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How to Include Augmented Reality in Descriptive Geometry Teaching
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Abstract

The geometric representation has always existed, from the antiquity when the man was using it to plan his areas to the present day. For the construction of any object or building the use of geometry is needed since the finish work has to be very precise. Teaching geometry is not easy at all and the new generations every time has more problems for the spatial understanding. With the new digital technologies the young persons are losing increasingly the sense between the royal space and the two-dimensional one, due to the fact that they are immersed on a screen. Therefore, the system of learning as for the spatial representation must change to manage to answer the interest for the use of these technologies. The matter of Descriptive Geometry is directed students of the first and second semester of the careers of Architecture and Industrial Design. Their aim is to develop skills of perception and spatial analysis, under systems of parallel and conical projection in the construction of volumes. The work that is realized in the semester is with instruments to hand, but we see the need to penetrate with the technology on having explaining basic aspects since they are the units, scales and coordinates (length, width and thickness). For what we know that the AR will help to make more understandable the process of modeling of a figure. Later the pupil will be able to be working with hand to learn to project the exposed figure, later it will be possible to work with the software SketchUp. The key point of this process of education is that the pupil learns to project, not to copy, from the work to hand up to the culmination with the software. For it I have to conclude of that the work of the AR does not remove importance to the work that the teacher does since this one is the one that programmes that makes learning understandable.

Keywords: Spatial visualization, SketchUp representation, visualization.

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1. Introducción

To teach geometry is not easy at all and the new generations every time have more problems to achieve a spatial understanding. With the recent digital technologies the young persons are losing increasingly the sense of the royal space, due to the fact that always they are immersed on a screen where from there they observe all his surrounding world. Therefore, one seeks to design a system of spatial representation that it helps to the conception of the forms to design using the Augmented Reality with SketchUp’s software.

This study is applied in the matter to which this project is applied is that of Descriptive Geometry for students of Architecture and Industrial Design of the Instituto Tecnológico de Monterrey, Campus Monterrey of firstly and the second semester, which their aim is to learn to represent the space on the basis of exact methods of projection for the construction of spatial models.

This article exposes the teaching of spatial representation across the Descriptive Geometry with constructive methods of projection applied both in the traditional form and in the foxtrot to manage to present the final results with the Augmented Reality.

This offer is based on months of investigation on how the pupil can learn to project with precise methods. For the designer it is very significant to have the aptitude to be able to project any idea that has in mind since his offers must be focused towards the needs of the human being.

Always there has been listened that it is very important that the student learns to project first with instruments by hand, and there are motives for justifying it since across this system of work the student has more direct contact with the royal space, so much the scales and as the managing unit they are important points that make possible that it approaches the royal dimensions of any offer.

The key point of this process of education is that the pupil must not copy but be able to project, because they are accustomed to expressing in agreement to since see it on the screen without any alteration. It is necessary to to understand what shows itself, is what implies a constructive representation.

The structure of this work is organized in the following way: First one will speak on how it appreciates the visual perception before the virtual reality. In the second point a comparison will be done between the Descriptive Geometry by the digital vectorial representation, it is important to know what points they have jointly in order that the learning in the pupil is more effective. In the third point a comparison is done between the Descriptive Geometry by the Augmented Reality. In the fourth point it treats on since the Descriptive Geometry works as a whole with the SketchUp to do the final presentation with Augmented Reality.

The fourth point involves the topics the Montea and the Axonometrias as methods to project three-dimensional models in a two-dimensional space. And since last the final conclusions are on the use that Augmented Reality can give in the education of the Descriptive Geometry.

2. Virtual reality vs. Perception reality

In the latter years we have observed that the new generations already do not conform to be informed across static images but they seek to get in a three-dimensional world with movement in the one that one could interact, being named a virtual reality. Let's remember that this reality is an IT system that generates a simulation computarizada of environments and virtual situations in a certain place. In many occasions this reality reproduces in three-dimensional form with a contained graphical, acoustic and tactile high place, understanding this way a perceptive condition without any physical support and that only gives itself inside the computers in order that they could describe scenes of places or objects that exist in the reality. The virtual reality supports a three-dimensional relation between the space and the time, the royal thing of the unreal thing is not distinguished due to the fact that the computer is thinking an environment in which the spectator could take part about acting, as it appreciates in the figure 1.
Ráfols and Colomer (2010) say to us that on having designed a virtual space they conceive the idea of that we can see a space where physically it is not there, this is done from the own experience of the spectator to create an illusion of depth. This point of view is very important because the visual perception influences very much the efficiency of the design of a space with virtual reality, in this speciality not only the psychological one enters the measurable aspect but also on having manipulated the images in order that they meet royal.

Since it is demonstrated in the figure 1 that with this system pieces we can adapt to create new designs in the self-propelling production. With the virtual reality it is possible to penetrate largely with the psychological and cultural perception in order that the people could intervene in these created environments. In this system of virtual reality one handles more the environment than the central figure, and in case of the descriptive Geometry it is the object in what more we are interested, therefore the Increased Reality gives us a more direct solution to do a final presentation of the piece that was projected.

3. Geometric representation and digital vectorial representation

We can say that the spatial representation bears very in mind to plan with efficiency, and so much for the representation with instruments since for the digital representation the quality of the line is very important. Both forms of representation use the same language as the system of coordinates X, and, Z (length, width and height), scale and unit metric.

Consequently, the geometric representation can be employed at more direct form with the royal space unlike the digital representation where the space only can be estimated across the screen or a virtual way.

This is what I can explain, which is transmitted in the table 1.

<table>
<thead>
<tr>
<th>Geometric Representation</th>
<th>Digital Vectorial Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructive representation through method</td>
<td>Representación intuitiva y constructiva</td>
</tr>
<tr>
<td>Scale managing</td>
<td>Scale managing proportional and numeric</td>
</tr>
<tr>
<td>Parallel and conic projections</td>
<td>Projection and modeling through parallel and conic projections.</td>
</tr>
<tr>
<td>For the outline of any figure it splits of the square.</td>
<td>For the outline of any figure it splits of the square.</td>
</tr>
<tr>
<td>Projecting through a method</td>
<td>The method for projecting is software</td>
</tr>
<tr>
<td>Use of X,Y,Z cordinates</td>
<td>Use of coordinates X, Y, Z (or U, V, W).</td>
</tr>
<tr>
<td>The image is formed with the line.</td>
<td>The image is with the line.</td>
</tr>
</tbody>
</table>

With table 1 we can observe that to work with these two systems, there is a great difference between work, both technologies help us to visualize any object to project, but we must have account of which both base on a visual structure to achieve the projection of any object.

4. **Descriptive Geometry and Augmented Reality**

The intention of learning to visualize the space for me is very important because the student can have a feasible method that allows him to imagine any object and to know how to start working. To imagine this figure in different planes and dimensions is a skill that helps to have a clear vision of what has to be done.

A student who cannot visualize, uselessly will be able to be employed at effective form with the Augmented Reality, since we have mentioned before, the information that is established in the representation has to be as precise as possible to be able to reproduce this image in digital form and integrate it to a royal space, this it is the importance of the spatial visualization.

The reasons by which the Sketchup is chosen is because it is possible to acquire easily across the Google, another advantage is that between the same students they help themselves and the tera turns pleasant and entertaining. The SketchUp besides operating across geometric measurable projections, relies on some plugins that they serve him to create the Augmented Reality they are like the AR Average, buildAR and Aumentaty Author.

Once installed any of these plugins, the student will manage visualizes any model who does actually Increased and to experiment with new forms of interaction between his digital image on a royal space.

To develop this spatial vision is important to have three-dimensional models who help to stimulate the imagination for the projection of his models, on having included Increased Reality in the geometric representation interesting solutions can propose and simultaneously enteretaining, that is for what the today student looks.

5. **How to teach Descriptive Geometry with augmented reality tool through SketchUp program**

As the virtual reality, the Descriptive Geometry is a science very appealed in the areas of design, architecture, engineering and the arts. First it develops an abstract and critical thought on having integrated the rational perception with the space. Now with the integration of the SketchUp in the Descriptive Geometry the process of modeling speeds up in digital form. And on the other hand the models that realizen with this software, they can be raised to the network by means of the same program and to be stored directly in the database.

Another advantage that the SketchUp has is his feasibility to work with representations in 3D even with the new version VRay achieves more royal settings.

6. **Working drawing and Axonometries**

6.1. **Working drawings**

If we want that from a beginning the student understands wherefrom it departs or as the projection of an object, first it is necessary to define his dimensions in each one of his conference later spend this information to the spatial representation.

The method of the working drawings is a determinant form to locate any point in the space. It is in use so much in the traditional system with instruments as in the digital system on having begun the coordinates X, And, Z (length, width and height) like can see in the figure 2.
In this figure we can observe an object of the left side showing the royal dimensions of each one of his conference and of another side his spatial representation, which comes being the magnitude that it involves in a visual space. This way, to the moment to project it is suggested to the pupils of whom they should initiate for the plant and of there they generate the heights of every point up to giving him form, this process helps in the traditional method to locate the points for his representation and in the foxglove to establish the coordinates of every point for the same thing.

6.2. Axonometries

This term is common in all kinds of parallel projection. This system consists of representing any object in position inclined with regard to the projection plane, is not a projected image, with exception of the orthogonal projection of multiple conference, all the rest systems of projection use the foreshortening to illustrate the three-dimensional nature of the object. The axonometries qualify in two classes: parallel Projection and projection oblique. In the first one they are the isometry, dimetry or trimetry, and in the oblique projection they are the caballera and military.

For the axonometry it is a requirement that all the measures that are projected should go in the same direction without any change. The dimensions are easy to represent because everything is measurable and the only thing that has to be done to be to establish the points that every figure shapes to be able to develop it.

This class of representation consists of projecting any object to announce his volumetry, since it manages to estimate in the figure 3.
As we can observe in the figure 3, first the representation is realized in 2D to define the technical information of each one of the sights of the object. After having the object already definite with the traditional system, it is possible to do the volumetric representation with the same information to the program of the Sketchup like estimates in the figure 4.

![Isometry Military Caballera](image)

**Fig. 4: Figures represented through SketchUp**

Reference: Image by author

The end of doing the representation with these two methods serves in order that the student could combine what he understands across the digital systems and what it must understand across the traditional projection since to see in the figure 3. Having presented these two styles of representation it is necessary that the teacher provides a feedback to the pupils on the successes and the mistakes in order that they can understand better the behavior of the images when they are projected based on a method.

After having approved the image of SketchUp's presentation it passes to Increased Reality to exhibit the figure in three-dimensional form, since it is possible to estimate in the figure 5.

![Maqueta virtual en realidad aumentada](image)

**Fig. 5: Figure represented with augmented reality**


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7. Conclusions

The Increased Reality has arisen as a new trend of digital expression, but still there has not been visualized the power that has to demonstrate all kinds of information in 3D. In the latter years offers have been done by this tool for the education in different specialities, and in this case like it I have exhibited focus on the Descriptive Geometry. Therefore, I can conclude:

- One proposes the SketchUp for his facility to obtain it across the Google.
- The SketchUp takes several plugins as the AR Happens, buildAR and Aumentaty Author that they take charge projecting actually increased.
- The geometric projection must handle precise information.
- To have the aims of the course defined well from a beginning not to have any problem.
- It is a requirement that the students learn to project across constructive methods.
- To join the Descriptive Geometry with SketchUp and Increased Reality turns into a new form to present three-dimensional models.
- The Increased Reality has to happen first for vectorial softwares.
- Though the Increased Reality could be related to the Virtual Reality, both work with digital models in 2D and 3D, only that the first one can create a mixed real time reality.
- The traditional projection and the digital projection have jointly the use of a system of coordinates, scale and units to transport images of the vectorial softwares to the Increased Reality.
- Nowadays the technologies offer new alternatives of solution as for the spatial representation, but even like that it is not necessary to to depend completely on her, is because of it that is insisted on being able to project.
- It is needed to learn processes as projection and proportion to use with efficiency the softwares in the models of Increased Reality.
- It is necessary be aware on how the teachers should communicate with the new generations of students in order that the courses should be more effective.

Finally I have to add that the new generations present a direction towards not such a personal system of life, and the virtual relations have taken charge of it. Consequently, it is necessary be aware on the new social behaviors. With the new generations of pupils we must be prepared by a good educational program of agreement to the interests and needs of this 21st century.

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References