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Immersive Cinema production: Characteristics, General standards & Patterns

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***Abstract*: Immersive cinema represents a new set of technological and aesthetic standards of paramount importance that support the sensual experience and actual immersion of the spectator in its surroundings. These standards are at the heart of the new designs of theater, film production and projection techniques, and new films that are produced and displayed. This kind of emerging cinema still raises questions about whether the frameworks of understanding of the old forms of cinema, and even understanding our relationship with ourselves in cinema, is out of date?**

The research identifies types of Immersive environments, the planetarium (the subject of research), simulators, the cave and Head mounted display. It also addresses, dome types and classify it into two categories: fixed and portable.

In addition, the study deals with the restrictions and limitations of projecting Immersive films such as rapid visual changes occurring in the 360 ° environment, which tend to use long scenes, with the gradual transfer between shots at cuts, specially cares about both the location of objects in space and the speed of movement.

It is clear from the research that there are considerations that must be taken into account by the designers and the animators in the production of the Immersive films due to the difference in the nature of the medium in addition to some general criteria which are related to the frame rate, resolution and frame structure.

The research addresses the challenges faces filmmakers, which are directly related to the huge size of the image. Designers must model more objects in a single scene with more details than what is needed in a traditional cinematic scene due to its wide field of view, add to that challenges related to production tools and projection, as projection facilities, image resolution and dome size vary from dome to another.

***Keywords:* Planetarium, Immersive cinema, Immersive environments, Fulldome, VR.**

1. INTRODUCTION

A planetarium is a theatre primarily built for presenting educational and entertaining shows about astronomy and the night sky. A dominant feature of most planetariums is the large dome-shaped projection screen onto which scenes of stars, planets and other celestial objects can be made to appear and move realistically to simulate the complex 'motions of the heavens'. The celestial Planetariums range in size from the Hayden Planetarium's 20-meter dome seating 430 people, to three-meter inflatable portable domes where children sit on the floor. Such portable planetariums serve education programs outside of the permanent installations of museums and science centres.

Implementing digital projectors in the Planetarium moved it from just a place to simulate the night sky, with its stars and planets, to an immersive environment [1], through its 360 Degrees screen that surrounds the viewers. So, the content of the projected shows have changed, in addition to the celestial projections, the major scientific documentary production companies have begun to compete to produce films for the Planetarium. Projection techniques also varied from the use of digital projectors, lasers and stereoscopic displays.

Some of the large domes began to mix motion picture shows with live performances of music and acting. New types of portable planetarium domes also appeared, that can be moved from one place to another with a diameter of about three meters, which can be used in education, training and art exhibitions outside museums and scientific centers.

Recently, designers and artists have begun trying to add interactivity to the Planetarium shows, whether the show controller or the audience participating in the show interact with tools attached to each chair. Some experimental artistic shows have also been linked to the fast information network, so the maps and images displayed are renewed from one show to another, as they change on the information network.

Freeing the image from the frame raises many interesting questions: Is any of the common cinematic rules applicable to producing an immersive artwork? What is an approximate Close up shot in the immersive cinema? What is a wide shot? Is there a reverse angle for the image that we see? That is often in television and feature films. How do we match sound and place? That is, how do we have a sense of place when designing the sound system? What is succession and sequence on the giant movie screen? What happens when moving from wide shots to close-up shots when there is no frame? Where can actors and things get in and out of the screen? There is no safety net for the field of view on frameless immersive screens.

There is a list of questions about this immersive cinema that has not been answered, and it is very logical to ask these questions now. If we look at the first twenty years of the film industry, there was no formal or even informal language for the screen. With the new trend of movies and cinema, the need for cinema language arose and emerged from the work. The giant screen is just over twenty years old, and I think that the frameless giant screen in the same place historically, as it is still looking for its own language.

From what is mentioned above, the researcher found that the matter requires identifying the most important features of Immersive Technology and its contributions and uses in the field of scenic design, since this technology is one of the contemporary computer applications that require identification of the possibility of its use in our Educational institutions in order to achieve the trends related to preparing Fine arts students and artists who are able to deal and adapt to the changes of this age, by identifying the general characteristics, standards and patterns of immersive cinema to achieve better understanding for this medium.

2. RESEARCH TERMS

a) What is an immersive environment?

Immersion is the state of consciousness where an immersion's awareness of physical self is diminished or lost by being surrounded in an engrossing total environment; often artificial. This mental state is frequently accompanied with spatial excess, intense focus, a distorted sense of time, and effortless action. The term is widely used for describing immersive virtual reality, art installation and video games.

b) Immersive cinema:

This type of cinema is based on giving the viewer a feeling of immersing in the centre of the artwork's events by being inside a picture that surrounds him from all sides [2]. Currently it's projected in different theatres, the most important one is the Planetarium. Like cinema, the projected shows vary in artistic and technical content.

At the artistic level, the shows varied from documentary, experimental and musical, and there are some experiments with dramatic performance. For the technical level, the presentation techniques varied according to the type and number of projectors used in addition to the technology of stereoscopic displays which excels in immersive film as it is compared to traditional films due to the lack of a frame for the image that surrounds the film, which gives the viewer the sense of image depth and illusion of dimensions.

c) Fulldome:

Fulldome refers to immersive dome-based video projection environments. The dome, horizontal or tilted, is filled with real-time (interactive) or pre-rendered (linear) computer animations, live capture images, or composited environments [3].

d) Dome master:

This term is called to the original image displayed on the dome through the projector. It is equivalent to the projected film in cinema .Technically, it is a circular image inside a square frame. The outer circumference of the image is the dome edge (Fig 1). The lower part represents the image facing the viewer, and the right represents the right of the viewer, the left is the left of the viewer, and the top behind the viewer is the least used and seen by the viewer.

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To project an immersive film we need thirty dome master for every second or its multiples which is corresponds to thirty frames per second in conventional films.

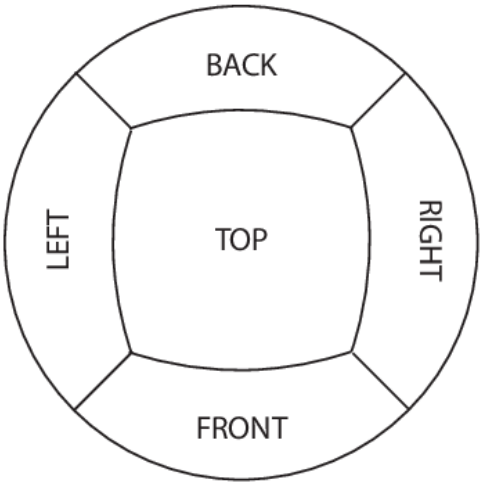

Figure (1) the main parts of the dome.

3. TYPES OF IMMERSIVE ENVIRONMENTS

There is a diverse of immersive environments, differs in the purpose of its establishment and the type its users. Some are intended for training, such as simulations that simulate flying, driving, maritime navigation and other applications. There are immersive environments dedicated to education such as planetariums, which is the focus of this research, and finally immersive environments that an individual can obtain and use at home, such as virtual reality glasses [4].

a) Simulators

They are artificial environments that depend on both software and Hardware to create an artificial world similar to reality through which the user can interact with virtual objects as if to interact with real objects. There are three conditions for achieving realism in simulations: first, the accuracy of images and objects proximity to realism, and secondly, how closely the design of interaction with reality, which is similar to popular video games, and thirdly, the physical tools and equipment that the user or participant uses to interact with the simulation [5].

b) The cave "Cave Automatic Virtual Environment"

'Cave' is an acronym for the first letters of: 'Cave Automatic Virtual Environment'. The 'Cave' measurements are 10 feet by 10 feet by 9 feet in the form of a cubic theatre. Cube faces are rear projection screens. As for the floor, it performs lower projection screens. And the participant inside the projection cube is surrounded by an image designed by 3D software, rendered in real time by computers. The movement of the participants provides interaction with the virtual world, where it is tracked by sensors .This environment differs from others in that it allows more than one participant to be in interaction inside it at the same time [6].

c) Head mounted displays

The primary function of the head mounted display "HMD" is to provide an image to the eye. The secondary function of the display helmet is to provide and transfer head and eye tracking information to the computer. Head tracking, tracks the rotation and orientation of the user's head, and the system reads this information and changes the view displayed in the HMD to match the current user's head position. Tracking systems can physically connect to a virtual reality system through wires, cables, optical fibres, radio waves, or magnetic detection.

Now there is an opportunity for anyone to have an exciting immersive experience at home [7]. Head mounted displays will offer the fulldome designers and producers the ability to see early exploration of the content in their workplaces [8].

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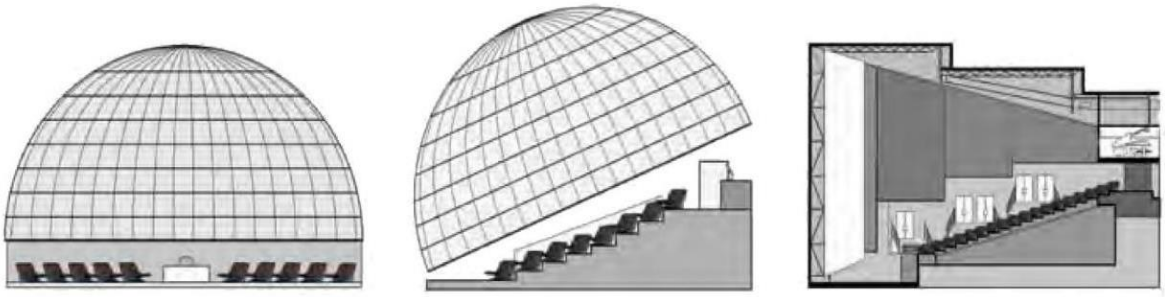
d) Planetariums

It is the beginning of a new era for cinematic shows. It is the product of a fusion between the star halls and the digital display technology that enabled the presentation of moving shows and films inside the dome (Figure 2).

In 1926 the first planetarium was opened to the public in Munich, Germany .As a result of brainstorming the engineering team of Carl Zeiss, And these dome theatres are designed with one purpose in mind - simulating the night sky. Domes were costly landmarks built to honour the wealthy .After the space race began in the late 1950's, more affordable domes were built throughout the United States as educational classes for astronomy and space science [9].

These modern planetarium theatres represent the most sophisticated and accurate systems, and are a general gateway to today's graphic display systems [10]. Advanced domes are those hemispheric theatres that use many projection (display) devices, including video systems, laser graphics, and optical projectors. When applied skilfully, the strengths of each presentation system are utilized to create the illusion of attendance.

Graphics production for hemispherical theatres is more urgent than film or video production alone. Factors such as geometric distortion, reflected scattered light, multiple projectors and graphics must represent many technical challenges in real- time synchronization, Control, and image recording.



A **B** **C**

(Figure 2) side view of a) a flat planetarium, b) a tilted planetarium, c) A theater with a large display [15].

4. DOME TYPES

Planetariums are classified according to their size, into three categories, small, medium and large. There are also many technologies, including portable, inflatable domes, hard shell domes, fixed domes, and amateur domes. Each type of these domes has uses, strengths and weaknesses. These domes can be divided into two main categories:

a) First category: Portable planetariums:

The advantage of portable planetariums is being Lightweight and easy to transport, that a person can carry in a bag .These domes are used in many fields, including education, art, and simulation. And it has a great advantage for designers of immersive films, because of their light weight, they can be installed or dismantled in a small room, through which the designer can test his artwork without the need to go to a large dome, which saves time and effort. This solution does not completely replace the testing of the artwork in a large dome before it is projected to the public, but it is an aid and facilitator for the production process [11]. Currently there is a diversity in the technology of these domes, some of which are inflatable domes, Most of it made from a special fabric, and the disadvantage of those domes is that it is difficult to obtain a smooth inner surface, where the confluence of the constituent segments of the inner surface are usually invisible to the eye, thereby reducing the feeling of immersion. Another type is called negative pressure domes depends on the geodetic structure it is built using some bars that interfere with the interconnecting discs. It is a structure that has near-perfect spherical results. Then an outer layer of one of the materials is tightened onto this structure, and an internal projection screen is built inside the structure, then attached to the outer surface. The air in the area is sucked by a suction device, and cause the result of diminishing the pressure that the internal projection screen pulls towards the structure. And be the final shape of the screen projection looks like half of a ball. Which is similar to the form of the dome, where images are projected [12].

b) The second category: fixed domes.

Hard shell domes are more widely used in trade fairs and content viewing environments. Often these do not exceed the domes diameter of six meters, and can in many cases dismantled for reasons of transport and reinstallation. It is most common in small professional fields, such as testing movies in studios before they are shown in large exhibition halls. Mostly, these domes are characterized by an interesting high quality of sound, as the lights bounce off the inner surface of the dome, the sound waves also bounce toward the axis of the dome [13].

The most regular planetarium is constructed of a solid rigid structure made of steel for its flexibility, rigidity and lightness. The traditional planetarium contains an optical projector for planets and stars at its center, preferably below the spring line as not to obscure the vision of the viewers. Usually large fixed domes use perforated surfaces as internal screens, to control the sound as the speakers are installed behind the dome screen, in addition to let the air flow inside the dome hall [14].

5. SPHERICAL IMAGE REPRESENTATION AND DISPLAY

Our visual senses are overflowing with a pulsating embodiment of both real and fictional scenes. This artistic incarnation has evolved from the engraving artwork on rocks, to printed media, photography, cinema and television, and most recently computer graphics and networking. These media are the main source of visual stimulation for our education and entertainment [16].

There is one common attribute among all these forms of artistic embodiment as they are all presented on a flat display perspective. Flat surface imaging is equivalent to looking through a window with one eye [17]. So, our field of view is limited to less than 180 degrees. Despite the problems associated with viewing a 3D space on a flat surface [18]. However, we have been prompted for this due to technical deficiencies.

Throughout history, Leonardo Da Vinci considered the classic view perspective "artificial", while the perspective view that produces the best image is by observing with an eye and described it as ‘natural perspective view’[19].

According to Da Vinci, the natural perspective is simply to project the environment onto a spherical surface, with a point of view focused on the spherical origin. Unfortunately, realizing the display on a spherical surface is one of the difficult tasks that requires the production of "graphics" on a spherical surface.

6. THE LANGUAGE OF FULLDOME

The debate over the cinematic language may seem limited to one of purposes away from the commercial process, but in the dome it is a living issue. There are many restrictions and limitations to the process of immersive movies projection, such as the rapid visual changes that may occur in a 360 degrees screen, which must be limited, add to that increasing the duration of every scene, with the gradual transfer between shots during editing, and the organization of the location of objects in space and the speed of their movement. The objects movement must be slower than in traditional cinema or Television productions, ‘if the movement looks right on the flat screen, it is very fast for the full dome’ [20].

Then there is the light reflection. When images are projected onto the light grey screen of the dome's circumference, the reflected light can reduce the image gain. Therefore, this must be taken into account during the production process, and the footage should be designed to mitigate this effect. Many full-dome shots use the dimming luminance to reduce the effect of light bouncing back in the dome. One of the solutions for the shots that focus on the front of the dome, is to darken everything in the background. No one will notice that there is a big dark section behind them because they look forward. Luckily, new projectors are improving, they have a good balance of brightness and contrast that can usually overcome these problems. There are some projection technologies that are derived from flight simulator technology that have additional panels to give a true black color.

From above, it is clear that there are considerations to be taken into account by designers and animators in the production of immersive movie screenings:

As for the movement of objects across the dome, it is important to consider moving these objects at a slower speed than usual in the traditional move. It is also important not to start a movement from still suddenly or to stop suddenly. We should also move and stop the camera smoothly, as in reality where everything has momentum. This is equal to the cinematic shots where every movement of the camera must be carefully taken care of [21].

For the text size and its attribution to the dome, as a result of the wide field of vision it is difficult to read large texts. In general, it is necessary to consider the presence of texts within a narrow range of vision where the viewer does not need to move his head within the limits of the field of view 120 degrees. For moving texts, and since they are displayed at a greater distance on the screen than usual, it is difficult to read them in the dome environment, and therefore it is not preferable to move text from the extreme right side of the dome to the other side. Another consideration related to text size is to ensure that the text is readable on both 4k and 1k systems. We have to assume that the movie can be played on different display systems in terms of image resolution.

Also its noteworthy for designers, objects that occupy a large area of the screen, its straight lines appear as if they were curved from some viewers angles, it is a natural phenomenon and can't be corrected in the current technology, since the curved nature of the surface of the dome is the reason. Designers can consider this problem in their designs to reduce its effect [22].

7. CHALLENGES FACING FULL DOME DEVELOPERS:

Immersive films producers face a number of challenges, which are directly related to the size of the image, where the designer must model more objects in a single scene with higher details than of what he needs in a traditional scene with limited field of view.

Consequently, due to the larger size of the picture frame in immersive films compared to traditional media, such as television and video, and as a result of increased detail, production artists face difficulties in rendering their scenes a result of the need for more powerful and faster processors, in addition to storage spaces, which are being tackled technologically soon [23]. For example, the normal image size is 1920X1080 (Full Hd) and the most popular size in immersive films now is 4096X4096 and it is called 4K That is eight times the full Hd image. The challenge will increase as a result of the development of projectors with higher image resolution that reaches 8K [24].

Designers also face another challenge related to display and viewing tools during production. As a result of the nature of the immersive image, it is surrounding, and at the same time, all the design tools and software depend on the presentations through flat and framed screens, the designer relies on his experiences in the field of surrounding immersive images and on his imagination and then he tests the main images produced in the Dome Theater and then returns again and makes adjustments. There is no doubt that these stages consume time and energy. Small portable domes are now available, but they consume the studio space. Designers and producers test their artworks inside portable domes, which facilitates and speeds up the production process. Now dome simulation software and plugins is available to help visualizing immersive images on flat computer screens. There is no doubt that production tools and methods are developing rapidly, serving designers and professionals in the field of immersive films.

a) Variations between installations

Indeed, to achieve a better result, the designer needs to know more technical details about the final projection environment. Also during the creation of content, it is important to be able to reach the place of the final projection before beginning the production. This is one of the obstacles that the designer faces during the production of his artwork, as a result of the difference and diversity in domes technologies, sizes and construction, which requires research and development to achieve unified format for all domes, as the case with most cinemas and other media, such as television and multimedia.

b) Difference in display technology

As the capabilities of the monitors in terms of image resolution differ from one dome to another, in addition to the properties of the dome surface in terms of light reflection and clarity of the convergence of the dome screen panels. Also, the color differences between display system according to gamma, white point, color temperature, and other color control properties that influence the clarity of the image from one theatre to the other [25].

c) Dome structure differences

Chair Orientation: There are two ways to row seats, one of which is called unidirectional where all chairs are directed to one direction, such as in cinema halls, and the other way is omnidirectional, which is the oldest method in planetarium domes, where the seats are arranged in circles inside each other, directed towards the middle of the theater.

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***Dome inclination angle**:* Inclination angles vary from zero degrees, in traditional planetarium domes, to 30 degrees in modern planetariums. IMAX theaters have inclination of 45 degrees, and finally, the 90-degree tilt angle called vertical domes, used in some small simulators. Also, some domes are complete and others are truncated (Figure 3).

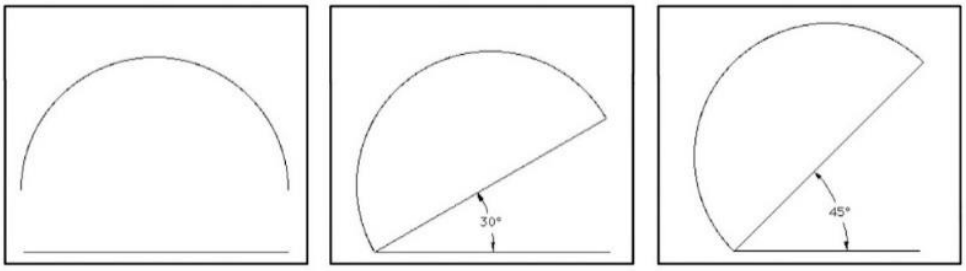

Figure (3) the diversity of dome angles.

***The level of viewer's vision**:* It varies according to the Spring line, Depending on the type of projector available at the dome and facility design add to that the inclination degree of viewers' seats varies from one dome to another in addition to the difference in the interior of the same dome, depending on the proximity or distance of the chair from the screen [26].

d) The cinematography stage is one of the biggest challenges in immersive cinema for a number of reasons

First, the technical difficulty caused by the nature of immersive photography, where the camera depicts all directions, which may result in the appearance of the team behind the camera in the image, in addition to the scenes, photography and lighting equipment.

Also, there is still a dearth of specialized cameras capable of producing this kind of immersive films, although in the last years there has been a major shift in the development of these cameras. Due to this technical difficulty, immersive film makers preferred computer graphics rather than filming, which is one of the main reasons for immersive feature films scarcity, and most of them are experimental.

Compositing based on polar coordination isn't available yet in most of popular software, but there are some additional software Plugins, but raises the cost of production software. In addition, there are still difficulties in the cases of real time projection and interactivity in spite of the current development in the graphic cards, the large size of the images displayed is still a hindrance to a large number of artistic ideas and immersive shows [27].

8. CONCLUSION

The range of subjects which will fill Planetarium domes will soon transcend those traditionally emphasized in domed theaters run as astronomy classrooms. Astronomy will be but one floating scrap in a flood of visual instruction and entertainment to come. As fulldome media comes of age directors and designers will arise, working out ways to tell stories suited to the possibilities of the medium. To achieve that, I recommend more research in setting rules for designers to find a new language for the new immersive medium. Also we need to set rules for the workflow in production stages of immersive films, such as having standard Storyboard templates for immersive production.

The role of set design is growing in immersive film production, as it will be one of the designer's challenges to find solutions for the visual continuity of the scenes it was carried out by the editor in traditional cinema.

It is my hope that the development of planetariums will be seen as a worthy medium for dramatic and esthetic projections by the heads of such facilities as well as by "filmmakers" and, of course, the audiences.

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