Go to contents 18

Visualising Non-Visual Building Information

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Architecture can be understood as a process and as an object. In both forms, it consists of a complex of mass, monetary, energy and information flows that occur over time scales ranging from hours and days to centuries. The parts or elements making up buildings and the processes involved in producing, maintaining, using and disposing of them are highly intertwined and multi-dimensional. The field of Architecture can range from complete building stocks down to individual buildings, their elements, and the materials and processes making up these elements. What is more, it is also necessary to introduce time as a dimension in order to model the complete life cycle of buildings. Current CAD systems concentrate primarily on the replication of the traditional drawing process (sometimes in three dimensions) and the visualisation of the finished building. While these models describe the geometry and visual appearance of buildings, the bulk of the information about the building remains unseen. Recently developed systems such as the German LEGOE system have combined a materials database with specification and CAD systems, which allows for a more comprehensive description of the building. However, this additional information is displayed either rudimentarily or as lists of numbers. The information describing the position or visual quality of building elements is, in fact, minuscule in comparison to that describing the properties of the materials involved, their production methods, the energy needed to produce, transport and install the elements, and information concerning toxicology and environmental issues. What is more, these materials are not simply in situ, but can be considered to flow through the building. These flows also occur at widely varying rates according to the type of material and the type of building. The view is taken that buildings are actually temporary repositories of various "flows" which occupy the building during its lifetime. Thus seen, the various aspects of a building at a certain stage of its life are taken to be the total sum of its inputs and outputs at any given time. Currently, its complexity and the lack of cognitive assistance in its presentation limit the understanding of this information. The author postulates that to better understand this information, visual displays of this "non-visual" building information are needed, at least for those who, like architects, are more visually inclined. The paper describes attempts made to go beyond conventional two-dimensional charts, which have tended to only complicate understanding. This is partly due to the need to display a high number of dimensions in one space. Examples are shown of experimental visual displays using three-dimensional graphs created in VRML as well as a "remodelling" of the building based on statistical rather than spatial information to form a building "artefact". The remodelled artefacts are based on a null-

Go to contents 18

value three-dimensional form and are then modified according to the specific database information without changing their topology. These artefacts are initially somewhat idiosyncratic, but become more useful when a large enough population has been created. With sufficient numbers, it is possible to compare and classify the artefacts according to their visually discernible attributes. The classification of the artefacts is useful in understanding building types independent of their formal "architectural" or spatial qualities, particularly with age-use-classes. The paper also describes initial attempts to create building information landscapes that unfold from the artefacts allowing detailed views of the summarised information displayed by the individual artefacts.

Keywords: *Building Information, Visualisation, VRML, Life Cycle Analysis*

The paper describes a work in progress.

Building Information

Architecture, as a field of study, is complex. This complexity stems from several areas. Firstly, architecture can be understood to be both an object and a process. Additionally, as either an object or a process, architecture encompasses a large number of processes, flows and participants in rhythms ranging from hourly and daily to decades long and spanning perhaps in total over one hundred years. The reconciliation of the various time scales with the multifaceted processes in architecture is one of the main activities of architects. In order to understand the information representing these processes architects often turn to visual representation of this information in order to better understand the implications of planning decisions. The paper presents a proposal for visualisation of building information in order to better understand this information, particularly in relation to existing building stocks. A system is proposed which consists of comparative visualisation between buildings or building sets and a representation of internal relationships of components within a building (fig 1).

The presentation of data (building related or otherwise) is currently concentrated around two main

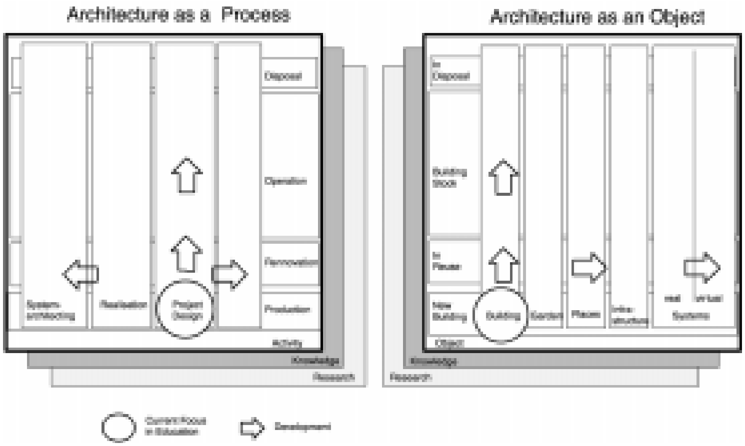

Figure 1. Architecture as an Object or a Process (Kohler and Russell, 2000)

areas. The first area or type is basically the extension of traditional two-dimensional graphing techniques to include more dimensions of information. This is done through the layering of more information or by using the third dimension as an additional axis on which data is mapped. Common data programmes such as Microsoft Excel, include these two and two and one-half dimensional graphing techniques as part of the standard application features.

The second area involves so called datascapes. A datascape is the creation of a three-dimensional "landscape" based on the data. The data is thus represented as an undulating surface or as a three-dimensional construct in which the user navigates. The resulting landscape is then not a place, but a surface of data points with valleys and peaks representing the extremes of the data set.

A third method used to display information is currently seldom used, but central to the proposed methodology. It entails the creation of artefacts, which then change their form or proportion based on the changing data. A parallel to this method of topological transformation are maps produced to indicate relative values between countries or distortions based on time rather than distance. In such a case, the map is proportionally varied yet remains topologically consistent. This method is effective when the base or default proportions and the overall shape of the artefacts are widely known, as is the case with geographical maps.

There have been attempts to create arbitrary objects to represent widely varying statistical information (See Figure 2). While enticing, these objects do not readily convey the information, as the form of the artefact as well as the mapping of the statistical information onto them is arbitrary. Arbitrariness is not in itself a problem, however, when the information is presented once in an arbitrary form, there is no potential for visual learning, or for comparative processes to take place. Thus, the reader or user has no basis on which to evaluate the information. Nonetheless, the creation of such data artefacts shows the potential for mapping information in three dimensions, particularly when involving individual objects.

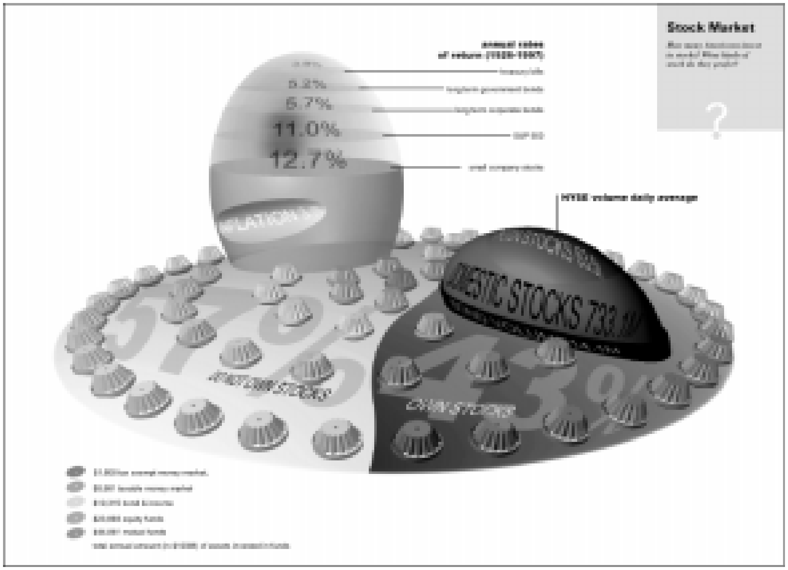

Figure 2. Stock Market Analysis (Couture, Rashid, 1999)

Go to contents 18

Architecture is, like shipbuilding, involved in creating a large number of individually different objects. Rarely are buildings mass-produced as, say automobiles are. Even so called mass built houses are produced in the hundreds as opposed to the millions as is the case for other objects such as automobiles or telephones. As a result, the shape, size and makeup of buildings vary from building to building. This makes it is difficult to determine what a standard building is. In evaluating, for example, ecological aspects of buildings, it is common to use a reference object in order to establish relative performances. However, these reference objects are neither an ideal nor a middle value object. Rather, they are chosen for some exemplary aspect and used to compare performance.

The comparison of individual buildings is often encumbered by cultural information about the building. The cultural information can involve its shape (and thus its "style"), its age, its designer and its location. For example, one could compare two museums to another. If, however, these were the Altes Museum in Berlin and the Guggenheim Museum in Bilbao, the differences in age, style, location and history encumber the straight comparison of the building information with information often coloured by cultural values.

In order to present the information in a neutral way, the building information is assembled as statistical (numerical) information. This information is then used to modify a three dimensional artefact in order to allow a simple comparison. Furthermore, the potential arises that, in larger groups of artefacts, the objects can be grouped according to their statistical similarities. These classes are identifiable as result of the congruent visual and statistical similarities.

The first experiments with "data modelling" sought to create "neutral objects" that did not look like anything else. The data was then modelled in a relative arbitrary and abstract way to create a "thing". The problem arose that the users, by their nature, attempted to classify these objects (A typical response was, "That looks like a ____." with a common object

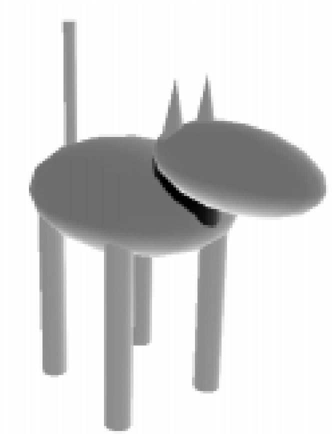

Figure 3 - House Animal or Haustier

such as an animal, piece of furniture or plant being used for comparison.) In fact, it is well nigh impossible to construct a figure or object without initiating this classification system. It appears to be "hard-wired" into our cognitive processes. As a consequence, the modelling of the data was undertaken with the intention of creating a recognisable object. Furthermore, an object was chosen where a sub-classification already exists: as small animals (fig 3).

The creation of a field of such animals allows the comparison of different buildings unencumbered by their actual appearance or their cultural value. In Figure 3, the animal is so modelled that the length of the legs represents the mass of the structure and the body is a summation of the area and volume of the building. The length of the tail represents the age of the building, the head size is based on the total of the ECO-Points and the ears represent CO2 values in producing the building.

When the artefacts are viewed singularly, the information becomes secondary to the form. When, however, the artefacts are viewed in groups, the information and the ability to compare the data takes a more prominent role in the visualisation. (See Figure 4).

The automatic classification of objects, which appears to take place at a sub-conscious level, is then used to identify groups of buildings with similar features. The artefacts with, say, long ears, belong to

Go to contents 18

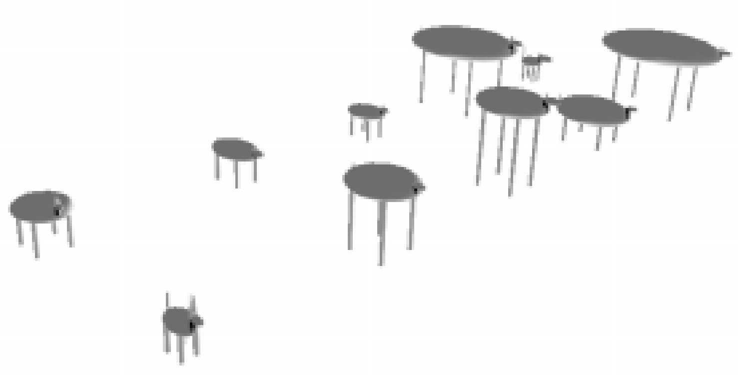

Figure 4 - A Collection of Buildings

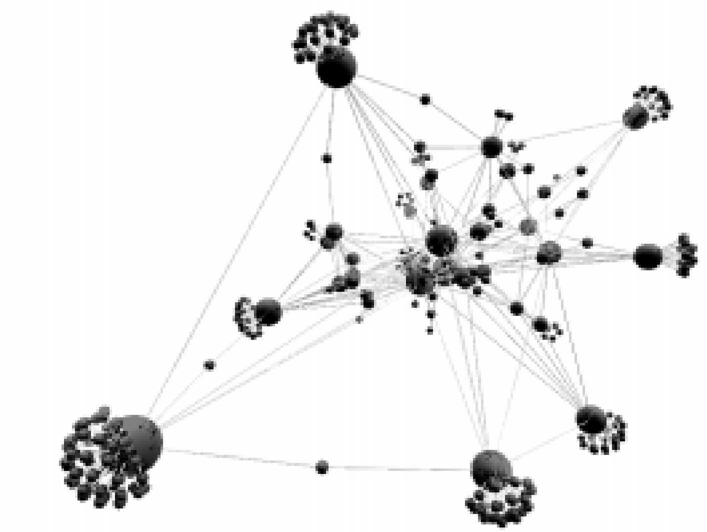

Figure 5. Typological Model for the display of building Information Relationships (Wood et al)

a classification that is independent of traditional classification or styles.

Currently, the artefacts are modelled in VRML extracted from a database. While VRML is perhaps not the best modelling language, it has the advantage that interactivity can be programmed into the building representations. Thus, interest in a single building will result in a detailed view of the building's attributes. This representation is a "zoomed" view, which does not rely on an artefact metaphor to display the information. While not fully developed for this paper, the display will follow lines explored by Wood et al (see Figure 5).

The representation of the building's components as the interconnected Orbs is intended to allow a reorientation of the information and its internal relationships according to the investigations of the user. Currently, approximately 20 different values are attributed to the building elements.

Go to contents 18

Further Work

The VRML models as depicted in this paper are merely the initial static visualisations of preliminary building information. The real potential lies in allowing the user to explore the information, both at the level of the building stocks, where the buildings are represented as artefact, or at the individual building level, where element and attribute relationships can be explored and identified. This work is continuing through the end of 2001.

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