ABSTRACT
In this paper we present our work on exploring the possibilities of using 3D projection, instead of 2D displays, for a media installation set-up, which we aim to use for exhibition and teaching purposes. We compare two visual media installations presenting a rotating Earth, one presented on a 2D display and the other projected on a physical 3D object, and present the feedback collected by using the product evaluation cards method.

Categories and Subject Descriptors
H.5.m. [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

General Terms
Design, Experimentation, Human Factors.

Keywords
3D media installation, 3D display, user experience, user studies.

1. INTRODUCTION
Projected multimedia installations or learning materials are part of everyday life in museums, exhibitions and schools. In this poster, we present our ongoing work to take a step further in creating more vivid and engaging multimedia presentations, and change from conventional 2D to 3D media by projecting the visual content on a physical object. Our work aims towards developing 3D exhibition and learning material, especially for educational purposes.

We have created projected 3D visualizations, which map to the curved surfaces of the object and thus provide images that appear on the object without skewing or other perspective mismatch. In our approach, we create a virtual 3D model of the object, which is then used in the projection. Figure 1 illustrates a projected image on a human-sized shape of a body, which aims to be used in medical education. The visualization technique attempts to provide more realistic educational material than 2D illustrations on books, computer displays or projection walls in classrooms, and it is our belief that the technique is promising for such purposes. The technique could be utilized e.g. for settings where the objects under investigations need to be examined from different angles, or visualized with dynamically changing data. Examples of dynamically changing 3D visualizations that could have value include augmented human body shapes in medical schools or a 3D world map at geography lessons.

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Figure 1. Visualization created as a virtual 3D model and projected on a body-shaped 3D object.

2. POSITIONING OF OUR WORK
Earlier research has introduced relatively much work on projection systems, where images are shown on arbitrary surfaces, see e.g. [5, 7]. While the aim of this kind of systems is typically to adapt the projection to the dynamic changes in projection surface geometry, we take a simpler approach and aim for stable systems, which however are shaped in 3D. Magic lenses are an interesting approach to project visual information, and e.g. in [6], a magic lens system to augment a 2D tabletop is presented. Here, especially the example of illustrating the physiology of human body with a magic lens is relevant prior art for our work [6]. In our work, the 3D objects are used as projection surfaces and the lens metaphor is not used, making our approach different to [6].

In the demonstration described in this paper, we use a sphere-shaped object and project a visualization of a rotating Earth on it. Earlier research has experimented with sphere-shaped interactive displays. At Microsoft, Benko et al. built and experimented with a spherical multi touch screen Sphere [2], and in [3], a spherical volumetric display with touch input is described. Our demonstration does not currently have input functionality, but it is considered as a potential direction for future work.

To investigate the audience’s perceptions of a projected 3D visualization more closely, we organized a user study to compare 3D and 2D projections. We adapted the method from Microsoft Product Reaction Cards [4]. The study method can be modified to match the research topic, and examples of its use for examining product desirability can be found in [1]. In our case we gave the participants two templates of words predefined by the authors, and asked them to assess which five they chose to describe installations, which presented a rotating Earth projected in 2D and 3D.
3. 3D DEMO AND ITS EVALUATION

3.1 Rotating Globe Demonstration
Figure 2 (bottom left) illustrates our setup, which contains five projectors, four in the sides of the projection surface and one at the top of the surface. The simulation in the virtual 3D world contains five cameras according the physical world setup, and each camera represents a projector. The virtual 3D world contains a 3D model of the sphere, which has textures from satellite images. It animates clouds as well as the change of the night and day as seen in Figure 2 (top right). Our setup is made using open source libraries such as Open Scene Graph and Projection Designer. At this point the projector calibrations are made manually, but in the future we plan to enable automatic corrections.

![Figure 2. 3D projection demo and the 2D projection of the rotating Earth.](image)

3.2 Evaluation with Users

3.2.1 Study Set-up
Both installations were in the same room. The 3D installation was made on top of the table so that every participant could move around and examine it. The 2D installation was projected on the wall as seen in figure 2 (bottom right). The image on the wall was the same as the 3D installation’s one view, and the diameters for 3D and 2D shapes used in the evaluation were approximately 25 cm and 35 cm, respectively.

For the user study, we created 54 words (i.e. 27 word pairs) that the participants could select to describe the 2D and 3D installations. The words were laid out on a sheet of paper and randomized. Each participant was given two sheets, one for 3D and one for 2D projection, and they were asked to select five words that best described their experience with each installation. Half of the participants described the 2D installation first and the other half the 3D installation.

Altogether 30 participants (13 male, 17 female) filled out the evaluation form. The age of the participants varied between 19 and 61 years, the average being 30 years.

3.2.2 Results
When examining the participants’ subjective user perceptions between 3D installation and 2D projection, the results showed that the 3D presentation receive positive acceptance. A total of 93% of the selected words for describing the experience with the 3D installation were positive. These words were related to the novelty and attractiveness of the presentation. The 2D projection accumulated 65% positive and 35% negative words as responses. Experience with the 2D projection was commonly described to be conventional. Five of the most common words with both presentations are shown in Table 1.

![Table 1. Five of the most used words in 3D model (left) and 2D projection (right).](image)

4. DISCUSSION AND CONCLUSIONS
In our study, we compared user perceptions of a traditional 2D media presentation and a 3D visualization projected on a physical 3D object, a rotating Earth. The results show that the 3D installation was found more interesting and attractive. We acknowledge that our findings are limited due to the single evaluated demo setting, but we find them encouraging and will continue our work with the subject nonetheless. As we expect that the ability to interact with the installations would make them more interesting and useful e.g. for teaching purposes, this direction should be examined next. Moreover, the results presented in this paper were studied in exhibition settings. Next, we aim to continue to experiment with the system in teaching situations, i.e. a class room setting in situ.

5. REFERENCES