Visualisation of Design using Animation for Virtual Prototyping

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Although recent technology in time-based representation has vastly improved, animation in virtual prototype design field remains the same. Some designers invest a huge amount of money in the latest visualisation and multimedia technology and yet may create even worse animation. They often cramp sequences resulting in many viewers failing to interpret the design positively as they miss a lot of vital information that explains the design.

This paper basically reports the importance of film-making understanding for producing good virtual prototype animation. It will be based on a part of a research project on the use of time-based media in architectural practices. It also includes an empirical analysis of several architectural-based documentary films (including an interview with the film director) and past and present computer animation. This paper then concludes with recommendations of good techniques for making animated visualisation relative to the stage at which the animation is produced for better design decision.

Keywords*: virtual prototype, animation, time-based, film-making.*

Introduction

The on-line Dictionary of Computing defines prototyping as the creation of a model and the simulation of all aspects of a product. CASE tools support different degrees of prototyping. Some offer the end-user the ability to review all aspects of the user interface and the structure of documentation and reports before code is generated. [1] Generally, we define virtual prototype as product development in the form of virtual representation on which it allows visualisation to be at the most approximate model of reality ranging from engineering, architectural and product design. In this research, we believe that although there are certain levels of differences on the design of the virtual prototype, each of this specific area shares a common denominator in the process of producing a well-told story especially for good decision making.

Designing a story for virtual prototype animation

In many ways, designers use animation as an aid to develop products in the design developments. They use animation to manipulate three-dimensional objects, but have no experience in creating cinematic space. Computer-aided design (CAD) tools, for example, are often used simply to produce the products quickly or rather to transfer the techniques of traditional design media onto the computer. In order to realise the potential of animation, we propose that designers learn the way film-makers develop their ideas or story lines on film. However, before they can

start designing animation for virtual prototype, designers must first understand the difference between illusion and representation.

Design for illusion

Film-makers and games developers are amongst the professionals that use animation for telling stories. This way of communication may be adapted in the form of entertainment, psychological manner, information, creative stimulation, imagination and drawing attention. Whatever it is, animation is produced as a form of illusion.

Design for representation

On the other hand, computer animation has been an integral part of the design development for more than five years, particularly in the decision process and visualisation. In principle, viewers are looking at the most approximate output version to reality known as the representation of a real-life situation instead of a replica of it. From this point of view, designers and other parties can be surprised by their 'virtual representation' as it is not as they expected as in the virtual format.

Why Film?

Animation, virtual reality and other interactive media nowadays have become the important ways of communicating ideas which in many sense have the cinematic characteristics known as time-based. For engineers, product designers and architects, this representation should be a platform which could lead towards a better understanding of the design, appreciating design information, marketing strategy and decision making process. According to Grigor, only filming can deliver the essential spatial dimension of space and volume. (Murray, 1994)

A film can create perspectives, scales, depths and detail only if the image field is utilised carefully. The subject must be presented at different levels of colour contrast, light and shadow, and film planes (background, middle-ground and foreground). The film camera should be placed in certain positions (or with clear movement) to get the best result of the subject and to draw viewers' attention, so that objects will not look flat on the screen.

However, many of the 'virtual' freedoms have been abused and taken for granted in most computer animation representation, especially in camera control. Because of their inexperience in manipulating motion sequences, many designers simply produce animation based on a few different shots (e.g. a vertiginous fly-through). Designers, therefore, need to learn how film-makers utilise the film potential to form a good story line.

To what extent do Virtual Prototype Designers require an understanding of film making?

In a survey on one of the virtual prototype designs, all of the architects who agree on having a key guideline, believe that film-making understanding is crucial as cinematic principles can be found in film-making. However, many designers feel that in-depth knowledge should be avoided simply because the effort and time spent in real practice is minimal and obviously does not relate to architectural and virtual prototype animation.

A few designers believe that relying just on architectural and design knowledge is not enough to ensure a good animation. As Kelman explains, there are a lot of skills in film-making that architects don't have. What really happens in the practice is that most animation development is in the process of trial and error to get the best shot. (Kelman, 1998) Therefore, having film-making principles will ensure a good result as the designers refer to the people who are experts in the time-based illusion.

Above all, many designers agree that animation should be used as an aid to produce a better design (viewers were presented with the medium that they were familiar which could reveal the three-dimensional effect). However, in order to get the best of it, they suggest that animation should be focused as a

specialty or separate business.

Why Animate?

A few minutes of animation walk-through or other form of simulations means a lot to architects, engineers, product designer, clients and viewers. Even by removing or adding a line; or a variation in colour, texture and lighting can effect participants' understanding before any decision is made (the 'what-if' scenario). In order to keep the production within budget, designers usually try to cramp this set of elements without any story line. As a result, viewers often receive misleading information or miss the vital element.

There are a few important reasons why designers animate their projects. In most cases animation is more convenient, cost-effective, safer and required by the client as this technique gives the closest experience to physical reality. Animation, in nature, has the potential to attract our senses for better understanding of subjects. It gives viewers the flexibility to view in various angles and positions which can lead them to identify the potential and problem of the prototype design. Designers are able to test the proposed or predicted prototype mathematically or graphically which practically can be hazardous and an 'eye-sore' to the environment. In fact, with the right skills of manipulating real-time animation, viewers can understand better as the experience of time is parallel with the physical environment.

Case Studies in making effective animation.

Several important aspects of creating virtual prototype animation can be identified by observing at computer-animated sequences of building prototype design representation. The result of the each research is determined.

Animation trends in architectural practice.

A survey that has been carried out in architectural practices in Glasgow, United Kingdom shows that thirteen out of forty six practices develop computer animation as part of their design process. Some would model (block model) and animate at the early design stage to foresee design development earlier. Animation that were developed in the sketch plan and later stages allowed a positive feedback and decision from the viewers (client) as the animation input deals with quite extensive detail. (Rafi, 1998) This sequence is created based on the architect's point of view without any storyboard (76.9%) as it does not give a similar visual reference to the production shot (or even confused the clients with the final production). This research has found that a preliminary or 'pilot' animation helped several firms to get the most appropriate sequence idea and prepared the fee agreement before the animation was finally produced.

Most productions are developed in-house and relied on CAD packages (do not support editing) available at each firm as an unedited (i.e. 85.7%) on-screen and video (VHS) footage. Scale references (e.g. human, trees and car) are often added later as computer stills. Post-production exists in the form of simple editing on large and special projects (for public presentation or when required by the clients) as a 'stand alone' animation. (Rafi, 1998)

Trends in filming architecture.

Four films related to architectural information are reviewed as they have several elements of film design which may suggest ways to improve virtual prototype animation. Generally, these films are presented in a linear story line that comprises a start, middle and end. Most shots are establised in a natural way of seeing things (i.e. eye level shot, fixed frame shot - 46.2% and a fixed station - 34.7%) especially to reveal a three-dimensional form. Camera movements are established in a slow tempo particularly in full shot and close up. Fixed frame shots are not presented as still images (with object movement) but are used as an exploration sequence of detail design. (Rafi, 1998)

When establishing a subject on a large area many directors tilt (31.8%) and pan (22.1%) the film camera

to capture the context. Roll and zoom (including 'focus pull') are used occasionally as a cutting alternative or to direct viewers' attention between shots. Some important objects are also explored by tracking the camera in sideways and passing through spaces (usually in diagonal and curved path) in a consistent tempo, thus, aiding the visual indication. In contrast, individual building or smaller subject sequence is often introduced with a full shot as the film space is enough to establish the context before it is cut into medium shot and a lot of close ups. Viewers will be navigated using an obvious visual reference to maintain a consistent experience in between frames (e.g. point-of-view shot). Important subjects are highlighted with sound effects, narration, and transitional sequence.

Trends in computer-based architectural animation.

In this empirical analysis, all (fourteen) architectural animation are created as 'stand alone' computer-generated building sequences (i.e. three minutes on average). Building sequences are focused on visual representation. Most animation are established with horizontal angle (14.3%) and high angle (10.7%) as a walk-through and fly-through sequence. As such, a lot of important sequences are often visualised by chance especially when animators fail to pause frame before changing different viewpoints.

The most obvious element that draws viewers' attention is special effect. A few good impacts are shown in a 'strobing' and 'particle' to show design transformation (e.g. daytime and night time comparison) and 'fog' effects to create depth. Scale and proportion are developed as a photo montage of various human activity is included on individual space. But, with 'live' people 'chroma-keyed' onto the still or moving background, the sequence becomes more convincing as well as holding the viewers' attention. Animation editing are established without cutting in between shots thus leading to a continuous camera movement. Many animators prefer a single background sound (78.6%) rather than using natural sound, sound effects or narration especially to further enhance the important subject. This sometimes can become even worse, with the absence of graphic or text indication.

Checklists for Visualising Design

There are several simple rules that need to be clarified earlier to get a successful result and reduce the production time.

Virtual prototype designs animation is mainly influenced by design stage which requires a different level of detail and should be carefully understood to give a certain impact on the viewers. Animation sequences are best developed using a natural viewpoint (i.e. using a standard lens) to avoid any perspective distortion and other misinterpretation of visual form. For this reason, a continuous aerial view shot should be minimised as it prolongs the rendering time and most objects are relatively small.

Digital alteration is best avoided in any design stage as it vastly increases the production time. All sequence materials should be well-prepared during shooting (either virtual or 'real') before they are developed in the post-production stage as each production stage has different capability. Several elements based on the critical analysis of the architects' requirements, film and computer animation that can be very effective for other virtual prototyping visualisation may be defined.

- Storyboard
- Using Available Visual Material
- Establishing Site Context
- Designing the Cinematic Depth
- Establishing Scale and Proportion
- Detailing
- Lighting
- Visual Editing
- Sound Editing

Storyboard.

Storyboard (or sketches) should be used as a routine process in any design stage to ensure consistency in

Figure 1 (top right). A key shot sketches of the New Ministry of Finance (1998), Malaysia (developed from the original source of the Ministry of Finance (1993) Animation, Malaysia: courtesy of CAD Centre, Universiti Teknologi Malaysia).

Figure 2 (middle right). Transformation shots (from a still drawing (left) to a sequence (right)) of the Unity Temple, clips from The Architecture of Frank Lloyd Wright (1983).

Figure 3 (bottom right). A low angle shot establishes the main building (chroma-keyed) of Les Envois de Marseille (1991).

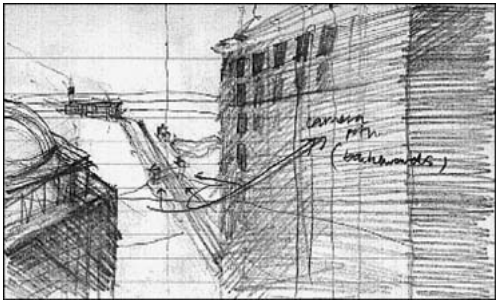
production process (animators' references) and important shots are included (figure 1). However, this should not be the only aid to see the full design potential as key shot sketches on a fixed storyboard often do not give the exact camera viewpoint. For this reason, establishing shot during modelling (i.e. a preliminary or 'pilot' animation) should also be considered as it can reduce production time and give accuracy in shot. Perhaps, a preliminary shot (ten to fifteen frames of simple modelling) is the best way to get the result in a short time and it may even be used as a fee benchmark (printed form or on-screen presentation) before starting to manipulate the high-end images.

Using Available Visual Material

Virtual prototype production is often developed with other forms of visual such as drawings, slides, physical model and 'real' on-site video clips (figure 2). In animation, this element can be very effective if it is developed in a way that enables viewers to see and relate the changes between two different possibilities directly (e.g. existing to proposal or two-dimensional to three-dimensional). As such, designers can implement a 'strobing' effect to smoothen transformation. Visual material such as the 'chroma-key' of 'real' figure may even be re-used (superimposed) on other still (e.g. building and car section) sequences.

Establishing Site Context.

The idea to establish context is to explain the subjects' relationship within its surrounding. For example, a prototype car can be more convincing if imposed on a real city traffic by cutting a high angle (still frame or slightly fast movement) into a ground level shot. Also, by having a moving element with high colour contrast, visual attention can be directed to view the location at a glance. Where objects are more closely integrated with the site, different types of shots may be more appropriate such as tilting the camera from a low angle shot and chroma-keying the subjects on the 'real' site (figure 3).



Designing Cinematic Depth.

Unlike real shooting, animation often looks artificial (objects in the background can be as clear as in the foreground) as the subject compositions lack 'real' perspective effects (see figure 3). In order to avoid this problem, directors usually suggest a few simple composition exaggerations such as foreground framing and establishing the subject with other objects in different planes. According to a research on Robert Mallet-Stevens by Vaillant, another way of showing depth is to locate an object in the foreground on which the eye can focus, to give the impression that the background is further away. (Odile, 1997) In animation, this technique does not work effectively as virtual objects do not always provide a very dark colour or extreme contrast as it naturally appears in real shooting (figure 4). For a true illusion, the foreground object needs a combination with 'fog' effects to give

the utmost depth in subject composition as it differentiates the object in each plane.

Establishing Scale and Proportion.

One thing that designers often forget to apply traditional techniques in virtual prototype design is establishing scale. Many animation do not provide with enough visual reference, especially human figures for the viewer to identify the scale and proportion of the subjects. At its simplest, a still human figure (e.g. collage or 'mapping' technique) allows a positive understanding of relative size in the object's setting, but this method is strictly effective on still images. Alternatively, by establishing a 'real' figure or object in the virtual space, the comparative size becomes more realistic as the visual clue directly draws the viewers' attention and gives a closer approximation to reality. Planning this technique within budget and time can be achieved by superimposing 'real' figure (minimal movement) on a still background (figure 5).

Detailing

Human vision is usually attracted by larger, closer objects and what it can see best. For example, an image of a subject with detailing in the foreground would attract more attention than a similar detail in the foreground. Designers can develop animation sequences with several close up shots that portray the character of the objects in different angles. When integrating camera movement, a slow pace tracking diagonally or following a curve path usually gives better three-dimensional effect (figure 6).

Lighting

In animation, without careful lighting arrangements, three-dimensional objects may look flat. Therefore, rather than just concentrating on the basic lighting arrangement (e.g. three-point lighting) to reveal the form of an object, designers can develop lighting effects as an illumination difference by shooting the subject in daytime and night time. Although lighting comparison is not usually developed in virtual prototype design, it can be very useful to enhance

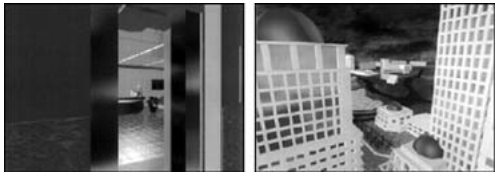


Figure 4 (top left). High colour contrast between foreground and background of the New Ministry of Finance (1998), Malaysia to establish depth (developed from the original source of the Ministry of Finance (1993) Animation, Malaysia: courtesy of CAD Centre, Universiti Teknologi Malaysia).

Figure 5 (bottom left). A 'Chroma-key' shot of the New Ministry of Finance (1998) office to establish scale and proportion (developed from the original source of the Ministry of Finance (1993) Animation, Malaysia: courtesy of CAD Centre, Universiti Teknologi Malaysia).

the effect on individual objects for specific reasons such as building safety and lighting components.

Visual Editing

Designers must edit their sequence to get a successful result especially when it is developed for public and promotional presentation. In general, the overall quality should be sufficient to give clear information without any obvious defects such as frame drop-outs and graphic distortion. (Rafi, 1998) A good editing preparation may start with a 'rough cut' (outline of the overall sequence) and edit decision list or EDL (for longer story line) to ensure efficiency in footage cross-referencing. A non-linear editing should only be utilised based on this decision to develop sequence within budget. Apart from transition and titling effects (e.g. credits), one should bear in mind is to give enough time (i.e. frame repetition) to maintain visual consistency when the sequence changing into different viewpoints. This may include a slow, intermediate and fast movement (not a continuous fly-through). The first thirty seconds should be used to grab viewers' attention, perhaps in the form of graphics introduction. Viewers often find it easier to

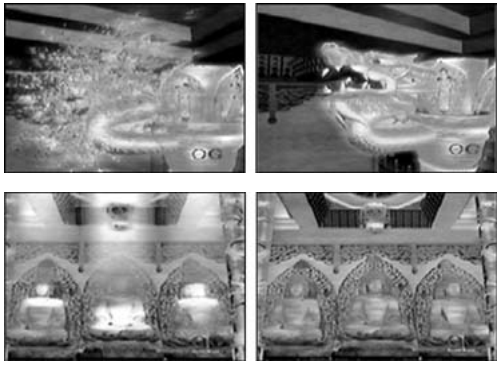


Figure 6 (top right).A 'particle' effects transformation of the 'bracket' detailing in Chen Lung Tien (1993) animation sequence (Courtesy of CGCG, Taiwan).

Figure 7 (bottom right). A special lighting effects of the Buddha statues' transformation is enhanced with a high pitch sound effects to draw the viewer's attention (Chen Lung Tien (1993), Courtesy of CGCG, Taiwan).

understand if the end sequence is developed the same way as the introduction shot.

Sound Editing

Sound for virtual prototyping should be the story instead just a compliment although the development cost (e.g. narration) is high (which normally end up with illegal sound copyright). In the early stage of animation, sound might be best avoided as the visual footage itself is in the process of development. This may work effectively even at a later design stage with a combination of other visual aids (physical models, slides and drawings). If the footage is developed for promotional purposes or public presentation, a combination of sound effects, narration (voice-over or a presenter) or a few different background sounds should be properly utilised to explain the subject. A good start perhaps should focus on a natural background sound (e.g. recording the 'real' sound on the site).

Conclusion

Digital animation is still expensive. Apart from the time spent, image and sound quality, every frame will be counted for professional charges. The longer sequences usually cost more. Getting straight to the point of the representation (gain from film-making) helps a designer to reduce recording duration to comply with the client's budget. The linearity in animation should be considered as viewers' option to visualise the subjects (getting the best shot) in interactive media design. Thus, future computer animation in virtual prototype design may branch out largely from the film skills, interactivity and time-based knowledge as part of the professional interest. The success or failure will mostly depend on the designers' competent in using this skill to produce and manipulate the best selection of shots with the correct integrated time-based facilities to fulfil the needs in the design field for the next millennium.

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