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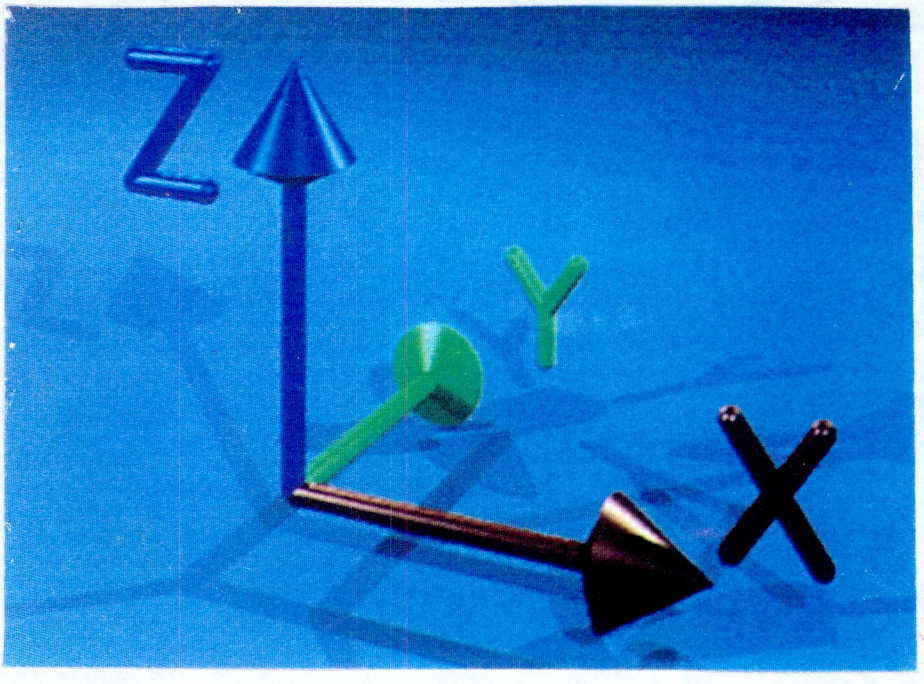

Computer Modelling in the Third Dimension.

Its Application and Future Development of Architecture and Industrial Design.

By
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Submitted to the Department of Art and Design and Complementary studies in Candidacy for the Degree of Bachelor of Design
1993.

Acknowledgements

I wish to thank my tutor, Brigid Henihan, for her help and insight into interior design, through her own experience. I also wish to thank Maurice Bryan of Jacobs International, David Harvey of David Harvey Partnership, Athlone, Gearoid O Conchubhair and Kirsten Briggs, tutors in the department of Industrial Design, N.C.A.D.

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Introduction

Computers are having an increasing impact on our daily lives. While the personal computer has not found a place in everyone's home, it is descending rapidly through the education system and the microchip embedded in our domestic products is controlling the washing cycle of our automatic washing machines, the programming features of video recorders and the interaction of Gameboy entertainment systems. As with any rapidly evolving technology, many become lost in the pace of change and no one can boast of complete knowledge in terms of technical understanding and its application in the various fields of human endeavour. Through lack of understanding, people become protective of their existing values seeing the computer as a means of displacing existing human skills. Work generated is associated with the technological tool employed in its development and the importance of the creative force behind it, the human being, is not realised. Many of the buildings and products around us have been designed with the help of computers. A major feature of present computer systems in the design environment is the move towards 3D modelling at various levels enabling a more centralised body of information which through computer processing has broader applications. Its use is of interests primarily because it relates to things which are later constructed and appear in our environment and

secondly because it develops in response to the needs of the commercial operator needing to give direct benefits in order to justify its use over alternatives.

Firstly computer technology must be explained and all of us updated to its present level in terms of what it can perform and how this is achieved. Through the first chapter the computer will be explained to be a processor, manipulated by human commands which are received in a variety of forms and predictable responses generated in varied forms.

Having grasped the technology, its application in architectural development shall be observed both in theory and in practice with reference with reference to architectural practices actively using 3d representation in the design process.

Following the architectural analysis, industrial design shall be explored in the same context and similarities and differences of approach noted.

Having looked closely at both architectural and industrial design the elements necessary within the office and outside supporting structures shall be analyzed. These include management, understanding, training from within the office. While the computer suppliers and their backup services, coupled with the contribution of the academic institutions enter the equation from the outside.

Finally having explored computer technology as it exists in architecture and industrial design conclusions shall be established and from these a future predicted. Unlike the computer program there is no mathematical formulation for predicting this future or obtaining an appropriate solution. It is more a fusion of knowledge of mankind and its approach to progress combined with a knowledge of the computer as a powerful electronic tool employed in human striving for the ideal world.

CHAPTER 1
3D IN COMPUTERS

The following chapter gives a background knowledge of computers indicating how they operate and relate to human activity.

UNDERSTANDING OF 3D

3d is really a geometric definition which refers to an entity which cannot exist on a flat plane because a third dimension is required to define it. A 3d entity can be measured in terms of its three dimensions ie. length, breadth and height and consequently it has volume. In the real world this 3d entity exists as solid objects which are made up of matter and consequently have certain properties associated with them within the environment ie. its response to gravity, heat, etc.

RELATING 3D TO THE HUMAN BEING

The process of living involves the interaction of the human being with 3d objects within our environment. This interaction relies on three steps:

1) Gathering of information on the object through the senses of sight, hearing, touch taste and smell.

2) The information gathered is referenced to existing information stored within the brain and processed to formulate a thought and possibly a response.
3) The response to the object is physically initiated.
This represents 3d in its most direct form, but through the medium of communication 3d can exist in the form of language. When we look at graphical representation of an object, we receive information on its geometric form and properties. Similarly through the medium of verbal communication we gain an understanding of the 3d object being described. The power of television as a means of communication is based on the fact that it appeals to the senses of sight and hearing. In the case of sight motion is added through changing images.

HUMAN 3D AND THE COMPUTER

Finally my thesis revolves around the addition of another element to the equation, the computer. Many fears and misunderstandings exist regarding the computer its development, its relationship with humans and its role in the human environment. It must be realised that the computer is a tool developed by people for the purpose of performing tasks which are of benefit to us. Our existence is based on the constant desire to develop ourselves and the environment we live in. The computer has become an integral part of this development and as is true of

everything else its survival relies on its ability to evolve and develop to meet the demands of its environment.

The role of the computer is to receive, process and output information. By itself its activities are governed by the programs on which it operates and it is incapable of making any impression on its environment. However when it is linked to tools which can utilise its information to generate real output its potential can be realised. This may be in the form of a visual display unit (VDU) displaying text or graphics, a print on paper or a model generated on a cutting machine under computerised control. Through the development of programs which allow the computer to process information on 3d objects, applications are being identified and developed for the resulting computer output.

Development of the Computer for 3D Applications

There are two main factors which affect the way computer processing developed. The first relates to the creator of the concept of computing, the human who uses human information processing techniques as a reference for mechanical and automated development. Also the ideas are developed with a view to application in a familiar environment as envisaged in the future which have problems requiring solutions. The computer developed must also be capable of communicating either directly or indirectly through a series of tools with people.

The second factor relates to the foundations of computing in mathematics. The computer is simply a complex structure of electronics which allows complicated requests to be broken down into a multitude of simpler mathematically based commands. It is this factor which separates the human from the machine. We use mathematics as a means of measuring things in the process of thinking but we communicate most efficiently through graphics and sound which are further removed from mathematics. Consequently, computer processing development has concentrated on being able to receive and output information in a form which is closer to the optimum human interface, through computer programming. Correspondingly, computer hardware is constantly in a state of development which allows programs to be processed as quickly as possible and the input and output to be of higher quality.

The 2D engineering drawing was the first application of computers in the graphic design process to be explored. Historically, the engineering drawing consisted of a number of views of an object which were represented on paper using lines and other 2d entities in the form of a standard engineering language. The image on paper was permanent. It could be added to or referenced, but it did not lend itself to revision which involved modifying lines already laid down. In 1963 the digitised 2d drawing was born through the development of a program called sketchpad by Ivan Sutherland as part of his Phd thesis in college in America. The lines and arcs represented on the plotted sheet taken

from the computer represented data stored in the computer's memory which could be further processed. The drawing now lent itself to editing and was mathematically accurate.

While the computer had acquired data on the object being described in the drawing, it still represented the drawing board at a more versatile level. When the third dimension was considered a whole body of information came into contention. The information was liberated from being a 2d image into a database open to ideas associated with 3d objects such as shape, appearance, volume, weight, etc. A platform for advanced computer processing was established. It is only in recent years that, that this processing platform has reached the design professions. The most obvious reason for this lies in the cost, which made it completely infeasible to introduce such ideas at consumer level. Advances with electronics and in computer programming are continually making such ideas more real to the consumer through price reduction of fast computer processors. Less obvious to those who are not actively using such systems is the user interface. This concerns how humans communicate with the machine, ie. in the process of inputting data and obtaining data from the machine. The user's time is primarily employed in inputting data into the computer. This entails using an input device such as a keyboard or pointing device in conjunction with the computer monitor in a process determined by the computer program. This process can be relatively demanding

particularly at 3d level. The whole purpose of using a computer must be to obtain output of some form and which in the case of designers should be a part of the design process. The advantage of allowing the computer to process at 3d level is that there is such a broad range of media which are explored to communicate results.

3D VIEW

The 3d view as its name indicates is an image of the 3d object generated by projecting the object onto a 2d plane. The basic form of representing a 3d object on computer is through wireframe modelling. If parts of the model which are hidden from view are removed through hidden line removal, an image similar to a conventional drawing of the object is obtained. By choosing a number of views and adding dimensions, technical drawings can be obtained. A more exciting form of the 3d view is the rendering. Through considering the surface of the objects material and the inclusion of one or more light sources an image of the object approximating to how it would appear in reality is generated. Photorealism is rapidly becoming more of a reality with rendering programs and hardware becoming more powerful a good example being the telephone shown in illustration 1. Retouching techniques are also available through additional packages which serve to enhance the rendered image.

Illustration 1 : Telephone Rendering

MULTIMEDIA

Following rendering developments came the idea of animation. TV a powerful and universally accepted communication medium is combined with the computer through video recording. It involves multisensory presentation through the use of both sound and dynamic pictures. Simulated Buildings can be viewed from a variety of angles zooming around it as illustrated in illustration 2 and prototypes can be observed in motion in their working environment. Manufacturing and assembly processes can be simulated and analyzed. In some cases multimedia has made it possible to eliminate expensive prototyping.

Virtual Reality

Largely still at experimental level, virtual reality represents the future development stemming from multimedia and through the addition of sensations which allow the operator to experience another world, a virtual reality. It is achieved through creating the illusion of seeing objects as they would appear in reality through optical tricks. Corresponding sound effects and sensations of touch eg. heat and pressure are applied to the body. Because sight is the most dominant sense virtual reality at the moment is usually restricted to visual and sound stimuli of the virtual world. Designers and clients shall be able to enter the world of their choice to see their simulated prototype, by wearing a headset and glove

Illustration 2 : Building visualisation..

In time information from the whole body will be available to enter the virtual world and possibly no special sensors shall be required with lasers identifying body movements.

Construction of a Computer Model.

While we are familiar with the construction of the end product or building the computer model is not constructed out of tangible materials. Instead it is usually necessary to construct the computer model through defining its geometric shape and through attributes associating information with the form generated in terms of material etc. As components become standardised the process of construction will be more closely linked with our present approach to the real model. This will be achieved through inserting units into the model workspace on the computer. The first stage in the building of a model consists of identifying the boundary edges which act as a framework for manipulation through rotation or extrusion at a 3D level. Following this, the appropriate 3D manipulating processes are applied allowing it to be viewed from any angle. (Refer illustration 3) When the 3D object has been generated, information can be linked to it which will define its properties such as material and interaction with light within its environment. It may also be necessary to define the level of refractivity and transparency. At this point the object has been constructed and is ready for processing. There are many options available. In terms of visualisation it may be desirable to have a selection of different

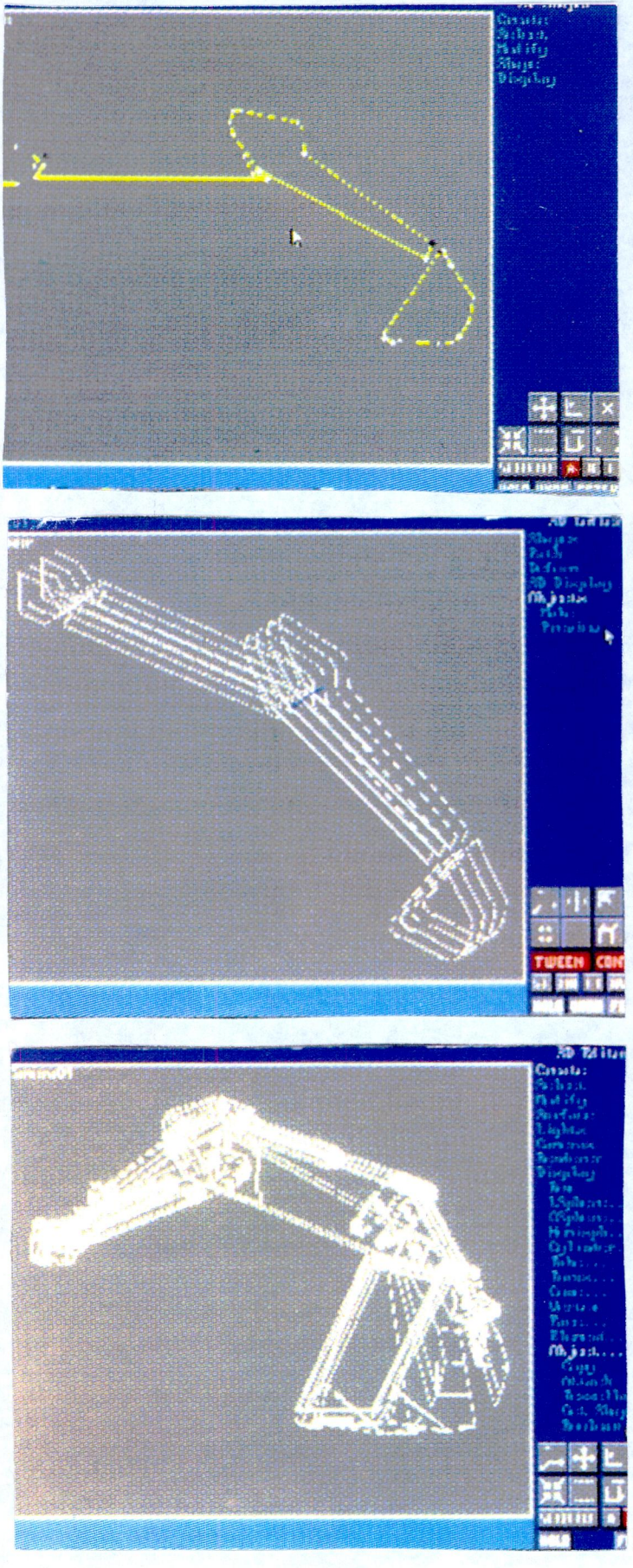

Illustration 3: Generation of a model

views which is easily achieved through computer technology. The power of the image is further enhanced if it is rendered to a photo-realistic level. Motion can be added in the form of animation and through placing these different views in sequence to simulate the motion. (Refer illustration 4).

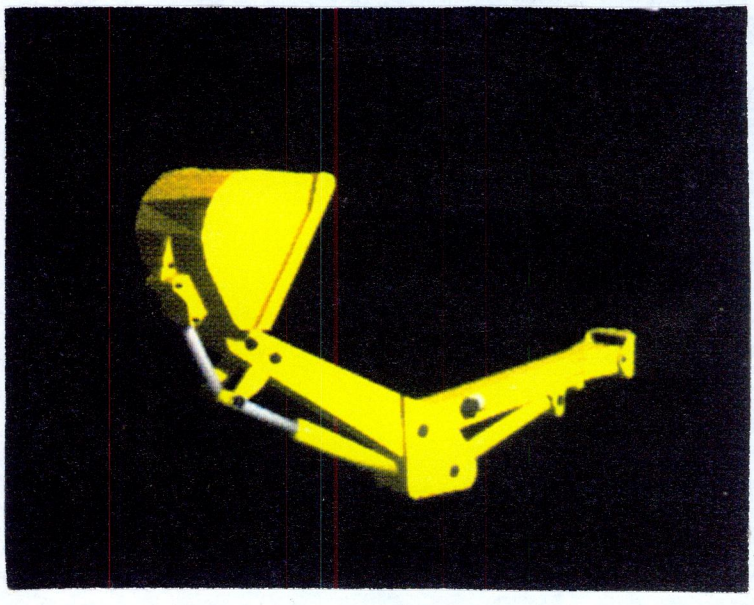

Illustration 4 : Computer model in motion

Chapter 2 - Architectural Design

The following chapter shows computer modeling in the architectural design environment, looking at the benefits gained through the use of the computer model and how these can be realised.

Computer Modelling at Present

At the moment in architectural design computer modelling is having limited use and its full potential has not been realised. This is largely due to the fact that present computer systems are not fully resolved, requiring demanding data input procedures and an ability for the operator to visualise co-ordinates in three dimensions. However with improved programs user interfaces and an availability of more information in database, architects and people involved in the architectural design process are starting to explore this new medium of communication and analysis.

Possibilities of Computer Modelling

Computer modelling is allowing buildings to be simulated and viewed as it would appear in reality. This is achieved

through specifying the geometric form of the building, information on it's related materials, available light sources and the surrounding environment. Illustration 5 shows a building proposal for a disused quay. Images can be rendered to a photo realistic level and through compiling a series of images in sequence, walk-throughs can be generated. A walk-through, for example, allows people to view the building as if they were moving through it looking around. This brings the information to a more human level, where people without a technical background are able to understand the design. Similarly , people of different technical backgrounds are in a position to interpret the information more quickly and have it customised to meet their needs.

Integration of Computer Modelling into the Design Process.

Computer modelling represents a technological tool. In order to incorporate it in the design process it is necessary to understand it's capabilities and limitations. Through the use of computer programs, such as 3D Studio, a rendering and animation package, realistic images are possible but at a price in terms of time and financial investment in related facilities. It is necessary to have a clear understanding of the design being described through this technology and also the benefits in commercial terms, eg, illustrating a proposal to a client or planning authority. As with any other medium or aspect of the design process, effiency

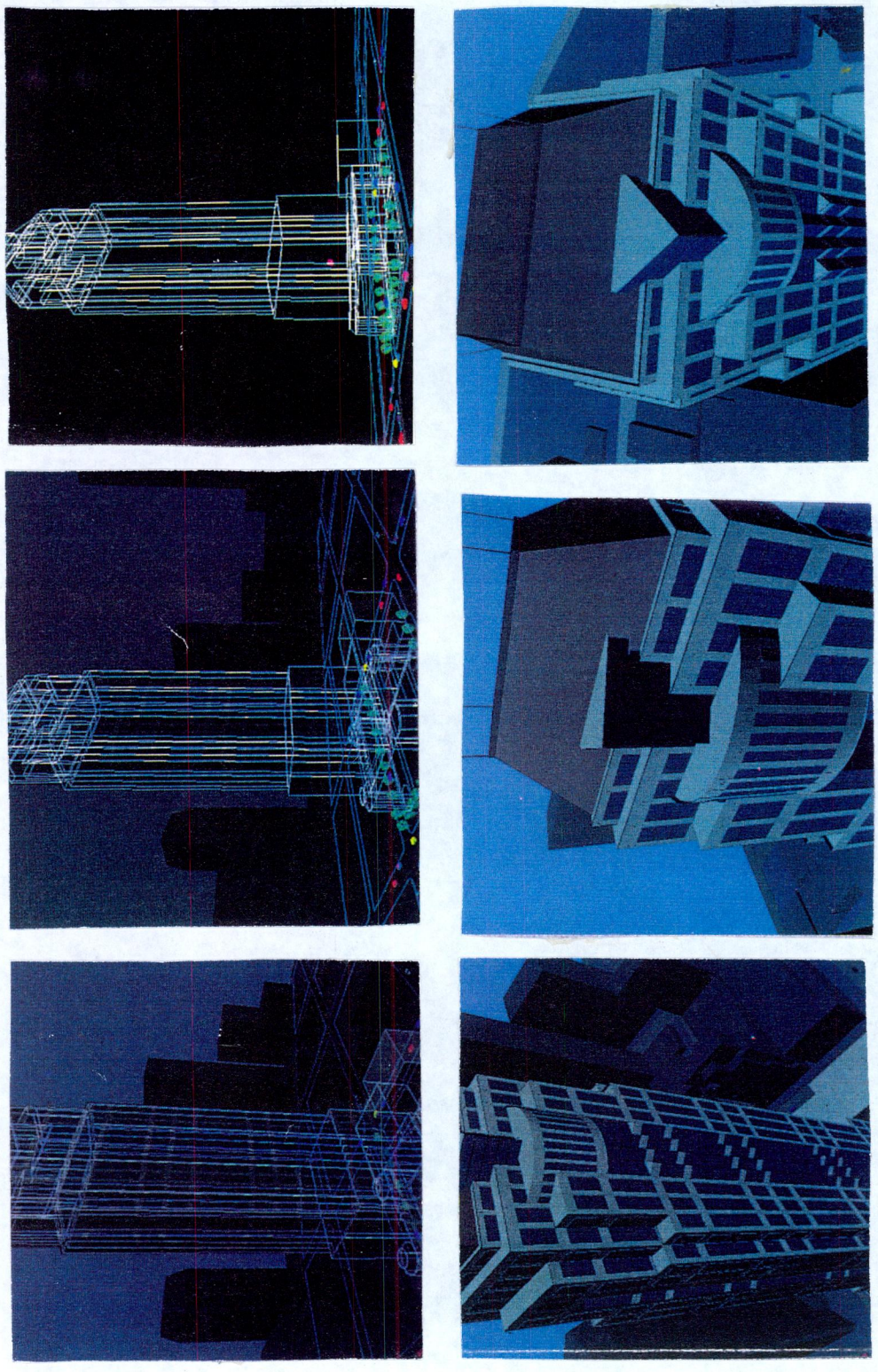

Illustration 5 : Simulation of building proposal

is called for in terms of fulfilling client requirements.

The value of the model must not be restricted strictly to visualisation of the design, but also it should have the capability to store related information on other elements of design. Possibly automatically updating the bill of materials. The power of computer systems in the area of architectural design is constantly improving through the increasing levels of information available to the computer processor in the form of databases. A typical example is the widespread conversion of landscape information from ordinance survey maps being converted from 2d to a 3d level. This will allow information on site and surrounding landscape to be transferred into the drawing office acting as a platform for building a simulated model on. Similarly information on materials, their properties, eg. density, appearance under lighting conditions, etc., and also the position of the sun as an ambient light source at a given location, time and weather condition, all of which can be incorporated in the computer modelling program.

Once the information has been centralised in the form of a computer model, it has a variety of applications including the use of common information among the various disciplines within the design process and the communication with those outside the design environment.

From Architect to Interior Designer

The architect is concerned with the design of the building, taking it from its environmental setting through to a level at which its interior can be developed. Consequentially, the architect controls the exterior character of the building and while not directly involved in the choice of furniture and decoration, decisions made in terms of overall form, placement of windows and walls strongly relate to its internal functioning. He must interpret the environment and the character of the building and its integration into the landscape or street-scape point will determine its acceptance by planning authorities.

A very general approach to the architectural design process - lack of research!

On the other hand some architects will have a stronger sense of function as opposed to sculptural shape. Sometimes this is only realised through human activity following the construction of the building. However with the aid of computer modelling, design features can be more easily communicated and realised long before construction. Normally following construction interior detailing is directed through lighting and interior designers. Presently this relies on the interpretation of the interior space by the designers and through knowledge, experience and flair a suitable lighting and furnishing configuration is chosen. As jobs become more complex, visualisation at this level becomes more difficult and obtaining the optimum solution can become impossible without some degree of trial and error or inaccurate scaled representations. Through

computer modelling full scale simulated models can be constructed with a selection of lighting and furnishing schemes included for visual verification. The output generated can be in a number of forms By taking a selected view the room can be rendered and the effects of light observed. Illustration 6 shows this very well through showing the effects of both natural and artificial lighting as it appears on a wide range of furnishings with material finishings such as wood. Where more mathematical based output is required, eg. the level of light lux at a particular work surface can be checked. This would appear in the form of a contour plan through which a technical observer could interpret accurately. The added advantage of this common need for a computer model across all the architectural and interior disciplines is that building information through a central database is linking the whole design process and disciplines. Those to whom the information is being made available to outside the design environment will effectively perceive the building as a whole unit. Illumination of a room will be equally dependant on the architects use of natural light as well as the artificial lighting applied.

The Changing Nature of Interiors.

Interiors can no longer be viewed simply in terms of the addition of lighting, furnishings and the application of paint. Two situations where this applies are in office design and in retail shops. In the case of offices the present move towards the open office structure

Illustration 6 : Kitchen Interiors

where people are arranged within temporary units in a large room. It has been realised that a standard format adopted across the room does not cater for everybodies needs. Also the organising of furniture arrangements proves a nightmare using conventional methods. Consequently the discipline of facilities management has evolved to successfully match available facilities to the needs of the operators. This has proved interesting within an architectural context in that it is the furniture manufacturers who have taken the lead in structuring the appropriate 3D modelling systems necessary for managing their furniture efficiently. Herman Miller Furniture Manufacturers have lead the field in this regard. Through many years of research they have identified the various personality types and the corresponding working format desirable to meet their needs. This facilitates the construction of modular furniture systems which require the assembly of a broad range of standard components including table tops, screens, shelving, etc.

Marketing the Design concept.

When the architect has reached a solution which he feels is appropriate the next task on hand is to present this concept to those outside the design environment. The first group to be encountered will inevitable be the client. The form which this body will take is obviously dependant on the project in hand, varying from an individual to a full board of

directors. The ability of these to interpret the proposed solution will depend on the medium and presentation, and how it relates to their experiences. The conventional technical drawings developed over centuries of drawing communication, while containing all the relevant information for construction, can represent a foreign language to marketing or business people. Should the designer wish to communicate an element of the overall solution, it will be necessary to humanise the form of presentation. This can leave the designer free to explore creative solutions, since they can be tailored to the specific needs of the individuals concerned.

In the present professional environment, it has become necessary to shorten the lead time, ie. the time between concept and marketing to the consumer. The Edinburgh Centre in Scotland illustrates this very well. Designed as a multi-million pound conference centre, it was intended as a major conference location. Traditionally these functions are booked up to five years in advance. A time lapse of this period from the completion of the construction to the holding of conferences could represent large financial losses. Consequently, it was deemed necessary to market the facilities in advance of construction. This overlap of construction and marketing processes allowed a more efficient use of the available time. The most powerful advertising tool would have to be the television. Through the construction of a simulated computer model in which the features of the centre were portrayed, in the form of an

animated walk-through, it was possible to show the proposed concept to conference organisers. Through this marketing tool, the response received which consisted of provisional bookings also served to validate the appropriateness of the design to investors. The benefits are not just to be measured in terms of marketing tool. It is intended to use the model and its associated information to generate other animations directed at others.

The Edinburgh centre was marketed in anticipation of its future success in the market place. However, sometimes it is necessary to market a concept which may not be realised. In this context I make particular reference to Architectural design competitions and proposals for architectural development based on the choice of a given location for the staging of a large event, such as the olympics.

Architectural competitions in general have had an unsuccessful history. Many winning entries being unbuilt owing in part to the lack of communication between designer and sponsor, leaving many problems undefined. There is also an obvious reluctance on the part of the competitor to make large commitments to the project, since the failure to secure a placing results in the loss of not only the contract, but also the investment made by the group. This is a shame since competitions leave a lot of freedom for creative exploration of an idea. Through computer modelling, the loss of the opportunity to carry the concept through to construction will be compensated

through the fact that the design can be explored in the simulated model

Generating Databases for the Future.

Databases at the moment are generated through the need to gather information in a form which can be utilised by the computer to aid design and in the process of design, objects being described in the third dimension form three dimensional databases, both for active use and future reference. Future referencing is becoming very important in terms of design control as changing environments and human activities impose new demands on the products of design. Buildings can now be manipulated with structural features altered. As the application of computer models become more widely explored, the information stored will find further applications beyond that which was originally intended.

Chapter 3 - Industrial Design.

An Introduction to Industrial Design

While Industrial design concerns the design of products to be integrated in the human environment and the process in their development is similar to that of architecture, going from the abstract to the concrete, the nature of that which is generated is very different. Products are developed for mass production and as a result their manufacture is largely dependant on automated tools such as injection moulding machines and metal dies. In contrast to the architectural area, the level of scale can vary from microscopic electronic circuit boards to fuselage panels in airplanes. These products demand tighter control in terms of tolerancing of components, insuring ease of assembly and motion of the product in service. Market success is based on large volume sales to justify tooling expenses.

Computer Modelling in the Design Process

At the moment pen and paper are still by far the most popular of drawing tools in the initial stages of the Industrial Design process. The preference for these is based on the limitations of computer technology, when applied at this level, where the designer is primarily concerned with

leaving the ideas open to a multitude of solutions. Consequently, the sketches generated are abstract based, defining features without dimensions or any fixed focus.

Computer programs which allow solid modelling without clear definition of dimensions are available. These allow shapes to be combined, subtrated from each other, etc to generate objects. However, when the concept is ready to be translated into concrete form the program does not facilitate this transfer. This is due to the fact that computer programs have developed in two directions, one being based on designing shapes while the other is engineering based facilitating the development of technical drawings and accurate computer models where the dimensions are tightly defined. Consequently, industrial designers have generally opted to use the conventional tools for concept development and when the chosen direction has been established, the design will be further refined through generation of models and sketches to analyse its form, interaction with users and ease of manufacture. Following this technical drawings will be generated and prototypes may be necessary to analyse the performance of the product mechanically. Revisions and further prototyping may be necessary until the problems identified are resolved.

It is estimated that the first five percent of the design process impacts over eighty prcent of the final manufactured product cost (Coenen, 1991, p. 73). Consequently, it is necessary for the client to have a clear

understanding of the design as it develops and for the designers to consider implementing any tools which when employed within the design environment will make the process more efficient. The use of computers is becoming more widespread in downstream activities in this processs with most consultancies boasting computer facilities for technical drawing generation. Over the coming two to three years, it is expected that 3d facilities will be added to this specification of facilities offered. The applications of computer facilities in industrial design can be broadly categorised into two areas, those concerned with communication both within the design environment between the various areas of the design process from concept through to manufacture and with the client and general public to communicate the design features an those concerned with the technical development of the product from analysis to manufacture.

Computer Modelling for Technical Developments in the Design Process

In a competitve market where the timing of product release is crucial and a delay of even weeks can substantially damage the sales and market sucess of the product , it is necessary to reduce lead time as much as possible. This can only be achieved through a process called concurrent engineering where design detailing, tool construction and marketing of the product co-exist. This immediately

questions the existing methods of communication between designer and manufacturer. With the seperation of these two stages of development through the Industrial Revolution and the division of labour, accurate communication has been strained with drawings open to interpretation when reaching the shop floor. This can result in deviations from the origional concept and may compromise the quality of the design generated. Since computer models contain all the geometric information of the components and their relationship to each other this vital link can be re-established

The areas of automobile and airplane design were the first to adopt computer modelling techniques in the construction process. This is due to the fact that aerodynamic styling defined double curves which were impossible to communicate through existing technical drawing media. A gap was formed between the concept and downstream processes which followed it. Through the introduction of computer modelling these ambiguities which previously existed were clarified.

Developments in manufacturing technologies which allow computers to directly control the tool manufacturing process through numerically controlled machines have encouraged an adoption of computers in the design process. This also opens up the possibilities of new manufacturing techniques such as laser or water jet cutting.

In recent years the development of computer programs which, given computer models and the relevant information associated with the materials and their properties allow the analysis of the product under various stress conditions. A situation where this applies is in the analysis of car performance in accidents. Traditionally at Ford Motor Co. in the United States it was necessary to repeatedly crash cars travelling at thirty miles per hour into a wall. (Willis, 1992, p. 53). The motion is recorded on video and through analyzing this and also looking through areas which crumpled in the collision, engineers investigated weaknesses in the design. This design is then updated and the process repeated possibly up to four times, until eventually a satisfactory performance is obtained. This is a destructive testing procedure, and while information obtained indicates weaknesses in the design, theses are not clearly defined and all that remains is a ruined car body. In contrast, computer simulated crashes are less costly to generate and yield more information. The design can be altered and the car returned to its original status. The information can be output in a variety of forms. Replacing the video recorder output is the computer animation of the event which can be controlled more easily, focusing on different areas of the car, eg. it will be possible to observe the deformation of the front axle on impact. The appropriate computer programs can also preform stress analysis on individual components. The results being presented through colour coding of a 3d image, various colours indicating the level of strength at that particular point. This alone allows

the engineer and designers to identify areas which are not sufficiently strong and re-enforce these accordingly. Areas which are not stressed can be cut away maximising weight and use of material.

In the design process it is necessary to establish clear tolerancing in terms of the assembly and relative motion of components in the product. Animations are very effective in this regard. They allow the respective processes to be viewed.

Presentation and computer model visualisations

When concepts have been generated and details finalised , it is necessary to present these ideas to the client. The most effective means of communication are renderings depicting the design, illustrating its features and form. Illustration 7 shows two products rendered in a simulated environment. There are computer packages such as Zoom and Ray Dream Designer which allow photo-realistic images of the product to be generated. Flexibility of the tools allows various finishes and colours to be quickly applied, evaluated and reproduced. Again the creativity and flair of the designer are essential in being able to identify the optimum mode of presentation. At computer level this relies on being able to identify the needs of the client, the process of rendering and the limitations of the system. A good example of this is the ability to successfully fuse both conventional and

Illustration 7 : Rendered Products

modern rendering techniques. This can be achieved through the use of line perspectives generated on the computer and subsequently manually rendered. Combining of resources as always to meet the desired requirement is dependant on the aesthetic perception of the operator, a good visual illustrating this being the rendering of the satelite depicted in illustration 8.

A more advanced form of fusing modern and conventional media is in the form of multimedia. This can show the integration of the various components and place the design in a simulated environment, interacting with human models, which allows ergonomic considerations to be assessed. These human models have been used in the design of tractor interiors insuring sufficient leg room and ease of access to the seated position within the cab.

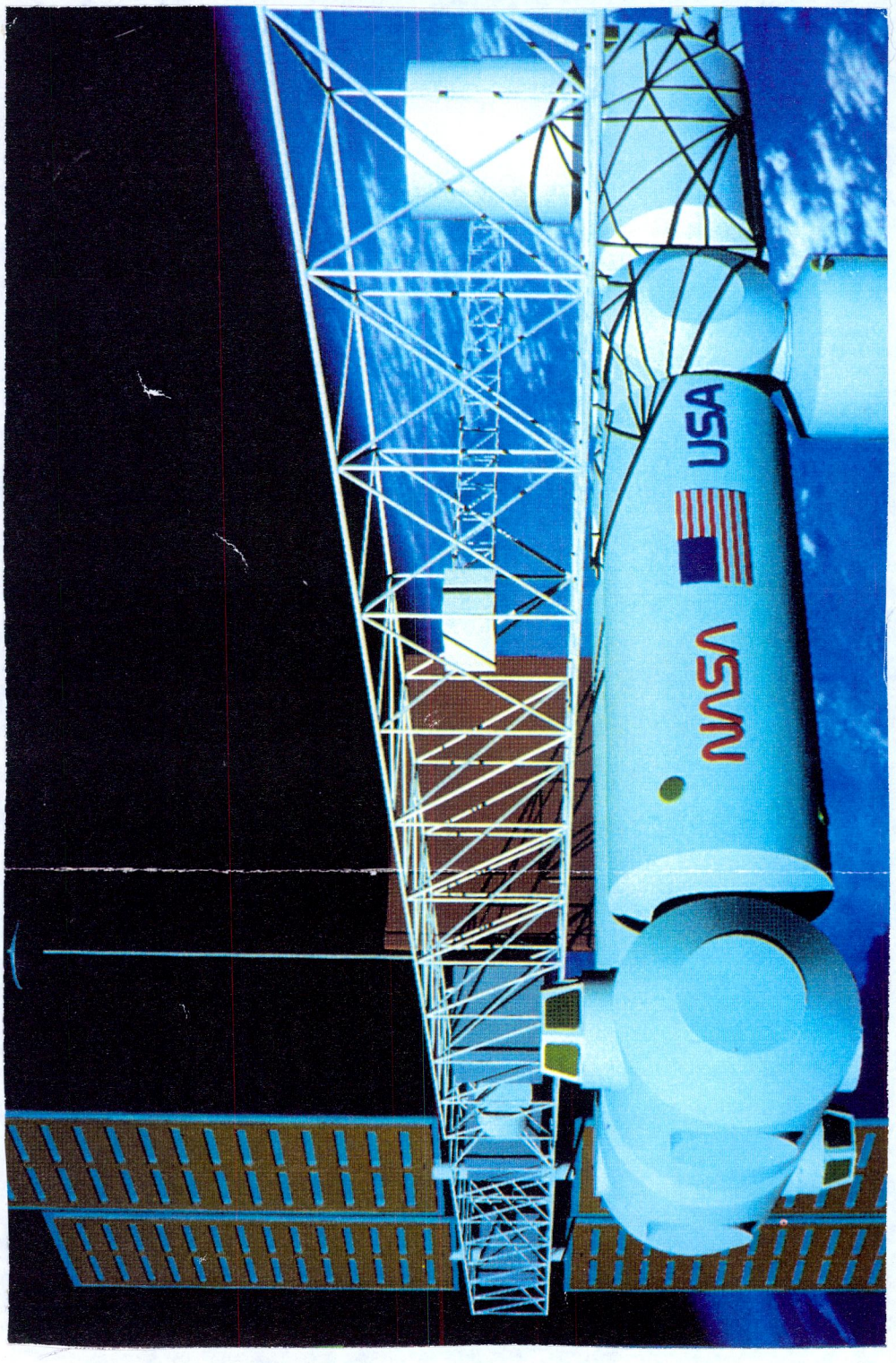

Illustration 8 : Satelite Image

Chapter 4 - Integration of computer modelling into the design office.

Computer Technology adjusting to designer needs

With developments in computer software and hardware the use of computers has become more widespread as increased input - output and processing facilities become available at reasonable prices. One of the greatest complaints to date of the computer technology has been in relation to developments regarding the user interface. The successful use of the technology relies on ease of interaction between human and computer. In terms of hardware the greatest developments in this area at a practical level have been in terms of the mouse and the digitiser, as opposed to the conventional keyboard. This has been further facilitated through scanning technology, where graphic images can be directly communicated to the computer processor.

However for people approaching this technology with specific tasks on hand, without the benefit of familiarity of the system problems have been experienced. This relates to the user interface of the software. Until now there has been a distinct divide in the format of user interfaces, ie. word and graphic based. Graphic user interfaces have proved the most user-friendly since they can relate computer

activities to our daily life experience, a good example being the use of the waste paper basket. Through our everyday lives we are accustomed to associating the bin with disposal. Consequently we can carry this knowledge into our interaction with computers, leaving the technology more accessible to those not using it on a regular basis. Tests actively comparing both systems have shown a higher level of productivity on graphics based systems due to less errors in inputting data and only needing to reference the monitor with motion being directed through the movement of an icon along the screen, guided by a hand held mouse. This is expected to be the dominant interface of the future. Experiments are currently being carried out on the use of voice activated systems with some systems already in operation.

Paperless Office

For many years now, computer technology has made promises of the paperless office, in practice, the opposite has occurred. People still require hard copies on which to reference their work with the monitor of limited value. The added advantages have been the ease of modification and editing and while the computer plotter has served in helping the depletion of the worlds forests, the increasing use of paper indicates the human need to visually verify and update ideas which has been facilitated by computer systems.

Accuracy of drawings.

One of the advantages of computer drafting and modelling facilities has been the level of accuracy which is embodied in the system. This has proved advantageous in improving the level of communication between architect and those in construction, and also form designer to manufacturer in Industrial Design. There are many fears that people without drafting knowledge and understanding will be in a position to generate drawings without any competence in the discipline concerned. Traditionally first impressions of the drawing acted as a cue towards the level of drawing ability of the technician. With computers it is feared that quality of design will be measured through a computer image. In practice it has been found that computer knowledge is not sufficient in itself to generate accurate drawings. Very often work to be converted into drawing format maybe ill defined, relying on the experience of the operator to interpret it.

Increased productivity

Productivity refers to the quantity of work generated and in real terms refers to the ability of a company to meet the requirements of a given contract. At this level the success of the computer system is obviously dependant on the power of the system, skill of the operator and nature of the work being described. Through editing features of C.A.D. in general companies have remarked on its increased

productivity levels once successfully integrated in the design system. As the applications of 3D become more widely available, the productivity benefits through the use of 3D will be realised. This can be measured in terms of the linking of the design process with the downstream activities. Of added benefit are the communicating facilities for outside use, directed at clients, planning authorities, etc.

Project Control

These promises have at many levels been realised but through miss management of this technology many problems have also arisen. Management of information generated and supplied to the system has been the most obvious. Information was traditionally stored in a static form on paper, which meant it was in a tangible form and consequently storage systems were developed to deal with this medium. In contrast computer technology stores information through disks. A large number of people may be referencing both the information and the system on which the information is stored.

The arrival of the computer has also brought headaches to the operators who, if unfamiliar with the technology, may experience problems should the system crash.

Investment

Prior to the investment in computers at any level, it is necessary to review the applications and subsequent benefits to be gained. It is also necessary to identify the period of time necessary for these benefits to cover the investment. A typical time period would be two years as expressed by Maurice Bryan of Jacobs International. This period is based on the rate of computer developments and cost reductions as a result of these.

Management

As the use of computers becomes more integrated into the design process, both in the area of architectural and industrial design, it has realised that computers and their related technology do not naturally fit into existing office layouts. It is necessary to adapt the office and its furnishing to accommodate these new tools. Computer manufacturers have also recognised the need to make the computer user interface more friendly in operation. This approach to the office is both beneficial in terms of employee health and productivity. Our European legislators have realised the needs of these operators and corresponding legislation is to be introduced, which will direct employers on the layout of computer work stations.

Training

It has been realised that 3D represents a new way of visualising information. Operators familiar with the 2D format, while computer literate, need further training to allow adjustment for the transition to 3D. Experiences indicated that those operating Cad systems should have a bases in the discipline being applied and not strictly Cad operators. The process of training has been carried out at many levels from architect through to technician, from design through to manufacturing and both within industry itself and through educational institutions. One survey indicated that in British industry small companies were unable to afford investment in computer training when the work load was low and in comparison when the work load was high operators were not available to attend courses. As computer technology becomes more widespread, people experienced in its use will become available in the market place. Educational institutions have a substantial contribution to make in this regard through incorporating computer instruction and facilities within the course structure. While most colleges at third level have made some degree of computer investment both in terms of hardware and software, there are many deficiencies which have been identified. The most obvious limitation has been in transferring from existing media to the modern counterparts. Tutors have found themselves lost in relation to the rapid pace of computer advances, heightened through

the lacking of a structure to allow them to update their skills. Colleges have been slow to recognise and implement suitable training of both staff ad students. Consequently through inappropriate use computers can be seen to promote bad design practice and separate the student from the design activity.

Legislation to improve the integration of computers in the design office.

At the moment legislation is being implemented to ensure good working environments for Cad operators. As designers become more involved in the use of this technology their needs in terms of furniture, lighting, etc., will have to be realised. This is not just in the interest of the operators health, but also serves to improve productivity in the design office.

Conclusion

Computers in the Design Process

Through the thesis, it has become evident that computer modelling is a technology in evolution. Its successful integration into the design process is dependant on matching man and machine. This is achieved through identification of the requirements and the benefits to be gained through choosing computers over conventional techniques. The true potential of any tool can only be realised through the creativity and the understanding of the operator in terms of the work being processed and the corresponding approach necessary in dealing with the machine. Being proficient in one or the other is not sufficient to generate appropriate solutions.

Realism

The new levels of accuracy attainable through computers from geometric shape to stress analysis has lead to a need to question our definitions of accuracy and realism, since these will determine our level of control over a design. Reality is different for each individual. a design may be measured, not in metres, but in relation to the person standing beside it, while the manufacturers will need

information which can define a component possibly in terms of millimetres.

Computers co-existing with people.

From the thesis I have come to realise that technology cannot be viewed alone, but must be analyzed in relation to people. This can be measured in terms of successful application in the design process where its use and work generated cannot be measured in terms of megabytes, input devices, etc. but must be measured in relation to the interactive use with the operator.

Appendices

INTERVIEWS

The following is a summary of the interviews conducted in relation to the thesis

David Harvey

David has his own architectural practice in Athlone, Co. Westmeath. He uses AEC an Autocad based architectural package which is 3d based creating the option of drawing at 2d or 3d level. David feels that professionalism is very important in presenting oneself to clients, both in his work and within the office. Basic wireframe computer models are forming part of this professional approach, giving the client an unexpected insight into how the building will look. This impresses clients, but it is very important to be able to identify the optimum investment in time necessary to generate the desired 3d image to communicate how the building will look. A client must feel that his money is being efficiently used and the generation of detailed computer models which do not have any bearing on the design or construction would be seen as superfluous. The first 3d model generated was in connection with a factory design project. It was used to generate an ariel view of how the factory would look. David is presently working on a

computer model of a shopping centre to be based in the town. To date he has attracted much interest in the project both in terms of investment and shop owners interested in taking shopping units. Through using the model to generate walkthroughs on video he hopes to secure further interest in the project and present the idea to planning authorities.

David from a 2d technical drawing point of view has found computers superior to conventional drawings, both in terms of productivity and efficient use of office space. He is reluctant to update to newer versions as they become available, since through past expierence he has found that there is generally not any significant changes in consequtive versions and the investment of time and money required does not justify the gains.
In terms of operators in design practice, he feels that Cad in itself is not sufficent to generate accurate technical drawings. The operator must understand what is going on in the drawing through a background in construction or civil studies. Otherwise, the drawings will not be sufficiently accurate for consruction purposes and though at a glance give an indication of the building's form are of no real value.

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