2.1 Introduction

The advent of the IBM PC in the early eighties, enabled for the first time, affordable desktop computing for the surveying industry. Over the past decade, the power of the desktop PC has increased almost exponentially, while the price of the hardware has continued to fall.

On the software side, the release of Windows 3.x, Windows NT and now Windows 95 operating systems, has seen development of extremely powerful, yet easy to use, survey, engineering and CAD applications. The intuitive graphical user interface of the Windows family of operating systems, has encouraged many more surveyors to utilise computers in their everyday work.

The desktop PC is now such a common survey office tool that it is rare to find a survey office that does not utilise a PC for its report writing, survey computations and plan preparation. This section outlines some basic concepts in relation to the capture, processing and exchange of digital data for surveyors.

2.2 Digital Data

In the past, a surveyor was called upon to measure, calculate, design and draft plans, typically of real world objects which they surveyed. The resulting product for a client was often in the form of a report, and hard copy plans or maps. Although many of the tasks performed by a surveyor today are essentially the same, the extensive use of computers within the surveying and allied industries has seen the introduction of a new form of final product, digital data.

2.2.1 Data Structure

One of the many advantages of digital data is the easy manipulation of the data by appropriate software packages. When changes are required to a design or a plan the data is simply manipulated in the software package being used. Although the required manipulations in some cases can be far from simple, the ease of change in comparison to traditional methods is significant and can mainly be attributed to the structure of the data.

A surveying software digital data base can be simplified into two main sections, a graphical component and an attribute component. The graphical component of a digital data base usually contains positional and relationship information (typically co-ordinates) for point, line and polygon objects, while the attribute component holds other information relating to the objects. The attribute component usually contains associated textual information such as a description, but the next generation of surveying software should allow any form of attribute data. Eg. Sound, video etc.

Essentially, all surveying software packages hold additional attribute information relating to the data within their data bases. The ease of manipulation and the flexibility of the data is governed by the attributes contained within the data base. Perhaps the two most basic attributes associated with any object within a surveying software related digital data base is the feature code and layer.

The feature code is basically a tag that is used to identify the type of real world object the data represents. Typically, feature codes are assigned to the objects at the time of collection in the field and passed into the digital data base via a data collector. Tagging of the digital data with a feature
code enables manipulation of the data based on the object type. For example, if all fire hydrants within a
digital data base have been assigned the feature code "HYDRANT", then it is a simple task for the surveying
software package to locate and manipulate only objects of that type. The feature code is often used to define
other attributes associated with the graphical object, such as symbology and other display characteristics.

Layers can be described as logical groupings of feature codes to form themes of information. For example, all
feature codes associated with water (HYDRANT, METER, PIPE etc.) could all be associated with the
"WATER" layer. Most surveying software packages enable layers to be turned on and off, thereby changing
the displayed data. The ability to turn on and off different layers of information enables different themes of
the data to be displayed and can obviate screen clutter.

Fig. 2.1 shows schematically the layering concept.

2.2.2 Data Flow

The flow of digital data from a surveying office to other organisations follows the same path as that of
traditional hard copy data, however the handling and transport media are now far more flexible. A single
floppy diskette has the capacity to store many plans or maps in a digital form.

The wide spread use of digital data has smoothed the flow of data between surveyors, their clients and allied
professions. It is not uncommon for a surveyor to provide an architect with a detail and feature survey plan in
digital form, for the architect to create a design on a separate layer and then pass this updated digital data on
to an engineer so that they can add their civil design on yet another layer. All this can be done without a
single hard copy plan being produced, although usually a hard copy plan is provided to verify the digital data.

The following data flow diagram is far from extensive but shows the surveyor as the central hub to the flow
of digital data.
The surveyors' knowledge of co-ordinate systems and appreciation of positional accuracy make them ideal leaders in the administration of digital data. Each of the lines in the Fig. 2.2 indicate two way digital data flow, however, the flow of digital data along many of these lines is still a thing of the future. Although not shown on the diagram, digital data already flow between many of these organisations.

2.2.3 Data Exchange & Standards

Unlike traditional plans and reports which can be easily interpreted by the intended recipient, digital data must be provided in a format known to the software package for it to be able to interpret the data. This requirement has led to the development of digital data exchange formats and standards to facilitate the exchange of data between various software systems.

Digital data exchange standards can be categorised in the following way:

- Australian published standards. Eg. AS2482, SDTS etc.
- Defacto standards. Eg. AutoCAD DXF, MicroStation DGN etc.
- Regulated standards. Eg. Melbourne Water asset collection etc.
- Organisational standards. Eg. Client defined specifications

Although a number of Australian Standards for the exchange of digital data have been defined, defacto standards are still the most common means of digital data exchange between the surveying and allied professions. The most common defacto standard for the exchange of CAD type data is AutoCAD's drawing interchange file (DXF). Although far from elegant, the early arrival on the market and user numbers has made DXF a major exchange standard.

With more government and utilities organisations wanting to be provided with digital data, surveyors are faced with the problem of providing different exchange formats for different organisations. A single exchange standard format that is acceptable to all government and utilities organisations is what we should be striving to achieve, as the cost of developing specialised data exchange software is prohibitive.
When dealing with allied professions, the organisational standard is perhaps the most common standard the surveyor will encounter. An organisation standard simply means that the client has a set of rules within their organisation that define attributes for objects such as codes, layers, colours, sizes etc.

It is essential that the surveyor knows the required exchange standard before undertaking any work as this could affect the feature coding, processing and exchange mechanism utilised by the surveyor.

In relation to the transport side of digital data exchange, there are a number of alternatives to the transport medium which include the following:

- CDROM
- Floppy diskette (5 ¼” and 3 ½”)
- Tape
- Modem / E-mail
- Zip Drives

The most common transport medium is the 3 ½” floppy diskette, however modems are also used to exchange digital data.

A typical problem associated with the exchange of digital data is the size of the physical file. The DXF exchange format is well known for the physical size of the exchange files required to transfer even small amounts of digital data. Typically, a 3 ½” floppy diskette has a capacity of 1.4Mb however it is common for a DXF file to be many times this size, therefore making it impossible to transfer to a single floppy diskette.

The use of file compression software tools can help overcome this problem. Tools such as LHArc and PKZIP can compress DXF files to a fraction of their native size allowing in most cases, even the largest files to reside on a single floppy diskette. These tools can also provide a level of security for the surveyor during the transport of the digital data, via password protection and also by Cyclic Redundancy Checking (CRC) which ensures that when a file is decompressed, it is returned exactly the same as before it was compressed. These types of compression tools are ideal for the archiving of old data files allowing much more data to be stored on the backup media and even allow large files to span a number of diskettes.

2.3 Surveying Software

To allow the surveyor to achieve the processes detailed in previous sub-sections, the extensive use of surveying software packages is essential. There is a wide range of surveying software available in Australia and local surveying software developers are acknowledged as world leaders in this field. The functionality of the software required will vary from company to company, Fig. 2.3 shows the relationships between surveying software, surveying sensors and other software systems.
The following items should be considered when evaluating surveying software. The importance of each item will vary with the surveyor, the type of work and clients that they service. Consideration should be given to both long and short term requirements of the surveyor.

Ease of use:
- Graphical User Interface (GUI)
- Totally integrated modules
- On-line help
- Flexible feature codes and layering

Data Collection and Setout:
- Operation and feature coding capabilities (speed of collection)
- Support for different data collectors
- Automatic attribute generation
- Data transfer integrity

Map Projections:
- Full rigorous geodetic computation
- Support for all projections needed

Computations:
- All required computation methods
- Extensive reporting
- Adjustments and transformations

Data Exchange:
- Bi-directional exchange
- Support for CAD, GIS and other application software
- Level of exchange support
Surveying CAD

• Fonts supported
• Symbols supported
• Line styles supported

Additional functionality:

• Contouring
• Long/cross sections
• Alignment design
• Volumes

The above list is far from extensive but is a reasonable starting point. Consideration should also be given to data base capacity if large projects are undertaken, as well as to the availability of all required functionality from a single vendor. This single vendor solution can have significant savings in purchase and training costs.

2.4 The Future

The question of "where to from here?" is one that cannot be accurately answered, however like all professions surveyors will be guided by new technologies.

One of the most talked about technologies over the last few years is the Internet. This global network of computers will have a major impact on the surveying and allied professions. The publication and transfer of digital data across the globe opens the doors of opportunity for everyone. Perhaps the most useful feature of the Internet is E-mail. E-mail is already extensively used to transfer digital data between organisations. This medium allows the transfer of a project completed by a surveyor in one part of the world to the client’s desk on the other side of the world within minutes.

The digital lodgement of plans etc. will be mandatory and most likely be performed from the surveyor's desk, as will the searching and retrieval of required survey information. The floppy diskette as the preferred transport medium is rapidly being replaced by the Internet and E-mail.

The standards for the exchange of digital data is an area for much debate. Although a single uniform exchange standard for all government and utilities organisations would be ideal, the reality is that such an agreement is unlikely. However, commonality in exchange standards amongst these organisations must be sought.