Task 2.2– Visualisation Tools To Aid Public Understanding of New Developments in Urban Historical Areas

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1. Introduction

The development of low-cost, powerful, and sophisticated computer-based modelling tools has revolutionised the presentation of architectural and urban design proposals. Powerful techniques for generating photorealistic views are now readily available to most if not all design practices for a relatively modest outlay. Convincing visualisations of new developments can be generated quickly and easily on a standard desktop computer. As the cost of hardware and software continue to fall and performance increases, even Virtual Reality (VR) systems—once restricted to use within research institutions and universities—are now within reach of the larger design firms and consultancies. These new techniques are supplementing, and often replacing, traditional ways of communicating design proposals within design teams, to relevant authorities and to the general public. To date, the tendency among built environment professionals has been to assume that increasing sophistication and photorealism in visualisation is always for the good. However, very little research has been conducted into the efficacy of new techniques compared to their more traditional counterparts, and there is some evidence to suggest that reliance on highly realistic 3d perspective renderings can obscure important properties of design proposals (Tweed, 1997a; Teller, 2001).

The aim of this report, therefore, is to review currently available techniques for visualising developments within urban historical areas and to consider whether the use of these tools can enhance the benefits of existing participatory techniques to ensure not only, a better public understanding of intended interventions, but also, to increase local capacity, allow experts better access to local knowledge and help to build trust between all stakeholders. The specific objectives of the report are:

? to review existing methods of visualising development proposals in urban areas;
? to examine these methods for their suitability to the broader aims of the SUIT project; and
? to summarise characteristics of visualisation techniques relevant to their use in promoting debate about development in urban historical areas.

It is often within historic and cultural areas of towns and cities that public feelings about new developments run high. As Day (1994) suggests, it is in our historic towns and spaces where there is particular concern about how new should relate to old: “When new buildings are proposed there is a desire for public debate, but that debate can very easily be stifled by problems of understanding exactly what is intended and in assessing the impact of the proposal on its surroundings.”

Researchers and practitioners (King et al, 1989; Al-Kodmany, 1999) increasingly believe that visualisation techniques are the key to promoting effective public engagement as they can provide a common language which all participants can understand, helping to overcome problems of more traditional methods of involvement, which have tended to disenfranchise non-design oriented people (Sanoff, 1990 quoted in Al-Kodmany [1999]). Careful use and implementation of visualisation techniques can generate debate and discussion amongst stakeholders and communities, raise design awareness and facilitate communication between all interested parties. But we should not take for granted that increasing photorealism will inevitably lead to greater lay understanding of every important concern and in every case.

The increasing use of more sophisticated visualisation tools incorporating the latest technologies, within the planning and architecture professions, is outlined in this report and some of the techniques currently available for engaging the public in design issues discussed. Our own
research then seeks to establish the practicality and benefits of using some of these visualisation techniques and in SUIT SEA procedures for the environmental assessment of new plans, projects and proposals within areas of urban cultural heritage. Different types of visualisation techniques are reviewed and tested for their effectiveness. Finally, some conclusions and recommendations, in the form of a protocol for practitioners, are presented on how such techniques could be effectively and practically incorporated within the EIA/SEA process.

2. The role of visualisation

In presenting development proposals, the primary goal is to communicate to multiple stakeholders their possible impact on an urban historical area so that the stakeholders can decide if the changes will, on balance, lead to improvement. Visual presentations are normally used to convey how proposals will alter the appearance of the area, though other types of information can be presented in visual form to ease understanding of abstract concepts (diagrams, charts, graphs). This study considers only various ways of communicating the physical properties (form, geometry and texture) of developments.

Visualisation is the primary mode for communicating design proposals. There are limits to what can be conveyed visually. Drawings, photographs, computer models all require explanation beyond what can be conveyed in purely visual terms. Visualisations therefore are always presented in some wider context in which meanings are amplified by verbal communication, either written, spoken or both. The role of visualisation changes, depending on when, where and by whom visualisations are viewed. Public participation is a major interest within the SUIT project, and it offers a particular interpretive context to consider the efficacy of different techniques. Most of this report will examine visualisation techniques as tools for enhancing public participation.

2.1. Communication processes

Successful communication depends on the ability of the person receiving a message to understand the language it is encoded in. Alternatively, putting the onus on the message ‘transmitter,’ success depends on the ability of the person wishing to communicate with others to express her intentions in a form and language that others can understand. Architects and other built environment professionals are often accused of using language—whether graphical or verbal—that is opaque to others, particularly lay people. However, specialised languages generally emerge in response to a need, and this is true of some languages of visual presentation: there simply is no other way to express the intended meanings. Indiscriminate use of jargon—again, whether verbal or graphical—is counter-productive, but specialised terms and techniques, when there is no other way to communicate the same meanings, are not only unavoidable but vital. If unfamiliar terms and concepts are outlawed in pursuit of immediate understanding by all stakeholders, then the ensuing debate is likely to be highly impoverished, reduced to the lowest common denominator.

There are many different types of visual presentation—sketches, maps, diagrams, graphs, charts, photographs, paintings. Beyond conventional photography and figurative painting, visual presentations usually require some interpretive ability from the beholder. Someone wishing to understand the meaning of an urban plan, for example, must have the ability to read a map and to make the necessary connections between what is represented on a flat, 2d surface and the actual network of streets and places of the city. Communication between parties with different backgrounds but shared interests in development proposals will inevitably involve learning. In such discussions it has become easy to think in terms of ‘experts’ and ‘lay public’ as the two
main groupings. Neither group, however, is likely to be homogeneous. It may be more reliable to think of stakeholders as constituting a single group in which different individuals will have expertise about different topics. For example, it is safe to assume that members of the lay public will be expert in crucial aspects of community life and local history, and will be in the best position to educate built environment professionals and developers about how their community ‘works.’ Democratic communication requires that such expertise be recognised.

2.2. Visualisation techniques

The potential benefits of emerging visualisation techniques in helping the public to understand new developments are slowly being acknowledged. Within a relatively short space of time, particularly the past five or six years, planners and architects have been given access to a wide range of visual communication tools—from maps through to interactive and immersive virtual reality—made accessible through a wide range of media—from printed brochures, leaflets, questionnaires, exhibition panels and illustrative perspectives, to multi media CD-ROMS, DVD’s, Web sites, videos, 3d simulations and panoramas. Computer graphics and animations have now become common place in helping to present key information to the public, and indeed Local Authorities often now marry Geographical Information Systems (GIS) with desktop publishing applications to produce documents such as Local Plans and Unitary Development Plans digitally. To increase public access even further, many of these documents and plans are now being placed on the Internet.

As public involvement in the planning and decision making processes becomes increasingly important, new technologies can play an important role. A study by Pullar and Tidey (2001) confirmed the importance of 3d GIS in urban planning in helping to realistically visualise the built environment and proposed development scenarios, but cautioned that such techniques had to be utilised with appropriate evaluation techniques and participative processes.

2.3. Traditional methods of visualising designs

Traditional methods of visualising are derived from the standard orthogonal projections (plans, sections, and elevations) used by architects and others to communicate dimensionally accurate information about designs. Although such projections no longer convey enough information to serve as complete instructions for the construction of a design, their origins lie in the detailed construction drawings of the 19th century that served both purposes. Today, architects normally produce two main sets of drawings: one to communicate the appearance of the design before it has been fully elaborated—the so-called ‘sketch scheme’ or design drawings; and the other to tell the builders how to build the agreed design. Both sets rely heavily on the established orthogonal projections of plan, section, and elevation.

Orthogonal projections, historically, have performed definite functions. They are dimensionally accurate such that in the course of discussions one can measure directly from the drawings to establish true heights etc. They are an efficient way of capturing the formal properties of designs. Within the construction industry they are the accepted way of explaining designs. However, they are not naturalistic in the sense that anyone can immediately understand how a proposed design will sit within the physical environment. Reading such drawings requires skill and practice, which explains why they are notoriously difficult for those without training to understand. To provide a more accessible description of designs—originally for ‘paying’ clients—architects have relied on the “artist’s impression” as a means of showing what a design will look like.

Perspective projections are the mainstay of the artist’s impression. The ‘artist’ is usually someone employed by an architectural practice to ‘translate’ the information represented in
orthogonal projections into a form that could be understood by lay people. The time and skill required to construct these precisely has tended to limit their use to the larger, more prestigious projects. Even then, it is rare to find more than one or two artist’s impressions, thus allowing only limited access to the appearance in context of a proposed design. Viewpoints for perspectives are often chosen to flatter designs and to increase their acceptance to clients, planners and the public. Designs are routinely adorned with mature landscaping to soften their impact and to suggest longevity of the building. In keeping with their name, they often exhibit considerable artistic licence.

Artist’s impressions may be helpful in conveying a sense of realism that lay people can readily understand, but as 2d representations they lack the depth that is felt in embodied experience of actual lived space. Physical models are used to overcome the shortcomings of drawings. Models vary greatly in their degree of sophistication and associated cost. The most basic models are intended to communicate formal properties of proposals—massing, shape, geometry—and can be made relatively quickly and cheaply from low-grade materials (card, and balsa wood). They rarely show details of window or door openings, and so their use is restricted to discussions about scale, and overshadowing, for example. More expensive models show greater detail and will often include windows, doors, street furniture, landscaping, texture and colour. As with perspectives, models are usually only made for large, prestigious projects. The advantages of physical models over artist’s impressions are that they are to scale, can be viewed from any angle, can be lit in different ways to show the distribution of sunlight, and represent the crucial third dimension.

Beyond the standard types of design drawings, traditional methods are mostly confined to the more lucrative design projects. This is primarily a business decision. Perspectives and models are expensive, mainly because they are so labour-intensive. The development of computer-based drawing and modelling systems has radically changed the production of design drawings and creates new opportunities for presenting unbuilt designs in ways that seem much easier for lay people to understand.

A major difficulty in using all traditional methods is to maintain consistency across an entire set of drawings and models. In theory, Perspectives are constructed using established geometric techniques to ensure that the resulting projections are faithful representations of measured or intended objects. This entails an elaborate construction of the drawing based on dimensions transcribed from other sources—plans, sections and elevations. This is not an exact science and requires some judgement and discretion on the part of the artist. To complicate matter further: designs are seldom finalised before drawings and models are needed to describe them to others. Apart from the potential for mistakes to be made in ensuring the same dimensions are used in all representations of the same design, there is the added danger that evolving design features will be present in later visualisation yet absent from earlier versions. Consistency of representation is one of the main attractions of computer-based systems.

2.4 Digital tools for visualising development proposals

A decade ago it was relatively straightforward to classify different types of digital visualisation tool cleanly. Most approaches sought to perform one major function and there was little overlap between the feature-sets of—for example—a GIS and a CAD system. This is no longer possible. So-called ‘feature-creep’ has led to GIS acquiring some of the functionality of 3d modelling packages, whereas 3d CAD systems are increasingly able to deal with collections of buildings, as might be found within a sizeable urban area. In an attempt to broaden the markets for their products system developers have strayed well beyond the original focus. This has advantages and disadvantages. On the positive side it reduces the need to move data from one package to
another. A GIS can display 3d images while retaining its map basis. A CAD system can be used to construct a 3d model and render it to produce highly realistic images. On the downside, individual programs have tended to become bloated with unnecessary features with greater complexity and demands on computer power.

Outlined below are some of the tools increasingly being used in relation to planning and public participation. This report does not seek to provide a comprehensive classification of all the types of visual representation but rather seeks to highlight important trends emerging in the fields of planning and architecture and seeks to clarify how these latest technologies could be applied to promote more effective involvement of the public in debate about historic urban spaces.

2.4.1 GIS (Geographical Information Systems)

Fundamentally, geographical information systems consist of a map-based graphical interface to a database. This combination provides a means of attaching and interrogating data on a spatial basis using either point or polygon (area) features. As Batty (2002) notes “the heartland of GIS and the focus of most proprietary software systems is representation, visualisation, and mapping.” GIS programs such as MapInfo, and ArcInfo, are increasingly used in the strategic planning of cities and spaces. In recent years, using the Internet forms of these applications it has been easier to access, interrogate (or analyse) data and share information on a common basis.

In the USA, the Orton Family Foundation has developed a GIS software system that allows land use planners and communities to visualise the impacts of development. The foundation, established in 1995 has created the CommunityViz suite of applications based around ArcView (Reference www.communityviz.com). The system, primarily aimed at rural community planning, is designed to open up the communication process, enhancing dialogue and enabling the exploration of alternative scenarios in real time. It offers the ability to examine the impact of proposed developments over the short and long term in 3d.

CommunityViz has proved that using GIS visualisation techniques is an effective tool for helping to engage young people in particular, due to its “cool factor”. This group is often difficult to reach through more conventional participative processes.

2.4.2 Computer aided design (CAD) systems for modelling and rendering

Computer software to create photorealistic renderings of conventional perspective projections has been widely available for the past ten years. There are now more than 100 different computer-aided design (CAD) packages available, many of which can generate 3d views. The different systems vary in their functionality and sophistication, though most have now converged on a common feature set. Differences now are confined to the design of user interface, import and export features and cost. There is little to choose between, for example, AutoCAD, Microstation Triforma, or ArchiCAD in terms of their functionalities. The major differences are in the user interface rather than in the features they offer.

Most of the higher-end packages consist of two main parts: a 3d modelling system and a rendering ‘engine.’ Models are built from geometrical ‘primitives’ such as cuboids, spheres, meshes, and trapezoids. The range of primitives determines what can be represented in the model. To take an absurd example: if a system did not offer cuboid shapes then it would be impossible to incorporate any form of rectilinear block in the model. As with many computer programs, modelling systems require precise (numerical) information about what is to be modelled. This has become a major drawback in using sophisticated modelling packages. Everything to be included in the modelled must be capable of being described numerically, though user interface design can allow the system user to manipulate models graphically, thereby
avoiding having to enter numbers (such as coordinates) directly. The effort required to build a 3d computer model with any significant detail or complexity should not be underestimated. Even though sophisticated surveying tools are now emerging, such as 3d laser scanners, collecting and entering data is still time-consuming.

CAD systems alone seldom produce high realistic shaded and textured images. To increase the degree of realism modern, modelling systems either incorporate a rendering engine or allow models to be exported in a range of formats that can be imported into dedicated rendering packages, such as 3d Studio, Artlantis. Rendering packages allow modellers to specify different types of light sources, detailed optical properties of materials (including reflectivity, light emission, transparency), and textures. In the right hands, differences between computer rendered images and actual photographs can be almost indistinguishable, hence the term photorealism. Beyond the obvious application for realistic rendering, researchers have adapted the same technology to study and explain important characteristics of the built environment. Figure 1 shows the same techniques used to visualise solar irradiation of surfaces in an urban setting.

![Figure 1: rendering techniques used to visualise annual solar irradiation of urban surfaces (Source: http://www.iesd.dmu.ac.uk/~jm).](image)

Increasing computing performance/price ratios have made it feasible even for small organisations, with no special in-house expertise, to produce highly photorealistic images of buildings and other physical features of the urban environment. Most modelling programs also provide the ability to generate sequences of rendered images animations. By specifying camera positions along a path, a modeller can generate a walkthrough or fly-past. Animations require considerable computing power and are usually generated in ‘batch-mode’ when a dedicated computer is allowed to run unattended over a period of hours or days, depending on the complexity of the scene and the degree of realism required.
Animated views can convey a sense of movement through a space that begins to approximate actual movement in real spaces, albeit that of a passive observer. However, the computing power required rules out real-time rendering of scenes or any spontaneous interaction with what is depicted in them. Walkthroughs preclude deviation from a predefined path established before the visualisation was generated. To allow dynamic interaction with objects and user-defined movement around a scene it is necessary to move to the next level of sophistication, virtual reality (VR).

2.4.3 Virtual Reality (VR)

Virtual Reality, as applied to planning and the built environment, can be divided into two types; “Immersive” and “Desktop” (Hamilton et al 2001). Immersive systems involve head sets and VR rooms, which create a human-sensory interface by creating a 3 dimensional space that interactively responds to, and is controlled by, the behaviour of the user. Desktop VR can be achieved on standard computer screens but does not provide the same quality of sensory stimulation. Hamilton et al (2001) note that desktop systems have the same sensory impact as any image on a screen, leading to problems of scale but these can be overcome through giving the viewer an eye level view of the scene to simulate actually standing in the space. Within the historic environment, VR is used to simulate actual urban spaces with all the detail and features giving the user a feeling or sensation of actually walking through the space. Its primary purpose is therefore to aid understanding of a space by representing in it as realistically as possible. Such techniques have been widely used in archaeology to recreate urban spaces long since demolished or for which there are only partial remains surviving.

VR technology goes beyond providing unscripted movement through a modelled environment. It can also allow users to interact with models. Some of these interactions deliberately break the rules of reality and in doing so offer new ways of experiencing the richness of the modelled environment. A VR model of St Petersburg allows its user to journey along the streets lined with reasonably accurate models of historic buildings, one of which is an art gallery. The user may enter the gallery and study paintings hung on the virtual gallery walls. One painting shows a Russian scene from the 19th century. The user can examine the painting and enter the scene it depicts. This creative use of VR has yet to be fully exploited and clearly pushes the envelope of VR beyond what is needed to help users understand design proposals.

The downside of this technology is of course the high cost of the hard and software, coupled with the high level of skill and training required to maintain and operate the systems. There are also concerns about disorientation and nausea following even quite short exposure to immersive VR systems. As a result, VR has had little practical application in relation to the built environment in the UK due to the large investment necessary, but its huge potential to engage the public in meaningful debate cannot be overlooked.

2.4.4 Geographical Visual Information Systems (GVIS)

This is the integration of GIS, VR and Internet Technologies in order to facilitate more effective and efficient participation (Zhang et al 2001). Models of entire cities can illustrate this best. City models began to be introduced by Local Authorities in the 1990’s, and examples include the Bath and Edinburgh city models. Early graphical models were commissioned out of a desire to protect unique urban landscapes, but they also raised awareness amongst the public and other stakeholders of the rich cultural heritage and are now considered an important element in their conservation.

Many more cities around the world are now developing their own virtual models as a basis for providing as wide access as possible to the planning and development process within those
cities. Although the participatory potential benefits are clear, Hamilton et al (2001) point out that much work still needs to be done, citing the example of the designers of the London model who state “true virtual cities that provide effective digital simulation of real cities, which give users a genuine sense of inhabiting an urban space, do not yet exist on the web. Research in the field of Internet GIS and 3d urban modelling using VR, is creating the foundations for true virtual cities with realistic built form interface, a richness of geo-referenced information content, and crucially, the ability to support social interaction (Dodge et al, 1998).

Day (1994) in writing about the uses of such large-scale city models discusses the possibilities that they offer in reconstructing the historical development of a particular city. He goes on to state:

“Urban models offer something that has never been available before, a way of analysing the present and considering the future which is available to all. Just as the drawing is a tool used by the designer and, as such, becomes a way of thinking about a problem, so the urban model can become a way for the whole community to focus and articulate its thoughts on how urban growth and change might be accommodated”.

2.4.5 The Internet

Strictly speaking, the Internet is not a visualisation technique; it is a medium for disseminating existing types of visualisation. However, the rapid growth of the Internet—in particular the World Wide Web—and its pervasive presence open up new opportunities for engaging a wider audience in debate about the built environment. The last decade has witnessed a huge growth in the use of the Internet in households. Local Authorities are using the Internet to provide access to plans, policies and proposals and in this way are exploring its more effective use for consulting with the wider public. The benefits of the Internet include its interactivity. It is a useful tool at the scoping stage of the EA procedure in that any person interested in the proposal can sign up to a mailing list for further updates and meetings.

Computer-based visualisations can be accessed through proprietary World Wide Web browsers (Internet Explorer, Netscape Communicator, Safari). Image files can be viewed without additional software but more advanced techniques (GIS, VR) require ‘plug-ins’, such as the Cosmo Player for virtual reality files. Without an accompanying explanation of what the visualisations depict, it will be difficult for those not closely involved in their production to understand their full import. As noted previously, visualisations must be explained within a broader discussion in which ambiguities and uncertainties can be identified and clarified. There are two main technical obstacles to widespread access to VR across the Internet: limitations on data transfer (download) imposed by the bandwidth of connections; and, competing standards that lead to incompatibilities between different software systems. Until high bandwidth connections are available to residential users the prospects for VR as a means of communicating development proposals to the wider population are slim. Even a small area of a city, using current modelling techniques, consumes several megabytes of computer memory as a VR model. Download times of an hour or more are likely to discourage all but the most enthusiastic citizens from viewing the scene. Nor is it obvious how the scene will be formatted given the stiff competition between proprietary standards for exchanging VR data. Work on the non-proprietary VRML (Virtual Reality Markup Language) has slowed because of lack of funds under the threat of stiff competition from commercial alternatives. It is too soon to say what the eventual agreed standard format will be, but it seems clear that it is unlikely to remain stable for many years.

The Web is often presented as a panacea to difficult problems of access. It should be noted that despite widespread access to the Internet there is a significant number of people who either are unable to access the Web or who do not wish to use the technology, for various reasons.
Technical obstacles to providing access can ultimately be resolved or lessened, whereas social, economic and cultural issues are less tractable. However, lack of complete access is unlikely to impede future growth of the medium as a means to democratise decision making.

The range of digital visualisation tools is continuously changing, with the result that reviews and recommendations date very quickly. However, the fundamental techniques remain reasonably constant. Research on the efficacy of these tools with different groups of people is scant. The assumption is that more realism is better. Although it is not possible to test all of the techniques described above with the constraints of this project, we can conduct some preliminary studies, which may help to shape and inform future research. The remainder of this report documents empirical work carried out by the authors to determine people’s attitudes to a selection of tools.

3. Empirical research

The central concern of this research is to establish how to present a design proposal to an individual or stakeholder in such a way that the person can obtain whatever information they need from that visual representation. With increasing use of digital tools, the key is to ensure that a sense of reality is conveyed to the stakeholder whether it is in the space being planned, or in trying to convey an understanding of the design interventions proposed. The problem is how different people visualise the space as they see it or remember it. Gibson (1986) considers this point, “Each object is seen from all sides, and each place is connected to its neighbour. The world is not viewed in perspective”. The difference between real space and visual representations of that space is in movement. This was an issue considered in Task 2.3 – Morphological Analysis. The research undertaken as part of this task developed a new mathematical means of modelling a space. The resulting spherical projections took account, not only of bifocal vision, but also of the relatively free movement of the head and shoulders, that is, vision as part of the human ecology. The maps show how a person might experience those volumes of a void that define a space, not from a fixed point, but from moving about inside the entire urban open space. Other 2d representations such as elevations, sections and plans, approach the problem by providing various views of the space—‘snapshots’ available at different stopping points within a space.

Clearly some forms of visualisation will be more accurate, efficient and easily understood than others. Our research therefore seeks to take a sample of the tools currently available to practitioners and test them for their effectiveness in helping people to recognise and orientate themselves within a visual representation of a space and in helping them to understand proposed design interventions within that space.

3.5. Research design

The first stage in the empirical research has been to map the range of possible types of visualisation tools by identifying their main dimensions of difference. Figure 2 shows a taxonomy for visualisation. The figure captures the major features of different forms of visualisation. Using this taxonomy, it is possible to locate the main kinds of visualisation techniques currently available.
Figure 2: An outline taxonomy for visualisation.

The figure can be used to identify the ways in which different types of visualisation technique vary. For example, one can have 3d lateral perspectives that vary in the degree of interactivity they offer, as well as showing variation in colour, type of shading and presentation style. Ideally, the research should address the entire range of visualisations, but to construct a comprehensive understanding of visualisation would require experiments capable of isolating each of the properties of each type of visualisation to measure its impact on different people. This is not feasible in the current project. Instead we have focused on a small number of techniques—maps, photographs, sketches, elevations, and various types of 3d computer-generated images—and two media—paper and computer screen.

3.5.6 Outline of visualisation tools employed in SUIT testing

A. Photomontages (Digital Photo Manipulation)
The technique of digitally altering photographs was one which the SUIT project has previously incorporated successfully as part of Task 2.1, where members of the public were surveyed in relation to their attitudes and perceptions within urban historical areas (ref: Tweed et al (2002)). The research discovered that this technique could be employed relatively cheaply and was an effective tool in eliciting quality responses from the public. Al-Kodmany (1999) and his team of researchers also found during testing that “computer photo imaging was exceptional at creating realistic scenarios which greatly assisted the audience in voicing their design preferences”. The technique requires photographs to be taken of the urban space and using software such as Photoshop™ to make alterations to the view in order to convey different development scenarios. Clearly the technique requires some experience with the appropriate software and difficulties can be encountered when introducing sophisticated interventions. Al-Kodmany found that photo manipulation was most helpful in cases where the design issues have already been defined, since the image library must be prepared ahead of time.

B. Artists’ Sketches
Sketching can be incorporated in two ways when engaging stakeholders. Firstly, through presenting the proposed intervention in the form of a sketch, and secondly, by employing an artist during the participation process or workshop situation to sketch stakeholders visions,
perceptions and ideas. Al-Kodmany employed the latter technique and found it useful for promoting participation in the early stages but too abstract and imprecise for generating final design solutions. Our research concentrated on the former scenario – where we presented the participants with sketches of the urban space as a means of conveying proposed interventions.

C. Geographic Information System (GIS)
Aerial photographs and base maps (with minimal layers) from a GIS database were incorporated into the process, due to their wide availability to authorities as tools in the planning, conservation and design of historic urban areas. As Planners are increasingly incorporating GIS into everyday urban design and planning, the aim was to test if they could also aid public understanding. As the section above highlights, GIS information can be sophisticatedly employed to integrate all manner of strategic information (data on population, transportation, housing, listed buildings or conservation areas, for example). Our primary aim however was to test if people could understand such GIS information at its most basic level before considering the incorporation of more complex data. The photographs and Maps were aimed to assess the individual’s ability to orientate themselves within a space and identify salient features.

D. 3d Modelling
The chosen survey space was measured and a 3d model of the space was produced using *ArchiCAD*. Variations on different hypothetical development proposals were also develop in this program and a range of photo-rendered images was generated for the survey. The rendering engine in *ArchiCAD* is not considered to be particularly high quality, but the resulting images were intended to be typical of the quality that could be produced by a typical architectural practice with standard workstations.

E. Spherical Projections
This is a visualisation technique produced as part of the SUIT project under Task 2.3 (ref. Teller). The spherical projection uses a mathematical modelling technique capable of mapping the variation of sky visible from points distributed throughout the space. This effectively provides another way of looking at the space – a “worm’s eye view”. As this technique is new, the participants would not be familiar with such representation of a particular space.

3.6. Survey methodology
We decided early in the research to use a survey technique to determine the effectiveness of different types of visualisation in answering specific questions about new developments. We had previously enjoyed some success with an illustrated questionnaire to study perceptions of and attitudes to an actual urban historical area. The major difference, of course, in using the same format for visualisation tests is that the illustrations would need to present design proposals rather than describe the existing environment.

The questionnaire focused on the space in front of the Lanyon Building on University Road, Belfast (the oldest, and one of the most symbolic, conservation areas within Northern Ireland) and the various visualisations tools and techniques were used to communicate proposed physical changes in this area. The questionnaire consisted of three main sections, corresponding to the three objectives for the task listed previously.

Questions 1-4 addressed issues of identifying and locating salient features of the selected space by asking respondents to locate three landmarks on an Ordnance Survey (OS) map, a spherical projection (see Figure 3), an aerial photograph, and a schematic isometric projection.
Questions 5-7 were designed to test if respondents could identify changes depicted in watercolour and pen sketches, digitally altered photographs, and a 3d computer generated axonometric image, shown in Figure 4. A corresponding axonometric image featuring a new design for the Students’ Union was displayed on a computer to test respondents’ ability to identify change in this type of projection.

Questions 8-11 focused on how successful the different forms of visualisation are at communicating the impact of changes. The first two questions—using a spherical projection and a conventional elevational drawing—asked respondents if a proposed building would be taller than the existing ‘Lanyon’ building. The remaining questions presented replacement designs for the Students’ Union and for a listed terrace on University Square using 3d computer images, spherical projections, sketches and a watercolour painting. A crucial element of these questions was the attempt to influence responses by presenting the same proposals in different contexts—for example on sunny and cloudy days. Different background information was also provided about the same physical interventions—in one case a design proposal was described as a new arts centre, and in another as a centre for asylum seekers. Figure 5 shows the two depictions of the same design. Note the difference in sky conditions, overall brightness of the image, and the absence of trees in Figure 5 (b).
(a) a replacement for the Students’ Union presented as a new Arts Centre.  
(b) a replacement for the Students’ Union presented as a centre for asylum seekers.

Figure 5: identical designs for a replacement for the Students’ Union presented in ‘positive’ and ‘negative’ associations and depictions.

The final question asked respondents to indicate their general preferences for different types of visualisation technique.

3.7. Testing different visualisations in a workshop setting

A workshop session, organised in conjunction with Belfast City Council as part of the Look Up Belfast International Built Heritage Conference (held on 1st – 3rd October 2002), provided the first and main opportunity to apply the questionnaire. Twenty-two (mainly) built environment professionals participated in the workshop. The session was divided into three parts—the introduction explained the background to the project and described the urban space used in the questionnaire, to allow those who did not know the survey space to become more acquainted with it. As part of this introductory session, a slide presentation was made showing different views and details of the historic urban space. In the second part of the session participants were asked to complete the questionnaire/workbook described above. While completing this workbook, participants were invited to roam around the room, looking at the relevant visualisations, whilst in the background the slide show, displaying images of the space, was played on a continual loop. Finally, participants were invited to comment on and give feedback about the exercise, the relative advantages and disadvantages, and their own particular preferences amongst the visualisation techniques employed.

3.7.7 Main conclusions from workshop testing

a) Nearly all of the participants (99%) were able to identify salient features correctly regardless of the type of visualisation.

b) Most participants were able to identify changes.

c) Few of the participants were able to understand the impact of changes. For example, 41% failed to identify from 2d elevations that the proposed development would be taller than the main University building.

d) Digitally altered photographs (or photomontages) were the preferred tool for illustrating and understanding the impacts of changes within the survey space—followed by the computerised 3d model and then the artist’s sketches. Participants preferred the spherical models least.
During the discussion and feedback session, respondents indicated that they had difficulty understanding and interpreting the spherical models as they could not relate to the “worm’s eye” view. Others felt that the spherical model was “too distorted and unreal.” The lack of detail on the computer-generated 3d models, which showed the buildings stripped of their detail, also caused difficulty for some participants in identifying key features. Comments were made that these models were “too sanitised.” One respondent indicated that “the buildings stripped of detail affected the brain’s storing of memories and devalued it visually.” The participants agreed that the paintings and sketches aided the recall of memories surrounding the survey space with one participant indicating that they “fired the imagination”.

There was also some debate about whether greater context should accompany the visualisations—some participants felt that it was necessary to be told which buildings were ‘listed’ or that more historical detail be presented. The contrasting view was that the use of visualisation techniques to assess the impact of new developments should allow individuals to make his or her own judgements on the value or impact of development rather than be influenced by statutory designations. Participants also agreed that more information needed to be given about the proposed use of the new developments for full assessments to be made about their anticipated impact upon the physical, social and economic character of the space.

Overall it was concluded that a combination of the techniques employed in this exercise, which could also include a physical model, would provide the most effective means of visually representing new developments.

3.8. Additional visualisation survey

As the workshop consisted almost entirely of built environment professionals, follow-up tests were conducted with members of the public, or lay people, to supplement the research and highlight differences. In contrast to the conference workshop, the visualisation tests were carried out on an individual basis in one-to-one interview sessions. Twenty of these interviews were held over several days with students from Queen’s University (but not with students from the Schools of Architecture or Environmental Planning). It was decided to interview students because of their familiarity with the space around the Lanyon Building, as it was important to retain the same survey space as the one used in the conference workshop. Respondents were asked to complete a questionnaire similar to the one used during the workshop, and some visualisations (such as the 3d model) were demonstrated through the use of a laptop computer.

3.8.8 Main conclusions from the additional survey

a) There was a slightly lower ability amongst respondents to identify salient features in tests—particularly using the Ordnance Survey map and the spherical model—although an overall high correct response rate in this section of the testing.

b) Digitally altered photographs (photomontages) produced the highest correct response rate for identifying changes.

c) Highly inaccurate response rates were recorded for understanding the impacts of changes.

d) The great majority of respondents (75%) identified the photomontages as their preferred form of visualisation, followed by 3d models (15%). The Ordnance Survey (OS) map was the least favoured.

The interviewees were also asked for their comments and feedback. Comments were characterised by distrust and cynicism about the use of visualisation techniques to represent
proposed developments. Comments were received such as “any of the illustrations could be good or bad when they are built,” and “sketches make the proposals seem more attractive, but I distrust them.” Respondents agreed that they found the GIS maps confusing and many respondents indicated that they usually had trouble interpreting plans—but found this individual session helpful as they had time to work out what was being proposed and to relate this to the knowledge of the space. Overall the digitally produced photomontages were again the preferred means of visual representation.

4. Conclusions from empirical studies

There are obvious limitations to the research, which make it unadvisable to present any firm conclusions and we acknowledge that a detailed understanding of visualisation tools could only emerge from a much longer research task. However, there are useful points to be made, and these can be explored further through further research.

All forms of visualisation are obviously open to manipulation and dishonesty—images, animations and VR presentations can be distorted to deceive and to look attractive. However, our testing revealed that the public understand this to be the case and are suspicious when presented with such tools and techniques. Perhaps it is for this reason that our findings indicate that simplicity was favoured by the majority of respondents in the visual representation of new developments—digitally altered photographs proved to be the preferred tool. Photographs can be more easily related to reality, leading to a better understanding of physical interventions and how they will sit in their surroundings.

Techniques such as spherical projection, while useful as a specialist tool for measuring particular impacts such as effects upon sky openings, confused respondents. It is worth noting however that since the main interest of SUIT is on the impact new development has on urban spaces—rather than on individual buildings or street façades—spherical projections are one of the few techniques that can capture an entire space in a single image. Perhaps, as with many of the drawing types we now take for granted, spherical projections may become as easy to interpret as traditional lateral perspectives.

Participants also had difficulty relating to “sterile” computerised images, and while the professionals favoured artists’ impressions and sketches, the lay people distrusted them. The sterility of computer images probably arises from the lack of fine detail in rendered scenes. Rather ironically, we can conclude that the pursuit of photo-realism in this type of image often works against it because it leaves nothing to the imagination. Sketches and paintings, on the other hand, for lay people, leave too much to the imagination.

Finally, the importance of sensitive interpretation and explanation needs to be stressed. During the workshop session, facilitators were available to answer questions and clarify any confusion amongst participants. Likewise in the individual sessions, respondents highlighted the importance of having a “one-to-one” session to help with interpretations. For any participative exercise it is important to have someone to explain the context, introduce the tools and techniques and be available for advice, and we found that this to be an important factor in eliciting responses.
5. Conclusion: a protocol for integrating visualisation tools within environmental assessment procedures

This research task has reviewed different techniques for visualising new developments and conducted an empirical survey in a conference workshop and through fieldwork to test some techniques using hypothetical developments in an urban historical area in Belfast with different subjects. The choice of a single urban area and the small survey sample preclude any firm conclusions. We are also aware of other limitations; for example, we have neglected the design process—by the time developments are visualised using the above techniques many of the important decisions have already been made. Involving stakeholders as co-producers of development proposals suggests a different set of criteria for assessing visualisation techniques. The move from passive observers to active participants may favour a simpler set of tools requiring less operating expertise. GIS, CAD, VR all require technical skills that are not available to the lay public, many of whom are openly hostile to advanced technology.

We have also ignored other potentially important aspects of visualisation. In an earlier paper, Tweed (1997b) argues that it is important to examine not just the content of the visualisations but how they are presented to different people. For example, computer visualisations by necessity are displayed on computer screens, which can reinforce previous associations with television. There is a real danger that, after a while, computer presentations become ‘more TV,’ possibly undermining connections to real spaces. This type of concern should remind us of the complexity of studying visualisation techniques and how much work still needs to be done in this field.

Despite these limitations, we can still make some observations about the possible role of different types of visualisation technique in debates about interventions in urban historical areas: As a guide to the possibilities of different techniques we conclude this report with the summary shown in Table 1 below.
Table 1: protocol for applying visualisation tools

<table>
<thead>
<tr>
<th>Technique</th>
<th>Description</th>
<th>Resources</th>
<th>Suggested Application</th>
<th>Participation Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maps</td>
<td>2d cartographic projections</td>
<td>Relatively low-cost option for conveying some forms of information.</td>
<td>Indicating broad areas of development.</td>
<td>Most people can read and interpret information displayed on maps, though it can be harder for people who are not routinely involved with maps to connect the map to the reality.</td>
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<tr>
<td>Sketches</td>
<td>Artistic representations of design proposals. 1. Artist can be employed as part of the consultation process to generate ideas and participation in process 2 Sketches can be incorporated in Environmental Report and consultation process to ascertain comment and views</td>
<td>Low tech and low cost Requires drawing skills.</td>
<td>Incorporated as part of the Draft Environmental Report and the consultation process. May be too imprecise for conveying final design solutions. Useful in combination with others?</td>
<td>Technique does not alienate technophobes. Public scepticism about the level of reality actually portrayed by sketches and that they may mislead.</td>
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<tr>
<td>Architectural drawings</td>
<td>The standard orthographic projections—plans, sections and elevations—used to describe the built environment.</td>
<td>Normally generated as part of any development proposal.</td>
<td>To be used when it is important to convey dimensionally accurate (scaled) information.</td>
<td>Notoriously difficult for lay people to understand.</td>
</tr>
<tr>
<td>Photomontage and photographic manipulation</td>
<td>Photographs are taken of the urban space and alterations made digitally to convey development scenarios or implications.</td>
<td>Existing Software: Photoshop™ This is a relatively low cost option but does involve time in preparing quality representations of the proposed developments. Skills and experience in using the software required.</td>
<td>Most useful at the consultation stage following scoping, screening and preparation of the draft report. Most useful for smaller developments or design proposals which have already been defined rather than plans, policies or major redevelopment.</td>
<td>Presents a close version of reality, which is quickly and easily understood by stakeholders at the consultation stages. Although limited to 2d. Problems of perspective and other software limitations lead to difficulties in realistically conveying the complexity of larger scale development proposals.</td>
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<tr>
<td>Computer generated images</td>
<td>Images generated from computer-based 3d models with varying degrees of detail and photographic realism.</td>
<td>Modest investment in hardware and software. 3d models will require survey work and data entry.</td>
<td></td>
<td>Depending on level of detail can alienate non-experts. Requires interpretation and explanation to accompany their use in consultation procedures.</td>
</tr>
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<td><strong>Spherical Projections</strong></td>
<td>Mathematical modelling technique capable of mapping variation of sky visible from points distributed throughout the space.</td>
<td>Major investment commitment required for both Hardware and Software as well as supporting infrastructure.</td>
<td>Most useful for practitioners at the screening, scoping and Impact Evaluation stages. Used for assessing impact of new developments on urban space rather than plans and policies. Provides a interim between 2d and full 3d?</td>
<td>Public may find the projections confusing due to the unfamiliar “worm’s eye” view of the space. Useful to scheme assessors more than wider public, but could be used if sufficient training and familiarity was gained by lay public.</td>
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<tr>
<td><strong>Virtual Reality (VR)</strong></td>
<td>Normally applied to full urban models or masterplan areas Immersive – uses headsets and VR rooms Desktop – achieved on standard PC screen with fly through views. Less quality of sensory stimulation Can be distributed by CD to increase access</td>
<td>Specialist skills need to be developed. Once urban model has been designed this technique can be used at every stage of the EA process by all stakeholders to envision, interrogate, present alternative scenarios etc Longer term visualisation of change over time possible.</td>
<td>Major high profile developments in larger cities</td>
<td>Provides closest representation of reality or how a person experiences or remembers a space Participation limited to those with physical access Particularly attractive to younger population</td>
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<td><strong>Geographical Information Systems (GIS)</strong></td>
<td>A means of attaching and interrogating data on a spatial basis. Can be presented as Aerial photos or scaled maps and plans on raster and vector format. Layers of information can be added to give more detailed strategic picture.</td>
<td>Existing Software: Map Info™, Arc Info™ Fewer skills required and often uses existing information. Free viewers exist and can be combined with the internet thereby widening access.</td>
<td>Very useful tool for practitioners when setting plans, proposals and policies in their strategic context. Can be used at every stage of the EA process. Most useful for helping to visualise impacts of plans and policies rather than individual design proposals within historic urban spaces. Interrogative due to layers of data and can respond to the user inquiries.</td>
<td>Requires explanation and sensitive interpretation. Many people can encounter difficulties in orientating themselves and identifying salient features using such GIS tools Requires consideration of the layering and gradual interrogation by the user.</td>
</tr>
<tr>
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<td>Internet</td>
<td>Not really a visualisation technique, more of a medium for disseminating visualisations created by other means. The Internet can be used in conjunction with VR and GIS. Allows ease of access to information by members of the wider public by placing, models, plans and documentation on the Web.</td>
<td>Will depend on level of information to be disseminated. Documentation can be placed onto the web at fairly low cost but sophisticated VR and GIS simulations will incur greater costs. Can allow both broader delivery to wider community but also help local delivery through installation of access points locally in libraries etc.</td>
<td>Appropriate to all forms of proposed intervention – plan, policy or new development. Appropriate for all types of historic spaces. Can be applied at screening, scoping, consultation and final decision stages.</td>
<td>Wide use of internet in many homes but still discriminates against those with lack of IT access. A public terminal could overcome this issue. Concern by some that net is thrown too wide and allows comment from those outside of the area of interest. Also need to ensure that people recognise the site as genuine.</td>
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</tbody>
</table>
6. References


**Web site references**

http://www.iesd.dmu.ac.uk/~jm

http://www.communityviz.com/