

A simplified procedure for anamorphic sculpture

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Abstract:

The research review and analysis the art of anamorphic sculpture as a new kind of the common themes of contemporary art in the world by Review its elements shroud and the pioneers of the this new kind of sculpture Then the conclusions and results . These artworks shows 3 dimensional forms that so heavily distorted that they cannot be perceived without special mirror .

A chain of software and programming languages are used in order to build the sculpture, using a 3D printer. This work, through the genesis of the idea, the elaboration of software tools and solutions, and the interaction between the two partners involved, illustrates how fruitful a collaboration between artists and scientists can be. The novelty of this work is represented in the creation of anamorphic 3D digital models, resulting in a tool for artists and sculptor.

Keywords:

- *Anamorphic*
- *anamorphoscope*
- *oblique*
- *catoptric*
- *digital models*
- *3D printers*

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Introduction

The word anamorphic is from the Greek "ana" (again) and "morphe" (form). It refers to sculptures that are so heavily distorted that they are hard to recognize without the use of a mirror, sometimes referred to as an anamorphoscope. When viewed in the anamorphoscope (which is a cylindrical mirror for correcting the distorted sculpture created by anamorphism⁽¹⁾) or viewed from a certain point, the sculpture is "formed again", so that it becomes recognizable.

Anamorphic art as known from middle ages in painting. European painters of the early Renaissance were fascinated by linear anamorphic images, in which stretched pictures are formed again when viewed on a slant. A famous example is Hans Holbein's "The Ambassadors" (1533), which contains a stretched-out skull.

Types of anamorphosis

There are two main types of anamorphosis:

1. In one common form of anamorphosis--- usually termed "oblique"--- the unconventionality arises from the fact that the sculpture must be viewed from a position that is very far from the usual in-front and straight-ahead position from which we normally expect sculpture to be looked at. Figure (2)
2. In another common form---sometimes termed "catoptric"---the sculpture must be seen reflected in a distorting mirror (typical shapes

being cylindrical, conical and pyramidal).(2) Anamorphic sculptures here are distorted forms that (sometime) doesn't make any sense .. but, as you put a reflective device i.e. cylindrical mirror at the middle of the deformed sculpture .. the reflection showed the form as intended.(3) Figure (2)

Looking at anamorphic sculpture

Since each anamorphic sculpture is special for you the viewer, each type has its own way to be looked at. The fun of anamorphic art is to look rather than expect.

The Catoptric Anamorphosis Principle

Figure (4) illustrates the principle behind our method. The designer of the anamorphosis installation wants the observer, placed at position V, to see a correct image into a mirror M. This image is obtained by reflection of a distorted image laying on a surface P. The image can be thought of as laying on a virtual screen E. Let S1 be a pixel from the image on E: when the observer looks at S1, ray R1 passes through V and S1, hits the mirror M at point T1. This ray is reflected and hits the plane at point W1. Reversing the direction of R1, we can say that W1 is seen by the observer, who looks in the direction of the mirror, in the exact direction of S1.

hit the mirror never reach the plane P : this will result in blank regions in the mirror. One can control which part of the original image will be represented on P by moving the screen E nearer

or farther, or by modifying the position of V; Figure 3 for instance, illustrates one viable alignment.



Figure (1) The Ambassadors- 1533- oil on oak- Length: 209.5 cm (82.5 in). Height: 207 cm (81.5 in)



Figure (2) 2010 | Resin, powder, steel and perspex | 150 x 63 x 35 cm



Figure (3) Kiss of Chytrid- 2009-2010 | Resin, Powder and Steel

This reasoning is true for each pixel. The distorted image is the union of all W_i , each associated with a pixel S_i from the original image. We remove Screen E, which was used for explanatory purposes. The position of pixel S_2 shows how much an image can be distorted: two

neighbouring pixels in the original image can result in very distant points on the surface of distortion.

Of course, some rays passing through V and Si never hit the mirror, and some other rays that We see how similar this principle is to Diderot's idea: V plays the role of the candle, pixels S_i are the holes drilled in the design, and each W_i corresponds to a spot of light generated by the candle through a hole.

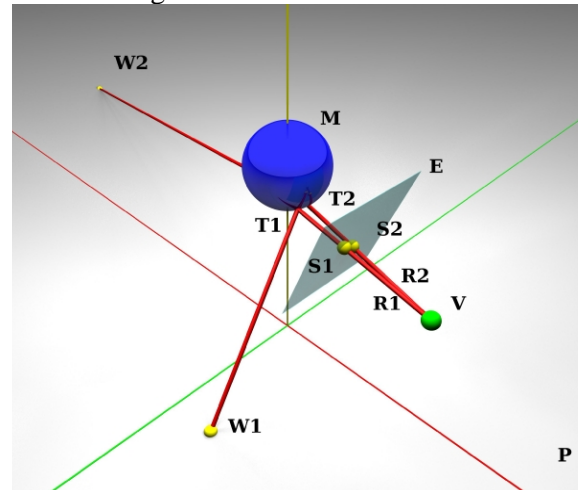


Figure (4) : The Catoptric Anamorphosis Principle

This general principle naturally calls to mind a method to produce the distorted image: map an image onto the virtual screen E. For each pixel S_i of this image: compute and output the coordinates of the corresponding pixel W_i , together with the color of S_i . Finally, use the collected data to produce the distorted image.

However, another classic method for constructing anamorphoses might save us from mapping every pixel through the mirror. This method is to place a grid of control points on the original design, and compute the corresponding distorted grid to use as a guide to produce the distorted image. Combining control points with Diderot's idea, we drill regularly spaced holes in the design, and join adjacent spots of light with straight lines. Ideally, this gives a network of quadrilaterals. Drawing the distorted image entails mapping pixels from each elementary square of the original design to its image in the corresponding quadrilateral(4)

To make an anamorphic sculpture look intelligible when reflected off a curved mirror, the only physics you need is the law of reflection. The law of reflection notes that if a ray of light hits a mirror at an angle measured off a line perpendicular to the mirror, then the reflected ray of light will come off the mirror at that same angle.

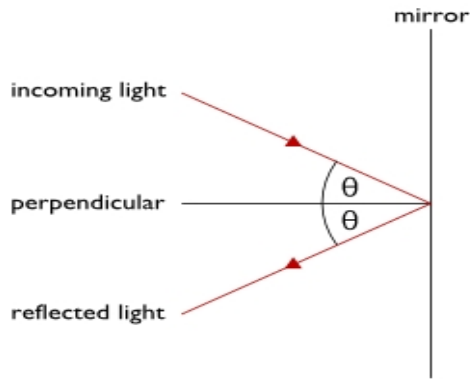


Figure (5) Simple case of the law of reflection where the mirror is flat.

Reflections off flat mirrors create every-day optical illusions. The mirror appears to be a window to an ethereal world on its other side. However, every ray of light that appears to be coming from the other side of the mirror is in fact coming from the same side we are standing on, only bent at angles that we can calculate using the law of reflection.

To make our anamorphic sculpture work with a cylindrical mirror, we have to imagine that the L-shaped membrane is sitting on the other side of the window the mirror appears to make. This is the same as imagining that the sculpture is sitting in the center of the cylinder. Let me explain further by referencing the drawing below. For every point P on this apparent sculpture inside the cylinder, we'll draw a straight line to the eye of the viewer at a point V . This line from P to V is the path that our eyes think a ray of light took. However, the light actually came from some point P' on our side of the mirror, hit the mirror at some angle, reflected off the mirror at that same angle, and then hit our eyes.

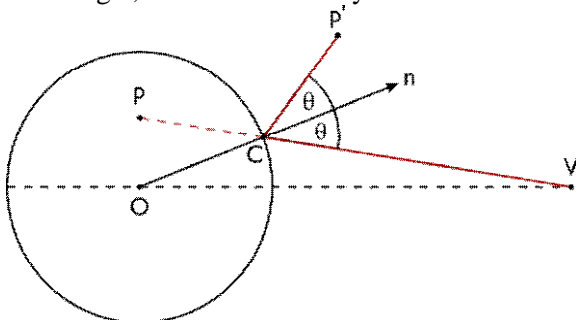


Figure (6) showing how light reflects off a cylinder from P' to the viewer's eye at V , creating the apparent image at P . The cylinder is shown from above.

Our task is to figure out where P' is located given the location of P , V , and the radius of the cylinder. Since our sculpture of the L-shaped membrane is made up of triangular faces, we

need to solve this problem for every triangle vertex.

Once the intersection points are found, the problem is essentially two dimensional. Each reflected pair of points P and P' will have the same altitude. The rest of the problem focuses on lines and points that are projected onto a plane to create drawings like the one shown above.

The inverse reflection problem

This problem can be solved in just a few steps.

1. First, we'll find the point of intersection C between the line PV and the cylinder.
2. Then we'll find the angle between the line perpendicular to the cylinder and the line PV . This is the angle of the reflected ray of light shown in the drawing above.
3. Finally, we know that the light ray CP should have the same length as CP' , so we can find P' by rotating the point P about C by an angle that satisfies the law of reflection.

The intersection points

Imagine a photon traveling along the line PV from P to V . This photon's journey can be tracked by a vector J defined by position vectors P and V , and a factor t :

$$J = P + t(V - P) \text{ where } t \text{ is in the range } [0, 1],$$

so as t increases from 0 to 1, the photon moves from P to V .

The photon will hit the cylinder's surface at some particular t . At this point, the position vector of the photon measured from the cylinder's center will have the same length as the radius of the cylinder, or $|J|^2 = R^2$

This equality sets up a quadratic equation for the value of t at which J intersects the cylinder. This equation can be solved for t using the quadratic formula (5)

The technique of anamorphic sculpture:

For the anamorphic pieces it's an algorithmic thing, distorting the original sculptures in 3D space using $2\pi r$ or πr^3 (cubed)(6). We all know about this irrational number but the anamorphic pieces really are a distortion of a "normal" sculpture onto an imaginary sphere with its centre at the heart of the cylinder.(7) Much of it is mathematical, relying on processing power. There is also a lot of hand manipulation to make it all work properly too as special transformation have a subtle sweet spot which can only be found by eye.

the famous anamorphic sculpture :

There are not many sculptors who have used this anamorphic sculpture technique, the most

famous and important is the sculptor Jonty Hurwitz and sculptor Marco Cianfanelli

Jonty Hurwitz

His artworks have algorithms as their essence, and are the result of a mass of technology and human ingenuity. Hurwitz took an engineering degree in Johannesburg where he discovered the fine line between art and science. Hurwitz discovered that he could use science as an artistic paintbrush. Each of his sculptures is a study on the physics of how we perceive space and is the stroke of over 1 billion calculations and algorithms.(10)

These sculptures by Jonty Hurwitz do just that! As much mathematics as it is art, Hurwitz spends months planning and calculating before he materializes his ideas. For his cylindrical mirror paired sculptures, he begins by scanning each object (shown here are hands and a frog), then distorted digitally by using Mathematics or a range of 3D software

tools and fabricated the model, but when placed in front of a cylindrical mirror the projected reflection reveals the original object. Still, Figure (7,8)

.in shape(8) we can see his creations feature an abstract figure circling a metallic cylinder whose purpose is simply to reveal a recognizable figure within its reflection. In the piece titled Rejuvenation, the chrome cylinder in the center visually transforms what appears to be a misshapen mold of copper is into a grasping human hand.

other works deal with pixilated or sliced human forms that are only viewable from a single perspective. as we can see in Figure (9,10). A scientist at heart, Hurwitz explained that his artwork is his way of “expressing calculations

visually,” and also allows him to experiment with cutting-edge manufacturing and fabrication technologies..



Figure (7) Rejuvenation- this abstract sculpture blends artwork and algorithms to reveal the gripping figure reflected upon the cylinder surface



Figure (8) ‘yogi banker’ by jonty hurwitz - copper and chrome / 75 x 52 x 36 cm -at the centre of the pillar is a ‘sweet spot’ that needs to be achieved through careful positioning to eventually realize the complete, recognizable object (9)



Figure (9) sliced human forms that are only viewable from a single perspective

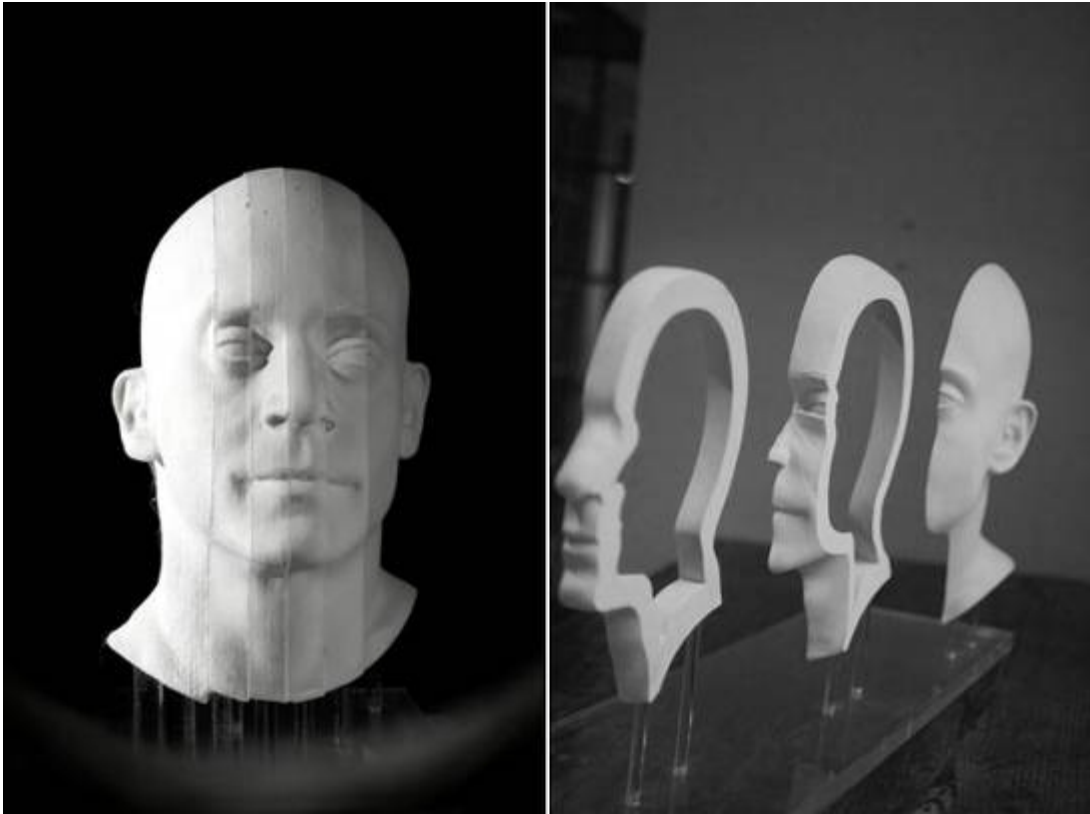


Figure (10) The Hurwitz Singularity-

sculptor Marco Cianfanelli:

Marco Cianfanelli was born in Johannesburg in 1970 and graduated, with a distinction in Fine Art, from the University of the Witwatersrand in 1992. He has had seven solo exhibitions. He is a member the design team for The Freedom Park, South Africa's national monument to freedom, situated in Pretoria. And his monumental fragmented portrait sculpture, Capture, has recently been inaugurated to symbolically mark the 50th anniversary of Nelson Mandela's capture at the site in the KwaZulu Natal Midlands

Cianfanelli's work embodies a vast variety of media and materials, from laser cut materials, masked glass and digital imaging. Although he uses computer-aided design and technology in the production of his work, he often engages with the more visceral organic aspects of the material he works with. Marrying the application of data to more expressive gestural acts, he aims to set up a tension or dialogue between the controlled accuracies of the digital realm and the uncontrollable realities of being human.(11)

the famous sculpture of the Artist Marco Cianfanelli shows us that 50 steel columns can become so much more than mere metal, if they are viewed from the right perspective. The sculpture was created to commemorate the 50th anniversary of Nelson Mandela's arrest by the

apartheid police.

The sculpture, by artist Marco Cianfanelli, significantly comprises 50 steel column constructions – each between 6.5 and 9.5 metres tall – set into the Midlands landscape. The approach to the site, which has been designed by Jeremy Rose of Mashabane Rose Architects, leads one down a path towards the sculpture where, at a distance of 35 meters, a portrait of Nelson Mandela, looking west, comes into focus, the 50 linear vertical units lining up to create the illusion of a flat image.

Cianfanelli's perceptive rendering of this meditative image of the international icon – a portrait achieved from interpreting composites of several portraits of Mandela sourced off the Internet, and a film grab – is appropriately monumental, yet fittingly transient and delicate. From its main focal point, the sculpture reads as a familiar photographic image, structurally suggestive of his incarceration, while from a side view, the design and arrangement of the columns create a sense or moment of fracture and release.(12)

The sculpture, which eloquently both impacts and becomes part of the surrounding landscape, visually shifts throughout the day, with the sculpture itself being affected by the changing light and atmosphere behind and around it.



Figure (11) Marco Cianfanelli-Release-2012 -Painted laser-cut mild steel & steel tube construction/ to be rusted-Width: 5.19 meters-Height: 9.48 meters-Length: 20.8 meters

How do the sculptors make their own anamorphic sculpture:

Scanning objects :

The sculptors do their anamorphic sculpture by scanning objects, using The 3D Scanners, it work just like a regular video camera, but instead of a two-dimensional image, the result is a three-dimensional image captured at speeds of up to 15 surfaces per second. The scanning process is extremely straightforward: simply walk around the object and scan it from various angles, while the accompanying software combines all the scanned images into one. The scanners are equipped with wide-field-of-view 3D and mega-pixel 2D sensors, and the technology allows capturing both Figure and surface texture of objects in a snap-shot or video mode.(8)

Creating an anamorphic catoptric sculpture by using 3D max:

The study took a considerable time searching for how to make anamorphic sculpture ,which programs the sculptors use in making their sculpture, but did not find any reference to mention it, but she finally reached for her work on the program 3d max and this is the steps which she follow:

1. Create a cylinder with the parameters shown in figure 14
2. Create a circle with the following

parameters shown in figure 15

3. Also it should be made sure that it is centered with the cylinder , figure 15
4. Select your object ..then form the modifier list and select path deform , figure 16
5. click on (pick path) then select the circle , figure 18.
6. The object may need to be rotated 90° in the negative value, figure 19 , making sure that the right axis is selected, in the viewed case it is the (Y) Axis
7. increase the stretch value to 7 ., figure 20
8. Merge the object you want(import- merge)
9. Put the material of mirror on the cylinder and render the object , figure 21



(12) scanning head

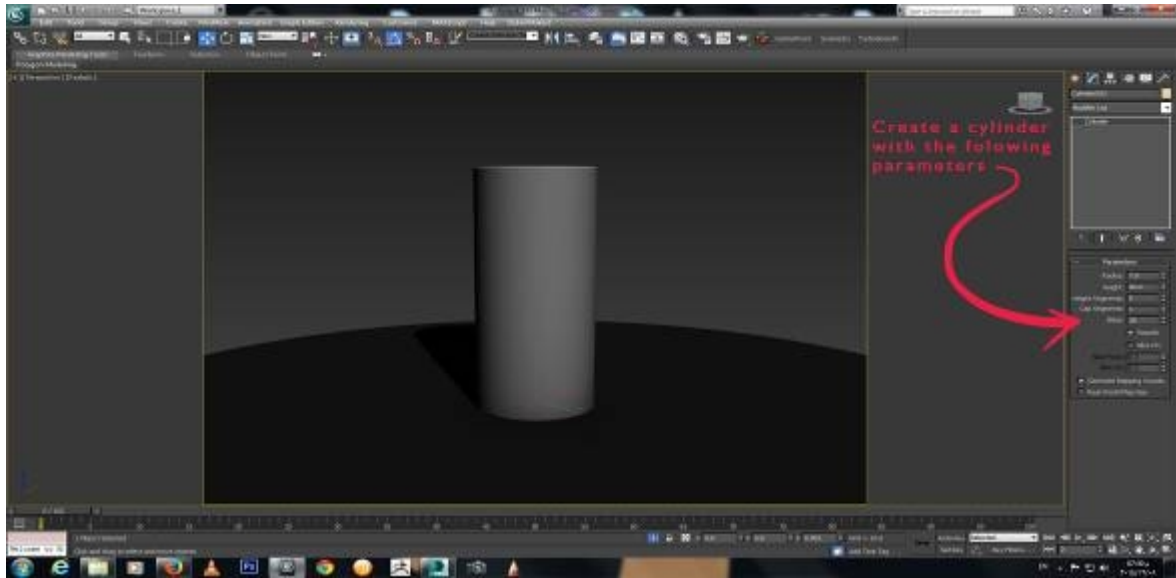


Figure (13)

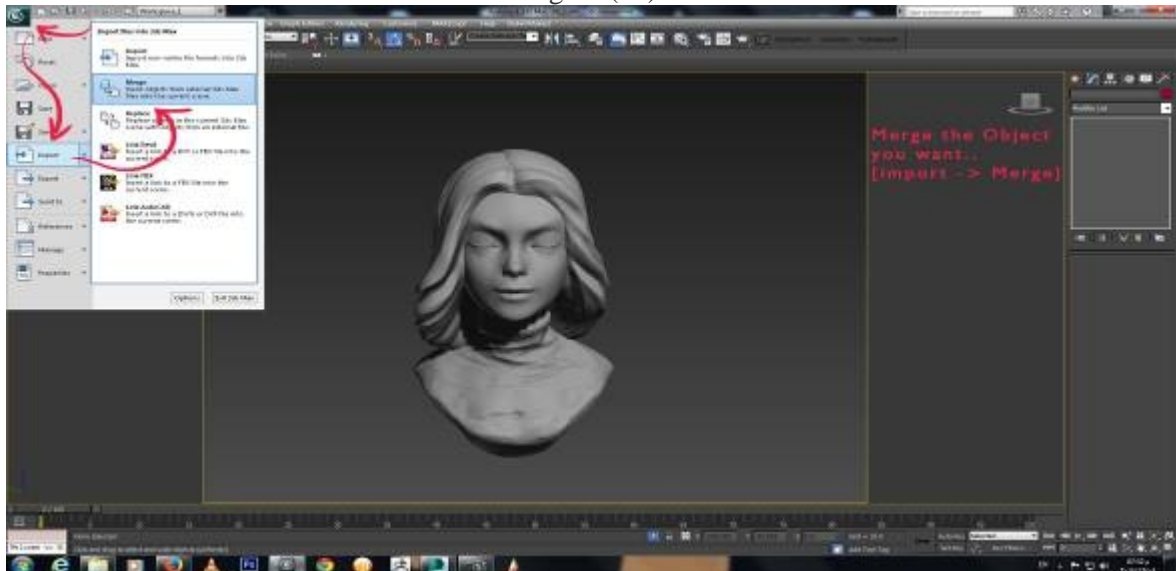


Figure (14)

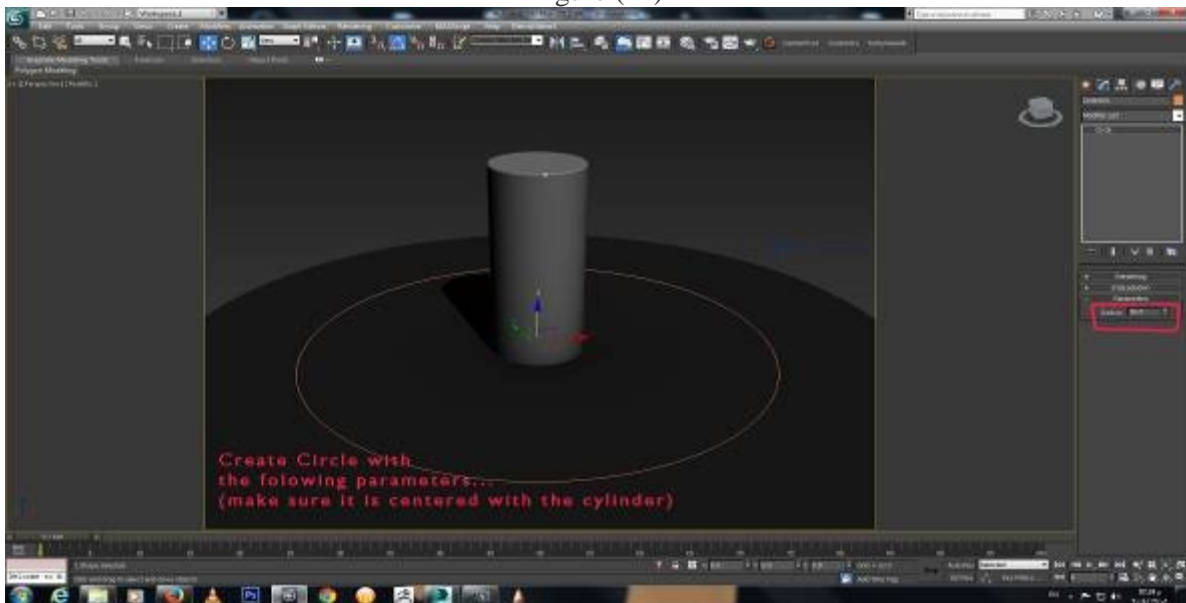


Figure (15)



Figure (16)



Figure (17)

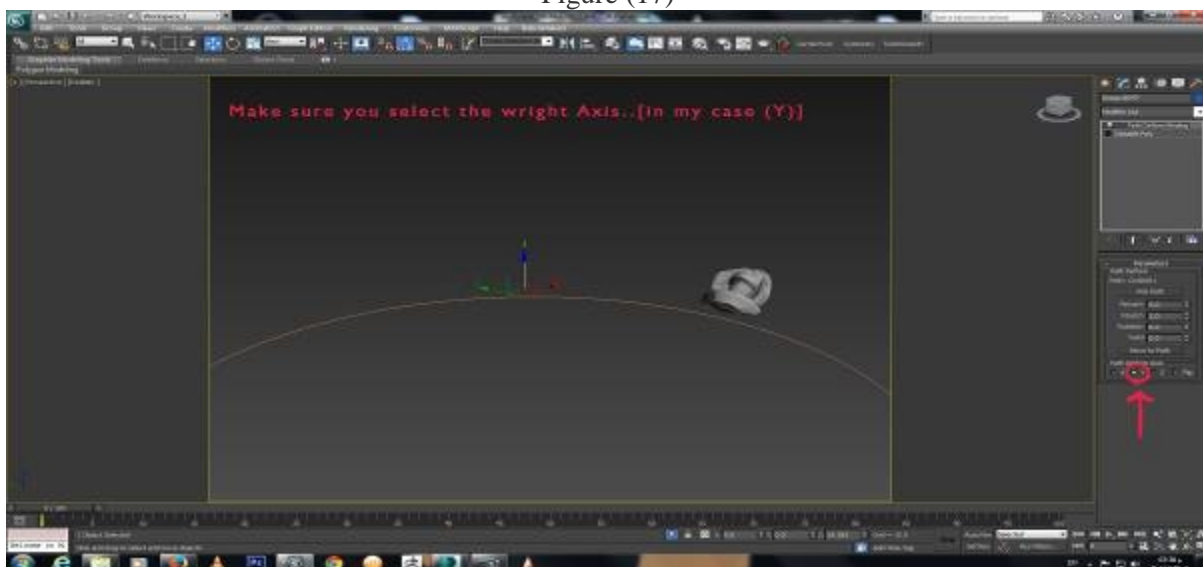


Figure (18)

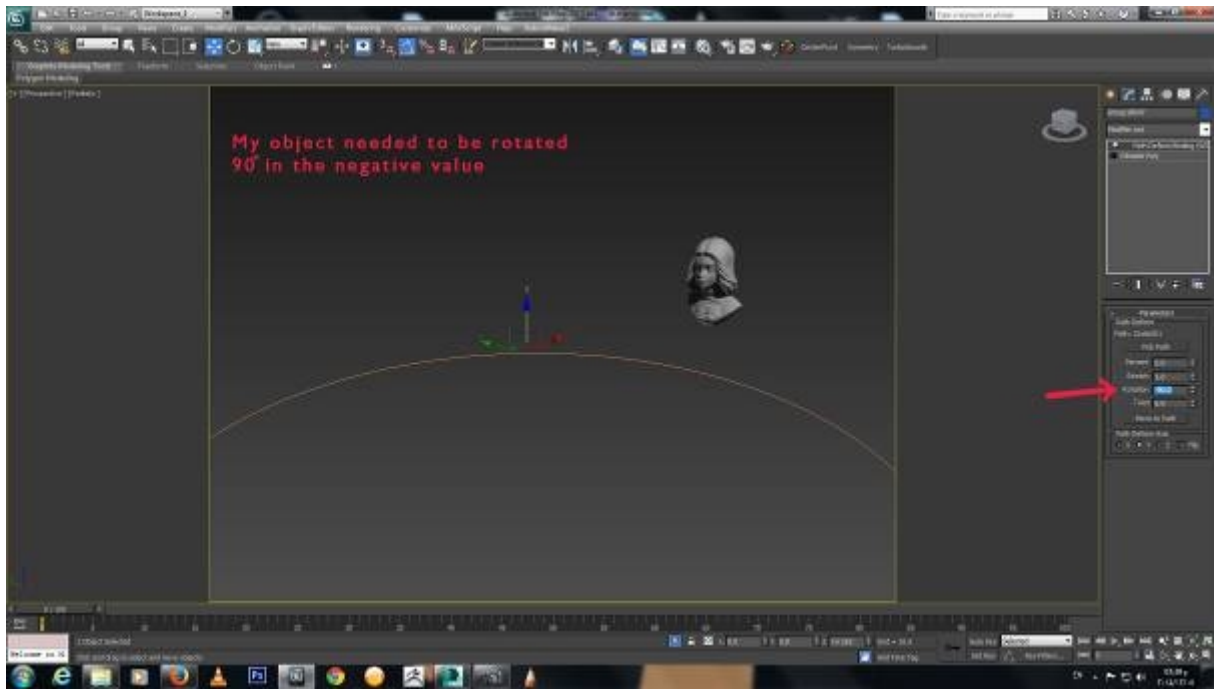


Figure (19)

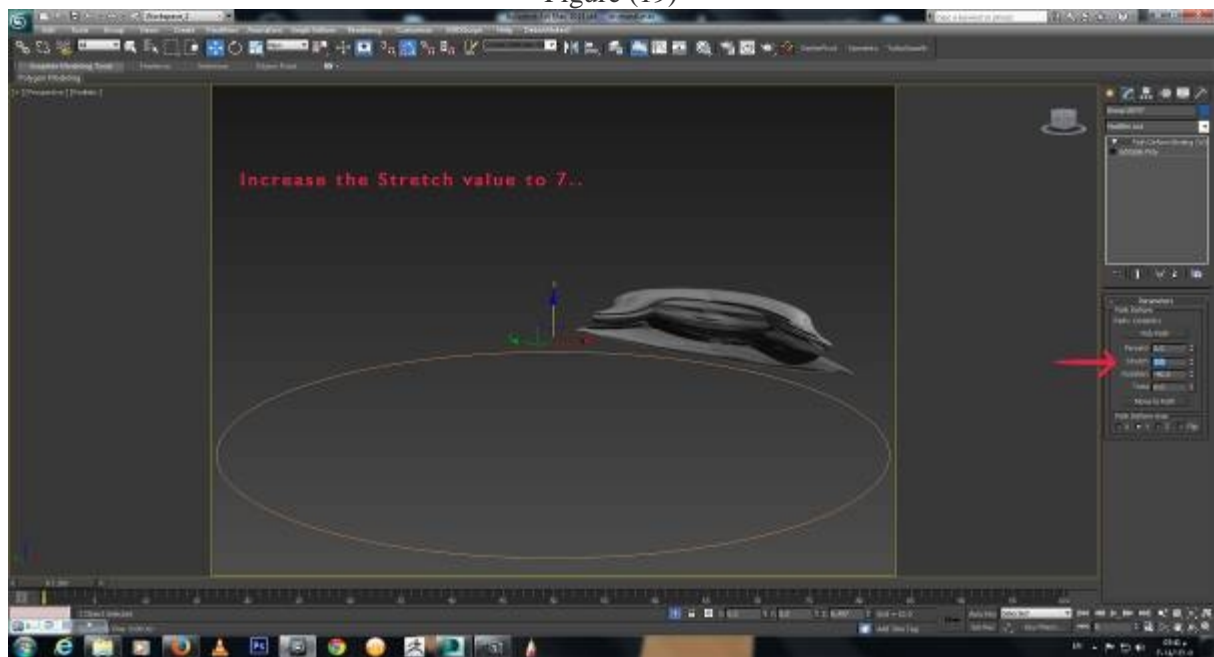


Figure (20)

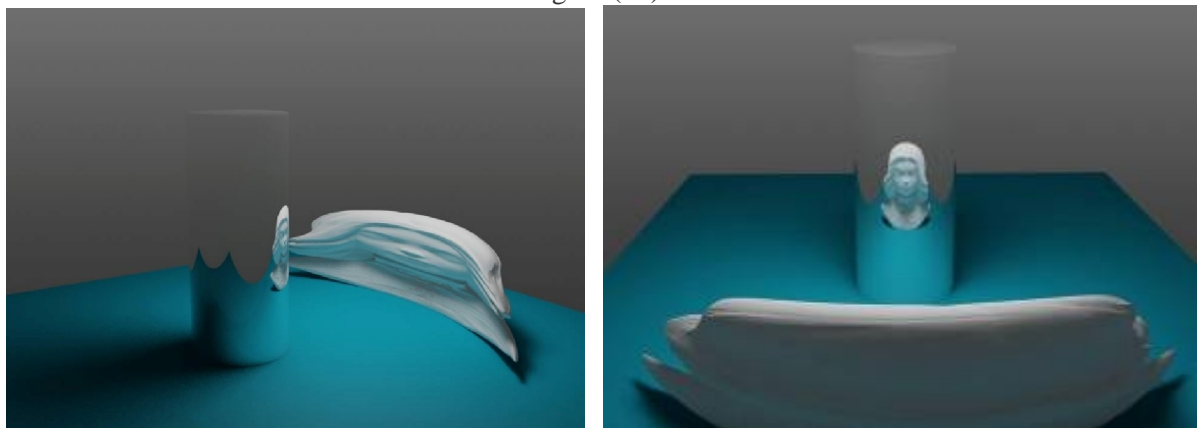


Figure (21)

Fabricating the digital models.

Upon finishing the digital model the sculptors fabricate it in any material required by 3D printing machines .

Conclusion:

Computer programs and new technology open the door to anamorphic sculpture as a new kind of contemporary art, The novelty of this work is the creation of anamorphic 3D digital models, resulting in a tool for sculptors and artists.

The number of sculptors who have used this anamorphic sculpture technique are really few, the most famous and important is the sculptor Jonty Hurwitz and sculptor Marco Cianfanelli the researcher has identified the steps required to create an anamorphic catoptric sculpture by using an extremely simplified procedure that employs Autodesk 3D max

Anamorphic art as known from middle ages in painting, but in sculpture appeared recently as a result of fruitful cooperation between science and art, as that we live in an age where computational power has overtaken the capability of the human brain. Each of them can be defined and tested at no cost in less than an hour. It takes no more time to translate the virtual design into a suitable file, and then send it to a 3D printer. Using online 3D printing websites, one then has to wait one week to see the real-world result, with no surprise: everything is like in the virtual version. the anamorphic sculpture is the recent trend in addition to the history of contemporary sculpture

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