Computer visualisation in planning control: some case studies and issues
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ABSTRACT

Computer visualisation has a currently unrealised potential for assisting the control of urban design by planning authorities through its ability to provide and amend realistic pictures of proposed development and so enable lay groups, especially local politicians, and the public at large to view directly the impact of proposed development and to participate more effectively in negotiations concerning it. The author has been conducting research to test this assertion for some years, most recently via a 15 month project which involved taking examples of development being considered by selected British planning authorities, visualising them using micro-based systems and then monitoring and assessing the use made of the images produced. The principal system used was Autodesk 3D Studio on a PC platform, although Intergraph software and Apple Macintosh hardware were also employed. Hard copy was obtained by screen photography and supplemented by animated walk-throughs. The issues studied ranged from the impact of a large scale shopping proposal to the colour of a small apartment block, and included examples of both advance preparation for a design brief and reactive action by the controlling authority. The results confirmed the importance of the technique for design control and tests involving the design of domestic extensions revealed how questions of objectivity and level of realism could be resolved by reference to the position of the negotiating parties.

INTRODUCTION

The importance of computer visualisation for planning practice lies in its potential for the improvement of the quality of decision making by virtue of its ability to avoid misunderstandings in the negotiation of the outward form of development. One of the greatest stumbling blocks in the negotiation of the design of new development, be it between developers and their architects,
applicants and planning authorities or planners and the public, is the difficulty in visualising proposed schemes in such a way that their three-dimensional visual impact on the user can be appreciated and discussed. Architects' plans and elevations are difficult for the lay person to interpret; models are expensive to construct and update and the devices required to view them as from ground level are cumbersome if not actually impractical; artists' impressions are also expensive and can be highly subjective in their interpretation of the proposals. Information technology has the ability to overcome this obstacle through its ability to model buildings and landscapes, both existing and proposed, in precise perspective, and to reproduce the effects of light, shade and shadows impinging on different building materials. The capability of computers to carry out these tasks has been in existence for at least ten years but the high cost and lack of convenience of use of both the hardware and software has previously put it beyond the day to day reach of those who were not experienced computer users. However, computer visualisation has now become available in user friendly form at affordable prices and is, therefore, within the reach of planning practitioners. Unfortunately, in Britain there has been no rush by planning authorities to test this potential, presumably through lack of both resources and information, and between 1987 and 1990 only a few isolated (but noteworthy) examples were undertaken*. One was the full colour visualisation for a proposed market cross to be constructed in the central square of South Woodham Ferrers new town in Essex, carried out by the author during 1987 and 19882.

A full-scale investigation of the application of computer visualisation to planning practice, financed by the Leverhulme Trust was undertaken by the author from January 1991 to March 1992. Its objective was to test the usefulness of computer visualisation in the context of day to day planning. The idea was to take a number of examples of development proposals under consideration by local planning authorities, visualise them, feed the images so produced back into the decision making process and monitor the results.

COMPUTING FACILITIES

Commercially available software on micro-computer was used to model the selected development proposals. Hard copy was obtained in the form of colour prints and slides by photographing the monitor screen. The first software and hardware combination used was Integraph Microstation 3.5.1 on an Apple Macintosh IIcx platform with 13" colour monitor. The program provided surface modelling facilities with limited colour and shading effects. Microstation was a general design package and which, while both powerful and easy to use on its own terms, was neither a specialist visualisation nor a specialist architectural package. Perspective views could be obtained although, with this version of the program, eye level views were difficult and views from inside a proposed development scheme almost impossible. In April 1991 the
software was changed to Autodesk 3D-Studio, which had just appeared on the market, as it offered very high quality lighting and materials effects and facilitated the easy animation of images. This program was not available for an Apple Macintosh environment and so the hardware was also changed to a substantially enhanced PC386 with a Super-VGA monitor. The Super-VGA monitor (256 colours at a resolution of 640x480 pixels) was used to display the working environment. The Targa video card was used to supply a high quality RGB signal at a higher resolution to the Electrohome 19" monitor which was used to display the final rendered images.

The 3D-Studio program was a specialised visualisation package. Three dimensional modelling was facilitated both by extrusion and by use of a small range of primitives. The powerful features of the program related to the rendering of surfaces. 3D-Studio possessed a materials library which could be extended by means of a powerful on-screen menu. When compared with some contemporary advanced CAD programs it was easy to use for both modelling and the generation of perspective views. Its limitations arose from the fact that it was not a purpose designed CAD package. 3D-Studio made the process of animation very straightforward, and images rendered to sufficient quality for display on the VGA monitor could be animated within the computer's memory and replayed on that monitor. The animation could be stored in a file and, using an ancillary program, AAPlay, short versions could be put on to a floppy disk and replayed by other users.

THE BERKHAMSTED EXAMPLE

For the first test the CAD program Integraph Microstation on the Apple Macintosh IIcx machine was employed. The subject was a planning application for a major shopping centre and multi-storey car park on back land behind Berkhamsted High Street. A computer based model of the proposals was constructed from the architects' drawings and some adjoining buildings were modelled, mostly in block form, from maps and site visit information. A large number of colour perspective views were generated, both aerial and ground level. The planning officers dealing with the case visited Chelmsford to view the model interactively and were thereby able to see for the first time the true appearance of the proposed development and to assess the relative bulk of the structures. The development was delayed by negotiations and, ultimately, the recession in the property market. At the time of writing, the design was being reconsidered by the architects. Their views on the visualisation of their initial scheme were, however, sought and they showed great interest and were supportive of the idea. They were already using CAD (in the form of t²-Sonata on an Apollo platform) for design but not, normally, for visualisation. They preferred, for the latter purpose, manually rendered computer generated perspectives as they considered that this gave a more accurate representation of the appearance of building materials than could be obtained with the computer
software available to them. However, no such visualisations had been prepared for the Berkhamsted scheme.

THE GUILDFORD EXAMPLE

The next test, and the first using 3D-Studio, was undertaken for Guildford Borough Council and concerned the proposed redevelopment of a Borough owned leisure centre in the town centre. The aim of the visualisation exercise was to provide assessment of visual impact of the proposal in order to facilitate:

a the selection of an outline design by the officers

b appreciation by council members of the physical implications of the proposal

c the production of a three-dimensional design guide for inclusion in the Council’s corporate brief to potential developers.

The first step in the exercise was to model the surrounding buildings, roads and other structures, leaving a vacant plot where the leisure centre stood. The alternative outline designs for the development were then modelled and inserted into the model of the surrounding buildings. Oblique aerial and ground level views were produced together with animated walk-throughs. Hard copy was sent to Guildford for study in the form of screen photographs and floppy disks containing the animated walk-throughs. The Guildford architects and planning officers also visited Chelmsford to work interactively with the facilities, exploring views and design alterations of their choice. Figures 1 - 4 show the development of the design which was used as a basis of a joint officers report to members. The matter was still proceeding at the time of writing.

THE EAST CAMBRIDGESHIRE EXAMPLE

Both of the tests described above concerned major new development. However, computer visualisation has just as much application to day to day planning control when the design of small scale proposals, such as domestic extensions, is being considered. An example of such a use was sought for the third test and a case under consideration by East Cambridgeshire District Council in the summer of 1991 was selected. The owner of the existing house wished to extend the upper floor above the garage. As this was forward of the building line the proposal was of concern to the residents of neighbouring houses and to members of the Planning Committee. Using 3D-Studio, the proposed development was visualised from the plans submitted with the application. The house on one side was similar in design to the applicant’s house and, therefore, it was convenient to model it explicitly. Views were obtained for five different directions specified by the planning officers, with and
without the proposed extension, and also for winter and summer seasons as screening by vegetation greatly affected the view of the property. Plan views were also generated. Cast shadows were included in the visualisation as overshadowing was a significant part of the issue. Colour prints of the screen images were turned into OHP transparencies and were shown to the Development Control Sub-Committee when it considered the application. The application was refused by the Committee. After the meeting, a group of members expressed the view that the visualisation had enabled members who had not been on the site visit to participate fully in the discussion whereas normally they would follow the views of those who had without formulating a position of their own. The applicants and their architects did not attend the Sub-Committee Meeting and so a copy of the images were sent to them by the research team for their comments. They replied by letter raising a number of objections and criticisms particularly on the overshadowing issue, where they maintained a more realistic result could be obtained by means of a protractor and calculations. They also queried the objective status of the visualisation on the basis that judgement had to be used on what items are included or excluded, and maintained that architects' perspective drawings in colour could give a more objective impression, in appropriate circumstances. They believed that computer visualisation had a role in the presentation of projects but not any special or independent role in the control process. The architects appealed to the Department of the Environment against the refusal of planning permission. The Council forwarded copies of the visualisation to the Department for illustrative purposes to show the likely effect of the proposals. The inspector dismissed the appeal. Analysis of the arguments of the parties revealed two points of debate relevant to the study:

a  was overshadowing a subjective reaction to the dominance of a building (the Councils usage) or a consequence of the precise incidence of the shadows cast by it (the appellants' usage)?

b  did the computer visualisation give a realistic impression of either interpretation?

The position of the sun in relation to the structures in the computer model was checked and found to be realistic. The visualisation did not, in fact, show shadows falling on the neighbours' windows for most of the year and, somewhat ironically, it could be said to support the appellants' position. The Council, however, saw it as supporting their own interpretation of overshadowing. Their interpretation of overshadowing was ultimately that upheld by the inspector.
THE DANBURY EXAMPLE

The example described above did not test the full power of the computer visualisation technique as, although hard copy was circulated to the participants, they did not come together at any stage to negotiate using the computer interactively. An opportunity to observe interactive use in a routine development control context arose from an example provided by Chelmsford Borough Council. At the end of 1991 the Council had received a planning application for an extension to a detached house in Danbury, Essex. The adjoining house on the east side already had a modest extension. The planning officer handling the case was concerned at the bulk and appearance of the proposal and had suggested in informal negotiations with the applicants' agent, a builder, a repeat of the A-frame roof shape or, less enthusiastically, an extension similar to that on the adjoining house. At the beginning of February 1992 the issue was referred to the research project by the Council so that informal negotiations could take place, using computer visualisation, with a view to the householders submitting a revised application acceptable to the planning authority. Visualisation of the existing house, the adjoining properties, the proposed extension and the planning officer's alternative was undertaken in the days leading up to the negotiating session. Highly realistic effects (as used in the East Cambridgeshire Example) were not considered necessary for the purpose envisaged and the adjacent houses were modelled with colour but without surface detail. In late February 1992, one of the applicants, her agent and a planning officer (not the original case officer who had been prevented by illness from attending) assembled around the computer screen at the research unit for a 1 hour 40 minute session. The basic model of the house and neighbouring properties (Figure 5) was displayed on the large monitor and was agreed by all the parties to be realistic for the purpose intended. Oblique aerial (Figure 6) and eye level views of the applicants' proposal were examined and its merits debated, followed by the research team's understanding of the development control case officer's ideas (Figure 7). The discussion moved on to consider an extension of similar appearance to that next door (Figure 8). Unfortunately, examination of the plan (displayed simultaneously on the VGA Monitor) demonstrated that to achieve a room of sufficient depth would also have required a ground floor extension that would have been unacceptable to the applicants on grounds of loss of natural light and increased cost. The applicant then suggested that an A-frame extension at right angles to the existing roof would be acceptable to her because it would then have a blank end wall that would facilitate the arrangement of her furniture. She had brought with her a rough sketch of the arrangement and the idea was then visualised on the spot (Figure 9). This proposal met with some support all round. At the conclusion of the negotiating session, the participants were asked for their reactions to the use of the visualisation process. The applicant and her agent, the builder, both confirmed they had found it to be very helpful and the planning
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officer commented that it was a very useful procedure that had saved a lot of time. He commented further that it was especially useful for people, as in his case, who had not visited the site as it enabled them to participate fully in the discussions (c.f. the East Cambridgeshire example). He added that negotiations usually took place in the lobby of the planning office, away from the site in question, with ideas being sketched out in pencil on scraps of paper. Hard copy was subsequently produced by screen photography and the colour prints circulated to all the parties. A revised planning application based on the applicant's suggestion was subsequently submitted and approved by the Planning Subcommittee in April 1992. Selected visualisations were shown to the meeting and members were enthusiastic in their response to the use of the images.

THE WALTHAMSTOW EXAMPLE

The attitudes to the colour of new buildings by both users and neighbours can be an important factor in both sales and the obtaining of planning permission. This is illustrated by the 1990 example of the block of flats designed by Julyan Wickham Associates for Bisterne Avenue, Walthamstow. Although the block was of modernist outline in a street of early 20th century houses, it did not excite the attention of the public until the striking post-modern colour scheme was applied to the exterior. The local residents objected strongly and tried, unsuccessfully, to halt the work via the planning process. This issue was used as an example within a limited study of lay reaction to building colour was undertaken as a separate exercise. Using the Integraph Microstation program on the Apple Macintosh platform, a three-dimensional model of the block was prepared and the colours varied to provide ten different combinations. Colour slides of the images were obtained and projected before a jury of students who had no connection with the built environment professions. The images were shown both in isolation and against the background of the adjoining houses. A questionnaire was administered to the jury to record their subjective reactions both to the colour schemes themselves and their relationships to their surroundings. The results showed the taste of the jury to be on the conservative side with stronger negative than positive views to the colours shown. A particular point of controversy with the new flats the use of a strong shade of blue, was confirmed. The investigation was, in effect, a pilot study as only a small jury, not necessarily representative of the population at large, had been used. There is clear need for further study of the reactions of the lay public to building colour, a project which computer visualisation technology can readily facilitate.
ASSESSMENT OF THE TESTS

The study took the form of a limited number of trials of the use of visualisation covering a range of likely planning control situations. An extensive investigation involving a large number of trials from which quantitative data could have been obtained was beyond the limits of the available resources. The results of the tests were bound, therefore, to be somewhat subjective, and have value more as pointers towards future developments rather than as providing the definitive and concluding word on the issues involved. Bearing this caveat in mind, the points that arise from a comparative assessment of the tests are as follows:

a. All the participants were impressed with the quality of image that the current hardware and software could produce. The realism of the images depended on the human resources that could be employed and, in general, was found adjustable to the requirements of the task in hand. The only exception to this was the concern that the representation of the colour, pattern and texture of certain building materials was not as realistic as could be obtained by manual drawing. However, given the rate of progress of software development this is likely to be only a temporary problem.

b. There was no problem producing images of development on small sites within the time scale required by the development control process. This was especially so for visualisations that did not require a great deal of surface detail and, moreover, such images could be produced "while you wait". On the other hand, visualisation of large scale development (such as the Berkhamsted shopping centre) was a very time consuming operation.

c. The modelling of extensive background features was not found to be necessary when dealing with the issues affecting development on small sites. In all cases, the computer modelling of adjacent buildings sufficed and the overlaying of the images on to photographs of the background scene (by scanning or otherwise) was not found to be necessary.

d. The question of objectivity (as raised by the architects in the East Cambridgeshire example) is an important one as decisions had to be made about the degree of detail to be included in relation to the issues at stake. The answer would appear to be that definition of objectivity is a matter for the judgement of the
negotiators in relation to these issues. There is, therefore, a strong argument for obtaining the agreement of all parties to the visualisation of the existing development before proceeding to the negotiation. The benefits of this were illustrated by the success of the Danbury example in contrast to the negative reactions expressed by one of the parties in the East Cambridgeshire test. (The question of objectivity is discussed below at greater length).

e An important advantage of computer visualisation appeared to be its ability to bring the "site" into the office. The way that it could enable people without a detailed knowledge of the site to participate in discussions was frequently cited as a major innovation.

f There was direct evidence of the advantage to lay people of visualisation. The Danbury example, in particular, illustrated how it could enable an applicant to make a decisive suggestion that may not otherwise have come forward.

g There was also confirmation of the assistance that computer visualisation could give to professionals engaged in the design process by providing feedback on the appearance of their proposals.

THE OBJECTIVITY ISSUE

The issue of objectivity, referred to on several occasions above, is a central one and one that deserves further discussion. Although visualisation has an obvious use as a presentational device for advocating the merits of a proposal, enabling its initiators to advertise and clarify their position, it is suggested that this is neither its only, nor its most potentially valuable, role. It is asserted that a central component of the argument for the use of computer visualisation in planning control is that it should be seen to be independent of the positions of all the negotiating parties. It can, thereby, provide them with a common point of reference, a means for resolving disputes on points of fact and the basis for an independent test against which the participants can measure the strength of their arguments. However, this is not an assertion that meets with universal agreement and at least one respondent (see the East Cambridgeshire example, above) expressed grave doubts about its use in an independent capacity. It would seem unlikely, though, that the argument would lie with the extreme positions of total acceptance or rejection of the objective role. Even if the general assertion above were accepted there would still remain some important caveats to be debated.
The argument can be addressed most conveniently by considering one extreme on the scale, the artist's impression. This is normally held to be the epitome of the subjective image: very much a device for advocacy and little use as independent evidence. Why is this so? The subjectivity arises where, in the course of producing the drawing, the artist, who is employed to represent the interests of developer, is confronted with choices which require judgement to exercised on the basis of opinion and interpretation. In attempting to break down the components of the subjectivity the following points of choice and decision can be identified:

a. a single viewpoint (or a very limited number) is selected to show the proposal to advantage - unflattering views need not be made available

b. perspectives, where not obtained geometrically, may be liable to distortion

c. lighting, especially sunlight, and consequent shading and shadows may be exaggerated or underplayed for good effect and only ideal conditions may be shown

d. the detail in which buildings can be shown can be selected for effect

e. background buildings, parts of buildings, paving, street furniture and landscaping can be included or excluded to create the desired effect

f. the appearance of materials to be used can be enhanced or played down as required.

The argument for the objectivity of computer visualisation rests primarily on the first three qualities:

a. the viewpoint is infinitely variable and can be selected by any party

b. perspectives are calculated to such accuracy that it is possible to fit a computer image on top of a photograph of the same site taken to the same visual parameters

c. the lighting is variable in colour, intensity and direction and can be adjusted to positions
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requested by any party. Shadows can be calculated exactly (and can be checked for accuracy by comparison with those on existing buildings).

The argument for objectivity with regard to these three qualities relates to the independence of the observer. Assuming there is confidence in the methods of calculation used in the software, any desired image can be requested by any party and all will be obtained on an equivalent basis. For the other qualities listed for the artists impression, however, the matter becomes more complicated. It could be argued that the increasing ability of information technology to produce photo-realistic images could provide the solution. The test could be: "if the computer image is indistinguishable from a photograph for the existing situation then the modelled proposals must be completely objective". There is the immediate objection that photographs incorporate outside judgement and therefore, a level of subjectivity. There are also problems with the more general "realism equals objectivity" argument. Questions of level of detail and inclusion and exclusion of items will continue to exist for two important reasons. Firstly, the economics of the visualisation process imply that it is not always expedient to model to the maximum level of realism. For example, if cast shadows are the only issue then why spend time and money modelling the colour and texture of the brickwork? Secondly, negotiations concerning development proposals frequently occur at a stage where all the details have not been incorporated in the design, let alone agreed. To come to arbitrary decisions on, for example, such matters as choice of colours, building materials and landscaping merely in order to achieve total realism could confuse the deliberations by raising points prematurely or even go so far as to create a misleading impression. (It is not being suggested here that there would be a deliberately subjective input, merely that confusion could result). In practice, therefore, users will need to make decisions about what items should be included and the level of detail to which they should be modelled. The decisions thus made should relate to the purpose of the exercise and will include an element of subjective judgement. The objective quality will lie, as referred to in the test results above, in the way the images are used and in the basis upon which the negotiations are conducted. If all the parties agree, at the outset, that they have confidence in the ability of the hardware and software to produce a usefully realistic representation of the existing situation, then the subsequent visualisation of the proposals will command an objective status on the grounds that it has been deduced from a common position. (There is an analogy here with the view of scientific method post-Popper where the value of a theory stems from its ability to provide predictions by deduction which can be tested by experiment). The argument for the objectivity of computer visualisation rests, therefore, in part on the independence and validity of the algorithms employed within the working of the programs and in part on the way it is applied in the modelling and decision making process.
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The arguments on objectivity and realism above and the results of the tests point to the solution of the more general problem in computer-aided design, how to determine the level of realism to be modelled. The concept of total realism is open to criticism as it is practically unachievable. Realism is a relative concept. In theory, finer and finer detail of the components of a building could be modelled given sufficient computer power and operator time. Every door handle, keyhole and grain in the wood could be shown. It has, however, been suggested above that the balance between the realism and economics is determined by the agreement in negotiation by the parties involved. This was readily obtained in the Danbury example and could point the way to a means of resolution in all CAD situations. The agreement between designer and client could be obtained prior to a discussion of the merits of the design by an interactive trial and error negotiation around the computer screen.

POSSIBLE LONG TERM DEVELOPMENTS

It is now conceivable that in a few years time computer visualisation facilities will be available to development control officers at their desks and will facilitate pre- and post-application discussions with all parties engaged in simultaneous negotiation, as in the Danbury example described above. As also mentioned above, planning applications may eventually be submitted on disk using a template supplied by the planning office. There is no reason why the disk could contain not only CAD files but also a variety of other media, such as visualised still images, digitised video recordings of actual and simulated development and an accompanying sound commentary. Technological innovation should also reduce the labour involved in entering the data into the computer for CAD and visualisation. Raster to vector conversion facilities are already available that can turn a scanned image into a digitised form. Their marketing in cheap and convenient form should ultimately mean that data held in the form of two-dimensional plans and elevations and, possibly, isometric and perspective drawings, could be read directly into the computer. However, the most impressive long term innovation is likely to be the use of virtual reality. Masks, gloves and earphones may not be necessary for planning control purposes but the advantages of seating a planning committee inside a simulator for a "drive around" a computer generated model of their town will be clear. Proposed buildings could not only be viewed from all angles but could be altered interactively. Moreover, individual members would be able to "explore" the town independently. Two dimensional virtual reality enables the user to move around the simulated environment, in vision only, on the monitor screen and is now available "off the shelf" though at a price. All these innovations will bring both the public and the participants in the process of negotiation ever closer to experiencing the true impact of proposed development.
CONCLUSIONS

Limited as they are, the examples studied have pointed the way both to the resolution of certain issues in visualisation generally and to its practical use in the planning office for design control. This has been achieved by making a central feature of negotiation between the parties to the development process. The ability of information technology to visualise development such that the images can be amended interactively facilitates its direct use in such negotiation. By removing potential obstacles to communication it helps to bring about agreement between the parties in situations where it may previously have seemed far from easy. The agreements between the parties will determine both the levels of realism modelled and the objectivity with which it is regarded. Moreover, the use of visualisation to assist negotiation of agreements will greatly improve the practice of design control.

REFERENCES

   Welsh, Colour Coding, Building Design, No. 1012, p. 2, 16 November 1990
Figure 1  Guilford Example - first design - oblique aerial view

Figure 2  Guilford Example - second design - oblique aerial view
Figure 3  Guilford Example - third design - oblique aerial view

Figure 4  Guilford Example - fourth design - oblique aerial view
Figure 5  Danbury Example - before - oblique aerial view

Figure 6  Danbury Example - proposed extension - oblique aerial view
Figure 7 Danbury Example - planning officer's proposal - oblique aerial view

Figure 8 Danbury Example - extension similar to next-door's - oblique aerial view
Figure 9  Danbury Example - applicant's concept - oblique aerial view

Figure 10  Danbury Example - agreed proposal - oblique aerial view