

IMPLEMENTATION OF METHODOLOGICAL PROCESSES OF USERS EXPERIENCE WITH 3D TECHNOLOGY AND AUGMENTED REALITY. CASE STUDY WITH STUDENTS OF ARCHITECTURE AND USERS WITH DISABILITIES.

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RESUMEN

Architecture and other cultural places of interest are shown as the results of the progress of evolution of society. People have a right to access these: *"Everyone, as a member of society ... entitled to the satisfaction of economic, social and cultural rights indispensable for his dignity and the free development of his personality."*

The society has a responsibility to bring this knowledge to anyone, whether or not disabilities their mental or physical abilities that may prevent access to this information.

The new technology provides effective tools for interpreting the architecture and culture in general. Thus, a project may have an emotional impact in people as well as while more widespread in society as a whole.

The project defines a methodology for evaluating accessibility in architecture and its application (with people with visual disabilities) to visit emblematic buildings of architecture, as the Church of the Sagrada Familia in Barcelona, designed by architect Antoni Gaudí.

The project is made by disabled people and students of architecture. They work in definition of development and practical application of designs. The experience of students as users and content developers will allow us to empirically assess the usability and accessibility of the built environment.

Keywords: Augmented Reality, Disabled Users, Accessible Architecture, User Experience

1. INTRODUCCIÓN

Access to the architectural culture for disabled people is difficult in most cases (museums, visits to buildings, exhibitions, etc.). The effectiveness of that access depends on the information provided to the user. Also it must allow interact with the physical spaces. The senses like touch, sight and hearing are the main channels from which users can be helped, and is in these senses where students must be alert to provide the initial information.

For disable people it is important that they can visit the exhibition spaces, museums or other places of interest to complete the user experience. Some previous teaching

experiences are the basis of research and development of methodologies based on the response to these stimuli in the end users.

Thus, previous project experience shows that by involving users in the different phases, results have a higher effectiveness of the proposals to show the contents of any cultural event. The development team composed of teachers, technicians and students of architecture increases the ability of the theoretical approach more specifically.

The methodology is aimed at achieving a satisfactory experience for developers and end users.

2. STATE OF ART

The French philosopher Diderot said, *"... of every sense, sight is the most superficial, the ear the sense most arrogant, the most voluptuous is smell, taste, the more superstitious and more variable, touch is the deepest and philosophical"*.

Currently, there are many museums and organizations that offer alternatives for accessibility. Some museums have art galleries especially dedicated to people with disabilities. Some of these are:

- Typhological Museum of ONCE, Madrid, Spain.[1]
- Touch Museum in Athens. [2]
- Social Work Cataluña Caixa, building La Pedrera, exhibit *'La pedrera touch'*.
- Louvre Museum, París.
- National Museum of Archaeology, Anthropology and History of Peru.

Some of these experiences have been made in the field of architecture and access to built heritage. These are experiences that are related to the project.

3. METODOLOGY

The current project is a continuation of the practices developed in a previous projects [3] [4] which established a new research line with disabled users by the students of the Architecture degree. The methodology is defined in six phases and the previous project developed the first one. The next stages to develop in this paper are phase number 2 and 3:

- **Phase 1:** Practical development of a project and evaluation of the different phases.
- **Phase 2: Definition and implementation of a theoretical methodology.**
- **Phase 3: Analysis of results of the proposed methodology.**
- **Phase 4:** Modification of the methodology based on the results.
- **Phase 5:** Analysis of the new methodology.
- **Phase 6:** Definition of the final methodology and iteration in other frameworks.

In the previous phase of the project we obtained initial results, which will be defined in an implementation of this present second phase. The main points to consider in this new phase are defined as follows:

- **Analysis of results of the previous phase:** The results will allow us to improve some aspects of the workflow of new stages incorporating advances in technology and training methodologies.
- **Implementation of 3.0 training methodological approaches:** The collaborative workflow method which involves several team profiles allows us to add new experiences to the common objective of the project.
- **Evaluation of new techniques of representation:** In this phase we will evaluate and analyze new techniques developed and using augmented reality (AR) and their possible incorporation in the application of the project.
- **Implementation of the methodology:** The application of new techniques of representation and increasing participation of involved agencies will improve the final experience.

The definition of the parameters related to the past experience has focused on a more complex training process developed into the following steps:

- **Step 1, the context:** the project developed in this paper is a continuation of the first phase addressed to disabled users and developed the last year. The theme of the work is the Basilica of Holy Family (Gaudí, Barcelona, Spain) and the geometry of some of its architectural elements.
- **Step 2, development of prototypes:** the student projects are done using CAD technology in the definition of constructive elements and their representation in 3D.
- **Step 3, evaluation of geometric models by disabled users:** the students have the opportunity to check with the disabled users experience the effectiveness of the models used in the previous step and evaluate the results.
- **Step 4, trail with 3D models in AR:** evaluation of new imaging techniques for future possible incorporation into the project content. This step is still in experimental process but it opens new lines to guide the contents to other user profiles.
- **Step 5, new user experiences:** Iteration of user experiences in this second general phase with the final models, descriptive text and raised panels, following the direction of the project. The students have the opportunity to redefine content of their teaching material.
- **Step 6, presentation and public exhibition of the didactical adapted materials:** the works are presented in this stage in a box with all the material. The exhibition takes place in a public location of the university.
- **Step 7, visit of the monument:** teachers, students, disabled users, rehabilitation experts and disabled guides

visit the monument to share the experience and evaluate the results [Figure 1].

- **Step 8, analysis of results and methodology:** the Project ends with the conclusions and evaluations of the experiences of the whole process.



Figure 1: Basilica of Holy Family visit.

4. PHASE 2: DEFINITION AND IMPLEMENTATION OF A THEORETICAL METHODOLOGY.

Step 1: The context.

The proposal continues the research of an earlier draft. Students participate in collaboration with organizations of persons with disabilities. The project has a duration of six months in the third year of Architecture degree.

The group consists of twelve students and a teacher. Volunteers are three technicians people and four volunteers with disabilities. In the final visit are included three tour guides to the building and a group of thirty people, including at least 15 who are disabled with partial or total blindness.

The technicians of these organizations provide initial training to be considered in project design adapted. The organism ONCE for disable people also provides students the technical resources to develop teaching materials. The volunteers with disabilities will participate in the process of project design.

Step 2: Development of prototypes.

The prototypes are designed with 3D models in specific CAD programs. Students learn new techniques to develop models (laser cutting, 3D printing, silicone molds and resin). Knowledge of the properties of these materials is aimed at applying these techniques in their own studio projects.

The process for creating 3D models is as follows:

- The prototypes are designed in wooden elements (conceptual prototypes of architectural geometry). [Figure 2].



Figure 2: conceptual prototypes of architectural geometry.

- Students apply a plaster finish and latex on the wooden models [Figure 3].



Figure 3: student with the prototype in plaster.

- The models are placed in a container upside down and covered with silicone rubber (a process that needs time to dry)
- Later, it is necessary to invert the mold to fill it. Epoxy resin will be the final finish.

Other didactic materials are developed in the department of ONCE using writing machines and Braille printing tools and molds plastic panels.

Step 3: Evaluation of geometric models by disabled users.

The volunteers with disabilities participate in the design definition phase. Architecture students can carry out experiments with users and evaluate prototypes with surveys that reflect the effectiveness of the work.

The suggestions of the volunteers will be critical to the correctness of the designs for further evaluation. The surveys were incorporated into the information system of the Intranet of the university to discuss the overall results of the project.

This phase of consultation has the support of the national organism ONCE. This organism is actively involved because they give us technical support providing access to the classrooms of his delegation and human resources to make

appropriate contacts with users whose may experience the project [Figure 4].

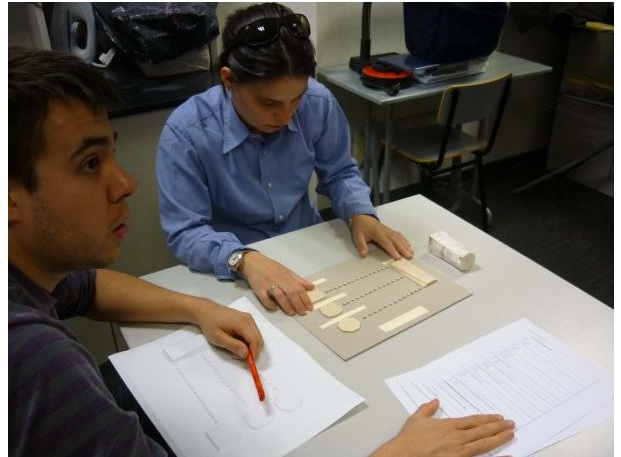


Figure 4: evaluation of geometric models by disabled users.

Step 4: Training with 3D models in AR.

Students test new augmented reality techniques to assess their possible incorporation into the project with people with disabilities.

This phase will be a test for future projects where new ways of implementing applications for mobile devices which are integrated into the course.

The project is in the aimed to approximate the experience the students as a specific application to their own exercises in other courses of Architecture degree [Figure 5].

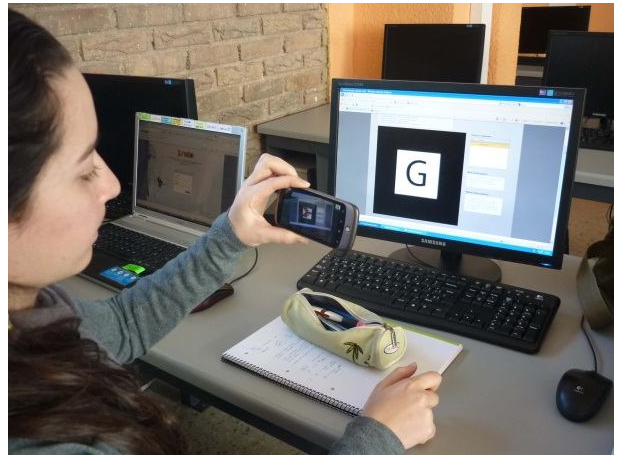


Figure 5: trail with 3D models in AR.

Step 5: New user experiences.

The second stage of development of the project is also led by volunteers and students. On the second visit is made the test materials adapted and improved from the changes suggested by the first experience.

Also tested new content adaptation. These are relief panels, panels with large font size and Braille texts with descriptions of 3D models [Figure 6].

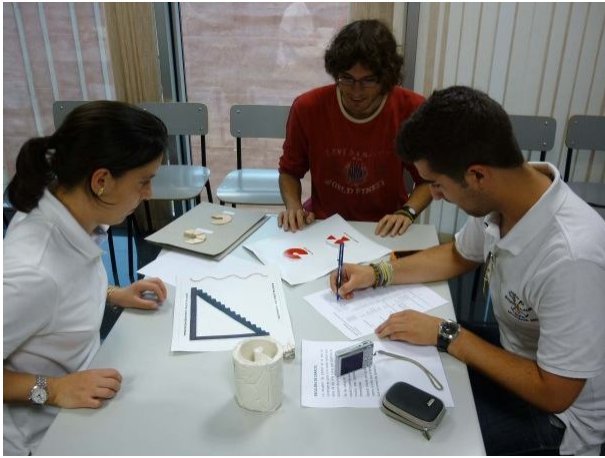


Figure 6: new user experiences.

Step 6: Presentation and public exhibition of the didactical adapted materials.

The presentation is inside of a small suitcase containing of all materials adapted and protected in order to use them on a tour. In the last phase, these bags are used for the group of disabled people in the church [Figure 7].



Figure 7: didactical adapted materials.

Step 7: Visit of the monument.

The last step is to visit the place with all participants of the project: students, teachers, volunteers, disabled users, rehabilitation technicians, guides and leaders of the Basilica. In this step have been used adapted models from the models of the Basilica and the contents generated by the students. The visit is conducted in several stages:

- **Description of the research project and the Basilica of Holy Family:** It develops in the annex building which it was originally the school for the children of the firs workers of the temple. This explanation also includes the experience of touching the models and the adapted material realized by the architecture degree students [Figure 8].



Figure 8: Students explanations to disabled users.

- **Tour visiting outer and inside places of Basilica of Holy Family:** The group of disabled uses covers with the guides and students all the spaces and pay attention and stopping at singular points. In this tour the users can touch the materials and experience the feeling of space inside the acoustic perception. Students also experience the difficulty of accessibility architectural tours of singular buildings for disabled users [Figure 9].



Figure 9: Tour inside the Basilica of Holy Family.

- **Tour at the exhibition “Gaudí and Nature”:** In this permanent exhibition space placed inside the Basilica, the users can touch models of architectural features made with references to the nature. The chairman of the exhibition serves to visitors and can also observes the reactions of disabled users [Figure 10].



Figure 10: 'Gaudí and Nature' tour with adapted material.

Step 8: Analysis of results and methodology.

Finally we evaluate the experience and the result of applying these materials developed by students in a guided tour of the Basilica.

The graphic material collected during the tour and all comments from the users are analyzed to obtain new conclusions to improve future experiences.

5. CONCLUSIONS

The most relevant conclusions of our study are:

- In the previous phase, the disabled experts and the Basilica visit have facilitated the understanding of the structure of the project to the students. The objective and methodology to be followed are defined in this first step of the project. This system has been evaluated positively by students.
- Prototyping and their evaluation by users in the design process (into two stages, initial and final process), it is a system that helps to improve the models for the explanation in the monument visit at the end of the course. The volunteers with disabilities have evaluated as indispensable their participation to improve student proposals.
- The geometry is easily interpreted, but not in all cases due to the different levels of knowledge related to the matter. This is an aspect to improve in future activities: the adequacy of the contents in its definition and terminology to be used.
- The vision impairment is not the determining factor to understanding of the geometric models, as the touch and text description along with raised panels are crucial for quick interpretation. For this reason they need to have even greater clarity of understanding.
- The architectural project is another important factor. In this research project, the Basilica of Holy Family is very complex but the selection of singular elements facilitates understanding of the whole. It is necessary to realize projects with other similar buildings as historic monuments to compare experiences and methodology.

6. REFERENCES

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