

The Role and Relationship Between the Land Surveyor and Architect

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Abstract

In modern times the use of a survey plan is paramount in construction. Architects and Civil Engineers make use of these plans to aid in the control of design and setting out purposes. The survey plan can be used for every stage of design from planning to construction design.

In producing surveys and setting out the design based on the survey, there will always be a relationship between surveyor and architect. It is not always a harmonious affair where every stage runs to plan. There are issues that cause concern from a surveyor's point of view and which can affect the way architects and surveyors co-exist. There are points concerning survey specification standards, mapping grids and setting out plans, which are the main components that link both parties together.

There seems, in my experience, no consistency in the way individual architects operate and design new sites for setting out, which in turn makes every survey a hazard in the way it is conducted. This is not meant as a disparaging remark but just a generalisation drawn from life experience, where education of the way a surveyor works is needed to be able to ask the right questions. This dissertation will analyse the relationship between the two parties with a hope of educating both parties in providing the correct information from the surveyor to the architect and the architect to the surveyor. It will provide a way of analysing the way the two parties work and if a standard for working can be implemented.

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Author's Declaration

The Role and Relationship Between the Surveyor and Architect

Final Year Dissertation

For

BSc (Hons) Surveying and Mapping Sciences

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I hereby declare that the content of this dissertation is wholly my own work, except where otherwise acknowledged, cited or referenced. The main body of this dissertation is approximately 10750 words in length.

Signature.....

Date.....

CHAPTER ONE

1.0 General Introduction

There are many reasons for surveys of the land to be undertaken, none so greater than the need for planning for construction.

The Institution of Civil Engineering Surveyors (n.d) describes Land Surveying as:

The measurement, definition and portraying, either digitally or graphically in the form of maps or plans, of the physical features of, and the structures on the earth's surface.

With a scaled land survey any design can be realised from accurately knowing the size and area of the site, the relief of the ground, drainage details, vegetation, boundaries and so forth. Land surveys supply many facets of detail of the environment that is being mapped. The amount of detail and accuracy is based on the specification of the survey set by the client.

This dissertation is based on the experience and problems of life working as a land surveyor and daily dealings with clients by way of supplying the plans for construction or setting out from the design plans, post planning.

The main profession to utilise the services of a land surveyor is that of architects. Working as part of a small land survey company, the main bulk of work comes from architects, whether they employ the service direct or a development company requests a survey but with the finished data making its way to the architect. The surveyor is then often employed by the development company to set out the architect's design.

The survey could be as small as a garden to the site of a complete new housing village consisting of many acres of land. The specification for each survey is not always the same and the detail to be surveyed varies in type and quantity. There are standard survey specifications, which will be discussed in more detail later, but they act as guidance rather than a strict regime. This is where the professional relationship between surveyor and architect is tested. All too often a draught of the architects' specification is forwarded with the enquiry for the survey. It may not be a reasonable specification, with details requested that are beyond what is needed such as asking for accuracies that are unachievable but

still wanting the quote for the survey as minimal in price as possible. Is it up to the surveyor to contradict their needs or in a more professional sense give advice based on experience and skill, with fear of upsetting or losing their client? The answer is not always straightforward and needs dissecting and examining.

The post planning side of surveying in the guise of setting out involves interaction with the architect by way of understanding the construction plans, which is not always an easy task. Frequently setting out data is left off or dimensions do not tally, which ultimately costs time and money. This is not negligence in most cases but a misunderstanding of how setting out is achieved in the field.

Consideration of the technology used in surveying and the adopted methods of use needs some understanding as these can have ramifications in terms of cost, accuracy and quality of product, with areas like Global Positioning Systems (GPS) changing the way survey control is processed.

This dissertation hopes to find out the flaws in the relationship and how to correct or educate both parties, not only for the benefit of the surveyor but also the architect. This in the long run will make for a more professional relationship with a commitment of trust between surveyors and architects alike.

1.1 Aims and Methodology

With so many facets concerning the relationship between surveyor and architect and so many differing types of work, it is prudent to stick to the main areas that affect the surveyor at work. An insight into specification standards whether they are set by a professional body or ad hoc by the surveyor or architect. The requirement for surveys to be mapped onto the OSGB36 control network, illustrating the flaws in surveying and setting out. The problems encountered in setting out plan information and the importance of topographic surveys in the aid of design and setting out by way of case study.

1.2 Hypothesis

The hypothesis for this dissertation is whether the problems encountered by both architect and surveyor can be remedied.

1.3 Critical Literature Review

The literature content in this subject area is minimal in content. The subject area is not based on facts but on problems surrounding working practice. There were different areas of media to review however that aided in research.

1.3.1 Technical Document

The Royal Institution of Chartered Surveyors. (1996). Surveys of Land, Buildings and Utility Services at Scales of 1:500 and Larger. London: RICS Business Services Limited. 2nd Edition.

As a basis for understanding land survey specifications, this document is a valuable piece of research literature. The document was introduced by The Royal Institution of Chartered Surveyors (RICS) to guide clients requiring land surveys, but also acts as an essential tool to both the surveyor and client in setting a specification, from setting the site boundaries to be surveyed, accuracy in both survey control and plan feature, details to be surveyed and presentation of data. This document was of significant importance as it allowed me to identify the needs for a survey specification and to contrast with specification input from other professional bodies. It does however lack in the area of measured building surveys, which in recent years has undergone certain changes in method and approach in both software and survey instrumentation.

1.3.2 Interviews

Interview a) Mr. John Tew of Tew & Associates. Interviewed 28th April 2006.

I spoke with Mr. John Tew over the telephone. Mr. Tew is a director of an architect firm, which is well known in Northampton. I have at times carried out land surveys for Mr. Tew and set out construction design from plans produced by his associates. I asked questions on how they set their survey specifications, why they mapped onto National Grid co-

ordinates, what specification did they have for survey control and does the Royal Institution of British Architects (RIBA) give any guidance. These questions were relative to subject area of this dissertation. Further questions were asked on university education in surveying and their method of producing co-ordinated setting out plans. Discussions of the associated problems lead to further notes on the subject. All these questions and answers gave valuable research into the architect's knowledge of surveying.

Verbal permission agreed by Mr. Tew to use the interview in this dissertation.

**Interview b) Mr. John Dorward, Civil Engineer of Pell Frischmann Consultants.
Interviewed 27th April 2006.**

As a comparison, I interviewed Mr. John Dorward in person. I felt this interview seemed appropriate as surveyors often deal with civil engineers as well as architects. I asked similar questions to those in interview a, with regards to survey specifications from the Institution of Civil Engineers (ICE). I asked how they draw up the setting out plans where three dimensional design packages are used and again why they map to National Grid co-ordinates. The interview gave a good comparison of how the two professions work, where surveys and design are concerned.

Verbal permission agreed by Mr. Dorward to use the interview in this dissertation.

**Interview c) Mr. James Kavanagh of The Royal Institution of Chartered Surveyors
Geomatics Department. Interviewed 2nd May 2006.**

I interviewed Mr. Kavanagh by telephone to ask his opinions on survey specification. He was helpful and explained his thoughts and offered some advice on other specifications. He explained about future developments for specifications being set by the Institution and advised about revised specifications, particularly for measured building surveys.

Verbal permission agreed by Mr. Kavanagh to use the interview in this dissertation.

1.3.3 Journal Research

Roberts, Andy (2006) Survey Drawings – an Oxymoron. Geomatics World, Volume 14, Issue 3, 29-31.

The article delves into the subjects of scale, accuracy and precision and how clients misunderstand these concepts. It combines fact and opinion and places emphasis on the concept of Computer Aided Design (CAD) defining scale and accuracy by 'zooming in', which is pointed out as not true. The article explodes the myth of 1:1 survey through means of CAD. The article gives a simple knowledge of accuracy levels and how they should be interpreted. All in all it states some of the problems that need addressing on this subject.

Collins, Patrick (2006) Measured Building Survey. Geomatics World. Volume 14, Issue 3, 32-35.

This article addresses the lack of professional standards of surveyors. The author talks about measured building surveys and a brief history, the lack of education in this subject and inconsistency in the quality of work. The author places the onus on the surveyor as well as the client in providing a quality article in terms of surveying. Reference is made to the new software technology that perhaps does not quite hit the mark, although having myself used software of this ilk, it is not necessarily a true remark. A comment is made on the different groups preparing measured building surveys and thus the inconsistency coming through. All told, the article is slightly negative from a point of view that the author is suggesting that not enough training or education is given in this surveying form. The problem is that times have changed, where no longer is it the norm to tape and sketch surveys, but it is most likely to be surveyed using state of the art survey instrumentation. This article shows that not all problems stem from the client but that the surveyor may be as much to blame. This article has aided in my dissertation, not so much in research, but more in compounding the fact that the problems that I suggest that exist, really do exist.

1.3.4 Internet Search

<http://www.ordnancesurvey.co.uk/oswebsite/gps/information/coordinatesystemsinfo/guidecontents/guide7.html#ns>

This website gives a good knowledge on geodesy and in particular transformation from geodetic to Cartesian co-ordinates. It mentions the subject of scale factor, National Grid mapping and working with Global Positioning System (GPS). It is a good site for understanding the process of mapping to the National Grid, which helps the understanding from a basic knowledge building up to a more complex understanding. In viewing it in a basic concept, then beginners to geodetic surveying can gain a reasonable knowledge by reading through the areas on this subject. It is not too scientific in its content, which can put readers off if it becomes too much to take on board. It has helped in providing the necessary facts attributed to scale factor error.

1.3.5 Experience

Highly critical to this dissertation is my own experience working for a land surveying company for many years. I have experienced many problems, based on many factors, most of them discussed in this dissertation. I have drawn a great percentage of my research from these experiences that I have encountered. This dissertation has added interest for myself due to personal experience dealing with architects on a day-to-day basis.

CHAPTER TWO

Specification

2.0 Specifications Introduction

A specification is an agreement either verbally or written that ensures that both parties in any form of work delivers what the other requires. Without a set specification there will always be a problematic situation ready to surface.

In terms of surveying it is absolutely paramount that a specification of some type is set out before a survey is carried out. If some detail has not been surveyed on site that was requested then there is case for remediation, likewise if the client complains that they would have liked something else surveying that was not on the specification then there is a case for the surveyor. Either way a specification settles the dispute.

One of the problems with setting specifications within surveying is the vast amount of information to be supplied and the way in which it should be carried out. It is difficult to express every feature to be surveyed, especially when the person asking for the service is not a surveyor.

In my experience, the enquiry letters from the client within reason has the specification attached. In the main they are usually very limited in what they require and often more information is required from the client to be able to supply an accurate quotation. Some clients do supply a separate specification that is concise and to the point, which helps to supply an accurate quotation and carry out the necessary work in the field but these are few and far between.

2.1 A Typical Problem

A client makes an enquiry for a measured building survey including floor plans and elevations to be carried out on a certain building. The enquiry does not make much reference to any specification only in saying which floors and which building is to be surveyed. Herein lies the problem.

There are many facets to producing floor plans, which may include production scale, levels, door and window heights, overhead features, fixtures and fittings and so forth. The

point is that floor plans can be simple or complicated where by just requesting a floor plan is not nearly enough information.

Acting in a professional manner would mean a telephone call to the client to ask for specific requirements. Invariably the client will say 'yes' to every question asked, which they are entitled to. However, a problem could arise when other surveyors quoting for the survey do not make the telephone call to the client and provide a quotation on a basic survey. All things being equal will mean that the surveyor who did not make the telephone call will be awarded the job on the basis of them providing the lowest quotation.

The impact on the architect is that they will most probably receive a survey that is not fully what they would have liked. This can then cause a dispute between the two parties, which will most likely end in remediation to keep good relations or the client paying an extra over charge to complete the survey. Either way the architect or surveyor loses out. This situation need not happen if the architect had set out a detailed specification in the first instance.

2.2 Who Produces Standard Specification?

The professional body of surveying is known as the Royal Institution of Chartered Surveyors (RICS) who state (RICS, 2004 (a)):

RICS is the leading source of land, property, construction and related environmental knowledge

The RICS supplies a document called 'Surveys of Land, Buildings and Utility Services at Scales of 1:500 and Larger' which is described as (RICS, 2004 (b))

Millions of pounds can be wasted by inadequate or inaccurate briefing at the survey stage. This practical working document helps property professionals to avoid these hazards, offering a standard method of defining large-scale surveys for the detailed design of construction and development projects.

A flexible approach has been taken to allow 'tailor made' specifications to be created which meet exact survey requirements. A user guide is included alongside the specification, providing information and guidance on each clause.

The RICS produce this document as guidance for client and surveyor, which can help in implementing a specification. Interestingly the Royal Institution of British Architects (RIBA) does not set a survey specification/guidance document akin to the RICS¹. Moreover, not only does RIBA not produce a specification standard, but according to Robin Jones (Jones.R, Interview 26th April 2006) of the Institution of Civil Engineering Surveyors (ICES) neither they nor the Institution of Civil Engineers (ICE) produce one either.

Working for a land survey company I have encountered set specifications from larger companies and corporations such as the Highway Agency or Environment Agency, who supply a very detailed specification. These companies are generally engineering consultancies and thus have more knowledge from an educational level of surveying.

2.3 A Common Specification

In the case of most architect firms, the survey specification is of an *Ad-Hoc* basis, where the details that are required are set out, but usually in not much detail. In most cases the survey control is not mentioned, the level datum is not mentioned and usually only special requirements that are additional to a standard survey are specified. In a way it provides a way forward, but then at the same time it does not outline everything. This leads to the problem of; how would someone without knowledge of survey skills know exactly what they require?

After speaking to Mr. John Tew of Tew & Associates (Tew.J, interview 28th April 2006) he advised that they set their survey specification by stating exactly what they want and leave the survey control to our discretion, so in respect it is an *Ad-Hoc* specification. But this places a certain onus on the surveyor. Where does the surveyor derive a specification for survey control? Again we are led back to the RICS document that gives guidance on accuracy levels of control. How many architects use the RICS document can only be ascertained by a poll, but according to Andy Roberts, who is a Land Surveyor and Business Manager at MBS Survey Software, out of over 100 seminars aimed at architects, there was only one architect practice that had ever heard of the document. (2006, p30)

In theory it is not the RICS that should be controlling how architects set their specification, it should be RIBA, but according to Mr. John Tew (Tew.J, interview 28th April 2006) RIBA

¹ E-mail sent to RIBA to gain information asking of such. information. No reply given. Information sourced from Mr. Tew.

do not produce any valid documentation for specification. Non-provision of a specification leaves the system somewhat lacking on the architects behalf.

In theory the professional bodies that govern architects and engineers should perhaps each produce a specification or guidance for requesting survey work, but then too many documents could cause confusion or disparity

2.4 'The RICS Surveys of Land, Buildings and Utility Services at Scales of 1:500 and Larger' Document

This document has been mentioned frequently, but of what benefit is it to all parties?

The document states that (RICS, 1996 (c) p vii):

The specification may be prepared by the Client (the individual or organisation requesting survey information) or by the Surveyor (those will be tendering or undertaking the provision of survey information).

As is indicated it is for the benefit of both parties, so where a client maybe unsure as to certain parts, then the surveyor can fill in the rest from their expertise or experience. It is not totally rigid in its approach but allows for input from either party, for example, when reference to survey control is made, there are stated accuracy levels but also an input from the user to state a suggested accuracy level.

It forms a contract as such, where every facet is detailed or enabled for compromise between parties. The reasoning behind this document is basically to ensure that the survey is carried out to the exact requirement of the client. If at the end there are problems with the survey then the document acts as a form of resolve, especially if the situation ends up in a courtroom.

The document is informative in description, where it mentions certain areas that can be curtailed, such as the type of permanent control marker choice.

It covers every aspect of the survey from stating where the survey boundary lies to presenting the data.

The section on Measured Building Surveys is perhaps becoming a little dated, due to the advancement in surveying technology. The method of surveying has changed due to software development, where special software has allowed for the drawing of plans in the field. The software in general allows the user to survey in a hybrid fashion, where controlled and taped measurements are combined and thus accuracy levels are not standard on any single survey.

A new specification document for measured building surveys is forthcoming due to the new software development and the recognised aspect that measured building surveys have become a separate part of surveying. (Kavanagh.J, interview 2nd May 2006)

2.5 Specification Solutions

The right specification is important when sending an enquiry for a survey. It has been known for firms to be given a bad survey and then set an extremely rigid specification when it is too late. Some firms set complicated or very near unattainable accuracy specifications, especially when to achieve these accuracies a very high quotation would have to be submitted, when often there is not enough funds allocated in the budget for this part of the project.

The RICS document should be revered as the way to go forward when setting specifications. The document is concise and adaptable, giving explanation along the way. The fact that it is not widely known needs to be reasoned, which is probably explained by the fact that the document is not distributed freely. If it was free, then the RICS could distribute it to firms, which would then make them aware and might possibly use it to set specifications.

One solution is for the survey firm to advise their clients of this document for future use. This would set a standard when quoting for surveys or even set up a relationship where the client knows that they will receive a quality product and thus keep using the same surveyor. It could create harmonious relations, where the surveyor is able to approach the architect and advice without feeling that they should not be telling the client what they should be doing.

The surveyor however, should always act in a professional manner when a client requests a survey without supplying a suitable specification. A telephone call to discuss

requirements should always be made, where the client if unsure should be advised on the level of detail that they would receive. At the very least, the amount of detail should be set out in the quotation, so at least the client has an idea of detail to be surveyed.

On reflection, the architect should be aware of specialised specifications aimed at their industry, whether RIBA or RICS should make them aware is a discussion for another day, but at the very least RIBA should advise their members to purchase the RICS document to prevent any unnecessary problems that could end up in court.

It is also the surveyor who should adopt this document as their way of setting out what they will do in producing the survey, whether they are members of the RICS or not. Both parties will be carrying out their duties to a professional standard set by the main professional body of surveying and thus maintain good relations.

Most of all, a lot can be said of communicating with the client and finding out their needs. This will iron out most anomalies and within reason set an amicable relationship. When inspecting complicated specifications, it can sometimes be a little overawing trying to take in all aspects, but usually a call to the client can eradicate the obsolete parts of the specification. A chat with the client will also let the surveyor understand their needs, so that advice may be given that could help formulate the correct specification.

CHAPTER 3

Scale Factor

3.0 Scale Factor Introduction

Working on a day-to-day basis surveying sites and setting out, National Grid (NG) co-ordinates play a large role in the mapping process. More and more clients are requesting for surveys to be mapped on the NG rather than an arbitrary or local grid.

Global Positioning Systems (GPS) play a large role in this factor, due to the costs of surveying in GPS coming down as equipment prices fall. Utilising GPS, the area to be surveyed is almost instantly co-ordinated on NG co-ordinates (post processing of information is required in most cases) thus making it an intrinsic part of GPS surveying. Firms that adopt GPS will instantly be producing surveys on NG and thus producing the problem of scale factor into the survey plan. Scale factor can create numerous problems from the surveying, planning and setting out tasks that are mainly encountered by the surveyor. The architect is rarely aware of these problems without the surveyor informing them.

3.1 Scale Factor Background

The world is not flat but it is more spherical in shape. In correct terminology the world is an oblate spheroid. If the earth were flat, mapping would be a simple task using only Cartesian² co-ordinates to express co-ordinated points, where X, Y and Z in metre values are used. The earth however is mapped using geodetic³ co-ordinates that are measured in latitude and longitude angular values. The framework consists of parallels and meridians of latitude and longitude and is known as the graticule (Figure 3.1)

² A co-ordinate system, consisting of an X and Y perpendicular axis, where X can be named as Eastings and Y can be named as Northings.

³ An angular co-ordinate system, where the origin is the centre of the earth. Northings and Southings are measured in Latitude and Westings and Eastings are measured in Longitude.

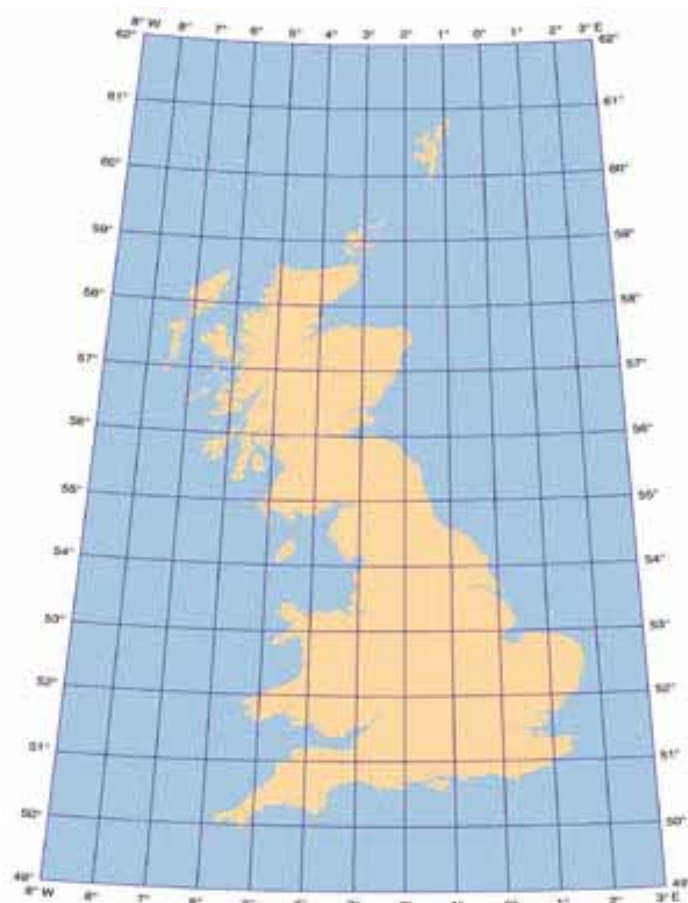


Figure 3.1 The graticule of Great Britain. (Ordnance Survey, 2006(a))

The main geodetic co-ordinate system used to cover the entire planet is known as the World Geodetic System 1984 (WGS84), which is a best-fit solution to map the earth. As pointed out the earth is not a perfect sphere and so we use various spheroid models for the entire planet. The spheroid model for Great Britain is known as the Airy Spheroid.

To convert geodetic co-ordinates to plan co-ordinates is a complicated task that requires a projection to represent the earth's surface as a plane. Fig 3.2 shows Great Britain as mapped onto a plane surface.



Figure 3.2 The National Grid of Great Britain. (Ordnance Survey, 2006 (b))

There are various map projections, and similar to spheroid models there are particular projections to maintain certain aspects such as area or shape. Countries that are thin and long generally use a Mercator projection or a Transverse Mercator like Great Britain. The projection process is how scale factor is introduced. It is impossible to project geodetic co-ordinates to plan co-ordinates without causing distortion in the plan, as is stated by the Ordnance Survey (2006 (c))

When features on the curved surface of the Earth are represented on a plane surface, distortion of distances, angles or both are inevitable

In simple terms, it is similar to laying an orange peel flat, where you will find that it creases and shrinks.

The scale factor changes for any point on the plan, so that there is no constant factor. Therefore any distance measured on the plan needs to be divided or multiplied by the scale factor to gain the true distance.

To emphasise this point the Ordnance Survey (d) (2006) proclaim that:

The stated scale of an Ordnance Survey map is only exactly true on these lines of true scale, but the scale error elsewhere is quite small. For instance, the true scale of Ordnance Survey 1:50 000 scale map sheets is actually between 1:49 980 and 1:50 025 depending on easting. (Ordnance Survey, 2006 (d))

This statement hi-lights the inherent flaw of surveying onto the NG.

3.2 Surveying

In days gone by the recognised way to survey onto the NG was to occupy Ordnance Survey triangulation pillars or stations and traverse into the site. A scale factor was calculated for that particular area and used to calculate the survey control co-ordinates. This operation could be fairly expensive to perform and thus minimised clients requiring surveys on NG. Ideally it is of benefit to have a survey that can be realised within the rest of Great Britain, but it is not entirely necessary.

GPS has made that method redundant to the point where triangulation pillars and stations are no longer maintained and therefore should not be used to co-ordinate surveys.

Scale factor can become a problem when producing a survey. The client, without being disrespectful, usually does not fully understand the concept of scale factor and Geodesy, they are not surveyors and hence do not require that specialised knowledge. The client tends to think that this will be like any other survey but is just related to a grid that can be connected to the OS mapping system. The concept of spheroids and projections is alien to their working minds. They measure in millimetres and metres and so therefore everything should be true scale.

In most cases, mapping a survey to NG is still a costly exercise. Small survey companies do not generally have the need for GPS equipment, due to the total cost of ownership. To purchase equipment, train personnel and find the right sort of work takes a lot of investment. When most of the work is for architects surveying smaller sites, particularly in urban areas where most sites do not have good satellite reception, there is not much call for GPS. To buy the equipment would add cost on to any survey to pay for the price of purchase. The company that I work for will contract a GPS trained surveyor in for a day to

relate the survey to the NG. Therefore for what might be a two day field survey becomes a three day field survey in terms of cost. This is cost that in all eventualities is not needed, as what is the necessity to have for example a small survey of a factory unit and surrounding area to be mapped onto NG.

3.3 Planning

If the client requests a survey on NG and no more questions are asked then within reason the survey will be supplied with a scale factor incorporated, thus in theory it is not an exact scale survey. The problem or the unseen problem is the design stage where the architect is designing a 1:1 design onto a plan that could be between 0.9996 to 1:1 scale.

This could have ramifications on design, where every one hundred metres measured on the ground could at the extreme measure 99.96 metres on the plan, which works out forty millimetres per one hundred metres scale error. This is not so detrimental if the client realises or understands the fact that this error is present but it will always cause problems when the setting out is applied. As with all scale error it is a function of length, hence the larger the site the worse it will have an affect.

In my experience a question posed to the client pre processing of the data usually can eliminate this problem. A suggestion that the scale factor should be removed from the survey so that the approximate origin is held in the middle of the survey is posed. The usual response is that of mixed feelings due to not understanding the theory behind it. It has been known to send a plan out with scale factor taken out, then a month later re-issued with the scale factor in and then within another month the scale factor removed once again. This is even after a discussion with the client explaining the situation and trying to educate.

3.4 Setting Out

Design plans that are on the true NG co-ordinate system can cause complications on site that are difficult to resolve. On a normal site that is on an arbitrary grid system, where there is no scale factor present, the computation of distance between survey stations co-ordinates will be of a true distance as the distance measured will be what is calculated. On a NG system with a scale factor, the measured distance will in most cases be larger than the calculated distance between co-ordinates. This opens up a plethora of problems.

Firstly the design, as already mentioned, is placed upon the plan in its true dimensions and not scaled to suit. The methodology to set out the design can vary but the widely used method is to set out using a Total Station Instrument, where bearing and distance are calculated for any point from the occupied station. The design is then set out directly from the station. If there was no scale factor present, any point can be set out from any station and should still be in the same place, dependant on how accurate the survey control is in the first place. i.e. if a house corner is set out from Station 'a', and then set out again from Station 'b', the house corner should fall in exactly the same place both times. Coinciding with that is if two points are set out, whether from one station or one from one station and one from a different station, the distance should be the same as the calculated value between co-ordinates. This as mentioned assumes that no scale factor is present in the survey control. When the original survey is on true NG then there will always be scale factor present, then there is the problem of the fact that the design is on a 'shrunk' plan. When it comes to setting out from the survey control, which is also affected by scale factor, there are problems when placing the design in the correct place.

On a true scale survey, if a point was positioned on the ground with a check dimension to a surveyed point, then within reason the dimension should measure the same on site. When positioning with scale factor present, then there are certain points of consideration. In order to position the point so that it falls in the same position if set out from any station, then the scale factor must be applied to any calculated distance.

The solution therefore is to apply a scale factor, but this is not necessarily so, due to the fact that if two points are set out with a specified dimension between them, then due to the scale factor, the two points will be affected also. The dimension will not be the same as specified when checked on site. Quite simply, if a building that should be 100 metres long is measured, it will be 99.96 metres long when set out (assuming scale factor of 0.9996). One solution may be to set out one corner, set on this and position the next using a true distance. The distance to the site boundaries will not tally but in this case the error will be minimal.

If the site consisted of two buildings that are each 500 metres in length and in line, much alike to modern day distribution sites, then the gravity of the situation increases. As an example this scenario can be analysed. Fig 3.3 shows the general layout.

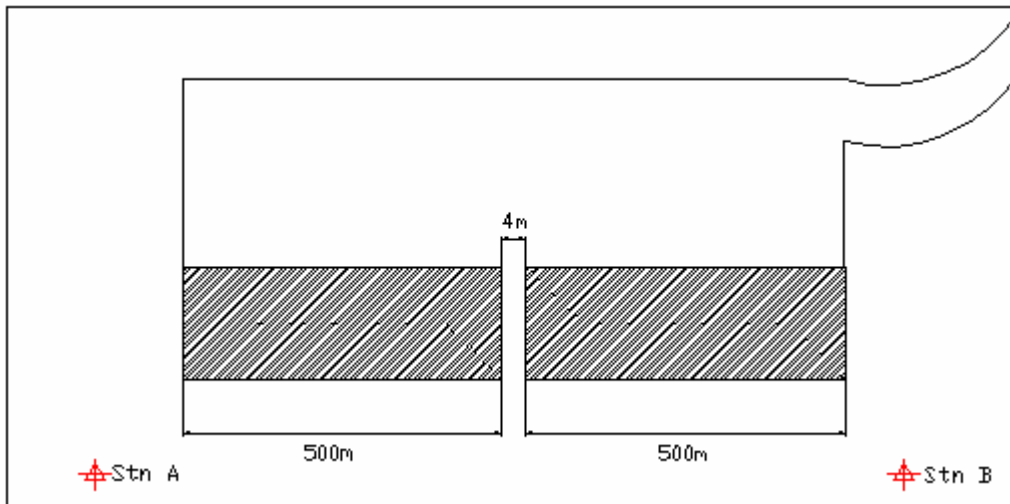


Figure 3.3

The buildings need to be positioned by way of setting out from more than one survey station. In this case we assume that there are survey stations at either end of the site, 'A' and 'B'. Station 'A' is set upon and the corner of one building is positioned and likewise the same with Station 'B'. Each building point is set upon and the end point of each building is positioned. In a case like this the dimension between the buildings would be critical. In this case we will say 4 metres. If the building were set out this way then there would be various measurement errors. Firstly the buildings total length end to end should be 1004 metres. This becomes 1003.598 metres assuming a scale factor of 0.9996. This measurement minus the two lengths of the buildings (1000 metres) equates to 3.598 metres. This is a deficit of approximately 0.4 metres, which would almost certainly be unacceptable.

The only realistic solution would be to set a point in the middle of the two buildings and then set out the buildings from here. This would then leave errors from the buildings to the boundaries, which is inevitable.

3.5 Scale Factor Solutions

There is no real remedy to combating this situation from either party. To have the survey on NG is still essential when boundaries are critical. To overlay on the OS mapping grid on large jobs such as new road or tunnel networks is critical due to its impact on surrounding areas. A tunnel for example has to be analysed for the area that it passes under so that it does not affect the structure above. On smaller surveys, it is not always essential, so as to why it is requested is a question that needs to be answered. In research of this, Mr. J. Tew of Tew and Smith Associates (Tew.J, interview 28th April 2006) was consulted, where he indicated that he thought that all surveys were on NG, as all he wants is a survey on a grid. So there may be misunderstanding of the concept between NG and an arbitrary grid. If this is the case, the reality that the plan may be not be true to scale is not taken into consideration.

On the role of the surveyor when producing surveys on NG, it is really his professional responsibility to ask the question and explain the potential problems to the client about the inherent scale factor problem. One suggestion may be to produce the survey on two grids; NG with scale factor and on a local grid without scale factor, where one should be used on the OS system and the other used for design setting out purpose. Whether this would cause logistical problems is one for the future, but would at least release the burden of setting out problems on site.

On the role of the architect, it would be prudent to set some specification on this subject when required, which does pose the question that if the client wants the survey on NG then there should be no more to it. The survey should be supplied with scale factor. The fact is that most architects in my experience do not fully appreciate the lurking problems in mapping to NG and so by requesting a survey on NG needs a better understanding.

With the future of surveying trending towards GPS and with the advent of OS Net transmitted by the Ordnance Survey, which is a system that allows the surveyor to survey to NG co-ordinates by way of Real Time Kinematic (RTK) GPS methods. The reality is more surveys will be automatically produced on the NG whether the client wants it or not. It may soon become a standard in some land surveying practises. It is a subject that will need more appreciation from both surveyors and architects.

Architects, and in some cases surveyors, could benefit from reading up on this subject. The OS have a very informative website on this subject.

Finally the education of architects at university level in this subject, even at the simplest level would give some background information and hi-light the relevant problems.

CHAPTER 4

Construction Setting Out Problems

4.0 Setting Out Introduction

Every construction project needs positioning on the ground. It is an essential part of the building process. The design needs to be accurately positioned, not only within itself, but also within its surroundings. Everything is connected, where inter-relationships between structures are paramount.

Most construction projects are designed on an original land survey of the site. Utilising the original survey grid, the architect is able to reference any part of the design so that it has a co-ordinate attributed to it. The survey grid is one of the most important features when drawing the setting out plan. It enables the setting out engineer to place the design accurately on the ground. In a sense it is like surveying in reverse, where instead of taking an angle and distance reading to a point of detail and turning it into a co-ordinate, the point of detail is being positioned by turning the co-ordinate into an angle and distance measurement.

The way we set out is not really of concern but the data that we set out from is. All too often the plans that are used to set out from do not contain all the information required, or the information is often wrong. This can cause many problems on site, especially for a small construction company employing an engineer to set out on an hourly rate. If the engineer turns up on site, analyses the plans and finds information is missing, then it becomes a waiting game where telephone calls between engineer and architect need to be made to enable the productivity of the site. The maxim 'time and tide wait for no man' is very apt for construction sites. Contractors start to worry about costs when the engineer is sitting in a cabin waiting for information or even calculating from poorly laid out plans. What these problems are and why they occur need investigating.

4.1 Co-ordination

The fundamental requirement of modern day setting out plans is based on the co-ordination of key features. Co-ordinates for features such as building baselines, road centrelines, drainage positions etc. are needed to perform accurate setting out and further to these, drawings showing finer details of these features. A pair of house baseline co-

ordinates for example, is not of use if a plan showing the remaining dimensions of the house is not readily available.

Along with these plans, survey control needs to be provided so that the co-ordinated points have a means of being set out. Survey control is the only true way of referencing back to the original survey grid. Without these features, life on site becomes a difficult existence, with contractors pushing for everything to be set out yesterday and not understanding or even caring that the information is incorrect or not concise. This in my experience working on small to medium sites has occurred on many occasions.

An example of a plan with limited co-ordinates is shown in Figure 4.1, where as can be seen only certain co-ordinates are placed on the setting out plan. Although there are enough to enable co-ordination of other points by means of intersection, such as point B, there are not enough to be able to calculate all points, such as Points A, B and C cannot be calculated. This would not be a stopping point if the house layout drawing were supplied where dimensions of all the sides of the house were given. Using these dimensions, the remaining points can be calculated by way of trigonometry.

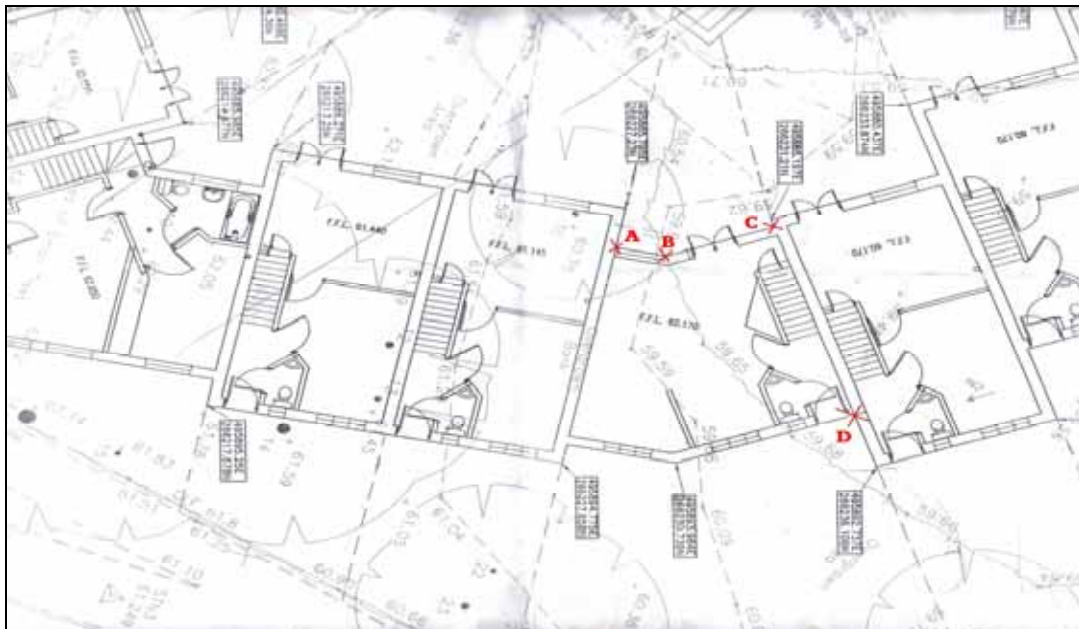


Figure 4.1. Supplied courtesy of David Smith Associates.

The problem with this example is that no house layout plan was available even after speaking to the architect, although a facsimile message was sent with the missing co-ordinates. This in itself lead to another problem, where in this instance, the initial setting

out was for structural piles to be driven into the ground at certain positions. All setting out was now based on these co-ordinates without any check of dimensions. Had the co-ordinates been mislabelled in value, there would be no check between lengths of the sides. If the piles had been positioned in the wrong place it would have led to large remedial costs. Fortunately all was fine, but had all the missing information been labelled at the start and all the drawings issued at the same time, it would have reduced the worrying and time spent on the telephone to the architect.

Plans like Figure 4.1 are common, which in itself is a worrying point because it shows that the person drawing the setting out plan must surely have limited knowledge of how setting out is performed on a practical side. After talking to Mr. John Tew (Tew.J, interview 28th April 2006) he acknowledged the fact that minimal co-ordinates were placed on their setting out plans, but did mention that dimensions were readily placed. He did concede that in recent times he has started to put more co-ordinates on plans. Mr. Tew's son, who also works as an architect, indicated that he did not receive any training at university in surveying. This surely must leave the area of drawing the setting out plans slightly inept in the knowledge of what is needed to be able to set out.

One aspect of this section that needs mentioning, is the concern that some architects still do not use co-ordinated design. The belief that tape measures are used to position design still exists. The technology of today has over ridden that method. Co-ordination allows every feature to be placed accurately, whereas pulling tape measures across overgrown sites is not the best method.

4.2 Dimensions

As with most building construction, a dimensioned plan is produced. From this plan using the baseline co-ordinates and trigonometry procedure all points can be set out. The key point is that all dimensions are given and work. When the dimensions do not add up, again this will cause unnecessary time and botheration. The example in Figure 4.2 shows a typical layout plan.

4.3 Three Dimensional Design

When Three Dimensional Design (3D) is mentioned it becomes more complicated in a setting out sense as opposed to Two Dimensional (2D). No longer are we thinking of just position but of level as well. The level situation takes on a whole new methodology where we are changing the deformation of the land. The information that is given needs to be accurate in order to make the drainage of the roads and land run in the right direction so that no flooding or pooling of water appears. The correct information is critical to the removal and placement of earth to the design level, known as a cut/fill exercise. If the wrong levels are calculated then it will lead to huge costs if the earth volume does not balance, if too much earth is left over at the end of the construction then a removal charge will be incurred, likewise if the more earth is needed, then it will need to be brought in at a cost.

The way the new design works with existing levels needs to be taken into account. This is not always an easy task to carry out, where the plans need to be analysed in both a 2D and 3D sense. To position a road in 2D is simple in comparison, where in 3D the need to find not just changes in geometry but also in height is more of an investigative task. Generally speaking on large road jobs the information will be of a good standard with a Bentley® MX (formerly MOSS) or an Autodesk Civil 3D printout giving road alignment co-ordinates at specified chainage intervals, tangent points of straight to curve and levels at each corresponding chainage. It will also give high and low point co-ordinates and levels. In theory it gives everything that you need to set out a road. When smaller sights have a road structure to be set out, quite often the information is complicated or very convoluted. In some cases the co-ordinates will be on a plan, which will give either the centreline co-ordinates or channel line co-ordinates. The levels will be given on a different plan or on a long section, which is a plan that shows the vertical alignment of the road, giving levels at certain chainages, usually 5 or 10 metres. If, only the centre line is given, many calculations need to be made to work out the co-ordinates of the channel lines to enable profiles or pins to be set out accurately for construction. In order to set out a road it can involve looking at the co-ordinate plan to calculate all points to be set out, then a look at the long section to work out the high and low points and vertical alignment and then finally a look at the level plan to attribute the level to the co-ordinate. Along with this a calculation of the co-ordinates for the high and low spots need to be worked out. All this can take a lot of preparatory work before even a stake has been placed in the ground.

Another factor that can cause problems on site is the realisation of how the existing ground level has an impact on the new design. Fig 4.4 shows an extract from a design plan that shows the design levels for a car park.

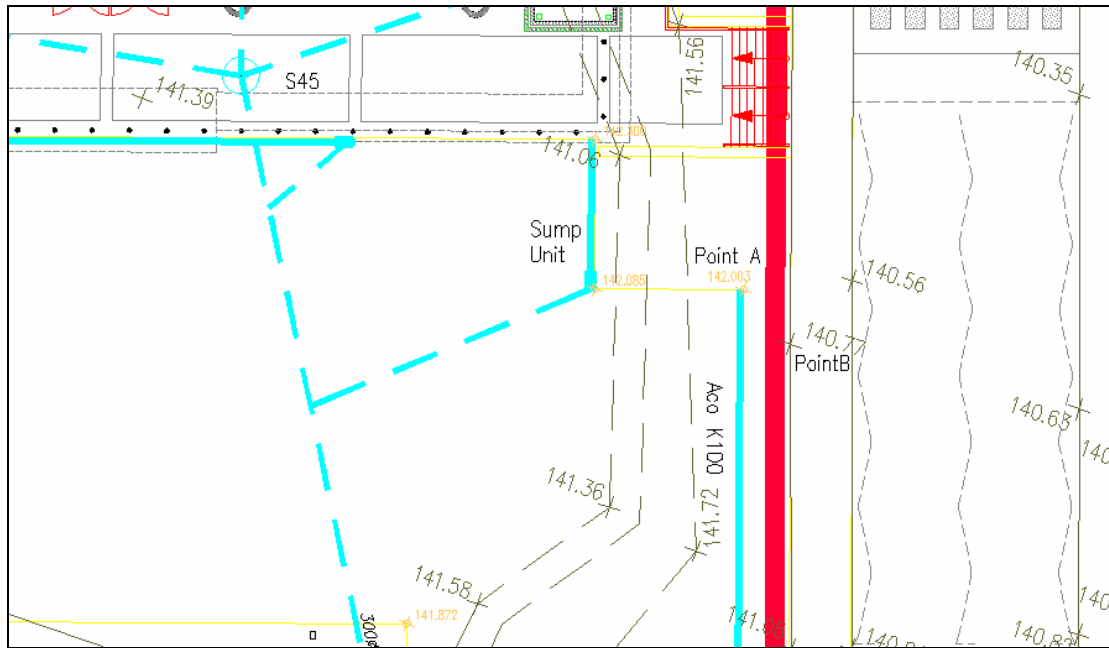


Figure 4.4 Courtesy of Gyoury Self Partnershi.p

The level at point 'B' on the extract shows a level of 140.77metres. The level of the new design next to it shows a value of 142.003metres at point 'A'. This gives a difference of 1.333metres between levels. This is fine until the plan between the two points is taken into account. A distance of approximately 1.5metres can be scaled, which will be reduced allowing for the kerb construction. The gradient of the design to existing is approximately 1 in 1. This is extremely steep and in this instance as the ground was built up to formation level, the bank material was falling off onto the pavement which resulted in a redesign of this part of the site. An oversight like this should be able to be seen before any work is carried out on site by way of 3D modelling software.

Another encountered problem with 3D design is when levels are placed on the plan but with no associated co-ordinate. This happens frequently on car park designs or factory service yards. Generally speaking, co-ordinates will be given on the corners of the kerb lines along with levels, but also levels will be placed between the two co-ordinates without any dimensions or co-ordinates. These levels indicate a change in gradient of the design and so can be of great importance to the relief of the design. The only way to calculate is

to scale off the plan, which depending on the scale the design is produced at, can lead to a significant margin of error. The correct procedure would be to supply either a dimension between the levels or a co-ordinate attached to the level. It is difficult to accurately position a point without a co-ordinate.

4.4 Setting Out Solutions

Some of these problems may seem minor, where all that is needed is to use a calculator or onboard software on the survey instrument to compute the missing points. But some problems where co-ordinates cannot be calculated due to lack of information can be highly detrimental in terms of time and confidence.

The root of the problem as Mr. John Dorward (Dorward.J, interview 27th April 2006) pointed out is the pressure to get plans out. More often than not, the construction work is started whilst the plans are still at the tender stage, which for all intense and purpose are bound to have mistakes. This is a purely financially made situation, where the building needs to be built yesterday. In a pressurised situation, there will always be mistakes made.

How this particular situation can be overcome is possibly unachievable while there is outside pressure forcing the situation. The absolute requirement however, is as soon as a revised plan is available, it is sent to the setting out engineer. Even subtle changes to the plan can have a detrimental affect on construction. I have been on many sites where the plans have been revised frequently. This causes a logistical problem, where the architect will send the plans to the main contractor. The plans are then released to the sub contractor, which are then finally given to the setting out engineer. Sometimes the plans have not found their way through the chain of command to the setting out engineer. The perfect solution would be to have a correct set of plans at the beginning, but money, planning and unforeseen difficulties will probably never let that happen.

How the plans are drawn and the content that is placed on it could be improved. Areas such as mislabelling co-ordinates should be eradicated with automated attribution using

CAD. On the problem of missing co-ordinates however, perhaps more education in setting out technique could be given to architects at university or courses post graduation, after all providing the correct information for the setting out engineer's needs, can only really be ascertained by knowing how the engineer works in the field.

Missing co-ordinates and dimensions can be remedied by putting time aside to logically see if all points on the construction can be calculated. Arithmetic checks such as adding up the dimensions on building layouts to see if they tally or even redrawing the plan free hand to see if all relevant dimensions are available. The outcome will be that if the architect can theoretically work out the information in a site situation, then the engineer will be able to as well.

The more architects embrace CAD technology and realise that co-ordinates are the recognised way of setting out, then less errors and time wasting will ensue.

CHAPTER FIVE

Case Study

5.0 Case Study Introduction

This chapter is based upon experience of working for a development company, where everything concerned in my company's participation is unorthodox. Every so often, the company that I currently work for is requested by the contractor to insert survey control before any setting out is carried out on site. This may appear to be normal practice, but with the knowledge that a controlled land survey has already been carried out beforehand makes it an unnecessary exercise. This case study exposes the flaws in not understanding the use of a land survey to its true potential, conjointly involving planning and setting out.

5.1 Background History

The contractor is a builder and designer of large retirement flat complexes. These buildings are usually very complex in shape and fairly large in size. The contractor originally requested my company to set out the grid lines of a building so that the ground works company's engineer could use the grid to set the building foundations out from.

The building was not co-ordinated in any way, but was dimensioned off features such as fence line corners or back of pavements. The setting out method used was to position the building grid off of these features. This was a complicated task, due to certain factors. Firstly the contractor had erected hoarding around the entire site, which made it extremely difficult to position any building point accurately due to restrictions in measurement of features outside of the hoarding. Secondly the points that the building was referenced to were not altogether the most suitable for dimensioning from, such as neighbouring houses, which were inaccessible and sometimes to new fencing that had not even been erected. Thirdly most of the reference points had been destroyed when erecting the hoarding or clearing the site. These factors meant that it became a difficult process to set out a complicated building to any real accuracy.

The contractor requested a temporary benchmark (TBM) to be installed on the site, but as there was not any survey control shown on the setting out plan, then the method agreed between contractor and surveyor was to establish a TBM using the levels off existing

surveyed manhole covers. This is a slightly crude method to use, where in reality the survey control for the original survey should have been used to ensure accuracy.

These methods were used on various sites and were always deemed as a difficult job by the surveyors involved. If the building was co-ordinated, the task could be carried out in half the time with the knowledge that it is in the correct position.

On arrival on one site, it became apparent that this task could not be carried out. The site had not been cleared properly, where a large spoil heap was in the location of the new building. The dimensions to position the building were a long distance away and some points of reference were on the boundaries of a wooded area. The result was that it could not be carried out on that particular day. In resolution I came up with the idea that if the boundary was re-surveyed by putting fresh survey control in, then the building could be drawn onto the boundary survey using CAD back in the office. This would be a simpler cost efficient exercise and would give a better result due to the fact that the building is easier to move in CAD than on the ground. The building could then be co-ordinated in relation to the fresh survey control. These co-ordinates could then be issued to the ground workers engineer to set the building out directly. Each job was carried out in that manner there after.

This new method cut down the time from usually two days on site, to half a day on site and half a day in the field.

5.2 Correct Methods

The methodology always seemed unorthodox in its application, but as the client wanted it carried out this way, the surveyor could hardly argue. The reality of the situation is that the contractor already had a land survey of the site carried out each time they bought a new site. The usual approach to design would be to use the land survey as a base model and co-ordinate the design on the original survey grid. The design could then be set out from the survey stations directly and accurately. Had this been the case then there would have been no need for our company to have any involvement in the process. Instead the contractor was paying for two surveys, and two design processes.

5.3 Reasoning

After numerous meetings with the contracts manager, I remonstrated the fact that the setting out method could be improved with input from the architects. The contracts manager appreciated the fact that they were paying for a service twice but conceded his hands were tied, but would suggest to the planning department that we should carry out the original survey in future due to some previous surveys not being the best in quality. He did suggest however, that our involvement did act as a check survey.

The reasoning behind this convoluted process seemed to be the misunderstanding of the use of survey control and the associated land survey. The fact was that the contractor had all the necessary information to be able to co-ordinate the building off of the original survey, without the need for any other survey work. With the knowledge of survey control and how grid systems work, all that was needed to enable setting out was to show the survey control and co-ordinate the building on the same grid system.

There are certain failings in not understanding the merits of a co-ordinated land survey. All that was required in the simplest way was a land survey with survey control, the design to be placed upon the survey and relevant co-ordinates shown. The building can then be set out directly and levels referenced from the survey control.

The irony that came from this situation is that members of the contractors' company set up a similar company, who then approached me, to carry out exactly the same exercise. This time, a building layout plan was sent with co-ordinates on the building but with no survey control shown. After a discussion with the contracts manager and the architectural technician, I advised and persuaded them that they only needed the original survey control to begin setting out. This was taken on board and I had no further part in the process. The fact that the building had co-ordinates on meant that they had referenced it to a grid system, but why co-ordinate it, if there was no means of setting it out to these co-ordinates.

5.4 Further Involvement

To keep carrying out surveys akin to this type of situation is not good for either party. The surveyor is performing what seems like a pointless job, whereas the client is throwing money away, all due to the contractor not keeping up with modern methods. In one

respect, we should carry out the exact requirements as the client is paying for our service. In another respect, we as surveyors should adopt a professional approach and give advice in this area, as after all it is our area of expertise. The latter is the probably the best course of action to take, but then financially it does not pay the bills.

CHAPTER SIX

6.0 Conclusion

In writing this dissertation, I have endeavoured to hi-light some of the relevant problems encountered by land surveyors and their working relationship with architects. In a way it began with a certain bias towards the surveyor's side, but in reality the surveyor is as much a part of the associated problems as the architect. It is not a one sided problem, but a problem borne of misunderstanding. The resolve on this dissertation is that there could be improvements in certain areas, while other areas will continue as they are.

Specifications need to be improved and need more understanding by the client. As mentioned in chapter two, there needs to be more of a standard specification than clients setting Ad-Hoc types. It is up to the surveyor to contradict the client's specification if it does not state the relevant requirements. The surveyor has the experience and thus should advise in this matter.

More understanding of how scale factor affects mapping processes is needed and furthermore the understanding of a grid system whether it is to the National or local Grid systems. This is especially so due to the advancement of GPS technology such as OS Net.

The way setting out plans are produced and the information shown on them, will possibly always be this way. As in all aspects of life, everybody makes mistakes and even more so when under pressure to produce. As mentioned, more co-ordinates could be shown and an understanding of what the minimum requirement is to set out on site is needed.

The simple fact is that surveyors do not communicate with the client enough. This can lead both parties down the road to disaster. Everything can be resolved if it is discussed. Clients could be educated through simple talks, for example the case study in chapter six tells of a convoluted process of setting out. A telephone call to the relevant people in charge of planning was never made. If it had been, then the client may have possibly adopted the suggested methods. The negative factor to this point is that the surveyor is then becoming a consultant, which is not what he is paid for. Is it their responsibility to give advice when ultimately it could be detrimental to their business? The reality of this can be

proved in the case study. If a telephone call had been made and the advice taken, then there would have been no more survey work for the company that I work for.

In conclusion there is little scope for immediate improvement in the role and relationship between the surveyor and architect. There is scope however for a better understanding of how the surveyor works in theory and technique. This would go a long way in improving the working relationship between the two parties. A module at university or a postgraduate course in relevant areas in surveying and setting out, would give a better understanding in asking and providing the correct information.

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