have praised the virtues of multidisciplinary alliances for solving particular problems that a single discipline might otherwise find impractical. Developing partnerships with other information providers is an appropriate mechanism for exploring market opportunities. Alliances with firms specializing in environmental audits, for instance, was described as a mutually beneficial undertaking. As well, building

alliances with local government and other database custodians will be a critical component of the success of SURVUS.

Leading business commentators believe that the concept of the virtual corporation is very likely to characterize organizations in the information economy. The virtual corporation is described as a temporary network of independent companies possessing different expertise and resources that will be applied to a fixed-term project, the completion of which will witness the dissolution of the corporation [Byrne et al., 1993]. This concept has many ramifications for SURVUS.

The land surveyor may find that maintaining in-house information technology expertise is uneconomical from a business perspective due to the rapid pace of technological change. In that instance, the use of external expertise may be needed on a periodic basis to infuse the organization with the appropriate technology and training. For example, an organization such as SINET, which was described in Chapter 3, may be able to fulfill the surveyor's technological requirements. As a corporation of surveyors, SINET could take on the role of a technology service bureau, whose mandate may include keeping abreast of technological developments and selling that expertise back to the member surveying firms on a periodic basis.

Another consideration that may affect the structure of the organization concerns the field data gathering activities. If the demand for field data gathering activities declines, there will likely not be enough work to sustain the profession's members in this traditional role. Those firms embracing the SURVUS concept may find that the field activities comprise such a small segment of their work, that its continuation would be uneconomical. There is also likely to be surveying firms that will choose to focus primarily on the traditional field activities. This number may be small. The SURVUS organization may chose to relinquish all field activities to the surveying firm specializing in field data capture, and concentrate on

the information management component in the office. Based on this scenario, the SURVUS organization will form a virtual corporation with the field specialist surveyor on the basis of need. While this is necessarily a long-term structural change, it does offer food for thought.

5.5 Summary

The implementation of the SURVUS model will require a number of changes within the surveying firm. The assessment of those changes was performed by viewing the firm as an organization comprising four complex and interrelated systems. The comparison of past and present forms of the surveying organization highlighted a number of important trends. The most significant observation was the effect that technology has had over time on the other systems of the organization. Different incompatible tools were used to perform different tasks by different people within the firm. The integration of the tools has lead to the integration of tasks, which has placed more demands on the individual in terms of education and responsibility.

The land surveyors' shift from working predominantly in the field to working almost exclusively in the office was linked to the abandonment of the apprenticeship system in favour of university education. The growing knowledge base was an important factor contributing to the requirement for the university education of land surveyor. The increasing capabilities offered by the technology, combined with an expected decline in field data gathering activities, suggests that the surveyor's office will be the location of an increasing amount of the surveyor's activities.

The examination of the dimensions of innovation revealed the benefits of the incremental, proactive approach. Organizations whose characteristics include high strategic choice and low environmental determinism are the most successful in using this approach. A recent survey of land surveyors showed that the typical surveying firm felt it was

subjected to a high level of determinism and possessed less than the optimal level of strategic choice. It was suggested that by embracing the SURVUS concept, land surveyors could reduce the level of environmental determinism. The enhancement of internal organizational systems would have the effect of increasing the firm's strategic choice, which in turn would facilitate a proactive, incremental implementation of the SURVUS model.

The trends derived from the comparison of past and present forms of the surveying organization, combined with knowledge of the changing external environment, were used to describe the characteristics of the organizational systems that will provide an atmosphere conducive to the implementation of the SURVUS model. The tasks are characterized as land information management activities that will be performed by individuals with a high level of education who will be given an increasing amount of responsibility.

The development of alliances was described as an important part of the structural changes in the surveying firm. The removal of traditional disciplinary boundaries within the surveying community will facilitate the creation of these alliances. The growing complexity of the four organizational systems suggests that much more of the surveyor's time will be devoted to managerial activities. Many of the suggested organizational system modifications represent a snapshot of long term changes, and as such are subject to change. In that regard, one of the important tasks to be undertaken in the SURVUS organization will be the process of monitoring the external environment to identify change and develop appropriate responses within the firm.

At first glance the SURVUS model seems to be a radical departure from the traditional concept of surveying. The trends, however, suggest that it is an evolutionary rather than revolutionary response. Envisioning the model of the future form of the surveying firm provides a vantage point from which the surveyor can use the organization to push the

strategy toward its realization [Davis, 1987]. It allows the manager "to lead from a place in time that assumes you are already there, and that is determined even though it hasn't happened yet" [Davis, 1987, p. 25].

6. Implementation Strategy for SURVUS

The objective of this chapter is to design an implementation strategy for the SURVUS model. The strategy will bring together the many disparate issues discussed in the previous chapters to form a cohesive and coherent blueprint for transforming the land surveyor into a land information manager. The strategy is separated into two components. The first component involves the enunciation of guiding principles that will provide long-term direction for the land surveying profession. Based on the guiding principles, the second component of the strategy outlines the specific actions that each stakeholder within the surveying community must take in order to implement the SURVUS model. These stakeholders include the surveying education community, the professional associations and the individual land surveyors.

6.1 Guiding Principles

The essence of the strategy is that it represents an evolutionary rather than a revolutionary change. Elements of each of the five guiding principles have been derived from the surveying profession's past and present circumstances, which provides a level of consistency and continuity needed in an environment whose pace of change is steadily increasing. Embodied in the guiding principles is the recognition that certain elements of the profession's past and present circumstances have been problematic and as such should be rectified and avoided in the future.

1. Land and the effective management of its resource is the ultimate objective of the surveying profession.

Throughout its history, the land surveying profession has worked under the broad mandate of land and resource management, which is the process of making and implementing decisions about how land and its resources are distributed, used and

protected. The recent specialization under land development was in part the consequence of national priorities at that time, but had the effect of relegating the land to a position of secondary importance when it should have been the primary focus. By viewing their role in the context of land and resource management, members of the surveying profession can incorporate the environmental protection function to complement its involvement in land development in response to changing national priorities. It also allows the profession to embrace land information management as its primary function.

2. Land information management is the primary function of the surveying profession.

Land information management is the primary means by which the land surveying profession participates in land and resource management. It involves the provision of land-related information to land management decision-makers in a form and at a time suitable for their requirements. The examination of the exploration, settlement and subdivision periods showed that land surveyors have always been involved in gathering, analysing and disseminating land information, which included the creation and maintenance of the cadastre. By embracing the land information management function, the focus is placed on the information rather than the tools and techniques that have characterized earlier periods. The significance of this function is highlighted by the recognition of the growing importance that information has in the post-industrial economy. As well, the land information management function provides a wider perspective from which current marketplace pressures can be converted to new opportunities.

Effective land information management is inherently interdisciplinary. It would be impractical to require any single professional to keep pace with the growing amount of knowledge being generated from within and between disciplines. Developing appropriate responses to complex societal issues such as the natural environment, and professional

challenges such as the spatial data infrastructure requires cooperation among the professions and other disciplinary specialists. This necessitates the removal of disciplinary boundaries or barriers that have shielded the surveying profession as land measurers.

3. Long-term sustainability of the surveying profession requires a commitment to its stakeholders: Society, clients, members, employees.

The future of any profession lies in its ability to respond to the needs of the society that it serves. One of the long-term objectives of land management is sustainable development. The land surveying profession's ability to work toward this most important objective is presently constrained by the focus on land development and land measurement, which has precluded its involvement in the environmental protection function. By viewing their role from the land management perspective, members of the surveying profession can incorporate the land stewardship role to fulfill its societal obligation.

The SURVUS model and its implementation will benefit the profession's clients by improving the mechanisms through which information is provided. The timely access to a wider variety of information will enhance the services to the profession's clients and may ultimately result in the implementation of better decisions about how land and its resources are used and protected. As well, members of the profession have a duty to work toward ensuring that the profession has a viable future. The SURVUS model represents a significant mechanism through which members can create a vital and progressive profession.

Finally, the long-term sustainability of the surveying profession requires a commitment to the employees of the surveying firms. The field staff that projects the profession's image to the general public, and the office staff that is taking on a growing amount of responsibility must be treated as stakeholders and assets that make a truly valuable

contribution. Investment in their continuing education will provide great benefits for the surveying firm and the surveying profession as a whole.

4. Members of the profession are integral components of the spatial data infrastructure, regardless of its state of maturity.

The concept of the spatial data infrastructure brings together a number of previously disparate elements, with the ultimate objective of improving the management of land and its resources. In that light, land surveyors share a common goal and thus should consider themselves integral elements of the infrastructure, as both suppliers and users of land-related information. As well, the infrastructure provides the framework through which land surveyors can envision their land information management role. Participation in its development is a significant part of the implementation strategy for the SURVUS model, and the means by which land surveyors can position themselves within the infrastructure and effect its shape.

5. The surveying firm is viewed in terms of an organization comprised of a set of complex interacting systems.

The mechanism through which the land surveying profession will implement the SURVUS model is the surveying firm, which must be viewed as an organization consisting of complex interacting systems. The people, technology, tasks and structure components of the organization will continually be subjected to a certain amount of strain as each seeks to deal with changes in response to the evolving external environment. Recognizing the interdependent nature of these components is a critical part of implementing organizational change. Changing a single component without due consideration for its related components will yield less than satisfactory results.

The SURVUS model is essentially an innovative concept. Its implementation will require an organization whose internal systems are amenable to change. Those firms that

exhibit or create flexibility in their structure and promote adaptability in their personnel are more likely to be successful in using an incremental and proactive approach to implementing the SURVUS model.

6.2 The Roles of the Stakeholders

The guiding principles provide the long-term direction for the land surveying profession. In accordance with these principles, there are a number of specific actions that the various stakeholders within the land surveying community must undertake in order to ensure a viable profession for the future, and in particularly to implement the SURVUS model. The roles of the educational community, the professional associations and the individual members are discussed below.

6.2.1 The Role of the University Surveying Programmes

Those charged with the education of professional land surveyors must re-assess the emphasis they have placed on land measurement and land development in the light of technological changes and changing national priorities. The ability of the surveying students to simultaneously contribute to society and to adapt to its unrelenting change, requires exposure to, and an understanding of, a much broader framework than that which is currently being emphasized. The framework is the land and resource management process, which provides the students with the leeway in which to adapt and change.

In terms of specific actions, educators may consider the replacement of first year surveying courses which teach the fundamentals of measurement and instrumentation, with courses that convey to the students the broad framework of land and resource management and the role of the professional therein. While there will likely always be a need for measurement specialists, the attainment of this specialist status should be the result of the reduction of the sphere of activity over time, and not the sole focus of the education or

training. In that sense, the specialization occurs after acquiring an understanding of the broad framework.

In the long term, the university programmes may consider reforms similar to those proposed by Hyde [1992] and discussed in section 3.4.2 of the thesis. This would provide the students with a better understanding of the society that they serve and the environment that they manipulate. Curriculum reform may also attract different types of students with skills and aptitudes that the profession will need to advance and grow. The reforms should address the concept of interdiscipline cooperation with the other science and engineering disciplines in addition to the social sciences. As Dale and Fischer [1991] point out, "a largely technological education does not prepare the educated mind to deal with human beings" [p. 16].

Educational reforms must necessarily reflect long term changes in society. Both the university programmes and the professional associations must assess the long term effects that the spatial data infrastructure will have on the profession and its licensing requirements. Consider the following scenario some time in the future. One of the features of a mature infrastructure may be the definition of property boundaries by coordinates that are available on-line from the land registry office. Hand-held GPS receivers are available on a daily rental basis from the local 'do-it-yourself' centre. Amendments to the Surveys Act and Surveyors Act allow property owners to stake out and certify their own boundaries for fencing or conveyancing purposes.

Consider as well the land development process. In this scenario, boundaries in new subdivisions are defined by coordinates and designed with an expert system whose inputs include topography available through the municipal database, which also provides the minimum lot size, side yard clearance, and road grade constraints. The subdivision approval process is no longer required as the expert system has been certified by the

municipal government. Lots are staked by the subdivision owner's site personnel, as are the house locations with GPS.

The question of the future of the land surveyors' monopoly in cadastral surveying demands reflection. In this scenario, the surveying profession has used its expertise to build an infrastructure that may in time render some of its current specialized skills obsolete, and may cause the repeal of its legislated monopoly in boundary demarcation and retracement. Furthermore, the consequences of the codification of land and survey law within an expert system also deserves the profession's consideration. In this light, educators and the professional associations must assess the long term validity of the current curriculum which produces students with qualifications for professional licensure under legislation that may in time be repealed.

There is also the need for a collaborative effort between the educators and the professional associations in addressing the environmental protection function of land and resource management and its impact on the profession's membership. The incorporation of a land stewardship role within the profession's Code of Ethics is a necessary response to changing national priorities. This new role, however, must be founded on and supported by education. The universities' role will be to explore the profession's role in working toward sustainable development and to develop courses for the continuing education of the profession's existing membership.

As an illustration, the university educators should determine the qualifications needed in order to be considered the "environmentalist's yes person". By determining and teaching the appropriate combination of qualifications from the land protection and land development functions, the profession may avoid the connotation of being anyone's "yes person". In working toward the societal defined goals of sustainable development, members of the profession may consider themselves as society's "yes person".

In addressing the profession's short term requirements, surveying educators must pursue initiatives such as the Integrated Survey Office (ISO) discussed in section 3.3.1.1. The basic premise of the SURVUS model is that information can be gathered and disseminated through communications networks. Interacting with disparate databases of land information is currently an unfamiliar practice for most surveyors. For that reason, the continued development of the ISO and other infrastructure initiatives in the academic setting is critical for the profession. These initiatives provide the opportunity to demonstrate future capabilities to the student surveyors and offer a proof of concept to the profession's existing membership.

6.2.2 The Role of the Professional Associations

As mentioned above, the professional associations must address the long term licensing requirements for membership under legislation that may in time be repealed or amended as a consequence of the maturing spatial data infrastructure. The place to begin is with an assessment of the limitations that the enabling legislation has on the interdisciplinarity of land information management. The Association of Ontario Land Surveyors, for instance, has made amendments to its enabling legislation to expand the professional membership to include geodesists, photogrammetrists, and hydrographers. Similarly, the associations should examine the legislated and regulatory impediments to interdisciplinarity in terms of ownership of private practice firms. The requirements for majority or full ownership by members may inhibit their ability to innovate by restricting the full participation of non-members.

The associations should also assess the legislated and regulatory impediments on the profession's members in terms of marketing. The changing nature of the marketplace will require land surveyors to change their approach from one which has been characterized as "waiting for the phone to ring" to one which requires the ability to proactively seek market

opportunities. The reduction of impediments in this regard is viewed as an important mission of the professional associations.

Mention was made in the previous section of the university educators' role in developing courses that deal with the environmental protection function of land management which may be offered to the profession's membership. The associations should undertake an assessment of the profession's duty in relation to land stewardship. Following the assessment the associations should amend the profession's Code of Ethics to incorporate a mission statement regarding stewardship. Examples of these mission statements were provided in Chapter 3. Provisions for educating the membership should also be made as the statements alone will be insufficient.

The professional associations also have an important role to play in the development of the institutional arrangements that will govern the conduct of participants in the infrastructure. In much the same way that they have dealt with the copyright issue of survey plans, the associations will have to expand the breadth of their mission and begin addressing issues such as access, privacy, ownership, security and liability in relation to its members operating in a distributed information environment. The associations should establish a committee whose main objective will the development of policies, in cooperation with other infrastructure participants, that will govern its membership and permit the latter to interact in the infrastructure.

6.2.3 The Role of the Individual Land Surveyors

Individual land surveyors and their organizations will play perhaps the most significant role in the implementation of the SURVUS model. The model, in essence, represents the land surveying firm as a part of the spatial data infrastructure, whose characteristics are constantly changing. To reflect this situation, a strategy is proposed for land surveyors that involves the simultaneous and continuous assessment of the organization and the evolving

infrastructure, where the components of the former are modified to both effect and reflect changes in the latter. A discussion of specific actions is provided below. The framework for the strategy is depicted in Figure 6.1.

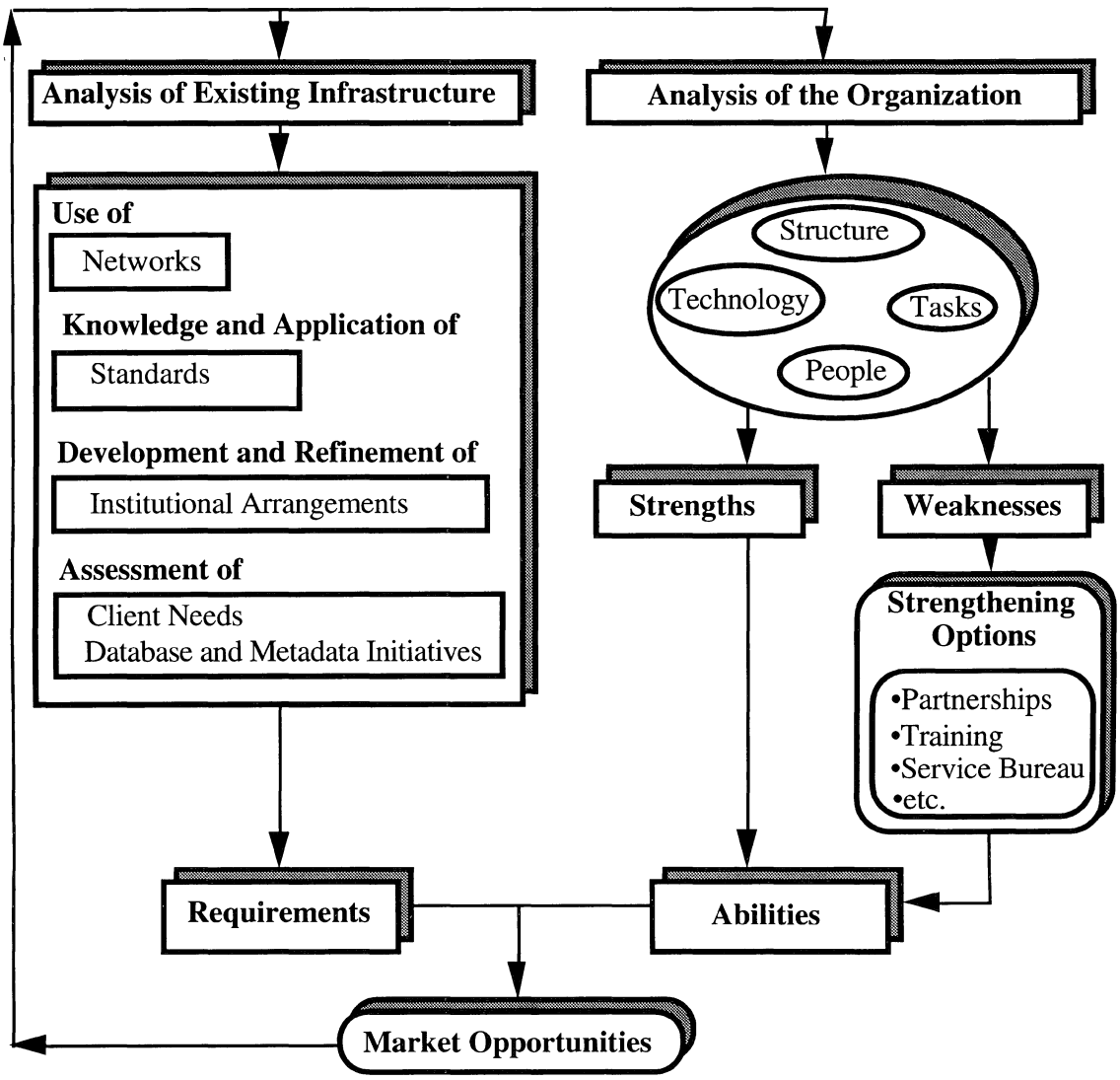

Figure 6.1: Iterative Strategy for the SURVUS Model

6.2.3.1 The Infrastructure and the Organization

The prime objective of this part of the strategy is to assess the ways in which the incorporation of the existing infrastructure elements will complement the land information management functions carried by the surveying firm. Taking the proactive approach, land surveyors should also assess the benefits to be derived from improvements in the infrastructure, and respond accordingly. As land surveyors are predominantly community based professionals, the state of the existing infrastructure will to a certain degree be dependent upon local conditions.

Figure 6.1 illustrates the key elements of the infrastructure upon which the implementation of the SURVUS model is dependent. The use of communications networks for transmitting digital information is an important part of SURVUS. SINET is one example of the use of networks for sharing information among surveyors. Although there are limitations associated with the existing modem-based communications, in a number of situations it can offer time and monetary savings for its users. Improvements in data networks resulting from, for instance, the CANARIE project should be monitored to assess its applicability to the provision of the surveyors' information products.

Interacting in a distributed information environment that is characterized by heterogeneous technology requires the adherence to standards. Data model, data quality, data feature, and data transfer standards are all essential to the connectivity of information users and providers. To that end, land surveyors should familiarize themselves with these standards, and in particular the Canadian draft national standard known as SAIF. As work continues in standards development, land surveyors can participate in the process as information members who are kept abreast of the work-in-progress. This may be an effective means of familiarization of standards and their application to the flow of information in a distributed environment.

The formation of networks and standards within the infrastructure is to a large extent beyond the control of the land surveying profession. For that reason, monitoring their development will be an important part of the implementation of SURVUS. The institutional arrangements, on the other hand, require the surveyors' full participation. The arrangements, in essence, represent the relationships between all of the infrastructure participants. Taking part in the establishment of policies that deal with access, privacy, ownership, pricing, and other information issues is the means by which land surveyors can voice their concerns and solidify their relationships within the infrastructure. This should be done in cooperation with the professional association that provides guidelines and policies to govern the membership.

The final component of the infrastructure and perhaps the most important from the business perspective is the actual data. Land surveyors gather information and provide information to meet the needs of their clients. As information gatherers, land surveyors have a vested interest in ensuring that the database initiatives of organizations with whom they have dealings meet their requirements in terms of accessibility, completeness, and usability. The other dimension of the surveyors' role in this component of the infrastructure is the provision of information to create, maintain and update the databases. In this respect, land surveyors can view the custodians of databases as both sources of information and clients as well.

6.2.3.2 The Organization

Chapter 5 provided a thorough discussion of the surveying organization and emphasized the need to view it as a complicated system of four interdependent elements. One of the land surveyors' important tasks will be assessing the firm's strengths and addressing its weaknesses in relation to the development of the infrastructure. The market intelligence function is one such task. Expertise in this area may be acquired by recruitment

efforts into the organization or partnerships with organizations that having the necessary expertise.

Land surveyors have a number of strengths that give rise to a competitive advantage in the infrastructure. The professional designation, status in the local community and an established firm with an existing client base are among some of the favourable factors contributing to the SURVUS model.

For instance, as land surveyors are professionals who adhere to a Code of Ethics, they may have opportunities to deal with organizations that manage information products whose sensitive nature requires a high degree of discretion and professionalism. Contracting with a municipal government for database updating, where information privacy and security concerns are paramount, may be easier for land surveyors than non-professionals. The government or other organizations within the infrastructure will have recourse against the land surveyor if there is an abrogation of duty – the threat of losing licensure. Non-professionals do not have this collateral to offer in dealing with infrastructure participants. As well, existing ties to the local community and its government also play a beneficial role in these situations.

The comparison of the firm's abilities with the requirements of the infrastructure serves to highlight the weaknesses within the firm. The basic objective is to address the weaknesses in the firm both to effect and reflect changes in the infrastructure. As each individual firm is different, it would be impractical to provide detailed strategies on an individual basis. The analysis in Chapter 5 resulted in a number of suggestions for adapting the surveying organization to implement the SURVUS model. While the latter may be an ambitious undertaking, the principles of cooperation, flexibility in the structure, and investment in employees will facilitate the long-term success.

Continuous training and education of employees and the recruitment of appropriately skilled individuals are among some of the strengthening options. The creation of a service

bureau, for instance, in cooperation with other land surveyors and/or other professionals may be useful in combining the expertise needed to participate in the development of the infrastructure. SINET may be an appropriate model for this type of venture. Employing new technology to aid in the performance of the land information management functions is also an option, but should be accompanied by appropriate modifications to the organization's other elements.

6.3 Summary

Five guiding principles were provided. They offer long term direction for the three primary stakeholders in the surveying community. Educators and the professional associations will play a facilitative role in the implementation of the SURVUS model. The land surveyors and their organizations will be the primary vehicles for implementing the SURVUS model.

Developments in the spatial data infrastructure will occur in an incremental fashion. Monitoring and participating in these developments will allow land surveyors to identify new markets that will contribute to the profession's long-term viability. Taking a proactive incremental approach to implementing the SURVUS model will permit land surveyors to take advantage of the window of opportunity and shape their external environment.

7. Conclusions

The thesis has examined a wide range of issues that deal with the land surveying profession's past, present and future, the result of which culminated in the design of a strategy for implementing the SURVUS model. The model envisions the land surveyor interacting in a distributed information environment which permits the gathering and dissemination of land-related information to and from a wide variety sources and clients. The SURVUS model and its implementation strategy represent an evolutionary change for the land surveying profession. The activities carried out in this evolving environment are characterized as land information management, which are rooted in the profession's past and present functions.

The strategy provides appropriate responses to the pressures currently being exerted on land surveyors. It is based on five guiding principles that provide long-term direction for the profession. It envisions the land surveyor as an integral part of the spatial data infrastructure, and involves a proactive approach to participating in the development of the infrastructure. The strategy also stresses the importance of viewing the land surveyors' role as being the provision of information into the land and resource management process, rather than simply activities related to land measurement and land development.

The strategy outlines the actions that the various stakeholders must undertake. The strategy also highlighted the importance of viewing the surveying firm as an organization composed of interdependent elements. The surveying organization is the mechanism through which the SURVUS model will be implemented. Suggestions for modifying its constituent elements were provided. A proactive approach to monitoring changes in the infrastructure and instituting changes within the organization is a basic tenet of the strategy.

Performing the land information management activities and interacting in the distributed information environment will require expertise in a number of areas that land surveyors will

not possess. The building of alliances and partnerships with other disciplines and organizations and the recruitment of individuals with specialized skills are some of the tactics required for implementing the SURVUS model. The pursuit of initiatives such as SINET, which features cooperation among professionals as a guiding rule, will likely grow in importance as the profession seeks to respond to societal needs.

One of the most significant issues arising from this research is the questionable long term future of maintaining a monopoly in cadastral surveying. The result of a mature spatial data infrastructure may be substantial amendments to, or even the repeal of, the land surveying profession's enabling legislation. Technological developments may also render some of the current specialized skills obsolete. This must be given serious consideration particularly at the educational level and within the professional associations.

The broad nature of the topics examined in this thesis has precluded an in depth analysis of many issues. One of these is the role of the land surveying profession in the environmental protection function of land management. While the provision of information into land management process to allow environmentally sensitive decision-making is an important role, it is rather passive in nature when compared with the profession's involvement in land development. By increasing the exposure to the land and resource management process in the surveyors' education, the profession may be able to better respond to society's needs in this regard.

One of the limitations inherent in this research, which is imposed by the nature of the problem and consequently the strategy that addresses the problem, is that only time and the actions of the various stakeholders will determine its validity. Another disadvantage of the strategy for implementing the SURVUS model is that it has the effect of removing the land surveyor from the land and into the office setting. While the office may be the environment where the surveyors are best able to respond to the needs of society, lessening their contact

with the land may be the unfavourable consequence of operating in the post-industrial economy.

In summary, the thesis has addressed the goals of the research as outlined in Chapter 1. The examination and analysis of the major issues facing the land surveying profession showed that there is a need to redefine the role of the land surveyor. The definition of that role was developed and expanded upon in the thesis. Lastly, a strategy for implementing the new role was designed which provides an action plan for each of the major stakeholders. The implementation of the strategy will ultimately contribute to the long term viability of the land surveying profession.

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Appendix I

Components of an Information Access and Privacy Policy (from Anderson [1992]).

Commitment to Information Access

- Declaration of commitment to the control of information
- Statement of the priority placed on providing access to information products and services
- Affirmation of the importance of relevant legislation

Access Mechanisms

- Description of media independent access control categories
- Specification of technical standards addressing data format, exchange, enquiry, etc.
- Expression of commitment to the provision of meta data

Equity

- Pronouncement on the provision of equitable access to information

Privacy

- Statement of the importance of the value of privacy
- Declaration of the commitment to balance the qualities of access and privacy
- Declaration of the controls established to protect privacy
- Proclamation of the applicability of privacy provisions to all sectors and members of the community
- Recognition and application of privacy legislation and/or principles of fair information dealing
- Statement of the genre of intended, appropriate and accepteble uses of the information

Security

- Statement of appropriate security provisions
- Statement regarding the security responsibilities of custodians and information users alike

Information Ownership

- Declaration of the status of ownership of information
- Statement of the rights and responsibilities tranferred upon release of information
- Statement regarding the redistribution of information to third parties and the development of value-added products
- Description of public benefit factors to be proved if monopoly control of public information is proposed
- Expression of the balance to be maintained between ownership rights, information flows and equitable access

Pricing

- Declaration of the pricing strategy to be pursued
- Specification of the tangible and intangible costs and benefits to be considered in the provision of information

Role of the Public and Private Sectors

- Recognition of the qualities that the various sectors of the community possess that may prove beneficial in the development of a diversity of access avenues
- Enunciation of the roles that each sector may play and recognition that these roles may change over time

Liability

- Statement of custodial responsibilities
- Enunciation of the obligations of all parties to a data use agreement
- Statement of the limit of liability

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