University of Southern Queensland
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Implementation of Electronic Measurement and Recording of Strata Title Field Notes

A project submitted by

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Abstract:

The preparation of strata plans of subdivision is a regular task for the modern surveyor. While electronic measurement and recording have permeated all other survey tasks the recording of Strata measurements is still largely the domain of pencil and paper. The advent of hand held distance metres with Bluetooth transfer capability has opened the way for electronic recording and in field use of a pocket or tablet PC to create the strata plans in the field. This project will implement and test a variety of equipment and procedures for electronic measurement and recording. It is envisaged that a successful system will result in time and cost savings and a reduction in errors due to on site data checking. Upcoming electronic lodgement options will be explored as an extension of the plan production.

University of Southern Queensland

Faculty of Engineering and Surveying

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CERTIFICATION

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I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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Mike Morris
Signature

23/10/2011
Date

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1.1 Background to Strata Title

The introduction of the *Strata Titles Act 1961* in NSW in 1961 and similar acts in all other Australian States in the following years has enabled the volumetric subdivision of a building into individual titles and common (shared) property. The 1961 legislation was updated in 1973 to *Strata Schemes (Freehold Development) Act 1973* and amendments made again in 1996. Strata Title has also been adopted in other countries including but not limited to Canada, New Zealand, Singapore, South Africa, Indonesia, Malaysia, Fiji, The Philippines, Dubai, and Abu Dhabi. (Randolph 2008).

The *Strata Titles Act 1961* was intended to improve upon the system then in common use namely *Company Title*. In *Company Title* a home owner purchased shares in a limited company that holds the Title for the land. The articles of Association of the Company then allowed shareholders of the company to reside in the building. Unlike Torrens title the owners of a company title unit acquired no estate in the land. The chief practical draw back of company title was the implementation of a Mortgage over only part of the building. Banks saw company titles as a less desirable security for loaning against and charged a risk premium in the form of higher interest rates. Company title is still used in NSW for example where local government approval for a strata subdivision can not be gained.

In NSW a Strata plan of Subdivision may only be prepared by a Registered Surveyor. The measurement of the buildings and common property normally takes place as the building is nearing completion. Less commonly an existing building may be subdivided for example the conversion of an old warehouse into apartments. The fundamental difference with a regular Land Subdivision is that the boundaries are formed by the structure of the buildings themselves and as such are not dimensioned on the final plans. The exception to this being where there is no structure at the boundary or the structure on the boundary is deemed to be not permanent for example a painted line that defines a car parking space or a timber fence. In this instance dimensions are shown along the strata boundary from a structural boundary to enable the reinstatement of the boundary if needed. Areas shown on a strata plan are

approximate only and a statement to this effect should be on all sheets that show an area. Strata areas can be quite different to lease or PCA areas.

1.2 Measuring Strata Title Units

To someone unfamiliar with the process it might seem fairly easy. Take for example the typical unit shown in figure 1.1 there are 12 distances that need to be measured. With a laser distance meter just a few minutes work you might think. If we then look to the layout from the architectural drawings as shown in figure 1.2 it can be seen that in most cases the strata boundary is made up of a series of room widths and wall thicknesses. It may not always be apparent if a strata boundary has a bend or otherwise and quite a few extra measurements will be required to enable a surveyor to confirm the strata boundary. The strata boundary is shown in red on figure 2. A good eye for detail is needed by a Strata Surveyor.

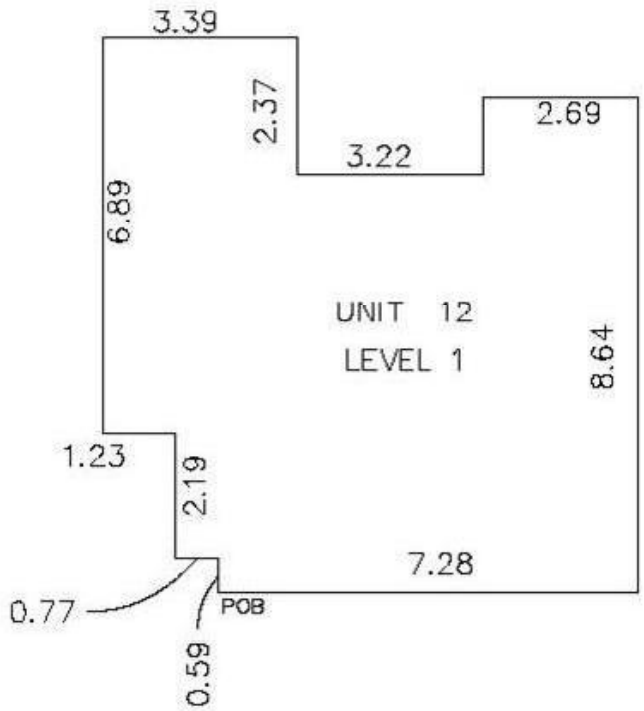

Figure 1.1 Typical Unit Layout
Measure the 12 distances and you're done. Easy!

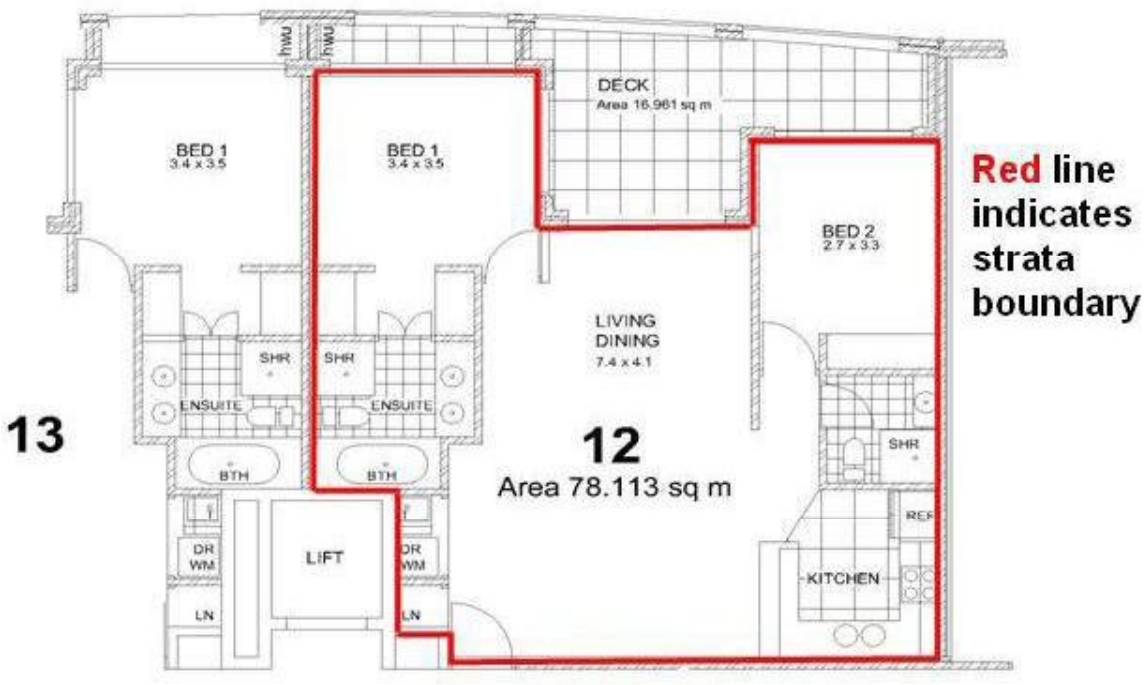

Figure 1.2 Layout with walls shown.
Now let's add some walls. Not so easy!

Not only must a Surveyor measure the units he or she must certify in their Surveyor's certificate on the Administration Sheet that all structures actually exist and have been sighted. This therefore prevents the strata subdivision of a proposed or incomplete building. This declaration is made in the surveyor's certificate on administration sheet 1. The actual wording of this statement is contained in Schedule 1a of the Strata Titles Act and is not repeated on the Administration Sheet.

To enable contracts and sales to be made against an as yet unbuilt strata subdivision plan a draft strata plan is prepared from the architectural drawings of the building. There is no restriction in NSW requiring that a draft strata has to be prepared by a registered Surveyor. I regularly see DA submissions from one firm of designers that contain a draft Torrens or Strata subdivision prepared by the designers themselves who are not Surveyors.

A print out of the draft strata plans at A4 size is used as the field notes for the final measure up. If the building has been constructed in agreement with the architectural drawings then all that is required is that the boundary walls be measured and confirmed in the field. While this is commonly the case on smaller projects on larger projects there are usually some deviations from design. Some examples are different service ducts than planned requiring a change in

the length of a wall or relocation of entry doors, extra cleaner cupboards and telecom rooms, a late decision by the electricity utility to require an on site sub station to name just a few. Locating these changes is an important skill for the Strata Surveyor to acquire.

The surveyor will attend the site armed with a copy of the draft strata and a distance meter and measures each of the units along the internal walls. The internal walls form the Strata Boundary in NSW. In some other states such as QLD the boundary is the centre of the wall. The dimensions are then marked in pencil directly onto the copy of the draft strata. As each unit is measured a competent surveyor will check the Misclose of each unit by addition and subtraction before moving on to the next unit. A typical misclose in a unit is in the order of 50 mm. A larger Misclose could indicate a wall thickness has not been allowed for or more likely that the unit is not constructed perfectly square or plumb.

The measure up can be done by a single surveyor but more often at our company by a two man crew, one member reading the distances the other one noting them down. For a simple structure the process is simple and fast. Difficulties arise when angles of other than 90 degrees are encountered or a curved section needs to be measured. As Structural boundaries are not dimensioned on the final plans perfect spatial accuracy is not necessary or warranted.

1.3 Processing of Field Work

At completion of the field measurements the surveyor will return to his office and enter the measurements into a calculation package such as Terramodel in our case. A calculation model drawn at true scale and direction is created and used to calculate the areas and layout for the Linen plan. The drafting of the final plan is then done by a draftsman in a drawing package such as AutoCAD. A typical strata plan measured by me is shown in figure 3. In NSW a plan set consists of a location plan followed by the floor plans and Administration sheets. This project is concerned with the production of the floor plans.

The surveyor will then deliver the final plans to his client. As a strata plan is a form of subdivision a council certificate is required before the Register Generals Office will accept the plans. Signatures and seals of all parties having an interest are added to the

Administration Sheets and the paper plans are usually lodged across the counter at the titles office for registration.

1.4 Electronic Lodgement

Electronic lodgement of plans is a recent development in NSW and still not universally used by Surveyors. The NSW system is called e-plan. The current e-plan system involves lodging a Tiff image of the plans in a zipped file. This is simply an image of the paper plans and documents and contains no electronic measurement data. Future developments are being discussed in the industry and by government that will involve lodging electronic drawings in Land XML format. It is intended that this will automate the checking process and supply subsequent users of the plan with an electronic cad file.

1.5 Statement of Research Problem

From the above outline of the Strata plan process it can be seen that the production of a set of Strata Plans and subsequent registration is a labour intensive process. The techniques in use are still largely manual in nature.

This project aims to explore what methods are available to a surveyor for using electronic recording and a relatively inexpensive pocket PC to record his measurements electronically in the field and use the resulting data files to produce a final product in a more efficient, faster and more error free manner.

1.6 Research Approach

A review of the existing literature on the topic will lead to a discussion of the hardware and software options available to a Surveyor wanting to implement electronic measuring.
An examination of commercially available hardware and software products will result in a suitable commercial software being purchased and tested on a trial job and then on an actual Strata subdivision project. As an extension of plan production current and upcoming e-plan initiatives will be explored in the Literature review.

1.7 Project Objectives

The objectives of the project can be summarized as:-

- Research the background on Strata title and its use in NSW
- Examine current measurement techniques and survey practice in Strata Surveys.
- Examine and document available equipment and software.
- Test electronic methods and quantify differences by timing to determine if they are faster than manual methods.
- Use the electronic methods to measure an actual project successfully.
- Determine if electronic measurement is a worthwhile technique for Strata measuring.

1.8 Structure of the Research Project

This Project may be divided into five areas. These areas are developed further over six chapters. These areas are:-

1. Introduction and discussion of background to project including literature review.
2. Analysis of available equipment and Software
3. Trial testing of equipment and methods at our offices.
4. Further Testing on an actual job to produce a Strata Plan.
5. Discussion and Analysis of field results leading to conclusions and recommendations.

There are six chapters and a brief summary is as follows:-

Chapter 1 – Introduction: Introduces the reader to Strata Title Surveying with an outline of the methods used and the problems that might be encountered by a Strata Surveyor. Includes an overview of the project

Chapter 2 - Literature Review: Researches the background literature to support the project. A look at Strata practice in Western Australia and electronic lodgement in New Zealand is included.

Chapter 3 - Methods: Describes the methods used to select equipment and software and a brief outline of the system testing stages.

Chapter 4 - System Development: The project examines the types of data we will need to record and alternatives for doing that. Various softwares are tried out on two different platforms. Commercial software is purchased and tested in a non production environment. A comparison to manual methods using time taken was carried out.

Chapter 5 - Evaluation of the Automated Strata Measuring System: The system developed thus far is tested on a real site using similar methods and a Strata Plan produced. Some problems were encountered and overcome.

Chapter 6 - Conclusions and Recommendations: Summarizes what was acheived and suggests areas for further investigation.

1.9 Conclusion

Electronic data recorders have progressed in the last 20 years from merely recording data to being fully fledged in field computers with on board calculation software. In the same period Strata surveys have only advanced in so much that the tape measure has been replaced with a laser distance meter. At the end of this project I aim to have implemented electronic surveying and recording for this last bastion of manual measurement.

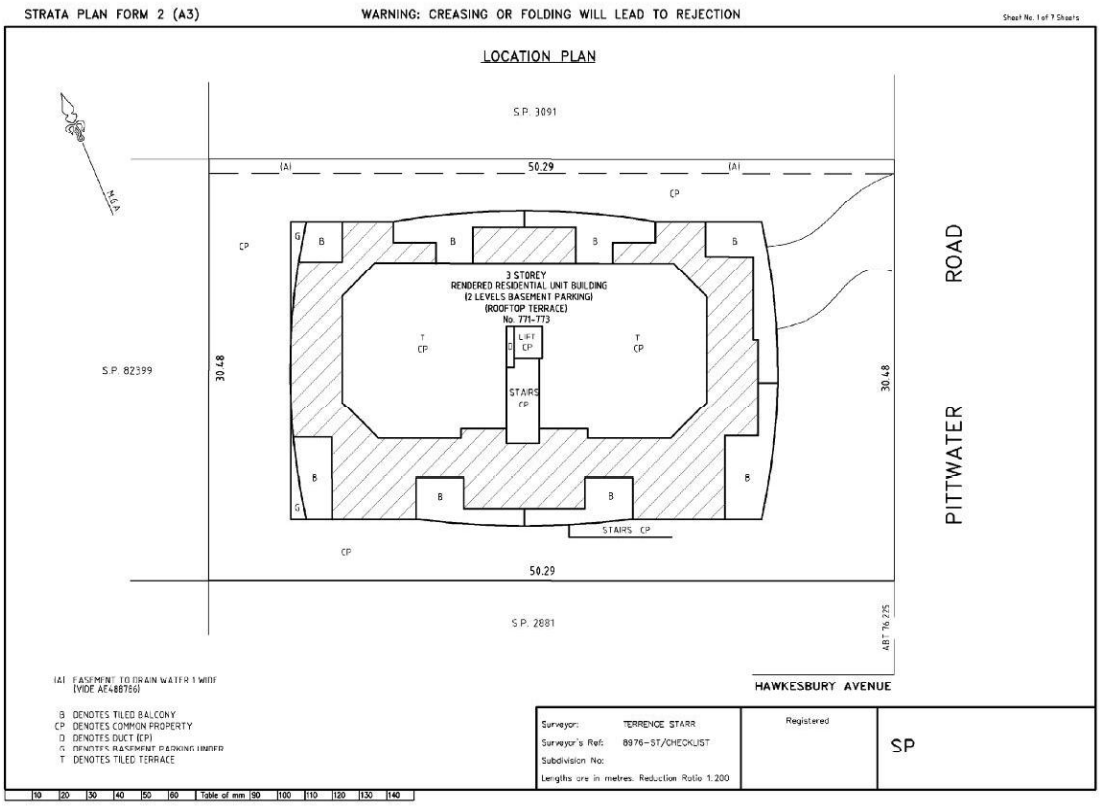

Figure1.3 Typical Lay Out Plan

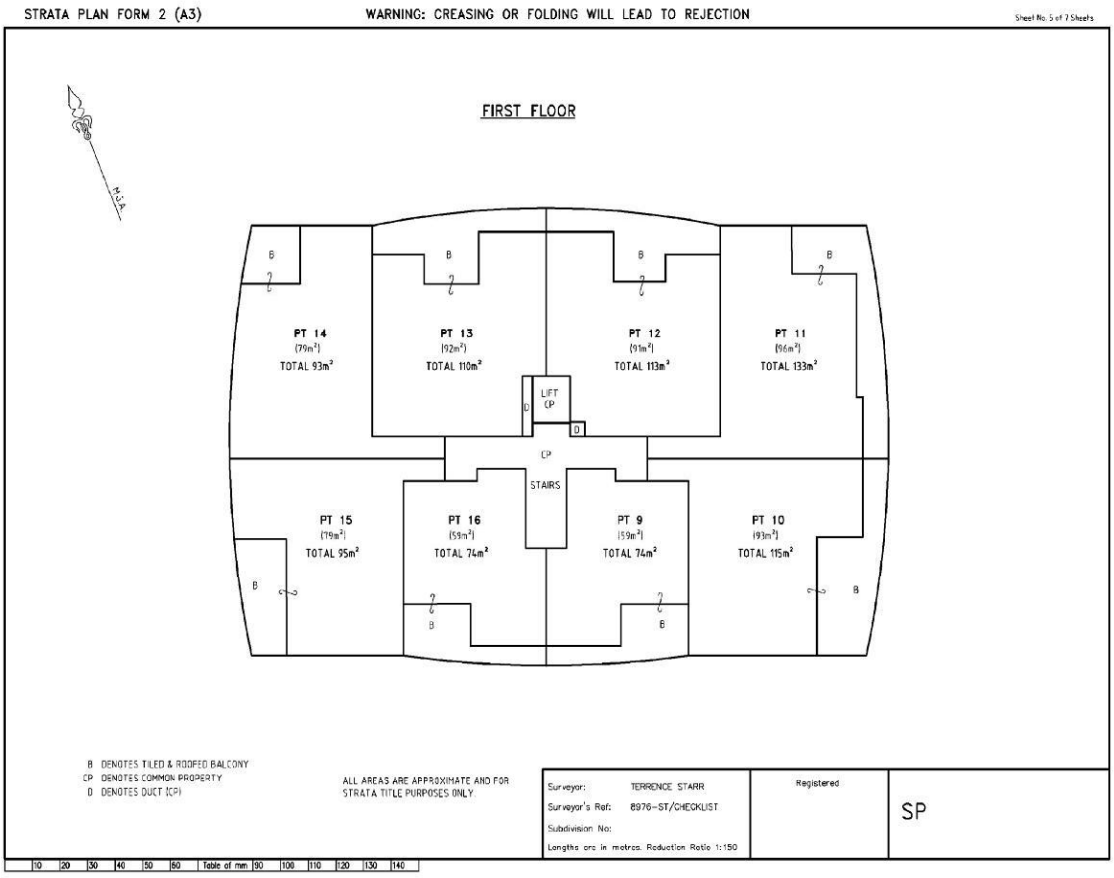

Figure 1.4 Typical Floor Plan

Chapter 2- Literature Review

2.1 Introduction

In order to fully explore the topic of Strata Title measurement it is first necessary to know something of the history and practice of Strata Title in New South Wales and other states. The literature review will look at how strata plans have evolved and are currently measured and then look into the future directions for Strata plans by looking at current and upcoming eplan initiatives in NSW and elsewhere. The equipment and methods used to carry out a Strata Survey are documented in order to identify items suitable for electronic survey techniques.

2.2 What is Strata Title?

The following definition is taken from the Macquarie Australian Dictionary.

Strata Title
noun a system of registration of strata of air space in multistorey buildings, similar to the registration of titles under the Torrens System, to create a type of interest similar to the interest a person has in the land with a single storey building.

Strata Title may of course also be applied to single storey buildings. It normally includes but need not have some common property. There must be a building on at least one lot for a Strata Subdivision to be applicable in NSW. A Strata subdivision of vacant land is therefore not possible in NSW.

2.3 Strata Title Legislation in NSW

The **Strata Titles Act 1961** introduced 50 years ago in NSW was the first Strata title act in the world (K Everton-Moore 2006) Similar acts in all other Australian States followed the NSW model. The legislation was updated in 1973 to **Strata Schemes (Freehold Development) Act 1973** and amendments made again in 1986 with the introduction of the

Strata Schemes (Leasehold Development) Act 1986 and the **Strata Schemes (Leasehold Development) Regulation 2007.** Further Legislation regarding Strata scheme management was introduced in 1996 and 2010 with the **Strata Schemes Management Act 1996** and the **Strata Schemes Management Regulation 2010**. The intent of these acts was to separate strata management from other the act.

Similar legislation exists in all the other states of Australia. In some states such as Queensland Community Title Legislation is bundled with Strata Title. NSW has a separate act covering Community Title. The various State schemes are listed in Table 1 showing the variations in Terminology used from State to State.

All lots created by a strata subdivision are Torrens Title and stand equally with lots from any other plan of subdivision. The Torrens act for NSW is the Real Property Act 1900 (RPA). A Strata subdivision may only subdivide land under the RPA. Old System land must be bought under the RPA before it can be subdivided using a Strata Scheme. The RPA was amended at the time of the introduction of Strata Title in 1961 to include lots created under a Strata Scheme. This is stated explicitly in section 6 of the Strata Schemes Act and the act Title and the Construction of the act. These are reproduced below.

Section 6 (Strata Titles Act-1961)

An Act to facilitate the subdivision of land into cubic spaces and the disposition of titles thereto; to amend the Real Property Act 1900 the Conveyancing Act 1919 the Local Government Act 1919 the Land Tax Management Act 1956 and certain other Acts in certain respects; to repeal the Conveyancing (Strata Titles) Act 1961 and certain other Acts; and for purposes connected therewith.

Construction of Act

1. *This Act shall be read and construed with the Real Property Act 1900 as if it formed part thereof. The Real Property Act 1900 applies to lots and common property in the same way as it applies to other land except in so far as any provision of that Act is inconsistent with this Act or is incapable of applying to lots or common property.*

Source: www.legislation.nsw.gov.au accessed 19-Sept-2011

Table 2.1 Australian Strata Schemes Terminology

	Terminology for 'Scheme'	Terminology for 'Body Corporate'	Terminology for 'Management Committee'	Terminology for 'Manager'	Terminology for 'By-laws'
QLD	Community Title Scheme	Body Corporate	Committee	Body Corporate Manager	By-laws
NSW	Strata Scheme	Owners Corporation	Executive Committee	On-site-residential property manager, caretaker or strata managing agent	By-laws
VIC	Subdivision, Strata Subdivision or Cluster Subdivision	Body Corporate	Committee	Manager	By-laws
SA	Strata Scheme	Strata Corporation	Management Committee	Agent (*STA*[1])	By-laws (*CTA*[2]) or articles (*STA*)
WA	Strata Scheme	Strata Company	Strata Council	Strata Manager	By-laws
TAS	Strata Scheme	Body Corporate	Committee of Management	Manager	By-laws
NT	Unit Title	Management Corporation	Committee	Employee or agent	By-laws
ACT	Unit Title or Community Title	Owners Corporation (*UTA*[3]) or Body Corporate (*CTA*[4])	Executive Committee (*UTA*) or Committee of Management (*CTA*)	Agents, employees & contractors (*UTA*) or Manager (*CTA*)	Articles (*UTA*) or by-laws (*CTA*)

[1] *Strata Titles Act 1988* (SA).
[2] *Community Titles Act 1996* (SA).
[3] *Unit Titles Act 2001* (ACT).
[4] *Community Titles Act 2001* (ACT).

Source: (K Everton-Moore 2006)

From the point of view of the Surveyor the NSW Strata Titles Act is mainly concerned with the legislative and legal aspects of strata title. A Section particularly pertinent to surveyors is Schedule 1a which sets out the complete form of the surveyor's declaration.

On the Strata Plan Administration sheet the surveyor needs only to certify that the development complies with Schedule 1A. Schedule 1A is not listed in full on the actual strata plans. A full listing of Schedule 1A is shown in Appendix 1.

Section 8 of the act sets out the approved plan format for a Strata plan as listed below.

(1) A plan intended to be registered as a strata plan must include, as sheets of the plan:

(a) a location plan, and

(b) a floor plan, and

(c) a schedule of unit entitlement.

The current format for Strata plans has changed slightly from the above such that a separate administration sheet for owner's signatures and contact details is now required instead of being part of the plan set. The unit entitlements are also now listed on part of the administration sheet(s). This project is primarily concerned with the measurement of the floor plans in part (b) above.

2.4 Registrar Generals Guidelines

In NSW the registration and administration of survey and boundary plans is done by the Registrar Generals Department. The RG issues directions for the guidance of surveyors in the preparation of Strata Scheme plans. These regulations are now days to be found on the RG's website and no printed copy is issued to Surveyors as was formerly the case.

The RG guidelines are not intended as a handbook on how to carry out a strata survey and are concerned chiefly with administrative matters. A better source of information for the practicing surveyor is the Strata fast facts handbook published by the Lands department. It lists many practical examples of good and bad plans. Strata fast facts was last updated and increased in size in mid 2010, it does not contain any information on how to go about the fieldwork of preparing a strata plan.

These guidelines also do not have requirements for instrumentation, calibration or retention of field notes in a similar manner to the Registrar General's guidelines for regular (Torrens) land surveys. To this end a Surveyor is entirely free to use what ever techniques and equipment he likes to build the plan up so long as the end result meets the requirements of the act and regulations.

2.5 Strata Title Practises in NSW

In NSW a Strata plan of Subdivision may only be prepared by a Registered Surveyor. More often they are measured by other staff acting under the supervision of the registered surveyor. In the case of a new building the measurement of the buildings and common property usually takes place as the building is nearing completion. Less commonly an existing building may be Strata subdivided for

example the conversion of an old warehouse into residential apartments. The fundamental difference with a regular (Torrens) Subdivision is that the boundaries are formed by the structure of the buildings themselves and as such are not dimensioned on the final plans. Structure boundaries are shown on the plan with a solid thick line and are often referred to by surveyors as thick line boundaries.

The exception to this non-dimensioning rule is where the boundary is formed by something non permanent for example a painted line that defines a car parking space or a timber fence. A fence is deemed not a structure by the regulations and thus requires dimensioning. The term “Line Boundary” or thin line boundary is given to these dimensioned boundaries and they are shown on the plan with a thin line. In this instance dimensions are shown along the strata boundary to enable the reinstatement of the boundary if needed.

Areas shown on a strata plan are approximate only and a statement to this effect should be on all sheets that show an area. Strata areas can be quite different to lease or PCA area. The Lands Department allows a note on the plan to qualify the areas as being for Strata Title Purposes only.

2.6 Strata Title in other States

The methods developed later on in this project are for use in NSW. They should have applicability to measurement in other jurisdictions. In order to test this I have examined the Legislation in Western Australia, WA was selected simply because information was readily available.

2.7 Strata Title Surveying in Western Australia.

Strata Title in WA is controlled by the Strata Titles Act 1985 and Strata Title General Regulations 1996. The 1985 legislation was an update of the original Strata Titles Act legislation introduced in 1966. WA has in addition to standard strata schemes a "Survey-Strata Scheme" A survey strata scheme does not have the restriction that at least one lot have a building on it as is the case in NSW. It is essentially identical to a standard subdivision in appearance. There are however all the other requirements of a strata scheme such as by laws and unit allocations. Services and access ways for example may be shared as common property with the lot owners free to erect their own dwellings on the vacant strata lots. As WA does not have community title legislation survey strata schemes fill the requirements in WA that community or cluster title does in other states.

The WA department of land publishes for the guidance of surveyors a survey practice manual specific to Strata Surveys. This is available electronically from Landgates's website and I have drawn heavily from it to research the requirements for Strata Surveys in WA. The WA manual is more extensive than that provided to NSW surveyors.

In WA the same rules for accountability and accuracy apply to Strata Surveys as do to Torrens (TLA) surveys. This is actually stated in the Strata Survey Guidelines for Surveyors. The recording of field notes is mandatory for Survey Strata Schemes as they are almost identical to a Torrens Subdivision. These field notes must be lodged at the same time as the associated plan. No requirements for the make up of field notes are listed in the Strata Survey Guidelines and no field notes are required to be lodged for a purely Strata plan. Field notes in WA are scanned at A4 size and lodged in PDF format along with the electronic plan. Failure to lodge field notes results in a stop order being placed on the subject plan.

In common with NSW the boundaries for strata lots are the inner surface of the walls, the upper surface of the floor and the under surface of the ceiling. A notation on the plan sheets is required stating this. This may be varied if required for a particular scheme for example in free standing townhouses the structure of the buildings can be made part of the lot and not common property. This is done by altering the above statement in a similar manner to that used in NSW.

2.8 Strata Title Surveying

Currently at my workplace a laser distance meter is used to measure up for Strata Plans. No angular measurements are needed as angles are assumed to be 90 degrees. On those rare occasions where a curved wall is encountered a baseline is laid with a long tape and a few offsets taken to allow for plotting of an arc. The distance meter unit of choice at this time is the Leica Disto D8 as it has an inbuilt tilt sensor and can thus always display a horizontal distance regardless of the slope of the measurement beam.

Field notes are taken onto a clipboard in pencil and usually marked directly onto a copy of the draft strata. A pocket 8 metre tape is used in conjunction with the distance meter for short distances and for measuring wall thicknesses etc.

In NSW measurements are taken to the inside face of the external wall of the unit. Prior to the introduction of the revised act in 1973 dimensions were taken to the centre of the perimeter walls. This practice was abandoned as it could result in parts of the structure being part of a lot. The owner of the lot actually owned half of the perimeter wall. This occurred most often with balconies. The owner would own up to the centre of the wall by way of the internal lot and similarly to the centre from outside due to ownership of the balcony. In the case of a building in which each level was entirely surrounded by balconies it was entirely possible for the entire perimeter structural wall to be part of private lots and not common property. It is easy to see how this could lead to disputes over who pays what in the event of structural repairs being required to a building. The 1973 legislation also introduced the provision that any part of a building that was structural would automatically become common property. When asked by clients what they own I tell them that in relation to home units you own up to and including the paint.

2.9 Equipment

Very little in the way of equipment is needed to carry out a strata measurement survey. The location plan and external boundaries will still require traditional survey using total station techniques. To measure the floor plan part of the survey the only things that are normally measured are distances along the inside face of walls. To do this a simple tape measure is still

effective. A tape will still be needed when using a laser for example measuring distances too short for the laser or for outside measurements where there is no reflective surface to point the laser at.

2.9.1 Laser distance Meters

I first used a Laser Distance Meter in 2002. Prior to that time all measurements were made using an old fashioned tape measure. The first Leica Disto came on the market in 1993 [Leica Geosystems Website] The Leica Disto is now so ubiquitous that the term Disto is used to describe all Laser Distances Meters regardless of manufacturer in a similar way that the name IPod is used to describe all personal MP3 players.

The two methods used by laser distance meters to measure and calculate distance are phase shift and time of flight. The Leica Disto employs the phase shifting method to calculate the measured distance. [Disto Handbook] This technology is more suited to the shorter high accuracy distances that the unit is intended for.

The alternate technology is “Time of Flight” where the return trip time of the Laser pulse is measured directly. The high velocity of light requires the time to be measured very accurately with precision electronics making time of flight measurement techniques unsuitable for a low cost small size consumer device.

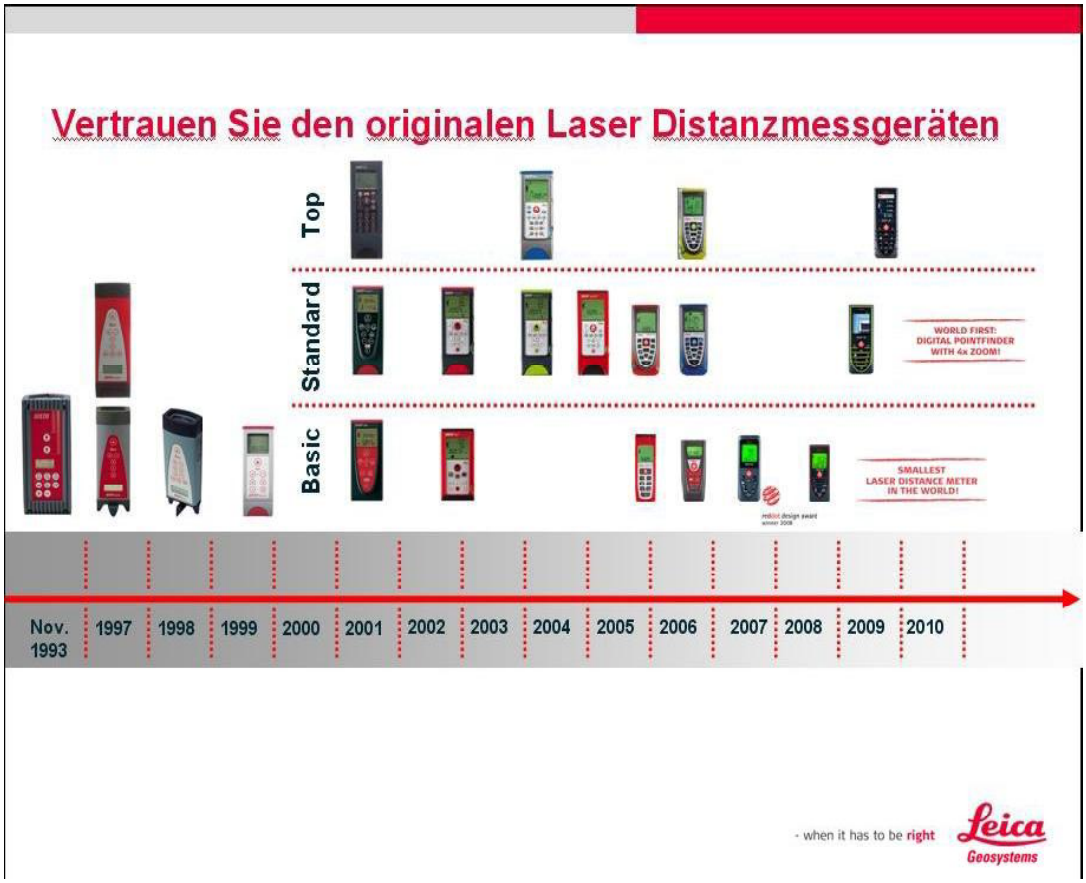

Table 2.2 Leica Disto Time-line Source [Leica Geosystems AG]

2.10 Measurement Techniques

2.10.1 Straight Walls

As mentioned earlier the majority of walls encountered in unit developments are straight. No surprise there. These are measured using the Disto along the inside face of the wall. As strict positional accuracy is not required if an obstacle is along the wall such as a wall unit the dimension can be determined by measuring parallel to the wall a metre or two out from the wall. The D8 tilt function has proved useful for measuring over obstacles along walls such as kitchen cupboards.

2.10.2 Curved and Irregular Walls

Once again as strict positional accuracy is not required I measure curved walls by taking offsets from a base line. These are easily keyed into a cad package and a curve fit routine

used to draw the resulting arc. Walls with angles other than 90 degrees can be measured by taking a few diagonals across the corners of the rooms and plotting in cad later. Non right angles are very uncommon in most Strata Surveys.

2.11 Recording of Measurements.

Data recording is now the norm in most surveying areas. This is not yet the case with Strata measuring. Surveyors still note the measurements onto paper. Current practice at my workplace has us note the measurements onto a copy of the draft strata. This is effective as it saves the surveyor time by not having to draw field notes from scratch. If the building has been constructed in accordance with the architectural plans then only the observed distances need to be noted down. If the building is different from the design then changes are drawn manually on the field notes in red. Some minor changes are found on most projects of any size.

2.12 Processing Field Data and Plan Production.

The current procedure for converting field data to a plan is straight forward. The measurements from the field notes are keyed manually into Terramodel or AutoCAD. As angles are assumed to be 90 degrees the ortho function in AutoCAD makes this a fairly simple task. A calculation model at real world coordinates is produced using the building footprint surveyed using total stations. The calculation model is used to calculate the areas for the final Strata Plan. This is a very manual process and is open to operator error. It is hoped that some of this process can be automated using the methods explored later in the project.

2.13 Digital lodgement of Plans

2.13.1 Current NSW e-plan

The lodgement of completed plans in NSW can be done by either lodging “across the counter” a set of hardcopy drawings and documents or alternatively using the LPI e-plan system. Eplan is simply the lodging of an image of the same hardcopy documents by way of an internet portal. (SIX Portal) E-plan has been in production since 2002. Currently 600 of

NSW 944 registered Surveyors are registered to use e-plan. (ISA-NSW meeting minutes Feb 2011) indicating a 63% uptake of the system by Surveyors. While speaking to the e-plan co-ordinator John Waldren on a different matter he told me that the 50% mark for electronic lodging was reached in September 2011.

The format adopted for the images is TIFF (Tagged-Image File Format). We create the TIFF files using a windows TIFF printer. The software selected by us is PeerNet as it is the product recommended by the lands department. The default Tiff printer in windows does not have sufficient resolution to meet the e-plan guidelines. PeerNet is Canadian in origin and costs about $160 for a single PC licence.

To reduce file size all files are compressed into a single zip archive. Strict file naming conventions apply. At the current time e-plan lodgement is available only to Surveyors. A scan of the administration sheet in Tiff format is lodged with the plans. The original administration sheet bearing the signatures and seals of the owners and interest holders no longer needs to be forwarded to the Lands Department. The lodging Surveyor is required to keep the original documents for a period of 7 years from registration. Original certificates of title must be forwarded to the lands department before registration can take place.

2.13.2 ICSM initiatives towards e-plan.

The Intergovernmental Committee on Surveying and Mapping (ICSM) is a body consisting of the representatives of all Australian State and New Zealand survey regulators together with Federal and Military representatives. Formed in 1988 it oversees national co-ordination and cooperation in the survey and mapping sectors.

ICSM is actively developing a system for future e-plan data. The format selected is LandXML. LandXML is a subset of the “eXtensible Mark-up Language” (XML).Current planning is for LandXML to act as the basis for e-plans throughout Australia and New Zealand. ICSM has now published a national specification document which fully defines every element within the national LandXML schema. [ICSM website July 2010]

As each state jurisdiction has slightly different requirements for Cadastral plans and information a further division of Land XML into Regional Schema has been developed. Each jurisdiction will be free to develop its local formats using a regional schema to vary the main Land XML command set (Schema) to suit local requirements.

2.13.3 Upcoming NSW e-plan developments.

The e-plan portal for lodgement of electronic plans is now in production and current planning is for LandXML files to begin to replace the current tiff image system by the end of 2012. (LPI circular Feb Azimuth 2011). This was original intended for mid-2009 (E-plan circular to Surveyors 2008) The use of LandXML will enable electronic validation and examination of plans using software.

Mark Deal is the LPI e-plan coordinator and he has stated while writing in Azimuth that the current timeline for test lodging by surveyors of LandXML plans is April 2012 with full implementation from late 2012. Testing by the LPI on LandXML plans is currently underway. The second stage system is designated E2 by the LPI. In the first stages surveyors will continue to lodge a TIFF file in conjunction with the LandXML file. Once any problems are ironed out the TIFF image will be discontinued. The administrative information for the plans will continue to be contained on an Administration Sheet in TIFF format. This TIFF file will be lodged along with the LandXML file.

Once E2 is in full production no plan sheet will be lodged either in hardcopy or TIFF format. As cadastral plans form the basis for many other drawings such as service and utility plans a user needing a hardcopy of the plan will be required to generate a plot from the LandXML file using a software tool.

2.14 New Zealand e-plan plan generation tools.

New Zealand has been using electronic lodging of plan data since 1 September 2007.
No images of the primary plan are lodged with a survey. A surveyor is required to import a LandXML version of their survey into a Land Information New Zealand (LINZ) software package and verify his data and plan image either online or with an offline version of the

software. Once the surveyor is satisfied with the files he has prepared the data is uploaded as a package (name.opg) file. This file is later available for download by other users online.

I downloaded the offline version of the software from LINZ's website (www.linz.gov.nz) together with a training set of data. Using the software is straight forward as it is a display tool not a cad package. The data is broken into title and survey information which can be turned off or on in the display panel. At its most basic only a diagram of the subject lot can be displayed with or without dimensions. This would be suitable for example for a solicitor who needed a diagram to accompany a conveyance, he would have no interest in seeing the surveyors traverse marks or recovery marks or the details of the adjoining titles. A surveyor would be more likely to have both the title diagram and survey information layers turned on.

The survey data package file (.opg) used by LINZ is actually a rebadged zip archive. By renaming the supplied example.opg file with a zip extension I was able to open the file using winzip. The contents of the archive were a single xml file which can be viewed in any text editor. The relatively simple 3 lot subdivision supplied as an example contained over 18300 lines of code. This huge file size would rule out manual coding as a means of creating an upload file for even the simplest of plans.

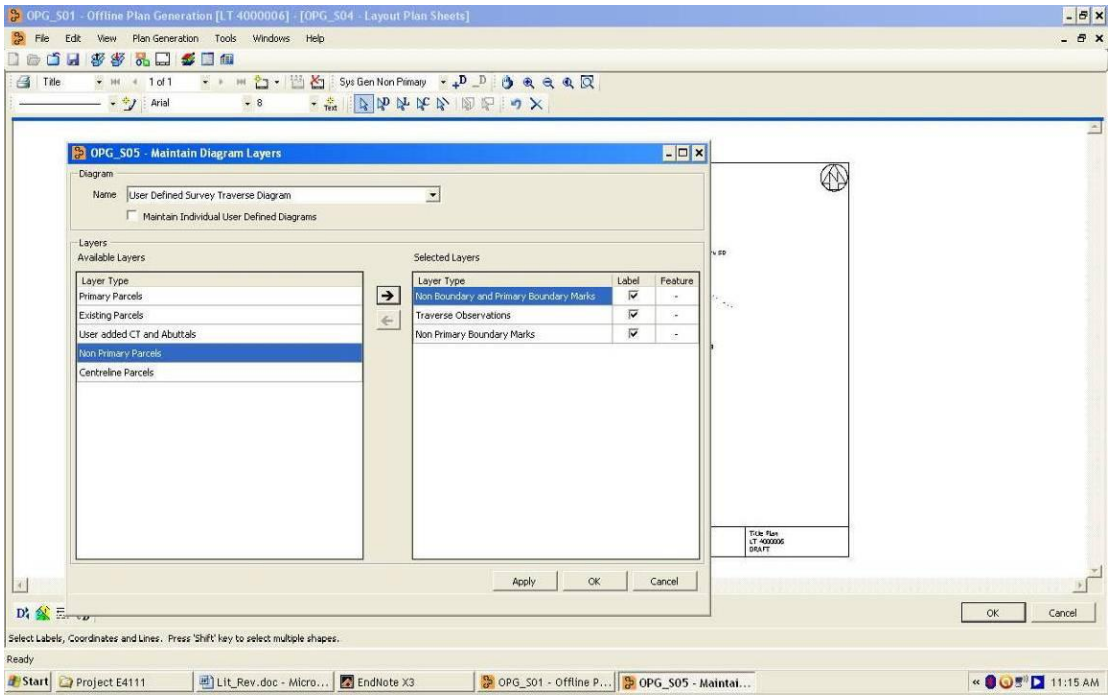

Figure 2.1 LINZ Offline Plan Generation Tool Screen Shot

2.15 Electronic Lodgement of data in Western Australia.

Surveyors in WA have been required to lodge digital survey data since 1995 (Falzon 1998). The format is one developed in WA by the then Department of Land Administration (DOLA). DOLA is now corporatized as Landgate WA. The format is called Cadastral Survey Data Format or CSD for short. A CSD file is a comma separated ASCII file and contains digital measurement data to accompany a survey plan. Prior to Feb 11 2010 it could accompany a hard copy of plan documents. Since then all lodgements in WA are fully electronic. An image of the plan sheets is lodged using a vector PDF image.

Landgate has issued a specification for CSD and convertors are available for major software packages used by surveyors. (White 2009). The format is a simple one as it was developed in the early 1990's. Each line has an identifying record number followed by the data for the record. For example a point is record type 10. The coordinates of the point then follow the record number in csv format. WA is an active member of the e-plan working group but is not currently converting to a LandXML based system. (ICSM 2010). Conversion to LandXML is planned to begin in 2013.

RECORD ID 10 Point Record
Record examples:-
10,1,50123.469,49861.098,456.532,0.020,T,O,,Y
10,2,50617.135,49747.483,256.823,0.001,L,S,"KAL87",Y

Figure 2.2 Example CSD Point Record. Source (Landgate-WA August 2011)

2.16 Advantages of e-plan

According to Pincott writing in The Azimuth May 2011 the advantages of NSW ePlan will be.

- Surveyors will be able to validate their plans themselves for data integrity of the survey information prior to lodgement.
- Speed up checking and time required for registration at the LPI.
- Surveyor can Lodge plans from anywhere using the internet, of particular advantage for country surveyors.
- Eliminate loss or damage to plans and stop unauthorized changes.
- Satisfy requisitions online.
- Track a plans progress online.
- Customized rendering of plans. Simplifies plans with out survey information can be produced for other users such as conveyanceor.
- Data can be downloaded and used by other Surveyors.

2.17 E-Plan and Strata Title

The initial implementation of ePlan will not have the capacity for 3d or volumetric subdivisions according to NSW eplan coordinator Mark Deal writing in Azimuth, 3D plans will be addressed at a later stage he says. As the majority of Strata Plans are multi level they will have to wait a few years before LandXML data can be lodged.

Not all eplan coordinators agree. Cumerford states in his paper at FIG 2010 that the ePlan model has been designed to support 3D surveys which include Volumetric and Strata (Building) surveys. These types of surveys can be prepared with the current protocol but have not been fully exercised he says.

Currently floor plans are simply numbered from ground first, second etc. Reduced levels are not given. The shift to an electronic data model may require that surveyors show a level for each floor adding a degree of complexity particularly if a unit is a split level or has

mezzanine floors. This extra cost will have to be passed to clients on leading to higher cost for unit purchasers when e-plan is fully implemented.

E-plan lodgement using electronic tiff imaging is already available for Strata plans.

2.18 Conclusion

Strata measurement surveys are generally straight forward and often given to the most junior member of staff or reserved for a rainy day. The equipment is straight forward as are the measurement techniques. So simple it seems that the LPI have not felt the need to issue any guidelines to surveyors on how to conduct of Strata Surveys as they have done for Land Surveys.

All this simplicity means that the topic has had little written about it. This does not mean that it can not be done better or quicker. E-plan will soon make the lodgement of plans possible from anywhere even a portable device. The requirement for geometrically correct data in LandXML format to be lodged with e-plan means that accurate measurement and geometric correctness cannot be avoided and will be a vital part of having an electronic plan registered. The use of small accurate measurement and recording devices to measure the data in the field will make this easier for the surveyor.

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Chapter 3 – Methods

3.1 Introduction

The desired outcome of this project would be to replace our current system of manual measurement and note taking with a form of electronic surveying specific to Strata Title. The preparation of a set of Strata Scheme plans requires more than just a measuring of the floor plans. The compilation of the Location Plan on Sheet 1 can only be achieved using regular survey methods and techniques usually with a Total Station. This part of the production of a Strata Plan set will not be examined in this project.

Any electronic system that we select must be able capable of recording in such a way that the data can be used to produce a strata plan that complies with the requirements of the Strata Titles Act as previously discussed in chapter two literature review. The usual requirements for strict positional location and accuracy are not needed in a Strata Scheme Survey nor is it warranted as the structure of the building is in effect a survey monument to where the boundaries are located.

The measurement of the building footprint is currently done electronically as is the preparation of the measurements into a CAD drawing which can then be followed by electronic lodgement of the plans. The measurement of the floor plans component is the missing link. It is still done in a largely manual fashion using pencil and paper. The methods selected will hopefully convert this last remaining area to full automation.

3.2 Research Approach

In order to complete the methods development section of the project the task was broken down into smaller segments. Firstly the different types of measuring and recording equipment required and available on the market were examined. Similarly the various options for software were looked at. Before proceeding to testing I examined the requirements for keeping field notes and the different types of data to be recorded and the options available depending on the style of data recorded.

A spreadsheet was used to test the disto and pocket PC to see if using a spreadsheet was a viable option for electronic notes. It was decided that this method would not result in an easy to use system. Therefore commercially available floor plan software was purchased and used for further testing.

To gain some experience in the use of the selected equipment I tested the system in a non-production environment at our offices. This enabled an idea of the time savings or otherwise to be gained and some initial experience in the use of the equipment, software and methods to be gained before trialiing on an actual job site.

Finally the equipment and software were used on an actual unit construction site to measure a Strata Subdivision. Experience was gained in the techniques required and comparisons made with manual measuring to decide if any advantages were worth the extra complexity introduced by an electronic system.

3.3 Equipment

Any hardware selected for Strata Surveying must be suitable for use in the field thus only battery operated mobile equipment is suitable. Options for pocket PC and Tablet PC were tried out. Other platforms such as apple i-phone, I-pad and smart phones are available but due to them not using windows operating system I have decided not to use them. The software available to me for use at the moment is all windows based so only windows compatible devices will be utilised.

3.3.1 Laser Distance Meters

The Distance meter selected for use must have Bluetooth or wireless transfer capability. As I already own a Leica Disto D8 I used that. The Leica Disto D8 can be regarded as a high end product in the laser distance meter market as it uniquely has a 360 degree tilt sensor. This enables the determination of horizontal distances and vertical distances. For example it has proved useful in the measurement of manhole depths where the belled shape of the manhole has precluded accurate vertical measurements from being taken with a tape or staff.

When used for strata measurement it can be used to determine the horizontal distance where the measured line is not horizontal due to obstructions along the measurement line or cupboards shower recesses etc stopping horizontal measurement. For example the laser dot can be placed over the top of kitchen cupboards up near roof level and a horizontal distance determined.

Figure 3.1 Leica Disto D8 [Photo: Leica Geosystems AG]

3.3.2 Recording Device

If the tape measure has been replaced by a laser distance meter then similarly it can be said that the clipboard and paper have been superseded by a hand held computer. Field data recorders have been in use by surveyors for many years now and the majority of surveyors would be familiar with their use.

The selected device should have the following capabilities.

- Be compatible with the Bluetooth distance meter.
- Be relatively small.
- Be Robust enough for outdoor use on a building site.

Possible Platforms

- Pocket PC e.g. HP IPAQ
- Palm PDA
- Smart phone eg Apple I-phone
- Tablet PC

Possible Operating Systems

- Windows Mobile or Windows CE
- Desk top windows e.g. Windows XP or Windows 7
- Palm operating system
- Google Android
- Apple OS

3.3.3 Downloading and Processing Hardware

In common with the myriad of other field devices available to a Surveyor the selected devices needs to output the field measurements to a PC for further processing and drafting. Special cables are normally required or wireless download is available with some data recording devices. The HP Ipaq I have selected uses Microsoft active sync to Synchronize and transfer data to a desk top PC.

3.4 Software

The various options for Software were explored. The option of writing our own package was to complex and was ruled out early on leaving a commercial software product as our best option. Several different software products were tried out for suitability. Both freeware and commercial products were looked at. The commercial software selected was SiteMaster by Graebert AG.

3.5 Testing

3.5.1 Initial Testing

In order to gain experience in the use of the selected SiteMaster software it was trialled at the offices of Citisurv Pty Ltd. These offices are ideal for testing as they are in an actual strata complex. Five surveyors measured the office using traditional manual methods and then again with electronic methods. A comparison of the results gave an indication of whether electronic recording is a viable option for Strata plans and an estimate of the resulting time savings.

3.5.2 Testing on an Actual Job

Unlike the initial testing at our offices some commercial constraints came in to the trial on an actual job site. As it was a paying job getting the job done had to come first and the trialling and timing was done with what time remained at the end of the surveying tasks. The much larger size involved with the actual job meant that the cost in measuring the site twice in order to compare methods, times and results was too expensive in staff wages and labour.

The software was tested in a similar fashion to the previous trial by measuring units twice and timing the observations. A total of five units were measured twice. SiteMaster measurements were then used to produce a final Strata plan. As expected some difficulties were encountered doing the measure up. These are discussed in chapter five and remedies devised where appropriate.

Chapter 4 – System Development

4.1 Introduction

In order to develop and select a suitable system I first looked at what sort of data we needed to record in order to meet the requirements of a Strata Plan. Was a complicated approach using sophisticated equipment really warranted or could our requirements be achieved using a simple text editor or spreadsheet? The results indicated a spreadsheet could be used in a limited fashion if care was taken. However I felt a better solution had to be found to ensure that the system would be used because it was really a better way of doing things and not technology for technologies sake. I selected a commercial product to advance to a testing phase, the product selected was SiteMaster LT.

Having settled on SiteMaster as a software product the next step was to test it in a non production environment to gain experience in the use of the equipment and software and to attempt to quantify any savings in time by using the electronic systems over traditional methods. The site selected is the office of Citisurv Pty Ltd in Sydney. This office is ideal for the test as it is in an actual Strata Complex and contains several obstructions to direct measurement that require some sleuthing on the part of the observer to collect the correct data.

4.2 Data Formats

Before advancing to far toward our goal of automating our Strata Measuring System it is first necessary to look at and analyse the types of data needed and the ways that data could be recorded and saved.

The *Surveyors and Spatial Science Regulations (2006)* do not mention the style or type of field notes that a surveyor should keep specifically in relation to a Strata Survey however it can be inferred that as the survey is for the production of a Torrens Title plan in the form of a strata subdivision the same regulations will apply to Strata Surveys as do other Torrens surveys.

The section of the *Surveying and Spatial Science Regulations (2006)* dealing with field notes are sections 52, 53 and 57. Any system used for recording our field observations will have to comply with these regulations.

The Surveyors Regulations require that our system must.

- Be able to be printed for signing and dating.
- Maintainable in the format they were recorded.
- Contain all of the information needed to produce the final plan.

The information needed to be field recorded can be further broken down into measured and non-measured data. The non measured data may be either linked to a set of measurements or stand on its own.

4.2.1 Data Types

Stand alone data

- Site details such as Address and Title particulars.
- Job reference number
- Surveyors name and Assistants Name
- Date of Survey.
- Any other miscellaneous Information.

Linked data

- Unit Number or PT identifier.
- Level or floor number.
- Description eg Veranda, Patio, Storage area, Garage.
- Direction clockwise or anticlockwise.

Measurement Data

- Distance
- Direction of turn left or right.
- Angle of turn if not perpendicular.

4.2.2 Text Based Recording

It can be seen that all of the measurements above could be recorded using something as simple as a text editor and a few abbreviations. A spreadsheet application such as Microsoft Excel could be used to record the measurements and could even generate a plot and check the Misclose. The biggest drawback of a spread sheet would be loss of visualization for the operator. A list of numbers is not as easily pictured as a plan drawn on a screen. Locating an error would be difficult with out the graphical interface.

Taking the actual Strata unit measurements shown below as an example job, measurements commence just inside the doorway at the point labelled POB. To some one unfamiliar with measuring strata this seems fairly straight forward. Measure the 12 distances and you are done. If there were no internal walls that would be certainly be true but who has ever seen a unit with out any internal walls? It may take about twice as many measurements and some arithmetic to arrive at the 12 dimensions. This is what makes measuring strata surveying a challenge sometimes. Locating a step in a wall when it is not immediately obvious requires a cautious mind and an observant eye. The draft strata may only be regarded as a rough guide in my experience.

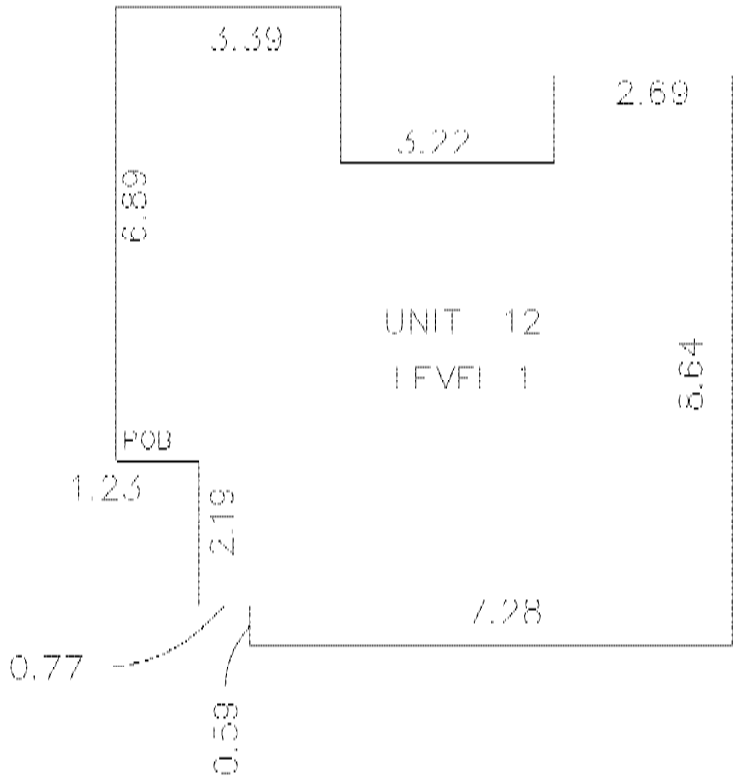

Figure 4.1 Typical Unit Layout.

Data Types- Examples

1. Standalone Data

Job Number 8976
Date 20-03-2011
Operators MM
Site Address 237 Pittwater Road Dee-Why

2. Linked Data

PT 12
LVL 1

3. Measurement Data

Direction Clockwise
POB 500E 500N
Initial Direction 0.0000
6.89
3.39
2.37
-3.22
-1.32
2.69
8.64
7.28
0.59
-0.77
2.19
-1.23
END

This fairly simple example shows that a text editor or better still a spreadsheet can contain all of the data needed to measure and later draw the unit. The example unit has only right angles. Left and right turnings are indicated using the sign of the distance, negative for a left turn and positive for a right turn. The format would need some additional data types added to handle non right angles or circular curves. This particular example building has curved balconies making it a suitable site for testing curved wall measurement methods. I have included the coordinates for the POB. These could be arbitrary and edited later or a more accurate estimate of coordinates derived from the draft strata or field survey of the building.

In order to explore this option a bit further I made up a straight forward traverse spread sheet using Excel and modified it to take only a right angled traverse. The azimuth of the individual lines are determined by multiplying the sign of the entered distance by 90 degrees. This makes the recording of the direction unnecessary in the field. The spreadsheet will show the operator the area and easting and northing misclose as he goes along. By using excel's grouping and outlining features the intermediate calculations are not visible in the field. This is an advantage considering the small size of the screen on the pocket PC. I made up the spreadsheet on a desktop PC and transferred it using Activesync to the pocket PC. Excel mobile has a limited subset of the desktop software's functions. Macros for example are not supported. The full spreadsheet is shown in figure 3.4 below.

Job No	8976
Date	5/05/2011
Unit ID	12
Level	1
POB East	100.000
POB North	200.000
Azimuth 1	0.0000
No	**Measured**
1	6.890
2	3.390
3	2.370
4	-3.220
5	-1.320
6	2.690
7	8.640
8	7.280
9	0.590
10	-0.770
11	2.190
12	-1.230
13	0.000
14	0.000
15	0.000
16	0.000
17	0.000
18	0.000
19	0.000
20	0.000
Length	40.58
Area	**78.73**
Delta East	**0.02**
Delta North	**-0.02**

Abs Dist	Sign Dist	Azimuth	DE	DN	East	North	Areas
			0.00	0.00	100.000	200.000	0.00
6.89	1	0	0.00	6.89	100.000	206.890	344.50
3.39	1	90	3.39	0.00	103.390	206.890	-350.68
2.37	1	180	0.00	-2.37	103.390	204.520	-122.52
3.22	-1	90	3.22	0.00	106.610	204.520	-329.28
1.32	-1	0	0.00	1.32	106.610	205.840	70.36
2.69	1	90	2.69	0.00	109.300	205.840	-276.85
8.64	1	180	0.00	-8.64	109.300	197.200	-472.18
7.28	1	270	-7.28	0.00	102.020	197.200	717.81
0.59	1	0	0.00	0.59	102.020	197.790	30.10
0.77	-1	270	-0.77	0.00	101.250	197.790	76.15
2.19	1	0	0.00	2.19	101.250	199.980	110.87
1.23	-1	270	-1.23	0.00	100.020	199.980	122.99
0	0	270	0.00	0.00	0.000	0.000	0.00
0	0	270	0.00	0.00	0.000	0.000	0.00
0	0	270	0.00	0.00	0.000	0.000	0.00
0	0	270	0.00	0.00	0.000	0.000	0.00
0	0	270	0.00	0.00	0.000	0.000	0.00
0	0	270	0.00	0.00	0.000	0.000	0.00
0	0	270	0.00	0.00	0.000	0.000	0.00
0	0	270	0.00	0.00	0.000	0.000	0.00
					100.000	200.000	0.00
40.58			0.02	-0.02			-78.73
						Absolute	78.73

Figure 4.2 Pocket PC Spreadsheets.

I loaded this spreadsheet onto the pocket PC with the right hand side cells hidden using the grouping and outlining tools. Pocket excel does not have outlining but the imported

spreadsheet still hid the cells in the same way as the desktop version. The spreadsheet is saved as a template and has space for 20 lines.

In the example measurement unit lines 13 to 20 are not needed. After keying in the readings I hid the unused lines. This made the spreadsheet easier to read on the small screen of the pocket PC. The zoom functions were particularly useful when trying out the spreadsheet. I found that 150% zoom allowed eight lines of data to be displayed and was clearly visible as lines were added.

The limited command set of the mobile version of excel mean keying something like this spreadsheet in by hand on the pocket PC would be some what tedious. Twenty lines should be sufficient for most projects. The auto fill function is not supported in mobile excel either so adding a line is not as simple as on a desktop. I feel it may be necessary to have templates with 10, 20, 30 lines saved on the pocket PC and chose the appropriate one as needed at each new unit.

The Disto D8 bluetooth transfer functions are able to fill in the measurements in the spreadsheet as they are taken. An added function of the Disto is a set of arrow keys that can be used to navigate around the spreadsheet with out having to use the stylus on the pocket PC. There is then no need for the operator to put the disto down to operate the spread sheet. I was able to move around the spreadsheet using only my thumb to press the arrow keys on the Disto. Each directional key stroke is echoed in the spreadsheet.

I also tried adding a plot of the measurements using an excel chart to the spreadsheet but the small screen size and limited functionality of mobile excel lead me to decide this option is not worthwhile. In any case the chart was only visible when the data used to make the chart was also visible As I hid the coordinate cells to reduce size the spreadsheet on the Pocket PC the chart appeared empty. If time permits I will return this idea. The final spreadsheet on the Pocket PC looked like this.

Job No	8976
Date	5/05/2011
Surveyor	MM
Unit ID	12
Level	1
POB East	100.000
POB North	200.000
Azimuth 1	0.0000
No	MEASURED
1	6.890
2	3.390
3	2.370
4	-3.220
5	-1.320
6	2.690
7	8.640
8	7.280
9	0.590
10	-0.770
11	2.190
12	-1.230
Length	40.58
Area	**78.73**
Delta East	**0.02**
Delta North	**-0.02**

Figure 4.3 Unit Measurements on Pocket PC

Figure 4.4 Spreadsheet at zoom 150% and Disto in use.

Having recorded the data into the field spreadsheet on the pocket PC I then used Active-sync to transfer the completed sheets onto a desktop PC. Getting the points into Terramodel was done by first opening the spreadsheets in Excel and cutting and pasting the co-ordinate fields into a text editor. These can then be imported to Terramodel using the ASCII import and stringing functions.

Using a spreadsheet for data recording was relatively straight forward and required no new software or training. Everything used was familiar already and I feel that with a bit of practise this method would be faster than taking down field notes by hand. The major drawback is the lack of a visual reference for the operator. Some time was saved over manual entry for processing the data. The removal of manual recording does however remove any chance of a transcription error and the Misclose is shown immediately the unit measurement is completed thus saving a few minutes of on site check calculation time.

4.2.3 CAD Based Recording

The alternative to a text based system is to use some type of Cad software to draw the plans on the fly in the field. As a final plan is needed in any case drawing the units as they are measured in an electronic format would save time in the later stages of drawing up the plans.

The production of even a very simple cad package for pocket PC is no small under taking and beyond the scope of my abilities and of this project. Accordingly I have looked to commercially available software for a suitable product. The individual products are discussed later in this chapter.

Any software that is used will have to either record in a format that is readable by our cad software or have the ability to export files in a format that can be read by the follow on software packages. A common format that has been around as long as I have been using cad software is Autodesk DXF format. This format is an ASCII text format that when read by a program will recreate the original drawing. It can be read by both AutoCad and

Terramodel and supports co-ordinate based measurements. Ideally any package that is used should be able to read and write DXF files.

When I trialled the text method above the individual measurements were recorded and a print out of the spreadsheet would be adequate to meet the field noting requirements of the Surveyors regulations (Section 53). They can be printed, signed and dated and the measurements that were taken are self evident in the spreadsheet.

If using a cad product the measurements are converted to a polyline, setline or similar by the software and while the distance can be queried on the screen it is not immediately visible. Two possible solutions come to mind. The first would be to dimension the lines as they are taken on the screen of the pocket PC. This adds to the workload in the field. The second is to use a macro or similar function to print a report of each unit. This could then be signed and dated as the official record.

As a product specific to Strata Title measurement is not available a software product aimed at another discipline will have to be used. If the dimensions can be shown graphically as they are measured and then the view printed this will meet the field note regulations. It

must be said that all the regulations can be met simply by using a pencil and paper. To make electronic recording worth while it must be either quicker or easier. If the process is not easier in the field then the advantages will need to lie in the follow on tasks of preparing the final drawings from the field measurements. If no advantage can be found there then pencil and paper will remain our best option.

4.3 Hardware Selection

I first used a laser distance meter in 2002 and the cost like most technologies has come down since that time to the point that I now occasionally see tradesman using them on building sites. A basic laser device now costs under $200. It is the addition of a wireless bluetooth connection to the distance meter enabling connection to a recording device that opens the way for this project. The Leica Disto D8 with its bluetooth capability is eminently suited to use in an automated strata scheme measuring system I decided to use the Leica Disto D8 as

the laser measuring device for this project principally as I owned one already. Other distance metres were available that would fulfil the role required.

In order to move forward I needed to acquire the PC component of the recording system. This project is not about finding the best possible equipment but about evaluating if electronic measurement is worth while and getting some processes that actually work together. I decided to purchase on e-bay some second hand gear and put that to use.

To that end I went online and was able to buy with out much searching an almost unused HP Ipaq 240 for $210 and a slightly battered Panasonic Tough Book for $800. Added to this are a Leica Disto D8 and a wrist mount for the Ipaq purchased from Laser Tools in Perth online. The necessary cables and some transfer software came with the pocket PC. All transactions took two weeks to complete. Total spend including the D8 was $2100 for hardware.

Figure 4.5 Wrist Mounted Pocket PC with Leica Disto D8.

4.4 Software Selection

As the measurement of Strata titles is a small market I have been unable to locate a software package that is specific to strata plan measurement. Numerous products are available commercially for other disciplines.

Examples include:

- Tradesman usage eg Carpet, floor tile estimation
- Valuation tools for measuring floor area.
- Architectural measurement.
- Facility and building management products.

I next looked to find a suitable product for either the Pocket PC or the tablet PC. The choice came down to either a special product designed for the purpose or using a CAD program to draw the plans as I went along in the field instead of later on back at the office. My initial preference was for a cad program as I own several licences already and would save money not having to purchase some more software.

4.5 Software for Tablet PC

It would be tempting to think that any product that would run on a desktop would also be suitable for use on a tablet in the field. This may not always be the case. A tablet PC uses a touch screen as its primary input and any software must be able to handle this type of interface. There is no mouse for instance.

At the moment we operate two CAD products. Firstly for survey calculation and basic CAD functions Terramodel is used. AutoCAD 2009 LT is used for the polishing of drawings and final presentation. Strata Title areas are calculated in either package.

Both Terramodel and AutoCAD LT will run in tablet mode. I installed both onto the Tablet PC for the initial testing stage.

4.6 Leica Disto transfer software for Tablet PC

Included with the Disto is a small transfer program for both PC and Pocket PC. There is also a utility for embedding the Disto measurement functions into AutoCAD and BricsCad. These proved to be easy to install. As I had never installed software onto a pocket PC there was a small learning curve. Software for pocket PC comes as either a cabinet file which is transferred to the Ipaq and then unzipped on the device or a Desktop program that runs the installer automatically. Both Systems were used by the various programs I looked at.

My laptop has a blue tooth port I tried the PC connection option first. Installation was straight forward and the first time I ran the program it informed me a newer version is available online. It must there fore have an online checking function for new versions. I then needed to pair the D8 and the Laptop. This too was trouble free as is not always the case. Once started the software immediately recognized the Disto and opened the following window.

Figure 4.6 Leica Transfer Utility

The software leaves this interface open while any other program that may be running such as Excel will be able to access it. The values shown above are echoed into the Excel sheet at the current cursor location. The program also supplies some more advanced features and the ability to log and then save successive measurements including continuous measurement. If only it had an electronic compass fitted then it would essentially be a hand held total station. The logging screen is shown below, angles are measured from the horizon not the zenith. The data fields are customizable. The three soft buttons at the base of the window can be used to operate the Disto in remote mode. The alternative is to measure the distance on the Disto and press the blue tooth send key.

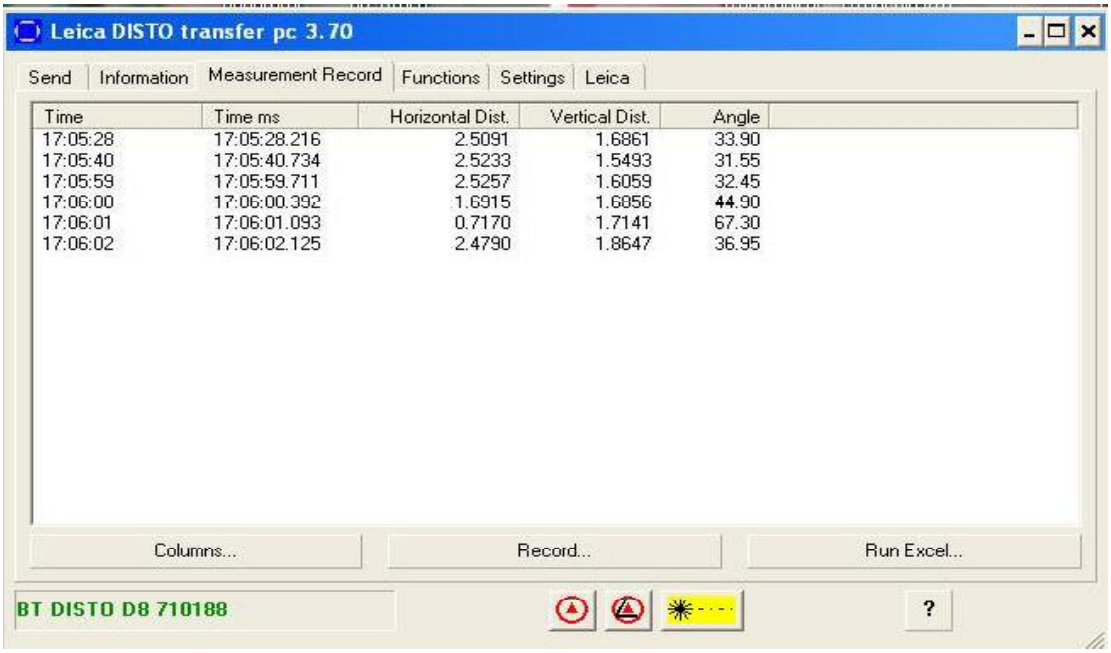

Figure 4.7: Leica Transfer Software

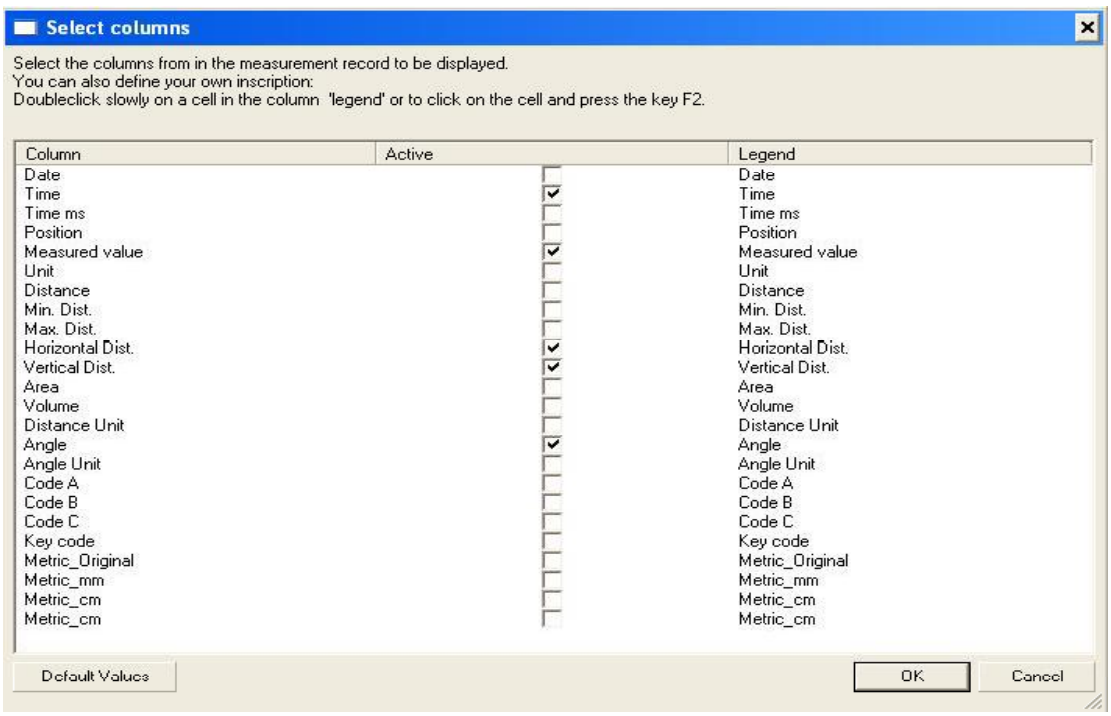

Figure 4.8 Showing customizable fields for the Disto D8

4.7 Software products for Pocket PC

A few hours spent online resulted in the download of several cad packages for pocket PC. Most are commercial products aimed at disciplines other than surveying. These products usually have either a time limited or cut down Demo version available which I downloaded and put on the Ipaq. Some of these packages have been around for some time and have not been updated for a few years. This indicates to me that the pocket PC may be being superseded by mini-tablets and smart-phones. For example the demo version of PocketCad was released in 2006. In addition a few free-ware products were found. Most proved to be worth the price I paid. An exception is ShortCad for Pocket PC which is a reasonable but incomplete cad drafting package.

Pocket PC Payware demo versions downloaded and trialled were:

- Orthograph Survey — Architectural floor plan software from Hungary.
- PocketCad — PPC Cad software from the USA
- Apex Mobile-Sketch — Floor plan drawing software from the USA
- PenMap Floor planer — Floor plan drawing software from the UK
- SiteMaster LT — Floor plan drawing software from Germany.

Pocket PC FreeWare downloaded included.

6. ShortCad for Pocket PC. — A general cad program for pocket PC.
7. Geoproject — Floor area measuring program of Italian origin.

4.8 CAD Products for Pocket PC

4.8.1 PocketCad

This product is a miniature cad package of American Origin. I was able to download the demo version from their website. The program itself has the feel of a cad package with layering and icon controlled drawing functions. It came with some impressive examples which I can't help thinking were drawn elsewhere than the tiny screen of a pocket PC.

There is no native Disto support so I used the generic interface program. Drawing a line at a set bearing and distance involved a two stage process of first tapping the toolbar and then tapping a line dialogue box to get to the entry fields. The Disto would fill in the distance with out problems. The whole procedure involved a lot of tapping on very small icons and would be infuriating in a field situation.

PocketCad uses native DWG as its format and comes with a desktop interfacing program to move drawings up and down from the pocket PC. It lacks a perpendicular snap which would be useful for drawing Strata buildings. Amongst the angular settings is the option for angles to be entered 360 degrees clockwise as surveyors require.

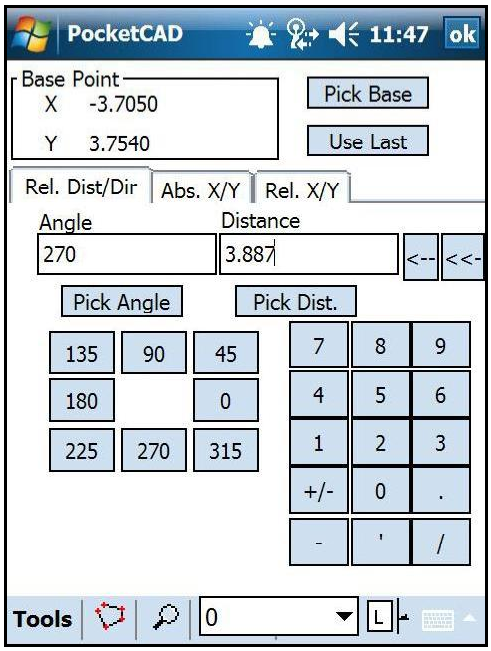

Figure 4.9 Pocket Cad Entry Screen

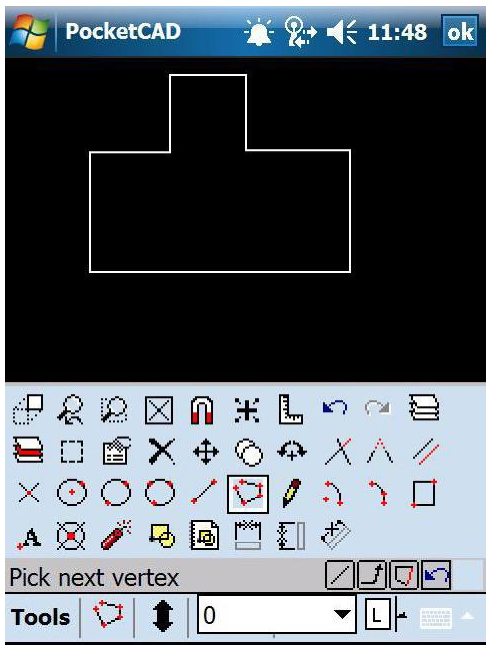

Figure 4.10 PocketCad Toolbar & Cad Screen

I found that the procedure for entering distances is simply too complex to make PocketCad a viable option for a field recording software. The frequent need to tap on the screen to complete drawings also makes field use impractical.

4.8.2 ShortCad Lite for Pocket PC

This is a freeware package for pocket PC of Ukrainian origin. All commands are implemented in English however. There are 68 cad functions operated by clicking on icons. Notably there is no extend command although trim is supported. Similarly there is no offset command. Recently used commands are placed on a toolbar at the base of the cad screen which helped too speed drawing up. I was able to interface with the Disto via the generic utility.

There was no setting available to change the angular entry method away from the default. Angles are entered annoyingly anticlockwise with zero to the right hand side of the pocket PC screen. This is standard for Cad packages and is modifiable in AutoCAD. I would have preferred to be able to have north up the page and 360 degree angles.

A major feature of ShortCad is the ability to write your own commands. These are implemented using Java Scripting. I had initially hoped I could write a simple script for use in Strata Surveys. The supplied examples show that this would be a major undertaking. The Java script for drawing a very simple circular flange was 550 lines long. This number was including many comment lines in the script.

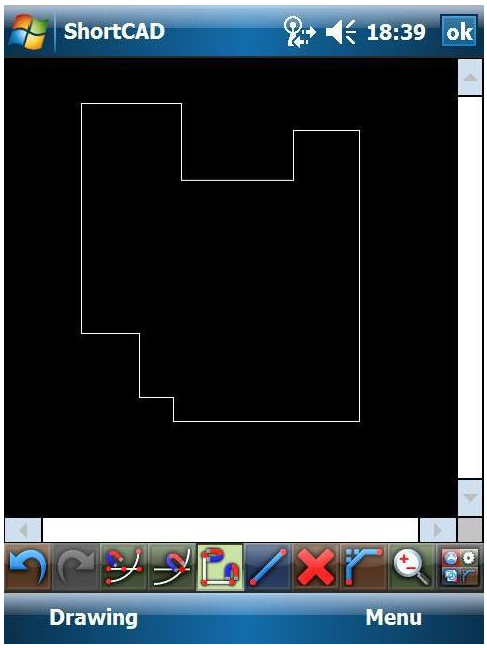

Figure 4.11 ShortCad Cad Screen

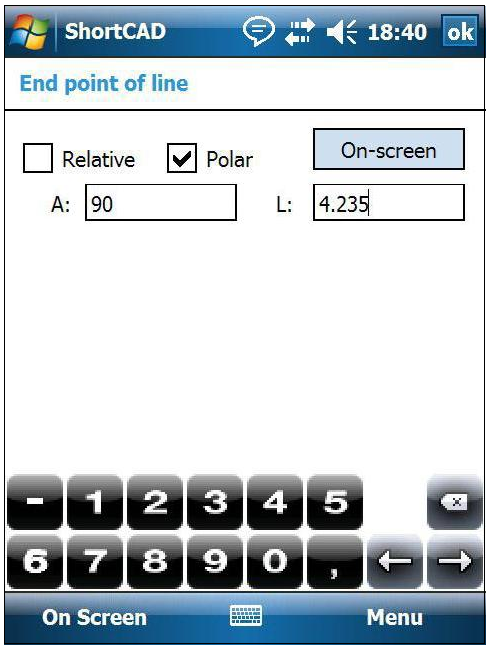

Figure 4.12 ShortCad Data Entry

Note: Distances are entered directly from the Disto D8.

This software was easy to use and is being continually updated by its developer. I can't help thinking that a Payware version reasonably priced could give the developers the resources to complete the software. The need to constantly click on the screen with a stylus would make field use trying. For a surveyor with Java Script programming ability it could be a useful tool.

4.9 Specialist Products for Pocket PC

4.9.1 Apex Mobile-Sketch

This program comes out of the USA and has an Australian Version. It is marketed in Australia at a cost of $270 for pocket PC. The target market is valuers and real estate agents. It interfaces with the Disto using bluetooth. I tried the download version for free and needed to watch the tutorial video in order to get it to work. It has its own Disto interface as opposed to the all purpose program I used with the spreadsheets earlier.

Operation in measurement phase is purely one handed using the arrow keys on the Disto. The terminology used was very American. The demo version does not come with any desktop software to view or critically to convert the measure up to a DXF or similar format. I found myself often needing to hit escape and the Pocket PC locked up at one point while using it. No data however was lost when I restarted the software.

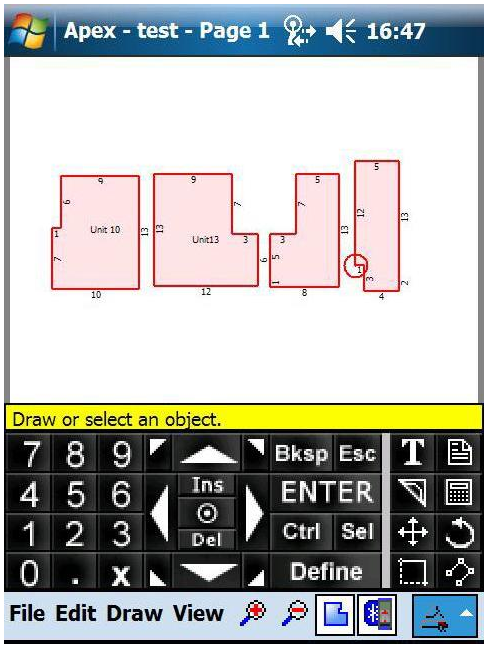

Figure 4.13 Apex Mobile Sketch Screen Dump

Overall I thought it was a fairly basic product and would need a bit of practise to be useful in a work situation. Price is reasonable compared to Orthograph.

4.9.2 Orthograph Survey

Orthograph Survey is part of a larger software product aimed at building managers. It has the ability to inventory furniture etc as well as measure up the buildings. If wall heights and window sill and head levels are also recorded it has the ability to create a 3d model compatible with Archicad and AutoCAD. The software comes from Hungary and is valued at 1800 Euros, currently about $3000. It also has compatibility with the Disto and I was able to download a 30 day trial version.

The management and inventory origin was evident when I tried the trial version. Each room or unit needed a small information form listing owner address and other details filled in before it would allow me to start drawing. Leaving these blank is not an option it would accept. Buildings are drawn by first drawing the shape roughly to scale freehand on the screen and then editing the line work to its actual length. This seemed a long way around to me. It also requested diagonal measurements across rooms allowing non perpendicular buildings to be drawn by distance intersection. Doors windows and furniture can be added which is totally unnecessary for a Strata measure up. The software stores drawings in a

folder system similar to windows explorer. Individual units can be turned off to declutter the screen. I found it unintuitive to use and some training would be needed to get the best from it. A few video tutorials are available on Orthograph's website and they were a big help in getting it to work at all.

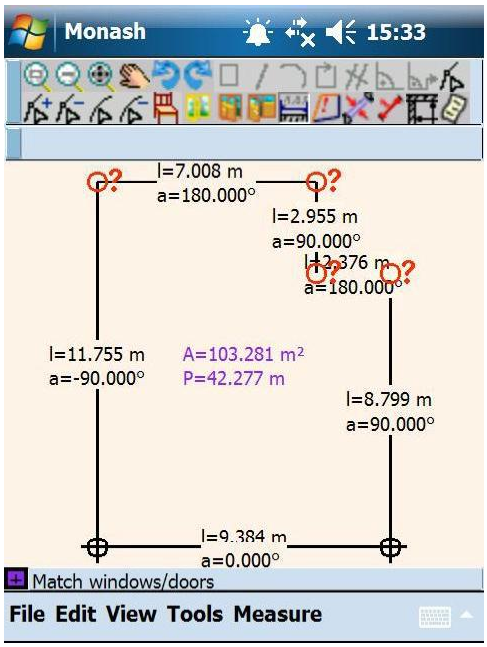

Figure 4.14 Orthograph Surveyor Screen Shot

Overall Orthograph looks and feels like a high end product with matching desktop software included. It is the most expensive of the products I looked at. Many of the features are unnecessary for the measurement of Strata buildings. Training would be a must if you invested the $3000 for the full product.

4.9.3 PenMap Floor planner

A British origin floor plan drawing product aimed at Surveyors. I downloaded a 10 day evaluation version. Like Orthograph it also uses a sketch then edit method of data entry. There is no built in Disto support but I was able to use the generic transfer utility to get distances into the cad area. This worked very well.

Individual rooms or units are drawn and then checked for Misclose, they are then joined to form a floor. Units are linked together by using the doorways. For example you would draw up the corridor and lift lobby for a floor and draw in the door openings.

Next draw each individual unit and balcony, patio etc and add the door openings. Following that you go to the linking option and select 2 areas to be joined. The software will highlight the doorways and if there is more than one opening in each unit you simply select the next option to cycle through the different permutations until you find the correct one. See figure 9. Door ways must be identical in width to be linked. The incoming area is automatically rotated to match the previous selection. Cost is £199 UK currently about $280.

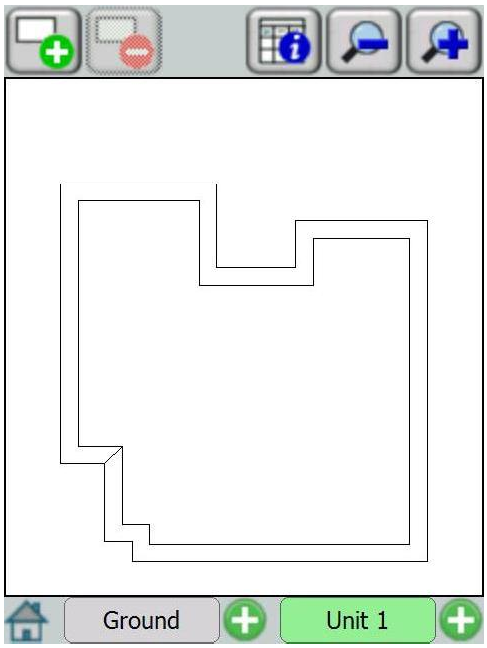

Figure 4.15 PenMap cad screen for a single unit

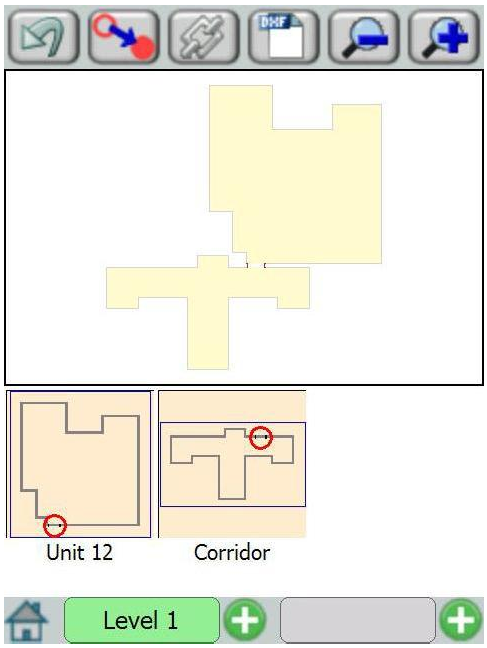

Figure 4.16 PenMap Linking Screen Unit and Corridor are linked.

I found this program surprisingly easy to use. It has a dxf export option which imported to Terramodel exactly as shown on the PDA. The doorways were open gaps in the DXF model so an area calculation was not possible in Terramodel without some further cad work. This program would definitely do the job but extra work is required to measure the openings in the field and close them in the office. Completed units can not be edited on the pocket pc and it lacks support for real world coordinates. Price is similar to Mobile-Sketch.

4.9.4 Geoproject for Pocket PC

Geoproject is a floor plan measuring program from Italy. It is freeware although you are required to register first and then Geoproject will send you a download link. Like Orthograph it also uses the sketch then correct technique for dimensioning the walls. The drawing interface was easy to use. Walls are dimensioned in text as you go.

The program has no Disto interface so I again used the generic transfer utility. The metric unit default is centimetres which necessitated changing the measurement style on the Disto to metres with 2 decimal places. The Geoproject software then interpreted this as centimetres.

To draw a wall you simply drag the stylus to the length required. The correction part I was unable to complete. Correcting a length always resulted in a wall going out of square. In short it simply did not function in the way that the well written PDF Manual said that it would. DXF export is supported.

I decided to move on and come back later if time allowed. It didn't.

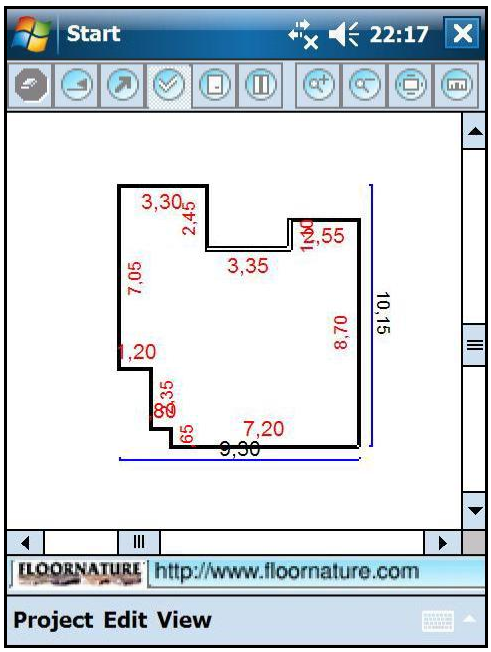

Figure 4.17 Geoproject Cad Screen

4.9.5 SiteMaster Building LT

SiteMaster Building LT is a floor plan creating software from Germany. It is one module of a larger package that includes total station interfacing for other survey tasks and photogrammetric measurements. The Australian agents are MAPC at Newcastle and they supplied me with a one month trial version. Cost in Australia is $600. Versions of the software are available for both pocket PC and Tablet PC. I downloaded a demo version of the tablet version from the UK agent's web site as well. The download package comes with a list of you-tube videos that act as tutorials. I watched the first couple and was able to operate the software straight away.

SiteMaster interfaces directly with the Disto and the instrument can be operated in remote control mode directly from the pocket PC. Data entry was similar to Apex Mobile Sketch with an arrow keypad for direction. Using the bluetooth second function keys distances are measured and the direction taken from the keyboard of the Disto allowing one man operation. Notes can be inserted at a flagged location as the plan is drawn.

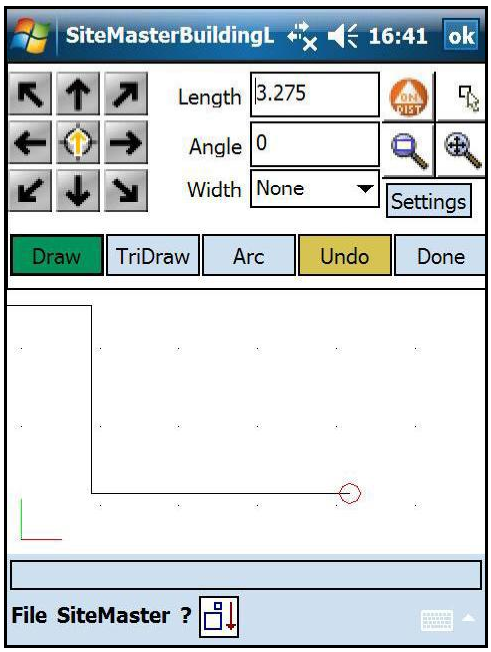

Figure 4.18 Measurement Entry Screen

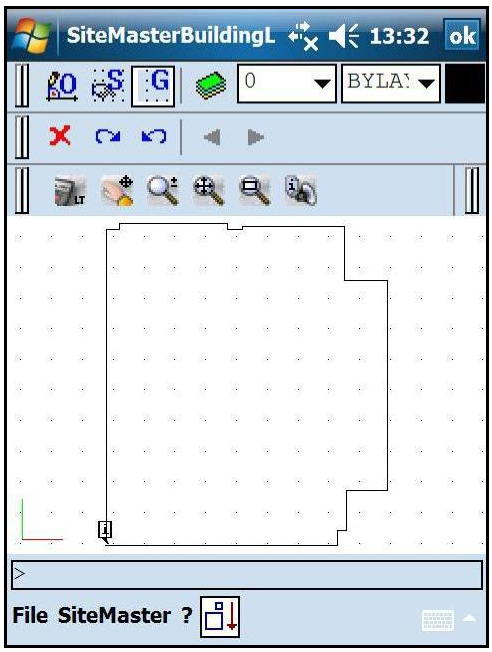

Figure 4.19 Completed Unit Plan

In a similar fashion to PenMap units or rooms are linked together using the door openings. The operator specifies the location of the opening and then a left and right dimension for the next unit along with a wall thickness. This then draws the first wall of the next unit automatically and so the measure up continues. The agents claim production rates of a 1000 square metres per day per operator for a full building plan including doors windows and furnishing. Taking into account that a strata plan requires no internal walls, windows or furnishing a much higher rate could be expected.

I tried the software by measuring up my office in a strata complex. I found it easy to use but there remained numerous icons for features I had no idea the function of. A draw back of the demo version is that you can not save anything. Once the software is exited all data is lost. As a businessman I find it difficult to assess a product I can only half test.

Uniquely for the products I looked at you can hire the software on a daily basis from the UK agent. Cost was about $100 per day. A time limited unlock key is supplied and the product useable for the prepaid duration. For a business who need this capability only occasionally or an increase in operators to cover a one off large job this might be attractive.

I was unable to save my measure up so I could not test the export ability. If the PPC has an internet connection and email a software option allows the file to be sent to the office from inside the program. The only other export function is DWF format. DWF to DWG convertors can be downloaded for free from Autodesk.

This product seemed to be the most polished of the ones I looked at and would be my choice to purchase for a Pocket PC.

4.10 Terramodel and AutoCAD on Tablet PC

A tablet PC is essentially a Laptop PC minus the keyboard, monitor, mouse etc. A popular brand for outdoor use is the Panasonic Tough-Book. The Tough-Book is a ruggedized laptop that can be converted to a tablet by rotating the screen 180^{o} and locking it to the laptop body over the keyboard. You thus get two devices for the price of one.

I used a Panasonic CF-18 Toughbook PC that I purchased on eBay to try out floor plan measuring on a tablet PC. The Toughbook did not have a bluetooth port as it was not standard in Laptop computers when the device was made in 2007. As the CF-18 is out of production I located an aftermarket card in Norway on eBay and to my dismay needed to dismantle the computer to install it. The bluetooth card is linked into the computer mother board using an internal ribbon connector. The operation fortunately proved to be relatively straight forward for an amateur technician.

The Toughbook as the name suggests has a sturdy alloy casing and is held together by numerous screws. It can survive a 60 inch drop and has a heavily cushioned hard drive installed. It can be used conventionally as a laptop with a keyboard or the touch screen unlocked and rotated 180 degrees then locked down to turn it into a tablet.

Terramodel support at Geocomp assured me I could use Terramodel on a tablet PC. This proved to be correct in so much as it did work on a tablet. A tablet PC has only a touch screen and a stylus for input. A keyboard can be emulated using a software keyboard. Terramodel usage depends largely on mouse selections and the absence of a mouse while in tablet mode made using the software difficult.

In tablet mode a left mouse click is emulated with a stylus tap on the screen. A swift double tap is designed to emulate a double click on a mouse. This worked well while on the windows desktop in windows XP. It did not work inside the Terramodel software or inside AutoCad software. The single tap left click did work reliably. I was able to use the incredibly tiny left right switch button in the system tray taskbar to initiate a right click. To do this needed a stylus input. Experience with the other products so far suggests this to be impractical for field use. The Toughbook is too large for a wrist mount so 2 hands were needed when doing stylus entry. This means the disto must be put down or in a fieldbag while using the stylus.

Connection to the Disto was accomplished by use of the generic software as previously used. I tested several line drawing commands. Lines joining points is the most common method used to draw shapes in Terramodel. This proved difficult in the mouse-less tablet environment. Polylines do not have points at the vertices and were a little easier to use.

The major difficulty was the need to use the stylus to advance from the bearing to the distance input fields during data entry. Remember the tablet is balanced on one hand and the stylus and Disto in the other.

A Terramodel command especially designed for building entry is BLDG. This draws a polyline with only right angle corners. A left turn is initiated with a negative distance as used in the earlier spreadsheet testing. As with then the need to enter the minus sign with a stylus would make the command tricky to use in the field.

The Toughbook has windows XP as the operating system. The newer windows seven operating system in tablet mode uses push and hold to emulate a right mouse click. This would be easier to operate than the small system tray icon used by XP. The problem would still remain that the operator has to put down the Disto in the field in order to operate a stylus on the tablet.

I also tried AutoCAD LT on the tablet and the same problems that made Terramodel impractical also held true for AutoCAD. Drawing a line in AutoCAD at a bearing and distance is difficult enough with a keyboard. Without one proved infuriating. To draw a line 10 metres long due west the command line is @10<270 assuming angular units are north clockwise. While this can be done using the soft keyboard it is time consuming and difficult while holding the tablet in one hand and the Disto in the other.

SiteMaster had a download version of their floor plan software suitable for tablet PC use on their web-site. I downloaded this as well as the PPC version of SiteMaster. The tablet version worked well and was essentially identical to the PPC version I had tried earlier. It worked with the arrow keys on the disto and was usable in the test at the office. I also liked the larger icons of the tablet version.

The two products are virtually identical and I could see no reason for testing both seeing that the software is a $500 investment. The extra size and weight of the tablet lead me to select the PPC version for purchase and further evaluation.

4.11 Initial Testing

In order to test the system I had several operators measure the office unit including myself. The operator first measured the office unit using only a Disto, tape and pencil and paper. The times taken to measure the unit and then key it into the cad programme were recorded. The process was then repeated using SiteMaster.

There is obviously some bias in favour of SiteMaster as the second time around the operator will know where the changes in direction are. In order to gain as fair as possible estimate of the time savings I asked all participants to act the second time as if they were measuring afresh.. That is if a wall width was needed then it had to be determined again not merely by memory from the previous run. To further reduce bias we did the two different measure ups a week apart.

In the case of the electronic recording I included both downloading and import in the data entry times. SiteMaster uses a proprietary recording format with an .FLX extension. The software has a save-as export function and the floor plans were exported to DXF format on the PPC device. Down loading consisted only of cutting and pasting the file to a directory on the PC using windows explorer. This DXF file was then imported into Terramodel to form the basis of a calculation model.

While SiteMaster is fairly easy to use I could not expect that the operators would master it immediately. Training consisted of me setting up the files and the bluetooth connection and a run down on how to enter the measurements. Each operator then measured a few walls under my guidance before doing the timed test. As I had already had several hours of practice at the programme I expected I would produce the quickest time for SiteMaster. This was not the case. For the other operators I did all of the transfer and saving functions. Naturally when the operators have gained experience times would fall on both techniques old and new.

Results

Operator	Years Experience	Method	Measurement Time inc Checking Misclose	Data Entry Time	Total Time	Remarks
MM (Surveyor)	27	Paper Notes	23:40	5:02	28:42	Plan correct and misclose checked OK
		Site Master	15:05	2.50	17:55	Results almost identical to Manual Measurements.
TS (Registered Surveyor)	54	Paper Notes	18:16	5.00	23:16	Plan Correct and misclose checked OK. Only operator who measured free standing columns.
		Site Master	NA	NA	NA	TS doesn't use those new fangled computer things.
JC (Draftsman)	10	Paper Notes	12:29	0:51	13:20	Plan Correct & misclose checked OK. Used AutoCAD not Terramodel to do data entry
		Site Master	07:56	1:20	9:26	Imported directly to AutoCAD not Terramodel.
GM (Surveyor) Attempt 1	25	Paper Notes	06:15	4:05	10:20	Plan totally wrong and no Checks carried out. Return visit would be required on a real job. Missed some common property and a wall step
TV (Surveyor) Attempt 1	2	Paper Notes	11:00	NA	NA	Plan had errors and yet checks showed no misclose Inexperience shows up.
GM (Surveyor) Attempt 2	25	Paper Notes	15:03	13:18	28:21	Made a mistake during data entry and took time to find it.
		Site Master	13:10	3:00	16:10	
TV (Surveyor) Attempt 2	2	Paper Notes	16:00	5.00	21:00	After some training from JC, TV remeasured the unit resulting in a correct plan
		Site Master	14:00	3.00	17:00	
Average Surveyor	23	Paper Notes	17:05	5:50	22:52	
		Site Master	12:32	2:32	15.04	

Table 4.1 Initial testing Results

Notes

1. TV kept his times to the nearest minutes only.
2. Batteries on Disto went flat on MM's first SiteMaster measure up.
3. TS did not do any computer or CAD work.
4. GM and TV first attempts not included in manual average.

4.12 Analysis and Discussion

4.12.1 Manual Methods

This exercise demonstrated as much about the operators' attitude as about the methods used. At the moment operator MM is the surveyor who usually does the strata measurements and then hands the resulting field notes to JC who is the company draftsman. JC then enters the results into AutoCAD. In this test I asked the operator to enter the data themselves which is a deviation from our normal procedure.

GM was able to draw a complete floor plan from his initial set of measurements. When I asked how he managed it with insufficient distance measurements he explained he intersected the last two lines at right angles to close the unit. No reputable surveyor could consider this to be good practice. He also missed a major step in the unit. This step required proper observation to spot. It was also missed by TV. On an actual job this would have resulted in a serious error on the final plan at worst or a return visit at best. GM is very competive by nature and treated this exercise as a race. His results show he did not take it seriously. Following some discussion and pointing out of the missed wall step he repeated the measure up getting a correct result.

TS was the only surveyor who measured the two free standing columns in the open floor area. These do not have to be shown on the strata plan and the LPI specifically state this in the Strata guidelines. His reason for doing so was that as the columns are common property the area of the columns is not included in the lot area. Thus according to him they must be measured even if they are not plotted on the final plan so the area can be taken into account. The area of the two columns amounted to 0.5 Sqm. NSW practice is to round down areas to the nearest square meter. Thus a 0.5 meter difference could result in a final title area change of 1 Sqm if the columns are included in the calculation of floor area. TS had the longest checking time as he did not use a calculator preferring old fashioned paper arithmetic.

TS is a registered surveyor with over 50 years experience and is undoubtedly correct about the areas. I did not ask TS to do the electronic part of the testing. His computer usage now days is limited to email and web-browsing.

TS is 72 years old and qualified as a Surveyor using the articles system. He has been surveying since 1957 when he commenced his cadetship. He has no Tertiary Surveying Qualifications and now works part time only.

MM, TS, JC all showed the engaged columns that are located along the western wall of the office. GM and TV did not show these columns, as with the free standing columns they are common property and should not be included in the lot's area. The area of the engaged columns is only 0.15 Sqm so the difference is negligible in terms of area. There is also a service duct on the western wall. Ducts that carry services to another unit are common property and thus excluded from the area. Ducts for the sole use of the subject unit are not common property. MM and TS were the only operators to measure this duct. On an actual job this can be sorted out by seeing if the duct is in the same location on the floor above or below. If it is in the same spot then it is probably common property in the form of Structural Cubic Space.

4.12.2 Electronic Methods – SiteMaster

SiteMaster is an easy to use program. Once the bluetooth connection is made and the first wall drawn the operator should not need to touch the screen again until the measure up is complete for that unit. This enabled me to get each operator to measure using SiteMaster with virtually no experience with the software. The opening and establishment of a new job was done by me each time to further simplify things and to reduce the time spent on the exercise.

From the differences in timing between the two methods it can be seen that there is a marked time saving for all operators when SiteMaster was used. Possible reasons for this may be due to;

- The data entry phase being virtually non existent when using SiteMaster.
- No time is taken up drawing the diagram onto the field notes in the field when using SiteMaster. The electronic notes are drawn automatically by the software saving entry time.

Some difficulties were encountered while using SiteMaster.

- The operator must remember to do a Save-As before exiting the software as the proprietary format can not be read on the desktop PC.
- Flat batteries on the Disto caused the software to shut down. A back up file is saved on the PPC but some data was lost. Lesson Check Batteries before starting.
- The Disto cannot be used to do arithmetic as the plus and minus keys have been reassigned by SiteMaster as direction arrows. Experience at measuring tricky dimensions should solve this. (Note: This problem solved during further site testing)

The two mismeasures were a surprise outcome. TV is a relatively inexperienced surveyor and has never measured an actual Strata Job on his own. Once shown how to do it correctly by JC he measured the job a second time correctly. GM was casual with his first measure up and consequently had to repeat the job.

4.13 Conclusion

There can be little doubt from the times achieved using SiteMaster that for a job of any size using SiteMaster will result in a faster outcome. It can be seen that all operators worked quicker using SiteMaster than by manual methods. The operators had a wide range of experience and accordingly the times varied widely. In this test only one performance factor has been measured and that is time taken.

Even though my personal times were not the quickest a certain amount of confidence in the resulting floor plan can be inferred from the correctly carried out checks and weight of many years doing this type of work. This is also the case with operators TS and JC whose manual measurements were drawn and checked correctly and who both have considerable experience. This experience bonus is difficult to quantify. Some checking will be required before measurements by TV & GM are accepted on our next strata plan.

The table below shows the percentage improvement for each operator. TS did only a manual measure. His time is included in the manual average only with an allowance of 5 minutes for data entry.

Name	Manual	SiteMaster	Percentage Change
MM	28:42	17.:55	-37%
JC	13:20	09:26	-29%
GM	28:21	16:10	-44%
TV	21:00	17:00	-19%
TS	23:16	NA	NA
Average	22:52	14:23	-33%

Table 4.2 Initial Testing Time improvements

Currently our Strata Surveys are measured using a one or two man crew depending on availability on the day. Using SiteMaster all measuring can be done by a one man crew. The cost savings of not needing to pay an assistants wages are obvious. Further savings in wages for the Surveyor of about 30% for field time can be expected. Added are savings in drafting time as the plan is largely drawn on site and requires only finalizing once downloading is complete.

For me the greatest bonus is confidence in the result. The visual representation on the screen means that a measurement error is less likely to be overlooked. Any misclose is apparent at the end of each unit measure. SiteMaster tells the operator how far he missed his starting point by when ending the unit measurements. Based on these early results I envisage that electronic recording using SiteMaster will become our standard method of measurement for Strata surveys.

Chapter 5 - Evaluation of the Automated Strata Mapping System

5.1 Introduction

Having gained some experience using the SiteMaster software by testing at the office the next job was to take the equipment and software onto an actual site and measure a real Strata Scheme subdivision. The decline in the number of unit developments in NSW means that we now days do not always have a strata job on-going. Accordingly I had to wait until early September 2011 for a job to become available that could be used for further testing.

The test site is located on Pittwater Road in Gladesville an inner north west suburb of Sydney located about 10 km North west of the Sydney CBD. The site was formerly used as a petrol station and is zoned commercial. It is located in a small suburban shopping street.

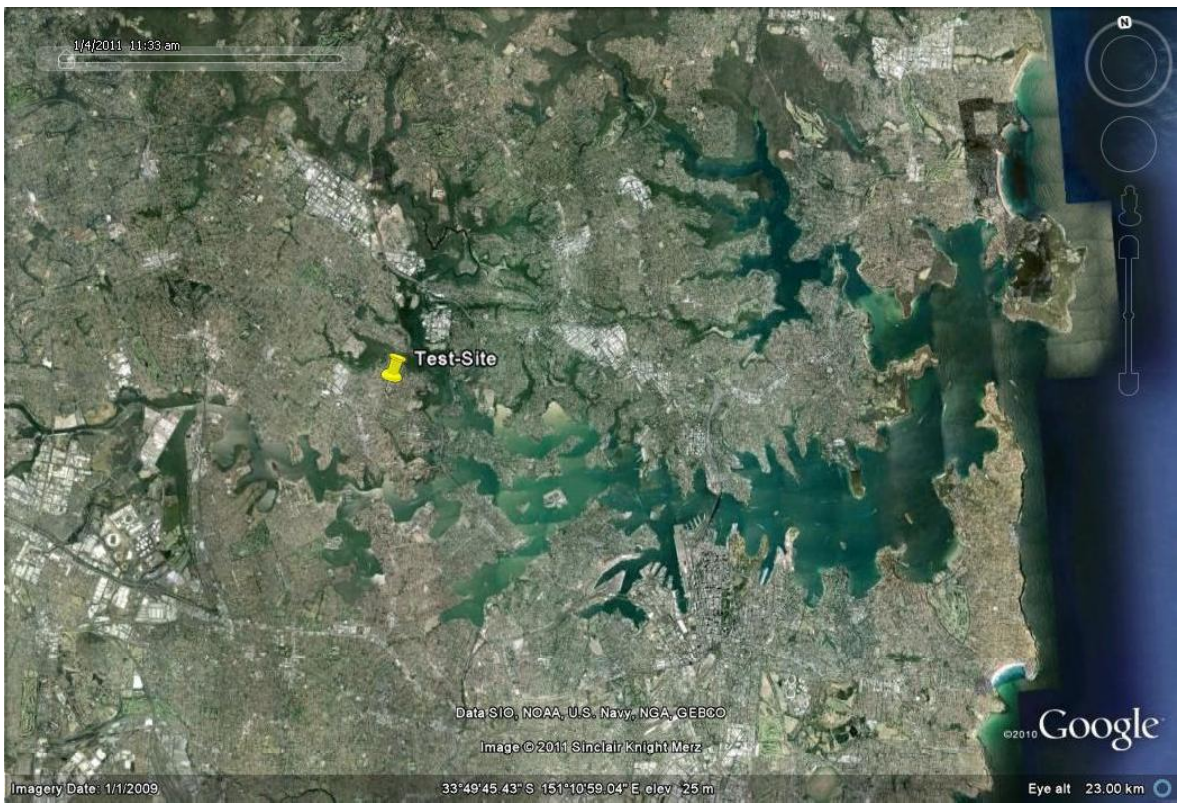

Figure 5.1 Test Site Location

The development consists of a mixed use building comprising a supermarket at ground level with eight residential units located on the first and second floors. Initial development plans had the entire site as a strata subdivision but this was changed to a two lot volumetric subdivision followed by a strata subdivision of one lot. Lot 1 is the supermarket and car parking and Lot 2 the residential portion of the building which is to be Strata Subdivided.

Figure 5.2 Test Site, Supermarket at Ground level & Residential Units above.

5.2 Planned Procedure

The comparison procedure used was similar to the initial testing. Units were measured twice using both SiteMaster and manual techniques. Not all units were measured twice. As this is an actual site for a paying client I had to first measure everything to get the job completed and then with what time remained I was able to measure some units a second time using manual techniques.

Times were taken for comparison as before. I have measured many Strata Subdivisions over the years so I expected I would also be able to form a qualitative opinion of the method based on past experiences only i.e. does it feel faster or better than in the past. I also took notice of any problems encountered along the way.

5.3 Using SiteMaster

SiteMaster was used to measure all the areas for the Strata Plan on this job. I tried to avoid falling back to using paper notes if at all possible. The software is in fact a small cad package for use on the PPC. It has some editing and drawing functions besides the floor plan measurement program that is its primary use. These cad drawing features proved ok for fixing an error in the field but would be trying to use for any real cad-drawing given the limited screen size, slow update of the small processer and stylus only input device.

Prior to using the Disto D8 it has to be paired with the PPC using the PPC's blue tooth set up program. I had already done this during the testing of the various download versions in chapter three. The PPC and Disto need both to be placed in Bluetooth mode prior to starting SiteMaster. Once SiteMaster is started the link to the Disto is not automatic. The program will default to manual entry mode and the user can select the Disto from the settings dropdown menu. This is quick and need only be done once each time the program is used.

The next thing to do was to set up a job directory on the PPC. I created a directory called Project Files and stored all of my measurements to jobs in this directory. Before taking any measurements it is necessary to decide which way to orient the drawing on the PPC. That is which way will be up on the screen. SiteMaster uses the cad convention of angles read anticlockwise from 3 o'clock. I measured the first few walls as a test using the arrow keys on the Disto with the head of the Disto pointed at the eastern boundary of the site for orientation. The resulting lines on the screen were 180 degrees out from the floor plans shown on the draft strata. I then repeated the procedure this time pointing the up arrow on the Disto at the western boundary for orientation. The resulting lines were then oriented the same as on the draft plans.

After each distance measurement I would point the head of the Disto toward the western boundary before pressing the appropriate direction key. Measuring proved to be very fast after the initial few lines had been measured and become almost automatic. The procedure involves measuring the wall, turning the Disto to face the west and pushing the appropriate direction arrow key.

5.4 Strata Boundary by Arithmetic

Many strata boundaries pass through an internal wall or walls and thus can not be measured directly. The manual method of finding the length of these boundaries involves measuring the parts separately and noting the individual measurements in the margin of the field notes. Wall thicknesses can be determined by addition and subtraction. When all the dimensions necessary were completed the surveyor could add them up and write the final boundary dimension onto the field notes. Later models of distance meters have made this easy with built in add and subtract functions.

SiteMaster uses the shifted bluetooth arrow keys to enter direction for each wall to be plotted. The addition and subtraction keys on the Disto are reassigned by the software to NE and SE directions respectively. Initially I got around this by using a second non bluetooth Disto to do the arithmetic and keying in the boundary manually. This defeats the purpose of using electronic recording and introduces the possibility of a transcription error by the operator. In a Homer Simpson style Doh moment I tried switching off the bluetooth on the Disto. I was then able to do the adding and subtracting before turning bluetooth back on for the transfer to SiteMaster. Problem Solved easily in the end. A look through the software manual failed to show up any mention of this feature. The software is intended for measuring floor plans and the assumption by the authors is that you must be trying to draw everything not merely the perimeter walls as required for a Strata plan.

5.5 Partial Floor plans

After a few hours of using SiteMaster on site I was measuring so quickly that I thought it might be faster to measure an actual floor plan than to measure the strata boundaries directly by the arithmetic method of adding together walls and rooms. Where walls are not all the same thickness it can take a few minutes to confirm how wide a wall is from the arithmetic method. Why not just record the floor plan and click off the strata boundary on the computer back at the office? Only sufficient floor plan as necessary to get the boundary need be measured not the entire floor plan. I measured units two and three by the partial floor plan method and clicked off the strata boundary from the downloaded site model. The extra work involved in first measuring more walls in the field and then doing more cad in the office led me to decide that this is not a worthwhile method especially once the arrow reassignment problem was solved.

5.6 Linking Units Together

As with most surveying tasks it is better to work from the whole to the part. Accordingly I first measured the external footprint of the units at first (Lower) floor level. The external footprint was required as the units on the lower level all have court yards that abut the perimeter wall. It is a LPI requirement that court yards are dimensioned on the final plan if they are not formed by a structural feature. Thus measuring the footprint is not an extra required only when using SiteMaster. Measuring the footprint had the added bonus of making linking the units together on the Cad screen in SiteMaster much easier.

On the upper level where there are no courtyards so only sufficient external measurements were taken to link the units together. This is not absolutely necessary for Strata purposes, the units could be measured separately as the strata regulations do not require that common property be shown on the final plan.

To measure a floor plan internally a link is made to the outside walls in SiteMaster by using an opening and a wall thickness. The opening can be either a window or a door. I tried both and found that using doors was slightly easier.

The window entry routine asks for sill and head heights and the door routine does not. Window heights are unnecessary information for a strata plan. SiteMaster is aimed at drawing floor plans with doors etc shown in an architectural style. These are also not necessary for a strata measure up. Doors, windows etc are not shown on the strata plan only the strata boundary. A downside to linking by doors is that the doors showed up in the final cad-model and had to be edited out.

5.7 Measuring Short Distances

The shortest distance the Disto can measure is 50mm. Distance shorter than this must be measured with a tape and entered manually. The Disto D8 is 180mm long and measurements are by default taken from the base of the unit. It is also possible to measure from the front of the instrument and this proved useful for measuring distance less than 200mm. The audible beep given out by the Disto when measuring from the front changes frequency to warn the operator that the measurement is from a different end than normal. A well thought out feature by Leica. A third measurement point is located on an extendable arm at the base of the unit. This is useful for measuring accurately into the corners of walls where the thickness of the unit would prevent accurate measurement.

Figure 5.3: Leica Disto D8 showing third measure point at an internal corner

Note: Screen icon shows location of measure point.

5.8 Measuring Stairs

SiteMaster has an automatic stair drawing function that requires only three measurements and the number of risers to draw up a set of stairs. Stairs are not shown diagrammatically on a strata plan but can be labelled as stairs or an abbreviation such as ST can be used if the stairs are common property. I decided to draw the stairs as a memory aid even though not strictly necessary for Strata purposes. It also allowed me to become familiar with another part of the software. Stairs in NSW are not identified if they are part of the same lot on both levels. That is the full stair area is shown on both floors and not a void on one floor and stairs on another.

5.9 Problems Encountered

Several visits were required to get all of the measurements. This was due to access not being available to all units because tiling and waterproofing were taking place on the days of my visits. We also needed to return to measure the car spaces which were not marked in advance as agreed with the client. This is a common problem on our sites. Clients are always in a hurry to get the survey completed and will say the site is ready for measuring when it is not quite ready.

These multiple visits precluded me from using the equipment until the batteries gave out. On the longest visit I used the PPC for about five hours and had 25% battery life left according to the PPC power monitor. Thus I expect it would not be possible to get a full days work of eight hours from the on board battery. This could be a problem on a large site where measuring might take several days. The PPC has a cigarette lighter style external adaptor so if needed I could rig a gel cell in a back pack to power the software almost indefinitely. Of course this would make field use more cumbersome.

To save the cost of an assistant while measuring I did all the work singlehanded. Most of the time working alone does not present a problem for the measurer. The exception was when measuring an outside dimension where there is no surface to reflect the laser. Normally I get the assistant to hold up the clipboard and measure to that. This was solved
with some blue-tak and a piece of scrap cardboard as shown in the photo below. I have since added a packet of blu-tak and a plastic reflector board to our electronic Strata kit.

Figure 5.4: Temporary Cardboard Reflector and Blu-tak. (Note the Laser dot)

The stylus for the HP is a small metal one that slides into a retaining hole at the back of the unit. Any one who has used a stylus in the field will know that it gets dropped regularly and has the ability to home in on cavities, storm water grates and lift shafts when dropped. To prevent this the styluses for all of my field recorders are retained by a lanyard. I added a Trimble TSC2 stylus and lanyard to our strata kit. Similarly when using the Disto it needs to be put down to use a tape or the stylus. I added a lanyard for the Disto to our kit. The Disto can simply be released when not in use and hangs at about waist level around the operator's neck.

5.10 Error Locating

With both manual and automatic recording it is good survey practice to check your misclose before moving onto the next unit. Miscloses are normally in the order of 50mm or less for easting and northing. A larger misclose usually indicates a wall thickness has not been allowed for. When an error is found using the manual method it can be detected quickly by measuring an overall dimension down the centre of the unit and seeing which half of the job does not match the overall dimension. The offending half is remeasured and the error located.

Using the software I only had a misclose of significance once when measuring unit one and it proved difficult to find on the PPC. I had missed a step in the wall of 0.28 metres. The software has functions for interrogating the length of a line on the screen but it was agonizingly slow to use and in the end the easiest option turned out to be measuring the unit again from scratch and erasing the first measure. More experience in using Site Master's CAD functions may make editing a better option in the future.

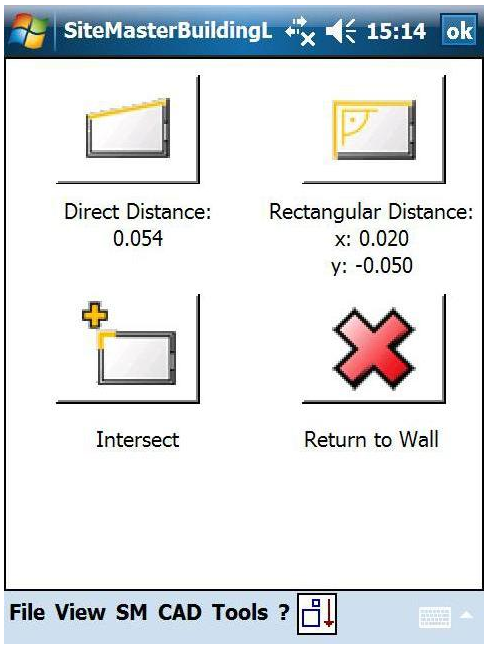

Figure 5.5 SiteMaster Misclose Notification

5.11 Processing and Plan Production.

When using manual methods the dimensions measured in the field and noted on paper are keyed in by hand to Terramodel or AutoCAD to produce a calculation model. This model is used to calculate the areas for the final strata plan set and to form the basic line work for the final drawings. Using SiteMaster to record the measurements in DWG format meant that the keying in phase disappeared entirely. The model as downloaded still required some editing to produce a calculation model. The same also applies to a manually entered model.

To process the field file I imported the DWG records from SiteMaster into Terramodel. The line work is imported as poly-lines so I converted these to set lines. Converting to sets makes it easy to remove unwanted lines simply by deleting the points at the end of the line. Not all the units were closed with SiteMaster in the field. I used trim and extend commands to close the lines on the screen i.e. remove the misclose.

The doors and windows which were used to link the units together in SiteMaster are not needed in the Strata plan and I deleted them as well. This left just the walls of the units and the external walls used to link them. Editing the cad model for the upper two levels took about 45 minutes. I didn't process the job manually as I didn't have a full set of manual measurements. Based upon past experience on similar jobs producing a model like this would take two to three hours. A significant saving in time.

The resulting calculation model was used to produce the final plans in AutoCAD. This stage of the process is identical to manual methods. Strata plans have only a single solid line to show the unit boundaries. The cad model has two lines one for each side of the wall. Producing the final plans is simply a matter of removing one side of the wall and tidying up the ends of the lines. No advantage is gained using SiteMaster over the manual measurements method from the calculation model stage onwards and this phase of producing the plans is not discussed further in this paper.

5.12 Final Strata Measuring Equipment

Figure 5.6: Final Measurement Equipment**.**

Legend

A. HP-Ipaq 2400 Pocket PC.

B. Leica Disto D8 with bluetooth.

C. Wrist Mount for Pocket PC

D. Blu-tak for securing reflector plate.

E. Lanyard for retaining Stylus

F. Plastic Reflector Plate

G. Download cables and charger.

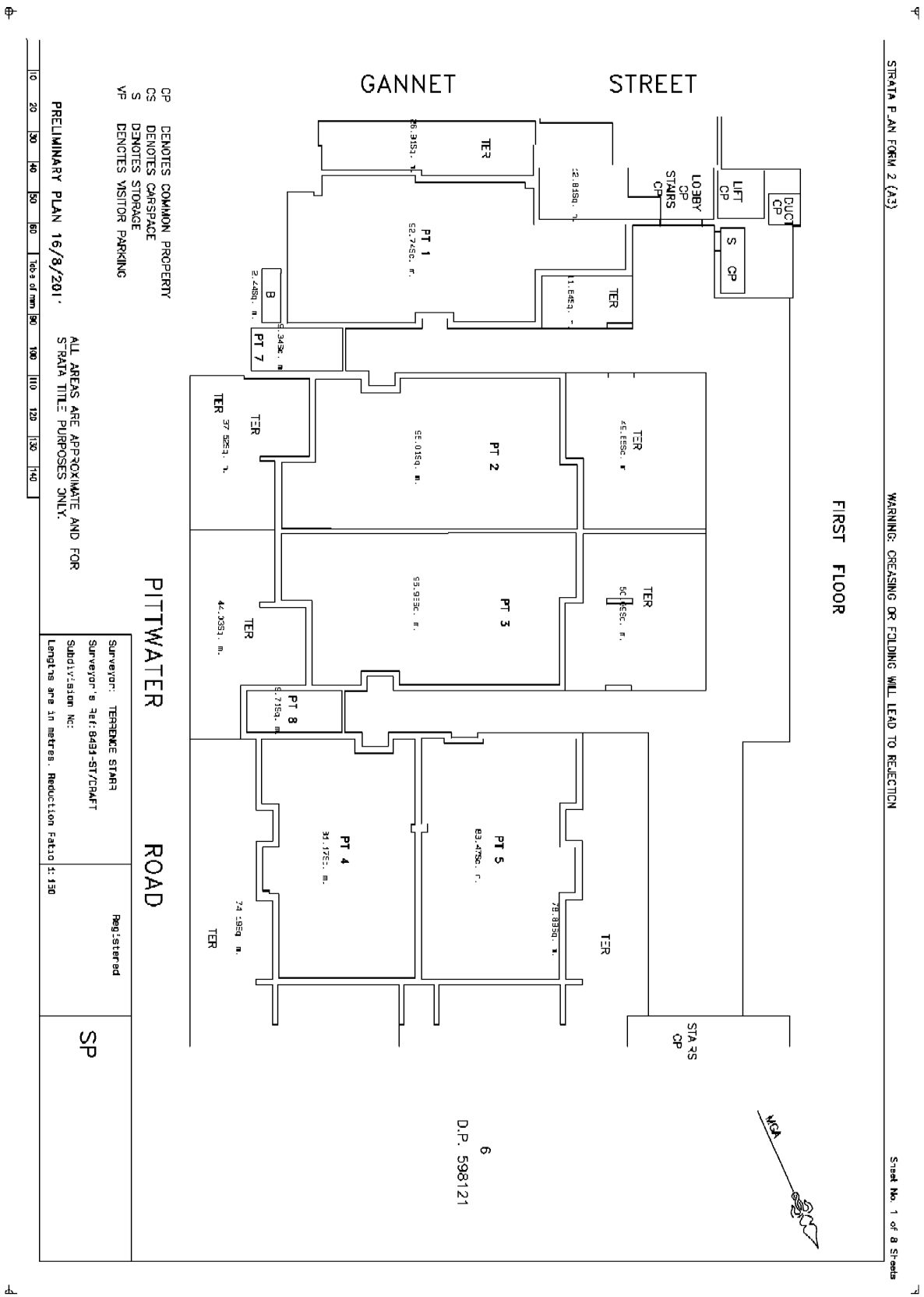

Figure 5.7: Calculation Model from SiteMaster Measurements. Level 1

5.13 Comparative Testing using Measurement Times

As with the previous testing at the office I measured some units twice, once with SiteMaster and once using manual methods. The units measured twice were units 1, 2, 4, 5 & 7.

Unit No	Manual	SiteMaster	% Improvement
1	13	8	38%
2	10	4	60%
4	11	6	45%
5	12	8	33%
7	12	8	33%
Average	11.6	6.8	41%

Table 5.1 Measurement Times

Results achieved are similar to the previous comparisons taken at the office indicating an improvement of 30%-40% in time taken over manual measurement with an average of 41% improvement. The manual measurements were this time marked directly onto a copy of the draft strata so no time was taken up in producing a floor diagram by hand. I would have therefore expected the improvement to be less than that found at the office measure up. The difference has remained much the same and I feel can be attributed to the extra experience gained using SiteMaster in the field. I did the first three remeasures at the end of the job after about five hours of using SiteMaster to measure units and common property. The other two units were remeasured on a subsequent visit. Thus I was quite familiar with the software usage by the time I did the manual comparisons.

In order to create the location plan for level one I measured the external footprint using radiations taken with a Trimble S6 Total Station. When I overlaid the SiteMaster footprint and the more accurate S6 derived footprint they were almost identical. The difference in distances for the furthest two common points was 60mm over 49.7 metres. Considering SiteMaster does not measure angles a well calibrated building.

5.14 Discussion of Results

Using SiteMaster on an actual job showed that the system was a viable method for measuring a Strata Subdivision. I was able to produce a result that was identical to that which would have been arrived at by manual methods in about three quarters of the time.

This was the first job for the automated methods so I expect that the improvement in times achieved on this job will continue to increase as operator skill improves on future projects. We have two more Strata Jobs to measure up in the next few months and will be using SiteMaster for both of these. I envisage that in the future using this method will seem as routine to a surveyor as using a data recorder does in other forms of surveying.

Figure 5.8: Electronic Strata Measurement System in use

Chapter 6 - Conclusions and Recommendations

6.1 Introduction

The principle aim of this project was to develop a method of automating Strata Subdivision Surveys at my workplace. This was successfully completed through the examination of the information that needed to be recorded and the evaluation of hardware and software that was available on the market to meet those needs. A system was purchased and tested and then a comparison made with our existing techniques. The results indicate that the electronic recording methods developed are faster and more efficient and have the potential to reduce errors in fieldwork.

6.2 Review of Objectives

The introduction of the Leica Disto D8 in 2010 with bluetooth transfer capability was the seed for this project. While there exist already several commercial software products for measuring and drawing floor plans I wanted to use the software and equipment for a very specific task that was probably not even considered by the developers of the software specifically Strata Subdivision measuring.

The examination of current manual methods and proposed electronic methods identified that three components were needed for the task, namely a Laser distance meter, recording device and appropriate software. The distance meter was the easy part as I already own a Leica Disto D8. The different options for tablet PC and pocket PC were investigated and a pocket PC purchased for further development testing.

The twin project objectives of identifying methods and equipment suitable for electronic Strata surveying were met by examining a range of hardware and software options. The selected software was SiteMaster. SiteMaster is a floor plan surveying program of German origin. The resulting Strata plan has now gone to the LPI for registration.

A project objective was to test the selected system in a test environment and then on an actual site. Accordingly SiteMaster was installed onto the pocket PC and tested at our offices. The technique used was to measure the unit twice first using pencil and paper to emulate our current manual field practices and then again with the software. Five different operators measured the office, times were recorded and a comparison made. A similar method was used for a larger trial on an actual development site. The resulting electronic measurements were then used to draw a final Strata plan.

6.3 Results Achieved

The initial testing at our offices showed that the supposition that electronic measurement would be faster was correct with an average improvement of 33% over manual methods found. The testing on site found that improvements in time taken also applied in a work situation with an average improvement of 41% by a single operator. Data entry time was also completely eliminated from the plan processing stage resulting in even more time savings.

It is difficult to quantify some of the other advantages to using an electronic system. If no errors are found during testing this might be due to the system eliminating errors or simply to no errors being made. A reduction in errors is obviously possible using SiteMaster. In common with other electronic measurements the chance of a transcription error while writing down measurements is removed. Miscloses are calculated automatically as each unit is completed and data entry errors being removed from the office processing stage. Based on past experience with similar jobs it is my onion that using SiteMaster will result in fewer errors in measurement going undetected.

6.4 Project Conclusion

At the beginning of this project I had hoped to take a Tablet PC loaded with AutoCAD or Terramodel into the field and draw the strata plans directly using the CAD software. I purchased a tablet PC to try this out. This proved to be possible but very difficult to use due to reliance for command entry on a mouse and keyboard by CAD software. Cad programs for pocket PC were also difficult to use. The small screen and constant requirement to tap the screen with a stylus made them impractical for field use.

Next I trialled several software products for floor plan mapping and intended for use in the field and found them in comparison to the cad programs easy to use. Thus my conclusion is that at this time only purpose designed software is worth the time and effort of using. I used a Pocket PC for testing simply because it was smaller and lighter. I have no doubt that software on a tablet PC would achieve similar results.

It is often said that time is money and this is certainly true in small business. Any opportunity to save time on site should result in an improvement in the profitability of a strata subdivision job simply by saved wages firstly for the surveyor in the field and secondly in speedier plan preparation at the office. In the field no assistant is needed and our research has found that a surveyor is likely to require 30-40% less time on site.

It is not unusual in Sydney for several surveying firms to quote on a particular survey. The lower field costs could enable a firm to bid a price slightly lower than the opposition tenders. In our case most strata plans are for long standing clients who do not shop around but still expect to be looked after on price. The additional savings bought on by using SiteMaster I hope will convert directly to more profit on these jobs.

A survey company wanting to use electronic recording would need to consider if they were going to get regular use from the software. There is the initial outlay of about $2000 for all new equipment and software plus the difficulty of getting it all to work.

An experience bonus in time and cost savings will only come if the software is used regularly. I used SiteMaster on three site visits and by the end of the last visit was noticeably faster at using the equipment than on the first visit.

If the system is used only occasionally or by different operators it may be better for a firm to stay with manual recording. Manual recording will still do every thing required to produce a strata plan. It is inexpensive and easy. The methods I have explored are faster and less prone to error however they introduce a level of complexity to the measuring not present in manual methods. In short pen and paper may take longer but they still get the job completed.

A competent surveyor using manual methods will always check that a unit closes before moving on. The same checking happens automatically in SiteMaster. It is quicker and easier in SiteMaster. The software does nothing that can't be done manually in this respect. They only advantage is in the time saved. For an average unit two to three minutes are required for checking manually. With SiteMaster only a few seconds to confirm the misclose is needed. These savings in time are small and on a ten unit strata may only amount to half an hour which is not a significant saving in my opinion.

A negative to using the software is when a misclose is found at the end of measuring a unit. I found it was quicker and easier to delete the measure up then measure the unit again rather than to review each line looking for the error. The main error elimination comes when entering the measurements into cad back at the office. Transcription or errors in direction are easy to make during manual entry especially on a large tedious job. This phase is totally eliminated by using SiteMaster.

While I selected SiteMaster there are other software products available on the market and this paper is not intended to be an endorsement of SiteMaster over any other product. The findings regarding time and efficiency should hold true for any well written product. My opinion is that electronic recording is an improvement on manual methods where the circumstances warrant the extra effort involved. Small or occasional use in my opinion do not warrant setting up electronic measurement.

I would recommend these techniques to other surveyors as a way of improving productivity on a Strata subdivision project.

6.5 Recommendations for future development

While SiteMaster or any other suitable product will undoubtedly result in time savings it would be even better if a product aimed directly at Strata Measuring could be developed by a Surveyor or future surveying student with the software skills to create a user friendly product. There are currently 930 registered surveyors in NSW. If only 100 of them could be persuaded to buy the product at $500 this could finance the development of a product. I would be prepared to help test any software that may be produced by a future student.

I have resisted the onslaught of the Apple I-Phone, I-PAD and similar devices so far preferring a phone that looks like a phone to a phone that looks like a spaceship. The Apple I-Pad is essentially an advanced tablet PC. I did not look at it as a possible platform in this project due to all the appropriate softwares being windows based. Looking ahead a time when a surveyor uses his phone to measure floor plans is potentially not far off. When such a product comes along it can be tested as I have done.

I have recently used a Trimble tablet PC to operate a GPS for machine Guidance. It was loaded with a Windows 7 tablet addition operating system. Left and right clicks were emulated differently than in the Windows XP tablet that I tried. It may be the case that CAD software will be a realistic option with these devices. I will try this myself when the cost of a Yuma tablet drops to an affordable amount from the current $5000. If Autodesk or another vendor produce a tablet specific CAD package it should be tried out for suitability for on site plan drawing.

6.6 Final Message

As a part time student this project has taken most of a year to put together in my spare time. It proved to be more difficult than I expected and I wish to thank Associate Professor Kevin McDougall for his supervision, help and suggestions. If any reader is thinking of doing something similar I am happy to answer questions by email to **mike@citisurv.com.au**. Thank you for reading.

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Appendices

Appendix A – Project Specification

Appendix B – Leica Disto D8 Specifications

Appendix C – SiteMaster Quick use instructions

Appendix D – Final Strata plan derived from electronic measurements.

Appendix E – Risk Assessment.

Appendix F – Schedule 1A Strata Titles Act- Surveyors Declaration.

Appendix A

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG4111/4112 Research Project
PROJECT SPECIFICATION

FOR: ***Mike Morris Q8285337***

TOPIC: Electronic Measurement and Recording of Strata Title Field Notes.

SUPERVISOR: Associate Professor Kevin McDougall

SPONSORHSIP: *Citisurv Pty Ltd (Employer)*

PROJECT AIM: Implement the use of electronic equipment for the field measurement of Strata Title field notes in my workplace. Current company practice uses paper notes which are then keyed into a cad program manually for plan preparation and area calculation. Occasionally field errors are only picked up at the office requiring a return visit to site with the associated expense in wages and time. Field confirmation of area and closure should reduce errors. It is hoped that the measurements can be recorded in a format closely matching the final plan for lodgement also reducing the time spent by our draftsman. If time permits investigate the option for lodgement of plan using e-plan portal's upcoming XML format.

PROGRAMME: Issue A, 18-February-2011

1. Review of possible equipment including; (Feb 2011- April 2011)
   i. Distance meters with Bluetooth or other wireless technology.
   ii. Palmtops, PDA's, tablet computers as field platforms.
   iii Review commercially available software. As there is unlikely to be specific products available adapting a product designed for architectural or asset management will be required. What is the likely cost of hardware and software?

2. Review of current practice and regulations in NSW. (April 2011- June 2011)
   What are other surveyors doing at the moment?
   Are there any legislative requirements to prevent electronic measurement and recording?

3. Procedure Development (June 2011- August 2011)
   i Development of a procedure including selection of equipment, software and methods.
   ii Trial equipment and procedures on a simulated job (Our Office in a strata development) to ensure reliability and accuracy of procedures.

4. Use methods on an actual Strata job with both electronic and manual methods to compare time and expense. (August 2011)

5. Discussion of results and implications for industry. (August 2011-October 2011)
   Would strata plan standards improve if all plans were done this way?
   Was it worth the trouble ?
   Was it worth the expense and what savings in time and cost were found?

6. Present project at annual conference. (October 2011)

AGREED _____ (student) _____ (supervisor)

Date: / / 2011 Date: / / 2011

Assistant Examiner: _____

Appendix A University of Southern Queensland

Leica Disto D8 Specifications. [Source Leica Disto D8 Manual]

ⓘ	Cause	Remedy
240	Data transfer error	Repeat procedure
245	2nd button pressed although no Bluetooth connection exists.	Establish Bluetooth connection
252	Temperature too high	Cool down instrument
253	Temperature too low	Warm up instrument
255	Receiver signal too weak, measurement time too long, distance > 100 m	Use target plate
256	Received signal too strong	Target too reflective (use target plate)
257	Wrong measurement, background brightness too high	Darken target (measure in different lighting conditions)
260	Laser beam interrupted	Repeat measurement

Error	Cause	Remedy
Error	Hardware error	Switch on/off the device several times. If the symbol still appears, then your instrument is defective. Please call your dealer for assistance.

Technical data

Distance measurements: Measuring accuracy up to 30 m (2 σ)	typically: ± 1.0 mm* ± 0.04 in*
Power Range Technology™: Range (use target plate from about 100 m)	0.05 m to 200 m
Smallest unit displayed	0.1 mm
Distance measurement	✓
Minimum/maximum measurement, Continuous measurement	✓
Area/volume calculation of room data	✓
Addition / subtraction	✓
Indirect measurement using Pythagoras	✓
Trapezium measurement	✓
Tilt measurements: Tilt sensor: Accuracy (2 σ) - to laser beam - to the housing	 - 0.1° / +0.2° ** ± 0.1° **
Indirect measurement using tilt sensor (direct horizontal distance)	✓
Angle measurement using tilt sensor (360°)	✓
General: Laser class	II
Laser type	635 nm, < 1 mW
Ø laser point (at distances)	6 / 30 / 60 mm (10 / 50 / 100 m)
Autom. laser switch-off	after 3 min
Autom. instrument switch-off	after 6 min
Display illumination	✓
Multifunctional endpiece	✓
Timer (self-triggering)	✓
Save constant value	✓
Historical storage	30 values
BLUETOOTH® 2.0	QD ID B014433
Range of BLUETOOTH® Cl. 2	10 m
Tripod thread (Type: 1/4-20)	✓
Battery life, Type AA, 2 x 1.5V	up to 5 000 measurements
Protection against splashes and dust	IP 54, dust-proof, splash-proof
Dimensions	143.5 x 55 x 30 mm
Weight (with batteries)	195 g

Temperature range: Storage Operation	 -25°C up to +70°C (-13°F up to +158°F) -10°C up to +50°C (14°F up to +122°F)

* maximum deviation occurs under unfavourable conditions such as bright sunlight or when measuring to poorly reflecting or very rough surfaces. Measuring accuracy may deteriorate by approx. ± 0.1 mm/m for distances above 30 m. In long range mode the maximum deviation from a distance of 30 m increases to ± 0.15 mm/m.
** applies at room temperature. For the whole operating temperature range the maximum deviation increases by ± 0.1°.

Measuring conditions

Measuring range

The range is limited to 200 m.

At night or dusk and if the target is in shadow the measuring range without target plate is increased. Use a target plate to increase the measurement range during daylight or if the target has poor reflection properties.

Target surfaces

Measuring errors can occur when measuring toward colourless liquids (e.g. water) or dust free glass, Styrofoam or similar semi-permeable surfaces.

Aiming at high gloss surfaces may deflect the laser beam and lead to measurement errors.

Against non-reflective and dark surfaces the measuring time may increase.

Care

Do not immerse the instrument in water. Wipe off dirt with a damp, soft cloth. Do not use aggressive cleaning agents or solutions. Handle the instrument as you would a telescope or camera.

Warranty

The Leica DISTO™ D8 comes with a three* year warranty from Leica Geosystems AG.

More detailed information can be found at: **www.disto.com**

All illustrations, descriptions and technical specifications may be subject to change without prior notice.

* To receive the three year warranty, the product must be registered on our website **www.disto.com** within eight weeks of the purchase date. If the product is not registered, a two year warranty applies.

Appendix C

SiteMaster Quick User Guide for Strata Measuring.

1. Turn Bluetooth on on PPC
2. Turn Bluetooth on on Disto. Make sure batteries are OK for job.
3. Go to SiteMaster File Menu and save a new job with a reference number and name in the Project Directory. Eg 9255-Strata-1
4. Go to SiteMaster Walls/Columns menu.
5. Select draw Walls.
6. Select drawing layer - use default 2D_WALLS layer if you want.
7. Tap on screen to select first starting point. (arbitrary coordinates)
8. Hit the settings button at the top right and select Disto input.
9. Software will then connect to the Disto using Blue Tooth.
10. Exit settings menu and measure first distance.
11. Turn on 2nd key on the Disto to activate the arrows. (In the middle)
12. Orientate the Disto toward the site boundary that will be up on the screen. .(Always point it this way after a measurement)
13. Measure a wall using the big red measure button key on the Disto
14. Hit the appropriate direction key on the Disto. (Turn Disto toward previously selected up direction)
15. Proceed around the unit getting the strata boundaries.
16. To do arithmetic on the Disto turn off arrow keys by pressing 2nd key. (Blue key In the Middle)
17. At end of arithmetic hit 2nd key to turn arrows back on.
18. Following measurement of last line hit the done button.
19. Hit close wall at bottom left. This will display the misclose.
20. If misclose is OK close walls using the intersect key. (This will give a square closed wall)
21. To start the next unit it must be linked to the previous one.
22. Go to openings Menu (SiteMaster Menu)
23. Select D. Opening (A door opening with no actual door)

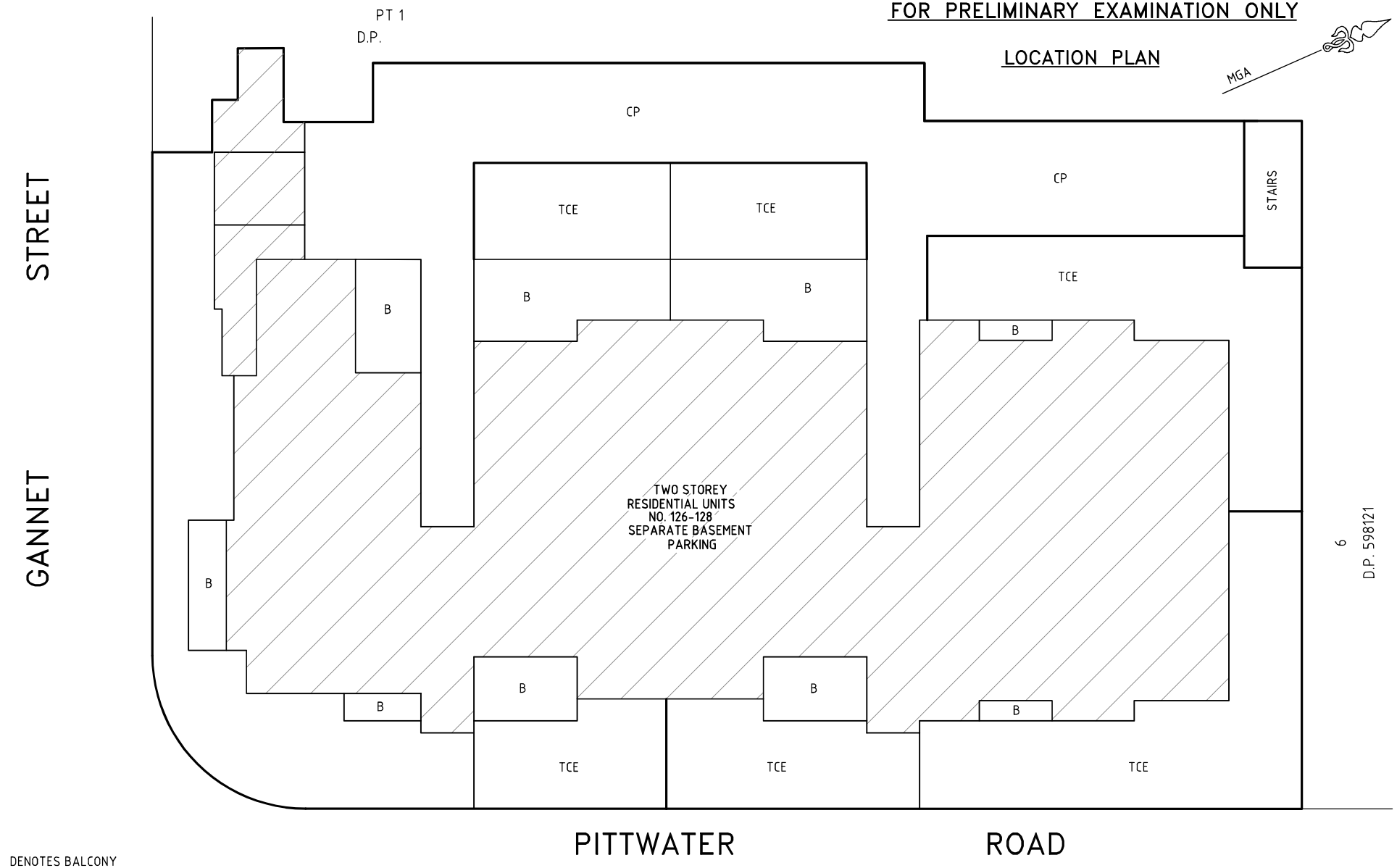
24. Follow prompts for width and wall thickness. (Use Disto and bluetooth to fill in)
25. Select side left or right by tapping on the screen.
26. Fill in first two room distances using the Disto. Then select end.
27. Go to walls menu again and select connect option.
28. Click on the wall where new measurement is to start and select a distance along the wall of zero.
29. Repeat the wall drawing procedure from above.
30. Use FILE then save after each unit is completed and when done
31. Turn off Bluetooth on Pocket PC to save batteries when done.

Appendix D

Final Strata plan as measured using Electronic Measurement in Chapter 5.

FOR PRELIMINARY EXAMINATION ONLY

LOCATION PLAN



B DENOTES BALCONY
CP DENOTES COMMON PROPERTY
TCE DENOTES TERRACE

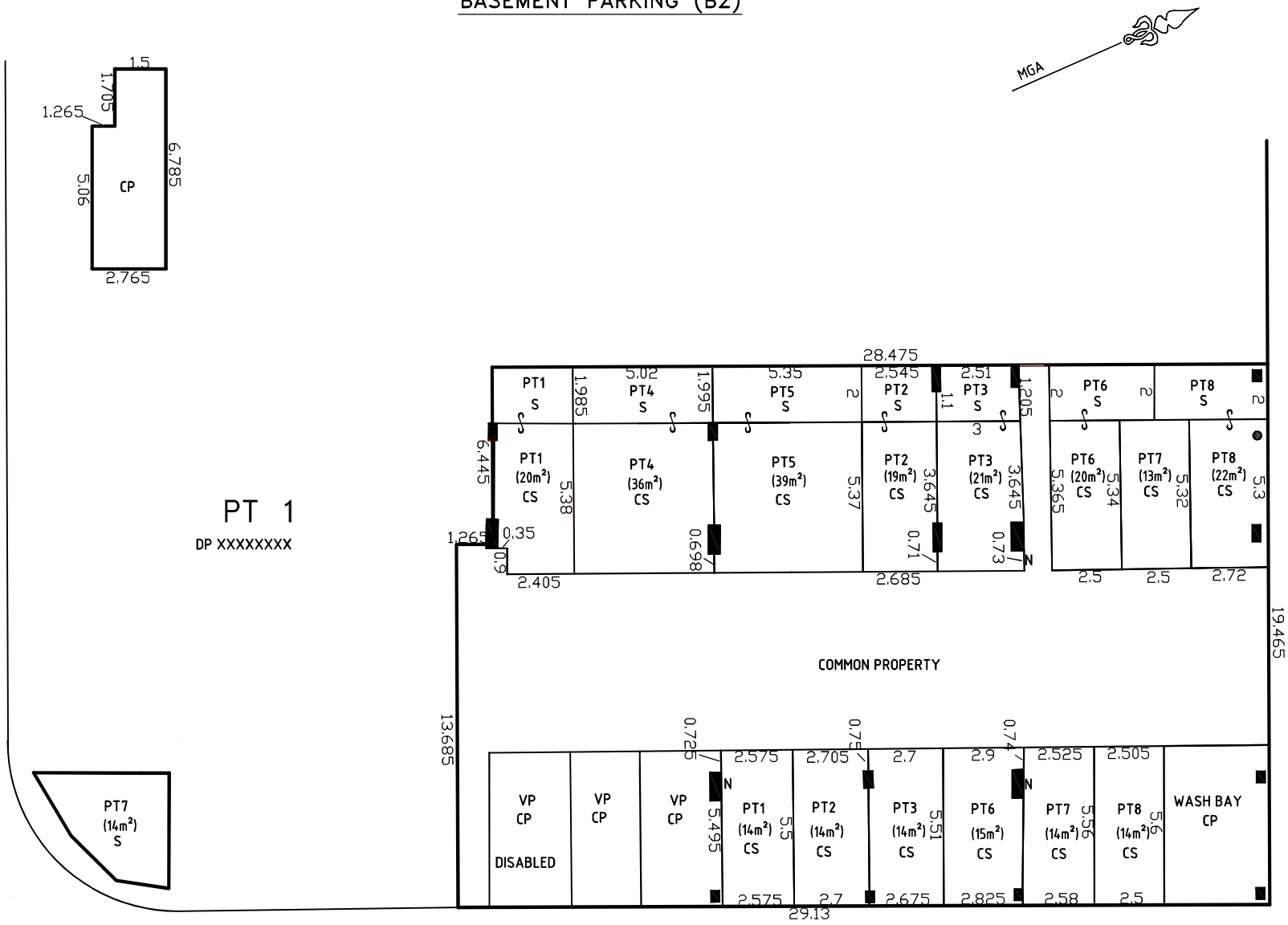
ALL AREAS ARE APPROXIMATE AND FOR STRATA TITLE PURPOSES ONLY.

Surveyor: TERRENCE STARR Surveyor's Ref: 8491–ST/P.E. Subdivision No: Lengths are in metres. Reduction Ratio 1:150	Registered	SP

10 20 30 40 50 60 Table of mm 90 100 110 120 130 140

FOR PRELIMINARY EXAMINATION ONLY

BASEMENT PARKING (B2)



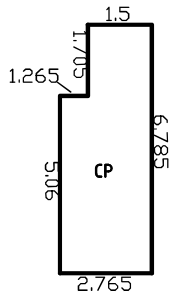
S DENOTES STORAGE
CS DENOTES CARSPACE
VP DENOTES VISITOR PARKING
CP DENOTES COMMON PROPERTY
DENOTES CORNER OF COLUMN
DENOTES CENTRELINE OF COLUMN
D DENOTES DUCT COMMON PROPERTY
N DENOTES PROLONGATION OF NORTHERN FACE
ALL AREAS ARE APPROXIMATE AND FOR STRATA TITLE PURPOSES ONLY.
STRATA PLAN SUBJECT TO PRELIMINARY EXAMINATION.

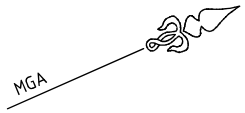
Surveyor: TERRENCE STARR Surveyor's Ref: 8491–ST/P.E. Subdivision No: Lengths are in metres. Reduction Ratio 1:150	Registered	SP

10 20 30 40 50 60 Table of mm 90 100 110 120 130 140

FOR PRELIMINARY EXAMINATION ONLY

BASEMENT PARKING (B1)





PT 1

DP XXXXXXXX

CP DENOTES COMMON PROPERTY

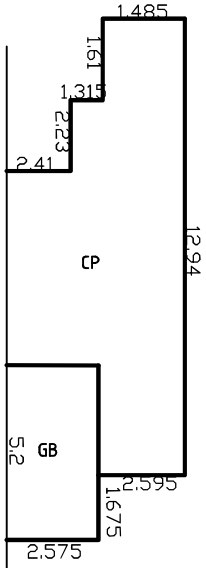
ALL AREAS ARE APPROXIMATE AND FOR
STRATA TITLE PURPOSES ONLY.
STRATA PLAN SUBJECT TO PRELIMINARY EXAMINATION.

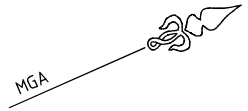
Surveyor: TERRENCE STARR Surveyor's Ref: 8491–ST/P.E. Subdivision No: Lengths are in metres. Reduction Ratio 1:150	Registered	SP

10 20 30 40 50 60 Table of mm 90 100 110 120 130 140

FOR PRELIMINARY EXAMINATION ONLY

GROUND FLOOR





PT 1

DP XXXXXXXX

CP DENOTES COMMON PROPERTY
GB DENOTES GARBAGE ROOM COMMON PROPERTY

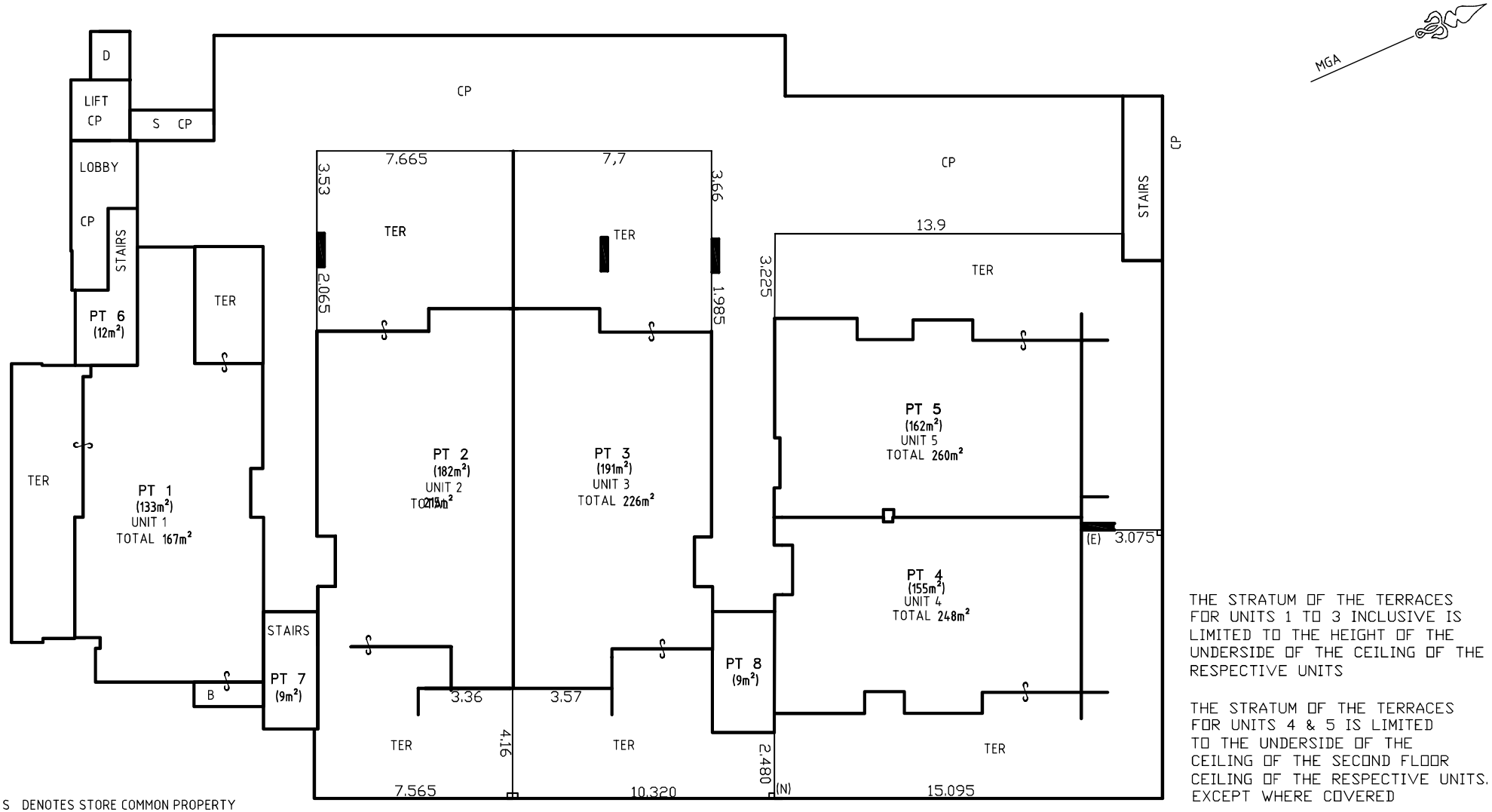
ALL AREAS ARE APPROXIMATE AND FOR
STRATA TITLE PURPOSES ONLY.
STRATA PLAN SUBJECT TO PRELIMINARY EXAMINATION.

Surveyor: TERRENCE STARR Surveyor's Ref: 8491–ST/P.E. Subdivision No: Lengths are in metres. Reduction Ratio 1:150	Registered	SP

10 20 30 40 50 60 Table of mm 90 100 110 120 130 140

FOR PRELIMINARY EXAMINATION ONLY

FIRST FLOOR



THE STRATUM OF THE TERRACES FOR UNITS 1 TO 3 INCLUSIVE IS LIMITED TO THE HEIGHT OF THE UNDERSIDE OF THE CEILING OF THE RESPECTIVE UNITS

THE STRATUM OF THE TERRACES FOR UNITS 4 & 5 IS LIMITED TO THE UNDERSIDE OF THE CEILING OF THE SECOND FLOOR CEILING OF THE RESPECTIVE UNITS. EXCEPT WHERE COVERED

S DENOTES STORE COMMON PROPERTY
D DENOTES DUCT COMMON PROPERTY
CP DENOTES COMMON PROPERTY
(E) DENOTES PROLONGATION OF EASTERN FACE OF WALL
(N) DENOTES PROLONGATION OF NORTHERN WALL
DENOTES RIGHT ANGLE

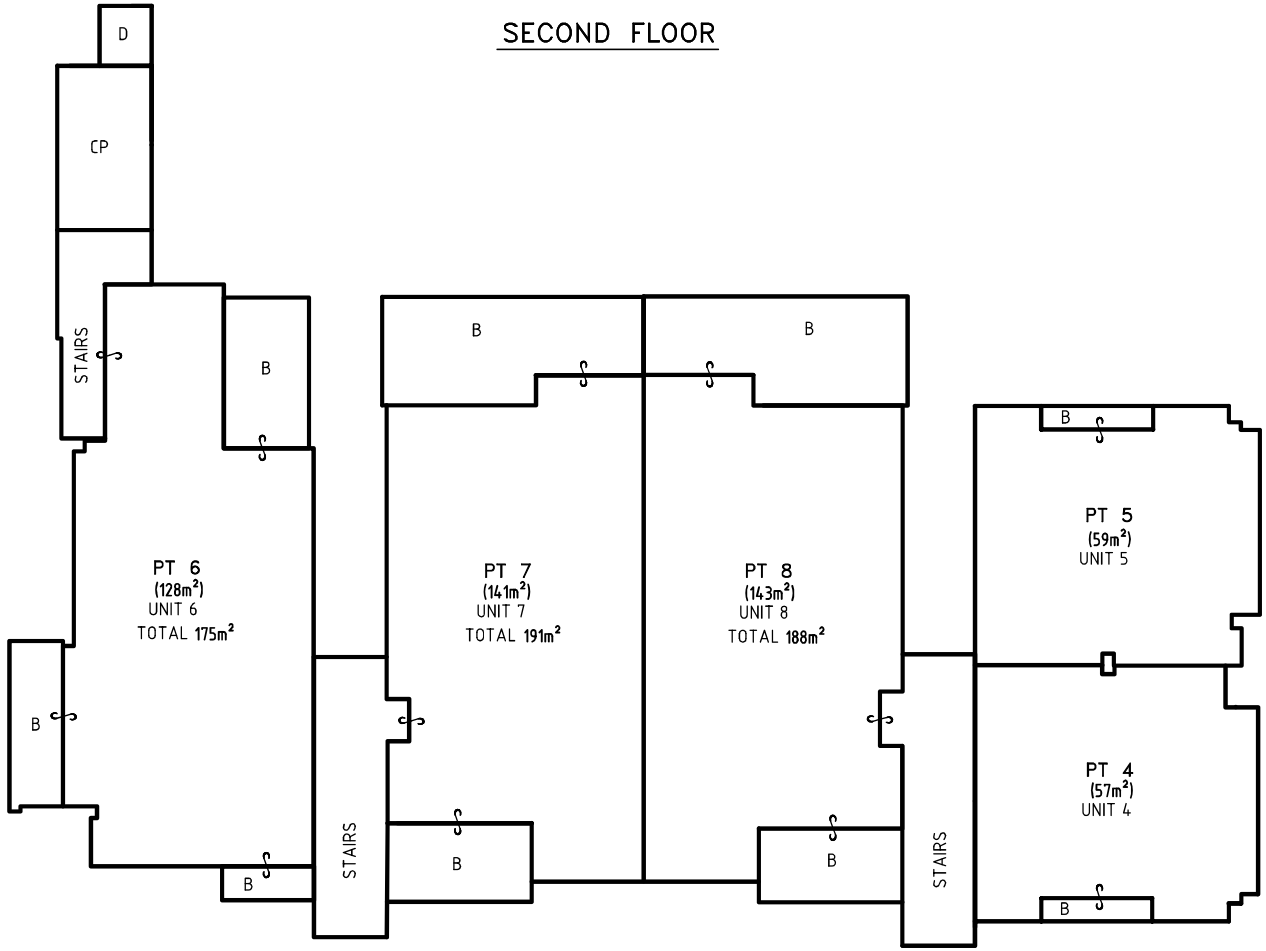
ALL AREAS ARE APPROXIMATE AND FOR STRATA TITLE PURPOSES ONLY.
STRATA PLAN SUBJECT TO PRELIMINARY EXAMINATION.

Surveyor: TERRENCE STARR Surveyor's Ref: 8491–ST/P.E. Subdivision No: Lengths are in metres. Reduction Ratio 1:150	Registered	SP

10 20 30 40 50 60 Table of mm 90 100 110 120 130 140

FOR PRELIMINARY EXAMINATION ONLY

SECOND FLOOR



THE STRATUM OF THE BALCONIES
OF LOTS 4 TO 8 INCLUSIVE IS LIMITED
TO THE HEIGHT OF THE UNDERSIDE
OF THE CEILING OF THE RESPECTIVE UNITS
EXCEPT WHERE COVERED

B DENOTES BALCONY
CP DENOTES COMMON PROPERTY
D DENOTES DUCT COMMON PROPERTY
S DENOTES STORAGE
TER DENOTES TERRACE
ALL AREAS ARE APPROXIMATE AND FOR
STRATA TITLE PURPOSES ONLY.
STRATA PLAN SUBJECT TO PRELIMINARY EXAMINATION.

Surveyor: TERRENCE STARR Surveyor's Ref: 8491–ST/P.E. Subdivision No: Lengths are in metres. Reduction Ratio 1:150	Registered	SP

10 20 30 40 50 60 Table of mm 90 100 110 120 130 140

Appendix F

When a Registered Surveyor signs a strata plan he is certifying that the plan complies with schedule 1A as set out below.
Source: *STRATA SCHEMES (FREEHOLD DEVELOPMENT) ACT 1973 (NSW)*

Schedule 1A Requirements for strata plans

(Sections 8, 8A and 9)

1 Floor plans

(1) Each wall, the inner surface or any part of which corresponds substantially to a line shown on the floor plan as a boundary of a proposed lot, must exist.

(2) Each floor or ceiling, the upper or under surface or any part of which forms a boundary of a proposed lot, must exist.

(3) Each wall, floor, ceiling or structural cubic space, by reference to which any boundary of a proposed lot is determined, must exist.

2 Location plans--no stratum parcel

(1) This clause applies if the proposed parcel will not be a stratum parcel.

(2) The building erected on the land comprising the proposed parcel and each proposed lot shown on the location plan must be wholly within the perimeter of that land.

(3) This clause does not apply to so much of any encroachment as is an encroachment referred to in section 38 or an encroachment by the building on to land other than a public place.

3 Location plans for stratum parcels

(1) This clause applies if the proposed parcel will be a stratum parcel.

(2) The proposed parcel must include part of a building and another part of the building must be outside the proposed parcel.

(3) The proposed parcel and that building must be wholly within the perimeter of the site of the building.

(4) Each part of that building and so much (if any) of the site as constitute the proposed lots and common property (if any) must be wholly within the proposed parcel.

(5) Subclauses (3) and (4) do not apply to so much of any encroachment as is an encroachment referred to in section 38 or an encroachment by the building on to land other than a public place.

4 Location plans--encroachments on private land

If the building encroaches on to land other than a public place, an appropriate easement must exist or be created in accordance with section 88B of the *Conveyancing Act 1919* on registration of the proposed strata plan.