Testing the Benifits of Animation

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This paper presents the results of an attempt to empirically test the hypothesis that expanding the range of graphic formats used in architectural communication can lead to an increase in effectiveness. To be specific, the comprehension of users was tested to measure the effectiveness of computer generated animation in comparison with still images. The dynamic functioning of a natural ventilation system was explained to two matched groups of building users. The explanation was presented in an animated video to one group and in still images to the other group. Immediately after viewing the group which viewed the animated version demonstrated a superior comprehension in a multiple-choice questionnaire test.

Testing the Benefits of Animation in Architectural Communication

Introduction

Whilst much of what is done under the title of CAAD is simply an amplification of the draughtsman's function, one of the truly innovative functions which CAAD brings to architects is the ability to create animation. This might be compared to the quantum change which takes place when a designer shifts from plan and section, to perspective and/or axonometric representation. Eastman (1970) presented results from experiments which demonstrated that architects working with three-dimensional drawings were able solve functional problems in room layouts which were not even perceived by architects working in two dimensions. A similar enhancement of ability can be hypothesised for architects who work in four dimensions in comparison with their colleagues restricted to three dimensions.

However, little evidence exists to support such a contention. Indeed there is anecdotal evidence to the contrary. The availability of technology which makes it possible for every designer to indulge in the kind of fantasy which many associate with the medium of the moving image, appears frequently to result in the indiscriminate adoption of animation as a gimmick to demonstrate technological capability rather than as evidence of the effective communicator's skill of selectivity.

The animation used in this experiment was created in Superscape VRT, a virtual reality creation package. Devlin and Rosenburg (1996) have warned that "Attempts to use VR … have been … problematic. In the specific domain of the construction industry the main problem is that the virtual world presents users with too much information. This makes it too difficult to abstract all, and only the information relevant to the task in hand". It is therefore not certain that new media will always prove superior to existing solutions. They must be used selectively.

The resources available to the communicator (transmitter), the particular needs of the audience (receivers) and the nature of the material to be communicated (message) must all be considered. This experiment is made possible by the increased resource available to the architectural profession in their role as communicators. An audience of architectural students has been selected in order to ensure a basic level of interest in the message and an inherent ability to comprehend it. Finally it was decided to test the new medium with a message which previous experience led us to expect would benefit from the use of a time-based medium.

Appropriate formats for specific content

The use of more elaborate graphic representations, such as iconic formats representing the appearance of the built environment, has been recommended by McCartney (1985) in situations where the message is

complex in terms of its sensitivity to design characteristics, particularly formal variables. Iconic formats were also recommended when the audience was not completely familiar with the message and required assistance in relating the new information to previous knowledge. McCartney and Rhodes (1991) presented the argument that the difficulties faced in attempting to comprehend environmental phenomena is often due to the mismatch between the essentially dynamic nature of most environmental phenomena and the static techniques architects adopt to present them. Their comparative experiments indicated the possibility of using task based measurements to discriminate between the effectiveness of 2-D animation and still-frame based presentations in assisting designers to predict wind movements through urban environments.

Few built environment phenomena are more essentially dynamic than air movement. The students who participated in this experiment had recently moved into a new building which featured five prominent towers which were an integral constituent of the building's natural ventilation system exploiting the convective circulation which occurs in stacks. The nature of air circulation through the studios and towers, and the techniques of controlling the flow, constituted the referent content, or *message* which was represented in both static and animated formats.

Experiment Design

A class of 79 first year architectural students were divided into two groups. Each group received a presentations explaining the design strategies for natural ventilation for the building they occupied in one of two alternative presentation formats. One group were shown a video created from a virtual reality 3-D model of a building using animated analogue elements with a tracking viewpoint. The second group were given a presentation of equal length using 13 key frame images selected from the animation. (Examples of the still-frame presentation are shown in figures 2 and 3). The duration of each presentation was equal (4 minutes), and there was no verbal commentary. A comprehension test applied to both groups was intended to test the effectiveness of the specific function of animation in communicating the ventilation strategy.

Test

Unlike Eastman's experiments, the effect of the means of representation on problem-solving capability has not been tested. Instead, the more fundamental condition of comprehending the nature of the built environment phenomena which are represented was the subject of test which comprised eight questions. Multiple-choice questions were used to facilitate consistency in marking the responses.

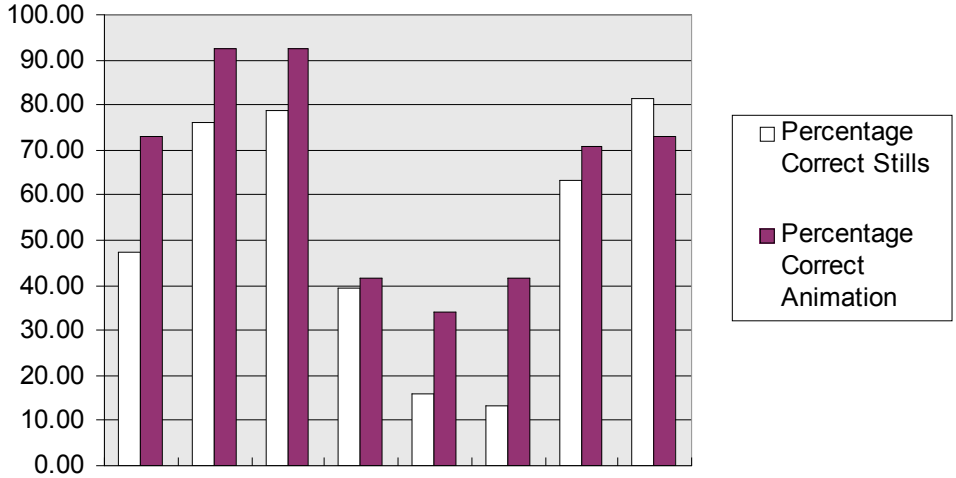
The questions were intended to test comprehension of the presentation, rather than prior knowledge. The questions are therefore highly specific, referring to information which was conveyed in the presentations. They deal with different aspects of the ventilation system which is illustrated, including questions of quantity, recognition of actions and components, identification of component position, and direction of movement.

1. *What action does the automatic building management system take to induce natural ventilation within the studio spaces?*
2. *What action can the building users take to initiate natural ventilation within the studio spaces?*
3. *Where are the inlet grilles to the ducts in the studio located?*
4. *How many smoke dampers are positioned in the duct between the studio space and the stairwell?*
5. *Within the duct, how many times does the air flow change direction, before it reaches the stairwell?*
6. *In what direction is the airflow moving when it leaves the duct and enters the stairwell?*
7. *In case of fire, how would the automatic building management system prevent contaminated air passing from the studio spaces into the stairwell?*
8. *If the building overheats, how can the automatic building management system increase the rate of air flow after the windows have been fully opened?*

Table 1 Questions used in the Comprehension Test.

Results

In seven out of eight questions used in the test, the group which had watched the animated presentation achieved higher scores than the group shown the static, key-frame presentation (fig. 1). Averaged over all eight questions the difference between the scores of each group was 13



percentage points. Statistical analysis using the Kolmogorov Smirnov test, showed that the difference in performance of the two groups was significant at a level of $\alpha = 0.05$.

Question (8) concerned the operation of two large fans at the top of the tower. It is perhaps surprising that this was the one question in which the group who received the static key-frame presentation recorded a better score As the fan blades were shown rotating in the animation, it might have been assumed that this additional graphic cue would have drawn additional attention to them. However the difference recorded is small (81% cf 73%).

In questions (1) and (6), the differences in percentage scores were 26 and 28 respectively. Question (1) is similar to (8) in that it requires the identification of a moving component. Question (6) on the other hand concerns the identification of the direction of air movement.

The three questions which both groups found most difficult to answer correctly are (4), (5) and (6). Both groups achieved an almost equal score of about 40% for (4) which was quantitative, in that it required subjects to recall the number of smoke vents in the ductwork. (These elements had been represented as moving in the animated version, and had broken arrows to indicate movement in the still frame presentation). In both (5) and (6) the group which had watched the animated presentation scored more than twice as many correct answers than the group who had watched the still frame presentation. These questions both required respondents to recall, or infer, directional information.

Comment on experiment design

It is a well known problem in experiments with alternative graphic formats that it is difficult to establish conclusively that two alternative formats are equivalent. They might differ in either their ability to represent the class of formats, or in the information content. It might also be necessary to alter modes of symbolisation to suit the special needs of a specific graphic format. In this experiment, the symbol adopted for air movement in the still-frame images, is a twisting, two dimensional arrow. When it came to viewing the air movement in a three dimensional animation this symbol would disappear if viewed from certain angles. Therefore in the animation, a cone shape was substituted for the arrow to symbolise air movement and to indicate the direction of flow. It may be that the mode of symbolisation affected viewers.

However, a survey of architectural journals showed extensive use of the arrow format to represent air movement, and no use of cones. (In the year ending in July 1995, the weekly *Architects Journal* published 118 examples of different types of arrows being used to illustrate air movement through buildings Jacobs (1997)). It is not unreasonable to

assume therefore that architectural students would therefore be more accustomed to interpreting the still-frame images, and that the improved comprehension exhibited by the animation group was achieved in spite of a potential disadvantage with regard to the mode of symbolisation.

Conclusions

The experiment presented here demonstrates that it is possible to measure significant differences in audience comprehension when comparing alternative graphic formats, such as animation and static representations. In this case, comprehension was shown to be significantly greater in the audience which was presented with information in an animated graphic format.

However, in the experiment described here, there is considerable variation in the differences between the two test groups in answering different kinds of questions. The variation in responses reinforces the introductory comments regarding the importance of selectivity in the preparation of effective communications, and the necessity of matching the media and the message. The experiment presents evidence of the large improvements in comprehension which can be attributed to the superiority of the animated presentation used in the experiment particularly with regard to questions of direction of movement. But surprisingly, less improvement is shown in responses to questions concerned with the identification of mobile building components.

It is also difficult to draw reliable generalisations due to the difficulty in comparing both the graphic quality of the two presentations used in this experiment and the extent to which they might be claimed to represent the categories of "animated" and "static" presentations.

Animation has been shown to make significant improvements in the effectiveness of communicating specific types of information to certain types of audience. But with some types of information content, animation might actually distract some audiences from the intended message.

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