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ABSTRACT

The revolution brought about by computerized technology, in general, and television imagery, in particular, challenges the perceptual habits and alters the television viewer's means of expressing appreciation of the aesthetic merits of such television images. This study speculates on several perceptual and aesthetic drawbacks of future massive applications of three dimensional (3-D) video images. Specifically it: (1) reviews the technology of existing 3-D media; (2) discusses the principles of visual perception and aesthetics which are challenged by the development of 3-D media technology in television; and (3) provides alternatives to the problems raised by massive application and commercializing of 3-D media technology. It is concluded that the novelty generated by 3-D media technology challenges the fundamental rules of perception and aesthetic appreciation of film and television images, but that neurophysiological bases of the visual perception processes and psychological standards of aesthetic appreciation have strong roots and traditions, and will not easily be bypassed by 3-D media technology. (40 references) (Author)

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Three Dimensional Video: Perceptual and Aesthetic Drawbacks

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Abstract

The revolution brought forth by computerized technology, in general, and television imagery, in particular, challenges the perceptual habits, and alters the television viewer's means of expressing appreciation of the aesthetic merits of such television images. This study speculates on several perceptual and aesthetic drawbacks of future massive applications of 3-D video images. Specifically, it (1) reviews the technology of existing 3-D media, (2) discusses the principles of visual perception and aesthetics which are challenged by the development of 3-D media technology in television, and (3) provides alternatives to the problems raised by massive application and commercializing of 3-D media technology. It is concluded that the novelty generated by 3-D media technology challenges the fundamental rules of perception and aesthetic appreciation of film and television images, but that neurophysiological bases of the visual perception processes and psychological standards of aesthetic appreciation have strong roots and traditions, and will not easily be bypassed by 3-D media technology.

Introduction

"The future is not all tech. Respect of the physiology of perception and the essential requirements of human communication is an absolute necessity before any 3-D medium prematurely eclipses the TV set" (Hlynky, 1987, p. 16).

The rapid developments of computer generated television technology during the last ten years has alarmed scholars of the television medium. It has generated serious discussions on the issue, and brought new speculations and empirical observations into focus (Hlynky, 1987, Zettl, 1986).

These discussions, speculations and empirical observations were centered on the potential covert effects which computer generated television images will have when the fundamental rules of visual perception and aesthetic appreciation of televised images are violated, ignored or by-passed (Metallinos, 1988).

Researchers, developers, theorists and technicians of the visual communication media of film, television and holography are equally concerned about the commercialization and massive application of three dimensional media technology, particularly in television, which is developing rapidly (Green, 1983, Rosenberger, 1982, Fouts & Johnston, 1982, Hlynsky, 1987, Starks, 1982, Symmes, 1982, Hunter, 1987). These researchers and developers fear the hidden and hansel unpredictable, physiological and psychological consequences of 3-D television, the least of which is discontent, fatigue, bad taste and boredom.

Experimentation and small scale application of 3-D imagery, film, holography and television during the last thirty years undoubtedly have produced a novelty which seems to attract since it offers a new dimension, a vivid presence of the fictional world of film and television. In view of this advantage, however, researchers in 3-D media, have raised several questions. For example, how will the technical and communicative obstacles of 3-D media effect viewers? Does the novelty of 3-D video demand viewer sacrifices of the freedom of motion and viewing conditions? If 3-D video causes viewer discomfort, fatigue, or boredom, why bother? What particular drawbacks, both perceptually and aesthetically, generate 3-D television images which should be made known and prevented? Shouldn't we encourage, and indeed embark on long term, scientific research projects and experimentation on the potential hidden effects of the 3-D television images before we allow its expansion into an unprecedented massive application?

Basically, this study speculates on the foreseeable changes in viewers' perceptual and aesthetic habits which will be generated by the broader application and vast commercialization of 3-D television programs. It is argued that the physical restrictions imposed by 3-D television will require a considerable readjustment of viewing habits. Furthermore, it is argued that the ways by which a viewer involves himself emotionally or psychologically with 3-D television images requires a new set of rules, a "3-D vocabulary and grammar" (Green, 1982, p. 25) which must be learned quickly. The massive application of 3-D film glasses in the early fifties and sixties proved catastrophic.

The perceptual and aesthetic restrictions imposed on the viewers were so severe that 3-D films were discontinued, and since then, only small scale 3-D media experiments involving a few viewers have been done.

Considerable improvements in the technology of 3-D media (particularly in film, television and holography) have been made. Well known researchers in respected institutions such as M.I.T. are now working to improve the technology and ease the obstacles posed by 3-D media (Brand, 1987). However, broader application and commercialization of 3-D media is being held back so far because of the inherent perceptual and aesthetic drawbacks

In order to focus on the issues posed by the forthcoming massive applications of 3-D television, and to answer some of the questions raised earlier, the following topics will be discussed:

1. A brief review of the evolution of 3-D media technology which point out the advantages and weaknesses of the various systems.
2. An analysis of the key principles of visual perception and aesthetics as they relate to 3-D media, in general, and television in particular.
3. The required changes in viewers' perceptual conditions and aesthetic habits in view of 3-D television technology.

From 2-D to 3-D Media

The necessity to extend man's experience with the three dimensional world to photographic images of those experiences was evidenced in the evolution of painting. To the masters of painting,

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the creation of the illusion of deptk in the two-dimensional surface of their canvases was of major concern. The same concern was carried on by artists and scientists who created photography, striving th enhance the depth cues of the photograph. With the advent of motion pictures, this necessity increased even more, demanding better, more realistic images. Finally television, with its intimacy and spontaneity, stimulated scientists and television artists to create depth systems, or technology that displayed spatial differentials (Symmes, 1975, p. 441). Such depth systems which were intended to add the third dimension to two dimensional pictures are grouped under seven basic categories: (1) stereoscopic, (2) anaglyphic (3) polarized, (4) rastering, (5) alternative viewing, (6) volumetric imaging, and (7) holography. A brief explanation of each of these systems and their major drawbacks is necessary.

<u>Stereoscopic Methods</u>

Man's binocular vision, called stereopsis, which allows him to see the phenomena in the world three dimensionally has triggered physicists and artists to attempt to duplicate this phenomena artificially, thus creating the stereoscope. As far back as 1833, the English physician, Sir Charles Wheastone created the first stereoscope which allowed each eye to see a different picture after an appropriate placement of three mirrors at the right angles. The stereoscope, in turn, created the pseutoscope which used prisms to exchange the eyes' visual fields, resulting in the concave look of objects (Gardner, 1983, pp. 64-63). According to Symmes (1974, p. 406), the stereoscopes were found in many houses throughout the

1800's and were perfected and widely used throughout the 1890's, although several experimental screenings conducted by William Friese-Greene found the stereoscopes to be totally impractical for commercial application.

Various types of stereoscopic equipment were developed later on, particularly with the advent of motion pictures, such as "the twin lense camera, or stereo-pair" developed by Harvard L. Hull of the National Laboratory of Chicago in the early fifties (Symmes, 1982, p. 1269); the "Hammond Organ Fame," a system in which the stereo-pair was projected in alternate frame style, left to right; the "stereovisor" system which was developed by James Butterfield, made with small mirrors and "held on the spectator's face with elastic bands" (Symmes, 1982, p. 1269), etc.

Although these systems aided in the development of 3-D media, they had serious drawbacks. They were primitive and impractical because "they required viewers to wear cumbersome apparatus on their heads or mounted in front of each seat" (Gardner, 1983, p. 66).

Anaglyphic Methods for 3-D Media

Based on the perceptual principles of stereopsis and complimentary colors, this method was developed by scientists as far back as 1891. According to Balasubramonian and Rajappan (1983, p. 101) "Ducos du Hanron was the first to suggest the anaglyph method of separating the stereo pair of images by printing them in complementary colors and viewing them through color filters. . ." Although Symmes (1974, p. 406) attributes the

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anaglyphic method to scientists Rollman and J. D. Almeidre, he too states that "the anaglyph (relief picture) system involves coloring the stereo pair red and blue (or green) and superimposing them. Decoding is achieved by glasses with red and blue lenses." Since each eye sees a different picture when the two images are projected in superimposition and viewed with glasses made with filters of corresponding colors, a three dimensional image is created (Symmes, 1974, p. 406, Frisby, 1979, p. 77).

Experiments with anaglyphic methods for 3-D media continued through the fifties and the sixties involving television as well, and improving the glasses required by the system. Several 3-D movies and 3-D television programs were made, some of which were successful, while others were not. The drawbacks of the anaglyphic system were decisive, particularly in 3-D television applications. Summing up this various drawbacks, Balasubramonian and Rajappan (1983, p. 101) conclude that:

1. It is suited to monochrome 3-D TV only...
2. Good black and white quality cannot be achieved...
3. The spectral response of the eye for different colors is not uniform and therefore the intensities of images seen by each eye will be different...
4. Color filters with narrow band spectral response characteristics are not available in practice...
5. Continuous wearing of color filters is strenuous...

The same views are shared by Free (1988, p. 58), Symmes (1974, p. 406, 1982, p. 1271), and Gardner (1983, p. 67).

Balasubramonian and Rajappan (1983, p. 101) conclude that headaches and tiredness invariably affected everybody after using the color filters for a considerable length of time, although the depth perception was generally good. Therefore, the anaglyph separation technique is inappropriate for 3-D TV as a permanent solution."

Polarization Methods of 3-D Media

According to Balasubramonian and Rajappan (1983, p. 102) and Symmes (1974, p. 408), the principle of polarized light for the stereo projection of images can be attributed to English scientist J. Anderson in 1891. The Polaroid filters were developed, according to Gardner (1983, p. 67) by Edwin H. Land. Symmes (1974, p.408) states that:

> A polarizing filter is like a comb that combs light so that it travels in one direction. If the two combs are oriented in the same way they let light through. If they are oriented 90 degrees to each other they cross polarize and block light, thus becoming opaque.
>
> Polarizing filters, substituted for the colored ones used in the anaglyph method, produce the same 'selective' effect without coloring the image.

Throughout the fifties and the sixties, more than 50 polarized 3-D features, both films and TV productions were made using special and improved 3-D glasses or special TV sets, cameras and/or transmitters (Symmes, 1982, p. 1211). The latest of these polarized methods are the "bicircularly polarized viewing system" which employs an electro-optic material for a 3-D color TV using only a single picture tube (Balasubramonian and Rajappan, 1983, p. 102), and the "electro-optic polarizer based 3-D viewing system" which uses an electro-optic plane polarization twister which "generates the linear orthogonal plane polarized lights needed for the bicircular polarization" (Balasubramonian & Rajappan, 1983, p. 102). This system is the latest extension of the bicircular polarized viewing system and is quite compatible with conventional 2-D color TV equipment.

As with previous polarization methods, researchers are not particularly optimistic about broad consumer application of these two newest systems due to their significant drawbacks. For example, Balasubramonian and Rajappan (1982, p. 102) point out that the bicircularly polarized viewing system". . .due to crosstalk problems poses a constraint on the viewer that he has to keep his head erect while seeing the picture tube." And, with the electro-optic polarizer based 3-D system ". . .there is little cross talk in the fringe area of vision. If anyone looks at the screen with naked eyes, he will be able to see a strongly defused 2-D image due to averaging of left and right eye view images." (Balasubramonian and Rajappan, 1982, p. 102).

<u>Raster Method of 3-D Media</u>

The raster method of 3-D imaging assumes several names ; "lenticular 3-D" (Symmes, 1974, p. 408), "single and double sided lenticular 3-D" (Free, 1988, p. 61), "autostereoscopic 3-D system" (Balasubramonian and Rajappan, 1983, p. 104). The principle under which this system operates is both an old and a simple one. It dates back to the 1800's and is based on genuine stereopsis. Although this

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system has been greatly improved since the 1800"s, the basic technique, according to Gardner (1983, p. 67) is:

> ". . .to slice two or more pictures into hair-line thin vertical strips [called lenticular sheets or screens], interlace them side-by-side, and cover them with a plastic coating of vertical ridges that act as cylindrical lenses. If the head is held straight, the left eye sees only the strips forming the picture for the left eye and the same is true for the right eye."

The raster method has been applied to various still panoramographs such as post cards, magazine covers and inserts. However, its application to motion pictures has proven to have serious drawbacks such as cost of mass production of lenticular screens and restrictions on spectator viewing zones (Symmes, 1974, p. 408). Undoubtedly, the most improved rastor 3-D method is the autostereoscopic 3-D system which was applied to television. According to Balasubramonian and Rajappan (1983, 104):

> Autostereoscopic television is one form of stereoscopic technique wherein the stereo image pair separation is performed in the display screen itself by using special types of screens known as direction selective screens such as lenticular lens sheets and the lense does not call for any viewing aid.

Experiments with this system thus far have not produced the desirable results since ". . .all these autostereoscopic systems using lenticular sheets are not compatible with the conventional 2-D TV

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equipment and standards due to increased band width requirements and optical complexity." (Balasubramonian and Rajappan, 1983, p. 104).

Alternative View 3-D Methods

The alternative view method of creating 3-D images is also old and relatively simple in its mode of operation. According to Symmes (1974, p. 408):

> The right and left views are stacked one upon the other. When projected they appear to be forming one, blurry image. When the composite image is viewed through an appropriate viewing aid, one eye is allowed to see every other frame and vice versa.

At the beginning, the most commonly used viewing aid was a mechanical apparatus in which a shutter was connected to projectors which alternately covered and uncovered the spectator's eyes (Symmes, 1974, p. 408). Used primarily during the twenties and thirties, this system produced good 3-D effect, but practical considerations in projection and viewing reduced its efficiency drastically. The advent of television brought a new alternative viewing 3-D system called Fast Liquid Crystal Shutters, or LC. According to Free (1988, p. 60):

> Liquid-crystal shutters, worn as glasses, appear with many 3-D systems. Left and right views of scenes or objects are displayed sequentially-a split second apart-on a screen. Small electric currents, synchronized by a controller, flow through a wire connected to the LC

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shutters. When the view of the left eye appears on the screen the right shutter is triggered and darkened. When the right eye view appears, the left shutter becomes opaque. Rapid switching simulates normal binocular viewing, which creates a 3-D image in your mind.

Various electronic companies like Toshiba, computer companies like Atari, and video game companies like Sega, have projected the LC system in their efforts to eliminate some of its major drawbacks , namely flickering, picture tube brightness, contrast, and blurring.

Volumetric 3-D Imaging Method

This method is restricted to 3-D television imaging and is created by assembling the sectional images of a 3-D object and exposing them physically in a three dimensional display machine. In explaining how this method works, Balasubramonian and Rajappan (1983, p. 104) state that "a varifocal mirror operated by a loudspeaker registers different sectional images of the object sequentially and another varifocal mirror associated with the picture tube vibrates synchronously to produce a virtual volumetric display."

In the beginning, a major drawback of this 3-D imaging method was the image blur due to the unfocused region of the object depicted. Some techniques to remove the blur were tried, but with no great success. Balasubramonian and Rajappan (1983, p. 104) conclude that ". . . the varifocal mirror techniques invariably demand longer band width to obtain realistic display. Also phantom imaging effect is inherent in this system."

Holographic Method

This is the ultimate 3-D medium which has been around since the 1940's. The principle under which holography operates is described by Rosemerger (1982, p. 48) as follows:

> Holograms are made with lasers and photosensitive emulsions. Simply described, a laser is directed to a beamsplitter, dividing the beam of laser light into a reference beam and an object beam. The reference beam bounces off a mirror onto a photographic plate, and the object beam bounces off another mirror onto the object being 'photographed' before rejoining the reference beam on the photographic plate. As the two beams intersect on the plate they create an interference pattern that conveys 3-D information about the object in the hologram.

In order to be able to see a hologram, a reference beam of light must shine on the photographic plate. Today holograms are found in art galleries, holographic museums, and public displays. They have found application in popular magazines, post cards, credit cards, etc. Holographic films have been made in laboratories and have been shown on a small scale in public. But holographic television, the ultimate 3-D method is yet to come.

At the Massachusetts Institute of Technology (M.I.T.), researchers are working to perfect the ultimate 3-D television system, holographic television based on auto stereoscopic television viewing and holographic imaging combined (Brand, 1987, pp. 83-91).

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The transmission of holograms into real time in order to broadcast them on television is but one of the obstacles in the development of holographic television. As Alexander (1988, p. 35) points out, "currently the information contained in a single still hologram far exceeds the capability of any mass broadcast communication method. Vast reductions in the amount of information in a hologram, then, is a key goal to researchers in the field."

Researchers are optimistic that computer interface with holographic information, digital-to-hologram converters, and fiber optics (due to the enormous amount of information they are able to transmit) will offer tremendous assistance in eliminating the problem of the huge amount of bandwidth, or frequency space required (Free, 1983, p. 110) for the successful broadcast of holographic television.

Reiterating on this major obstacle, Rosenberger (1982, pp. 36-49) is much less optimistic about the development of holographic television and its future massive application. He points out that the numerous inherent differences between the two media (holography and television) distance the development of holographic television beyond the year 2000. The fact that holography is a photographic medium, not an electronic one, as is radio, that it is made with lasers and photosensitive emulsion, that broadcasting would require such an enormous amount of television bandwidth, and that holograms cannot be produced outdoors since they require coherent light are all

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serious obstacles in the way of the development of holographic television.

As this brief review of the development of the various 3-D media methods indicate, there are certain inherent mechanical or technical drawbacks which influence the perceptual and aesthetic principles that govern the visual communication media. It is this factor that must be examined next.

Perception and Aesthetics of 3-D Media

From the seemingly unrelated fields of perceptual psychology and telecommunications, a number of guidelines in viewer perception and television composition have been developed. Through extensive study, research and experimentation in both fields, new concepts, principles and theories have emerged which fall under the new field of study called media aesthetics, or visual communication media aesthetics. In this field , the physiological conditions under which viewers perceive and recognize pictures, and the psychological processes involved in viewers' comprehension and appreciation of pictures are examined. From the works of such scholars in the field as Arnheim (1969), Gibson (1979), Berlyne (1974), Kennedy (1974), Dontis (1973), Zettl (1973), Baggaley, et al (1980), D'Agustino (1985), etc., we know the physiology and the psychology of picture perception and appreciation. Both perception and appreciation of images composed in the visual field, the concentrated space of the film and television screen, differ significantly from objects or people in the real world. The distinctive

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ways in which the visual world and the visual field are perceived have been underlined by such perceptual psychologists as Gibson (1950), Gombrich (1960), Hochberg (1968), Goldstein (1980), etc. The visual world is borderless and three dimensional, the visual field is bounded and two dimensional. Objects and people in the visual world have depth, whereas their images in the visual field are depthless or two dimensional. A limited, framed or bounded visual field dictates that construction, composition or synthesis of images photographed in the visual world must be done using certain rules of composition which are pertinent only to the particular medium. In the case of television images, such primary rules of composition as main direction of visual elements within the television screen, proportions which divide the various areas and elements within the television screen, and balance of both the positive and negative spaces within the frame must adhered to (Arnheim, 1969, Zettl, 1973, Dontis, 1973, Metallinos, 1979).

Additionally, television images require a certain amount and certain types of lighting. They require properly distributed colors. They must be framed with special, well established rules of enhancing the illusion of depth, maintaining the figure-ground distinctions of the visual elements with the visual field. They are composed with restricted speed of motion, juxtaposition and clarity of visual elements within the television screen. When these perceptual and aesthetic guidelines are violated, ignored or abused, viewer attention might be captured momentarily-particularly when such violations are purposeful (Cerulo, 1978), but clear understanding and appreciation of the visual images are found to be significantly diminished (Metallinos, 1988).

The fundamental rule of depth of field, which allows our eyes to sharply focus on objects in the visual world by adjusting our binocular vision automatically, is a biological-physical property of our visual apparatus which cannot readily be duplicated by mechanical means such as cameras, lenses and computer generated images. While our eyes can easily bring into focus objects in the visual world, readjusting automatically from wide to narrow depth of fields, cameras - film or television - do not have that flexibility. The mechanical apparatus which force readjustments of the depth of field in order to produce 3-D images produce discomfort, viewing fatigue, headaches, etc. The process is, therefore, limited aesthetically and perceptually (Williams, 1974, pp. 420-425). It requires viewers to readjust to these new conditions.

Pioneering technicians of 3-D motion pictures and television have pointed out yet another serious perceptual drawback in the construction of 3-D images, the cardboarding effect. According to Williams (1974, p. 425), the physical property of our eyes called *interocular* (the separation of our eyes) which allows us to see the visual world three dimensionally must be duplicated by mechanical means in order to create the illusion of 3-D in 2-D images. Whereas our eyes are flexible and adjust automatically to perceive depth in distant objects and scenes, cameras attempting to duplicate this property have not always been successful. They are limited and thus sometimes create the cardboarding effect. When the interaxial, the

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stereo camera's right and left eye separation, is not flexible enough, as is the case with the majority of the 3-D media systems described earlier, the elements in the scene appear to be either flat, lacking roundness, or depthless, lacking distance separation. This crucial area of 3-D mechanics is yet another physical obstacle which has decisive perceptual and artistic drawbacks, and requires readjustment of natural viewing habits (Williams, 1974, pp. 420-425).

According to Gardner (1983, p. 63): "It is the binocular illusion called stereopsis that must be simulated if movies and television are ever to become truly three dimensional." Regardless of the years of experimenting to simulate this important human property, we are still far from complete success. Due to occular separation, each eye is presented with a slightly different view. The eyes receive information pertinent to the distance of subject as the two lines of sight converge on the observed phenomenon (Waldern, et al, 1986, p. 653). Perceptual discrimination of this visual perception property does not go unnoticed by 3-D viewers. It is a novelty to which they must learn to adjust. As Gardner (1983, p. 65) explains:

> Seeing is a process by which the brain unconsciously forms hypotheses about the world, then rapidly selects the best bet in the light of one's experience . . . The mind's tendency to interpret flat pictures in light of experience is the basis of many depth illusions.

However advanced stereo film and television cameras become, they will never be able "to interpret pictures in light of experience."

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The 3-D camera will always rely on mechanical tricks to force the viewer to perceive depth. In short, the viewer is told what to perceive, which is an important drawback.

Perceptual psychologists and optical engineers who have studied the perceptual factors in 3-D images have pointed out two additional important factors to be considered, namely motion paralax and motion perspective In the mechanical construction of 3-D images, the depth cue factor known as motion paralax presents a serious obstacle. According to Walder, et al (1986, pp. 650-651):

> When a person viewing a scene moves his or her head, objects which are near appear to move more rapidly than those more distant. Similarly, if two objects (which are at different distances from the viewer) are moving at the same speed, the object closer to the viewer will appear to move faster than the ones further away.

It was shown that duplication of this phenomenon with mechanical means on the 2-D surface of the film or TV screens cannot be done faithfully, regardless of the attempts made. Neither the speed at which near objects move or the distance of the objects from each other and from the viewer can be maintained consistently by any 3-D media system existing today.

An equally, serious obstacle in the perception of 3-D images is the depth cue factor known as motion perspective defined by Waldern, et al (1986, p. 651) as " . . . the continuous manner in which the view changes providing information about the scene, when the viewer and scene move steadily with respect to one another." In many 3-D media systems, the viewer and the scene cannot easily "move steadily with respect to one another" since they are produced by mechanical means. Unwanted and unwarranted instability of camera movements often disturb the normal motion perspective which, in turn, limits the information about the scene. Such drawbacks cannot be discounted.

Apart from the above perceptual, physical or biological factors, 3-D media systems in existence today present a number of emotional, psychological or aesthetic obstacles. At the top of this list are the various hardware restrictions imposed on viewers such as viewing glasses, specially designed viewing seats, polarizers or specially designed 3-D viewing areas. Efforts to eliminate such hardware restrictions are being made, but they are unperfected and as yet on an extremely limited scale (Free, 1988).

The present requirement to wear specially designed 3-D viewing glasses, either with green and red filters or the electro-optic ones, restrict both the viewer's field of vision and head and body movements. Emotionally speaking, this creates stress, uneasiness, fatigue, and inevitably, boredom (Free, 1988, pp. 58-62, Starks, 1982, pp. 987-993). With such emotionally distressful viewing conditions, how will it be at all possible for anyone to fully appreciate the 3-D images? The specially designed viewing seats, in some cases, have also proven to be emotionally disturbing, primarily because the viewer's head must remain motionless and in perfect vertical position throughout the viewing process. As soon as the head moves, the vertical and horizontal parallax are disturbed, resulting in emotional disturbance as well. This in turn, destroys any attempt to relax, to understand and to appreciate the 3-D images on display. The same is true with the use of polarizers or the special designed 3-D viewing areas where, again, the spectator's field of view and their free flow of movements are decisively restricted. The viewer's organic readjustment to these conditions is necessary. But is it possible to become easily conditioned to this new viewing situation?

Additional 3-D hardware generated factors such as image noise, blurring, flickering, unfaithful (unnatural) colors, etc., are known to influence 3-D media viewers' aesthetic appreciation of 3-D images. They have been known to cause such emotional and psychological distress as headaches, visual fatigue, dizziness, and upset stomach, and, of course, this hinders the ability to fully appreciate the 3-D images (Symmes, 1982, pp. 1269-1271).

When a massive application of 3-D television will materialize, a significant aesthetic factor in television composition known as figure-ground consistency of visual elements within the visual field will be decisively violated. The viewer's habit of perceiving certain visuals as grounds and others as figures will be decisively challenged (Bloomer, 1976, pp. 35-38, Metallinos, 1988). Looking at holographic television images, for example, the viewer at first will be confused as to what elements constitute the figures and which constitute the grounds since they will be perceived as though they are phantoms, ghosts, floating in space, completely transparent and coming from nowhere (Rosenberger, 1982, p. 49). The viewer will be receiving much more information, much more visual imput, than they need or are accustomed to. This will create an overwhelming feeling of imbalance in the aesthetic appreciation of 3-D television images. In speculating on this issue, Prof. Stephen Benton, head of the Spatial Imaging Department of M.I.T.'s Media Lab., states:

> If you consider what passes for acceptable video, our visual system seems to be very 'low-fi'--it makes massive assumptions about the way the world is tied together. In fact, we're giving it much more data than it wants or can use. My instinct is that there's playdirt in that direction (Brand, 1987, p. 89).

Certainly there are limits to both the viewer's tolerance for the perceptual violation of the harmonious figure-ground relationship and the viewer's ability to comprehend and appreciate over-loaded, complex and often unnecessary visual data.

Just as the novelty of stereo television sound was initially received by the average viewer with cynicism and skepticism (particularly due to the perceptual and aesthetic imbalances between the low definition television picture and the high quality of stereo sound), so will the novelty introduced by stereo 3-D television be received (Skalnick, 1976, pp. 49-52, Schwartz, 1979, pp. 4-7). Until the viewer has the chance to understand its value, learn to appreciate its depth, and readjust himself to this new medium, any massive application or commercialization of 3-D television is bound to have undesirable results.

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Time, space, and motion are among the most important aesthetic agents in the synthesis of film and television images. The role of time and timing, of space and framing, and motion and editing as aesthetic catalysts in the construction of moving images has been studied and published by such pioneers of the visual communication media of film and television as Moholy-Nagy (1969), Kepes (1964, 1966), Millerson (1972), Zettl (1973), etc. Years of study and experimentation with moving images has helped to establish the parameters in which time, motion and space operate in order to compose visual messages with an aesthetic merit. Three-dimensional images, particularly in film and television, have been shown to have affected these aesthetic agents.

Holographic researchers such as Hlynski (1987), Rosenberger (1982), and Alexander (1988), contend that the liberties 3-D image makers take with time and timing are catastrophic and annoying. It takes more time to view and comprehend 3-D images than 2-D images, and contemporary television viewers have learned to watch fast-paced commercials. Hlynski (1987, p. 16) is very skeptical on this issue stating that:

> Contemporary film and video take great liberties with time and space. These need to be re-examined during the development on any future 3-D entertainment form. Fast-paced edits are easier to follow in two dimensions than in three. But even while holographic technology develops, TV advertisers are training the public to read more edits per minute than ever before.

Even more annoying and cumbersome is the abuse of the aesthetic principle of space and framing. Overuse and over-emphasis of Z-axis staging (the inward/outward motion of visual elements within the visual field), coupled with over-stretching the field of vision (over-exceeding its 180^{o} horizontal and 150^{o} vertical vistas), produces anti-aesthetic feelings. In commenting on this issue, Hlynski (1987, p. 15) states:

> First and foremost was the naive but persistent practice of impaling the audience on the Z-axis . . . Although this application is a natural choice, it ignores the more sublime qualities of stereoscopic visions . . . scintillation, reflectivity, transparency and complex space.

Closely related to framing is the motion of visual elements within the visual field which is an important and extremely sensitive aesthetic agent. Research has shown that the perceptual limits of motion are well established. Any stress, abuse or oversight of these limits will result in viewer misunderstanding, or confusion about the visual message (Metallinos, 1987). This is also acknowledged by Hlynski (1987, p. 15) who discusses the design of moving space and warns that:

> When panning the camera in 3-D cinematography or when an element enters the frame from off screen, any projection forward of the screen makes the limits of the frame more apparent . . . Three dimensional lap desolves create spatial confusion if not done continuously. Even careless dolly shots can produce sensations of motion

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sickness. It simply takes more viewing time to explore Z-axis

In the future, three strong forces will be constantly at work, namely technology, commercialization, and easy access to 3-D television programming, leaving no other choices for 3-D television viewers other than to abstain from viewing such programs or to learn to readjust fast and to cope with this technology.

Readjusting Processes for 3-D Viewers

Unquestionably, the world we live in is three dimensional, and the visual communication media we have created as extensions of ourselves must carry the perceptual and aesthetic properties of three and even more dimensions invariably interwoven into them. The future demands our readjustments to 3-D media (film and television, digital 3-D images, holographic television, etc.), and we must learn to slowly adapt to these somewhat , physiologically and psychologically awkward impositions posed by present day 3-D technology.

Equally, however, we must learn to be cautious, skeptical and even judgmental, and not to unquestionably give in to 3-D media technology just because it's a novel idea as we did with 3-D films in the early fifties. We must be skeptical as to the potential overwhelming effects the massive application of 3-D media programming will have on viewers. Our environment is complex and overwhelming enough, providing us with more data input than we can possibly need. The addition of 3-D media imagery on a grand scale will complicate and overload our visual information even more, and this might start turning viewers away rather than towards such media technology. We must be judgmental, critical and even analytical as to the actual communicative value of this new 3-D technology.

Contrary to the belief held by some neophiles of 3-D media technology (Gardiner, et al, 1989, p. 3), stating that we should let natural progression overtake the development of 3-D imagery, such important 3-D media researchers as Hlynsky (1987), Foutis & Johnston (1982), and Symmes (1974) are rather cautious, regarding the future application of 3-D media technology. These researchers, are aware that progression is not necessarily progress. Consequently, they recognize the power of rigorous and systematic research. The media are powerful. They touch everyone. They are capable of directly influencing the viewer. Hense, we must be alert to the potential problems caused by the rapid development of media technology.

What alternatives can we offer to the future consumer which will facilitate his easy, gradual and organic acceptance of 3-D media technology?

Knowledge of the advantages and disadvantages of the novelty of 3-D media technology is one alternative. As was pointed out earlier, there are advantages and disadvantages in each of the developed 3-D media systems. Industry and researchers, developers and consumers have an obligation to inform each other of such advantages and drawbacks long before the massive availability is implemented. The use of the media to inform the public about the media is an effective means of communication, reaching all segments and appealing to all levels of spectators. When potential spectators are made aware (perceptually) and are informed (systematically) of the technical, neurophysiological, perceptual, aesthetic and communicative drawbacks of the particular 3-D medium, they are given a chance to ease their way, to adjust slowly, and to adopt the 3-D media of their choice.

Another alternative is controlled exposure to the novelty of 3-D media technology. Because it is not a customary practice by the industry to instruct the media consumer as to what is good or bad for him or what is necessary or unimportant, the viewers themselves must be more responsible in their selection of 3-D media programming. As was pointed out earlier, 3-D television might be an overwhelming experience, a visual overload for those viewers who have been conditioned to commercial 2-D programming. Such functional programs as newscasts which provide straight forward information do not have to be viewed in 3-D images. When future 3-D media spectators learn to value visual and auditory input, selecting only those programs which they need or can handle, such spectators will slowly overcome the perceptual and aesthetic obstacles of 3-D medium technology

A third alternative is understanding of the new principles, the perceptual and aesthetic factors inherent in 3-D media technology. It is expected that a future potential 3-D media spectator will be better equipped to slowly adjust to any new 3-D medium if he/she has a fair understanding of the grammar of that medium. Such

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understanding, according to Green (1983, p. 25), will enhance the spectator's trust of the medium. The spectator who knows the vocabulary, the workings, the perceptual and psychological factors interwoven with the medium, will have less difficulty in adapting, and even control the medium rather than letting the medium control him.

In summary, the processes of adjusting to 3-D media suggested above are knowledge, control and understanding of the workings of 3-D media. This, however, is true for all new technology, be it medical, engineering or media. Developers, researchers, and teachers of any new technology including media have the responsibility to make potential users, spectators, aware of drawbacks and advantages of the technology. To alleviate and eliminate the discomfort caused by the perceptual and aesthetic drawbacks of 3-D media technology, we must all learn more about the media, and be critical of their aesthetic merits, particularly their massive consumption by uninformed spectators.

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