Analysis
Throughout history, the notion of ‘precedent’ has always provided conceptual models to serve the quest for appropriate architectural forms. It is a relatively recent phenomenon that considers architecture through a veil of literary metaphors. Since the end product of architecture is a built outcome, the most basic theoretical stance must be supported in turn by a few fundamental grammars. That grammar must need to be expressed physically, which could demonstrate the adaptation of a theory into successful acceptable architectural solutions with a certain degree of clarity.

Such was the case with Le Corbusier’s ‘Five Points of the New Architecture’ published in 1926. The design and construction of Villa Savoye by Le Corbusier (1928-31) gave an equally seductive physical expression to the ‘five points’ idea. In turn it provided a collective iconic precedent. Conversely, when analyzed, the built work of Villa Savoye was clearly able to demonstrate the principles of ‘five points’ and also supported the theoretical model.

Thus, it can be said that an analysis is an abstract process of simplification that reduces a total work into its essential elements. In architecture, the primary goal of a design analysis and its representation is to expose the underlying concept, organizational pattern, design characteristics, and ‘tectonics’ through simplified diagrams. Both the process and product of an analysis can be a valuable learning experience.

To construct a comprehensive understanding, all analyses can be divided into two basic categories: 1) Context Independent Analysis, and 2) Context Dependent Analysis.

Analysis for a built physical building will inherently lead to the reconstruction of the underlying design principles as a predicted hypothesis. The linear diagram (Figure1) represented here illustrates that the position of the analysis in the total design process is at the very end of the diagram. Considerations of principles are equally important for both the design process during design, and for the analysis during the interpretation of the built work.

This paper investigates the strength and limitations of basic 3D diagrammatic models and their related motion capabilities in the context of graphic analysis. The focus of such analysis is to create a computer based environment to represent visual analysis of architectural form and space. The paper highlights the restrictions that were found in a specific 3D-computer model environment to satisfy a basic diagrammatic need for analysis. Motion related features that take into account of parametric changes are also investigated to help enhance representation of analytic models. Acknowledging the restrictions, it can be stated that computational media are the only ones at present that can create an interactive multimedia format using components constructed through various computational techniques.

Keywords: 3D Model, Analytic Diagram, Motion Model, Form Analysis, Design Principles.
Analysis and Representation

It can be realistically speculated that the next few years will show a distinct elevation of general education of masses in graphics and audio-visual media. In contrast, the average level of understanding architectural representation is still much lower than most other visual media.

The advent of computers recently has added 3D models and 3D motion models (animations) into the spectrum of representation. Although 3D models can apparently be viewed as conventional axonometric and perspectives, their role in analysis nonetheless is far more valuable. It is because of their motion capability and ability to transform (an area unresolved since the Italian Renaissance) between two-dimensional plan-section and three-dimensional axonometric and perspective. Besides 3D computer environments, recent developments in interactive navigation modeled environments suggest significant ease, user involvement, and effectiveness in representation that can be incorporated with other conventional modes of analysis.

The process of analysis from conception, to formulation, and to the final representation can be suggested through a method that divides the representation format into three distinct levels of filters (Figure 2). While the first filter level is interpretation, formulation, and representation through text and existing drawings, the final filter level is identified as the interactive multimedia representation. The middle level representation is described through 3D computer graphics. The third filter level is the most flexible one. It is where information can be represented in any format, and indeed needs to be in various formats. Both level one and two have restrictions, because they can only display text and 2D graphics. Representation related to sensory perception can only take place at the third level through interactive media and motion related representation (fig 2).

3D Computer Models and Representation of Analysis

Traditionally, plans, elevations, sections, axonometrics, perspectives, physical models, and photographs are so far our means of representing form, space, and its analysis. These conventions of drawings date back to the Fifteenth Century. Although computer 3D environment has successfully converted these conventions, we have not seen any new drawing types with the advent of new digital media.

Constructing and composing objects in a three-dimensional computer environment that have length,
width and depth are usually referred to as 3D modeling. Without getting involved into technical details, it could be simply described that there are three basic factors that all determine what a 3D object will look like. The first factor is the rendering mode, which tells the model how accurately an object is to be drawn and how much surface detail to display. Secondly every object is assigned a surface, which gives the object color and texture. The third factor is the lighting, which provides shading and depth to the model.

Although a combination of all of these factors can provide a wide range of rendering options, the emphasis for analytical models would be to examine the options for wireframe variations, surface shades, and surface transparencies.

Reviewing works of analysis by various authors including Baker, Clark and Pause, Ching, and Unwin, it can be said that all conventions of drawings (plan, section, elevation, axonometric, and perspective) need to be considered in order to represent analysis of form and space. Axonometrics and aerial perspectives (with distant vanishing points, similar to an axonometric) are significantly effective because of their diagrammatic three-dimensional nature in communicating the main idea. The key seems to be in highlighting parts or segments within the 3D diagram. In that respect, it is important to note the following features that were used by the above authors in various combinations (Figure 3). Most of these are unique improvised features and not commonly encountered in conventional computer presentation. These features include: wireframe with varying line thickness, thicker profile lines, hidden line with varying thickness, dashed line in combination with hidden line, and dotted lines with arrows. Such features usually highlight and define an element, surface, volume, or non-physical concept.

The focus of all general purpose modeling application is to draw and render physical objects and render their material characteristics. It should be noted that in analysis, representation of non-physical objects is as important as the representation of physical objects. At present, the alternative solution for such a differentiation is the combination and variation of shades of color, transparency, and options of wireframe variations, all within a rendering mode.

As mentioned, a 3D model in a computer environment is created with lines, rather than dots or broken lines. Some of the improvised and unique features (Figure 3), like a thicker profile line in a hand drawing, do not represent a complete line or a specific number of lines that construct the model. A profile line includes only the peripheral segments, which a computer will not generate.

Although there are significant restrictions in representation of line drawings, we would expect computers to provide variations of shades, transparency, and luminance that are difficult to
produce by hand and can become very effective for analytical models.

The following models illustrate various rendering features available in the Form•Z 3D modeling and rendering application that can be compared with hand drawn examples. These are the features that can be used in various combinations to highlight elements to represent analytical models. Three cubes are purposefully taken to examine the clarity of depth cue and spatial reading (Figure 4). These available features include, wireframe in various colors and thickness (a, b), highlighted edges (c), hidden line (d), combination of wireframe and solid rendered objects (e), combination of solid, wireframe and translucent objects (f), and wireframe and multiple textured objects (g, h).

Figure 5 further explores above features to graphically analyze Louis I. Kahn’s National Assembly Building in Dhaka, Bangladesh. Illustrated diagrams explored various combinations of surfaces with solids and wireframe, varying intensity of shades and transparency, and lighting.

3D Motion Model (non-interactive animations)
Computer motion models also known as animations, which are generated from 3D models, have an unparalleled capability to demonstrate spatial experience. Animations can also manipulate the constitute components of the spatial structure, thus illustrating analytically the composition of a building or object. Since animated models can be built initially from a plan, it is possible to show both plan and three-dimensional structures in order to illustrate the sequential reading of the three-dimensional space (which has always remained an unsolved experiment for hand drawing techniques).

The most significant aspect of motion model representation is in its flexibility of manipulation of various physical and rendering attributes to illustrate the idea of the analysis. Computer animation may be constructed and approached from two methods. One is the Keyframe-based approach, and the other is the Event-based approach.

Although a keyframe animation is quite simple to create there are several handicaps when used for the purpose of analytic animation. This type of approach cannot be used to construct animations with changing parameters of objects. Succinctly, in an event-based animation, each event is recognized by the application software, and events occur each time an object is changed in terms of its position, orientation, scale, shape, and rendering characteristics. Usually every
event that has happened to every object is tracked, and a final animation is created incorporating changes of all objects. In an event-based motion model following available features can be very useful for analysis:

- Relative movement of objects in relation to each other.
- New object can be introduced within existing objects.
- An object can be removed from existing objects.
- An existing object can be scaled down to highlight other objects importance.
- Color and rendering effects can be changed while movement is taking place to emphasize or de-emphasize object importance.
- Transforming between drawing conventions can be achieved to illustrate both 2D and 3D spatial features.

Figure 6A illustrates a keyframe-based animation in Form-Z that incorporates change of views but can not incorporate change of physical characteristics of modeled objects. Figure 6B is an example of an event based motion model both in 3D StudioMax and in Infini-D applications, that illustrates separation of constituent components from the total mass of Le Corbusier’s Parliament Building in Chandigarh, India.

Both object parameters, and relative scale had to be changed in order to enlarge the primary components and to reduce the envelope boundary.

**Conclusion**

In the absence of thoroughly satisfactory methods of combining various means of representation for analysis, this paper investigated only the features of 3D computer model environments to aid graphic analysis of built forms.

Although there are specific limitations when it comes to wireframe rendering, the strength of computational media is its ability to provide unlimited combinations of rendering modes, various options of motion capability, and choice of interactive features. It is true that a hand drawing can be improvised to highlight only part of a line or to thicken the periphery of a complex shape. A computer model cannot accomplish such tasks because of its pre-defined command structure. On the other hand, modeling, rendering and motion techniques in a computer environment can produce a new generation of hybrid images that can enhance the representation of analysis. The computer medium has an edge in representation of form of space analysis because of its ability to create motion models with variations of
Figure 6A. Keyframe based motion model illustrates changing view parameters (from top view to side view), but not physical characteristics.

Figure 6B. Event based motion model illustrates change of both object parameters, and relative scale.

Computer 3D models converted into Real Time Navigation offers interaction to a viewer to view the model from any angle and to understand spatial composition of its components. Real Time Navigational techniques using photographic images are capable of generating physical contextual experience and even some sensual experience during the act of navigation. Computational medium is the only one at present that can create an interactive multimedia format using components gathered from various sources.

It is evident that we will never stop learning. What we may need is to learn more with less effort. The effectiveness of 3D computer models, and their compatibility with various modes of representation, including motion capability and interactive environment makes this medium significantly important in the context of architectural analysis and education of design teaching.

References


