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Creating Non-standard Spaces via 3D Modeling and Simulation: A Case Study

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Abstract

Especially in the film industry, architectural spaces away from Euclidean geometry are brought to foreground. The best environment in which such spaces can be designed, is undoubtedly the 3D modeling environment. In this study, an experimental study was carried out on the creation of alternative spaces with undergraduate architectural students. Via using 3D modeling and various simulation techniques in the Maya software, students created spaces, which were away from the traditional architectural spaces. Thus, in addition to learning the 3D modeling software, architectural students learned to use animation and simulation as a part of design, not just as a presentation tool, and opening up new horizons for non-standard spaces was provided.

Keywords 3D Modeling; Simulation; Animation; CAAD; Maya; Non-standard spaces.

INTRODUCTION

The use of computer aided design tools in architectural undergraduate education is increasing rapidly. Computer aided design tools became a part of the design, rather than being only a presentation tool. Students, who are aware of this situation, are increasingly demanding to learn computer programs that are increasing day by day and serving different purposes. Thus, various experimental studies on the use of different computer-aided design tools in architectural and design education have been conducted (Mark et al., 2003; Oxman, 2006; Oxman, 2007; Agirbas, 2015; Aish and Hanna, 2017; Agirbas, 2017a; Agirbas, 2017b; Agirbas, 2018). In this study, an experimental work in undergraduate architectural education was carried out for teaching of Maya, which is a 3D modeling and animation / simulation tool. The aim was to produce non-standard spaces and turn them into video.

Based on form, preferred spaces have been constantly changing from the past to the present according to time, culture and socio-economic condition. When we look at the choice of space in the cultural sense, it is seen that in some cultures, living in narrow spaces become traditional, and in some cultures, living in wider spaces become traditional. For example, while American society has a culture of living in wider houses, Japanese have cultures that they live in much narrower spaces. When we look at the space preference with the socio-economical sense, it is seen that people with lower income live in narrower spaces, and people with higher income live in wider spaces. When we look at the use of the space based on 'time', it is seen that there are periodic differentiations in form. In some periods, theoretically and practically, spaces have been designed away from the Euclidean geometry (eg Ramot Polin apartments, designed by Zvi

Hecker). So, in the future, it is not known, how a space that the creatures will want to live or will experience to live.

If we look at the use of space taking the time period a little longer, we can also reach different conclusions. When we look at the evolutionary period of human beings, we see that the evolution of the body (Darwin, 1859) is a long process. Throughout this long process, the characteristics of human beings, such as the anatomical form and the walking shape of human changed. So, from here, we can reach the conclusion that, at the end of another long period, we do not know what the future physical behavior of mankind will be. Consequently, we do not know the form of space that human beings will need. Another issue is that human's surroundings can effect on human's physical behavior on evolution. In other words, factors like nature or created spaces might shape the human's physical behavior over time. In the same way, technology and architecture can shape human.

For example, from the past to the present, might the buildings, which were created in Euclidean geometry because of their easy construction, have the effect on human physical evolution? Or can the use of new VR / AR technologies influence human's physical evolution? Another example can be given on the decline of human's physical movement. It is the case that the physical movements of human beings decrease considerably due to the fact that people can work at home without going to the office, cargoes can reach their houses by drones, and robots are included in life too much. Can the decline of physical movement of people affect human's physical evolution? Or can the production of different spaces with the possibility of constructions of buildings away from Euclidean geometry by 3D printer and multi-axis robots affect the physical evolution of human?

In this study, which started with the question of what space alternatives might be for the future, the elective course with the content of 3D modeling, the creation of alternative spaces was studied with undergraduate architecture students. The students used various 3D modeling and simulation techniques in the Maya software to create space alternatives away from Euclidean geometry.

METHODOLOGY

The aim of this course as an undergraduate elective course is to teach basic 3D modeling and animation / simulation techniques in Maya. Most of the students, who take this course, are the students who can use Photoshop, Autocad, Sketchup and Revit (to some degree) programs. That is, students have the ability to use computer-aided design tools in general.

The course begins with teaching the use of 3D polygon objects in Maya. Then, basic commands are taught such as rotating, scaling and moving these 3D polygon objects. The lesson continues with teaching the use of 'soft select' command to smooth these objects. At a later stage, rendering and material creation are focused on. Various render engines (such as v-ray, mental-ray) are introduced to create a rendered image. For these render engines, how to create the scene (such as creating light, shadow, ground, sky, sun) is focused on. Later, assignment of various materials to the objects, and the creation of various materials (eg, Lambert, Blinn, Phong, Ocean shader or materials related to mental ray such as mia_material_x, mi_car_paint_phen_x), changing the properties of materials (such as transparency, glossiness, reflectivity, refraction), assignment of 'bump' to the material are taught. After these explanations, applications of various renderings are made.

After students reach a certain level of Maya knowledge, various animation and simulation topics are taught in Maya. The subjects such as moving the object over a period of time, creating different camera views and moving the camera over a path are primarily taught. Then, we show the simulations, which can be characterized as more experimental for architecture undergraduate students such as nCloth, nHair, nParticles, Bifrost. With these simulations, how to create a complex architectural form are discussed with students. At this stage, the projects of Lynn (1999), Zaha Hadid (Schumacher, 2009) and Hernan Diaz Alonso (2014) are shown, and it is focused on the topic of form creation by simulation.

After students reached a certain level on the subject of making basic 3D modeling and animation / simulation, students are asked to transfer various animation / simulation studies done in Maya to After Effects program and to do post-production process here. In After Effects program, students can convert different animations / simulations produced in Maya into a video format by putting frames together. In addition, they can add various pictures, texts and effects to their videos.

At the end of this course, students are asked to create a differentiating interior space and to make a video with it by taking advantage of 3D modeling and simulation techniques. Here, it is expected that they can make good light and shadow combination and create various different materials. However, the most important thing is that the students were asked to present a story together while creating this differentiating interior space.

The students were asked to fictionalize a story in their minds simultaneously while creating the differentiating interior space. It was thought that this process would affect students' creativity on non-standard space subject.



Figure 1. A student work of non-standard interior space design. Source: authors.

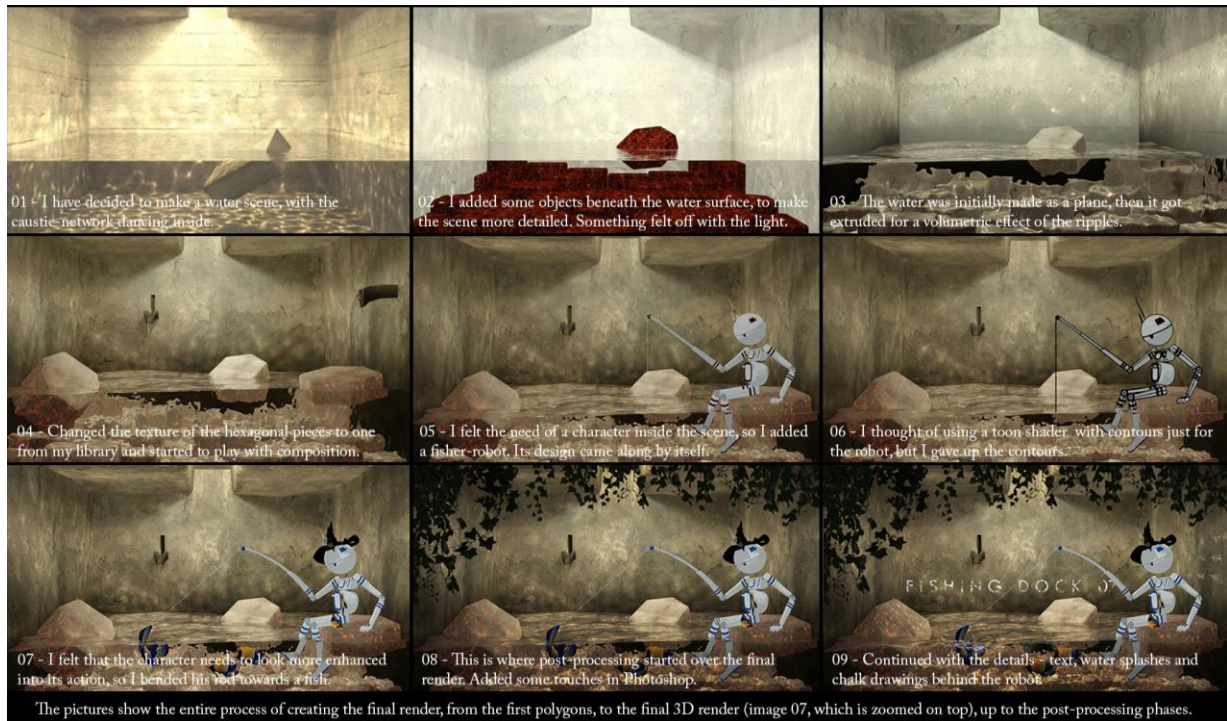


Figure 2: The progress of a student work. Source: authors.

RESULTS

One of the students produced an alternative interior space using the Maya program (Figure 1). In this study, the student started from the water in the interior space concept. To the object, which was created in the interior space, was set the ocean material and so the object was made as looking like a water object. By changing the properties (such as transparency, refraction, wave speed, wave height, wave turbulence, wave peaking, wave color) of this material, the student reached the desired water appearance. Using the polygon cubes in Maya, he created objects at the desired size and accepted them as walls. To give a good view of the wall, he set images on these objects. In doing so, he used mia_material_x belonging to mental ray, and he associated this material with an image (Figure 2). In addition, bump was set to this material, and a rough wall appearance was obtained and the wall appearance became even more realistic. He carried out the same procedure for the rock objects created in the interior space. He also thought that a complementary element to the interior space was needed, and for this, he imported to his scene a fishing robot in an "obj" format. After the preparation of the scene, he did many render tests. In order to capture the loess light he wanted, he changed many times the size of the angle of created sun and the size of the gap created in the roof and created rendered image. Finally, he prepared a video with a new camera, which walks around in the space.

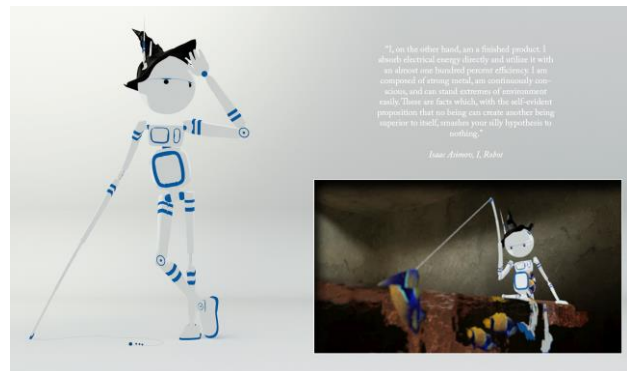


Figure 3: Concept of the student work. Source: authors.

While creating the story of this study, the student took the subject of the extraordinary life of a robot in an interior space. In addition, since a robot would live in the interior space created, the student entered the process of adding the characteristics of the robot to his scenario. At this stage, the student benefited from Isaac Asimov (1950)'s science fiction book, "I, Robot" and quoted the book about the robot as seen on his board (Figure 3) "I, on the other hand, am a finished product. I absorb electrical energy directly and utilize it with an almost one hundred percent efficiency. I am composed of strong metal, am continuously conscious, and can stand extremes of environment easily. These are facts which, with the self-evident proposition that no being can create another being superior to itself, smashes your silly hypothesis to nothing."



Figure 4. A student work of non-standard interior space design. Source: authors.

Since the concept of the study is robot's life in an interior space, the topics such as lighting and objects were shaped according to this concept. Therefore, it has been seen that the presence of a story / concept in this modeling process has quite shaped the atmosphere created.

In the other student study (Figure 4), a similar method was followed. In this study, the student did 3D modeling of final scene of the selected film, which was created from the direction of her imagination. In this study, the student continued the scenario of Wall-E (Stanton et al., 2008) film as specific to herself. The student analyzed the characteristics of Wall-E robot, which was the main character of the film. Wall-E is a robot with innocent character. The balloon, which is the object created by the student for this character, is remarkable because it is identified with the innocent character of the robot. Apart from this, it seems that the student, who interpreted the last scene of the film, left a gap in the ceiling of the room that she created, and this symbolizes the liberation of the robot. Therefore, it is observed that the last imaginary scene of the scenario in the film, created by the student, has a direct effect on the space that she modeled.

In this scene, the subdivisions of the ground plane, which was created by the object of polygon plane in Maya, was firstly increased, and afterwards the ground plane was modified by the soft selection command. She also added various objects to the scene and gave various materials to these objects. She obtained desired appearance of the materials by changing the properties such as transparency, refraction, glossiness, reflectivity, and so on. In addition, this student, who considers creating a semi-open space, made a partitioned (in the form of

columns) wall, allowing the light to flow into the space fragmentally. To create this light shadow combination, she rotated the sun outside the space many times and made render tests. Finally, she prepared a video with a new camera, which walks around in the space. In this video, she also moved the objects in the space, based on time.

In the other student study, the student created an alternative space using the nCloth simulation, which is a dynamic simulation in Maya (Figure 5) (Agirbas and Ardaman, 2016; Agirbas and Ardaman, 2017). First, she set an nCloth to a polygon object that was created in Maya. Then, she created another object to collide with this nCloth object. Meanwhile, to the nCloth object, she tried to set various nCloth presets (such as honey, waterBalloon, waterVolume, lava, silk, tshirt, airBag) present in Maya. After doing form-finding exercises using these presets, the student decided on a preset and continued to her work using this preset. She collided nCloth object having this preset with various objects, and froze the forms formed in some frames during the simulation. With these created forms, an alternative space was created using commands like mirror, copy and move. Various materials were set to these forms and the rendered image of the space was created. Finally, she prepared a video with a new camera, which walks around in the space.

This student focused on the objects in the space in the story that she created. The student tried to emphasize in her story that the contemporary architectural buildings could be made with curved lines, and the objects inside of these buildings could also have curved lines. She interpreted the non-standard forms that she created with



Figure 5. A student work of non-standard interior space design. Source: authors.

nCloth simulation as objects in the space, and tried to create a cluster from them.

Another student primarily created different geometric prototypes in Maya using 3D modeling techniques (Figure 6). Later, these prototypes were diversified in different sizes. Then, he tried to use them to make a difference in the interior space. The story imagined by this student is escaping from standard measures and is on designing a majestic entrance hall. The prototypes and the light-shadow games that he created seem to help the student, reflecting the main theme of the story.

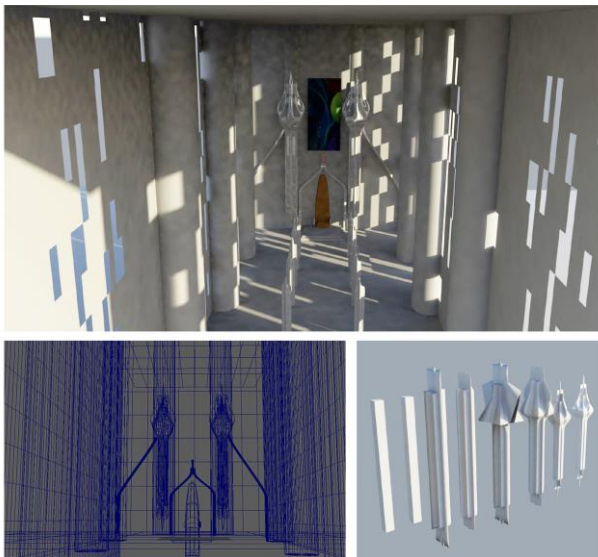


Figure 6. Student work of non-standard interior space design. Source: authors.

DISCUSSION

In this course, undergraduate architectural students learned basic 3D modeling and basic animation /simulation techniques in Maya and beside these, they carried out an experimental study on how to make forms that away from Euclidean geometry using these techniques. They also had an idea about creating alternative interior space and the relations of light, shadow and material.

In this work, the students were asked to create an alternative interior space, and at the same time, to fictionalize the story/ scenario for this interior space. It has been seen that as the students were creating the models of the space, the story, which was simultaneously fictionalized in their minds, influence greatly the formal properties of the interior space. Therefore, it has been observed that this simultaneous action has an effect on the creativity of the students.

In this study, it has been seen that the students have created non-standard spaces by the method that they followed. But, the students generally reached these types of spaces by bringing the objects inside of the space. It was noticed that the planes, which envelope the space, was still modeled with right angles. It is thought that this situation may have occurred because of the application of story / scenario focused method. Because, when the student thinks of the story, it was seen that the student focuses on the life inside of the space.

At the university where this work was done, the students, generally transform their architectural design studio projects to animations in the Lumion environment. The students can easily import their projects (produced in another 3D modeling environment) into Lumion and can transform their projects to animation. In this case, the students naturally do not see the animation / simulation as a part of their design, and think that the animation /

simulation is just a presentation tool. However, the studies done in the scope of this course, the students learned that animation and simulation could be used as a part of the project, not just as a presentation tool. They even learned to produce form via simulation and consequently, the students' view of animation and simulation changed.

Another important outcome is that the spatial imagination power of the students was forced. In this course, the student's imagination was forced by asking production of alternative spaces instead of spaces consisting of basic items such as classical stairs, chairs and tables. In this way, the stereotyped spatial content was broken and breaking certain norms by students was provided.

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