Transition in spatial authorship
Towards a pluralistic modulation of space
when designing in a voxel matrix

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Abstract. *In the past, culture expressed through built environment has been confined to results generated by a single author or small team, but has rarely been considered in light of data produced by a society with various sociological backgrounds. The state of a society can, however, be represented by social data used as a transmitter of cultural identity. Voxel facades use data as a generator for defining space. This paper defines: voxel facades; explains how data are fed into the voxel facade, proposes ways in which data can be represented meaningfully; it evaluates the cultural design intervention and investigates results.*

Keywords. *Voxel façade; spatial representation of data; spatial authorship; multilayered surface; decay function.*

Introduction

Contemporary architectural discourse has shifted to understand and design space as performative architecture (Kolarevic, 2005) or as info aesthetics (Manovich, 2001). This shift offers a possible change in the question of authorship of architecture, where the author of space is no longer an individual or a small group of designers but a society producing data used as space generator. Using information to build space is a design method used, amongst others, by UNStudio and involves taking diagrams and converting them into built space. The dilemma here is the dynamic nature of the collected data and their limitation across time in relation to built environments. Thus the paper seeks to look at voxel facades, which define and alter space and real time through intangible light-points. I will first define two premises, (1) voxel facades are capable of defining space and (2) data expressing the state of a society can be fed into voxel facades as a form generator. Further, I will argue that (1) in the past, cultural heritage through built environment has been generated by one author or a small team, and (2) a shift in design towards a cultural pluralistic modulation of space when designing in a voxel matrix is possible.

Research premises

The term voxel, a portmanteau of the words volumetric and pixel, has been used in various ways, such as in computer games and simulations. In all cases, it is defined as a volume element, representing value on a regular grid in three-dimensional space, analogue the pixel, which represents 2D image data. In this paper the terms voxel and voxel facade describe a subclass of 3D-display technology built from a static volume (LEDs) that creates images without any moving parts. In general, data is represented as 3D or 4D form by using a matrix of voxels, a volume element representing value on a regular grid in 3D space, represented as a sphere by the use of an LED-based static 3D display system. Several artists, designers and researchers have worked on the development of such 3D-display technology. Principles of the technology were taken from an art background into an architectural context by developments and academic discussions, such as the Spatial Dynamic Media System (Haeusler, 2007), NOVA (Schubiger, 2008) or Chromatophoric Architecture (Haeusler, 2009b). Thus voxel

facades are able to display a time dimension within a spatial construct. This time dimension can be achieved by ever-changing data that defines the movement within the zone set by the voxel arrangement.

After setting up the hardware premises, the focus is now on generating data expressing the state of a society, cultural group or the like, to be fed into the voxel facade as a form generator. Here I want to give a few examples to illustrate what data can be injected into a voxel facade. I have chosen these data from the field of social science. Social science comprises academic disciplines concerning the study of the social life of human groups and individuals. All of them, be it economics or anthropology, capture data in one way or another. Staying with the example of economics, it can be said that the analyses of economic relations in a certain country produce a series of numbers. These numbers are specific for a defined region and a defined time. The representation of these numbers gives a clear overview of the economic state of the region during a certain period. In principle, this method can be applied to all sciences using various suitable research methods and documenting the results in the form of numerical data.

When recorded and stored in an excel data sheet, data function as a digital injection to mould a dynamic surface within the voxel facade. The excel data sheet is a commonly used method of storing numerical data in a cell. Each cell has a defined position marked by rows (1,2,3…) and columns (A,B,C,…). The excel sheet, as such, therefore produces all the information in X, Y and Z needed to position this information in a 3D space, where the row defines the X-coordinates, the column the Y-coordinates and the numerical data is stored in the cell the Z-coordinates. In this way, the collective recorded numerical data would generate a surface or zone in a voxel matrix defined by LEDs, where each LED receives its ON/OFF command from the numerical data stored in the cell. Changing the numerical data in one cell would consequently cause an alteration of the zone properties and therefore generate and regenerate space. In principle, all kind of data is suitable and the nature of data required for the matrix is not limited or narrowed through the choice of data. However, limitations exist in the number of data points that can be represented. The only restriction that exists, through the dimension of the physical display when built, is due to limitation in size and budget.

From single to pluralistic designed spaces

I will to discuss cultural heritage through built environment designed by one author with one cultural background, followed by a shift in design towards a possible pluralistic modulation of space when designing in a voxel matrix.

Until now, the cultural contributions of individuals have determined space and design. Each individual has a unique design language, where the design characteristics are driven by factors such as region, environment or religion, to name a few. I will postulate that, contrary to a cultural contribution of an individual, a society as a whole body also produces cultural artefacts. The cultural output of a society can be also measured by data analysed and described through various disciplines of social science. Culture can be defined as all aspects of human life including arts, beliefs and institutions of a population that are passed down from generation to generation. As such, culture includes codes of language, religion, rituals, games, norms of behaviour such as law and morality, and systems of belief, as well as the arts, all of them part of social science interests.

So, if culture generally refers to patterns as described above, then social data collected within a population can be used to express culture. The interest of this paper is in using social data as a vehicle to represent cultural relations within a certain group, using these data to represent the group and possibly compare these social data with other groups in relation to time and location. These social data will now generate a voxel facade media content. The architecturally specific features of this spatial representation of data through a voxel facade, and therefore a shift from single authorship of space towards a pluralistic modulation of space when designing in a voxel matrix, can be defined by the following two characteristics: (1) representation of more than one social data set through a multilayered surface and (2) decay of surface to illustrate a shift of importance of a particular social data set.

Multilayered surface implies the possibility of layering a number of surfaces onto one facade by simultaneously displaying more than one surface as a 3D object and creating an extra spatial depth. I want to give an example from the field of social science to illustrate the meaning of multilayered surface when collecting the economic data of state or region. A state's economic data collected in year one is displayed as a voxel surface in green (see Figure 1). The economic data of year two is then collected and displayed as voxel surface in orange in the same voxel display. The display will then show two voxel surfaces, green and orange, at the same time based on the same set of data only with a year's time difference. The representation allows a comparison of the differences and similarities of the two data sets in the same display.
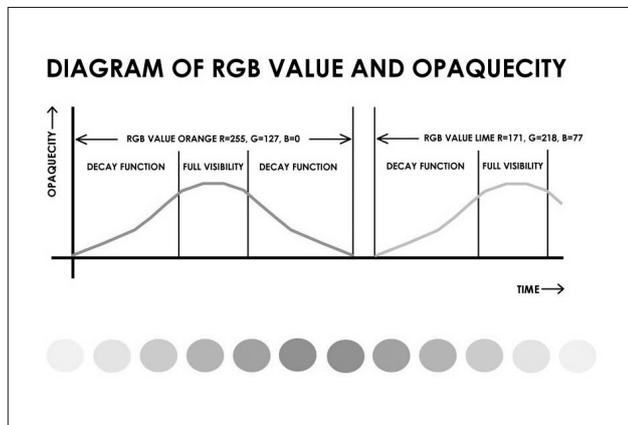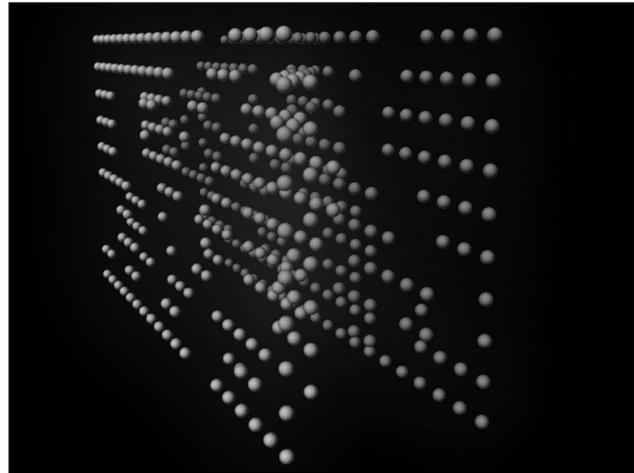

Figure 2. Decay function diagram

A "decay function" of the voxel surface is achieved by writing a script that puts a decay factor on each light point. The LED producing this light point will not simply be switched on and off; it will be decayed to create an after-effect of the facade that just existed.

Staying with the economic example, if the two data sets of two years are supplemented over time by a third year, and this third year should gradually replace the first year, then one can apply a decay function as a design method. While the light points of the first year slowly fade from 100% to 0% to represent the decline of its importance, the third year could steadily change from 0% to 100% to visualise the increase in importance.

The intangible light point surfaces generated by a social data injection make these two new surface tectonics possible, therefore creating a new canon of forms. Terms such as "multilayered surface" and "decay function" are new to architecture and open up a new notion in the field of architecture.

At present, the architectural discussion does not include materials, which would allow such surface qualities. Once access is gained to these new surface qualities, they would offer design a canon of forms to communicate cross-cultural interests. Both terms "multilayered surface" and "decay function" offer a form of representation that allows the viewer to experience something new, the understanding of cultural relations inside or outside one's environment.

Conclusion

The paper has discussed a new form of surface representation generated by a set of social data. To conclude, I will evaluate (1) whether the voxel zone generated by the collected data represents useful or meaningful data for the public, thus achieving a feedback loop and (2) if the viewers' point of view affects the perception of the matrix.

To answer the first two points I raise (i) a topic of how art has developed and draw a specific example from painting perspectives, (ii) give an example of an anthropological context to demonstrate that humans have to learn to understand and read images and (iii) introduce anamorphosis, a term for a distorted projection or perspective, requiring the viewer to occupy a specific vantage point to reconstitute the image.

Until the 15th century, painted representation of content did not have any perspective order. Before perspective, paintings and drawings typically sized objects and characters according to their spiritual or thematic importance, not by distance. In medieval art, for instance, art was meant to be read as a group of symbols, rather then seen as

DIAGRAM OF RGB VALUE AND OPAQUECITY

OPAQUECITY

RGB VALUE ORANGE R=255, G=127, B=0   RGB VALUE LIME R=171, G=218, B=77

DECAY FUNCTION   FULL VISIBILITY   DECAY FUNCTION   DECAY FUNCTION   FULL VISIBILITY

TIME

Figure 1. Multilayered Surface

a coherent picture. The only method known at this time to show distance was by overlapping characters. The first known use of perspective was by Brunelleschi in about 1415 (Manetti, 1970) in his painting of the Baptistery in Florence. I would argue that contemporaries of Brunelleschi certainly had difficulty reading and understanding perspective paintings as this form of representation was new and the public had no experience of it. A shift from medieval painting to perspective painting therefore involved a shift, firstly in learning how to draw perspectives and secondly, for the public to learn how to read perspectives.

This shift in learning is further demonstrated by an example of the anthropologist, Nigel Barley (1983). Nigel described a scene where people see mosquitoes in a movie shown as part of an anti-malaria campaign. For demonstration purposes, the mosquitoes were shown in a larger than life scale. When interviewing the people later about how they experienced the movie, they stated that mosquitoes that size are certainly dangerous but the ones in their home country are of smaller size and therefore not dangerous. What Barley concluded from this was that people not used to a form of artistic expressions are unable to read and understand the meaning and that a learning period is required to see and understand a new art form.

I would argue that the design of a voxel facade is a new art form that combines space with the factor time. Gaining an understanding of the meaning of this dynamic spatial representation of information is, in my opinion, a matter of learning to read a voxel surface, in much the same way as people learned to read and understand perspective paintings.

In order, to answer weather the viewers' point of view affects the perception of the matrix, I wish to mention the importance of a privileged perspective when viewing a voxel façade. An example for a privileged perspective in art would be the 16th century painting, The Ambassadors (1533), by Hans Holbein the Younger. The painting shows a distorted skull in the foreground. The distortion corrects itself completely when the painting and the skull are seen from an angle to the left of center. The example works with the previous mentioned anamorphosis, i.e. distorted projections or perspectives requiring the viewer to use special viewing devices or to occupy a specific vantage point to reconstitute the image. This is also what a voxel façade does. The viewer has to position oneself in a privileged position that enables one to see the data representation displayed on the façade. If the viewer were to move to the right or left, the impression of the data would change.

Arguably, first spatial representations of information via voxel facade could be difficult to understand, but as outlined above it will be a matter of learning until voxel facades are understood as an art form, where collective social data can define a space through a pluralistic participation.

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