Augmented Reality and Cardboard Models: New Possibilities for the Design of Interior Spaces and Furniture Based on the Link Between Analog and Digital

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Abstract

The purpose of this experience consisted of linking two methodologies usually used exclusively in the study of the design operation in the university academic environment: working with cardboard models and augmented reality. The methodology used consisted of work in groups based on skills to build cardboard models, to model in 3D, and to work with augmented reality. They developed interior space designs through the interaction of physical models (made of cardboard) and observed models on those physical models through systems equipped with applications to view augmented reality. Among the main results of this experience are the possibility of interacting with dynamic objects modeled in 3D in the physical field of the cardboard model, and the successful integration of two work methodologies (analog and digital), at least in one of the stages of the design operation**.**

Keywords: Augmented Reality, Design Operation, Interior Design, Models.

1 Introduction

In the Interior and Furniture Design career, which is taught at the National University of Río Negro, in the Graphic Representation Workshop 2, possibilities were studied to generate design alternatives from the use of Augmented Reality linked to models (material, physical) in the design of interior spaces.

Augmented Reality makes it possible to introduce 3D human figures in the model, in scale and with animations, and to visualize dynamic relationships between potential inhabitants / users with the interior spaces that are being designed. There is no precedent in the national university context (Argentina), in the field of interior design and furniture, of the realization of this type of link between Augmented Reality and models (yes in the artistic field, and for other purposes). Neither is this possibility of work considered in the study plan of the degree.

The objectives consisted of studying concrete possibilities to get to define design strategies by using the experience of Augmented Reality in the environment of a study model (that is, during the design operation itself). Augmented Reality has not been used directly in real space, but in the space that is being designed with the help of models made with materials used for a long time in the field of design and architecture (such as cardboard, wood, PVC).

The students were given the knowledge to model in 3D, and activities were proposed to link these models and their respective animations, with the free version of the Unity and Vuforia software. Animated 3D anthropomorphic figures were scaled and placed inside the cardboard models to later be visualized as dynamic models of augmented reality. In this way we worked on the formal definition of the interior spaces: the cardboard models were modified according to the movements of the 3D figures; and once the modifications were made, the 3D models exported to Unity were modified.

Free software versions were used, as noted; while for the construction of the cardboard models and wood were used. The socioeconomic reality of Argentina forces to work under these conditions in a public, free and free university; therefore, this fact was taken as data to define lines of action and not as an insurmountable obstacle that would prevent these exercises from being carried out.

The results of the exercises carried out in class (virtual, due to the management that the national government has made of the pandemic) have been encouraging: the students have been able to visualize the conditions of use of the spaces that they themselves were designing from a critical reading of the images perceived by the interaction of the 3D figures in the models. The conclusions are still being organized and weighed; However, it is recognized that this way of working (consisting of linking Augmented Reality technologies with models made of cardboard during the design operation) opens up new possibilities for studying the design operation and links, in turn, analog working modes with digital in a crucial instance for the definition of what is being designed. The possibility opens up for new scenarios related to the design operation, both in practice and at a theoretical level.

2 Proposal of activities in the workshop classroom

Usually, the spaces are developed and produced through the exclusive use of sketches and models that are built mainly with solid pieces of wood, cardboard and PVC in the early stages of design; whereas the content of the media and the physical and material space are conceived separately in the design operation by which, often, they remain operationally distinct from each other. With increasing scale and complexity, as the design operation progresses, materials become more diverse and sophisticated. At a certain point within this operation, and after the design is more or less established through the tangible model, digital software is introduced as a tool that allows students to geometrically describe difficult shapes and adapt them to the following scale with its respective detail, in order to refine the architecture and its spaces.

In this experience, 3D models were related to physical cardboard models from the very beginning of the design operation. Building on several years of teaching experience in the field of traditional and digital design, the author hypothesizes that design quality is affected by the exclusive use of digital software as a design tool. For this reason, the proposed academic exercise was organized as a laboratory for the exploration of the use of various digital media with analog models.

3 Organization in the classroom-workshop

The work was organized in three phases: 1) materialization of the model and 3D modeling of the same model and the anthropometric references; 2) coordination between model and 3D modeling through the use of augmented reality; 3) modifications to the physical material object (model) and readaptation of 3D models.

The pedagogical heuristics of organized work in these three phases responds to two types of objectives organized as follows: 1) those that account for the design operation as a material practice and 2) those that reflect the design operation as a cognitive activity. The objectives of the first group use the model as a working resource to define the material and structural arrangement; In this way, the scalability of the cardboard model creation process promotes the testing of the construction conditions of the interior space. The objectives organized in the second group relate model and model, this relationship becoming a promoter of conceptual thought of both a cognitive-perceptual and figurative-operational nature.

The procedural objectives were organized as follows: 1) definition of a conceptual structure of the space to be designed, 2) determination of activities

to be carried out within the space, 3) establish the physical material support for each activity, and 4) relate the physical with 3D models using augmented reality.

4 General objectives

The intention was not to generate a simulation of reality on a small scale; Likewise, verisimilitude was not sought, understood as the recognition of the appearance of the objects by virtue of the model made (through the use of 3D modeling software). The general objective of this work was to evaluate the relationships between models and augmented reality as a working method and form of research that differs from design operations based on classic iconic models of representation.

The model used in the design operation should not lose its status as such (capable of being materially redefined by cutting or adding new parts, pasting new surfaces, drawing on it, etc.). It is a joint work between the creations that are seen through mobile devices and the physical space of the model: the physical space is not denied.

5 Theoretical concepts

Definitions of design operations account for the tension between reality and the realm of the possible; between the execution and the ideation of the work; between idea and materialization; between human agency and the physical-material dimension of the things that are being designed. Those who do the theory of the digital design and manufacturing operation are making use of concepts that have been defined and articulated in the theory of the design operation based on the hilemorphic model.

This theory has served to account for fitness operations; however, it is insufficient to account for design operations that do not respect this relationship of subordination of matter to the intellectual intentions of the designer. And it is insufficient because the design carried out in a digital context has forced two displacements in the theoretical sphere: the first of them consists in abandoning the intentionalist structure (Luhmann, 1983) that links the designer with an object through the project; and the second consists of not basing the operation of putting into shape on the hilemorphic model (in which a shape is imposed on a defenseless matter). It is necessary to have concepts articulated in a theory that serve to account for the relationships between thought and action in this digital, that is, in the context of a non-hilemorphic shaping operation.

6 The necessary theory

The French philosopher Gilbert Simondon criticizes the hilemorphic scheme, directing his studies to the operation of individuation (Simondon, 2009); and it is this theory of the individuation operation that is presented to us as a reference capable of providing concepts to account for the non-hilemorphic shaping operation that is carried out in the design operation in this digital context. Thus, a debate arises around the limits of the discipline, due to the fact that a sequential process is replaced by a simultaneous one (Bevilacqua, 2020).

In Spanish we distinguish between model and model. The first of the terms comes from the French maquette which derives, in turn, from the Italian *macchietta* which means 'sketch of a drawing'. The concept of model becomes fundamental in this way of proceeding, relating models with augmented reality images, since by model we mean here a computerized model, that is, not a three-dimensional construction (made of cardboard, for example) but rather information (understood in the terms exposed by Simondon) organized in algorithms.

The model is the object that defines the physical space, which exists without the aid of any device; while real space was understood to be that area in which students and teachers were when they designed, that is, the classroom. Augmented reality space was understood to be those situations in which the studied space can only exist mediated by the use of electronic-computer-mechanical devices.

7 Reflections on implementation

Smartphones, tablets and notebooks are carried by teachers and students to design classes (or they have these devices in their homes, from where they participate in synchronous classes). They, teachers and students, carry out multiple interactions mediated by these artifacts (union between hardware and software) that they carry with them, along with their bodies. You have access to content that relates the material (real) geographic space with the virtuality of data available on the WEB. This relationship between the local (not with the universal) but with the delocalized is carried out in each of the interactions carried out with these devices.

Not all students possessed the same level of digital ability. There were huge differences between the skills presented by each one. This was due to: 1) individual choice, 2) previous educational experiences due to rigid university and high school curricular structures, and 3) inability to access digital resources. Even after many years since the advent of digital tools, many students are still intimidated by the use of sophisticated modeling and

visualization programs. Additionally, many students seem unaware that mastering the digital world requires a significant amount of time and energy.

Since the students had a very different level of knowledge about 3D modeling software, the study group also learned how to handle Blender as complex 3D modeling software. This allowed them to translate and further develop their ideas within the digital realm. Through the continuous change between the process of making the models by hand and the digital modeling of their shapes and sculptures, the students experienced the different emergent situations within the design operation that emerged as a consequence of establishing these relationships between systems; they understood very well the benefit of combining different methods to achieve a spatial design goal. No scanners were used to digitize the mockups so they had to model in 3D as modifications were made through the analog work of cutting and slicing their shapes.

The way of proceeding of the students in this organization of the design operation proposed here is not based exclusively on the program of needs and the function, but on conceptual processes, abstract diagrams, preliminary experiments or personal experiences of the participants; Artistic expressions such as theater or performance, film, sound and photography have also been used. That is, instead of working with an initial analytical interpretation, a needs program, or a specific design task, students were asked to approach the project with an intuitive strategy, acting as readers of their own work. Parallel to these intellectual processes, students learn to use Unity software with Vuforia for augmented reality. As the study progresses, both the technical knowledge and conceptual approaches of the project are related in the project.

The theoretical classes reflected on the difference between the definition of models (classic iconic) that represent a building, interior space or object, and non-iconic models that are schematic, in which function and structure are important, not their shape.

What is elaborated during the design operation becomes a hybrid material of environment and technology; the manufacture of models itself can be investigated through software. These relationships become a field of research that can be approached from the design point of view.

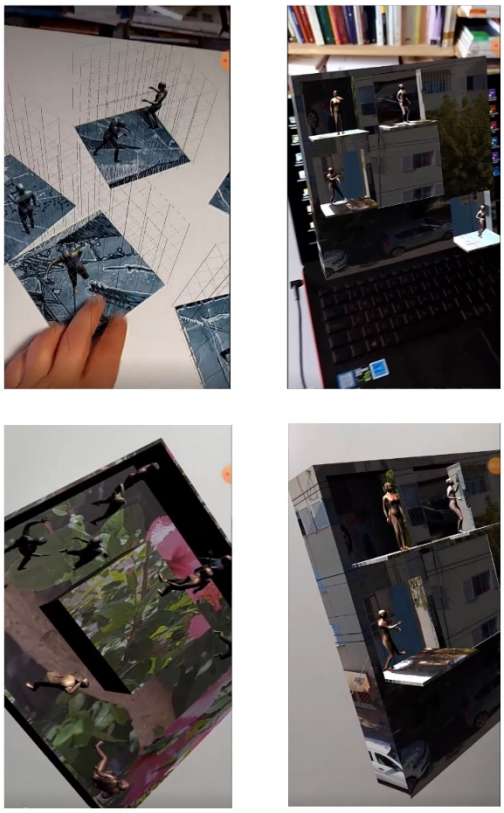

Figure 1. Examples. Source: self-made

We have verified that the use of augmented reality, with the movement of people on an appropriate scale relating to the model, allows us to avoid biasing the program solely towards the material construction, and opens the possibility of considering the design of the space in terms of human activities. That the project defines only the material aspect of what has been designed is not an inevitable conclusion, this is so because each activity that has been thought through 3D models does not necessarily need to use infrastructure supports. It is even understood, during the same design operation, that parts of the space can be resolved as interfaces and / or information displays.

Teamwork was encouraged: those who had skills to make models worked on it, complementing their activity with other students with facilities to use 3D modeling software. The most successful student teams in the study were those who were able to relate in the work dynamics a complete variety of traditional

and digital tools, from their own abilities, combining physical models and sketches with three-dimensional digital 3D models in augmented reality. A key factor here was using the right tool for the right task in a time-efficient manner.

There are different types of feedback between the act of materially defining the model and the model made by computer; It is not the model that anticipates the model and its construction, but rather the definition of what is being designed is established by putting them in relation, understood in the terms proposed by Simondon (2008). It is in these positions in relation to the disparities between the model and the construction that energizes the design operation.

For this way of proceeding to be possible, the scalability of the model creation process in relation to 3D models in augmented reality was essential: each model at its different scales raises different types of questions about the performance of the material and the constructive specificity, questions that serve as a guide to streamline the design operation.

8 The economic gap

The highly complex 3D modeling software available today requires excellent management knowledge; and access to it usually requires considerable investments of money that are not possible to address by a graduate student. Experiences in academic design work based exclusively on digital media showed that students are often overwhelmed by the exclusive use of that specific tool, and are often caught by the enormous opportunities, but also limitations, that the digital machine offers.

9 Conclusion (final thoughts)

The various design experiments demonstrate important aspects of merging complex 3D modeling and animation software in augmented reality with cardboard mockups. Due to the nature of many projects with simple geometries, this approach was appropriate and valuable. As it could be observed in the different projects carried out, and despite being basic and simple shapes, it has been shown that there are wide possibilities for the application of hybrid design methods that are based on different means and design approaches. As students' progress through the design operation, a harmonious combination of thought and work processes is needed.

The projects examined showed that design methods that make use of material systems, mostly made by hand, are hardly replaceable in their entirety by other means, because our ability to create is based on intuitive processes

(Carpo, 2011). Technology can relate to these design processes and invite designers to explore new means of design work; it can become the catalyst for new opportunities to emerge.

Beyond the ontological differences between the two technologies (augmented reality and cardboard models), these are not mutually exclusive, as we have verified throughout this exercise. The proposed thesis is that the product of relating these technologies in the design operation can be composed with a greater holistic effect: that of a fused reality that relates 3D modeling with the material fact.

Augmented reality technologies imply the ability of the observer to relate entities in the field of 3D modeling with the physical environment. Augmented reality is based on a psychological and phenomenological model of the observer, it is materialistic in nature, and requires physical intervention on the environment and, subsequently, the observer.

Computing and the space defined by cardboard are not mutually exclusive, as monitors are just one of many devices used as a visualization tool in computing. This relationship allows the coherent integration of computing devices and the creation of systemic behaviors (within the logic of the design operation), being able to link these productions through networks.

Unlike the more static forms of digital media, augmented reality, with its interactive and context-sensitive functionalities, engages users in more direct and meaningful ways.

Designing interior spaces and furniture using software requires not only digital dexterity, but strong material sensibility.

From using mobile devices to observe the occupation of space, to thinking about life itself relating to space through these mobile devices and augmented reality.

More time needs to be given to students to explore these tools so that they come to a natural and consistent use in the design process, using the digital toolkit to support the traditional tools that are still valid.

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