The Digital Lodgement of Cadastral Survey Data in Victoria

by

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ABSTRACT

An integral part of the Victorian land registration system is the lodgement of cadastral data. Originally data was lodged to support the operation of the land market and the legal rights of the individual owner. The purpose for which it was designed, coupled with the technology that was available at the time, resulted in a paper based system of plans and indexes. Due to many external factors, the current land registration system has essentially remained the same for the past 130 years. However the need for cadastral information means that plan lodgement now serves a wider range of needs, and although changes have been made to the system, it would seem that document-based systems are reaching the limit of cost-effective improvement.

A detailed study of the Victorian system of data lodgement has shown there to be several inefficiencies within the system, many of which would benefit by the shift to a digital environment. Research has also shown that the Victorian surveying profession is actually quite prepared to adapt to a digital environment, with many surveyors already preparing or submitting plans digitally.

Other jurisdictions that are experiencing similar problems to Victoria have progressed substantially in this area and form ideal examples to learn from. The study of these jurisdictions has shown that although technically the process of lodging data in a digital format is quite straightforward, there are still many technical and legal problems that must be resolved.

It is envisaged that in the future, data be lodged in a digital format, which would involve the re-engineering of the Victorian land registration system as we know it. This thesis explores the concept of the lodgement of cadastral survey data in a digital format, the issues associated with such a change and the long term benefits it will provide to the surveying, mapping and land development industries.

DECLARATION

This is to certify that this thesis has not been submitted for a higher degree at any other University or Institution.

This is to certify that this thesis is approximately 30,000 words in length.

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I would like to firstly thank Land Victoria for sponsoring me, and for their ongoing support throughout the project, which has been invaluable. Additionally I must thank all those people from Land Victoria who offered me their time to interview them, including representatives from the former Geographic Data Victoria, Office of the Surveyor General, and the Land Titles Office. The support of the Australian Research Council and the Department of the Surveyor General, New South Wales are also acknowledged.

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Representatives from the other Australian states must also be thanked for their willingness to supply me with valuable information on digital lodgement in their jurisdictions. Also representatives from New Zealand and Denmark were of great help for which I am grateful. Email has never been as appreciated as much until now!

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LIST OF ACRONYMNS

ACS	Association of Consulting Surveyors
ACT	Australian Capital Territory
ACTLIC	Australian Capital Territory Land Information Centre
ALTS	Automatic Land Titling System (VIC)
AMG	Australian Map Grid
CAD	Computer Aided Design
CRS	Core Record System (NZ)
CSD	Cadastral Survey Data format (WA)
CSRS	Cadastral Spatial Referencing System (NSW)
CST	Cadastral Survey Transaction (NZ)
DCDB	Digital Cadastral Data Base
DGN	Microstation geometry file format
DL	Digital Lodgement
DNRE	Department of Natural Resources and Environment (VIC)
DOLA	Department of Land Administration (WA)
DOSLI	Department of Surveying and Land Information (NZ)
DP	Deposited Plan
DTP	Digital Transaction Package (VIC)
DWG	Microstation drawing file
DXF	Digital Exchange Format
EPL	Electronic Plan Lodgement (NSW)
GDV	Geographic Data Victoria
GI	Geospatial Information
GIS	Geographic Information System
GPS	Global Positioning System
IP	Intellectual Property
ISV	Institution of Surveyors Victoria
LIC	Land Information Centre (NSW)
LINZ	Land Information New Zealand
LIS	Land Information System
LSG	Land Services Group (SA)
LSIC	Land Survey and Information Centre (VIC)

LTO	Land Titles Office (VIC and NSW)
NSW	New South Wales
NT	Northern Territory
NZ	New Zealand
OSG	Office of the Surveyor General (VIC)
PC	Personal Computer/Plan of Consolidation
PS	Plan of Subdivision
QLD	Queensland
SA	South Australia
SDC	Survey Accurate Digital Cadastre (NZ)
SDMB(C)	State Digital Map Base (Cadastral)
SDTS	Spatial Data Transfer Standard
SDVDM	Spatial Data Validation and Delivery Model (QLD)
SMES	Survey Mark Enquiry Service
URDS	Unregistered Dealing System
VIC	Victoria
WA	Western Australia
WWW	World Wide Web

1. INTRODUCTION

1.1 STUDY CONTEXT

The advances being made in information technology over the past decade has seen many industries embracing these with the aim to improve services, reduce costs and expand markets. The Victorian land information industry is moving in the same direction, with the majority of the state's spatial information being represented in digital form, enabling simpler updating and accessibility. However one component of this industry that appears to be lagging behind is the land registration process, in particular the lodgement of survey data.

The primary purpose of survey document lodgement in Australian jurisdictions is principally to support the Government's guarantee of title in support of an efficient land market. Originally cadastral systems in Australia were designed to support the operation of the land market and the land rights of the individual owner, rather than being part of a wider land administration system. They were also designed using the best available technology at the time, resulting in a paper-based process consisting of maps, plans and indexes. However, the need for complete and accurate spatial information has meant that plan lodgement now facilitates not only title creation, but also further subdivisional activity, updating of record systems and updating of the State Digital Cadastral Map Base.

The land registration process has had substantial changes made to it to take advantage of new technology, for example, the computerisation of titles. However many of these systems are still essentially paper-based, which has meant that the incorporation of new technology has only been by way of improving the current system. This has substantially limited the amount of automation and integration possible, and it seems that document based systems have now reached the limit of cost-effective improvement.

This thesis explores the concept of the lodgement of cadastral survey data in a digital format, and the long term benefits it will provide to the surveying, mapping and land development industries.

1.1.1 The Wider Research Context

The study is a joint research project between the University of Melbourne and Land Victoria (Department of Natural Resources and Environment). It is therefore important to be aware of

Land Victoria's current spatial data strategy, part of which is their vision that "all Victorians will be able to access and use the government information they need". The vision is highly customer-orientated, whereby the customers' geospatial information (GI) needs will be met by providing integrated, consistent systems enabling transparent access to information (Land Victoria, 1997).

Due to the evolving nature of the GI environment, it is important that the mechanisms used to deliver the information are constantly refined. One such example of this is Land Channel, which was launched in 1998, designed to offer integrated geospatial information of value to businesses and home customers. This is part of the State Government's electronic service delivery program, which will also enable land dealings information to be delivered remotely through the Land Channel (http://www.land.vic.gov.au/). Land Victoria aims to enable the electronic lodgement of subdivision and property development plans before the year 2000 (Land Victoria, 1997). Thus the project fits in well with Land Victoria's goals.

The study also falls within a research group at the Department of Geomatics at the University of Melbourne under the direction of Professor Ian Williamson, whose primary focus is to "investigate cadastral reform issues concerned with designing, building and maintaining spatial data infrastructures and communicating that data to users and stakeholders" (Williamson, 1998b). Projects being carried out within this team include using the World Wide Web (WWW) for cadastral data delivery, which is closely linked to this project as the Web is seen as an ideal medium for lodging digital data; and change management in spatial information systems which investigates different methods of upgrading and updating the State Digital Map Base. Another project investigates the delivery of spatial planning services to a mass market via the WWW (Williamson, 1998b).

As demonstrated, digital lodgement of cadastral data forms only a small part of the land information industry. Therefore it is important to always keep in mind the bigger picture, and not regard digital lodgement as an isolated problem on its own. The main objective of introducing digital lodgement is to contribute to a complete digital environment to efficiently manage and utilise land-related data.

1.1.2 Focus of research and problem statement

This thesis investigates the concept of digital lodgement which is a proposed method of submission for registration and management of cadastral survey information in an electronic environment (Pearce et al., 1997). The lodgement of survey data is a fundamental part of the land registration system, although it forms just one stage in the continuous cycle of land boundary definition. The main processes needed to lodge a plan are summarised below.

A cadastral survey is carried out by a licensed surveyor when a land transaction results, for example, from a subdivision. The surveyor then produces a plan of survey, consisting of spatial and textual data, as a record of the cadastral survey. This document is lodged with the Land Titles Office for the registration of title. This data is also used to update the Digital Cadastral Data Base (DCDB).

At the time the Torrens system of land registration was introduced in Victoria, it was designed to be simple, low cost, fast and reliable (Birrell et al., 1995). Using the best available technology of the time, these objectives were all achieved, and it could be argued that it still works today as it has survived for one hundred and thirty years without major amendment. However the rapid advances being made in computer technology over the past decade have been far-reaching, and it seems that the traditional system of plan lodgement is failing to keep up. For example the current cadastral system has a turnaround time often measured in months, in direct contrast to some parts of the DCDB, which are updated close to real time (Polley and Williamson, 1998b). It is envisaged that digital lodgement will speed up these processes substantially.

Several sources depict that the way of the future is a digital environment. Al Gore stated on the new age of spatial information that “a new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of information about our planet…” (Gore, 1998). It was also stated in the Survey Practice Handbook that in the future, digital lodgement of plans will be mandatory (Surveyors Board of Victoria, 1997). Traditionalists argue that the current system is working well and that digital lodgement should not be introduced simply for the sake of being digital. However there are several foreseeable benefits in it, as are listed below. Digital lodgement is proposed to:

- reduce the overall cost of the system to all participants;

- extend the applications and marketable uses of registered cadastral survey information;
- improve overall efficiencies of lodgement, registration, examination and use of cadastral survey information;
- provide 'absolute', authoritative and accurate spatial definition of cadastral data to support links to other systems; and
- ensure that the system can take full advantage of developing technology.

(Pearce et al., 1997)

This thesis aims to show how these benefits can be achieved by introducing a system of digital lodgement in Victoria.

1.2 CONCEPTUAL FRAMEWORK AND RESEARCH DESIGN

1.2.1 Objectives

The aim of this study is to investigate the implementation of digital lodgement to current cadastral processes in Victoria. The objectives of this study are:

- To gain an understanding of current lodgement techniques in the Victorian freehold system, by investigating the flow of cadastral data from one organisation to another;
- To understand lodgement processes used in other jurisdictions, both interstate and overseas;
- To investigate the attitudes of the survey profession in Victoria regarding digital lodgement;
- To obtain an understanding of the many issues involved, including data standards, digital signatures, data transfer, legal implications, quality assurance and intellectual property;
- To draw on the experiences of other jurisdictions in order to formulate a set of options for implementing digital lodgement in Victoria.

The importance of this research is highlighted by exploring the current land registration system in Victoria. The lodgement system is essentially linear, with the plan needing to gain approval from one organisation before it progresses onto the next. This has resulted in a largely slow and complicated system, where it may take between two weeks to a few months from planning approval to registration.

It is envisaged that by shifting land registration processes into a digital environment, many benefits will result. These will include speeding up the collection and processing of cadastral survey data, making significant reductions in the cost and space required for storing and retrieving land records, and preventing unnecessary duplication of records.

The study aims to demonstrate how digital lodgement will benefit the survey industry, and what changes will need to be made in order to facilitate digital lodgement. As the focus of the study is the consequences of digital lodgement on the survey community, it has been studied from a 'bottom-up' approach, by investigating digital lodgement primarily from the perspective of the data suppliers and maintainers, which in this case are the surveyors.

1.2.2 Type of study

The study is practical and industry based, through the close contact with representatives from both the private and public sectors. It was decided that a technical basis was outside the scope of the project, with a large component of the study being questionnaire based.

It was found during the course of the study that there was considerable cooperation from all parties, especially during the questionnaire phase. This can be largely attributed to the fact that it was university based research rather than industry based.

1.2.3 Data sources

The major data sources included a range of literature obtained from surveying and GIS journals, and conferences. However it was found that the amount of information directly related to digital lodgement was extremely limited, as it is quite a new area of research and relatively narrow. There was extensive literature on other relevant issues such as digital signatures and data formats. One beneficial source of information during the whole study was the World Wide Web, where current information could be gained worldwide.

Surveying legislation was also studied, in order to gain a grasp of the legal issues involved in digital lodgement. It was very important to make sure such information was current as legislation has a tendency to change significantly.

Interviews with representatives from the land information industry were conducted in order to obtain a clear understanding of the Victorian system. These included representatives from the

former Land Titles Office, Office of the Surveyor General, Geographic Data Victoria and private industry representatives.

Letters were sent to the Surveyors General of each state, requesting information on the current status of lodgement in each Australian State. These letters were forwarded on to the person with the most experience in the area of digital lodgement, and it was found to be a very successful means of obtaining information. Communication between most of these parties continued throughout the study through postal mail, electronic mail and the telephone. At the same time, a number of representatives from other countries were also contacted via email and this proved to be successful.

One of the most important sources of data during the latter stages of the study was the participation of the surveying industry in completing a digital lodgement questionnaire. This involved representatives from many of the private surveying firms in Victoria.

1.2.4 Scope of study and limitations

The original scope of the thesis was to develop a pilot project for digital lodgement in Victoria. However, it was deemed more important to produce a thesis focussing mainly on the problems and issues facing digital lodgement. There have been several other documents concentrating on the technical work that may be referred to if needed.

The study's main focus was not cadastral reform of the land information industry, although re-engineering of the system is discussed towards the end of the thesis. Digital lodgement forms only one small part of the entire land registration process and as such the study may be viewed as quite limiting as it concentrates primarily on the technical and legal issues associated with the actual lodgement of data.

The majority of the study was also specific to Victoria, as its main focus was implementing digital lodgement in Victoria. It is possible that this research could be applied to other jurisdictions, but it is important to be aware of the differences between such systems. The thesis concentrates entirely on freehold land as the processes used to deal with crown land are quite different.

1.3 SUMMARY OF THESIS STRUCTURE

The first chapter of the thesis is simply an introduction to the study in terms of the research context, the research design including the project's objectives, the scope and limitations of the study, and also data sources that were used.

The next two chapters are essentially a summary of the current cadastral systems around Australia, as well as two other jurisdictions, and the advances that have been made in the area of digital lodgement in these jurisdictions. Chapter 2 focusses solely on Victoria and discusses the current methods for lodging cadastral data in Victoria. It reviews each step that is needed to register a plan, including field survey, plan preparation, lodgement, examination and registration, and the subsequent information needed for each of these processes to occur.

Chapter 3 reviews the advances that are being made in the area of digital lodgement in other jurisdictions. In addition to Victoria, other Australian states reviewed are the Australian Capital Territory, New South Wales, Northern Territory, Queensland, South Australia and Western Australia. These have been studied as they have very similar land registration systems to Victoria. Also studied were New Zealand and Denmark, both of which are modern cadastral systems which make them ideal case studies to learn from.

Chapter 4 contains the results of the main research of the study. This consisted of a comprehensive questionnaire that was sent to all private consulting surveyors in Victoria, containing questions regarding the surveyors' technical capabilities, current lodgement procedures and attitudes towards digital lodgement. This chapter summarises the results of the questionnaire and compares them to similar questionnaires carried out in New South Wales and South Australia.

Chapter 5 discusses the key issues that must be resolved before digital lodgement of survey data can be fully introduced in Victoria. Most of these issues have been identified as a result of the questionnaire and an investigation of digital lodgement in other jurisdictions. This chapter summarises these key issues, mainly focussing on the problems themselves, with some attention being placed on possible solutions.

Chapter 6 draws on the knowledge gained in order to describe the various options available for Victoria to implement digital lodgement. It draws particularly on the experiences of other

jurisdictions in implementing digital lodgement, taking into account the opinions of the surveyors that completed the questionnaire. The chapter concentrates on short-term changes which could be used to implement digital lodgement.

The final chapter provides conclusions and recommendations as to how digital lodgement should be introduced. It highlights the fact that digital lodgement is not an isolated problem, but rather one that must be dealt with as part of a larger cadastral reform program.

2. EXISTING CADASTRAL PROCESSES IN VICTORIA

2.1 OVERVIEW

This Chapter discusses the current methods for lodging cadastral data in Victoria. It reviews each step that is needed to register a plan, including field survey, plan preparation, lodgement, examination and registration, and the subsequent information needed for each of these processes to occur. It also reviews the relevant parties involved in each of these processes, although the chapter focuses on the tasks performed, rather than the parties involved. In this chapter, the word 'lodgement' has been used in a very limited way, to mean the actual submission of the data to the Land Titles Office. In the broader context of the thesis, lodgement includes the movement of the plan through all the relevant agencies, and includes processes such as plan examination and registration.

2.2 THE VICTORIAN CADASTRAL SYSTEM

In Victoria there is a highly formalised system of marking out and recording land boundaries. The processes used to document these boundaries are called land registration, and form an integral part of the Victorian cadastral system. Registration of land is done through the Torrens system, which is a system of title registration where the state government guarantees that the person shown on the certificate of title displayed in a public register is the registered proprietor of the land in question (Williamson, 1994).

The lodgement of survey data is a very important component of the registration system. The primary purpose of cadastral survey document lodgement is to support the state's guarantee of title, and lodgement facilitates:

- title creation;
- further subdivisional and associated survey activity;
- updating of record systems; and
- updating of the Digital Cadastral Data Base (DCDB).

(Pearce et al., 1997)

The preparation and lodgement of plans has been traditionally carried out by licensed surveyors, who generate spatial and textual data when undertaking cadastral surveys of land

parcels. This data is used for the preparation of documents that are lodged with the Registrar of Titles, which then become part of the Register upon registration. A plan of survey is the format in which this data has traditionally been presented and lodged (Hayes, 1997).

During registration, a folio of the register is created and becomes a legal document. The folio of the register is conclusive evidence that the person named in the folio as the proprietor of an interest in the land is the legal owner of that interest. Interests in land can only be created, varied or changed by registration. If there is an error on the Certificate of Title, the government will compensate the registered proprietor for any loss incurred by the error (Williamson, 1994).

2.2.1 Brief History of Land Registration in Victoria

The Victorian cadastral system was designed specifically to support the land market and the individual land owner. The Victorian system is derived from individual surveys of individual parcels for individual owners in support of the legal land transfer system (Williamson, 1994). The reason why the Victorian system developed in this way is documented briefly.

At the time of settlement by the English in Australia in 1788, the Surveyor General was the second most important person in the colony, and was responsible for the alienation of all land. However due to rapid settlement, settlement often preceded survey, even though the actual alienation of land was always based on a survey. This resulted in isolated surveys rather than surveys connected to a state coordinate system. The English system of Deeds Registration where ownership of land was proved by a chain of deeds which evidence the transfer of interest in land from one person to the next, was used for the first 70 years after settlement (Williamson, 1994).

In the 1850s, the Torrens system was introduced to simplify land transfer which had become expensive, complicated and inefficient. During the 19th and 20th centuries, further land was alienated which resulted in two land title and survey systems. Firstly there were the systems which controlled the management and alienation of Crown lands, usually the responsibility of the Surveyor General. There were also the systems to manage the land ownership and records concerned with private alienated lands (commonly known as freehold land), typically the responsibility of the Registrars within the State Land Titles Offices (Williamson, 1994).

2.2.2 The cadastral system in Victoria today

Within the last few years, the trend has been to bring the responsibilities of the Land Titles Office (LTO) and the Office of the Surveyor General (OSG) together, with the objective of having a complete cadastral record of all land parcels in one system (Williamson, 1994). This has resulted in extensive re-structuring of the land administration authorities within Victoria bringing forth the amalgamation of the Land Titles Office and the Office of the Surveyor General into Land Victoria, which is a sector of the Department of Natural Resources and Environment (DNRE) within the Victorian State Government (Williamson et al., 1998a).

The former LTO, now known as the Land Registry, is responsible for the registration of freehold land within Victoria, whilst one of the initial roles of the OSG was to handle the alienation of crown land. Within Victoria, 58% of the land is freehold, with 3 million parcels under the Torrens system, and 50,000 parcels still general law land. Crown land occupies 42% of the state. (Department of Natural Resources and Environment, 1997). The LTO holds 2.5 million live titles, 0.7 of which are computerised (Charles, 1998). An important aspect to note about the Land Titles Office (as with all the Australian Land Titles Offices) which makes it unique around the world is that it is centralised, whereby it contains vast amounts of information in a paper format pertaining to all the freehold land in Victoria. As a result there has been a greater need to streamline records storage and computerise the title systems in Australia than in most overseas countries which operate decentralised land registry systems (Williamson, 1994).

Whilst the LTO is responsible for keeping a record of all freehold land titles, the private company Dataflow is responsible for maintaining the State Digital Cadastral Map Base (SDMB-C). The SDMB-C or the Digital Cadastral Data Base (DCDB) is essentially a digital map representing all the land in Victoria, and is recognised as one of the major core spatial data sets maintained by government (Wan and Williamson, 1995).

Dataflow was formed in 1995 by two large surveying companies in Melbourne, after being awarded a three year contract by Geographic Data Victoria, a subsidiary of the Department of Natural Resources and Environment. Dataflow's main purpose is to manage the State Digital Cadastral Map Base (SDMB-C), both metropolitan and rural, and to maintain the mapbase in such a way that all changes to the cadastral framework are reflected in a timely manner

(Marwick, 1997a). Other parties that play important roles in the lodgement process include local municipalities, water retail businesses and other utilities.

2.3 CADASTRAL DATA LODGEMENT PROCESSES

Figure 2.1 shows a simplified version of the flow of cadastral data between each of the respective agencies in the lodgement process.

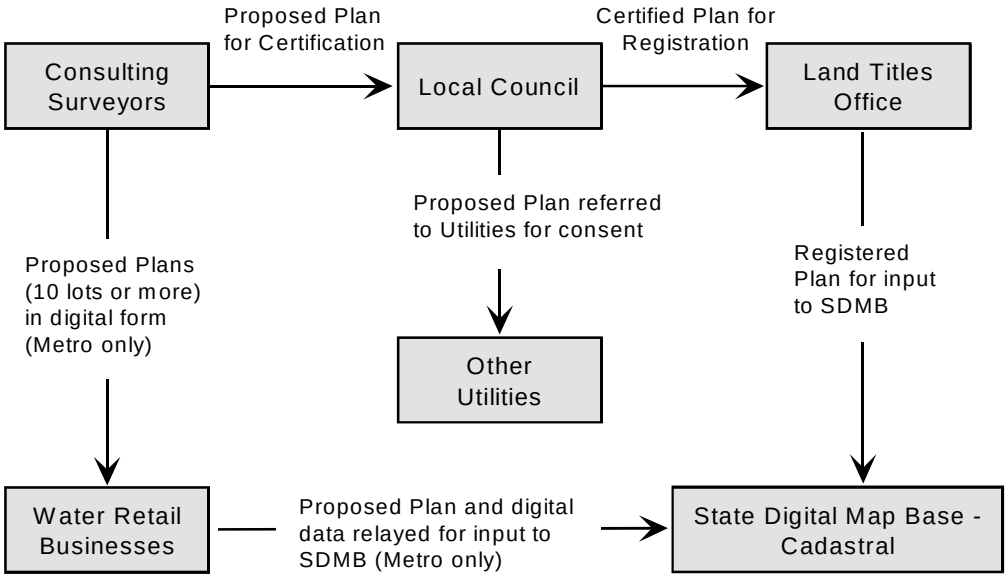


Figure 2.1 Lodgement process (adapted from Marwick, 1997)

Figure 2.2 expands on Figure 2.1 by showing the essential processes that must be followed in order to register a plan in Victoria. (The dotted lines in the diagram indicate information that flows back to the surveyor from the LTO and the DCDB when a survey information search is carried out.) Other processes such as the consultation of referral authorities are also carried out and will be discussed, but this is not an essential step for registering a plan at the LTO. This section will discuss the processes used to lodge a plan of subdivision, as there are slightly different requirements for other types of surveys.

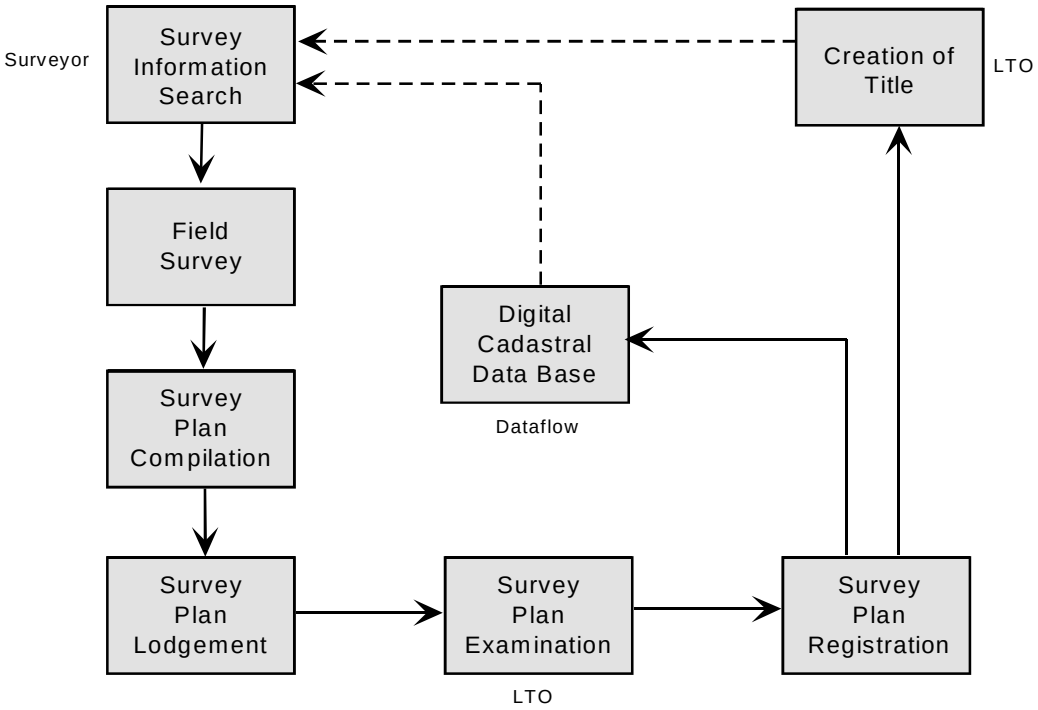


Figure 2.2 Cadastral data lodgement flow (adapted from Hayes, 1997)

2.3.1 Survey Information Search

Initially, the client will consult the surveyor and state their request. The surveyor plays a very important role in the lodgement and registration process, being responsible for fixing the boundaries of a land parcel in relation to the location of adjoining parcels of land based on the evidence of spatial data collected at the land parcel in question (Hayes, 1997).

Upon consultation with the client, the surveyor must obtain as much survey information on the parcel and its abutting properties in question before any survey work in the field can be carried out. This is known as a title and survey information search, and is usually done by professional title searchers, rather than the surveyor. The only information that is needed to perform a search is the volume and folio number of the parcel in question, and the address of the block for cross-referencing purposes.

A survey and title search is carried out at the Land and Survey Information Centre (LSIC), which is a section of the Land Titles Office. The first step in a search is to consult the Digital Cadastral Data Base (DCDB) for charting purposes. This will indicate the registered plans to refer to, along with other information such as relevant titles, plans of survey, abstracts of field records and surveyors' reports.

Additional to the survey and title search is a survey control mark search, which involves finding out information on any neighbouring permanent marks, in order to tie the survey into control. This can be done by using the Survey Mark Enquiry Service (SMES), which gives details on all control points. The SMES was developed by the Department of Natural Resources and Environment (DNRE) to replace the manual searching systems in the Central Plan Office (Land Victoria, 1998).

In many cases, the surveyor will simply fax the necessary information to the LSIC, who will then perform the search and fax back the relevant information. Other surveyors perform the search themselves using the on-line service provided by SMES. SMES has been designed to also allow users to update the information by means of digital lodgement techniques, where the user can add comments on a mark's status or coordinates, and submit additional sketches for an existing mark (Land Victoria, 1998).

Once all survey information is collected, it is up to the surveyor to decide on a suitable datum, preferably Australian Map Grid (AMG). Usually the most recent information is used, as it is often more reliable and accurate than the older information.

Before commencement of each project, the surveyor will assign each project a plan number, which is used throughout the whole process of lodging and registering the plan. The surveyor obtains these numbers from the LTO (Willis, 1997).

2.3.2 Field Survey

The survey is performed, usually using equipment such as a total station, which is capable of measuring both distances and angles, which are recorded digitally. Some surveyors still use theodolite and chain, but this is more the exception rather than the rule. Often the surveyor will manually draw up fieldnotes, which must include information such as traverse closures, permanent marks, reference marks, date, and other such information. For a complete list of the information that is required in field notes, see Appendix One. In most surveys, field procedures are essentially confined to traverses of angles and distances.

In the case of a subdivision, a feature survey is often completed prior to the actual pegging out of the subdivision, to enable the surveyor to design the most suitable parcels for that particular area of land. During the feature survey, the surveyor will immediately record the

measurements into a data recorder, even though a rough sketch is usually completed to clarify the matter. As data is collected, a feature code is assigned to an object and passed into a digital database via a data recorder. A feature code is a tag that is used to identify the corresponding real world object the data represents. This is extremely useful when the plan is drawn up using the appropriate computer software, as most software packages are compatible with data recorders, being capable of holding additional attribute information relating to the data (Surveyors Board of Victoria, 1997).

Increasingly surveyors are encouraged to tie their surveys into control, that is, connect the survey to coordinated permanent marks. This is stated in the Surveyors (Cadastral Surveys) Regulations 1995 (Section 10(3)(a)), where for surveys of more than 10 lots, at least 2 permanent marks must be connected to in the survey. It is also stated that no more than one additional set-up must be used to do this, however due to a lack of permanent marks, this is often quite difficult. Many marks are quite inaccessible or have been destroyed. As the Global Positioning System (GPS) is further developed, it is likely to be used more as a tool in cadastral surveying, enabling real time measurements of 3D coordinates of control points, which can be used to introduce control into the survey quickly and easily.

2.3.3 Survey Plan Compilation

Once the field survey is complete, the surveyor draws up the plans. Current legislation states that the surveyor is required to produce an Abstract of Field Records, and a Plan of Survey, both in hard copy format. The difference between the two is that the former is designed for reference by surveyors and includes technical details of the survey. In contrast, the plan of survey contains a simplified version of the boundary details and their relationship to existing documentation (Leahy and Hunter, 1992). Appendix Two shows examples of both the Abstract and Plan of Survey. Appendix Three shows the information that must be included on a plan.

One of the key features of this type of documentation is that vital survey information such as parcel boundaries and dimensions are clearly represented. Leahy and Hunter state that this procedure is useful in both monitoring the quality of the fieldwork and computations, and as a form of data storage, since:

- the design of the survey is quite clear;

- the adoption and measurement of both the map grid connection and cadastral datum can be readily verified;
- the precision of measurements can be assessed by the computational closures obtained for both the parcel identified by the survey traverse, and again for that adopted as representing the parcel boundaries;
- the data are in a readily accessible format for subsequent users.

(Leahy and Hunter, 1992)

The surveyor must prepare the appropriate field survey documents in accordance with the Surveyors (Cadastral Surveys) Regulations 1995, the Subdivision (Procedures) Regulations 1989, the Subdivision Act 1988, Transfer of Land (General) Regulations 1994, as well as Survey practice circulars as issued from time to time, and Volumes 1 to 3 of the Survey Practice Handbook. The formats and inputs are described in Table 2.1.

Document	**Purpose**	**Legislation**	**Storage**	**Comments**
Plan of Survey (PS)		Surveyors (Cadastral Surveys) Regulations 1995. Subdivision (Procedures) Regulations 1989. Survey Practice Handbook, Parts 1&2.	Microfilmed for public access.	
Abstract of field records	Graphical record of measurements and methods undertaken to support Plan of Survey.	Surveyors (Cadastral Surveys) Regulations 1995. Survey Practice Handbook, Parts 1&2.	Microfilmed for public access.	The survey information shown should be sufficiently complete to enable the relevant data to be shown on the corresponding plan without recourse to computation or any other document.
Surveyor's Report	Report submitted by surveyor in support of adoptions and actions.		Normally submitted in A4 paper format. Microfilmed and stored with abstract of field records.	

Table 2.1 Field survey document regulations

In the past, plans were often drafted by hand, and the result for the client was a hard copy plan or map. However recent advances in computer technology have enabled affordable desktop computing for the surveying industry, along with the development of extremely powerful, yet easy to use, survey, engineering and CAD applications. Thus the desktop PC is now a common survey office tool that is used for report writing, survey computations and plan preparation (Surveyors Board of Victoria, 1997).

Most surveyors now employ commercial surveying software packages to draw up plans, as data can be input directly from a digital data recorder, and they also enable easy manipulation if changes are required. The surveyor will essentially produce two types of data when creating a digital plan – a graphical component and a textual component. The graphical component usually contains positional and relationship information (such as coordinates) for point, line and polygon objects, while the textual, or attribute, component holds other information relating to the objects (Surveyors Board of Victoria, 1997).

2.3.4 Plan forwarded to referral authorities

Once the plan is complete, the surveyor must obtain a planning permit from the local authority in order to allow the land to be used in the manner specified. The information that must be included when applying is a planning permit application, the plan of subdivision (usually in digital form), a copy of the certificate of title, a cheque and an accompanying letter. The council are responsible for checking the plans to make sure all planning rules such as zoning and building laws are adhered to (McFarland, 1998).

The surveyor will often consult the relevant referral authorities and provide them with a hard copy of the plan. Referrals are carried out to ensure that all information on the plan is correct, usually prior to the plan being sent to the council. These authorities include the electricity, gas, water and telecommunications providers. The role of the referral authorities is to assess the plan, and state whether they agree with the permit granted, and what conditions must be fulfilled, or if they do not agree, they must provide a reason. If there are conditions to be met, this is known as a statement of compliance, and must be approved before the plan can be certified.

Once all the conditions set by the local municipality and referral authorities have been met, the plan can be certified by the council and lodged at the Land Titles Office. This is usually

the responsibility of the conveyancer or solicitor dealing with that land transaction. The plan passes through several stages at the LTO, as shown in Figure 2.3.

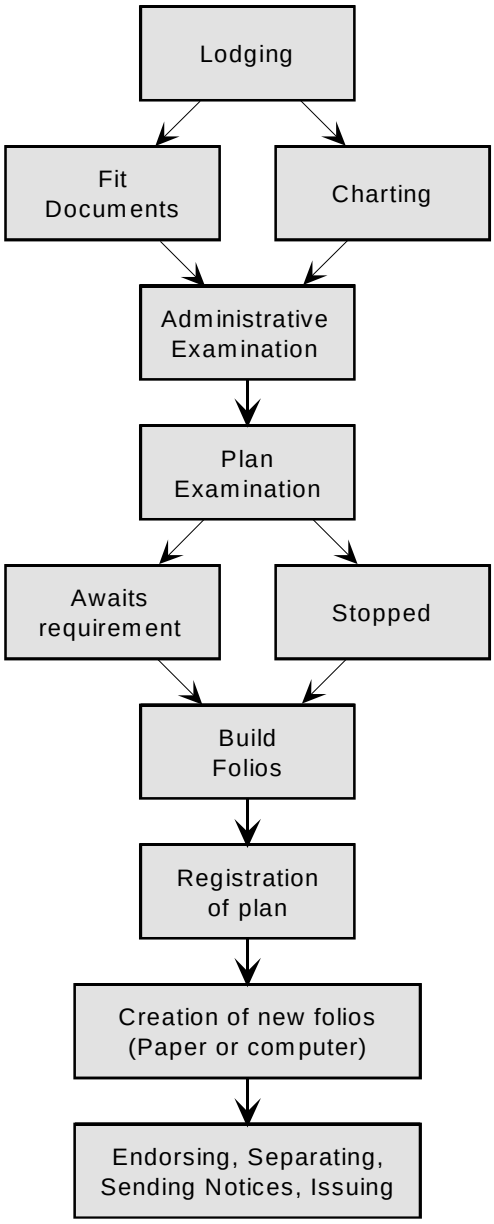


Figure 2.3 The lodgement and registration of a plan at the LTO

(Land Titles Office, Victoria, 1997)

2.3.5 Survey Plan Lodgement

The plan is lodged at the Plan Acceptance Office, usually by a conveyancer or solicitor. There are several documents that must be present, as listed. These documents must be checked

thoroughly to ensure that all are present, and that they have all been signed by the surveyor and council delegate.

- Sealed plan (plan of subdivision)
- Transparency of each sheet of the plan
- Abstract of Field Records
- Surveyor's Report
- Application
- Duplicate of Certificate of Title
- Consents from mortgagees, caveators

(Willis, 1997)

Usually, a plan can only be lodged at the LTO if it has been certified by council. However it is also possible to submit an uncertified plan, which can be examined, but not registered. The LTO can also determine whether a statement of compliance is required for a plan, which is used to ensure that the developer has complied with all regulations specified by the council. Until the developer complies with council, the council can examine and check the plan, but they cannot register it. Those plans requiring a statement of compliance are flagged with the word 'Requirement', and receive a different priority to the other plans. The developer has 5 years to comply with the council directions after the plan has been examined (Willis, 1997).

After initial lodgement, the plan number, which is the same as that originally allocated when the client contacted the surveyor, is then verified in the Unregistered Dealing System (URDs). This system was commissioned in 1983 and its main functions are to accept land dealings and track the progress of these dealings through the LTO; provide search information and the location and status of titles to facilitate search; create land title references for newly subdivided land parcels; and maintain records of when and where duplicate titles were last issued (Department of Natural Resources and Environment, 1997).

The plan number will contain 9 digits. The first two digits denote the dealing type, such as PS (plan of subdivision); the next six digits are the plan number; and the final digit (alpha character) is merely a random letter used as a check. The first check performed by URDS is to

compare the alpha suffix of the plan with that originally allocated, and if there is a discrepancy, the system will alert the user. The second check is to verify that a plan with that number has not been lodged previously (Willis, 1997).

The bundle of papers is then divided into two parts. The legal papers, including the application and title, are "fitted" by the lodging clerk, and the diagrammatic, including the plan, transparencies and the survey are sent to charting.

2.3.6 Fitting Documents and Charting

During the act of lodging an application, the original title stored at the LTO is flagged. This title is then placed on the "pulling" list, where it is retrieved and "fitted" (attached) to the application and duplicate title (Willis, 1997).

At the same time, the plan, transparencies and survey are sent to the charting section, where the proposed plan is compared to that in the DCDB in the proposed layer. If the plan does not exist, then it is entered into the map base, however this only happens in a small number of cases.

The plan is brought back from the charting office, where it usually has to wait for the legal documents to be fitted. The plan is placed in the pickup drawer where it waits to be checked. This is done in chronological order, the exception being if the plan is noted as *urgent* (Willis, 1997).

2.3.7 Survey Plan Examination

Plan examination is a crucial step in the lodgement process as it is important that plans are correct due to the State guarantee on title. Examination of a plan consists of both an administrative examination and a plan examination. The administration examination checks the application against the original title, looking at particulars such as the owner's name, address, interests in the land, covenants, easements and mortgages held. It is also necessary to check that the surveyor has signed the plan; that the dimensions are the same as those on the title, and that easements and roads represented on the plan are correct.

Plan examination primarily consists of mathematical checks. Traditionally the Land Titles Office has regarded it as imperative to try to be absolutely certain that every set of field notes

examined is correct in every detail, both logically and mathematically. However, staff cuts and a dramatic increase of work has meant that it is now beyond the capabilities of the LTO to persist with this approach. Hence, a form of quality control and error trapping mechanism is now being applied to surveys lodged with the LTO (Land Titles Office Victoria, 1997).

Essentially, this process involves applying a series of tests to the survey work only to a point where it is determined that the surveyor has satisfactorily tied their work into the surveys on which the subject title was based. This has been termed as achieving a *logical link* with the title (Land Titles Office Victoria, 1997).

The types of checks carried out include the following:

- Do dimensions agree with title?
- Is the land a transferable piece?
- Are boundaries in the correct positions?
- Are easement details correct?
- Are road abuttals correct?
- Is the land description in the panel correct? (This is important as it is linked back to records)
- Does the format and purpose of the plan conform to legislation?

(Land Titles Office Victoria, 1997)

At this stage, any plans that have been "Stopped" or are awaiting requirements, cannot proceed any further.

2.3.8 Build Folios in Interim Database

After the initial examination is complete, new volume and folio numbers are allocated to each lot, and new titles (known as *child titles*) are created in the interim database. The new title is created in ALTS (Automatic Land Titling System) which was commissioned in 1988 to manage computer titles. Currently it contains over 600,000 titles (Department of Natural Resources and Environment, 1997). ALTS is not compatible with URDS, the LTO's tracking program, but eventually the two will be merged into one system.

There are several steps the user must proceed through in order to create a title. Firstly, information such as plan number, lot number, volume and folio number, parish, township,

municipality codes and covenants are entered. Plans containing multiple lots do not have to be entered separately for each lot.

Secondly, the user must indicate what is to be done with the parent title, which can either be fully or partly cancelled. The next step is to enter all the new information into the computer. This includes the type of proprietorship, whether it is single, joint (where both parties must perform transactions together) or tenants in common (where each party can deal with their share individually). If the latter is the case, it is necessary to load in individual shares, if they are unequal. Finally, a report is printed out, which is used as a check before committing the title to the final database, using the plan of subdivision number as a reference (Willis, 1997).

2.3.9 Registration of plan/creation of title

A final check is carried out, which is simply used as a broad overview to make sure all details are correct. It is important to check that all documents are present, the main three components being the title, plan and the survey (including the abstract of fieldnotes). The transparencies which are used for imaging must also be present (Willis, 1997).

Once all checks are completed, the title is moved from the interim database to the database proper. Folios are created at this stage, and the plan is now officially registered. It is at this stage that the title can be searched on line. It is important to note that this is a text title, which does not contain any diagrams (Willis, 1997).

If a diagram is required, this can be accessed via the imaging system, which is used to image and store plans. This task is carried out at the same time as the folio is created. The imaging system was commissioned in 1991 and contains property location details for over 1,000,000 titles taken from plans of subdivision. It also contains copies of 250,000 registered instruments such as caveats, covenants and easements (Department of Natural Resources and Environment, 1997).

2.4 DIGITAL CADASTRAL DATABASE

The last stage of the process is to enter the data into the Digital Cadastral Data Base (DCDB). This is managed by the private company Dataflow. Dataflow's main purpose is to manage the cadastral layer of the State Digital Map Base (also known as the DCDB), both metropolitan

and rural, and to maintain the mapbase such that all changes to the cadastral framework are reflected in a timely manner (Marwick, 1997a).

2.4.1 The maintenance process

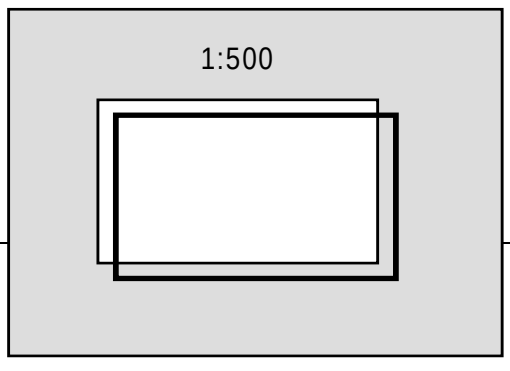
Data is entered into the DCDB via a number of sources, namely the Land Titles Office and the water retail businesses. Since July 1995, the currency of the DCDB has been improved. This has been done in the metropolitan areas by inputting 15,000 Plans of Subdivision from Melbourne Water, and 10,000 Plans of Subdivision as part of a reconciliation with Titles Office charts. In rural areas, 4,000 plans have been inputted as part of a reconciliation with Titles Office charts also. It has been estimated that between 80,000 and 90,000 lots have been input to the DCDB as part of the upgrade program (Marwick, 1997a).

For the metropolitan area, Dataflow receives all proposed plans of subdivision, supplied by the water retail businesses, and all registered plans of subdivisions, supplied by the LTO. Similarly, for rural areas, Dataflow receives all registered plans of subdivision, supplied by the LTO (Marwick, 1997a).

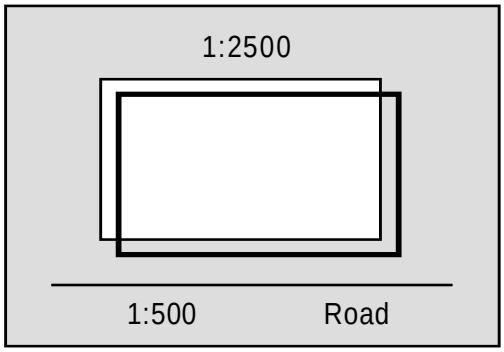
2.4.2 Processing digital plans

Maintenance of the map base is done either digitally or manually. All metropolitan subdivisions consisting of ten or more lots will usually be submitted digitally by the water authorities, in either Microstation (DGN) or DXF format. The data will be submitted via floppy disk accompanied by a paper plan, however before any data can be used, it is important that a virus check be done on the disk.

A sub-file is created, by allocating AMG coordinates to the plan if it does not contain any. The plan can then be inserted into the map base in one of two ways, either by accepting the AMG coordinates of the plan and changing the area around it, or by shifting the sub-file in order to fit it into the map base. The choice of which method to use will usually depend on the scale and accuracy of the existing area, as shown in Figure 2.4.



If the map base surrounding the area is of 1:500 accuracy (currently the best), then the plan is usually just slotted into this space, if the subdivision is within 0.5 metres of the existing map base. Outside 0.5 metres some adjustment to surrounding areas may be made depending on variation, and could involve seeking additional information.



However, if the surrounding areas are only 1:2500, and the plan is based on AMG, then usually a new plan is adopted (as it is more accurate) and the surrounds are shifted slightly. The original lines are deleted, and the map base is modified to the new coordinates. This may result in a bend in the road, or other anomaly, but the original accuracy of that road was not known, so technically, the DCDB is more spatially accurate as a result.

Figure 2.4 Methods of updating DCDB (Marwick, 1997b)

2.4.3 Processing hardcopy documents

Where the plan of subdivision is still in paper format, the subdivision is usually plotted by key entry of bearing and distance. The subdivision is "fitted" into the map base by adopting road alignments and those connections which provide the best fit. Where discrepancies outside accepted plan accuracies are found, further survey information is usually sought.

Most plans are still entered manually, by keying in bearings and distances. This is due to the fact that about 75% of plans are two lot subdivisions, which are currently easier to update using manual techniques. Considering the large number of two lot subdivisions, it is not surprising that that average number of lots in the plans processed by Dataflow is five. Another factor contributing to this figure is that the number of subdivisions with 20 lots or more now only makes up 10% of all subdivisions (Marwick, 1997b).

2.5 CHAPTER SUMMARY

There are several valuable lessons that can be learnt by investigating the current lodgement processes in Victoria. One of the most noticeable features is the amount of times the plan is transferred from one agency to another prior to registration. This is especially apparent when the plan is being checked at the referral authorities and councils. If the council states that a change needs to be made to the plan, it is sent back to the surveyor who must then alter the plan, and send it back to the council, who can approve it if they are satisfied with the changes.

This dependent nature of the current system has resulted in a largely slow and inefficient system. Although the lodgement and examination process is quite fast, it is possible that the plan can take up to 6 months to register, from the original time that the surveyor proposed the development.

It would seem that while some areas of the industry are making significant advances in the use of digital data, there are others which are negating any effects that are being created by these advances. One such example is the collection of data. Many surveyors now collect data in a digital format using data recorders and total stations, and as a result can use this information to produce a digital plan quickly and easily. The benefits to be gained from this are soon counteracted as the surveyor must produce paper copies of the plan, of which the information is then re-entered into both the LTO and Dataflow databases as digital information. Similarly, the information is also re-entered in several different databases maintained by the referral authorities and councils, leading to a high amount of duplication.

The lodgement system also relies heavily on many manual processes using large amounts of paper. An example is the 'bundles' of information that must be included when firstly, submitting the plan to the referral authorities, and secondly, lodging the plan at the Titles Office. This includes documents such as the plan, the certificate of title, a cheque, and an application. Another prominent example is the original search for survey information, which results in large amounts of hard copy information. In reality, all of these items can easily be produced in a digital format without too many problems.

The number of different computer systems used throughout the whole lodgement and registration process is also of concern. The Land Titles Office itself has three different systems, all of which are incompatible with each other. This problem is actually being addressed with a new platform being developed to replace two of the computer systems within the LTO (Charles, 1998). In this case, care must be taken to ensure the compatability of these internal systems with those from interacting agencies, to provide quick and easy flow of data between organisations, as there are several other digital systems used by the surveyors, the referral authorities and Dataflow. Although this shows an endeavouring effort to shift to a digital environment, if the systems are not integrated, then this will prevent processes flowing effectively.

It is important that any attempts to convert manual processes to digital are done with great care. This can be demonstrated through Melbourne Water's scheme several years ago, where it was requested that several surveyors submit all their plans of ten or more lots in a digital format (McFarland, 1998). Theoretically this sounds quite easy for those surveyors who had already prepared their plans digitally. However some would argue that the scheme was not implemented very successfully, as it was designed purely to fit in with Melbourne Water's requirements, and did not consider the needs or the capabilities of the surveyors. The surveyors were asked to prepare their plans in Microstation format, resulting in some having to install new software. As a consequence, it has made many surveyors quite skeptical of the need for digital lodgement.

The Survey Mark Enquiry Service (SMES) is another example of how a digital environment does not necessarily provide the best solution. Although there are obvious problems such as a lack of control marks, many surveyors have reported the program to be cumbersome to use, and would rather use manual methods. This highlights the fact that any digital systems introduced must be user-friendly in order to gain the most out of a digital environment.

A significant anomaly with the actual land registration system is the fact that each plan has two identifiers, being the volume and folio, and the plan and lot number. This stems from when the Torrens system was first introduced, as plans were stored as paper folios to permit an indexing system to be used. Theoretically, the volume and folio number is only used for storage purposes, and is not a unique identifier for a parcel. It would therefore seem logical to eliminate the volume and folio number in a digital environment, and rely on one unique identifier. Land Victoria is considering using the Spatial Parcel Identifier (SPI) (Charles, 1998).

As outlined, the current plan lodgement and registration system is inadequate for the demands being placed on spatial information today. Although several processes are already in a digital format, namely the updating of the DCDB, and the creation of new titles, it is still essentially a paper based system, of which could benefit in many ways if it were converted to a digital environment. However it is important that this be done with great care, as it has already been highlighted that digital systems can produce just as many problems as analogue ones.

3. DIGITAL LODGEMENT IN OTHER JURISDICTIONS

3.1 OVERVIEW

This chapter reviews the advances that are being made in the area of digital lodgement in other jurisdictions. Those reviewed are the Australian Capital Territory, New South Wales, Northern Territory, Queensland, South Australia, Western Australia, New Zealand and Denmark.

The other Australian states have been studied as they have similar processes of land registration to Victoria. New Zealand and Denmark are both modern cadastral systems which make them ideal case studies to learn from.

3.2 AUSTRALIAN CAPITAL TERRITORY

Within the ACT, there are two main agencies dealing with land – the ACT Land Information Centre (ACTLIC) and the Registrar General's Office. The processes used to lodge data at both of these organisations shall be discussed.

Digital lodgement has progressed within the Australian Capital Territory, with 99% of all cadastral information initially lodged in a digital form to the ACT Land Information Centre, the ACT's lead agency for land information and mapping (Hyde, 1995). ACTLIC validate this digital data and enter it into ACTMAP, the ACT's digital cadastral land information system.

The digital information will usually only include parcel boundaries and road centrelines, as opposed to complete survey information. The information is always compiled prior to field marking of the new boundaries. The surveyor carries out the calculation of the data, and then forwards the plan to ACTLIC in digital format. Most surveyors are now trained to provide subdivision data in a digital exchange file (DXF) or Microstation drawing file (DWG) file format in ACT Grid co-ordinates (Weaver, 1998). ACTLIC then validate and approve the data before inputting it into ACTMAP. The steps taken to update ACTMAP include three stages – "massaging", checking and data transfer, each of which are briefly discussed.

- Massaging involves naming polygons to the standard format, adding attributes and ensuring line and character styles are correct;

- Checking involves running a suite of 18 data integrity checks against geometry, spatial accuracy, attribute completeness, line and character style compliance;
- Data transfer is a batch process which adds time/date stamping to the new blocks and any which were made HISTORY. This allows for incremental updates to be given to clients. A textual (ORACLE) data base is updated in the batch process to keep it in sync with the spatial data.

(Weaver, 1998)

Surveyors are also required to lodge all plans to the Office of the Chief Surveyor for examination (Hyde, 1995). These are required in digital format for examination, however due to legislative requirements, it is necessary for surveyors to also submit plans in hard copy format. The examination process is carried out electronically using ACTMAP's cadastral base and data sets of Survey Control, Road Base, Utilities and Building Footprints. After examination, plans are registered at the Registrar General's Office as a Deposited Plan (DP). The DP is scanned, and the compilation of all DPs forms the DP database held in the Registrar General's Office (ACTLIC, 1998).

The Examination Section examines Deposited Plans to ensure that all legislative requirements are met and that the integrity of the ACT cadastre is maintained. There are four main reasons for conducting plan examination:

- To enable the Chief Surveyor to fulfil his statutory obligations under the Districts Act. (i.e. to ensure that the land is correctly described and identified);
- To enable the Registrar General to issue a title or titles based on the plan;
- To maintain the integrity of the cadastre;
- To ensure agreement with ACTMAP.

(ACTLIC, 1998)

While ACTMAP is survey accurate (calculated not digitised), there are some very small differences between it and the legal cadastre as defined by DPs. Work is needed to combine the two and produce all information shown on DPs digitally (Menzies, 1997).

ACTMAP has recently been made available for use online on the Internet, called ACTMAPonline (http://www.palm.act.gov.au/actlic/). The system uses standard World Wide Web tools and can be used from any browser. It also provides users the ability to zoom, pan, add layers of data and query blocks of land for more information. Through the Web, ACTMAPonline allows the community, business industry and government to access large volumes of ACT mapping data simply, efficiently and cheaply though offices, schools and homes (Collins, 1998).

ACTMAPonline is world class in its field as it keeps data in its original vector format, which means no matter how close the user zooms in, the lines and text on the map are always clear. Most web based mapping systems use static raster files, which become blocky and unreadable once the user has zoomed in (Collins, 1998).

3.3 NEW SOUTH WALES

In New South Wales, there is currently no digital lodgement of cadastral data, however an Electronic Plan Lodgement (EPL) program is being carried out, with the main aim to replace the existing paper lodgement system. The two bodies responsible for coordinating this project are the Land Titles Office (LTO) and the Surveyor General's Department (SGD), formerly the Land Information Centre (LIC), both of which are organisations within the Department of Land and Water Conservation. It is intended that the project develop a detailed understanding of the issues and mechanisms involved in the electronic transmission and receipt of digital data (Land Titles Office NSW, 1997b).

The project, which was commissioned in June 1996, is divided into five stages, as listed:

Stage	*Description*
1	Identify internal requirements
2	Identify external requirements
3	Development of issues papers and options
4	Implementation of pilot project
5	Cost benefit analysis

(Land Titles Office NSW, 1997b)

The first three stages have already been completed, and the pilot project commenced in August 1998. Each of these stages shall now be discussed separately.

3.3.1 Stage 1 - Identify internal requirements

The first stage required the LTO and SGD to collect fundamental organisational data to assist in determining the overall organisational requirements for plans and other lodgement data. After the primary data acquisition was complete, a first draft was written, however a quality review of the documentation revealed significant misunderstandings of the format and amount of detail required to complete the document. After on-going enhancements to the documents, they were completed, however they are still able to be updated to reflect changes in either organisation (Land Titles Office NSW, 1997b).

3.3.2 Stage 2 - Identify external requirements

The aim of the second stage was to identify the requirements and issues from external organisations. The methodology chosen was intended to address as many of the specific needs and interests of the participating organisations. A number of avenues were used to obtain this data, which included holding personal interviews with selected surveying firms, 13 in total, and also coordinating 6 workshops with industry and government groups. The results of these interviews were used to develop a questionnaire which was distributed to all surveyors in New South Wales. The questionnaire was prepared jointly between the LTO and the former LIC, and Professor John Fryer from the University of Newcastle (Land Titles Office NSW, 1997b). A brief summary of the questionnaire results is given in Section 4.5.

3.3.3 Stage 3 - Development of issues papers and options

The results of the second stage were used to develop issues papers and options. The most important issues were identified and individually addressed as follows:

- Legal – digital signatures, legislative change;
- Standards, including data collection, plan drawing and plan format;
- Fees/Payments;
- Timing/Availability, regarding dependent nature of lodgement process;
- Security of plans in transit;
- Technology Options – such as Internet protocols, email.

(Land Titles Office NSW, 1997b)

Recommendations were given to resolve each of these issues and these are to be adopted for use in the pilot project. The issue of copyright (intellectual property) was considered to have too many variables and was recommended to be discussed further on in the project.

3.3.4 Stage 4 – Implementation of Pilot Project

The pilot project will be instrumental in testing key technologies and also enable options documented earlier to be further assessed. It will consist of four phases:

Phase 1 – detailed project planning, infrastructure acquisition and pilot system design.

Phase 2 – implementation of core electronic plan lodgement technologies, including participation of surveyors and the type of drawing and geometry software packages they use so that a standard can be developed; development of data transmission medium; and a website to be set up to facilitate lodgement.

Phase 3 – other parties involved in data lodgement will be invited to join in the pilot project. The purpose is to provide the opportunity for these organisations to test the adopted file format and transfer methods refined in phase one.

Phase 4 – this will see the introduction of electronic lodgement of plans using the processes developed in Phases 2 and 3, parallel to the existing manual methods. It will also allow the project team to identify any other requirements to enable electronic data lodgement (Land Titles Office NSW, 1998).

3.3.5 The Cadastral Spatial Referencing System (CSRS)

In conjunction with the work being done on the Electronic Plan Lodgement (EPL) project, the LTO and SGD have also worked on the creation of a Cadastral Spatial Referencing System (CSRS). The CSRS was intended to be a spatially accurate layer in the statewide Land Information System (LIS), which was to be derived directly from data submitted to the Land Titles Office by the surveying profession in the normal course of the registration process (Suwandy, 1997). Unfortunately, the SGD have stopped further development on the CSRS however will incorporate its prototype features in their new Data Management strategy (Harcombe, 1997). Nevertheless it is quite a unique concept, which is worth briefly discussing.

The current Digital Cadastral Data Base (DCDB) for New South Wales is of varying accuracies and it was intended that the CSRS would grow to give a spatially accurate cadastral fabric for the state of NSW. The CSRS was to be both topologically sound and legally correct. Once there was sufficient coverage of the whole state, the CSRS was to become a viable product, whose data may have been used as a base layer for the LIS (Suwandy, 1997).

The CSRS was developed as a stand-alone database, enabling any new technology to access the data regardless of format. The structure of the CSRS contained four main subsets:

- *Aspatial information* – including all information currently incorporated on the panels in a plan such as a surveyor's name, survey date, registration date, parish, county, projection zone;
- *Polygons* – all lot and easement data is stored including parcel areas, centroids, perimeters;
- *Lines* – all dimension information appearing on the plans for easements and boundary connections are stored together with the calculated information from coordinates of the same information;
- *Points* – the location of monuments, measured corners, resolved corners.

(Suwandy, 1997)

The technical details of data entry into the CSRS are shown in

Figure 3.1.

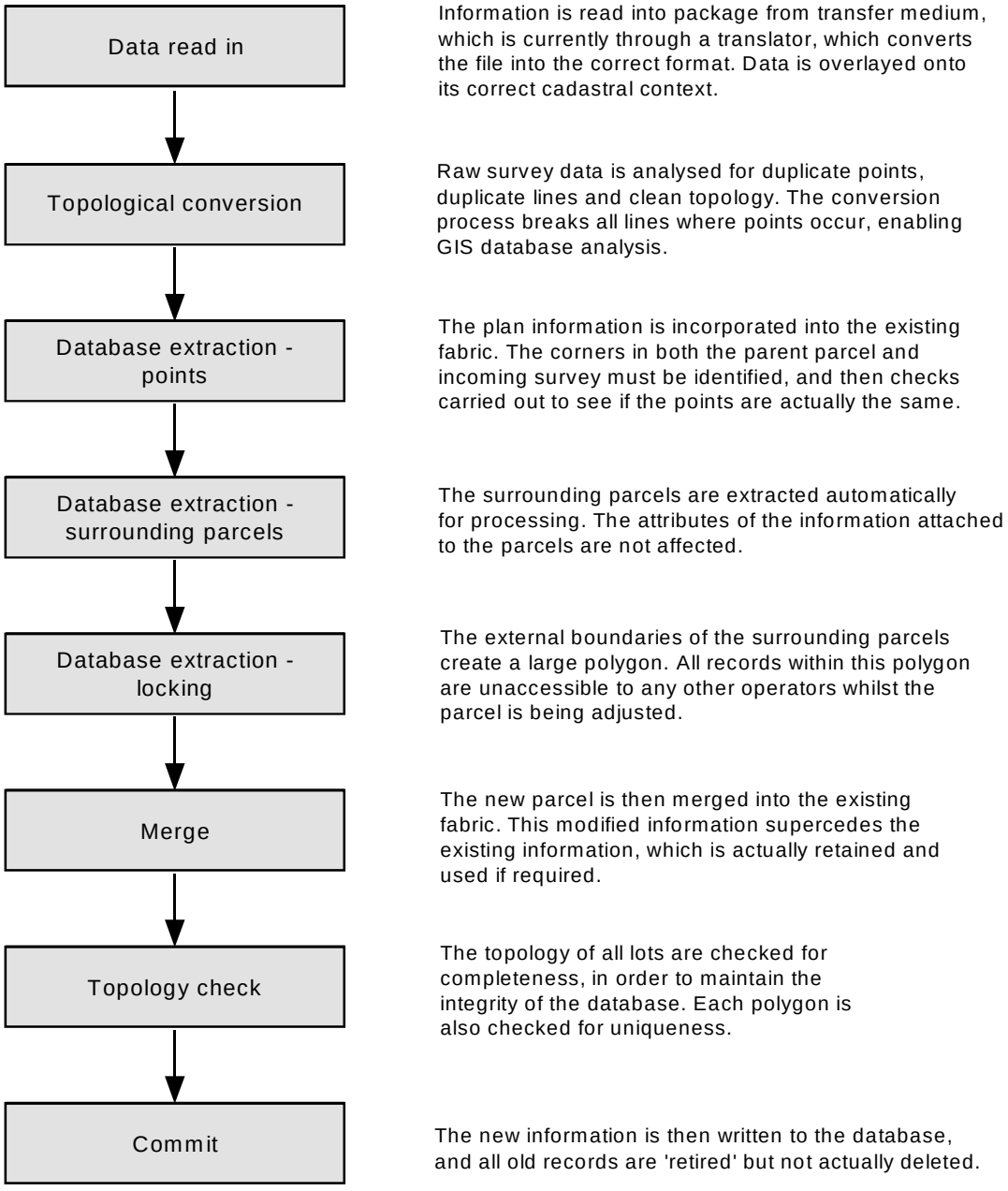


Figure 3.1 Data entry in the Cadastral Spatial Referencing System (Suwandy, 1997)

The intention was that as the LTO and SGD furthered the work they had already done on digital lodgement, the data produced by surveyors was to be forwarded to the SGD in a digital format, for inclusion in the CSRS database.

3.4 NORTHERN TERRITORY

There are no definite plans to introduce digital lodgement in Northern Territory. All plans are still submitted in hard copy format, and although it may be slightly inefficient, it is not really a problem as there are usually only about 300 plans submitted each year (West, 1997). Northern Territory is currently moving towards a coordinated cadastre in a fully electronic environment, and as this happens, digital lodgement is being addressed in an ad-hoc manner, although there is no group specifically working on it (Menzies, 1995).

Northern Territory are also concentrating on digital conversion of primary parcel data from lodged survey plans into their land information database. Digital lodgement of survey data will be required in Coordinated Survey Areas (legal coordinate areas) but the form of the plan is intended to be quite simple in comparison to current survey plans (West, 1997).

3.5 QUEENSLAND

A working group has been formed to look at digital lodgement, comprising members from the Department of Natural Resources, Local Government, the survey industry and Queensland University of Technology. So far, the group has examined the issue of an exchange file format, and has agreed that the Moreton Model should provide the starting point for development of the format. The Moreton Model was developed for digital lodgement of as-built subdivision data (McMahon, 1996).

The main aims of the working group were to develop:

- a digital land boundaries registration system which will be a new government accredited system for electronic lodgement of survey information and computerised registration of land title boundaries;
- software systems, procedures, and data and accuracy standards to enable digital output from land surveying activities to be input in digital format into automated land approval and registering systems;
- new or improved processes approved by the Queensland Department of Lands for the collection, manipulation and electronic lodgement of boundary survey information.

(Hayes, 1997)

There has also been substantial collaborative research done between Queensland University of Technology and the survey industry, where a student, Mr John Hayes, has just completed his PhD, entitled "A Prototype System for the Digital Lodgement of Spatial Data". The aim of the project was to develop a prototype to lodge and register digital survey data which was designed to take advantage of the growing amount of digital spatial data being generated by surveying organisations.

The prototype takes into account spatial data collection, manipulation and presentation procedures, transfer and retrieval processes, format and content standards, and best practice and quality assurance. It provides for immediate delivery of accurate, digital land boundary data, ensuring that all data is entered into the database at source accuracy, rather than the current procedures where it often passes through a series of processes often reducing the accuracy of the data (Hayes, 1997). The prototype consisted of two modules – the Data Collection and Manipulation Module, and the Data Validation and Delivery Module.

The Data Collection and Manipulation Module was designed to utilise existing infrastructure and readily available hardware and software components. This was done to minimise start-up costs and allow the majority of surveying firms to lodge their data sets in a digital format immediately. The creation of an accurate cadastral database was also an important factor, and this process involved using different approaches depending on the class of the area of cadastral development.

The Spatial Data Validation and Delivery Module (SDVDM) was designed to provide the mechanism for the supply of quality spatial data to public agencies. It comprised six logical sub-modules, each representing a discrete phase in the processing of data resulting from cadastral surveying and mapping activities. The sub-modules include database configuration, importation of spatial data, review of data, validation of spatial data, creation of digital lodgement tables and digital lodgement of survey transaction (Hayes, 1997).

The SDVDM takes advantage of existing software in the form of Microsoft Office. This was done to utilise the functionality of the data access objects provided within this program. The programs that were actually used were Microsoft Access – a relational database management system; Microsoft Word – word processing software; and Microsoft Excel – spreadsheet application. By using this combination of programs, it takes advantage of the integrated

nature of data transfer, manipulation and calculation functions provided by this application's environment.

The processing of spatial data within this environment is summarised in Table 3.1:

Function	**Application**
Data files in text formats are exported from CAD applications and reformatted into comma delimited text format files.	Microsoft Word
Spatial data files imported into data tables and validated at the same time using SQL. Tables created containing spatial data related to reference marks, reference to corners and points for coordinate conversion.	Access
Spatial data imported into Excel. Reference marks calculated, and coordinates converted into AMG values.	Excel
Data tables imported into Access. Tables are reformatted to created data tables conforming to standards for lodgement with public agencies.	Access
Tables imported into Word. Comma delimited files are created that are suitable for lodgement with public agencies.	Word
Survey Transaction, consisting of the spatial files and supporting data in a digital encrypted format, is lodged with the public agency.	

Table 3.1 Processing of spatial data within SDVDM (Hayes, 1997)

Queensland also have a surveyor accreditation scheme in place, whereby only 10% of plans lodged are examined for quality assurance, with the remainder passed without checking. This has dramatically reduced the plan assessment workload, however it is felt that the introduction of digital lodgement would also assist in automating some of the assessment checks (Rush, 1997).

Although there has been substantial work done in the area of digital lodgement in Queensland, Rush stated that in the absence of cadastral reform, digital lodgement only provides a limited reduction in the total cadastral data processing workload. He emphasised

the need for complete cadastral reform in order to provide the greatest benefits for both the surveyor and the government (Rush, 1997).

3.6 SOUTH AUSTRALIA

The responsible authority for digital lodgement in South Australia is the Land Services Group (LSG), part of the Land Boundaries Branch. One of the main aims of the LSG is to develop an Electronic Plan Lodgement System, resulting in improved efficiency for both the surveyor and the Land Boundaries Branch, less work to amend mathematical errors on plans and surveys, and reduced examination times (Land Services Group, 1997).

The issue of digital lodgement first arose in 1991, where a working party was established to examine the feasibility of the proposal. However, the main conclusion was that there were not sufficient technological resources available (Land Services Group, 1997). During this period, the development of a software package called PC-PLANS was done. This software was developed to:

- Mathematically check surveys and plans;
- Provide digital data for DCDB update;
- Capture permanent survey mark information for update of the Survey Data Base;
- Create a drawing file for the production of title diagrams.

(Land Services Group, 1997)

Several surveying companies were provided with a copy of this software, however it was fairly short lived as the general consensus was that it was rather cumbersome, not user friendly and took the surveyors longer to prepare plans with it than their normal software.

Digital lodgement (including the PC-PLANS software) then became a prominent issue in the 1994/95 LSG Strategic Plan, where another working party was developed. This included the distribution of a questionnaire to all surveyors and plan drafters who lodged surveys with LSG, seeking their views on electronic plan lodgement. 73% of respondents indicated support for the electronic lodgement of plans, the response clearly showing a high level of technological awareness in the industry (Land Services Group, 1997).

The main findings of the working party was that a plan would still be required, and that initially, electronic plan lodgement should only involve capture of data shown on the face of the plan. In the long term, the LSG proposes to develop a system whereby the survey plan comprises 2 parts, the plan graphic and a disk containing the digital information extracted from the plan (Land Services Group, 1997).

In terms of the software PC-PLANS, two options were put forward. The first was to develop and support a number of translators to convert the digital file from the surveyor's software into PC-PLANS. The second option was to redevelop the software to make it more user-friendly, and provide several surveying firms with a copy. This second option has been chosen and several pilot firms are now using PC-PLANS (Land Services Group, 1997).

It was stated that whatever the final solution was to be, it was critical that the digital data provided accurately reflected the information shown on the plan as lodged at the Land Titles Office. This is important as it is envisaged that this digital data be used for title diagram preparation, DCDB upgrade, and ultimately the development of a coordinated cadastre (Land Services Group, 1997).

3.7 WESTERN AUSTRALIA

The responsibility for the validation and registration of survey (deposited) plans for both freehold and crown estates in Western Australia resides with the Department of Land Administration (DOLA) through its Land Titles Division (Cribb and Higham, 1995). As a result of a government reform program in 1995, digital lodgement was introduced in Western Australia in that year with all plans being lodged requiring to be accompanied by a digital record of the plan.

The initial driving force for the introduction of digital lodgement was the need to automate existing business practices within DOLA. This was part of extensive government reform where the public sector was required to review its total operation with an intention to retain only core business within government. This was entitled the Public Sector Reform Program (Cribb and Higham, 1995).

As a consequence of the Program, the responsibility for survey plan examination was reduced to a 10% audit of the mathematical and legal aspects of surveyors' plans lodged at DOLA

(Houghton, 1996). Previously responsibility for plan examination was with the government, who audited one hundred percent of all documents lodged by licensed cadastral surveyors.

The revised responsibilities of the survey profession in this new environment include responsibility for quality control to a 100% error free level; and responsibility of the full survey, graphic, mathematical and legal elements of work lodged with DOLA, including accountability under the Licensed Surveyors Act disciplinary provisions (Cribb and Higham, 1995).

These new responsibilities have meant that surveyors must now meet "approved examiner" status, which is part of the continuing education requirements of surveyors who wish to lodge documents. This includes a two day workshop covering survey plan preparation specifications, legal and mathematical aspects, quality assurance procedures and case studies. It is also necessary for the surveyor to have lodged two error free plans (Cribb and Higham, 1995).

Digital lodgement was seen as the means to achieve data capture in the new work environment. It was also seen as the next logical step as surveyors in WA have been providing DOLA with digital subdivision data since 1990, which meant the modelling was already in place (Hyde, 1997).

Also, a great deal of time was previously spent on survey examination as it was necessary to manually key in angles and distances to validate polygon areas and dimensions, which was viewed as a duplication of those processes already carried out by the surveyor. It was recognised that if survey firms could supply digital data, then the examination process could be streamlined hence facilitating earlier update of the digital cadastral database.

Hence the opportunity was taken by DOLA to fully automate the digital lodgement of plans by surveyors. One of the problems with the earlier digital lodgement of plans was that DOLA had written translators to accommodate the various data formats, which meant that when new software and versions were released, DOLA was required to write and maintain translators for the new software. This problem has been overcome by DOLA writing specifications for a standard format called the Cadastral Survey Data (CSD), which was designed to provide for data to be extracted from various existing formats in the market place (Cribb and Higham, 1995). The current range of software packages used in the private sector in WA was identified

to be seven, and of these, four have had successful CSD conversions written for them (Hyde, 1997).

The digital data file is structured to provide records for a heading, comments, projection, spheroid, points, lines, polygons, angles, azimuth, topographic string, arcs and the sequence of lines describing a polygon. On lodgement, the CSD files is imported into SDI (DOLA's corporate survey data capture and calculation program), and run through a validation routine to ensure the completeness and correctness of the data. All survey plans lodged with DOLA (both crown and freehold) must now be accompanied by a digital record of the plan on a floppy disk (Hyde, 1997).

The digital data file is used in four different ways:

- for initial tracking and lodgement of the plan;
- for scaled plots for initial indexing and final reflection on public plan;
- for automatic bowditch closures of each parcel;
- for integration into DCDB.

(Cribb, 1997)

The new digital lodgement processes employed in WA have enabled faster updating of the DCDB and streamlined the plan registration process. DOLA currently receives 85% of survey plan lodgements with CSD files and the standard of these files is improving (Houghton, 1996).

3.8 COLLATION OF STATE RESPONSES

As part of the research into the status of digital lodgement in other jurisdictions, letters were forwarded to the Surveyor General of each Australian state and New Zealand concerning this topic. Appendix Four shows a copy of this letter. The questions covered topics such as the current status of digital lodgement in that jurisdiction, the respective roles of the private and public sectors and the difficulties or barriers encountered during the introduction of digital lodgement. In some cases, the query was passed on to the person who had been more directly involved in the implementation of digital lodgement. The following tables shows the main results of these letters.

Question	**Australian Capital Territory**	**Northern Territory**
Current status of digital lodgement	Survey data lodged digitally with LIC, but hard copy lodgement to LTO.	Do not currently accept digital lodgement.
Respective roles of public and private sectors	Surveyor – calculation and lodgement of data. ACTLIC – validates and approves data.	N/A
Difficulties in implementing digital lodgement	Certification, amendments and security.	Appears to be little gained
Impact on plan examination	N/A yet	N/A
Use of WWW	Yes	Yes, if possible
Any legislative reform necessary	Not yet, but will be necessary.	Require many amendments to accommodate staged introduction of digital lodgement.
Coping with issues such as digital signatures	N/A yet	Certifications, approvals and owner consent must be considered.
Source	(Menzies, 1997)	(West, 1997)

Table 3.2 State responses to digital lodgement questions

Question	**New South Wales**	**Queensland**
Current status of digital lodgement	Working on an Electronic Plan Lodgement project, with the aim at replacing the existing paper system with an electronic system.	Working group been formed, who have examined the issue of an exchange file format.
Respective roles of public and private sectors	Intended that private sector supply raw survey information, and public sector will register plans and manage spatial data base.	N/A
Difficulties in implementing digital lodgement	Copyright, loss of plan representation, resistance by profession, institutional issues such as dichotomy between LTO and LIC regarding administration of geospatial information.	Substantial development and implementation costs up front.
Impact on plan examination	New software has been developed which will allow plans to be accepted in many different formats and compare it with surrounding legal information, then make spatial comparison. Also CSRS has been developed.	Surveyor Accreditation Scheme in place.
Use of WWW	May include the use of an Internet home page for transmission of digital data.	Being considered.
Any legislative reform necessary	Legislative change is necessary, especially for allowing digital signatures to replace traditional signatures.	Consider digital lodgement as one feasible component of cadastral reform, so legislative reform will not result solely from digital lodgement.
Coping with issues such as digital signatures	Could be dealt with in 3 ways: • make documentation a separate issue from digital plan information • provide mechanism to allow transmission of signatures as faxes, pins, or encrypted codes • browsing software to allow tick boxes to be used to authorised persons	Persevere with paper system until issues are resolved. Current digital signature technology is not seen to be sufficient.
Source	(Benham, 1997) (Baitch, 1997) (Harcombe, 1997)	(Rush, 1997)

Table 3.3 State responses to digital lodgement questions

Question	**South Australia**	**Western Australia**
Current status of digital lodgement	Working group formed. LSG proposed introducing DL in two stages, firstly to lodge plan mathematical data, and secondly, lodgement of textual data.	All survey plans to be lodged digital on floppy disk, as well as hard copy.
Respective roles of public and private sectors	Government role to audit rather than capture data.	Government – register plans, legal verification, spot audit. Surveyors – 100% error free quality control, responsible for all elements of work lodged.
Difficulties in implementing digital lodgement	Acceptance by surveying profession. Copyright of data.	Digital lodgement considered as one component of complete reform package. Data formats – most packages had converters written, but not all. Ongoing support for small companies.
Impact on plan examination	Should reduce level of examination.	Surveyor Accreditation scheme in place. Digital data supplied by surveyor has automated the mathematical validation of the examination process.
Use of WWW	Yes, in longer term to both lodge data and also provide information back to surveyors.	Likely technology of the future. Files are now sent by floppy disk, or via web only for resubmission due to errors or additions to plans.
Any legislative reform necessary	Legislate to require the lodgement of digital data and certification of data lodged.	Regulations changed in 1995, requiring analogue plan lodgement to be accompanied by digital record.
Coping with issues such as digital signatures	Long way off digital plan. First capture mathematical information and then expand to include textual data. Still require a hard copy plan.	Signature on analogue plan is sufficient for the moment. Issue will be addressed further when full digital lodgement is implemented.
Source	(Kentish, 1997)	(Cribb, 1997)

Table 3.4 State responses to digital lodgement questions (cont.)

Question	New Zealand
Current status of digital lodgement	No digital lodgement as such. Digital lodgement may be facilitated through Survey and Title Automation Program, however paper plans will be required until legislative changes are made. Lodgement of intelligent data will be encouraged.
Respective roles of public and private sectors	N/A yet.
Difficulties in implementing digital lodgement	Current legislation requires a paper survey plan to record certain consents, which could possibly be a print out generated from the digital data.
Impact on plan examination	Four year vision is for 70% of cadastral survey datasets to be automatically validated, and the remaining 30% speeded up by automatic checks. This will ultimately reduce costs and cycle times.
Use of WWW	Expected that Internet will be preferred delivery mechanism.
Any legislative reform necessary	Legislative change to remove the need for paper copies is proposed. Also change to allow the register of titles to be held in digital form.
Coping with issues such as digital signatures	Digital signatures may be easier for survey transactions than for title transactions as the providers authorised to lodge cadastral surveyors (surveyors) are well defined.
Source	(Grant, 1997)

Table 3.5 New Zealand's responses to digital lodgement questions (cont.)

3.9 NEW ZEALAND

Land Information New Zealand (LINZ) is the authority responsible for the management of core land information. LINZ control the paper records and survey marks which provide core title and survey information and define New Zealand's land property rights.

As a result of a merger which involved the Land Titles Office and the Department of Surveying and Land Information in 1996, resulting in LINZ, two immense opportunities have been recognised by LINZ – the integration of processes in relation to survey plan approvals and deposit and the issue of new titles; and the re-engineering of work processes to reduce cycle times so that departmental time frames can be consistently met and to improve quality (Land Information New Zealand, 1997a).

LINZ are now in the process of restructuring their entire land registration system, as the current manual system has essentially remained unchanged since the 1870s, and has become quite slow and inefficient. For example, transfer of title can take 5 working days and approval of surveys up to 20 days. It is expected that with the new automated system, the turnaround time will be slashed to just 24 hours (Land Information New Zealand, 1997b). Table 3.6 gives some statistics on how many survey plans and title transactions LINZ deals with per year.

Land transactions processed annually	900,000
Survey plans approved annually	18,000
Land parcels covered by these survey plans	38,000
Searches of paper records by public each year	1.5 million
Number of records held by LINZ	30 million
Number of current records to be converted to digital format	7 million
Annual increase in LINZ shelving storage needs, in metres	1,500

Table 3.6 Land Transactions by LINZ (Land Information New Zealand, 1997b)

3.9.1 Land Titles and Survey Automation Program

A major project being carried out within LINZ is the Land Titles and Survey Automation Program that was commissioned and due to run between 1998 and 2002. The vision is a fully digital information system environment, closely integrated with external users of land information. The goal of the Program is to implement a secure national system available by computer from anywhere in the country with a turnaround time of 24 hours for 90% of survey and title transactions (Land Information New Zealand, 1997c).

A fundamental principle of this concept is the merging of survey and title transactions into a single digital land transaction, both of which were carried out separately in the past. For example, in order to deposit a plan, there were two processes involved, these being the survey checks (carried out by the Chief Surveyor's staff) and the legal checks (District Land Registrar's staff). One of the major initiatives of this project is to allow plans to be lodged for registration even before they have been approved as to survey. This means that once the plan has been approved, the dealing can be registered, and titles issued as early as possible, even on the same day that the plan was deposited (Grant et al., 1997).

Another major component of the project is the digital conversion of "physical records" to live and intelligent data that will play an active role in the automation process. It is important to note that this digital conversion is not simply a change of format to scanned plans, which are static. The key to the system is "intelligent data" (data containing attributes), which will be generated by back-capturing historical records and ultimately by digital lodgement of cadastral surveys and title transactions (Grant et al., 1997).

One principle that will not change is the state's guarantee of title, and secondly, the integrity of the data should not be threatened (Grant et al., 1997). This will be ensured through the use of a survey accurate coordinated cadastre, which is a fundamental building block for the survey component. It is crucial that there be a national geodetic control framework in place to support all cadastral data. The accuracy of this geodetic framework should be very high as any coordinates derived from it will only be as good as their source. It must be noted, however, that these coordinates will not attain any legal significance, but will merely be used to provide a summary of survey data that will enable existing survey marks to be more easily found. The automation of survey data will become increasingly reliant on an accurate geodetic infrastructure, enabling the efficient association and management of digital spatial cadastral data (Grant et al., 1997).

The project consists of a number of different stages of which the first stage, project design, is complete. LINZ are currently working on the second stage which is project building and implementation, scheduled to finish in January 1999 (Land Information New Zealand, 1997b). One significant area being addressed at this stage is the selection of hardware and software, which is very important considering the rapid rate of change in this field. Another subproject within this stage is the conversion of paper plans to electronic images by scanning. The final images will not be editable but able to be printed out and stored. Electronic images will result in much faster and cheaper access to the plans (Land Information New Zealand, 1998a).

In order to accommodate all these changes to the current system, several law changes will need to occur. These include changing the law concerning transfer and storage of data (such as the provision of digital signatures to validate and authorise transactions). The deadline for this law change is January 1999, after which survey and title records will be able to be stored

in electronic format. Further law changes will be required by 2001 to allow the digital lodgement of new survey and title transactions (Land Information New Zealand, 1997b).

Capture Electronic Parcel Project

One quite significant sub-project in the Automation program is the "Capture Electronic Parcel" project which will capture the dimensions of surveyed boundaries for entry into a numeric database to provide a survey accurate digital cadastre. Essentially, the boundary dimensions with connections to a new, modern, geodetic control framework will be entered into the Core Record System (CRS), which will enable LINZ to create the Survey Accurate Digital Cadastre (SDC), leading to the automation of both surveys and the processing of survey data (Land Information New Zealand, 1998b).

The first part of the project required LINZ to consult all survey system users about which land parcels should be included, as some (rural parcels) are not defined well enough to include them (Land Information New Zealand, 1997b). The initial planning stages of the project are now complete and as a result a very active geodetic program is underway, putting in place the geodetic control network which will support the automation project.

Electronic parcel capture will start in July 1999 with the commencement of Landonline, whereby the database will be created to provide an electronic representation of survey plans and land titles. All existing plans will be imaged and current land parcel dimensions for about 80% of them will be entered into the SDC (Land Information New Zealand, 1998c). The SDC will lead to the automation of both surveys and the processing of survey data. It has great benefits to surveyors as the majority of new surveys will be in areas covered by the SDC and the system will have the capability to process plans arising from these surveys within one day. The system will also allow the digital lodgement of survey data.

The Electronic Parcel Capture project is now at the stage where the automation project team is identifying the specific types of data that will need to be interchanged between surveyors and the SDC. The interface exists at a point where the new CRS exchanges data with a system or process which is external to the CRS. Data passing from the CRS (exports) or data arriving at CRS (imports) need to meet agreed criteria (standards) of content and format to successfully navigate the interface (Land Information New Zealand, 1998c).

Surveyor Accreditation

Another significant reform being implemented by Land Information New Zealand is the accreditation of cadastral surveyors. This is being done to achieve a more appropriate and effective process for the verification and approval of cadastral surveys. The new accreditation system will place more reliance on accredited surveys to maintain the required standard of work when lodging plans with LINZ, and less emphasis on detailed checks by LINZ (Land Information New Zealand, 1998c).

3.9.2 A vision for digital lodgement

A system of digital lodgement has also been proposed by Burgess and Dawidowski (1995), both of LINZ. The major concepts of the system include:

- "The Survey System will represent survey and cadastral data as an adjusted network, captured from source documents. Effectively the data held by the system will be analogous of one large plan of the survey control and cadastral fabric of New Zealand.
- Any changes to the system, such as a new subdivision, will be effected by the submission of a digital data set that will be verified against the Survey System's databases.
- The original legal documents, both physical and digital, must be securely archived.
- The existing system must continue to be supported until such time that the users and the new system have the ability to work in a digital environment, but at an agreed time, the old system must be stopped.
- The new system will be able to support a spatial data infrastructure which requires that the various layers of data are coincident and in 'absolute' position. There are two requirements, first is that the base layer must consist of the cadastre, and secondly that all the other types of layers are in terms of a single reference system for the entire country.
- The focus on a National Spatial Data Infrastructure will depend on numerous public and private sector processes being linked. An important part of the Survey System's business will be to provide this linkage."

(Burgess and Dawidowski, 1995).

Figure 3.2 shows Burgess and Dawidowski's (1995) ideas of the cadastral survey transaction data flow.

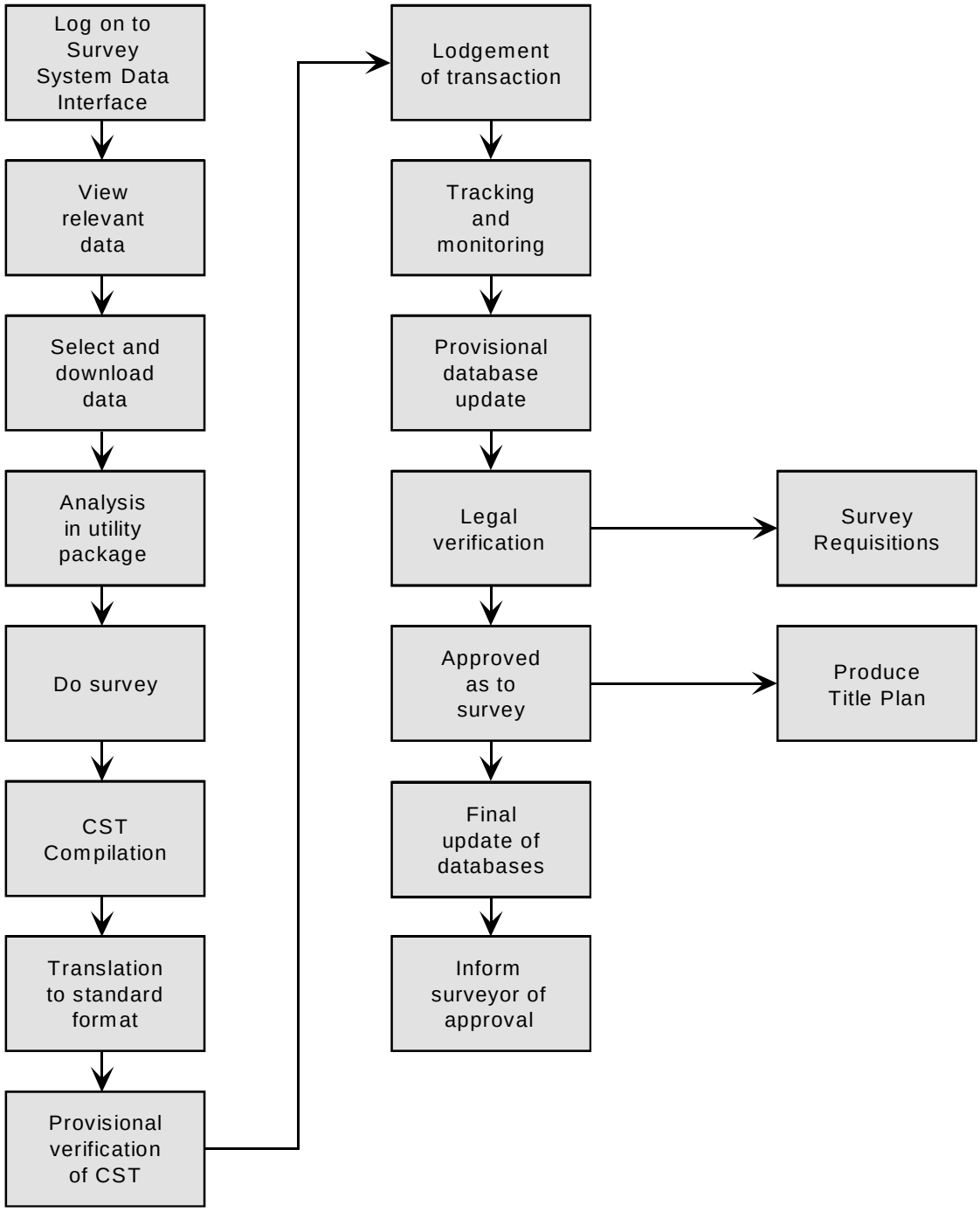


Figure 3.2 Cadastral Survey Transaction (Burgess and Dawidowski, 1995)

The most important aspects are discussed further. The CST, or Cadastral Survey Transaction, is essentially a single set of digital data of a survey submitted for the purposes of updating and/or changing the current cadastral land parcel fabric. It is not a digital or electronic plan, but rather a data set consisting of survey and related cadastral data which will facilitate the registration of land title. The CST will be based on three components:

- a spatial component which includes the survey geometry and graphic information;
- an attribute component which contains descriptive information;
- topology of the graphical data.

(Burgess and Dawidowski, 1995)

The pre-lodgement check would be carried out by the surveyor logging on to the survey system and submitting the CST. The types of checks applied would include internal misclose checks, checks for survey and cadastral "fit", and checks for completeness of entries. The system would inform the surveyor of how good the fit was, and nominate any data that was missing, such as a digital signature. Details such as lodgement fees would also be provided.

The CST could then be lodged properly, using the same process as the pre-lodgement, but containing more security provisions. Once this is complete, the CST would be verified in order to maintain the integrity of the Cadastral Survey System, with only "rogue" plans needing human intervention (Burgess and Dawidowski, 1995).

The result of this process is the significantly lower need to re-key data from 'paper' documents for different purposes. In effect, there would be expected to be significant cost reductions, and improvements in efficiency and productivity for both the surveyor and the regulatory authority (Burgess and Dawidowski, 1995).

3.10 DENMARK

The digital lodgement of plans in Denmark was introduced mainly as a result of the computerisation of the digital cadastral map, which was completed at the end of 1997. Digital lodgement will become compulsory from 1 January 1999 (Enemark, 1998a).

Prior to digital lodgement, all legal survey measurements and any proposed changes to the cadastral map were lodged manually in an analogue form. Digital lodgement was introduced

through the whole process of establishing the digital cadastral map, which was mainly undertaken by the private surveyors. The demand for digital lodgement therefore was logical and in fact was proposed by the surveyors' organisation itself. Surprisingly there was only minimal opposition coming from the most outdated one-person firms (Enemark, 1998a).

The legal survey measurements and the updated cadastral map are submitted in a special format for exchange of digital information. This is a Danish standard developed more than 10 years ago (Enemark, 1998a).

3.10.1 The cadastral map

Fundamentally, the Danish system consists of two main entities - the cadastral register and the cadastral map. The original purpose for the establishment of the cadastre was for land tax purposes, rather than for the property market. Recent cadastral reform has resulted in the computerisation of both the cadastral maps and registers. The cadastral register was completed in 1986, and includes 2.5 million parcels, representing 1.5 million properties (Enemark, 1998b).

More substantial was the computerisation of the cadastral map, which may be characterised as a legal map for identifying cadastral parcels as noted in the cadastral register. Due to the poor condition of the original analogue maps, it was not possible to simply digitise the maps in order to create a digital cadastral map. The method used was to digitise those points linked to the national grid in order to establish a skeleton map. The remaining areas were then established by digitising the analogue map and fitting in the single areas, using the framework established earlier. In order to update the map, any new cadastral measurements would be used to adjust the boundaries, ensuring a continual improvement in the quality of the map base (Enemark, 1998b).

Since 1910, it has been a requirement that all subdivisions and changes to the parcel boundaries be carried out only by licensed surveyors, hence all changes to the cadastral map are provided by this information from the licensed surveyors. All boundaries must be surveyed to a high standard, and most surveys are now linked to the national geodetic network.

3.10.2 Cadastral surveys

Upon obtaining the necessary information required to carry out a survey (in some cases this can be done by on-line access to National Survey and Cadastre), the surveyor must determine all existing boundaries in the field and agree, mark and finally survey all existing and new boundaries. This will be presented in the legal survey measurement and will appear in a digital format. The surveyor will then include the new boundaries directly in the digital cadastral map and the existing boundaries will be adjusted accordingly (Enemark, 1998b). Furthermore, the bundle of cadastral documents will include documentation on all legal rights as well as consistency with land use and planning regulations. This documentation will still be submitted manually, while the legal survey measurements and the updated cadastral map can be submitted in a digital format (Enemark, 1998a).

3.10.3 Updating of cadastral map

In principle, the DCDB is updated by the National Survey and Cadastre who by law hold the responsibility for maintaining and updating the cadastre. However, since an updated version of the digital cadastral map is submitted by the surveyor, one may say that the DCDB is in fact updated by the surveyor. When major discrepancies appear, the surveyor is expected to submit a proposal for updating the cadastral map to the National Survey and Cadastre for approval before finalising the subdivision or change of boundaries.

3.10.4 Plan examination

Most plan examination is carried out by random checks. The National Survey and Cadastre have estimated that about 90% of the updating can be carried out without any problems. In the remaining 10% the surveyor may have to do some additional surveys. The surveyors are responsible for their cadastral work for a period of 20 years ahead even if the National Survey and Cadastre in principle are responsible for the maintenance of the cadastre (Enemark, 1998a).

3.11 CHAPTER SUMMARY

This chapter has outlined the advances that have been made in the area of digital lodgement in other jurisdictions. Although each system is quite different to Victoria, it nevertheless provides many valuable lessons, both in terms of technical innovations, as well as the actual

process of implementing digital lodgement, and the types of problems that are likely to be encountered.

One of the first points to note is that many jurisdictions are implementing digital lodgement as part of a broader cadastral reform program, rather than an isolated case. Western Australia, New Zealand and Queensland are the most discernable examples of this. This highlights the fact that digital lodgement cannot afford to be treated as a problem on its own – it is important to consider the effects it will have on the whole industry, and what benefits it will provide.

In the same fashion, a number of jurisdictions have also introduced surveyor accreditation programs as a way of retaining only core business within government. It also ensures that surveyors are made responsible for quality control of their own plans, to a 100% error free level. It is expected that this trend will become more popular as the cadastral industry further enters the digital age, with more digital databases relying on the source data collected by the surveyors.

The bringing together of all the land administration agencies into the one department is another idea that is bound to have positive ramifications on digital lodgement. Western Australia is a prime example of this. Previously, there were separate departments handling the digital cadastral database, and the registration of title, however they were brought together several years ago. This is a similar case to Victoria, who have only just realised the benefits of managing all land information in the one department, with the bringing together of the Land Titles Office and the former Geographic Data Victoria (responsible for maintaining the SDMB) under the one group Land Victoria. New South Wales and New Zealand have also adopted this approach.

Solutions to several technical issues have also been highlighted within this chapter. In terms of file formats, Western Australia has introduced a system whereby the surveyors can produce their plans in the software of their choice, and then using translators developed for that particular software, the surveyor can then lodge the plan in this format. This is an ideal alternative to the surveyors having to purchase new software to accommodate digital lodgement. New South Wales are also developing a new file format to use. South Australia recommended that when digital lodgement in introduced, firstly only the data itself should be

lodged, accompanied by a hard copy plan, and secondly all information would be lodged digitally, which would include the plan graphic and the digital information extracted from the plan.

Denmark has shown that it is possible for the surveyor to directly update the DCDB, with digital lodgement becoming mandatory at the start of 1999. Although compulsory digital lodgement may seem unfair to the companies who are unable to lodge plans digitally and are likely to go out of business, it is important to keep in mind the larger industry benefits provided by digital lodgement, which far outweigh the disadvantages.

A number of jurisdictions have also adopted the idea of a coordinated cadastre, whereby all cadastral surveys carried out must be based on the state geodetic network. New Zealand and the ACT are the furthest advanced in this area. Coordinated surveys are expected to reduce the effort needed to lodge a plan, however it is important to realise that digital lodgement can still be introduced even if the plans are not coordinated. New Zealand have emphasised the fact that although plans will be based on coordinates, these coordinates will not have any legal significance.

New South Wales provides a valuable example of a state currently going through the motions of introducing digital lodgement, and the necessary background work and research to be completed. The program has so far identified issues, recruited several volunteer companies to take part in the pilot program, and as a result, the pilot program is now in progress.

Several conceptual ideas have been highlighted through the studying of other jurisdictions. One idea is the creation of a new cadastral fabric, created solely from plans of subdivision being lodged by surveyors, which has been proposed in NSW and New Zealand (Land Titles Office NSW, 1998). Another is the system proposed by Hayes (1997) whereby the surveyor can update the DCDB him/herself, by using Microsoft Office software as a quality assurance package. New Zealand has also had the same idea, where in essence the map base is updated by the surveyors themselves. Important components of this system include the cadastre relying on a solid geodetic base, so that all surveys are coordinated. Any changes to the system are verified against the original databases.

Due to the different needs and requirements of each state, it is difficult to implement the same system in any two jurisdictions however there are still many valuable lessons to be learnt which can be applied to Victoria.

4. THE VICTORIAN SURVEYING PROFESSION'S ATTITUDE TOWARDS DIGITAL LODGEMENT

4.1 OVERVIEW

The importance of the consulting surveyor within the plan lodgement process is paramount, considering it is the surveyor who is responsible for the initial collection and manipulation of the cadastral data. Any changes implemented to the current system as a result of digital lodgement must therefore take into account the needs and capabilities of the surveyors. It was decided that the most accurate and direct method of gauging the assessing profession's attitude towards digital lodgement was through a questionnaire forwarded to all the private surveyors in Victoria.

The objective of the questionnaire was to determine the technical capabilities of surveyors, their current lodgement processes and their attitudes towards digital lodgement, in order to provide valuable information for developing a vision for an electronic plan lodgement system. This chapter summarises the results of the questionnaire and compares them to similar questionnaires carried out in New South Wales and South Australia.

4.2 QUESTIONNAIRE FOR PRIVATE SURVEYORS IN VICTORIA

The questionnaire was sent to 104 private surveyors in Victoria, all of whom are members of the Association of Consulting Surveyors (ACS), who were in full support of the study. Appendix Five shows the letter that was forwarded to the ACS (of which a similar copy was also sent to the Institution of Surveyors Victoria) in preparation for the questionnaire.

The questionnaire was sent in early January 1998 with a closing date for responses in mid-February 1998. However, due to lack of responses, some follow up was required and the last responses were accepted in late April. The companies surveyed have remained confidential throughout the results.

The questionnaire consisted of both multiple-choice questions and short-answer questions. The first two sections contained questions regarding current technology, and current survey and data lodgement practices, whilst the third section concentrated on the surveyors' attitudes

towards digital lodgement. Appendix Six contains a transcript of the entire questionnaire, along with the letter that was sent to each surveyor.

The questionnaire was designed using a similar questionnaire carried out in New South Wales as a basis (Land Titles Office NSW, 1997a). Another questionnaire was carried out in South Australia in 1994 by the Department of Environment and Natural Resources which was also used to construct the Victorian questionnaire (Land Services Group, 1994).

4.3 RESULTS

A return rate of 42% (44 out of 104) was achieved which indicated quite a high interest in the general concept of digital lodgement. A higher response was anticipated in order to provide a more accurate range of answers, however these responses yielded some very important information nonetheless.

In hindsight, certain measures could have been taken to increase the number of responses. One idea would have been to supply a reply envelope, as an incentive to return the questionnaire. Another problem was that the list of surveyors obtained was quite out of date with several incorrect entries. Hence when follow up phone calls were done, many of the companies had not actually received the questionnaire in the first place. This problem could have been easily avoided by telephoning each surveyor before the questionnaire was sent out to gain the surveyors' approval, and simply out of courtesy. Also, more emphasis should have been placed on the fact that this questionnaire was being used simply to assess the general feeling about digital lodgement amongst the surveying profession and that the information resulting from the questionnaire would not be used out of this context.

The responses were entered into a Microsoft Excel™ spreadsheet in order to simplify answers and tally the number of responses for each question. Using this software, several graphs were generated, which provide an effective medium for representing such information. This section will provide a summary of the results of the questionnaire. In order to obtain the most beneficial results, answers from several questions have been integrated, whilst others have been discussed separately.

4.3.1 Nature of Company

The results indicated that 86% of responses were from private organisations, with the remaining 14% from sole practitioners. This is not necessarily representative of the number of sole practitioners in the industry however because it was not known how many sole practitioners were actually on the mailing list to begin with. The number of employees in each company was also obtained, which has been integrated with other information throughout the questionnaire. The results of this question showed that 27% of the companies had less than 5 employees, 37% had between 5 and 10 employees, and 36% had more than 10 employees.

4.3.2 Current Technology

All surveyors who responded used computers for data collection and/or drawing of plans. The number of surveyors with access to a personal computer (PC) was 93%, with the remaining 7% using workstations. In the questionnaire, a PC was defined as a personal computer which is IBM compatible (as opposed to a Macintosh), which may be stand-alone or networked. A workstation was defined as a computer usually connected to a network, possibly running UNIX.

The next section was related to software. This was deemed to be a mandatory question as one of the major issues in the implementation of digital lodgement relates to data formats and types of software that will be used for the submission of plans. The surveyors were asked to indicate what type of software they used for creating geometry, drawing and word processing files, which were defined in the survey as:

Geometry software is that which is used to create drawings which contain, amongst other things, details on parcel bearings and distances and coordinates for all parcel corners and connections. Geometry software should also be capable of calculating lot areas, volumes and other such processes needed in surveying.

Drawing software is that which is used to present data, rather than to perform complicated surveying routines. For example, a surveyor may design a subdivision using geometry software, in which all the areas and dimensions are automatically calculated. However, final editing will usually be done in a commercial drawing package after saving the file in a DXF format.

Word processing software is simply that which is used to prepare textual documents such as a surveyor's report.

Initial results showed that the most popular geometry software packages were Liscad and Autocad, both with 22 users. For both packages, the majority of firms were using either the most recent version or the previous version. Geocomp appeared to be the next most popular geometry software with 14 users. The combined total of the other packages (Civilcad, Microstation, Wescom and others) amounted to 20. The total number of software packages used amounted to more than 44 because many firms used more than one type. Figure 4.1 shows the types of geometry software used by responding survey companies.

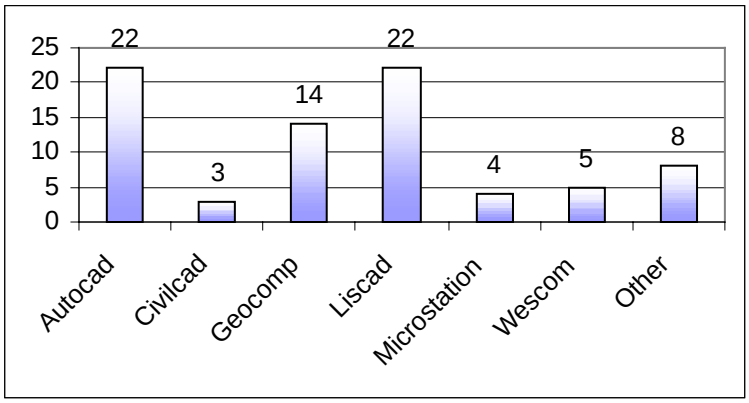


Figure 4.1 Geometry software used by surveying companies in Victoria

Similarly, the most popular drawing software was Autocad, with 25 users, followed by Liscad, with 14 users. Microstation only had 8 users, half of whom also used it as their geometry software. Again, most firms used the latest version or the preceding versions.

Microsoft Word was the most popular word processing package, with 36 users. Six of these used the latest versions, with the rest using previous versions. Word Perfect had six users. The range in versions was most probably due to user-friendly conversion functions in most word processing packages.

After the majority of the questionnaire responses were received, it was noted that the questionnaire did not accurately reflect the true status of the profession, as no allowance was made for the multiple software licences used within the major companies. Some 80% of the subdivisional work within Victoria is done by a handful of companies, which needed to be heavily weighted to obtain creditable results. Using this information, a second list of

companies was compiled, and then surveyed again by telephone. Hence the type of software they used and the number of licences was determined.

Table 4.1 shows a slight variation for the type of software being used in Victoria, although not as much as expected. Some of the larger firms have several licences for software, especially Microstation, Geocomp and Liscad. The main reasoning behind companies choosing to use Microstation was due to the Melbourne Water scheme a number of years ago when several firms were asked to submit all their plans of 10 or more lots in digital format using Microstation software (McFarland, 1998).

Company	Microstation	Geocomp	Autocad	Other
1	9			Geopak - 3 Wescom - 8
2	1	4	2	
3	1		1	Liscad Plus - 4
4	1	4	3	Listech - 1
5		2	2	
6	1			Liscad - 4

Table 4.1 Number of software licences owned by major survey companies

The next question concerned updating of software and it was shown that 56% of the surveyors updated their software when the latest version was released (within 1 year usually), whilst 22% updated within the last year, but not necessarily with the newest versions. 22% updated between 1 and 5 years ago. By correlating this data with the software data, it would appear that this updating generally referred to geometry software. The results are illustrated in

Figure 4.2.

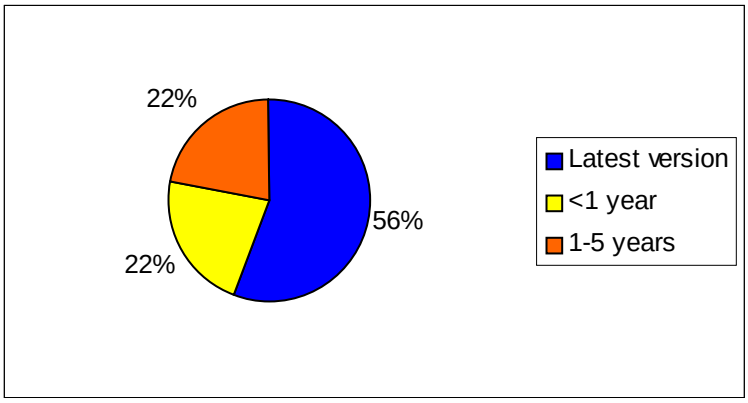


Figure 4.2 Updating of software

Figure 4.3 shows the principle methods surveyors used to transmit digital data. As most surveyors used more than one type of transfer medium, there is some degree of overlap in the percentages. For example, 70% of all surveyors used a modem, and approximately half also had access to the Internet and email. As indicated earlier, all surveyors had access to computers, so it is surprising that floppy disks were not used by all surveyors, as these are the most common format for saving and transporting digital data.

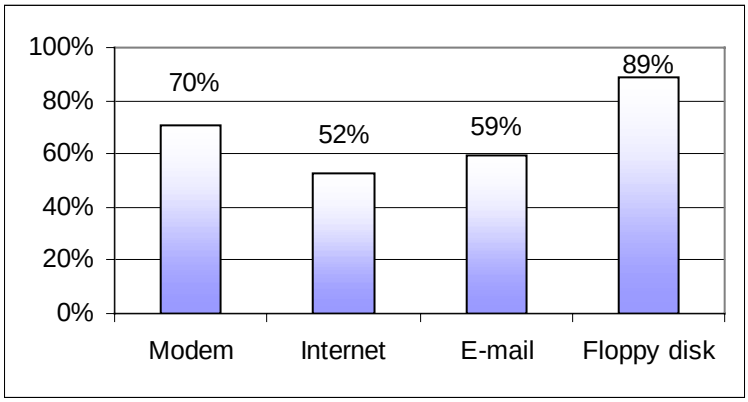


Figure 4.3 Types of remote computer communication

4.3.3 Current survey and data lodgement practices

The first question in this section regarded subdivisional work. The question was divided into five classes, each a specified number of lots, and the respondents were asked to state what percentage of each type of subdivision they would perform. For example, one company may be more inclined to carry out 2 lot subdivisions, say 70% of all the work they performed, whilst another 10% of their work may consist of subdivisions of more than 20 lots. Figure 4.4 shows the setout of this question.

	Percentage
2 lots	……
3-5 lots	……
6-10 lots	……
10-20 lots	……
More than 20	……

Figure 4.4 Question on subdivisional work

These particular classes were chosen because many of the smaller firms generally only carry out small subdivisions, that is 5 or less. Many firms only perform 2 lot subdivisions. The 10-20 lots category was chosen as a result of a Melbourne Water policy a few years ago which enforced several surveying firms to submit all plans of 10 or more lots in digital format. It also useful to know which firms carry out the large broad-acre subdivisions, which would generally be more than 20 lots.

In order to present the most useful results for this question, the results were correlated with the size of the company in terms of number of employees, and relations were calculated between these two categories. The following diagrams show the results of this.

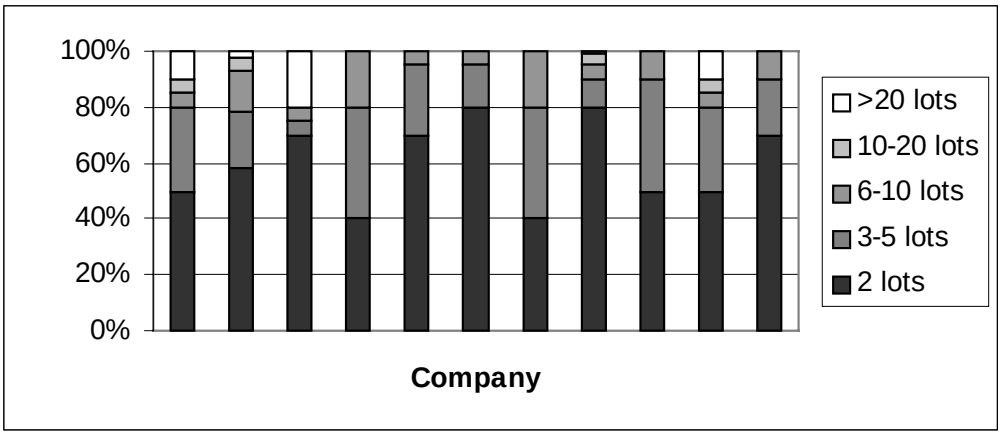


Figure 4.5 Less than 5 employees

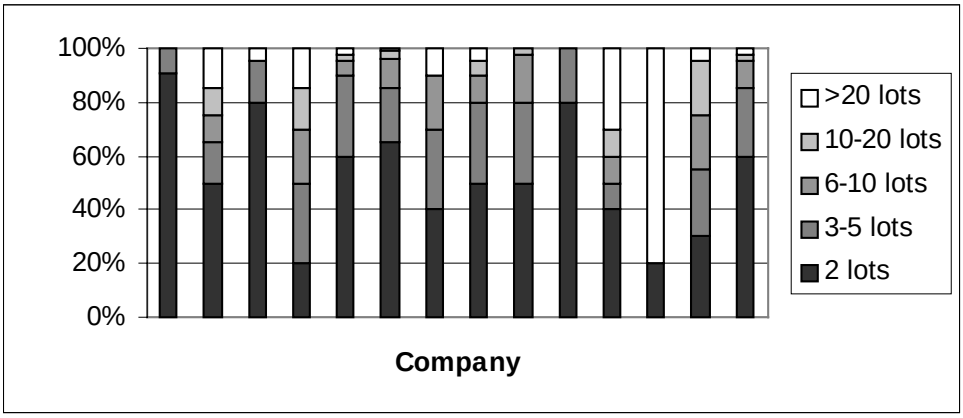


Figure 4.6 Between 5 and 10 employees

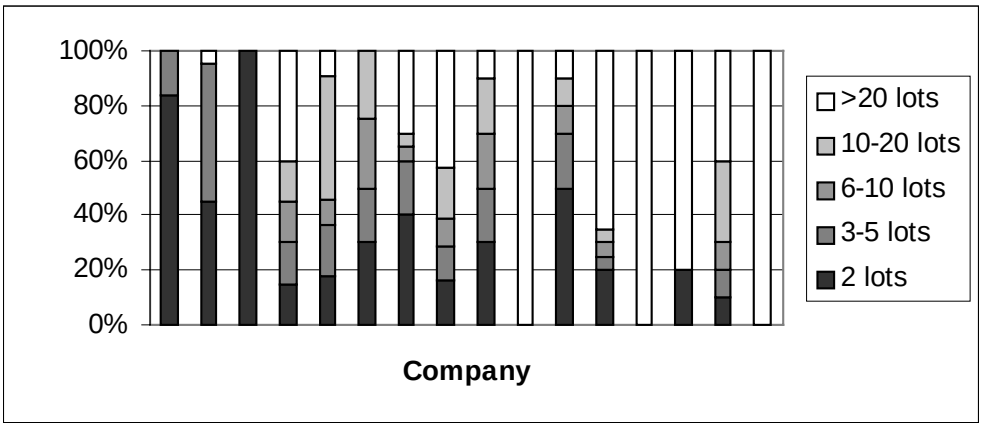


Figure 4.7 More than 10 employees

The most evident finding from this correlation was that as the company size increased, so did the number of multiple lot subdivisions of more than 20 lots. For instance, the majority of the companies with less than five employees submitted mostly plans of only five or less lots, whereas the companies with more than 10 employees submitted many plans of 20 or more lots.

A significant finding was that there were 10 companies whose plans of 10 or more lots made up more than 50% of their plans lodged. This is important because current guidelines require that subdivisions containing more than 10 lots have to be accompanied by a digital plan.

Another notable finding was that 14 companies submitted more than 50% of plans that were two lot subdivisions. This is important to know because it is easier to manually update files for two lot subdivision, rather than trying to enter a plan in digital form.

The survey showed that 78% of the surveyors carried out more than half of their surveys in urban areas. However, there seems to have been a misunderstanding in the question. Urban areas technically refer to the Melbourne Metropolitan area, not smaller country towns such as Geelong and Warnambool. Unfortunately, this was not specified in the survey and thus it appears that the question has been misconstrued. It would be safe to assume that the only companies who perform surveys in urban areas are Melbourne companies, and possibly those close by, such as Geelong. It is important to make this distinction between urban and rural plans as the DCDB contains two separate databases for the information, each with slightly different accuracy requirements, and different methods for updating the information.

The survey showed that 48% of surveyors submitted more than 50 plans to the Land Titles Office (LTO) each year, and another 36% submitted between 21 and 50 plans. So overall, 84% of surveyors lodged more than 20 plans a year to the LTO, which is quite high, hence the introduction of digital lodgement would be extremely beneficial to those surveyors, especially if it is expected to reduce time and costs.

The next question asked the surveyor to estimate the percentage of plans prepared by computer, the percentage by hand, and also the percentage as a combination of both techniques. The most outstanding result is that an average of 74% of all the plans prepared by the surveying industry are fully done by computer. Conversely, only 2% of surveyors prepare all their plans manually, although they all have access to computer facilities. These results show a high usage of computers in the area of plan preparation, which is extremely encouraging for the purposes of introducing digital lodgement.

The results from this question were correlated with the size of the company, and it was surprising to find that there was no direct relationship between those companies who prepared all their plans digitally and the size of the company. Therefore it cannot be assumed that simply because a company is quite small that they generally prepare their plans manually, because this is not necessarily true.

80% of surveyors submitted some plans in digital format, whether this was to the water authorities, or councils. 30% stated that they would submit plans digitally if needed to, although some of these included those that already do submit digitally. Only 7% stated that they would not submit plans digitally.

4.3.4 Attitudes towards digital lodgement

The next section contained four short-answer questions regarding the surveyors' exposure to digital lodgement, benefits and problems they predicted, and their recommendations for implementation. As expected, most surveyors supplied more than one comment for each question, so the results have been shown as a percentage of the total responses, in which case some surveyors may be represented more than once.

Current knowledge of digital lodgement

The results indicated that 18% of surveyors regularly provided clients with digital data, with three surveyors stating that this was a result of a Melbourne Water scheme several years ago requesting that selected surveyors submit all plans of ten lots or more in digital format. One surveyor had just recently started submitting his plans to the local council in digital format.

9% had heard of the concept through seminars and conferences, with one comment being that the concept was still relatively unknown since he did not practise digital lodgement in the workplace. Another two had a general appreciation of digital lodgement from articles in technical magazines. Two surveyors were aware of the concept through job demands for clients and other peers such as architectural firms, surveying firms and some councils.

25% understood the purpose of digital lodgement but not the procedures. A few had a general knowledge of digital lodgement though using email. 31% had little or no knowledge of digital lodgement.

13% of responses gave their understanding of the concept of digital lodgement. These included that it was a quick and easy method of transferring information; that the supply of data was immediate; that it would be an up-to-date method; and that digital lodgement to water authorities is okay, but not necessarily to the LTO as a few changes would have to be made by the surveyor.

Benefits

The most important benefit perceived was that of time efficiency, with 54% providing this response. Reasons for improved time efficiency included the time saved for downloading

data, time saved for processing subdivisions at council, faster approval times, and time saved by processing all the data in the same place.

The next most significant benefit perceived was that of paper saving, being noted on 18% of the responses. One thought that theoretically there should be less need for multiple copies of plans, although this may not be the case in real life. Others mentioned that there would be less printing/plotting problems, and that plans would be easier to prepare.

Another benefit was that of cost savings. It was not stated exactly where the money would be saved, but it was still noted on 16% of the responses.

Easier data retrieval at a later date was also mentioned on 16% of the responses. It was stated that digital lodgement would ensure accurate information would be readily available, and that digitally lodged plans could be accessed more easily by surveyors.

Other benefits that were mentioned included ease of plan amendment, whereby it would be easier to amend plans once they were in a digital format, either by the LTO, council or the surveyor (five responses). Another benefit was the increased accuracy of the DCDB that would result if surveyors submitted data digitally, as the data would be entered at source accuracy (five responses). Along the same lines, it was thought that surveyors would have more control over the data they produce, as there would be potentially greater involvement in the subdivision lodgement process, even hopefully direct lodgement (three responses).

Other responses included that less storage space would be required (for hard copy plans), that there would be no additional requirements for some current survey practices, that it would reduce the numerous duplication of subdivision plans which currently exist within all the servicing authorities, that the LTO would benefit when they update from scanning plans to storing in drawing file format, and that there would be more efficient tracking of lodgements. Only 13% believed that digital lodgement would not provide any benefits to the surveyor.

Problems

The number of problems in implementing digital lodgement as perceived by the surveyors was quite high. The most significant was the compatibility of software, as mentioned on 27% of the responses. Many were concerned that they would have to purchase new software and even hardware to comply with new regulations. It was suggested that the system would need

to accept all forms of data input, and some form of file exchange system would be needed. These responses also covered presentation standards, stating that there needs to be uniform standards such as layers and codes.

25% responded with concerns about the integrity of the data once it left the surveyor's control. The possibility of data manipulation resulting in professional indemnity claims was included. One suggested fingerprinting of data to ensure it correctly represented the original data.

Another major concern was that of intellectual property noted on 23% of the responses. The general thought was that the surveyors generated the data, which was then sold by the authorities to others for profit. Those who provided this response did not expand greatly on it.

18% thought that there would be financial losses, such as the costs involved in setting up, including new software, which in turn would incur extra fees on the client. Some were worried that they would be responsible for funding the introduction of digital lodgement, yet receive few benefits from it.

13% were concerned about staff retraining, as not all staff were computer literate, and retraining would be costly and time consuming. There was also concern about electronic communication between agencies, such as delays when a system "crashes".

Suggestions for implementation

The most significant methods suggested for implementing digital lodgement was that of using standards, such as a common DXF (digital exchange file) format, with 20% of responses suggesting this. Some were quite specific whilst others were more general in their comments, suggesting ideas such as supplying software translators to all consultants, to achieve an acceptable lodging format.

Six stated that a dual system should be used at first, with digital lodgement being introduced in tandem with existing procedures for a period of time. It was suggested that a dual system would result in more work initially, but a compulsory system would require a long lead time to train all users. A pilot program with a small number of firms to sort out initial problems was also recommended.

Another six suggested that digital lodgement should only be implemented after considerable input by and from organisations, professionals and individuals who are actively involved in the industry on a day to day basis.

4.4 SUMMARY OF VICTORIAN RESULTS

This questionnaire has revealed that the majority of surveyors in Victoria are already proficient in computer usage, with all surveyors having or using a computer in their workplace to use for the collection and/or production of plan information, as well as transmitting plan data. The comments provided by the surveyors also show a general support for the introduction of digital lodgement, with most surveyors willing to submit files electronically.

4.5 NEW SOUTH WALES AND SOUTH AUSTRALIAN QUESTIONNAIRES

A similar questionnaire regarding electronic plan lodgement was used as a basis for research on this topic in New South Wales. The questionnaire was devised by a joint Land Titles Office (LTO) and the former Land Information Centre (LIC) project team in collaboration with Professor John Fryer of the University of Newcastle. The questionnaire was sent to 1221 surveyors, with a 48.7% rate of return. The closing date for returns was 25 July 1997 (Fryer, 1997).

Analysis of results was conducted by Professor John Fryer who provided the project team with a summary of statistics and total list of comments. The questionnaire featured eight questions, regarding number of plans lodged at the LTO each year; use of computers for data collection and/or drawing of plans; type of software that was used; the percentage of plans completed using either geometry or drawing software; the types of remote computer communication used; what information the surveyor currently supplies electronically; what benefits they see in direct lodgement of geometry files for pre-examination; and the positives and negatives of electronic plan lodgement.

A similar questionnaire was carried out in South Australia by Mr Mark Barnes of the Land Services Group, within the Department of Environment and Natural Resources, with the closing date of returns being December 1994. It was circulated to 47 recipients including

private firms, individuals and government departments involved in plan preparation and the lodgement processes. A 62% return rate was achieved (Land Services Group, 1994).

This questionnaire was substantially longer than those done in Victorian and New South Wales, being seven pages long, and consisting of many short-answer questions, rather than multiple choice. Questions covered both technical areas and the recipients' opinions towards the issue of digital lodgement (Land Services Group, 1994).

4.6 COMPARISON BETWEEN THREE QUESTIONNAIRES

The Victorian and New South Wales questionnaires were conducted at approximately the same time in late 1997/early 1998, whilst the South Australian one was carried out several years earlier in 1994. The most noticeable difference between the surveys was that 1221 surveyors were asked to complete the questionnaire in New South Wales, 104 were asked in Victoria (Fryer, 1997), and 47 in South Australia. This is due to several reasons. Firstly the NSW questionnaire was sent to every surveyor, whilst in Victoria it was only sent to each surveying firm, most of which actually have more than one licensed surveyor. Conversely, the South Australian questionnaire was sent to a range of different companies dealing with plan lodgement, not just surveyors.

The NSW questionnaire showed a large disparity in the numbers of returns from sole practitioners (12.4%), with the mailing list indicating that 43.4% of registered surveyors fell into this category (Fryer, 1997). The Victorian questionnaire showed that 14% were from sole practitioners, however it is not actually known how many of these were actually asked to complete the questionnaire. The South Australian questionnaire did not indicate the type of recipients that responded.

4.6.1 Access to Computer

With regards to access to a computer, 89% of surveyors in NSW had access to a PC, with a further 8% having the availability of a workstation (Fryer, 1997). This is very similar to Victoria, where 93% used PCs, and the remaining 7% used workstations. In both the Victorian and NSW questionnaires, a PC was defined as a personal computer which is IBM compatible (as opposed to a Macintosh), which may be stand alone or networked. A workstation was defined as a computer, usually connected to a network, possibly running

UNIX. Again, the South Australian questionnaire did not include a question on the surveyors' access to computers, although it was shown that 56% had little concern with their technical capabilities if digital lodgement were introduced, the conclusion being that these recipients have already had sufficient exposure to computers (Land Services Group, 1994). This response was supported by another question which showed that only 4 of the 29 respondents had no computer facilities.

4.6.2 Software

The most commonly used software in New South Wales included Civilcad (43%), Landmark (20.5%), Autocad (52.5%), Microsoft Word (71%) and Word Perfect (25%). Other software packages in usage included Liscad (12.5%), Foresite (9%), Geocomp (6.5%), ACS (6.5%) and Microstation (13.5%) (Fryer, 1997).

In Victoria, the most popular geometry software was Liscad (50%), Autocad (47%) and Geocomp (30%). Taking into account the number of actual licences each company had for software, Microstation, Autocad and Geocomp had approximately the same number of users. In the cases of both New South Wales and Victoria, the software percentages sum to more than 100% as many companies have several different software types running.

South Australia showed very similar results to Victoria, whereby Liscad and Autocad were the most popular software used, both with 22%. SDRMap was the next with 11%, followed by Geocomp (9%), Wescom, Foresight and Caddsman, all with 6% each (Land Services Group, 1994).

4.6.3 Preparation and transfer of plans

The percentage of surveyors in New South Wales who used software to complete all their plans was around 41%, although this figure was influenced downwards by those who prepared small subdivisions manually. This is comparable to Victoria, where 31% of surveyors prepared all plans by computer.

For transferring data, 70% of surveyors in NSW used floppy disks, whilst 57% use modems and sometimes used electronic mail for this task. In Victoria, computer usage seems to be higher with 89% of surveyors using floppy disks, 70% using modems, and 59% using email.

The results of the NSW survey did not indicate how many surveyors had access to the Internet, whereas currently in Victoria more than half have access (52%).

A similar question in the South Australian questionnaire showed that 76% of the respondents would prefer to transfer digital data directly via modem, if this service was available. Only 17% stated that they would not transfer data in this way, and 7% did not respond (Land Services Group, 1994).

4.6.4 Comments by surveyors

The Victorian and New South Wales questionnaires both dealt with the benefits and problems of digital lodgement in the latter part of the survey. The benefits which were mentioned on the New South Wales survey included the speeding up of the lodgement process; time savings; the production of more legible plans; and the updating and improvement of the cadastre. This was similar for the Victorian questionnaire, with the most popular benefits being time and money savings, less paper usage, easier data retrieval, easier amendment of plans, and increased accuracy of data.

Nearly 50% of the NSW responses indicated concern for the security of the electronic file after it left the surveyor. Similarly in Victoria, 25% were concerned about this issue, with another 23% concerned about intellectual property, and 27% worried about the compatibility of software. Despite the high profile given to the matter of intellectual property, less than 2% of NSW surveyors mentioned this topic.

The South Australian questionnaire contained various questions regarding the recipients' opinions throughout the survey. One question revealed that 83% indicated that digital lodgement should be optional, with another 14% stating that it should not be optional. 3% did not respond to the question. The other primary concerns that were highlighted included validation procedures (72% were highly concerned), accuracy/quality concerns (72%), legislative requirements (69%), liability (71%), with about half concerned about copyright issues and costs involved. Compatibility of software, and the security of data were also mentioned, although it did not rate as highly as the other issues (Land Services Group, 1994).

4.7 CHAPTER SUMMARY

This study has been instrumental in showing the general trends amongst the current surveying industry, in terms of their current technological capabilities and lodgement practices, with particular emphasis on computer literacy within the industry. It is important to bear in mind however that the results have not even covered half of the surveying industry in Victoria, so they must not be used out of context.

This questionnaire has revealed that the majority of surveyors in Victoria are already proficient in computer usage, with all surveyors having or using a computer in their workplace. Coupled with this, 66% of all surveyors already own and use a modem, which will be essential if digital lodgement is eventually phased in. This level of proficiency with electronic transmission of data (also including email and the Internet) is essential as this will mean less training in this particular area.

The most popular software types were Liscad, Autocad, Geocomp and Microstation, both for preparing geometry and drawing files. In general, the smaller companies working on subdivisions of only a few lots used the first three packages mentioned, whilst the companies carrying out large subdivisions used Microstation as a rule, as it doubles both as a surveying application and drawing software. Following on, most surveyors update their software quite often, which is encouraging if new software versions must be released to accommodate digital lodgement.

The questionnaire has revealed that the larger companies with more employees actually concentrated more on subdivisions with more lots. It highlighted quite a clear trend showing that as company size increased, so did subdivision size. Most of the companies who responded tended to concentrate more on 2-5 lot subdivisions, and at the moment, these types of plans are more easily entered into the Digital Cadastral Data Base manually.

Many survey companies already use computers to prepare many of their plans. For example, an average of 84% of plans are fully or partly prepared digitally. Even more importantly, about 80% of surveyors already submit their some of their plans in digital form, either to the water authorities or the councils. Although it was not specified how these plans were submitted, it still highlights the high computer literacy standards amongst the industry. It also emphasises the inefficiencies of the land registration system, whereby surveyors prepare their

plans in a digital format, and then produce hard copies of these for lodgement purposes, only to have the information re-entered into a database at a later stage. The paper system is failing to take advantage of the increased efficiencies gained by surveyors by producing digital plans, and this is one area that will be improved substantially when digital lodgement is introduced.

In general, the Victorian surveying industry appears to be supporting the idea of digital lodgement, as they feel it would save time and money, increase data accuracy, and improve data retrieval. However several problems were noted that would have to be dealt with properly if it were to be introduced. One of the major ones was software compatibility, as it would seem unfair to force the surveyors to purchase new software if they felt they were not benefiting from digital lodgement. Also the integrity of the data as plans were in transit was highlighted as a major problem, in which security issues would need to be thoroughly investigated. Lastly intellectual property seemed a concern for many surveyors, as once again, they felt that they were the ones generating the spatial data, only to have it taken away from them and sold for profit by others.

Studies carried out in New South Wales and South Australia have revealed very similar results to this questionnaire. This is extremely beneficial to know as it means that the structure of the three survey industries is quite similar, so any initiatives being carried out in NSW and SA could be adapted to the Victorian system with only minor changes.

These facts, together with the rest of the results from the survey indicate that there is a high willingness to move towards the digital lodgement of survey data, providing it does not impose high setup costs on the surveyors. Many of the issues that were highlighted in this chapter will be explained in further detail in the next chapter, with recommendations for how they should be dealt with.

5. LEGAL AND PRACTICAL IMPLICATIONS OF DIGITAL LODGEMENT

5.1 OVERVIEW

There are several key issues which must be resolved before digital lodgement of survey data can be fully introduced in Victoria. Most of these issues have been identified as a result of the digital lodgement questionnaire and an investigation of digital lodgement in other jurisdictions, and include technological, legal and administrative aspects. More specifically the issues that must be dealt with include data standards, legal issues such as digital signatures and legislative changes, data transfer options and intellectual property. This chapter summarises these key issues, mainly focussing on the problems themselves, and possible solutions.

5.2 DIGITAL PLAN FORMAT

Current legislation quite clearly outlines what standards must be followed in order to output paper plans (for example, the Survey Practice Handbook), however there is little standardisation for digital outputs. As an example, the following two tables show extracts from legislation outlining presentation standards. More detail is given in the Survey Practice Handbook, Parts 1 & 2.

Regulation	Title	Specifications
6	Classification and accuracy of surveys	Length of misclose vector must not exceed 15mm+100ppm for boundaries crossing level or undulating land; and 15mm+150ppm for boundaries crossing steep or mountainous land.
10	Field survey	Up to 10 allotments, the survey must be connected to at least two PMs; if there are more than 10, a further two PMs must be connected to.
11	Recording and presentation standards	Must ensure a plan of survey is prepared using conventional signs and symbols, and the plans clearly portrays all relevant information. Information must include instruments used, all measurements made in the field, and sufficient information to prepare an abstract of field records.
12	Certification of abstract of field records	
13	Certification of plan	
14	Report by the licensed surveyor	Must prepare, sign and date a detailed survey report to accompany abstract of field records.
16	Amendment of abstract of field records and plan	May authorise another licensed surveyor to note or amend any abstract of field records or plan, and bring the survey up to date by remarking the land. A licensed surveyor may also amend any abstract of field records or plan lodged in the LTO, with the consent of the Registrar of Titles.

Table 5.1 Plan drawing regulations (Government of Victoria, 1995)

Regulation	Title	Specifications
7	Use of Office of Title Plan Numbers	A plan number must be used on all plans of subdivision.
8	Numbering and signing of plans	Sheets must be consecutively numbered. Each sheet must be signed and dated by a licensed surveyor.
10	Information which must be on plans for the LTO	AMG coordinates
12	Use of buildings to define boundaries	Boundaries may be shown on a plan by reference to a building.
13	Method of showing boundaries on a plan	Must be shown by a continuous line.
23	Special information for Councils and referral authorities	Plan may be supported by additional documents containing additional information (such as levels) required by the Council but which do not have to be lodged with the Office of Titles.
24	Special information for Office of Titles	Abstract of Field Notes, Surveyors Reports, transparencies of plans, or other supporting documents required by the Registrar when the plan is lodged. Additional documents are not part of the plan and must not be numbered as sheets of the plan but must include the plan number.
40	Lodged plan to be accompanied by application	When a plan is lodged for registration, it must be accompanied by an application to register the plan.

Table 5.2 Plan drawing regulations (Government of Victoria, 1989)

As shown, the specifications for the information that must be contained in a hard copy plan are quite well-established, whereas in a digital environment, there are much fewer specifications. In such an environment, there are two basic products that are required for lodgement purposes, each of which plays a unique role in the survey information gathering and management process. These are:

- Survey information required as a graphic or image, such as field records, plan, or surveyor's report;
- Survey information used to create the above graphic or image, such as a digital file of the survey dimensions or geometry.

(Pearce et al., 1997)

It is envisaged that in the near future both these products be lodged electronically, with the graphic or image products being lodged by fax, and the geometry files by email (Pearce et al., 1997). In a true electronic environment, there would be no hardcopy transmission of information such as faxes, however such measures will still be needed until the legal ramifications can be dealt with. The next section will discuss the file formats used to create this plan.

5.2.1 File types

In terms of surveying software being used in the industry, there are currently four main packages being used in Victoria – Geocomp, Autocad, Liscad and Microstation. Each of these packages is capable of outputting several different file types, the most common being DXF (digital exchange file). The problem with this format is that it is a layered file type, which is unsuitable for automated updating of the state map base. In the past, DXF files have been used to manually update the DCDB, however these files will need to be provided in a smarter format than is currently available in order to gain maximum benefits from a digital environment (Pearce et al., 1997).

The development of a smarter format to facilitate the registration process and the updating of the DCDB will require several key agencies, namely the Land Titles Office and the DCDB custodian, Dataflow, and to a lesser extent, local municipalities and referral authorities, to collaborate in designing a common format that can hold the base set of data, and satisfy the needs of all the surveyors. As indicated by the responses from the digital lodgement questionnaire, most surveyors feel that this format should be vendor neutral, that is, the standard chosen needs to be consistent with any of the existing major software packages presently in use by the surveying profession. The development of a single common format for the lodgement of survey data is imperative as it will minimise the burden placed upon the survey industry, and also help in gaining cooperation from the surveyors in this matter.

One option that is preferred is the use of the Spatial Data Transfer Standard (SDTS), which is a United States Federal standard that was designed to support the transfer or different types of geographic and cartographic spatial data. It was approved for use in Australia and New Zealand in 1994. SDTS specifies a structure and content for spatially referenced data in order to facilitate data transfer between dissimilar spatial database systems. Both NSW and WA

have recognised the benefits of moving towards SDTS compliance, and are using it in the development of their data formats for the lodgement of electronic data (Effenberg and Williamson, 1996).

Taking this information into account, there would seem to be two feasible solutions – DXF could be adopted as the de facto transfer standard or mechanisms must be provided to allow suppliers to provide data in the required format. It is important that the problem is not resolved simply by developing new software, hence forcing the surveying firms to purchase such software in order to facilitate digital lodgement, as this will only succeed in more resistance by the surveying profession to the concept of digital lodgement.

5.3 DATA TRANSFER

The physical transfer of the plan data in electronic format is quite a simple issue, yet it is probably the most significant in terms of facilitating digital lodgement. The current survey profession are already quite advanced in terms of level of technology, with the majority of the profession having available resources to lodge plans in digital form. Taking this into account, there are essentially four possible scenarios as listed in Table 5.3.

Method	**Advantages**	**Disadvantages**
Lodgement of plans in manual form – surveyor submits plan on paper.	Currently quicker to hand draw 2-3 lot subdivisions.	Not digital.
Lodgement of digital plans on portable media.		Little or no benefit from current manual method, as this media can be misplaced or damaged in transit. Cost of disc storage must be considered.
Lodgement of digital plans via the Internet by ftp (file transfer protocol).		Requires some degree of computer knowledge to operate successfully. Connections can 'time out'. No acknowledgement that the file has been received.
Lodgement of digital plans by means of electronic mail.	- Email is user friendly. - 59% of surveyors in Victoria have access to email. - Email software can also be obtained freely over the Internet. - Lower chance of data corruption (Most email uses some form of data encryption before sending mail, which is useful when dealing with legal documents).	Not as 'timely' as ftp data delivery. If a network is down, the email will be queued until it can be delivered.

Table 5.3 Plan lodgement methods (Land Titles Office NSW, 1997b)

The questionnaire completed by the Victorian survey profession has shown that all of these techniques are currently used to transfer data, but in the future the first two options will have to be phased out if the cadastral system is to be part of a fully digital environment with no physical products.

Pearce et al (1997) have listed the general issues that are associated with information delivery:

- Intelligent format of geometry file will enable automated updating of indexes and databases, automated examination, and storage for eventual return to the survey industry as core data to perform legal cadastral surveys without the need to re-key data;
- Paper or raster products cannot support automated validation, automated updating of indexes and databases, improved updating of the DCDB and automated population and updating of a survey accurate database;
- Manual lodgement will need to be facilitated until such time as electronic lodgement is finalised.

(Pearce et al., 1997).

The Electronic Plan Lodgement project in NSW has closely looked at this issue, and has devised two recommendations for transporting digital data. Firstly, due to the fact that a small percentage of surveyors do not actually have the facility to prepare and send digital plans, the current methods of lodging paper plans must be kept in place. The second recommendation was the use of email for lodging digital plans. Email is a widely acceptable method of data transfer from both the surveying and legal profession's perspectives. It allows for large files to be sent overnight, or for the data to be broken up and transmitted as a series of attached files (Land Titles Office NSW, 1998).

5.3.1 The Internet as a transfer medium

Over the last decade, the Internet has experienced extraordinary growth, resulting in an increasing range of mechanisms and tools becoming available for accessing and updating information. At the same time, as more people use the Internet, demand will bring more services on line.

The World Wide Web (WWW) makes an ideal choice for the transmission of digital data, and in order to do this, the following are needed:

- Provide a data viewing platform with standard functions such as zoom, move, find and scale, to facilitate viewing of the data;
- The ability for the user to pick and choose which data to receive;

- Some mechanism of verifying the data to be downloaded or uploaded;
- Security of transactions from interception.

(Polley et al., 1997)

In the past, the Internet has only been used for transferring information from the data provider to the data user, rather than in both directions. Victoria's Land Channel is an example of the first type of data transaction, with data being directed from the data custodian to the data user (http://www.land.vic.gov.au/). It is a system that has a "GIS-like" front end allowing users to perform queries to some remote database (Polley and Williamson, 1998b). In the past, many of these protocols have been geared for a client machine to get data from a remote server, and not vice versa, making them unsuitable for digital lodgement by surveyors.

However this is no longer the case. Research carried out at the University of Melbourne has focussed on the design of a system which facilitates on-line transactions of cadastral data in both directions between the legal data custodian and the private server (Polley, 1998a). The user accesses the system through the WWW using a regular browser, from which they connect to the data custodian's WWW site, bringing up the data display area. After loading the requested data, the user is then able to view it in a vector format (Polley, 1998a).

One highlight of the system is its ability to allow users to submit changes to the database. Submission capabilities are restricted to registered users, typically a licensed surveyor, and this is enforced by setting up a signup window before the user can submit data. For casual users, a different version is provided that does not facilitate data submission (Polley, 1998a).

Polley has demonstrated that the lodgement of digital information via the WWW is indeed possible. There are a number of problems that exist with the WWW that will need to be resolved if the Internet is to be used for these purposes. The first is the legal barrier, whereby digital data must be accepted as the legal document. One of the technical problems includes the limitation imposed by network bandwidth, or simply put, the amount of data that can be physically transferred in a reasonable amount of time over the Internet. Such a problem means that the Internet is not as efficient for large datasets as other methods. The other principal problem is the security of data as it is transmitted over the Internet. It is important that any data be kept safe from interception and modification while in transit, and also that the source

of the data and the data itself can be guaranteed (Polley et al., 1997). This particular problem is discussed further in the next section.

Even though there are a number of inherent problems with using the WWW for data transmission, it is important to note that the cadastral industry and the WWW are moving in the same direction, the objective being to make their products more accessible and more useable to a wider audience. Although the cadastral industry is not quite as advanced as the WWW industry, this is beginning to be rectified as is being demonstrated by the on-line Land Channel, and thus the integration of these two areas would seem to be a natural progression in this digital age.

5.4 CERTIFICATION AND INTEGRITY OF PLAN

The certification of a plan by a licensed surveyor is an important part in the lodgement process, as is the integrity of the plan information as it is transported between different agencies. Both of these issues involve legal ramifications, and thus it is important that they be dealt with properly.

5.4.1 Certification of plan

An important part of the Torrens land registration system is the state guarantee on the title. One component of this is the signing of plans by a licensed surveyor. Such a process is a vital part of the plan registration process as it provides evidence that the plan is complete and no changes were made after the plan was signed; that the information on the plan is correct; and also that the surveyor who signed it actually created the plan and is responsible for it.

The relevant legislation relating to the signing of plans is documented in Section 8(4)(a), Subdivision (Procedures) Regulations 1989, and briefly states that “each sheet of a plan must be signed and dated by a licensed surveyor”, or applicant, depending on who prepared the plan. Section 8(5) states that “by signing a plan a licensed surveyor certifies that the plan and any related survey is accurate and was undertaken by herself or himself or under his or her supervision.”

The other important component is the certification of the plan by the council. The plan is signed by the council when they are satisfied that all planning requirements have been met, allowing the plan to then be examined and registered at the Land Titles Office.

5.4.2 Security and integrity of plan

The actual security of the information of the plan in transit is also very important. Many surveyors fear that electronic transfer of data is not safe, thereby increasing the chance of litigation. It is important that a secure, legally binding transmission medium is adopted to minimise the risk of fraud or frivolous acts of data tampering. One solution to this problem is to use data encryption on the plan which prevents unauthorised persons from making sense of the transmission (Polley et al., 1997).

Both these processes can be solved using a combination of digital signatures and digital certificates, which are discussed next.

5.4.3 Digital signatures

Digital signatures, coupled with digital certificates, can be used for this purpose in order to prove that the information has not been tampered with and that the sender is authentic. As defined by the Division of Corporations and Commercial Code, a digital signatures is simply a “reliable electronic means of signing electronic documents that provide sender authentication, message integrity and non-repudiation” (Division of Corporations and Commercial Code, 1997a).

As stated by Polley, use of the digital certificate proves that the user is bona fide, whilst the digital signature proves the integrity of the encrypted message and the origin of the message. He also states that such a method is sufficient to provide guarantee on the dissemination of data, for data transmissions either from the data custodian or in this case, the private surveyor (Polley et al., 1997).

5.4.4 Security provided by digital signatures

Digital signatures provide the same amount, if not more, security than handwritten signatures. For example hand written signatures can only be verified by experts, using methods that are far from scientific, whereas the mathematical procedures for verifying digital signatures can be verified by any number of independent agents. There can be no room for disagreement as the numbers are either correct or not. This means it is almost impossible to forge a digital signature (Division of Corporations and Commercial Code, 1997b).

A much less effective alternative to digital signatures is a digitised signature, which is simply a scanned image of a handwritten signature which is then appended to electronic documents. Although digitised signatures resemble the handwritten counterpart, they do not provide the same protection as a digital signature. Such an approach is useless as the signature does nothing to authenticate the electronic information, as digitised signatures can be forged, and also duplicated and appended to other electronic data. Digitised signatures also do not indicate whether or not the message has been altered after it was signed (Division of Corporations and Commercial Code, 1997b).

5.4.5 Digital Signature Technology

A digital signature is created and verified by means of cryptography, which is simply the transformation of messages into seemingly unintelligible forms and back again. There are two types – secret key (symmetric) cryptography or public key cryptography. The symmetric key system uses the same key at both ends of the process to encrypt the message. The disadvantage with this method is that the symmetric key must be delivered to the target destination in a secure fashion. Also, this method cannot be used to prove to a third party that information actually originated from the sender, since both the sender and receiver of the information share the same key (Division of Corporations and Commercial Code, 1997b).

The second method of encryption – public key cryptography – was developed to overcome these problems, the only downfall being that it is relatively slow. This technique used two keys – a public key which can be distributed to anyone, and a private key which must be kept secret and its use controlled by its owner. The two keys are mathematically related, but the private key cannot be determined from the public key (Division of Corporations and Commercial Code, 1997a).

Creation and verification of digital signatures

The use of digital signatures is comprised of two processes, one performed by the signer and the other by the receiver of the digital signature:

- Digital signature creation is the process of computing a code derived from and unique to both the signed message and a given private key;

- Digital signature verification is the process of checking the digital signature by reference to the original message and a public key.

(Division of Corporations and Commercial Code, 1997a)

Figure 5.1 shows the method by which a digital signature is created.

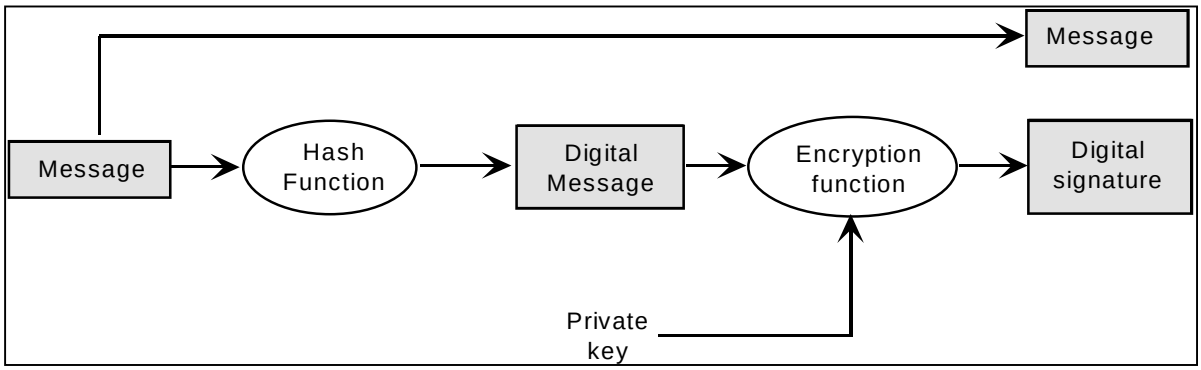


Figure 5.1 Creation of a digital signature
(Division of Corporations and Commercial Code, 1997b)

The first step is to create a hash function (or message digest) of the message, which is simply a mathematical summary, and is usually much smaller than the message, but still unique to it. If the message changes even by 1 digit, the hash code will change dramatically. Hash functions are used so that the software for creating digital signatures can operate on smaller messages (Division of Corporations and Commercial Code, 1997a).

The owner of the message then applies the private key to the message digest to create a digital signature. In this way the resulting signature is both unique to the message and the private key used to create it. The digital signature can then be attached to the message and stored or transmitted in this way (Division of Corporations and Commercial Code, 1997a).

Figure 5.2 shows the verification process for a digital signature.

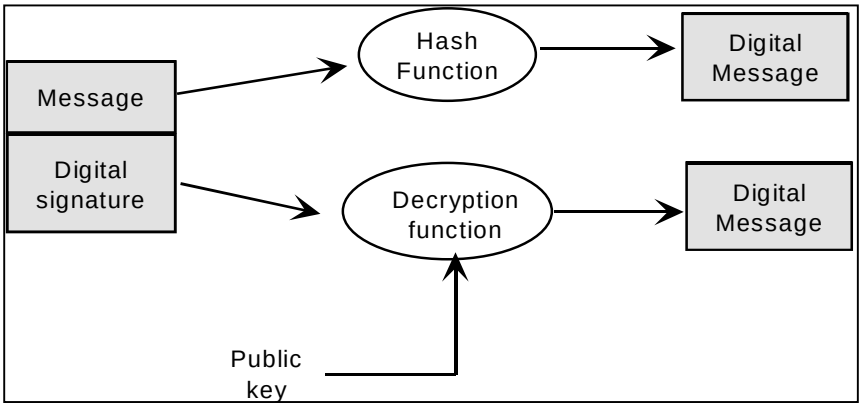


Figure 5.2 Verification of a digital signature
(Division of Corporations and Commercial Code, 1997b)

The first step in verifying a digital signature is to compute a new hash result from the original message by means of the same hash function used in creating the digital signature. Then, using the public key, the verifier checks whether the digital signature was created using the corresponding private key, and whether the newly computer hash result matches the hash result derived from the digital signature. If the signer's private key was used and the hash results are identical, then the digital signature is verified (Division of Corporations and Commercial Code, 1997a).

Two products arise from the verification process:

- The digital signature was created using the signer's private key. This is also called 'non-repudiation' and it means that the person who signed the message cannot deny this fact because the signature could have only been theirs;
- The message was not altered since it was signed, because the hash result computed in verification matches the hash result from the digital signature, which was computed when the message was digitally signed. This can also be termed as 'authenticity' and 'integrity', simply meaning the message is the original and has not been tampered with.

(Division of Corporations and Commercial Code, 1997a)

The only other issue that needs to be addressed is that of privacy. This can be easily solved by reversing the public and private keys. If the sender obtains the public key of the person they are giving information to, then the receiver is the only person who can view the information, as they are the only owner of the private key.

Public key certificates

In order for digital signatures to work, there needs to be some system of associating public and private key pairs to the corresponding users. However this is made difficult by the fact that a public and private key pair has no intrinsic association with any person as it is simply a pair of numbers. If the transaction were to be done face to face, the parties could both identify each other with the key pair each party would use, however in the real world, making such an identification is not so easy. The fact that many transactions will be carried out electronically, over large distances and also through corporations rather than natural persons means that obtaining certainty that a party is whom they state they are is actually quite difficult to attain (Division of Corporations and Commercial Code, 1997a).

In order to overcome this problem of assuring that each party is indeed identified with a particular key pair, a third party is used to certify the identity of the others. This trusted third party is termed the "certification authority". The role of the certification authority is to issue a certificate that sets forth a public key and represents that the prospective signer identified in the certificate holds the corresponding private key. This certificate will list the credentials of the private party, thus anyone who uses the public key to verify a digital signature can have assurance that the corresponding private key is held by the subscriber listed in the certificate (Division of Corporations and Commercial Code, 1997b).

To ensure the authenticity of the certificate, the certification authority (CA) digitally signs it, so by using the CA's public key, it can be verified that the certificate is genuine. In order to make public keys readily available to use, the certificates may be published in an on-line directory (Division of Corporations and Commercial Code, 1997b).

The reliability of a certificate depends on a number of factors, such as the subscriber misrepresenting one's identity, or the subscriber losing control of one's private key. In such a situation, the certification authority should suspend or revoke the certificate (Division of Corporations and Commercial Code, 1997a).

The amount of security provided by a digital signature depends on a number of factors, the most importantly being the mathematical soundness of the algorithms, the management of keys and the implementation of the system in an application. It is almost impossible to forge a digital signature, as although many people will know the public key of a given signer, they

cannot use it to discover the signer's private key (Division of Corporations and Commercial Code, 1997b).

Digital signatures provide an ideal solution to the problem of keeping plans secure in transit. Not only can they be used to identify the sender of the information, they also protect the integrity of the information in the plan, and ensure that the plan is kept private during transmission.

5.5 INTELLECTUAL PROPERTY

In the past, surveyors have not really received any recognition for the information they have collected and the representation of it on a plan. However it is now being argued that this information is a form of intellectual property (IP), which is defined by McNamara (1997) as "those distinctive elements of innovation and/or reputation within a person's business. It includes the elements of copyright, patents, designs, trademarks, trade secrets and goodwill".

Within the surveying profession, surveyors produce intellectual property in many areas including survey plans, software development, firm and product names, confidential procedures and processes. Professionals have not traditionally seen their activities in terms of intellectual property. However every day through the provision of services to solve particular problems presented by clients, surveyors generate vast quantities of intellectual property. The value of the products generated by the surveying industry has been largely overlooked in the past. However it is now in the position of being forced to recognise its intellectual property, and the value of that property for its survival (Kenny, 1997).

5.5.1 Copyright

One form of intellectual property which is directly relevant to the issue of surveyors is copyright. This is a method of protecting works which result from the skill and labour of the creator. Such works include literary works, artistic works, dramatic works, musical works, film, sound recording, broadcasting and published editions.

The purpose of copyright is to provide an incentive for creators and investors to produce original material from which the community can benefit. Copyright in Australia is free and automatic, and a work is protected from the time it was first written down or recorded,

provided it has resulted from the creator's skill and effort. The Copyright Act 1968 sets out copyright law in Australia.

It would appear that a surveyor's plan may fall under the category of artistic works, which can include a painting, sculpture, drawing, engraving or photograph. Furthermore, the Act defines drawing as including diagrams, maps, charts or plans, thus the inclusion of a surveyor's plan of survey.

However of a more controversial nature is the information on the plan itself, which some argue, should fall under the category literary works, which is defined by the Act as a table or compilation expressed in words, figures or symbols. This opinion is supported by McNamara (1997) who states that "the expression of bearings and distances in Surveyors' plans form the basis of a literary work".

This opinion has been expressed through a report on intellectual property that was commissioned by the Association of Consulting Surveyors Australia (ACSA). Amongst other issues, it discussed how digital lodgement of survey plans will have ramifications on intellectual property.

The main points covered in the report were:

- Surveyors own intellectual property and should be rewarded for it;
- There should be some examination of the commercialisation opportunities for surveyors in their copyright;
- There must be an education campaign, not only of ACSA Members but government employees and future surveying students, as to the meaning and value of IP;
- ACSA will be a major player in the IP market, protecting the rights of surveyors and directing surveyors to maximise the business opportunities that arise;
- IP is an integral part of every surveyor's business;
- Every surveyor, whether employed by the private or public sector, need to consider the implications of IP at all times;
- Recognition of surveyors' IP will be a milestone for the surveying profession.

(McNamara, 1997)

McNamara (1997) also discussed a chain of infringement within government departments whereby they use the surveyors' plans to generate their land information systems, of which they then sell parts of to various organisations for profit. As they are using the surveyors' plans of survey, McNamara believed this to be an infringement of copyright.

5.5.2 Intellectual Property in Contested Markets

Siebrasse & McLaughlin (1997) offer another point of view that copyright has the undesirable consequence of restricting the use of copyrighted information by allowing pricing above marginal costs. They state that if copyright protection was granted to both plans and the information on the plans, the surveyors would have to engage in competitive bidding to produce the information. This would mean that the surveyors would not increase their total revenue as the fee they would receive for producing the information would be accompanied by a fall in fees charged to the client (Siebrasse and McLaughlin, 1997).

The basic argument of their paper is that the amount of copyright that can be granted to any product is highly dependent on the nature of the market for the supply of the works in question. For example, in the case of a surveyor's plan of survey, there are two distinct markets for the information that surveyors generate. Essentially the Land Titles Office require the plan of survey for generating certificates of title and archiving purposes, and the government requires the data from the plans in order to create and maintain the Digital Cadastral Data Base. The two markets are quite distinct from each other (Siebrasse and McLaughlin, 1997).

Siebrasses & McLaughlin (1997) firmly believe that further research must be done in this area as to whether copyright protection should be granted to facts and information, and also suggest that narrower classification should be used in preference to "factual works".

5.5.3 Future of intellectual property in relation to digital lodgement

Intellectual property within the surveying profession is a very ambiguous issue that has no clear-cut solutions. The importance of intellectual property becomes even more significant if plans are lodged digitally as the potential for infringement of copyright is far greater for digital plans than for paper plans. Digital data is capable of being copied and transmitted far easier than paper copies (McNamara, 1997).

One problem with the current system is that private surveyors are actually licensed by the Board of Surveyors to carry out cadastral surveys which means they are agreeing to produce the cadastral data for the government, who then have the freedom to use this information how they wish.

As stated by Siebrasse & McLaughlin (1997), there are two distinct markets for the information, and hence, two types of information produced by the surveyor. It appears that the actual plan of survey should be copyrighted, as it is the surveyor's own work, and as previously mentioned, can be classified as an artistic work. The main problem arises with the copyrighting of the actual information on the plan.

One possible solution is to provide all surveyors who submit their data digitally with a copy of the State Digital Map Base, as they are then able to use the information they collect. This will not only encourage more surveyors to submit their data in this format, but hopefully it will encourage a more conscientious attitude by surveyors towards their work.

The issue of intellectual property is one that is becoming increasingly ambiguous, not only within the surveying profession, but also within other industries. Although it affects digital lodgement in an indirect manner, it is not an issue that should prevent digital lodgement from proceeding in the near future.

5.6 OTHER ISSUES

Pearce et al (1997) have identified several other key issues that also must be taken into consideration. These are areas that do not impact quite as directly on the implementation of digital lodgement, but are still significant issues. These include coordinated surveys, quality assurance, education, ease of conversion to digital and fees/payment.

5.6.1 Coordinated Surveys

Williamson (1996) has envisaged that as the cadastral system moves further into a fully digital environment, coordinated cadastres will become standard, whereby all cadastral surveys are carried out on state coordinate systems. The key to making this work is the quality and maintenance of the survey control network, as well as the control mark density. Coordinate cadastres will further accommodate the digital lodgement of surveys, and also the upgrade of the DCDB to survey accuracy (Williamson and Hunter, 1996).

It could be argued that this is the role of the public sector to put in new marks so that coordinated surveys can be facilitated. Another solution could be to sub-contract private survey companies to maintain control networks in their immediate vicinities.

It is already expected that surveyors performing surveys within proclaimed survey areas must be connected to at least two permanent marks or coordinated permanent marks provided they are within 500 metres of the survey (Regulation 16(1)-(2), Survey Coordination (Survey) Regulations 1992). However this has been extremely impractical to achieve in the past as the number of permanent marks that have been available has been insufficient, as many have been destroyed or lost. In any case, the idea of completely coordinated surveys requires substantially more work before such a system can be implemented.

5.6.2 Quality Assurance

Several jurisdictions that have been studied have adopted the idea of surveyor accreditation, shifting the examination of cadastral surveys out of the government and into the private sector. Such an initiative provides the opportunity for all surveys to be quality assured with reduced need for legislative support. This concept has been taken up in Western Australia, where the function of survey examination was completely revised, such that licensed surveyors are now required to fully exercise the responsibilities that the licence imposes (Cribb and Higham, 1995). This involves quality control of plans to a 100% error free level as well as responsibility of the full survey, graphic, mathematical and legal elements of work lodged.

The new responsibilities are known as surveyor accreditation and require the surveyors to complete a two day workshop covering survey plan preparation specifications, legal and mathematical aspects, quality assurance procedures and case studies. It is also necessary for the surveyor to have lodged two error free plans (Cribb and Higham, 1995). Surveyor accreditation will play an important role as digital lodgement is introduced, as it is envisaged that the plan will not be required to follow the same stringent examination techniques as it currently does, in order to reduce the time taken to register the plan.

5.6.3 Education

Although the majority of the agencies involved in the data lodgement process are encouraging the introduction of digital lodgement, there are still a number that believe that change is not necessary (such as small surveying firms), and that the current system is working fine. There will need to be extensive education and training to outline the benefits that can be gained from converting to a digital environment, as well as the changes that will need to be made. In particular is the issue of software as it may be necessary for surveyors to learn about different map projections, digital data management, and how to use their current software to generate the required files for the provision of digital lodgement. When digital lodgement is introduced, it is likely that there will need to be a two year period when both digital and current techniques can be used for lodging data, but after this, digital lodgement will become mandatory, which could see the demise of several smaller survey firms.

5.6.4 Ease of conversion to digital

Another major issue is how prepared each party involved in the plan lodgement process is to convert to digital methods. Table 5.4 shows the situation in NSW, stating each party's availability to convert to digital methods. The situation is very similar in Victoria.

Party	**Readiness to convert to digital**
Surveyor	The EPL questionnaire indicated that 89% of all respondents have the technology to prepare plans in electronic form. 50% are also currently using Email or the Internet.
Solicitors	It is assumed that most solicitors use some type of computer software to prepare their legal documentation.
Councils	Approximately 60-70% of the 177 councils in NSW have the capability to process plans in a digital form.
Government Authorities	Most government authorities are capable of accepting plans in digital form, with the majority stating that they currently accept engineering plans using Email.
Banks/Lending authorities	Most banks have no facilities to view electronic plans files, however there is no need as banks do not lodge plans. They have no objection to providing digital signatures, as long as they could be related to the plan.

Table 5.4 Each party's readiness to convert to digital (Land Titles Office NSW, 1997b)

5.6.5 Fees/Payment

There is currently no accepted method for accepting plan lodgement fees in an electronic format at the Land Titles Office. The current system involves generating invoices upon lodgement of the plan, with the Land Titles Office directly billing lodging parties, who must then pay within a certain time. Other electronic payment methods that could be considered are shown in Table 5.5.

Payment method	Advantages	Disadvantages
Credit cards		3% charge on each transaction, amounting to a loss of revenue of approximately $300,000.
Eftpos (Electronic Funds Transfer at Point of Sale)		Transactions usually limited to a maximum of $500 or $1000, however most transactions would exceed these limits.
Direct debit – office directly debits a lodging party's account		Run risk of payment bouncing, as there is no proof that the account holds enough money.
Direct debit with limit of amount	LTO could access the lodgement party's account with some security procedures in place.	High costs in setting up.
Phonebank – lodging party deposits fees into LTO Bank Account upon lodgement of plan.		Reconciliation of matching deposits to specific lodged plans must be considered.
Advance accounts – lodging party set up credit account within LTO's accounting system, who then draw from the balance when needed.	Not a bank account, so not as costly and more secure.	
Account receivable system – similar to current manual system, whereby invoice is generated upon lodgement of plan.	Can work in conjunction with advance accounts.	

Table 5.5 Payment methods (Land Titles Office NSW, 1997b)

This issue has been considered as part of the NSW Electronic Plan Lodgement Project, with the following outcome. Due to the relatively low average number of plan lodgements per day (51.54 in the last financial year), and the fact that only a relatively small number of plans will be initially lodged digitally means that the payment system must be simple to use, reliable, and have low operational and maintenance costs. Taking these considerations into account, the EPL committee recommended that an account receivable system be adopted, as a fully

electronic payment system is seen to be too costly and unnecessary (Land Titles Office NSW, 1998).

5.7 CHAPTER SUMMARY

This chapter has concentrated on the technical issues of data formats, data transmission and security of data in transit, whilst also focussing on the legal issues of plan certification and intellectual property.

An issue that is predominantly relevant to the survey profession is that of file formats, and the software used to create the files. Currently the only output that can be obtained by all packages is DXF format, which is not suitable for passing between systems due to its layered approach. Therefore it is imperative that a file format be developed, which can either be output using standard surveying software, or secondly can be converted at a later stage of the lodgement process. The main objective is to prevent the surveyor from having to purchase new software to accommodate digital lodgement. Similarly, standards for the actual presentation of the data must be determined. At the moment, there are set standards for hard copy plans, as set out in the Survey Practice Handbook, but nothing for digital plans.

The actual transfer of the digital data would seem to be the next most logical process in the sequence of plan lodgement. Although there are several methods which can be used at the moment, including floppy disk (which does not solve the problem of handling physical objects), FTP and email, it would appear that the most logical solution is using the Internet to directly update databases. Polley (1998) has shown that it is possible to achieve two way flows on the Internet, both from the data provider to the user, and also from the private surveyor to the data custodian.

There are certain security measures that are also necessary if plans are to lodged electronically. These include the integrity of the plan during transit, ensuring that the information in the plan is not tampered with. Secondly is the actual certification of the plan by the licensed surveyor. At the moment, handwritten signatures are used to certify that the information is correct, however these have several drawbacks such as forgery, and no scientific proof of verification. Digital signatures actually provide more stringent security than handwritten signatures as they are created by mathematic algorithms, which means they

are almost impossible to forge. They can also prove the integrity and origin of the message, which makes them ideal for transmitting data electronically.

The issue of intellectual property is one that is relevant to the land information industry as well as many others. Some argue that the facts produced by surveyors when carrying out surveys in the field should be copyrighted, whilst others argue that facts cannot be copyrighted. The problem is quite ambiguous, and although it does have an impact on digital lodgement, it should not be a deciding factor as to whether or not digital lodgement proceeds.

Several other issues have also been identified in this chapter, including ease of conversion to digital, coordinated surveys, and educating the involved parties. One issue of high importance is quality assurance, and determining who has the responsibility for extensively checking plans. A number of jurisdictions have reviewed this function and have shifted it into the private sector.

The issues identified in this chapter are some of the most significant that need to be resolved if digital lodgement is to proceed. Technical issues such as file formats and data transmission have been partly solved for other industries, and it appears that the major barriers are the legal problems such as recognising that digital data should become the legal document.

6. OPTIONS FOR INTRODUCING DIGITAL LODGEMENT IN VICTORIA

6.1 OVERVIEW

This Chapter discusses the available options for introducing a system of digital lodgement in Victoria. It draws on information from other jurisdictions which are currently in the process of introducing digital lodgement themselves, and as a result, provides a list of recommendations for introducing digital lodgement in Victoria.

The recommendations made in this chapter are not designed to be technical solutions to the problem at hand, but rather options which may require further research. Issues such as digital signatures and data formats have been discussed at length in previous chapters however further research may be needed to resolve such issues.

6.2 PROPOSED OUTCOME

It is important that any systems implemented to facilitate digital lodgement are done in a manner so as to improve the quality of surveys and plans lodged by clients, and to improve the efficiency of the plan lodgement process. Burgess and Dawidowski have recognised this and have developed a conceptual survey system that allows for the digital lodgement of cadastral data. This was discussed in more detail in Section 3.9.2. One of the main features of the system is the emphasis on the fact that the survey industry must accept that physical documents should no longer be the origin of the data but rather the digital environment itself (Burgess and Dawidowski, 1995). Additionally, they have listed three conditions that should be adhered to when designing and developing a digital survey system:

- To create a new cadastral survey data record that will supercede the survey plan and its associated documents;
- To create and maintain a digital cadastral survey data set which is based on the original source documents;
- To create an integrated data interface for digital input and output for both internal and external use.

(Burgess and Dawidowski, 1996)

In support of these three conditions, several key concepts have also been recognised that have been used repeatedly in other jurisdictions. These are listed below:

- Package of digital information used for lodgement. An example of this is the Cadastral Survey Transaction proposed by Burgess and Dawidowski (1995) and would include information such as the plan, surveyors report and geodetic control. It would exist as a digital document but hardcopy outputs could be obtained at any time.
- Surveyor Accreditation which places the responsibility of survey examination back on to the surveyor, and reduces the time spent on plan examination within the Land Titles Offices. This is currently being done in Western Australia, Queensland and New Zealand.
- Digital data to be used throughout the whole process with no re-keying of data. This will decrease errors in databases, and also reduce the time taken to enter data into databases.
- Standard data format needed whereby new software is not needed. Data maintainers need to be responsible for the development of any translators.
- All plans based on national coordinate system to increase the integrity of the DCDB and facilitate easier updating of the DCDB.
- A dual system at the start, whereby digital lodgement may be used in parallel with current manual procedures, but after a trial period, digital lodgement will become compulsory.

These concepts have been used to derive a set of options for introducing digital lodgement in Victoria. However any schemes that have been used in other states may not necessarily be suitable for Victoria, due to small differences between each cadastral system. These differences must be taken into account if digital lodgement solutions are to be transferred from one state to another.

An example of such a difference is the number of surveyors and parcels in each state. For example, Western Australia have implemented a surveyor accreditation program which is extremely suitable for that state as they have a small number of surveyors, whereas this may not work as well in Victoria. Also states such as Western Australia and Northern Territory have much fewer land parcels to deal with, which can have a considerable effect on the lodgement of data. Another example is the small variations in survey legislation from state to state.

Another factor that must be taken into account is the capabilities of the consulting surveyors involved in creating and providing digital cadastral data. This was highlighted through the questionnaire forwarded to each consulting surveyor in Victoria. As a result, three main ideas were identified through the questionnaire completed by the private surveying profession, as discussed in Chapter Five. These were based on the third section of the questionnaire, which consisted of four short-answer questions, one of which asked the surveyors to give their ideas for how digital lodgement should be implemented. The three suggestions are listed below:

Use of a common data format – it was suggested that the onus should be on the receiving agents to accept data in multiple formats, rather than expecting the surveyors to provide data in a special format. Alternatively, the body responsible for the management of the spatial data (in this case Dataflow) would need to supply software or translators to all consultants to achieve an acceptable data format. Generally, the opinion was that whatever system was chosen must be compatible to current software being used by industry. The use of a common base format such as DXF was also suggested, however such a format is not "intelligent" so would not be an acceptable long term solution.

Dual system at first – it was stated that digital lodgement should be introduced in tandem with existing procedures. This trial period would possibly involve a number of willing participants, in order to sort out the initial problems, and then in a few years, the process would be reviewed. Such a system would mean more work initially, however a compulsory digital lodgement system from the start would require a longer lead time to train all users.

Consultation of people in industry – many thought that the system should be implemented by professional contractors with a cost limit imposed, rather than the main ideas being conceived by academics and public servants. There would need to be much consultation between the various parties including the surveyors, Land Victoria and other parties such as solicitors, and should only be implemented after considerable input from organisations, professionals and individuals actively involved in the industry on a day to day basis.

It was stressed that the system should not be implemented purely for the benefit of the end user, but rather for the data suppliers (surveyors) as well. This could be achieved by making sure that the end product becomes available to the development industry, such as providing surveyors with a copy of the DCDB, which would prevent the Government expecting the

industry to contribute without giving up vital resources, such as titles, maps, levels, services and others.

Taking all these factors into account, a set of recommendations for the introduction of digital lodgement in Victoria has been discussed next.

6.3 RECOMMENDATIONS FOR THE INTRODUCTION OF DIGITAL LODGEMENT

In order to provide the greatest number of benefits and also the least amount of disruption to the surveying industry, it is recommended that digital lodgement be gradually implemented in a number of stages. This section explains several immediate changes which could be made to the current system. Such changes must be implemented so that not only they improve the current manual system, but they are also able to be carried through into a new land administration system if cadastral reform occurs in the future.

6.3.1 Stage One – resolution of major issues

This stage will involve further research into a number of the most prominent issues that must be faced in order to implement digital lodgement. Those that will have the most impact are data formats, data security and technology options (refer Chapter 5). Other issues such as legislative changes and intellectual property can be dealt with later, but in order to have a pilot project running, these first three issues will need to be dealt with.

It is important that the type of data format chosen needs to be “intelligent” whereby it can have attributes attached to data points. It also needs to be compatible with the structure required for modern GIS, enabling diverse applications and integration with established databases, such as the DCDB, local councils, and LTO. A compatible data format will facilitate data access, manipulation and storage for many customers and maintenance of industry standards.

It is also important that it will not require large outlay costs for private surveyors. As indicated by the digital lodgement questionnaire forwarded to consulting surveyors, there are approximately six different software packages being used for the collection of plan geometry in Victoria. As it is important for the surveyors to be able to use the software of their choice, it is a major concern that the six geometry packages have no common export file format,

except for DXF, which is not an "intelligent" format whereby data attributes can be passed from one system to another without having to re-enter the data. The NSW LTO have also encountered this problem and have decided that this issue should be addressed through consultation with software vendors, with one possible solution being that translators be written for each package (Land Titles Office NSW, 1998).

The issue of data security is one that will need to be further investigated. Digital signatures have been discussed at length in this thesis, and they have been proven successful by several industries who have adopted them in their work practices. The issue of data transfer options must also be resolved. The most feasible data transfer options at the moment are floppy disk, email or file transfer protocol (FTP), even though using floppy disks will still require physical equipment, which is not the desired effect of digital lodgement. The proposed option for the future is the Internet (Refer Chapter 5).

At this stage, it is also recommended that further research into the needs of all the participating parties be carried out. These will include consulting surveyors, as well as the Land Titles Office, Dataflow, utilities, Melbourne Water and local councils. This research would be carried out through extensive questionnaires, with the digital lodgement questionnaire discussed in this thesis being used as a solid base for the research.

Although it is recommended that digital lodgement be optional for a period when it is first phased in, there will come a point where it is no longer feasible to have two systems running in parallel. Therefore it is important to inform all parties at this stage allowing them enough time to come to terms with the change. Naturally, such change will be met with resistance from several firms, for a number of reasons. These include the simple fact that they are satisfied with the current system, and do not understand why it needs to be changed. In this case, it will be a matter of educating these parties on the contribution digital lodgement will make to the improvement of the information industry. Others will be opposed due to the fact that they are not technologically capable of providing data in a digital format. Unfortunately this is a technological society where computers are at the forefront and unless these parties are able to adapt to a digital environment, compulsory digital lodgement may see the demise of such companies.

One option that may be used for companies who are unable to provide the data in the required format is the idea of a central bureau, to which the surveyor can send plans, and the bureau is then responsible for converting them into the correct format. However this will only be appropriate for companies who already use computers in their workplaces for the preparation of plans. Thus it will be quite difficult to retain those companies who do not use computers at all.

6.3.2 Stage Two – digital lodgement of plan geometry

Due to the number of issues that must be resolved before digital lodgement is successfully implemented, it is recommended that initial digital lodgement be restricted to a number of voluntary surveying companies. This may also include other parties involved in the lodgement process, such as local councils. These initial companies would be chosen on their willingness to participate, their current lodgement practices and the software they use. A range of software amongst the pilot companies would be desirable in order to deal with problems from several software types. As an incentive to participate in the program, one recommendation is to provide each company with a copy of the DCDB free of charge.

The NSW Electronic Plan Lodgement program is adopting a similar approach, whereby nine surveyors have agreed to take part in the pilot. It was decided that the plans used for testing purposes would be those that have already been lodged and registered previously, as this would mean less work for the surveyor as they do not have to worry about generating new data; legal issues such as copyright and integrity of plan data would be avoided; and sufficient volumes of data would be obtained from limited suppliers. The types of plans to be used in the project were average 4 and 5 lot plans of subdivision, which in most cases are prepared electronically (Land Titles Office NSW, 1998).

This stage would see the digital lodgement of data, along with hard copy lodgement of plans. Initially it will be necessary to provide a hard copy of the plan in order to avoid legal issues such as data security and integrity of plan data. The digital data could then be used in a similar way to that in the Western Australian system, as listed below:

- for initial tracking and lodgement of the plan;
- for scaled plots for initial indexing and final reflection on public plan;

- for automatic bowditch closures of each parcel;
- for integration into DCDB.

(Cribb, 1997)

At this stage, the pilot companies would be required to transmit these plans via email or FTP. The provision of data in a digital format would result in very little distraction to many companies, as they are already submitting plans to the water retailers digitally. However it would be necessary to accommodate to any software or presentation standards imposed by the pilot scheme.

6.3.3 Stage Three – digital lodgement of all data

The third stage would require the digital lodgement of all information, including the data on the plan, the plan itself and any other supporting documentation such as the surveyor's report. This would see the need for digital signatures and security checks to be in place, as well as any legislative changes. The current plan of survey that is used for lodgement is not conducive to a digital environment, and as such, it is expected that the surveyor's plan will be phased out, and replaced by a more modern representation of the data.

It is crucial that the digital data provided accurately reflects the information shown on the plan, as it is expected that this electronic data would be used for many functions such as DCDB upgrade and automatic examination and validation. This is important as surveyors often make manual amendments to surveys between initial plan preparation and lodgement.

It is also recommended that a surveyor's accreditation scheme be introduced, whereby surveyors are made more responsible for the data they produce by carrying out thorough checks of the data before lodgement. Western Australia has recently introduced this method, with the Land Titles Office only performing 10% random audits, greatly reducing the amount of time taken for examination. This system is working quite successfully, and statistics have shown a gradual downward trend in errors versus total lodgement over the three year period that the system has been running (Cribb, 1997).

It would be also beneficial for all plans to be based on a state coordinate system, which would facilitate easier data entry into the DCDB. However for this to occur, it would be necessary for further coordinated permanent marks to be placed so the surveyors do not have to spend

extra time traversing to those marks that are already there. This could either be done by Land Victoria, or the task could be outsourced to the private sector. GPS is likely to be used further in this area in the future. Secondly, a common Australian projection for surveys to be based on needs to be chosen rather than each state using their own, which would encourage nationwide land information systems, rather than only statewide ones.

It is also recommended that all new files that are submitted digitally are used to create a new spatially accurate layer in the statewide Land Information System (LIS), as well as for the update of the current DCDB. The current cadastral layer in DCDB is of varying accuracies and it would be ideal for the new surveys to be used to create spatially accurate cadastral fabric. Once there is enough coverage of the whole state, this layer could be then used as the cadastral layer in the DCDB.

6.4 CHAPTER SUMMARY

The system proposed in this chapter is endeavoured to result in improved efficiency for both the surveyor and the data agencies (LTO and Dataflow), with less work being required to amend mathematical errors and also to reduce examination times.

This chapter has outlined the proposed options for introducing digital lodgement in Victoria. It has concentrated entirely on introducing digital lodgement into the survey industry, and has not expanded the concept any further.

It has been recognised that several conditions need to be adhered to in designing and developing a digital survey system. The first is that it will be necessary to create a new cadastral survey data record to supercede the current survey plan. The second is that all information resulting from the collected cadastral data must be based on the original source documents; and thirdly an integrated data interface for digital input and output must be developed.

The study of other jurisdictions' endeavours to introduce digital lodgement have highlighted several key trends. These include the tendency towards surveyor accreditation, whereby the surveyor is responsible for thoroughly checking his/her work before lodging it; the use of digital data throughout the whole process, whereby the digital data would be recognised as the legal document, but hardcopy outputs could be obtained at any time; standard data formats

needed which are compatible to all areas of the survey industry; a system at the start where digital lodgement is run in parallel with the current manual system; and all surveys to be based on a statement coordinate system.

Using these trends as a basis, several recommendations were made for the introduction of digital lodgement for surveyors. The first included the resolution of the technical issues that will allow digital lodgement to proceed, including data formats, data transfer and data security. These problems should be resolved in consultation with all participating parties, in order to gain fair solutions for all concerned.

The second stage will include a pilot project with several volunteer companies, who would be chosen on their willingness to participate as well as their current lodgement practices. It is recommended that the data used for testing be the same as that already lodged and registered, in order to avoid legal issues and also maximise the amount of information obtained from minimal sources. Surveyors would be required to submit data digitally, but accompany this with a hard copy plan. It is expected that the digital data would be used for several purposes including tracking of the plan, updating of the DCDB, and checking of parcels.

The third stage would facilitate the digital lodgement of all data. It is envisaged that by this stage the plan as we know it will have been phased out and replaced with a more up-to-date product. All security measures will need to be in place by this stage, as will any legislative changes such as the acceptance of digital data as the legal document. Another component, though not compulsory, is that all surveys should be based on the state coordinate system, which will not only increase the integrity of the DCDB, but will also facilitate easier updating.

At this stage it is necessary to note that a coordinated cadastre would provide many benefits to a digital cadastral system, however it is not a mandatory requirement for digital lodgement to work.

It would appear from these studies that it is not sufficient to limit the ideal of digital lodgement to simply the surveying industry. If the cadastral system is to be seriously upgraded, it is necessary to recognise the paradigm shift that we are moving into a digital age. Whilst this chapter has concentrated on methods available for the surveyor to lodge

digital data, it must be recognised that benefits will only be gained from this if the whole system is converted into a digital environment.

7. CONCLUSIONS & RECOMMENDATIONS

7.1 OVERVIEW

This chapter summarises the recommended directions surveyors in Victoria should follow in order to lodge data digitally. It also argues that this is too narrow a field, and that it is necessary to consider the whole cadastral system shifting into a digital environment. One of the main problems is that the word “lodgement” usually implies the lodgement of cadastral data from the surveyor to either the Land Titles Office or the DCDB, rather than the complete flow of data throughout the entire process. It needs to be recognised that the purpose of introducing digital lodgement is to contribute to a complete digital environment to efficiently manage and utilise land-related data.

7.2 DIGITAL LODGEMENT FOR SURVEYORS

Digital lodgement of cadastral survey data will provide many benefits to the Victorian land industry, both to the private and public sectors, and also to the general public. Chapter 2 showed that the current system of plan lodgement in Victoria is inadequate for the demands being placed on spatial information delivery today. Several strategies to bring the system up to today’s technological standards have been attempted, however it would appear that the most beneficial way is a complete re-engineering of the entire system.

Digital lodgement would play an extremely important role in the reform of the Victorian land registration system, as it would provide the means for efficient and safe data transmission. However the implementation of digital lodgement would involve the resolution of several key issues before it may proceed. Technologically, issues such as file formats and data transmission must be resolved, although theoretically, these have been researched thoroughly in many areas and are not prohibiting digital lodgement from going ahead. It has also been shown that the Victorian survey profession is essentially ready for digital lodgement with many surveyors already using computers to both prepare and submit plans (not for registration purposes yet).

The primary reason why digital lodgement cannot yet go ahead can be attributed to legal barriers such as the certification of plans in a digital format. Digital signatures have been shown to solve these problems, however it is not yet legally recognised that these are

sufficient for transmitting digital plans. Studies of other jurisdictions have shown this to be possible. Western Australia in particular have recently passed an amendment to legislation allowing plans to be lodged electronically. Other jurisdictions have shown similar initiatives such as Denmark where digital lodgement becomes mandatory in January 1999.

It is wholly recommended that digital lodgement of cadastral data be implemented in Victoria in the near future, as the benefits far outweigh the problems. If it is to be done successfully, it will need to be a part of a larger cadastral reform within the state of Victoria, with digital lodgement only forming a small part of it.

7.3 RECOMMENDATIONS

After studying the digital lodgement of data in other jurisdictions, it would appear that there are several prominent trends repeatedly occurring. Their integration into the Victorian system is paramount if digital lodgement is to be successful from the start. These trends are listed below:

- Standard data formats including intelligent data that can be passed between different systems to facilitate automatic checking;
- Surveyor Accreditation whereby the surveyor is fully responsible for checking that the information on the plan is 100% correct;
- Digital data to become the legal document, whereby paper copies can be generated if needed, but the actual legal document will no longer be in hardcopy format;
- Lead in time where both hardcopy & digital processes are allowed, to cater for smaller firms who do not have the facilities to lodge data digitally at present.

Taking these trends into account, the project has recommended that several strategies be put in place in order to implement digital lodgement in Victoria. These include immediate changes to the system, as well as long term cadastral reform.

- Further research with all participating agencies, including surveyors, LTO, councils, and Dataflow. This research will include questionnaires, workshops, interviews and any other methods deemed suitable.
- Resolve major issues including file formats, data transmission, digital signatures, and further research into intellectual property.

- Introduce surveyor accreditation so that eventually surveyors will be able to update the DCDB themselves.
- Pilot project with a number of volunteer companies where surveyors can lodge their data digitally.
- Digital lodgement of data but hard copy lodgement of plans at the start, and then eventually all data to be lodged electronically (no paper processes at all).
- Re-engineering of the system, such that the surveyor actually updates the DCDB. In order for this last event to happen, it is imperative the previous problems are resolved.

7.4 FURTHER RESEARCH

The thesis has concentrated generally on the lodgement of cadastral data by licensed surveyors, rather than the flow of data through the whole cadastral system. It has been shown that digital lodgement encompasses a much wider scope than this, and that cadastral reform is needed to provide for an efficient method of data lodgement in the future.

This will involve a more significant change to the survey system itself from a document based one to a completely digital environment. It has been shown that document based survey systems are reaching their limit of cost-effective improvement, being unable to provide the necessary infrastructure for the future.

The basis for the current cadastral system is that the survey information is created by the surveyor and then forwarded to the custodian of the cadastral map through a series of approvals, and then this data is entered into the map by the DCDB custodian. This section suggests changes to this basic principle, including changing the amount of plan examination and checking needed, to the surveyor physically updating the cadastral map.

This section discusses three ideas which focus on cadastral reform of the entire land registration system that have been proposed by other authors. The first is an integrated model which is similar to the current system, but allows more processes to be performed simultaneously, the second is the use of a central server to lodge all plans to, and the third is the concept of the surveyor actually updating the DCDB.

7.4.1 Integrated model

Effenberg and Williamson (1996) advise that any future models must attempt to reduce the time taken for the surveyor's plan and the proposed plans of subdivision to reach the DCDB. The model shown in Figure 7.1 is one possible idea which achieves this aim.

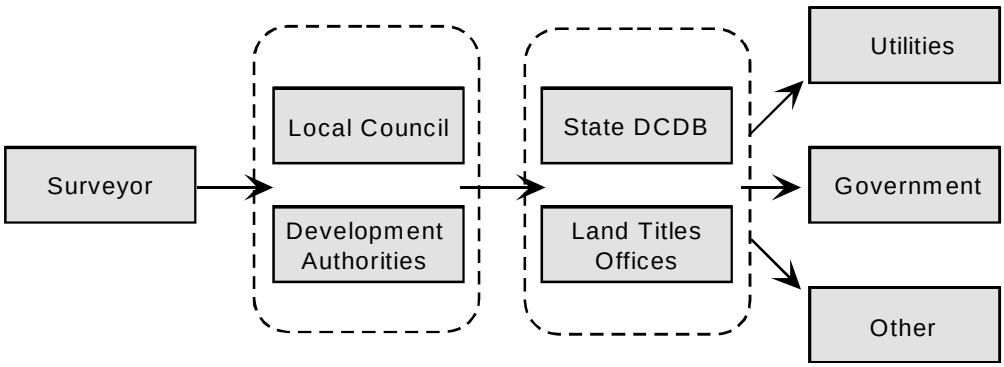


Figure 7.1 Flow of data for integrated model (Effenberg and Williamson, 1996)

The model suggests that processes work in parallel with each other rather than the plan passing through a series of approvals before it is passed on to the next party. The entities in the dotted frames are those where the data can be simultaneously available to the closed entities at the same time, whereby changes made by one entity are accessible by the other (Effenberg and Williamson, 1996).

7.4.2 Central data server

The concept proposed by Pearce et al (1997) which is shown in Figure 7.2 is one of a multi-tasking system, whereby documents can be lodged at a central point facilitating access by anyone with permission, including the surveyor, LTO, local councils, referral authorities and Dataflow, as well as those not involved in the maintenance of the system. This type of system provides benefits over the current linear system as it enables multiple processes to occur simultaneously whereas at the moment the plan must pass through one stage before it can go onto the next. It also improves data security, and digital records can be kept without hard copies. Pearce (1997) overviews this process.

The following steps would be taken to lodge and register a plan:

Information search and survey – using online technology, several pieces of information are output from the system, including a segment of the DCDB for the survey site; survey

information including permanent marks, field records, land parcel information and surveyor's report; and textual title information. This information is then used to plan and undertake the field survey, whereby the surveyor manipulates and integrates the data into one package (known as a Digital Transaction Package) containing spatial geometry, attributes and topological land parcel subdivision structure. This package is then submitted to the registering authority.

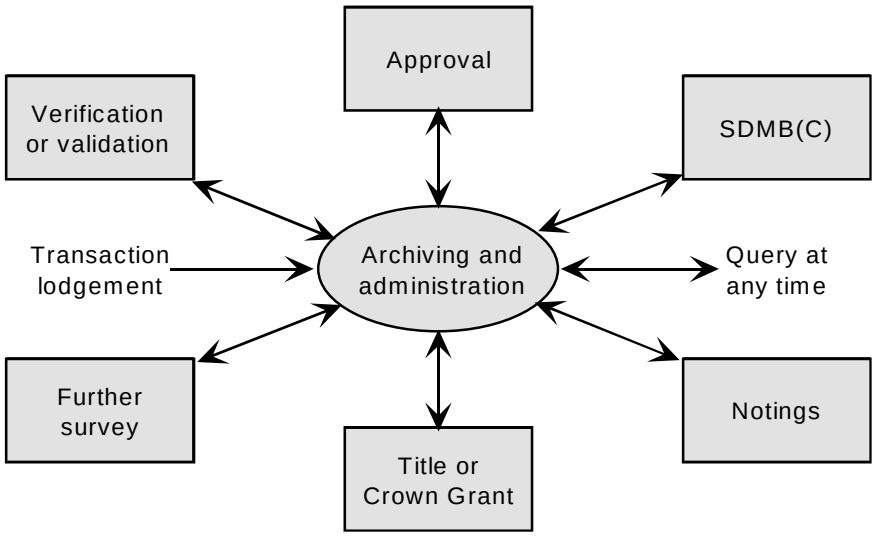


Figure 7.2 Central server for land registration (Pearce et al., 1997)

Lodgement – lodged documents enter a central registration, administration and archiving system where paper plans are scanned in as images and digital files loaded. The data is indexed by plan numbers and given provisional status. At this stage, it is made available to all users.

Examination – the examining authority is automatically notified that an unexamined transaction has entered the system. This technique, known as 'push' technology negates the need to be manually advised of the need for action. Upon successful examination of the plan, the status of the dealing is changed to 'approved'.

Approval – the responsible authority would have network access rights in order to remove provisional status from the documents, whereas at the moment, approval is achieved by the examiner signing the plan. The main issue to be contended with is the need for some type of

approval mechanism, and this may include digital signatures, personal identification numbers or access rights.

Registration and creation of Title – after the plan is approved, the LTO would then register it and create the title, which would be stored in the same system, and linked to the map base.

Updating of DCDB – this could be done at any stage of the process. Again, the maintenance providers would be notified automatically of the new plan, whereby the plan could be added as either provisional or approved. For plans of 6 lots or less, it has been proposed that these be key entered (Pearce et al., 1997).

The Digital Transaction Package (DTP) would be structured so that any information required could be extracted at any stage. It would consist of field records, plan, geometry and administration details. The proposed model would adopt a standard data set format enabling integration with established databases such as the DCDB, local council databases and other referral authorities' databases. Such a format would facilitate access, manipulation and storage for a diverse range of customers; maintenance of an industry standard; and automated updating of systems and validation processes.

Effenberg has expanded on this concept by adapting it to an Internet environment. The concept, which was developed through discussions by a research group within the Department of Geomatics, attempts to re-engineer the traditional land registration processes by taking full advantage of internet technology. This is shown in Figure 7.3.

In the current system, it is very much a "put" concept where each agency must wait for the previous one to pass on the document. The proposed system does not rely on this linear data flow. Instead, the surveyor forwards the plan to the server, and at the same time, specifies which parties can view the data. Once the plan reaches the server, the specified parties are notified, and they may then use the plan how they wish (for example, examination by Land Titles Office, certification by councils). As the other parties finish with the plan, they change the status of it, from a planning application, to a certified plan, and lastly to the Registered Plan. This is known as electronically 'marking up' the documents.

This concept has been designed to maximise the opportunities offered by WWW technologies. It is expected that the use of the WWW will exclude time delays and duplication that is inherent in the current cadastral system (Effenberg and Polley, 1998).

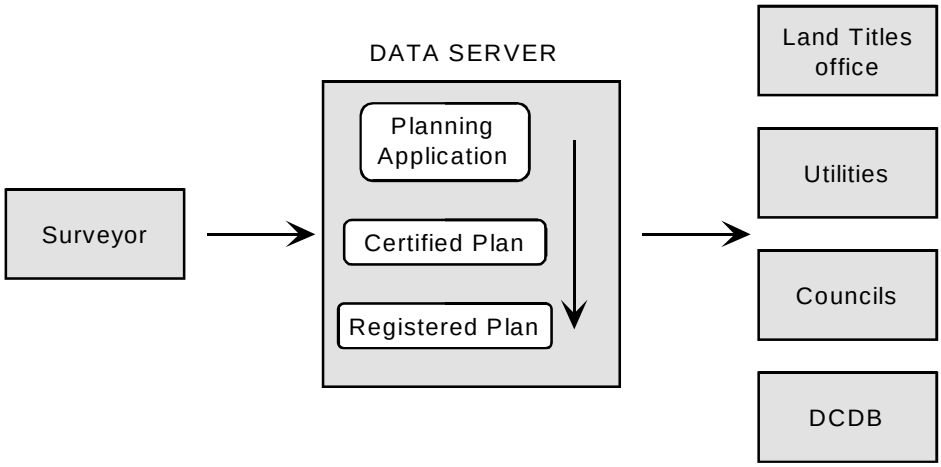


Figure 7.3 Changing status of plan (Effenberg et al, 1998)

7.4.3 Surveyor updating DCDB

This is the optimum solution as it envisages the surveyor updating the cadastral map using the original data. It is one of several models as discussed by Effenberg (1998) whereby parties other than the custodians of the cadastral map update the DCDB. It involves the surveyor gathering, maintaining and distributing all the cadastral map maintenance data. This would include undertaking all the processes of the spatial cadastral maintenance subject to prescribed standards in conjunction with a process of quality control and audit (Effenberg et al., 1998). Other models suggested were the regional model, the utility model and the council model, whereby the appropriate authorities update the cadastral map using a process of applying standards to the spatial data (Effenberg et al., 1998)

The main issue in such an environment is that in a totally digitally environment the spatial cadastral dataflow can be based on standards and the processes of quality control ideally exclude most time delays and duplication. The models also offer the advantage of capturing the cadastral data at the data collection stage (Effenberg et al., 1998).

7.5 CONCLUDING NOTE

The world we are living in today is a very different one to that 100 years ago. Technology has had a huge impact on the society that we live in, and it is important that we do not resist the change that is brought about by technology. Although it may seem that systems that were designed for society 100 years ago are still suitable for today, it must be asked whether our quality of life can be improved by upgrading or even changing these systems altogether. And often the answer is yes.

Cadastral systems are a prime example of this. Although the Victorian land registration system is still sufficient for its needs, it is due for a change, as it is a system designed with the needs and technologies of the 1800s in mind. One major part of this system is the lodgement of data, and the subsequent flow of that data through different organisations. As prescribed by this thesis, the lodgement of data in a digital format is expected to result in extensive benefits for the land information community. But it is important that it is not viewed as an independent problem, but rather as part of the re-engineering of the cadastral system in Victoria as we know it.

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APPENDIX ONE

CHECKLIST FOR INFORMATION ON FIELDNOTES

Heading – check crown description against C/T & LP
North points – AMG Zone
Reference Number
Traverse close – show misclosures
Title close – show misclosure
Are instrument stations described?
Sheet numbers
Sheet number cross references made?
Spelling
Old survey noted on plan if applicable?
Abutting survey noted on plan if applicable?
Road names
Occupation • description from fieldcard • ages noted
Offsets • check against fieldcard • do radiations have an offset as a check & does it compute?
At least 3 RMs
Datum • survey that datum is/are derived from? • AMG connection? • Datum points defined by a letter and correlates to a survey report
Bearings • bearings to any RO if applicable

- bearings on all traverses
- bearings on all radiations
- check against worksheet
- check against fieldcard
- is there any rotation against fieldcard and has this been applied correctly to each bearing?

Distances

- on traverses
- on radiations
- check against worksheet
- check against fieldcard

Chainages – check against fieldcard and worksheet

Road widths at each end of datum and opposite corners and bend points

- check against fieldcard
- check against Plan of Survey

Title Comparisons

- connection
- bearings
- distances
- area, closure
- crown allotment Nos. on diagram?
- Parish/County names on plan area if applicable?
- Compute Title Dimensions from adopt radiations if applicable
- Compute Title Dimensions from offsets/running chainages if applicable
- Compare dimensions with Plan of Subdivision/Survey

Certification: date and signature as per plan

Copy of fieldnotes/Surveyors Report for file

APPENDIX TWO

DIAGRAM OF PLAN OF SURVEY AND ABSTRACT OF FIELD RECORDS

APPENDIX THREE

CHECKLIST FOR INFORMATION ON PLANS – SUBDIVISION, CONSOLIDATION, CREATION AND REMOVAL OF EASEMENT PLANS

FACE SHEET	
1	Stage No. (all sheets)
2	Plan No. (all sheets & listing)
3	Location of Land: Crown Description
4	LTO Base Record
5	Title Reference
6	Last Plan Reference
7	Postal Address
8	AMG Coordinates, Zone
9	Vesting of Roads & Reserves
10	Depth limitation? Notation whole/part
11	Council name
12	NOTATIONS: (i) Staged subdivision (ii) Based on survey (iii) Common Property if any (iv) Boundaries (v) Lots containing parts (vi) Purpose/Other purpose of plan
13	EASEMENT INFORMATION (i) check from Title and/origin subdivision (ii) are easements fixed and dimensioned? (iii) Abuttals and appurtenant easements

	(iv) Transfers and creation of easements?
14	Company Reference, Version (all sheets)
15	Sheet No. (all sheets)
16	Planning Permit No.
17	Section 12(2) Statement
PLAN SHEET DIAGRAM	
1	North point
2	Scale and Plot
3	Bearings and distances and Title connection • Agree with C/T, worksheet, fieldnotes • Close
4	Roads – do they close, plot, intersection ties
5	Lot numbers and do lots close, check areas
6	Sum of lot distances equals total distances
7	Continuation sheets show abutting lots defined & plotted
8	Street names/(spelling) – check against Title and chart
9	Diagram No. if cross sections and notations?
10	Is plan in correct format with building plan, boundaries, etc.

APPENDIX FOUR

LETTER TO SURVEYOR GENERAL IN EACH AUSTRALIAN STATE

REGARDING THAT STATE'S STATUS TOWARDS DIGITAL LODGEMENT

APPENDIX FIVE

LETTER TO ASSOCIATION OF CONSULTING SURVEYORS AND

INSTITUTION OF SURVEYORS VICTORIA REGARDING QUESTIONNAIRE

APPENDIX SIX

DIGITAL LODGEMENT QUESTIONNAIRE FOR CONSULTING SURVEYORS INCLUDING COVER LETTER TO SURVEYING FIRM