Emergence of a space medium

Aesthetic and technical study of spatial perception in virtual reality

GARNIER, Francois

Head of research program EN-ER, EnsadLab.
Ecole Nationale Superieure des Arts Decoratifs, Paris, France
francois.garnier@ensad.fr

Abstract— **Stereoscopy and Massive interaction in virtual worlds open for first time the possibility to feel intuitively the three dimensions of digital spaces. By offering this shared perception of space, virtual worlds have become one of the first manifestations of the emergence of a new artistic medium, a space medium. This paper analyzes the technologic, esthetic and perceptive context of emergence of this new medium.**

Keywords: medium; stereoscopy; Immersion; interaction; perception, virtual word, augemented reality

I. INTRODUCTION

A three-dimensional digital space is spatial by nature. Therefore it is striking to note that the great majority of creations imagined and constructed for and in this space are reduced to an image plane when they are shown. The artist only presents a fragmentary two-dimensional photograph of a three-dimensional creation. This attitude has been inherited from cinematographic and television models. These visual methods still maintain a quasi-monopoly of the final projection of 3D computer graphic creations; they only show us traces of the space in which they originated.

Our working hypothesis is that the availability of spatial projection, made possible by the development of stereoscopic and interactive techniques, can radically transform the perception of digital spaces. By expressing volume, the 3D computer graphic image, transformed into a perceptible digital space, affirms its three-dimensional character and establishes its independence from other media. This space becomes more than a tool for modifying, simulating or storing other media: it becomes a medium in its own right, with its own perceptive, aesthetic and narrative codes.

Spatial visualization of digital spaces => establishment of the 3D computer graphic space as a separate image medium.

What happens when we put a pair of stereoscopic glasses in front of our eyes and suddenly a volume appears in our brain from a pair of images?
Why are we witnessing the return of stereoscopy, an outdated technology relegated to the rank of a curiosity, which is reappearing with the development of digital communication technology?
Why do the rules of planar images no longer apply to stereoscopic image pairs?
What are the new rules, the new practices, the new usages?

Finally, we come to the fundamental question of this paper. Are these change in practices, these new usages based on the recent evolution of digital technology and its transmission methods, not the signs of an event in progress: the emergence, or the affirmation of a spatializing medium distinguishing itself progressively from existing image media?

Our subject is located at the convergence of three major thematic axes. One is a human quality, the sense of spatial perception. The second is a principle of transmission, stereoscopy, more than a century and a half old. The third is the recently developed technology for artistic creation with the emergence of computer technologies of communication, in particular digital spaces.

II. A SENSE, THE SENSE OF PERCEPTION OF SPACE

The perception of space rests on a complex multi-sensory mechanism. Many sources of information come together to complete our perceptive space. Visual sources bring us a perception of distance.

With one eye we obtain relative information on space; scale and distance are evaluated by cognitive deductions. Binocular vision brings us an absolute measure of distance. The muscle tension that helps our eyes to converge on an object informs our brain of the distance. Supported by this information, the binocular disparity and the collected monocular factors, we construct our perceptive visual space.

In communication, stereoscopic vision (binocular perception) is fundamentally different from the viewing of an image (monocular vision). The interpretation of an image is purely cognitive. Based on relative information, it deduces the scales and distances of the space represented. In stereoscopic vision, convergence brings us additional absolute and phenomenal information about the perceived space. Our bodies are physically involved in this action of perception by their dimensions and the separation of our eyes. Our bodies are involved dynamically by the effort of the muscles that make our eyes converge. Also, zones particular to binocular perception are activated in our brains in addition to those associated with monocular vision (Guy A. Orban) [1]. Other senses participate in the perception of space: hearing, touch, the sense of balance and the sense of movement. The sense of movement also brings us absolute information about the dimensions of our environment. When we move in a virtual space, by controlling our point of view we dynamically perceive the space around us. Spatial perception is optimal when it brings multi-sensory experience to the spectators (Berthoz) [2].

Movement and stereoscopic vision are the two principal sources of phenomenological information about space. Numerous other sources bring us cognitive information. All this information converges in the brain and is decrypted, analyzed and reassembled. The brain reconstitutes the most coherent model possible of the perceived space in the perceptive space. This means that we move in physical space by guiding ourselves in a probable perceptive space.

Perceptive space is not a Euclidean space but a complex space associating information of very different natures. Digital Euclidean space and physical space are of a completely different nature from perceptive space. They are explored by our senses in a fragmentary and disassociated fashion following very different natural processes (Henri Poincaré) [3]. The perception of distances is inseparable from movement; it is a tool for the simulation of our movements. Our potential movements are themselves generators of information about the space around us. An immobile being could never acquire the notion of space.

III. A PRINCIPLE OF TRANSMISSION, STEREOSCOPY

The perception of depth has been a clearly identified quality of human vision since ancient times. It is just as valuable as the perception of contours, colors or movement. The remark of Leonardo de Vinci deploring that he could not give more depth to painting illustrates the importance of its absence in flat media.

For the inventors of the 19th century it was clear that a visual technology to reproduce "the appearances of life" would have to include depth. The first reproductions of depth were realized even before the perfection of photography, in the form of drawn stereograms.

The recording of depth is mastered quickly, but visualizing it is tricky.

The problems involved in recording depth were solved quickly. In the years that followed the first photographs, stereograms of very good quality were produced. The stereoscopic photograph was developed rapidly in the course of the 1850s to the point of becoming the most commonly used photographic format until 1890. The disappearance of stereoscopy coincided with the arrival of mass production of photographic images on paper. Since stereoscopic images were not suited to this means of distribution, they were gradually marginalized and reduced to the role of a curiosity. [4]

The first projection of a stereoscopic film took place in 1903, with *L'Arrivée du Train* by the Lumière brothers, a short film viewed through a stereoscope modified for the occasion. The first public projection to a paying audience of a short stereoscopic film in anaglyph dates back to 1915, in New York, with the projection of *Jim, The Penman* by Paramount Pictures Corporation.
In 1950 the major American movie studios decided to regularly produce and market full-length stereoscopic films. The goal was to lure people back to the cinema after the appearance of television. Projection constraints tied to the synchronization of two movie projectors and the use of glasses doomed this initiative to failure. A balance was eventually reached between moviegoers and television viewers, and the studios stopped producing stereoscopic films in the 1960s. Only a few theatres dedicated to particular sites (international expositions, theme parks, Imax, etc.) continued to show stereoscopic films.

The principle of stereoscopy has always attracted the public and corresponds to a real need expressed by its creators. The marginalization of this technology has been largely due to the difficulty of adapting it to a method of distribution capable of reaching a mass audience, be it the press, television or cinema.

In order to flourish, stereoscopy needs a method of distribution that is reliable, well adapted and accessible. Computer communication technology seems to have provided that method. But the reappearance of stereoscopy must be considered with regard to its history. Is it destined to fail like the two previous attempts, in photography and film, or has it found the distribution technology it has been waiting for, for more than a century, to establish it as a mass communication medium?

IV. A TECHNOLOGY FOR ARTISTIC CREATION, DIGITAL SPACES.

In the early years, digital spaces were presented in the form of non-interactive, planar computer graphic images. In this they shared the qualities of the digital image; they were immaterial, reproducible, transmittable and malleable (MacLuhan, Virilio, Couchot) [5] [6]. If they are different from other digital images, and notably from captured digital images, it is because they result from a calculation based on an underlying digital space. This characteristic makes it possible to regenerate them identically at any time, or to modify them by intervening in the digital space from which they are created.

It is this particular quality of 3D computer images which first interests artists. Photography, video, cinema and animation all find a powerful working tool in digitalization; it becomes possible to modify digital contents, to manipulate them, to associate them without any loss. In the palette of digital tools, 3D computer graphic technology becomes a tool for modifying digital images.

Digital technology is immaterial and does not have à priori dimensionality; it can be used to represent images in one, two, three or more dimensions. Humans were created to perceive at most three dimensions. It is the absence of an interface for transmission that hinders the visualization of digital spaces. Two technical developments have revealed its spatial nature.

The increasing power of computers reduces the time to calculate images and permits their display in real time. With the aid of an interface, it becomes possible to interact with a virtual space, to move and therefore to perceive the spatial dimension through movement. Digital space reveals itself as more than a simple tool and differentiates itself by its applications. It is this performance, this instantaneous nature, on which games and simulation are based, the first experimentations of a perception sensitive to digital spaces.

With the development of digital projection and small flat screens (virtual vision helmets), another mode of perception of space established itself: stereoscopy. It rests on the faculty of digital spaces to generate the two images of a stereoscopic pair with great reliability. It becomes possible to calculate and transmit the two retinal images of binocular vision and to restore a visual perception of these spaces.

With the advent of computers and stereoscopy, digital space has blossomed: the spectator can penetrate it, immerse himself and live a sensory, visual and kinesthetic experience in these new spaces. Connecting digital spaces to a network makes it possible to communicate and share an experience. Connected to mobile communication tools they offer a hybrid reality, a fusion of real and virtual.

Digital space provides a complete technology of expression, including creation, storage and projection of space; this opens up a new aesthetic dimension for artists. It is very different from other technologies in that, for the first time, it provides a medium of communication which allows artists to work in three dimensions. It becomes possible to express oneself in the same dimensional structure as that in which we normally live and for which our senses are optimized. This new technology, which adopts the dimensions of our physical world, cannot work without profoundly questioning our relationship with reality.

Together with dynamic interaction, binocular vision is one of the two sensory links permitting a phenomenal, absolute approach to digital spaces. The relationships between interaction and digital space are well understood today, due notably to the blazing development of video games in the 1990s. However, some of the relationships between binocular vision and digital space are still waiting to be brought to light.

There is clearly an affinity between digital communication technologies and stereoscopy. On the one hand, digital spaces are in need of projection mechanisms which allow them to express their three-dimensional nature. On the other hand, stereoscopy finds in information technologies for communication a reliable solution for its projection and a new technology for creation and production. Binocular vision is a clearly identified quality of human perception. It is one of the elements which inform us about our environment; in this role it corresponds to a potential vector of communication.

To attempt to define the complex relationships that unite this technology and this method of projection, it is necessary to consider the state of the art of the application of stereoscopy to digital spaces, both technically and aesthetically.

Digital technologies have had a decisive impact in two key phases of the application of the principles of stereoscopy: in the production of stereoscopic pairs and in their transmission.

The appearance of a new virtual, digital space for creation, in addition to physical space, has encouraged the development of fields of application for stereoscopy. But their association does not stop there. The mathematical nature of digital spaces is particularly well adapted to the geometric rules of stereoscopy. The absence of physical constraints simplifies matters, permitting its application without approximation, yielding results very close to the theory. This characteristic of three-dimensional digital spaces circumvents the technical difficulties involved in real-time filming for stereoscopic projection, and brings new tools that simplify considerably the production of programs integrating depth information.

Digital communication technologies have encouraged the development of stereoscopic projection technology and made it reliable. And stereoscopy has brought to light a new application of digital technology: digital spaces.

Three major principles of spatial projection appear to be developing:

- A principle of shared projection, based on digital videoprojectors transmitting stereoscopic pairs to a large screen, where a large audience shares the same point of view toward a linear narration. This type of transmission, directly inspired by cinema, is currently the most commonly used, notably in "3D films" or in Imax.

- A principle of immersive on-board projection, based on helmets (physical separation), immerging the spectator in a 3D universe by giving him complete control of his point of view. When spectators are connected in a network, this technology allows many people to attend the same event, each with his own point of view. When associated with geolocalization, it leads the way to augmented reality applications. Finally, VRD (visual retinal display), a technique based on direct projection of the image by a laser onto the retina, leads us to expect spectacular developments based on the principle directly inspired by the stereoscopy of the 19th century.

- A principle of localized projection, based on the physical display of visible 3D objects in a real space. The technology of collimated lasers, though not yet mature, allows us to envision the projection of a virtual volume in space with no particular equipment required for the spectator. [7]

Digital communication technology has had a decisive impact on the development of current techniques of spatial projection. The technology has made it possible, for the first time, to implement a technological infrastructure for the creation of spatial content (digital three-dimensional spaces) and its projection (technology of projection, transfer of data over a network). A dynamic exchange is created between these two technologies, based on their common application. Stereoscopy seems to have found the technology for its production, and for reliable projection, that has been missing since its invention.

In what ways does the use of stereoscopy transform or influence artistic practices, the usages and visual codes inherited from flat technologies?

To answer this question, we will start by analyzing the form and processes involved in one particular application of stereoscopy to digital spaces: the production of linear stereoscopic films projected onto large screens. This type of film today represents the majority of stereoscopic productions. They are projected in specific locations such as theme parks, large expositions or notable sites. Due to

the emergence of digital projection technology, they have also been shown in the traditional distribution network of cinemas for some time now. "3D movies" are very close in form to traditional cinema, of which they are often considered a technical evolution. This similarity allows us to isolate and compare the evolution of practices connected to stereoscopy in the processes of creation and production of these films. Our goal is to understand the origins of these changes of usage and their aesthetic implications.

V. USE AND AESTHETIC IMPLICATIONS.

A. From 3D cinema relief to special formats

If we compare the production workflow of a traditional film to that of a 3D film, many differences can be noted. Some are technical in nature. They are largely related to the presence of two cameras when filming, and to the adjustment of the two stereoscopic points of view. The material filmed must be adapted, transformed or recreated. New professions like that of the stereograph appear, as well as post-production jobs related to the adjustment of the stereoscopic image pairs.

But the differences do not end with simple technical changes. At each stage of the production pipeline, the spatial nature of the manipulated content influences the way people work. The requirements for framing, cutting in time and editing the film are no longer the same.

The brain needs time to explore the space that has been revealed to it. It seeks to project itself into it, to explore the possibilities, to try to touch it, even, to invest it physically. The rhythm of editing is slower, and the handling of equipment more time consuming. They call for an exploration of the depth, for a camera shot traveling forward, for the subjective vision, for the personal implication. The "ride" is the most extreme manifestation of this need to explore and penetrate the depth of the frame.

The frame itself changes in nature. It no longer marks delimits the possibilities within a set of graphic and animated lines of force. Its edges tend to fade, and to leave the visual field. The eye no longer decodes a narrow plane, but plunges into a space, while evaluating its scale, the distances and the potential to explore. The outer limits of the screen no longer form the structure of the field of view but rather its surface, a translucent plane in the depth of the projected space. The screen marks the limits of near and far, of "inside" and "outside", two volumes with different characteristics. The space of projection and the spectator become geometrically inseparable from the space of the dramatization. (Sergei Eisenstein) [8]

The two great principles of cinematography, the frame and (editing?)cutting, are profoundly transformed and reinvented with the presence of depth. The staging, the themes, the usages in films must be rethought.

These specific formal matters have a strong influence on the scenario, which is generally articulated on a penetrating axis. Among the recurring forms we find are the *quest*, a camera moving into the depth of the space in a forward traveling shot which pulls the spectator in, and the *face to face*, where we meet a volume and can contemplate it from up close. These two forms are among the preferred environments for the scenarios of stereoscopic films. On the one hand there are free universes without gravity, offering total freedom to move in all three dimensions (water, air, space); these are often associated with themes showing the sensuality of the form. On the other hand there are structured universes that are oriented horizontally (architecture, road, hallway, vegetation...) associated with themes giving priority to subjective dynamic action (hunt, pursuit, quest).

In both cases there is no doubt that the phenomenal, intuitive nature of stereoscopic perception explains these specific points. Stereoscopic vision involves us intimately in our relationship to the other (sensory perception of the form) and actively in our relationship with the world (kinesthetic perception, interaction, predatory activity, etc.). We no longer watch, we explore; we no longer learn, we discover.

Perception of a space mobilizes the body and the sense of movement. Moving seats and the physical effects of an amusement park ride and 4D cinema are not just simple fairground tricks; they are the logical extension of a sensory need, seeking to associate the visual perception of a space with the dynamic, kinaesthetic perception of the space. As a result the theatre becomes an integrating factor in the performance. It extends the decor or makes sense due to its localization. Virtual and physical space complement one another, and together form a hybrid.

This change in practices is symptomatic of a profound transformation of a technological platform for artistic creation. As numerous filmmakers agree (Cameron, Ben Stassen, etc.) [9], it can be compared to the introduction of sound in film.

But when the spectator becomes an active participant in the movie theatre, or when control of the frame is given to him – that is to say, when two senses of the perception of space are mobilized: the sense of movement and the sense of binocular vision – the last ties to traditional film are stretched and broken. We are definitely entering into another aesthetic dimension, a new medium. The comparison with another key moment in the history of media will be more accurate: when photography integrated an additional dimension, that of time and movement, to give birth to a new medium, film.

B. From special formats to interactive immersion. The physical involvement of the spectator.

New forms of expression associating stereoscopy and digital spaces are appearing. These experiments integrate the projection spaces in their scenarios and tend to actively involve the spectator in a multi-sensory interaction. The ensemble of practices is split between two major methods of projection. On the one hand are shared spaces, where a large number of spectators share a single action in a projected space, bursting out in front of them in the physical space of the movie theatre. On the other hand are immersive spaces where a single, active user is isolated in a digital space. Performances based on shared spaces are generally addressed to a large number of spectators watching the action from the same point of view. As we have seen above, these practices are the direct extension of those from film projection; they are currently being developed with the renewal of 3D films. In certain forms like 4D cinema and rides, they integrate a kinesthetic stimulation – moving seats or physical effects (wind, heat, smell). The more these physical sensations are present, the further the form of content is removed from the canons of traditional cinema.

1) Dedicated spaces – the living performance
This trend reaches its zenith in performances or attractions shown in dedicated spaces with combinations of physical sets, live performances and stereoscopic projection. Notable among these attractions are *T2 3-D (Terminator 2)* or *The Amazing Adventures of Spider-Man* or *Monsters of Grace* [10] [11], a digital opera in 3D by Robert Wilson and Philip Glass. Even if the dramaturgy is still linear in this type of performance, the temporal and spatial continuity of the action, the physical and multi-sensory involvement of the audience brings us closer to performance, to experience, than to recitation.

2) Interactive installations
Unlike the methods we have mentioned above, interactive methods rely on a mode of expression that is fundamentally individual. The break with narrative cinematographic code is complete. If the author wants to communicate with the visitor, he expresses himself not by editing the frame but through the structure of the space that he presents, the movements and meetings that he prefers, by the modes and levels of interaction that he proposes. Interactivity transforms the principles of communication into depth. The nature of the spectator changes to that of an active participant. This gives him the direct possibility to influence the course of the action in time or space. It involves the visitor dynamically in the space; with stereoscopic vision he is offered a multimodal perception of digital space. [12]

3) Immersion
Immersing spaces are addressed to a user equipped with powerful equipment including interfaces for interaction (control of point of view, manipulation of objects, etc.) and a stereoscopic helmet equipped with direction capture for point of view, or else equipment like the Cave. The user is isolated, immersed in the digital space. He has control over his point of view and his movements,

and he can interact with the content of the virtual space. The scenario is not linear; the creator proposes a universe, objectives and choices to orient the actions of the user. The structures of these universes are inspired by those of games. In these installations, the perception of space occurs above all through the sense of movement and interactions between the user and the universe. In this case stereoscopy is generally used to strengthen the experience. As in the natural perception of a physical space, stereoscopic vision prepares us for action. The senses of movement activated by control over the point of view help us to interact in these spaces. Stereoscopic vision predisposes us by helping us to perceive in order to consider our actions [13].

4) Hybrid spaces

Two extremes are reunited in the development of networks and virtual worlds. It becomes possible for many to share the same digital space, each maintaining the subjectivity of his point of view, his identity. Multiple users share the same scenario by interacting as a group. The space is modified by their action; the reality of these actions is validated by the group. These spaces can be perceived as a social reality. Stereoscopy is still not used much in these universes: visualized principally on a screen, an avatar does not hurt itself after a collision with a wall if it has misjudged the distance… In any event there are experiments in progress. They are notably motivated by the sensual aspect of the perception of volumes and by a requirement for immersion acquired in these spaces. [14]

The advanced technology of geolocalization works together with communicating objects to make it possible to superimpose and form a hybrid of physical and digital spaces. It becomes possible to move naturally in physical space while perceiving a hybrid space augmented by a digital space. Users see each other physically and share actions or interactions on both physical and virtual objects. Visual perception of these spaces is made possible by helmets, offering binocular vision of composite images. They associate two geolocalized points of view. One is in real space, either direct or filmed by cameras placed on a helmet. The other is in digital space and superposed on the first. Stereoscopic vision is of prime importance in this hybrid space, providing information at the same time about both the physical space and the virtual space. Its primary role is in physical space, where it is essential to the evaluation of distance and space before taking action.

We are seeing the development of new practices in an abundance of experimentation involving communication through space. They show the appearance of new forms of communication and exchange. In these experiments, two senses are inseparable: movement and spatial vision.

VI. CONCLUTION

At this point, are we ready to answer our question? Are we facing the emergence or the affirmation of a spatializing medium which is progressively becoming more distinctive from preexisting image media ?

- We can clearly identify its technological basis in digital technology. It is an important presence in all phases of its use: creation, storage, transmission, projection.
- It specifically addresses the identified senses, that of perception of space and notably the sense of vision and the sense of movement.
- It expresses itself in the three spatial dimensions and in time, the natural environment of human perception. In this it is clearly differentiated from other media and cannot be confused with a simple technical evolution of another medium.
- It is possible to produce a space with this technology, to store it, to transmit it, to project it and to perceive it in all its dimensions.
- We can identify some specific and autonomous visual codes, and characteristic new practices and usages are developing and transforming our modes of communication.

To answer our question, the greatest difficulty lies in finding the definition of a medium. If we refer to MacLuhan [15], the contours of a medium are so large that its definition easily includes this new medium. If we refer to Stanley Gibb, the virtual worlds can be classified as hypermedia.

Another solution is to compare the conditions for the emergence of this new technology infrastructure for expression with that of another recognized medium: film. This last major technical evolution brought a new esthetic dimension dating to the beginning of the 20th century.

The chronophotograpy of Marey shows that the procedures for recording and storing movement were working well as early as 1882. Only the process of restitution, of projection, was missing. The potential for movie theaters was there but could not be exploited. This is close enough to the situation of digital spaces around 1990. All their users knew that they were dealing with a space, but the flat areas of their screens only presented 2D images of the space: the "3D" computer graphic image was an expression symptomatic of the latent state in which they found themselves at that time. Cinema as we know it was born when the movie projector was able to project a fast enough cadence of photographed instants. Visible, perceptible by our eyes, the new temporal dimension that it exposed made it into a separate medium, detaching it from photography. A specific style of creation was structured in this new temporal dimension.

Like cinema, digital spaces have had to wait for the appearance of the first technologies for spatial projection to leave the role of images. Perception of space is multimodal; its projection is, too. Now we are proposing the perception of space through movement and

interaction using stereoscopy to provide visual perception of digital space; this opens up a new dimension of artistic expression. As it becomes possible to perceive the three dimensions of digital space in time, a new medium emerges, an infrastructure for expression with the dimensions of the human perceptive space. Practices are establishing themselves, diversifying, becoming autonomous.

We can state that we are experiencing a major aesthetic event. This is an event of the same magnitude as the appearance of cinema and moving images at the start of the 19th century that has profoundly transformed our perception of the world in the course of the 20th century.

Information is no longer presented solely in the form of text, images or sounds, but also in the form of spaces. As we have seen in this memoir, spatialized information responds to modes of perception, usages, rules and a style of creation that are unique to it. The spatialization of content will bring new forms of access to information which are no doubt more intuitive. We will have to rethink its placement in space, its structure, its scenography. Its content and its message will be transformed; its perception and its comprehension will be modified. A new field of research is opening: that of the spatialization of information.

After our "society of the image", a "society of space" appears to be emerging for the next century. What will be the implications of this radical transformation for our modes of communication? The projection of the image during the 20th century has radically modified our lives, our perception of the world, our society. What will these new digital spaces bring?

The recent appearance of virtual worlds following the connection to the network of digital spaces confirms that this medium has declared its autonomy. The usages now being developed are totally new and break with those we have known up to now. We are already seeing the emergence of new forms of communication, of new artistic, social and educational practices. Groups of university scholars and librarians are working in this collaborative universe to develop access to the information, apprenticeship through experience and intuitive research. With this new infrastructure for expression, collectives of artists are exposing, creating, communicating. A new mobility is appearing, people are meeting, moving, communicating through their avatars in these new territories. This virtual mobility is already considered a valid response to the crisis of physical transportation caused by diminishing energy reserves. It is considered to be true mobility and it is ecological.

These spaces, whether they are immersive or hybrid, will profoundly transform our rapport with the world. What place will these new territories occupy in our lives? How will they be associated with physical space? How will they complement each other? What new territories will emerge from the hybridization of the physical universe and the digital one? What will be our identity, our otherness? What will be the relationship of our avatars to ourselves, to others or to society?

These new spaces, this new medium with the dimensions of our vital space and our sensibility, will deeply transform our perception of reality. Will we know how to differentiate real and virtual? Should we be afraid of the loss of reference points? Are we just before a great leap into the unknown or a logical step in a long process in which humanity has been engaged for millennia? We already approach reality through mediation, that of our senses and our technologies of communication. Speaking, writing, images and information technology have initiated this process by profoundly transforming our perception of the world and its hypothetical original reality.

All this leads us to think that, by perceiving digital spaces, we are entering into a new era of communication. The era of communication by space will follow the "society of the image" of the 20th century. These new hybrid territories will reunite physical and digital spaces within the same perception.

[1] Guy A. Orban Vision stéréoscopique et structure tri-dimensionnelle des objets conférence au collège de France. 2007.

[2] Alain BERTHOZ, Le sens du mouvement. Ed. Odile Jacob (1998).

[3] Henri Poincaré La science et l'hypothèse. Paris Flamarion. (1932)

[4] Paris en 3D, de la stéréoscopie à la réalité virtuelle, 1850-2000, (cat. exp.), Paris, Paris Musées/ Booth-Clibborn Ed., 2000.

[5] Paul Virilio La Bombe informatique, essai sur les conséquences du développement de l'informatique Edition Galilée, 1998

[6] Edmond Couchot et Norbert Hilaire L'art numérique". Champs- Flammarion, Paris, 2003.

[7] Three Dimensional Images in the Air - Visualization of "real 3D images" using laser plasma -. AIST press release of February 7, 2006 www.aist.go.jp/aist_e/latest_research/2006/20060210/20060210.html

[8] Sergueï Eisenstein, " Le cinéma en relief ", in Le mouvement de l'art, Paris, Cerf, 1986.) [8]

[9] Lucas, Cameron show off 3D film conversion technology. By Associated Press. Friday, March 18, 2005 - LAS VEGAS (AP).

[10] The Amazing Adventures of Spider-Man, Attraction Ride relief 70 mm, Kleiser-Walczak For Universal Studios. 1999.

[11] T2 3-D (Terminator 2) : Spectacle Live et Multi-écran Stéréo, James Cameron, Digital Domaine For Universal Studios. 1996

[12] Elle, Lui, installations en réalité virtuelle. Catherine Ikam et Louis Fléri,1992.

[13] Osmose, installation immersive 3D relief, Char Davies, 1995.

[14] Wayne Piekarski and Bruce Thomas, ARQuake: The Outdoor Augmented Reality Gaming System, Communications of the ACM,2002 Vol 45. No 1, pp 36-38

[15] Marshall McLuhan, Pour comprendre les médias, Ed. Seuil, coll. Points, 1968, 404 p.

Papers base on the doctoral thesis Defended 12 December 2008 by François Garnier at the Ecole Nationale Supérieure des Arts Décoratif "Spatial projection and three-dimensional digital spaces. Aesthetic and technical study of stereoscopic perception in virtual reality. " University Paris VIII. UFR Aesthetics, Science and Technologies of Arts, Digital Images Option, Jury: Marie-Héléne Tramus, president, director of l'UFR ARTS, professor of universities at the University Paris 8, Hervé Huitric, thesis director, professor of universities at the University Paris 8 , Guy Chapouillé, thesis reporter, professor of universities at the University of Toulouse, Alain Derobe, chief operator, stereograph, president d'UP3D, Union of Professionals of 3D Vision

Text translated from French by Richard Foster and Geoff Levner