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THE VISUAL HARMONY BETWEEN NEW AND OLD MATERIALS IN THE RESTORATION OF HISTORICAL ARCHITECTURE

A study of computer simulation

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Abstract. This research is based on a historical architecture restoration project (the Taiwan 921-earthquake damaged Chi-chi train station). The objective of this research is to construct a computerized procedure for allocating roof tiles. We attempt to simulate different combinations of new and existing roof tile layout through the application of computer simulation prior to the actual construction. This computer simulation process assists the professional and non-professional's analysis and evaluation to achieve a visually harmonious and ready for construction solution.

1. Introduction and Problem

In the research of historical architecture restoration, scholars respectively focus on the field of architectural context and architectural archeology, and some concentrate on architectural construction and restoration. How to choose materials and cope with their durability becomes an important issue in the restoration of historical architecture.

In the related research of the usage and durability of materials, some scholars deem that, instead of continuing the traditional ways that last for hundreds of years (that is to replace new materials with old ones), it might be better to keep the original materials (Dasser, 1990). However, unavoidably, some of the originals have deteriorated. Thus we have to first establish the standard of eliminating components, and secondly to replace the old components with identical or similar materials (Lee, 1990). After completing the restoration, we often unexpectedly discover that the restored historical building is too new that the sense of history is eliminated. Actually this is the important factor that determines the result of restoration. In the past, some scholars find out that the contrast and conflict between new and

old materials are contributed to the different time of manufacture and different coating, such as anti-corrosion, design patterns, etc., which result in the discrepancy of the sense of visual perception (Lee, 1990; Dasser, 1990).

In recent years, a number of researches and practices of computer technology have been done in the field of architectural design. We are able to proceed design communication more precise by the application of computer software, such as image processing, computer graphic, computer modeling/rendering, animation, multimedia, virtual reality and so on (Hill, 1992, 1993, 1996, 1997; Lawson, 1995; Liu, 1996). Although the application of computer technology to the research of historical architecture is comparatively late, there are continually some researches conducted. Some researchers establish digital database of the investigation of historical architecture (Wang, 2000), or explore the archeological hypothesis of historical architecture by computer simulation technology (Potier, 2000). Furthermore, in order to probe into the process of construction, the digital models are combined with the factor of time (McKinney, 1998). Liu (2001)'s computerized visual impact analysis and assessment of urban design (CVIAA) has investigated the impact on sense of visual perception of utilizing computer simulation technology to choose construction materials.

Inappropriately restore a historical building has always been a problem of historical architecture restoration. The problem resides on the inability to accurately simulate the visual impact of mixing new and existing materials prior to design or construction (Liu, 2001).

This research is based on a historical architecture restoration project (the 921 earthquake damaged Chi-chi train station). The subject of discussion is the roof tile system. Our main goal is to solve the problem of mixing new and existing roof tiles. We are hoping through the assist of computer simulation to resolve the discrepancy of visual perception on mixing new and old materials. Further more, to provide a workable construction solution.

2. Methodology and Steps

This research is divided into 3 parts:
Part 1 is to collect information and categorize different tiles, for example: by shape, sizes, material and color. *Part 2* is using computer simulation to come up with various layouts of new and existing tile patterns. *Part 3* is to allow the professional and non-professional committee members to select and evaluate the computer simulated images, finally selecting a most visually harmonious solution for the restoration construction.

2.1. ESTABLISHING THE BASIC DATABASE AND CATEGORIES

Step 1. *Construct the digital model of the original roof tiles* (Figure 1).

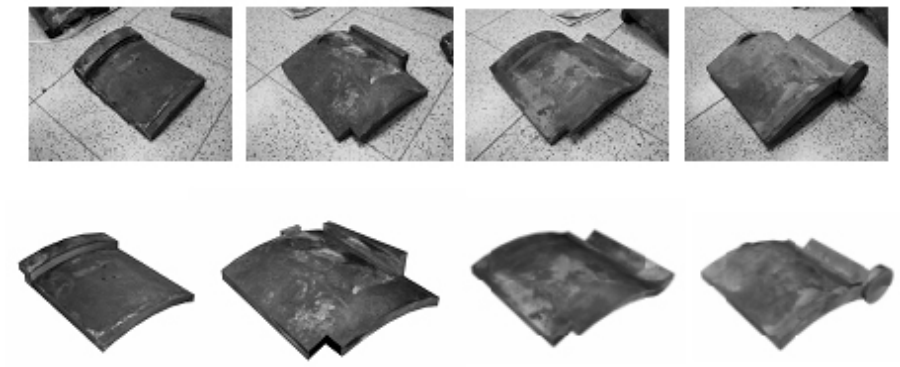

Figure 1. Digital model of roof tiles

Step 2. *Acquire the existing materials and establish information database.*

a. Acquire 1120 pieces of existing tiles (56 rows x 20 columns) (Figure 2) and 1 piece of new tile.
b. Method of acquisition: We will set the tile on a white platform, and photograph the tile 150cm away and parallel to the camera lens. This is for future color coordination (Figure 3).
c. Establish database (Figure 4).

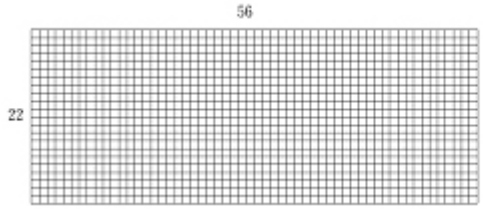

Figure 2. Layout of the tiles

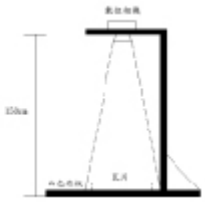

Figure 3. Photography equipment

Step 3. *Process of categorization of existing material*

We gather and calculate the digital information of all the tiles and categorize the result into 10 existing materials and 1 new material (Figure 5).

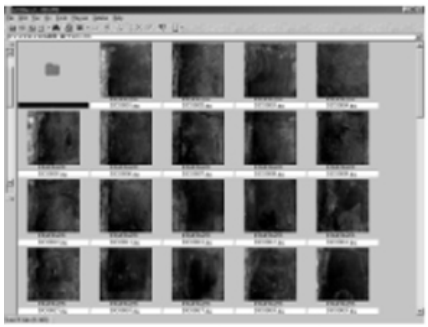

Figure 4. Tile database of tile materials categories

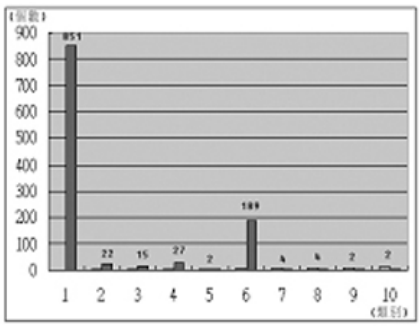

Figure 5. The calculation of

2.2. COMPUTER SIMULATION

Step 1. *Calculating of 90% to 50% of new and existing material mixture*.
Step 2. *Input material samples randomly onto computer model.*
Step 3. *Based on 3 different viewpoints to conduct computer simulation*.

Figure 6. Different viewpoints of simulation

2.3. CONDUCT SELECTION AND EVALUATION

After completing the above steps, we have gathered some different results of the simulated new and existing roof tile mixture layouts. For the purpose of examining weather or not the results will be appropriate, we have invited 20 professional designer with 4+ years of training and 20 non-design related individuals to conduct a questionnaire poll based on our computer simulation results. The results are the following (Figure 7):

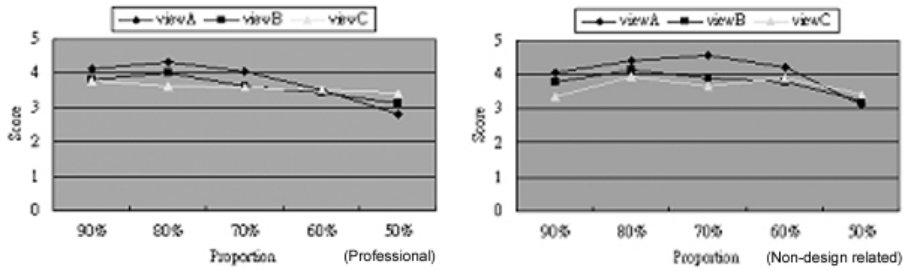

Figure 7. The distribution curve of the results from the professional participants (L) and the non-design related participants (R)

3. Analysis and Discussion

The purpose of the above experiment is to acquire a visually harmonious and workable construction solution, but we have accidentally discover:

1. The design professional feel the best result is achieved when the roof is covered with 80% of existing tile. Varying the percentage of existing tiles will not improve its visual quality. On the contrary, this does not have any effect on the non-design related participants.
2. The professional and non-professional, both feel when observe from a far distance, the higher percentage of existing tiles will result in better visual harmony, on the opposite, when observe in a close distance the lower percentage of existing tile will result in better visual harmony. In another word, when observe from afar, it is harder to tell the difference, but when observe in close distance, it is much easier to tell the difference between the new and the old.

Conclusion

By utilizing computer simulation we are able to provide some constructive suggestion on the visual impact of different materials prior to the construction phase. This process will assist us in the prevention of poor historical architecture restoration. According to Liu (2001)'s computerized visual impact analysis and assessment, this research has further discovered some common values between the professional and non-professional's results. That is, distance, angle, and proximity of visual points will influence

the simulation results. These details are seldom brought up in visual impact evaluation process. These details will be further investigated and discussed in the future research.

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