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Two key factors in the history of communicating immersive environments: mix of reality vs. cognitive realism¹

Marcin Sobieszczanski

Before considering the origin of historic immersive devices which were designed from the outset as multimodal we must clear up an epistemological ambiguity, which is crucial to our subject.

The history of immersive environments was strikingly presented in 2010 by van Krevelen and Poelman, particularly as a continuation of the work undertaken in the early 2000s by Tamura². Here we find the main prototypes as well as their technical progression articulated in terms of placement within the famous theoretical continuum "Reality / Virtuality", thus postulating a continuum of hybrid reality as invented in the 1990s by Milgram from the Department of Industrial Engineering University of Toronto and Kishino from ATR Communication Systems Research Laboratories in Kyoto³. But upstream of the uses that are made of this in the communication and presentation of contents, uses which engage precisely this game of the real and the virtual overlapping and inter-changing their positions and their ontological status, we will see here, overarching the history of technology, a specific history of the scientific bases of the progress in question. If the philosophical background exploited by Milgram and Kishino intentionally involves the issues surrounding the ontological status of the objects affecting communication of which the analysed prototypes are instruments, the scientific basis that led to the first technological achievements, especially with Sutherland, exploits the resources of the philosophy of appearance, of perception and of the gnostic status of the percepts that different devices provide. Indeed, the method of 3D "look oriented" (see-through) refers to the long tradition of the philosophy of perception initiated by Brentano, Stumpf and Husserl, in the case of the last of these firstly in *Thing and Space: Lectures of 1907* taken up by the psychologists of form⁴ and systematized in the cognitive approach used by cognitive scientists of the environment, such as James J. Gibson⁵, and of vision, such as David Marr⁶.

Moreover, it is not, curiously, the continuation of the theoretical hybridization Real / Virtual which led to the most convincing prototypes. The theoretical continuum that establishes this hybridization is based itself on the *qualitative* ideal of immersion. In fact, between 1962 and 1967 epistemological and technological separation between two approaches in the design of simulators of environmental perception is prevalent.

On the one hand, there is a continuation of the long line of analogue machines, both electronic and magnetic, aiming to produce the most complete and the most accurate perceptual substrate as possible, in the field of cinema and education by simulacrum, in military engineering and industrial traineeship. The patent of Morton L. Heilig⁷ submitted in the USA on August 28, 1962⁸ is one of the best achievements of this method. It involves the simulation of 3D vision expanded to the peripheries of the field of view, ambient stereo sound, tactile and epidermal vibrations, the olfactory dispenser and a device for the selection of film extracts recorded according to the line-of-sight!⁹

¹ Fragment of the book Sobieszczanski, M., 2015, [Les médias immersifs informatisés. Raisons cognitives de la ré-analogisation](#), Bern, Peter Lang

² Tamura, H., 2002, « Steady steps and giant leap toward practical mixed reality systems and applications », in VAR'02: Proc. Int'l Status Conf, On Virtual and Augmented Reality, Leipzig, nov. 2002 ; Krevelen, (van), D., W., F., Poelman, R., 2010, « A Survey of Augmented Reality Technologies, Applications and Limitations », The International Journal of Virtual Reality, 2010, 9(2), 1-20

³ Milgram, P., Kishino, F., 1994, « A taxonomy of mixed reality visual displays », IEICE Transactions on Information Systems, vol.E77-D, 12, dec. 1994

⁴ Ierna, C., 2009, « Husserl et Stumpf sur la Gestalt et la fusion », Philosophiques, 36(2), aut. 2009, Société de philosophie du Québec, 489-510

⁵ Gibson, J. J., 1979, *The Ecological Approach to Visual Perception*, Houghton Mifflin, Boston

⁶ Marr, D., 1982 (posthume), *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*, W. H. Freeman & Company, New York

⁷ Heilig, M., L., 1955, « El Cine del Futuro: The Cinema of the Future », *Espacios*, 23-24, reprinted in *Presence: Teleoperators and Virtual Environments*, 1(3), 279-294. Sur Heilig cf. Rheingold, H., 1992, *Virtual Reality: The Revolutionary Technology of Computer-Generated Artificial Worlds - and How It Promises to Transform Society*, Simon & Schuster

⁸ Sensorama simulator, Patent US 3050870 A

⁹ Cf. theory of the « personal ambient displays » de Craig Alexander Wisneski, Wisneski, C., A., 1999, *The Design of Personal Ambient Displays*, thesis, MIT. The movie viewing device is reminiscent of the « GIF collections » invented for interactive CDROM support by Jean-Louis Boissier, Boissier, J.-L., 2000, *Moments de Jean-Jacques Rousseau. Confessions et Rêveries*, Collection CD-ROM, Gallimard

On the other hand, the idea of a "dispatcher" of multimodal sensations implemented on a digital computing machine germinates. Later on this will also include also some analogue mechanisms¹⁰, as well as the functional modelling of "sensory-motor coupling" or the "retroactive subjugation" of the sensitive substrate and postural gestures and attitudes. In this second kind of approach, advantage is taken not only of that which predestines the computing machine to perform its role of being a simulator of the nervous system of animals and humans, but also there is established the *critique* of the ergonomics of cultural behaviours, both creative and receptive, on the basis of the design of the perceptual substrate as *affordances* (Gibson¹¹) and on the basis of perception as *enaction* (Maturana, Varela¹²). The functional complementarity of both concepts is revealed in the simulation of perceptual mechanisms realized in the 1960s, but the effectiveness of cognitive realism they infer becomes evident only in the late 1990s. One notices, besides, that *authenticity of the sensitive substrate* and *cognitive realism* are dependent, in this story of American technologies, on the same military and civilian sponsors, whose financial support led, in the same period, that is the second half of the 1960s, to the invention of the premises and the social uses of *digital networks*!¹³ The pioneer in the 3D digital interface, Ivan Sutherland, was indeed recruited at the age of 27 years by Joseph Licklider, a former participant in the SAGE project (interconnection of military computers using the telephone network), who in 1962 was in charge of the ARPA's Control-Command Office¹⁴. This conclusion of simultaneity of 3D and Internet is very significant and could be the subject of thorough consideration...

Van Krevelen and Poelman write:

« The first AR prototypes (Fig. 3), created by computer graphics pioneer Ivan Sutherland and his students at Harvard University and the University of Utah, appeared in the 1960s and used a see-through to present 3D graphics [151]. A small group of researchers at U.S. Air Force's Armstrong Laboratory, the NASA Ames Research Center, the Massachusetts Institute of Technology, and the University of North Carolina at Chapel Hill continued research during the 1970s and 1980s. »¹⁵

Sutherland himself speaks of the contracts, to which today for the most part unrestricted access, and which necessarily came from the same pool of sponsors who financed Paul Baran:

« The work reported in this paper was performed at Harvard University, supported in part by the Advanced Research Projects Agency (ARPA) of the Department of Defense under contract SD 265, in part by the Office of Naval Research under contract ONR 1866 (16), and in part by a long standing agreement between Bell Telephone Laboratories and the Harvard Computation Laboratory. The early work at the NUT Lincoln Laboratory was also supported by ARPA. »¹⁶

But apart from these economic and political contingencies, it is the substance of the future discussion on the enactive approach which is being prepared in both technological affiliations of 3D that Sutherland proclaims:

« The fundamental idea behind the three-dimensional display is to present the user with a perspective image which changes as he moves. The retinal image of the real objects which we see is, after all, only two-dimensional. Thus if we can place suitable two-dimensional images on the observer's retinas, we can create the illusion that he is seeing a three-dimensional object. Although stereo presentation is important to the three-dimensional illusion, it is less important than the change that takes place in the image when the observer moves his head. The image presented by the three-dimensional display must change in exactly the way that the image of a real object would change for similar motions of the user's head. Psychologists have long known that moving perspective images appear strikingly three-dimensional even without stereo presentation; the three-dimensional display described in this paper depends heavily on this "kinetic depth effect". (1) »

¹⁰ Cf. *supra*.

¹¹ Gibson, J., J., 1966, *The senses Considered as Perceptual Systems*, Houghton Mifflin, Boston ; Gibson, J., J., 1977, « The Theory of Affordances », in Shaw, R., & Bransford, J., (eds.), *Perceiving, Acting, and Knowing*, Wiley, New York, 67-82

¹² Maturana, H., R., Varela, F., J., 1973, « Autopoiesis and Cognition: The Realization of the Living », *Boston Studies in the Philosophy of Science*, vol.42, 30 Nov. 1979

¹³ The history of this period of US research is given in Rheingold, H., 1985, *Tools for Thought: The History and Future of Mind-expanding Technology*, Simon & Schuster

¹⁴ Gaston-Breton, T., 2012, « Arpanet, le monde en réseau », série « Saga, ces grands projets qui ont changé nos vies », *Les Échos*, 3-4 aout 2012

¹⁵ Krevelen, (van), D., W., F., Poelman, R., *op. cit.*

¹⁶ Sutherland, I., E., 1965, « The Ultimate Display », in *Proceedings of IFIPS Congress*, vol.2, May 1965, New York, 506-508 ; Sutherland, I., E., 1968, « A head-mounted three-dimensional display », *Proceeding AFIPS '68 (Fall, part I) Proceedings of the dec. 9-11 1968, fall joint computer conference, part I*, ACM, New York, 757-764

« As the observer moves his head, his point of view moves and rotates with respect to the room coordinate system. In order to convert from room coordinates to a coordinate system based on his point of view, a translation and a rotation are required. A computer uses the measured head position information to compute the elements of a rotation and translation matrix appropriate to each particular viewing position. »

« I did some preliminary three-dimensional display experiments during late 1966 and early 1967 at the MIT Lincoln Laboratory. »

Sutherland clearly distinguishes between the brain generating the 3D effect from the optical stereoscopic substrate and the production of a depth effect by head and eye movements that create on the retina a chain of apparent contours on the observed object (Kinetic Depth Effect). The placement of the artifact at that location gives the engineer a double benefit. On the one hand this method provides, as does the stereoscopic method, "mental 3D", on the other hand it actively engages the subject of the test at the level of cognitively valuable motricity, which in return delivers the advantage of engagement in the image / motor causality function, motor function in its widest sense. As seen, the theoretical bases of the "effector picture" were laid in the 1960s and now it is the current and future practices, prepared by the ludic behaviours phase, which profit.

Indeed, the majority of 3D movies since the early 2000s have been produced by blending the two processes: the shots of the bi-objective camera that provide the three-dimensional image, that is to say the low 3D depth which nevertheless creates a good optical illusion and provides the subject with a certain aesthetic satisfaction, and "real 3D" that preserves the distances of the points independently of the rotations and this in accordance with the laws of perspective in relation to a point of view, as constructed by the geometric method or generated from multiple spatially distributed photographs or video using travelling. However, despite the creation, in both cases, of similar spatial percepts, the two processes do not lead either to the same uses nor the same aesthetic values. If the three-dimensional image invites a kind of contemplation of the objects' surfaces which, thanks to the percept of asperities, effectively suggest their adjacent space shown in its depth, "real 3D", whether it is fastidiously manufactured or automatically generated, puts the motor sphere to work and leads to manipulative applications, such as video games, or to the cinematic aesthetic where the mental simulation of the actors' motor skills or of the spectator-potential-participants' own motor skills, is strongly engaged. For this reason the technology intended to prolong this effect is based on the animation of "full 3D" mock-ups, by the motion capture process in which the rendering of postural and facial veracity aims directly to amplify the *affordances* of objects / 3D agents related to their semio-creative motor skills.

This means that this 3D is responsible as much for the current transformations of cinema as for new participatory uses of 3D, which are breaking with the classic cinematic model.

To go beyond the purely optical approach in the construction of multimodal simulation devices, Sutherland evokes the work on "Kinetic Depth Effect" (KDE) through the intermediary of the American psychologist Bert F. Green¹⁷ who was then working at the MIT Lincoln Laboratory, the unit dedicated since its creation in 1951 to the design of an air defence system, a continuation of the efforts initiated during World War II by the MIT Radiation Laboratory in the field of pattern recognition through the information that these forms "print" in different electromagnetic waves. Bert F. Green was also a colleague, in 1962, of Paul Baran at RAND Corporation, and was later a professor at Johns Hopkins University. Green shows that the origin of the concept of KDE is to be found in the work of Hans Wallach, a former assistant of the director of the Berliner Schule für experimentelle Psychologie Wolfgang Köhler, the cofounder with Max Wertheimer and Kurt Koffka of Gestalt theory, who immigrated to the United States in 1934. Hans Wallach and his colleagues, Donald N. O'Connell and the famous Ulric Neisser¹⁸, refer in turn to the article written in 1950 by James J. Gibson¹⁹. Thus Sutherland is pointed in the direction of the theoretical basics of manipulable 3D:

- the virtual camera determining the viewpoint in the visual scene and
- the directional lighting of surfaces.

These two mechanisms will be "motorized" in all the geometric construction software of upcoming 3D. What is peculiar to all this plethora of works is their shared filiation: the study of forms in Germany from the early 20th century, the emigration of German scientists to the USA in the 1930s, US military

¹⁷ Green, B., F., 1961, « Figure coherence in the kinetic depth effect », *Journal of Experimental Psychology*, 62(3), sep. 1961, 272-282

¹⁸ Apart from its debate on cognitive realism versus laboratory cognition, Neisser came to the fore during the 1990s in the fight against cognitive racism visible in the reference book of Richard Herrnstein and Charles Murray « *The Bell Curve* ».

¹⁹ Gibson, J., J., 1950, op. cit.

research launched in the 1940s in the field of information and its treatment, and finally the taking into account of the environment of the perceiving subject, i.e. the development of the psychology of cognitive and environmental realism instead of the old laboratory-based psychology. If this great shift is characterized by its fundamental concept "Subject / Environment", we still note its coincidence, through the shared financial sources and the coexistence within the same scientific institutions, with the movement which leads to the engineering of digital communication networks working on the basis of the fundamental concept "Subject / Subject / Environment".